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The development of an acceptable culinary product using crocodile meat

Nerike Uys

Dissertation
M. Consumer Science: Food Management

Supervisor: Prof. G.E. du Rand

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By

Nerike Uys

Dissertation submitted in fulfilment of the requirements for the degree Masters in Consumer Science (Food Management)

in the

Faculty of Natural and Agricultural Sciences
Department of Consumer and Food Sciences

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Supervisor: Prof. G.E. du Rand

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Die ontwikkeling van 'n aanvaarbare kulinêre kosproduk met die gebruik van krokodilvleis

Deur

Nerike Uys

Verhandeling ingedien ter voldoening van die vereistes vir die graad Magister in Verbruikerswetenskap (Voedselbestuur)

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Studieleier: Prof. G.E. du Rand

Februarie 2019

DECLARATION

I, Nerike Uys, hereby declare that the dissertation for the Master's in Consumer and Food Sciences degree at the University of Pretoria, hereby submitted by me, has not previously been submitted for a degree at this or any other university and that it is my own work in design and execution and that all reference material contained herein has been duly acknowledged.

Nerike Uys

January 2019

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I registered for this post-graduate course because I wanted to do something that challenges me intellectually. By the end of writing this dissertation, I can confidently say that I got so much more than just that. It became a rollercoaster journey that challenged me emotionally and intellectually. I made friends and learned from so many people in various ways. Although there were tough times, it was worth it. I would like to thank the following people who made my journey much easier:

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- The rest of my family and friends who always showed interest in my studies and supported me all the way through in various ways.
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- **My Heavenly Father, who gave me the opportunity to start this task and the strength to complete it. He carried me throughout my journey and gave me hope and drive to succeed.**

DEDICATION

This dissertation is dedicated

to my husband and parents,

without whom I would not have succeeded.

Your support and love

means the world to me.

ABSTRACT

Title: **The development of an acceptable culinary product using crocodile meat**

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Supervisor: Prof. G.E. du Rand

Department: Consumer and Food Sciences

Degree: Master's in Consumer Science: Food Management

The increase in world population growth and an increasing middle class challenge the food industry to explore alternative sources of animal protein. This study examined the potential acceptance of crocodile meat as an alternative animal protein source. The crocodile industry globally has mainly consisted of crocodile leather/skin trade for the fashion industry, while crocodile meat has been considered a by-product. Little is known about the sensory perceptions and how the properties of the product contribute to its acceptance. Consumers' sensory perceptions of innovative crocodile meat products (sous-vide crocodile, crumbed crocodile strips, curry filled dumplings and smoked kebabs) were studied. Affective sensory evaluations were performed and consumers (n=87) assessed the food products' sensory attributes means of a 9-point hedonic scale. This was done to explore the food's identity and contribution to sensory perceptions and experience. CATA was conducted using 20 sensory characteristics. Insights into how the product characteristics influence sensory liking and acceptance for regular consumption were gained. CATA results showed a value of $p < 0.05$, regarding differences in the sensory profiles between the crocodile meat products. ANOVA and LS Means results showed that crumbed strips were most preferred for all sensory attributes. The overall liking and liking of texture of the curried dumplings had the lowest score. The sous-vide product gained the lowest results for appearance, flavour and aroma. Factor analysis illustrated expected sensory characteristics corresponded with the most preferred products' sensory characteristics. Promotion of crocodile meat as an alternative protein was positively concluded. Familiar preparation methods help to increase acceptability. Crumbing products could enhance crocodile meat. It is recommended that further research should be done.

Keywords: Crocodile meat, Consumer acceptance, Food innovation, Novel foods

OPSOMMING

Titel: **Die ontwikkeling van ‘n aanvaarbare kulinêre kosproduk met die gebruik van krokodilvleis**

Outeur: Nerike Uys

Studieleier: Prof. G.E. du Rand

Departement: Verbruikers- en Voedselwetenskappe

Graad: Magister in Verbruikerswetenskap: Voedselbestuur

Die toename in wêreldbevolking en 'n toenemende middelklas daag die voedselbedryf uit om alternatiewe bronne van dierlike proteïene te ondersoek. Hierdie studie het die potensiële aanvaarding van krokodilvleis as 'n alternatiewe dierlike proteïenbron ondersoek. Die krokodilbedryf wêreldwyd het hoofsaaklik bestaan uit krokodilleer- / velhandel vir die modebedryf, terwyl krokodilvleis as 'n neweproduk beskou is. Min is bekend oor die sensoriese persepsies en hoe die eienskappe van die produk bydra tot die aanvaarding daarvan. Verbruikers se sensoriese persepsies van innoverende krokodil vleisprodukte (sous-vide krokodil, gekrummelde krokodilrepies, kerrie gevulde kluitjies en gerookte kebabs) is bestudeer. Affektiewe sensoriese evaluerings is uitgevoer en verbruikers (n = 87) het die voedselprodukte se sensoriese eienskappe van 'n 9-punts hedoniese skaal geassesseer. Dit is gedoen om die voedsel se identiteit en bydrae tot sensoriese persepsies en ondervinding te ondersoek. CATA is uitgevoer met behulp van 20 sensoriese eienskappe. Insig in hoe die produkkenmerke sintuiglike smaak en aanvaarding vir gereelde verbruik beïnvloed, is voorsien deur verskillende innoverende voedselprodukte te evalueer. CATA resultate het 'n waarde van p <0,05 getoon, rakende verskille in die sensoriese profiele tussen die krokodil vleisprodukte. ANOVA en KK Gemiddelde se resultate het getoon dat die gekrummelde repies die meeste voorkeur geniet vir alle sensoriese eienskappe. Die algehele smaak en algehele aanvaarbaarheid van tekstuur van die gekerriede kluitjies het die laagste telling gehad. Die sous-vide-produk het die laagste resultate verkry vir voorkoms, geur en aroma. Faktor analise het bepaal dat verwagte sensoriese eienskappe ooreenstem met die sintuiglike eienskappe van die mees voorgekeurde produkte. ‘n Positiewe konklusie is gemaak dat krokodilvleis as 'n alternatiewe proteïenbron aanvaar sal word. Bekende voorbereidingsmetodes help om aanvaarbaarheid te verhoog. Gekrummelde produkte kan krokodilvleis verbeter. Daar word aanbeveel dat verdere navorsing gedoen word.

Sleutelwoorde: Krokodilvleis; Verbruikersaanvaarding; Voedselinnovasie; Nuwe kosprodukte

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CHAPTER 1: THE STUDY IN PERSPECTIVE

This chapter provides the background and justification for the research conducted. It introduces the problem statement and concepts applicable to this dissertation.

1.1 INTRODUCTION

In the past few years, most modern food producers have realised that the world will be faced with challenges of feeding the ever increasing global human population, which is projected to be 10.5 billion by 2050 and will be consuming two thirds more animal protein than today (United Nations, 2017).

One strategy that has been employed to increase meat protein output is to promote the harvesting of species that are indigenously abundant (Hoffman & Cawthorn, 2012b; Jori, Lopez-Béjar & Houben, 1998; Jori, Mensah & Adjanohoun, 1995). The trade of exotic meats is increasing in the global market and could make a big contribution to feeding the ever increasing world population. Exotic meats are generally healthier, with lower cholesterol, fat and sodium levels and are often organic, all of which is becoming more important to the modern consumer (Maheswarappa & Kiran, 2014).

A large number of crocodile species have served as protein sources for human populations across the globe. (Klemens & Thorbjarnarson, 1995). The crocodile industry across the world has mainly consisted of crocodile leather/skin trade for the fashion industry and crocodile meat has been considered a by-product in most countries. The meat produced usually ends up 'recycled' as unprocessed crocodile feed on the farms (Hoffman, Fisher & Sales, 2000). As the industry grew, farmers realised that production costs per unit of skin became very high and measures had to be taken to boost profitability. Successful research has also been done on crocodile meat in Australia and has resulted in delivering healthier novelty food products, which are sustainable and could contribute to the increasing demand for meat (Naveena, Muthukumar, Kulkarni, Praveen Kumar, Usha Rani & Kiran, 2015; Waitt, 2014).

When interpreting the use of exotic meats, the concept of food neophobia also comes into play. This concept is defined as a rejection towards new or unfamiliar foods (Moreau, Lehmann & Markman, 2001). Previous studies show that most people prefer foods that they are used to and reject those that they do not know. It could mean that the consumer dislikes sensory characteristics, believing that there will be negative consequences when the food is consumed, and that the food product is inedible and may be offensive (Fallon & Rozin, 1983; Jansen van Rensburg, 2001; Radder, 2001). Sensory

characteristics of a food product are one of the strongest influences on the acceptability of a food product.

The way in which people classify animals has a remarkable impact on their acceptability for consumption. Over the years acceptability has been referred to as *palatability*, *hedonic tone*, *liking/disliking*, *food preference* and *pleasantness/unpleasantness* (Cardello, 1996:1-2). It is a perceptual construct, which is influenced by learning, memory, context and expectations. A set of sensory information is formed from the experience of inherent physico-chemical characteristics of the food product. These include previous experience, context, culture, expectations and the consumers' physiological status. An overall liking and acceptance is formed from all of these influences (Cardello, 1996:2).

Within the culinary world, the ever-changing concept of innovation is dynamic and assessing its performance is a challenge. Innovation contributes to trends and consumer tastes. Consumer demands in the field of food production have also changed considerably (Mollet & Rowland, 2002).

For new culinary products to be developed, the synthesis of strategy, marketing, culinary techniques and food science and technology are required. The whole process is inter-functional. To ensure success, the innovation needs to consider customer needs, market structure, organisational capabilities and the innovator's competencies (Hardy & Dougherty, 1997). In food product development, quality guidance is the belief that food products should be developed and improved to reflect consumers' desires and tastes for which understanding and measurement of the consumer's quality perception process is a prerequisite (Steenkamp, 1990). It is important to be aware of the expectancies of the physical product characteristics that contribute most to the consumers' perception of a high level of quality. Food product development is a repetitive, integrative and ambiguous process within the food service industry and consists of culinary innovation formulation, innovation implementation, evaluation and control and innovation introduction.

The sensory evaluation is an imperative part of, and plays many roles in, product development. It can be defined as "a scientific discipline used to evoke, measure, analyse and interpret reactions to those characteristics of foods and materials, as they are perceived by the senses of sight, smell, taste, touch and hearing" (Stone, Sidel, Oliver, Woolsey & Singleton, 2004). In the process of sensory perception, all attributes overlap and support the experience of the others (Tuorila, 2007:34). It is nearly impossible, without training, to evaluate each attribute independently (Meilgaard, Civille & Carr, 2007b:256). The multimodality of sensory attributes emphasises the importance of the initial and the entire impression of a product. To make a product acceptable, the initial impression of a product

creates the expectation that has to either be confirmed or disconfirmed in a successful, positive manner (Tuorila, 2007:34).

From this information an opportunity arises to take advantage of the existing market and developing it in South Africa. If such an exotic product can be developed into a form which is acceptable to consumers, it could deliver a new culinary product to the market of consumers that are increasingly hungry for new innovative products.

1.2 PROBLEM STATEMENT

As stated by the United Nations Department of Economic and Social Affairs (2017), the ever increasing global population is putting a large amount of stress on the food resources of every country. Food producers are, however, aware of the challenges faced in feeding this increasing population and have been exploring and applying biotechnologies such as genetic modification to improve the yields of crops that are utilised for feeding both humans and livestock (Aiking, 2011). The problem with this is that the consumer is progressively becoming aware of the production systems of the foods they eat. They want food produced, stored and processed without the addition of synthetically produced fertilisers and chemicals (Burch, Lyons & Lawrence, 2001). Desertification and global warming are decreasing the available land for livestock very rapidly. This phenomenon has prompted animal scientists to consider protein production of certain indigenous species that have adapted over time to survive extreme conditions.

Radder and Le Roux (2005) reviewed the factors that influence food choice in relation to game meat (venison) amongst South Africans and noted that it is a highly complex process which takes into account issues such as sensory appeal, familiarity and habit, social interactions, monetary cost, availability, psychographics and various marketing related factors. There is also a perception amongst non-regular consumers of exotic meat that experience and skills are required when cooking game meat so as to prevent culinary dissatisfaction and the resultant negative influence on self-esteem. Due to the novelty of some exotic meats, very little information is available on their sensory characteristics. This is something to be explored. As there is a high percent of wastage of crocodile meat, due to only producing leather from a crocodile, production costs need to be reduced. Faced with all of these problems, it is important to develop acceptable culinary products from sustainable resources, not only for enjoyment by the consumer, but the continuous existence of them.

1.3 JUSTIFICATION OF RESEARCH

As part of a larger project, the Department of Consumer and Food Sciences has been handed an opportunity to develop a culinary product that could be introduced to the market. This will help

position a sustainable meat source in South Africa. There is an increased popularity in and demand for game meat and unconventional food products by the modern consumer (Hoffman, Crafford, Muller & Schutte, 2003). The trend of consumers looking for a healthier alternative to red meat is ever growing. Research has shown that game meat, and in particular crocodile meat, is high in protein and lower in fat and sodium compared to conventional meat types.

It is expected that the market for exotic food products will increase even more as young consumers become more educated in the culinary world. Their willingness to try new adventurous foods is also expected to increase. The culinary world is always looking for new additions to the industry, especially following trends, which this project will definitely do. To develop an acceptable culinary product from unconventional meat sources, will not only contribute to the health of consumers, but also help the country's decreasing livestock production to be supplemented with a sustainable alternative.
Most importantly, this study would contribute to literature in terms of sensory characteristics of crocodile meat, which has not been determined yet with *Crocodylus Niloticus,* the only crocodile species that inhabits South Africa. Previous research has determined the quality and preferred characteristics of conventional meat types such as beef, poultry and lamb. This study would indicate how well crocodile meat characteristics compare to these meat types. Findings would also give an indication of flavour pairings and cooking methods that could be applied to crocodile meat, opening the opportunity for further research after this study.

This study will not only deliver novel products, but also evaluate them with novel sensory research techniques such as Check-All-That-Apply (defined in Chapter 3). CATA is a technique that has not been used commonly in South African research yet and therefore this study will contribute to examples of how it could be applied. It allows for rapid sensory profiling of the products and has been selected as it is easier for consumers to use, limiting the time it takes to conduct the sensory evaluation process.
Final year undergraduate students of the Department of Consumer Science at the University of Pretoria will develop the products as part of the completion of their degree. Therefore, it will contribute to their training/education and give them skills to use for future endeavours.

Using other parts of the crocodile than the skin, is beneficial to crocodile farmers. A larger part of their product can be used, meaning less waste and more income. Since hygiene standards are already very high in abattoirs and crocodiles are only fed pellets, just an extra process of portioning the carcass has to be implemented. These can then be sold to food retailers or manufacturers.

The food industry will also benefit from the study. Retailers are always looking for novel products that will give them a competitive edge. The findings of this study will show if consumers are willing to try novel products such as crocodile meat and which way it should be prepared to make the consumers more interested in buying it. Should a product be successful on the retail market, chefs and restaurateurs could find that crocodile meat dishes can become more popular on their menus. This would give them a competitive edge, since continuous innovation is always important for a successful restaurant, especially in fine dining. These novel products can be included in the same range as venison, ostrich or other unconventional meat products. If the products become popular in retail stores, the consumers might even be more inclined to order it from a restaurant menu, thereby also benefiting the restaurants that already offer crocodile meat dishes.

For these reasons, it is an ideal opportunity to try to introduce an unconventional product such as crocodile meat.

1.4 RESEARCH AIM AND OBJECTIVES

1.4.1 Aim of the study

The overall aim is to determine consumer perception of crocodile meat and to develop suitable, acceptable culinary products for the mainstream South African consumer. The following is the study's main and sub-objectives:

1.4.2 Research objectives

- Objective 1: To develop, test and standardise culinary products using crocodile meat applying the culinary innovation process.

  Sub-objective 1.1: To develop culinary products using crocodile meat as main ingredient.

  Sub-objective 1.2: To determine sensory attributes of the products during the culinary innovation process.
- Objective 2: To explore, describe and understand consumers' perception of exotic meat products, specifically referring to crocodile meat.
- Objective 3: To determine the consumers' sensory evaluation and hedonic reaction toward the new culinary meat products, which will determine acceptability.

  Sub-objective 3.1: To determine the liking of sensory attributes of the culinary products.

  Sub-objective 3.2: To determine the consumers' experience of the culinary meat products.

  Sub-objective 3.3: To determine the relationship between the consumers' demographic characteristics and their acceptability of crocodile meat.

1.5 STUDY AREA

The study was conducted in the geographical area of the Gauteng Province, South Africa. Due to the sensory evaluation that had to be done, all participants had to be in close proximity to the University of Pretoria and its facilities at which the food was prepared. Only participants that resided in this geographical area were allowed to participate. This municipal province has also been considered to be a good representation of the targeted consumers that might be willing to purchase unconventional products such as crocodile meat. The supplier of the crocodile meat, Thaba Kwena Crocodile Farm, is however located in Limpopo.

1.6 RESEARCH DESIGN AND METHODOLOGY

The study is quantitative in nature. It comprises predetermined processes of validating relationships among objectively measured variables, and implementing standardised procedures to collect numerical data, a procedure Leedy and Omrod (2005:94) recommends. The study has two research approaches, exploratory and descriptive. According to Babbie (2008), exploratory research is done to study the field of knowledge that is available to gain new insights when formulating research objectives. The general motivation is to develop methods that can be repeated in further research on the subject, and also to test the feasibility of conducting current and other even larger studies (Babbie, 2016:92). In this study, the exploratory approach is supported by an extensive literature review that needed to be conducted as little information about the sensory properties of crocodile meat is available. This situation is developed and illustrated in the third chapter. As a key factor in this investigation, the sensory profile of crocodile meat was determined through the results of administering sensory analysis tests that a trained sensory panel undertook, as explained in section 4.6.

Descriptive research entails making observations to analyse and the ideas Walliman (2011:12) documented for attempting to understand consumer behaviour were adapted for this study. The consumers' perception and experience of crocodile meat products will be discussed in section 4.8. Products have been developed to finally identify one product that would be most viable to introduce to the South African market. An experimental design was adopted as a useful research strategy. The framework shown in a study, as in Figure 4.1, must include independent and dependent variables, pre- and post-testing and experimental and control groups (Babbie & Mouton, 2001:209). The independent variables were the crocodile eye fillet, the ingredients and cooking methods used in the culinary innovation process. The dependent variables were all sensory variables and consumer

perceptions that were measured. In this study the sensory attributes are flavour, aroma, appearance and texture and consumer perceptions expressed expectation, experience and acceptability.

1.7 DATA ANALYSIS

Descriptive analysis. From the sensory evaluation data, means were calculated for each sensory characteristic. A graphical presentation in the form of star diagrams was used to see where improvement of the product was needed. The data was organised into various demographic groups. The groups included gender, age, education level and population group. The total number of subjects sampled (N) regarding each demographic group was determined. Means and standard deviations were calculated from the consumers' psychographic information. Sensory appropriateness ratings were also statistically analysed to calculate means and standard deviations. With the mean values of each sensory characteristic the data could be ranked from the most appropriate to least appropriate. This indicated which sensory characteristics would be most desired in a crocodile meat product. These analyses provided better-organised data from which inferential statistics could be obtained, such as ANOVA and Factor analysis, which are discussed below.

Inferential analysis. Analysis of variance (ANOVA), at $p \leq 0.05$, and t-tests were used to determine the effects of independent variables on the dependent variables. The independent variables in this analysis were the demographics, sensory attributes and product sensory characteristics. These differences would indicate if marketing should be focused on certain demographic groups. With regard to the expected sensory characteristics, ANOVA tests were done ($p \leq 0.05$) to determine if significant differences existed between the appropriateness thereof. It is hypothesized that highly significant differences exist since some would be considered very appropriate to crocodile meat and some not appropriate at all. The researcher also aimed to find possible underlying relationships between these characteristics. This was done by means of exploratory factor analysis. ANOVA was performed to determine the differences of attribute liking (overall, aroma, appearance, flavour and texture) between the products. These results indicated where each products' strengths lay and which of their attributes were least liked, compared to the other products.

CATA data analysis. This was presented in a frequency table to show the occurrence of each sensory characteristic checked by the consumers for each product, after tasting the samples. This allowed for sensory profiling of the products. The frequency counts indicated which product received the most checks for the least appropriate characteristics and which were associated with the most appropriate characteristics. From the frequency counts, Cochran's Q test was performed to test if there were significant differences ($p \leq 0.001$) between products with respect to its sensory characteristics. These were the defining features of the respective products.

Correspondence analysis. From the results of the frequency table of the CATA data, correspondence analysis (CA) was performed using the Chi square-distance. From this analysis, a plot mapping the position of the products, with the characteristics, was obtained. It is important to note that CA gives a relative indication of results and therefore conclusions should be supported by also studying the raw data. The results from this analysis would indicate the sensory profile of each product, and it would be possible to see which of the most appropriate and which of the least appropriate characteristics are associated with each product.

A statistician assisted the researcher with data analysis and results were represented using XLSTAT (2016) and SAS 9.4.

1.8 PRESENTATION AND STRUCTURE OF THE RESEARCH

Table 1.1: Structure of chapters in this dissertation

CHAPTER DESCRIPTIONS
Chapter 1: **The study in perspective** This chapter provides the background of the project and introduces the main theme of the research study in terms of the research problem. It also briefly explains the methodology, theoretical perspective and presents the overall structure of the study.
Chapter 2: **Literature review** In this chapter, concepts that are important in the study is introduced. It gives background information on which the study is based as well as a review of new methods used in the study. The main concepts include exotic and crocodile meat, sensory perception and expectation, measures of acceptability, food neophobia and the food product development process.
Chapter 3: **Theoretical perspective, conceptual framework and research objectives** The theoretical perspective is explained and justified in this chapter. The conceptual framework and research aims and objectives are also presented and discussed.
Chapter 4: **Research design and methodology** This chapter introduces the research design and methodology. The plan on how the research was conducted, and procedures and tools were used are explained. The experimental design, data collection and analysis are presented. Products were developed according to the product development process in Phase 1. Phase 2 focused on the consumers' psychographics and their expectation and perception of crocodile meat. In Phase 3 a consumer panel was conducted to evaluate the products that have been developed. The matter of ethics, validity and reliability of the study are discussed as well.
Chapter 5: **Results and discussion** The results from the product development, determination of acceptability and sensory evaluation are introduced and an in depth discussion will follow, addressing its connection to the main aim and objectives.
Chapter 6: **Conclusion and recommendations** This chapter highlights the main findings. A conclusion and recommendations for future research are made.

1.9 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

Table 1.2: List of definitions, acronyms and abbreviations used in this study

ARC	Agricultural Research Council
UP	University of Pretoria
FAO	United Nations Food and Agriculture Organization
USDA	United States Department of Agriculture
CATA	Check-All-That-Apply
CA	Correspondence Analysis
AI1	All-in-one Test
RSA	Republic of South Africa
GP	Gauteng Province
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Exotic meat products	Also known as unconventional meat or game meat, such as crocodiles, reindeer, kangaroos, ostriches, rodents and ungulates (Hoffman & Cawthorn, 2013).
Food neophobia	Rejection towards new or unfamiliar foods (Moreau, Lehmann & Markman, 2001).
Psychographics	Refers to the characteristics that influence the consumer's response to product attributes. These include self-concept, lifestyle, interest and opinions as well as perceptions of these product attributes (Demby, 2011:13).
Lexicon	A set of words to describe the sensory characteristics of a product. It also provides definitions and references for clarification (Drake & Civille, 2003).
Trained sensory panel	A small group of sensory assessors that have received training of a specific standard for methods applied in an experiment, especially for quantitative descriptive analysis (Lawless & Heymann, 2009).
Consumer panel	A large group of specified consumers that have not been trained in the science of sensory evaluation. Affective (hedonic) tests are mainly performed to predict consumer response toward a specific product (Bi, 2015).
Perception	• "The act of becoming aware of a stimulus and its qualities based on the sensations that are caused and the interpretation of those sensations based on previous experience (Lawless & Heymann, 1998:812). • Information from memory and learning creates an expectation of the food product, from which a perception is formed (Cardello, 1996).
Expectation	• 'Sensory-based expectations' is the belief that the food product will possess certain sensory attributes, each at certain intensities (Cardello & Sawyer, 1992). • 'Hedonic expectations' is that the product will be liked/disliked to a certain degree (Cardello & Sawyer, 1992).
Sensory attributes	Attributes of a food product are perceived as, and usually in the order of appearance, aroma, texture and flavour (Meilgard, Civille & Carr, 2007:7).
Sensory characteristics	Product specifications that are measureable and are physical properties of products that are under the control of product developers (van Kleef & van Trijp, 2006:327), e.g. crispy, tender, sweet, dark colour etc.
Acceptability	"The emotional or hedonic response to a food product that can cause a pleasant/unpleasant or like/dislike response" (Cardello, 1994).
Hedonic experience	The consumer's hedonic response will result in whether he/she likes or dislikes the food product and it will therefore influence its acceptability. Hedonic experience based on sensory attributes, psychological factors, previous experience, context, culture, economic, expectations and physiological status (Cardello, 1996).

1.10 CONCLUSION

This chapter provided an introduction to all the aspects that will be discussed fully in the following chapters.

CHAPTER 2: THEORETICAL PERSPECTIVE

The theoretical perspective is explained and justified in this chapter.
It gives an overview of the main concepts of the food acceptance model and
explains how it is relevant to the research.

2.1 INTRODUCTION

This chapter outlines the theoretical framework of this research endeavour. It gives an overview of all the concepts included in the selected food choice process model and emphasises the applicability of the model to the research design. It conceptualises the features of the model and illustrates their relevance to the research. The chapter concludes with reference to the objectives and conceptual framework structured for this research.

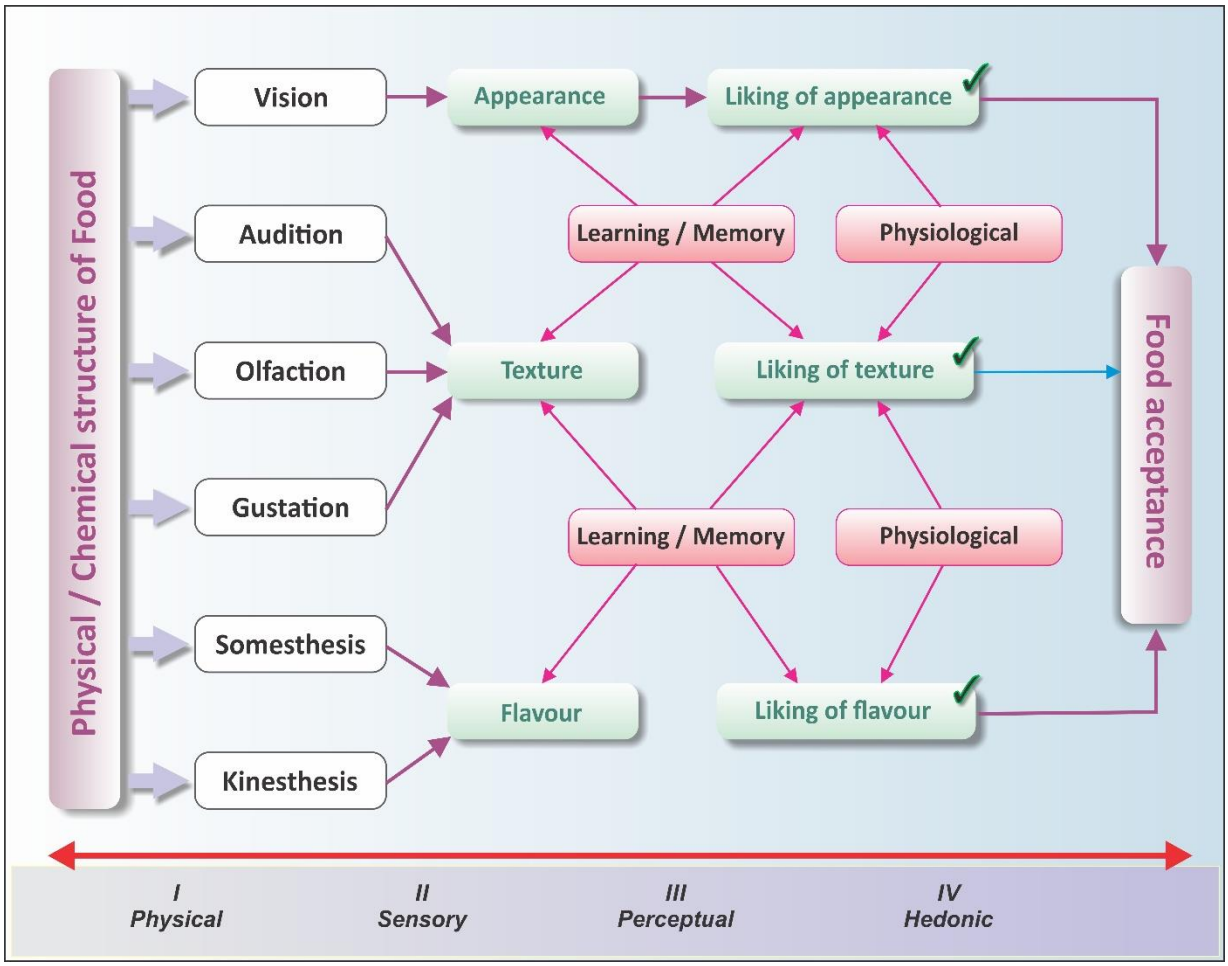

Figure 2.1: Food acceptance model (Cardello, 1996)

Food acceptability is defined as "the emotional or hedonic response to a food product that can cause a pleasant/unpleasant or like/dislike response" (Cardello, 1996:2). In other words, it indicates how much a person likes or dislikes a food and the sensory characteristics of the product (Cardello, 1996:2). The acceptability of a food can determine its level of preference, and is not compared to another product (Lawless & Heymann, 2010). A consumer's acceptance of food depends on their response to meet a need and the degree of satisfaction eating a particular food provides (Heldman, 2004). It is a multi-dimensional process as statistically it variates in different contexts, among groups as well as in the lives of individuals. It is essentially the interaction between people and food at a given point in time.

2.2 THE FOOD ACCEPTANCE PROCESS

According to Cardello's (1996) model as applied in this research, the food acceptance process theoretically follows a definite pattern. A food product interacts with the consumer causing a sensation that leads to a response to a food product. The sensory attributes of food, namely appearance, taste, texture and aroma, play a major role in the consumers' acceptance of food, as do socio-cultural factors, and nutritional and consumer characteristics (Shepherd, 1989:205).

Food acceptance consists of many interrelated factors namely physical, sensory, hedonic and perceptual. As a person experiences the intrinsic physico-chemical characteristics of a food product, a psycho-physical transformation occurs, which gives rise to the basic sensory experience of quality, the magnitude of its intensity and duration. As the data travels through the nervous system, the sensory information is transferred and gives rise to the sensory attributes of appearance, texture and flavour. Taste and odour combine to form a recognisable flavour. The interaction between kinaesthetic and somaesthetic information results in the perception of texture, for example, the crispness of food. Information from memory and learning creates an expectation of the food product that the consumer perceives.

In the third stage, the cognitive variables essentially are derived from an interpretation of data that comes from the participating consumers' perception of the food product. Ultimately, hedonic and perceptual information produce an evaluative experience, which is called *food acceptance*. Cardello (1996) maintains that the like/dislike of a food product contributes to the choice and consumption of food that produces a hedonic response. This then leads to the experience of pleasantness or unpleasantness, which will determine the acceptance or rejection of the culinary product. Both the personal characteristics of the consumer as well as those of the food product influence the hedonic

reaction to the food product. The age group, genetics, gender, cultural aspects and the physiological and psychological traits give each consumer a definite identity.

2.2.1 Physical properties

The physical characteristics of food are determined by its chemical components such as water content, carbohydrates, fat and protein (Bennion & Scheule, 2015; Blades, 2001). These properties can have an influence on the sensory attributes of a food, such as its aroma, appearance and taste. The consumer bases its food acceptance and choice on their experience of these characteristics. The physical and chemical properties of the food determine the consumer's experience of pleasantness or unpleasantness and play a definite role in the acceptability of the food product (Shepherd & Sparks, 1994). Factors such as the nutritional value, temperature of the meat, the mouthfeel and the aroma, are all aspects that influence the perception of a product. The physical and nutritious properties of a product should therefore not be underestimated in the determination of acceptability and development of a food product (Visser, 2006:77; Visser, 2013:77). The physical properties of crocodile meat are itemised Table 3.1 in the next chapter.

2.2.2 Sensory attributes

During food consumption, the brain receives different sensory inputs and the information from physiological sensory modes are integrated in the final sensory perception of the food eaten (Prescott, Soo, Campbell & Roberts, 2004; Small & Prescott, 2005). All these senses interact with each other on a perceptual and physical level, and each of them has an effect on flavour experience. There are six sense modalities which characterise food. According to Cardello (1996:5), these are:

- Vision: The consumer's first perception of a food product (size, shape and colour). It is experienced before tasting the food and gives an expectation of texture in the mouth.
- Audition: Detecting the textural experience of the food product by listening to it while biting into it. It usually gives the consumer the impression of crunchiness or crispness of food (Kälviäinen, 2002).
- Kinesthesis: Meaning movement, which detects the position and movement of the body parts while eating the food product, to determine the size and taste of food before and during consumption.
- Somaesthetic: Receptors in the oral cavity cause an experience of certain sensory attributes, which are associated with temperature, pain and touch. Nerve fibres are deeply imbedded in the oral cavity that comprises the tongue, palate and lips.

- Gestation: The taste experience of food comes from the taste receptors, papillae on the tongue that carry the taste message to the brain. The gustatory system leads to the last sensory modality, which enables a consumer to differentiate between the palatability and unpalatability of food, which, in turn, leads to the acceptance, or rejection of the product.
- Olfaction: The odour sensation of food is a physical process that starts when the odorous molecules dissolve in the olfactory mucus layer. These molecules travel through the olfactory neuron receptors that send odour information to the brain.

2.2.3 Perception of sensory attributes

Perception of a food product is the outcome of the selection, organisation and interpretation of information about the food product. It is the result of three main factors, namely, physiological effects of food, sensory attributes and influences from the environment. The consumer judges a food product based on the appearance, flavour, texture and suitability of use, and all of these factors interact with each other. The perceptual process begins the moment the specific food product is chosen, when the shape and size is recognised as well as the olfactory characteristics. It is then chewed, whereupon the texture is experienced. Perception can be considered as the outcome of the processes involved in determining the differences in sensory characteristics experienced during the consumption of the food product (Cardello, 1996:254; Schiffman, Kanuk & Hansen, 2012:158). The consumer's values, needs, and previous experiences also influence the expectation of the food product (Cardello, 1996:260; Costell, Tárrega & Bayarri, 2010).

2.2.4 Hedonic perspective

The fourth stage in the Food Acceptance model is the consumer's hedonic response, which will result in whether the food product is liked or disliked, and it will therefore influence its acceptability. The hedonic response of consumers also differs towards a food product. Hedonic perception is not only based on sensory attributes but also various other factors such as psychological factors, previous experience, context, culture, expectations and physiological status. The hedonic perspective describes consumer acceptance in relation to the liking of the sensory characteristics of the food product.

2.3 CONCLUSION

The food acceptance model is the theoretical model that was selected for this research. It provides an overview of the process from the physical to the hedonic reaction a consumer experiences to like and find an acceptable product. Some concepts will be reviewed in more depth in Chapter 3. In Chapter 4,

these concepts will be adapted and integrated into Cardello's model to clarify the relevance of the food culinary innovation process in this research study.

CHAPTER 3: LITERATURE REVIEW

In this chapter, concepts that are important in the study are introduced. It gives background information on which the study is based as well as a review of new methods used in the study. The main concepts include exotic and crocodile meat, sensory perception and expectation, measures of acceptability, food neophobia and the food culinary innovation process.

3.1 INTRODUCTION

The current study relates to determining the consumer's perception and hedonic reaction to exotic meat, which drives the acceptance of such a product to South African consumers. The following chapter will discuss the key areas that are concerned with this study. Following on from the first two chapters, supporting literature concerns exotic meat products, crocodile meat and novel food products. As a theme, food acceptance is explained as based on Cardello's Food Acceptance Model together with the factors that influence food acceptability. Literature that considers culinary products and practices, their development and innovation are then presented as specific objectives. The last sections focus on the sensory evaluation of food products, and the different techniques that can be used with data collected from panels comprising trained experts in sensory studies, and untrained consumers. Reviewing the literature enabled the researcher to apply appropriate experimental procedures to pursue the stated objectives of this research endeavour.

3.2 EXOTIC MEATS

Schupp, Gillespie and Reed (1998) define an exotic meat product as "meat from an animal which traditionally has not been used for meat production". Given that individuals differ widely in their familiarity with animals and their use for food, a particular animal could be classified as exotic by one individual person and traditional by another. South African consumers perceive game meat differently than the domesticated meat types such as chicken, beef, mutton and pork. They do not consider game meat as a 'regular' type of meat, but rather as an exotic product. This might be because they do not buy game meat regularly (Hoffman *et al.*, 2005). Exotic meat is currently a very relevant topic as there is increasing demand from consumers for sustainable and healthier meat products. Therefore the livestock sector is looking for alternative animal protein sources to supply the rapidly growing global population (Maheswarappa & Kiran, 2014). Dr Peter Oberem, vice-president of Wildlife Ranching South Africa (WRSA) said "food security is a real issue worldwide; almost every country in the world

has it on its agenda, including South Africa. There is no doubt that food production is an important political and economic issue" (Hofmeyr, 2014). Although the literature available on exotic meats is limited, different aspects of its trade and use, globally and locally, are dealt with in the sections that follow.

3.2.1 History of exotic meats

The past 15 years has seen considerable growth in the farming of game species and it is now regarded as an established sustainable agri-business. Generally, game species farmed in South Africa are not yet domesticated, as is the case in many other countries. Nevertheless, these farmers could consider combining their game farm breeding and harvesting activities with their domestic species (Hoffman & Cawthorn, 2012a; Mysterud, 2010; Volpelli, Valusso, Morgante, Pittia & Piasentier, 2003).

Earlier European settlements were unfamiliar environments to those settlers who started migrating inland, and wildlife populations decreased through unregulated hunting. Habitat fragmentation and diseases too reduced the numbers. Later on, colonial governments however, took centralised control over wildlife and limited their commercial use, making it difficult for landowners to hunt freely. Negative wildlife population trends improved following legislative changes made during the nineteen sixties and seventies that granted landowners the right to farm with wildlife on their land. A massive shift took place from livestock farming to wildlife ranching because of an increase in tourism, droughts, overstocking with livestock and declining state subsidies for livestock production. By 2013 there were 9 000 wildlife ranches in South Africa, covering 205 000 km^2 and an additional 15 000 mixed livestock and wildlife ranches (Cloete, Van der Merwe & Saayman, 2015). Since 2015, a slower growth rate in animal husbandry and the breeding and live sale of common game species has been observed (Cloete *et al.*, 2015). The breeding of other exotic or rare species are also said to follow in its footsteps. Various recommendations are mentioned in the following sections to improve this problem in the exotic meat trade.

3.2.2 Exotic meat trade in South Africa

The South African game industry produces approximately 120 000 to 150 000 tons of meat per annum(Flack, Camphor, Kitshoff-Botha, Combrink & Uys, 2017). Game hunters produce the biggest share of this meat for personal use and it makes up 20% of red meat consumption in South Africa(Flack *et al.*, 2017). As baseline information, currently 20 million ha of marginal agricultural land is used for semi-extensive game ranching, comprising 19 million head of game, which is 6 million more than cattle; R2 300 bn is embedded capital in land and animals; 20% of red meat in Republic of South Africa (RSA) is game meat that is produced without game meat safety regulations; 180 slaughter facilities

are unrecorded, and only 20 recorded on 10 000 game ranches. A game meat producing initiative involving small, medium and micro enterprises (SMME) was launched in 2016 with the goal of establishing at least 110 new game meat-processing facilities by 2021, and 300 new SMMEs by 2030. This will create a market for new game farmers for carcass sales of R650 million by 2021, and R7 200 million by 2030. It is expected to sell 180 000 animals per year by 2021 and 2 000 000 animals per year by 2030. The expected sales of final products by the new SMMEs is expected to be R2 100 million by 2021, and R23 800 million by 2030. This adds up to 18 500 tons of value added game meat products by 2021 and 206 000 tons by 2030 (Kitshoff-Botha, 2016). The Wildlife Ranching South Africa (WRSA) is the organisation that represents all South Africa's national and international interests in the wildlife industry, especially exotic meat products. Their role includes overseeing sustainable breeding, conservation, manufacturing and marketing of wildlife products in South Africa. The South African Department of Agriculture, Forestry and Fisheries (DAFF) recently created a separate division to self-manage and control wildlife protection and promotion. This organisation leads the previously mentioned game meat producing initiative with the Department of Agriculture, Forestry and Fisheries.

The South African game industry operates as a free-market enterprise, which means that the demand from the consumer determines the selling price and not government intervention, a price-setting monopoly or any other authority. This however, does create the problem that there are no standardised cuts or quality control for game meat in South Africa (Hoffman, 2001). Unfortunately, this leads to sub-standard quality game meat being available for purchase. Selling game meat is also illegal if not inspected. The WRSA has been negotiating with the Department of Agriculture, Forestry and Fisheries (DAFF) for over ten years to develop a game meat scheme that would fulfil health and safety requirements that make legal trade in the human food chain possible (Hofmeyr, 2016). Despite this, game meat is generally seen as a luxury product and is sold at a high price. Most game meat producers export the majority of their products, and only 5-8% of its total production is sold locally (Conroy & Gaigherr, 1982; Hoffman, Muller, Schutte & Crafford, 2004b). However, Lindsey (2012) state that game ranching contributes significantly to South Africa's gross domestic product (GDP) and allows for the diversification of local and national economies. Additionally, game ranching creates opportunities for industries such as tourism, animal breeding, wildlife auctions, taxidermy, wildlife capturing and translocation (Dry, 2012).

The Game Farming Industry in South Africa has become a world leader in sustainable utilisation of game meat but has now has also become involved in local and international meat markets. There is still said to be a gap in the promotion of game meat in South Africa and this leaves the South African

consumer with a lack of knowledge about a great source of protein (Bothma & Du Toit, 2016). Hoffman et al. (2004) suggest that the game meat industry can be enhanced if value-added products are accompanied by promoting recipes that would facilitate appropriate cooking of these cuts of meat. Important too is to provide extra information to educate consumers about the health benefits and preparation methods of game meat. Currently an organisation to promote game meat does not exist. However, restaurants, supermarkets and butcheries could accept this responsibility and opportunely convey information and knowledge about game meat to their consumers. Being closed associated with the Wildlife Ranching South Africa organisation, Dr Peter Oberem said "one should bear in mind that game meat is a rare, high-value product and should be treated as such. It needs to be marketed as a delicacy, a complete protein supplement high in vitamin and mineral content and not merely as an everyday commodity" (Hofmeyr, 2016).

3.2.3 Exotic meat in restaurants and retail outlets

Radder (2002) found from a study done in 2001 by Clary and Randel in Texas, USA that the best way to introduce exotic meats to consumers is through restaurants. It was suggested that restaurateurs and service providers should be aware of preparation methods, product information for promotion and pricing structure of exotic game meats. Restaurant staff particularly should have the competence to inform customers about exotic meat products on offer. Wherever an exotic culinary product is served on a menu, it is important to know and understand the market being serviced and its consumer demands. The location where such a menu is introduced should be carefully considered as the culture, income and eating habits of the people living in the area will influence their choices as the main customers. Although game meat is still considered a luxury product, more and more restaurants are putting it on their menu. Not only fine dining restaurants, but steak houses and South African as well as other African theme restaurants are featuring standard game dishes (Moyo, Carnivores, La Pentola, Kream). A study done by Hoffman et al. (2002) found that tourists are the biggest consumers of game meat in South African restaurants and are more inclined to try unusual foods. The most consumed game meat was springbok and warthog.

Later on, Hoffman et al. (2004) did a study on retailers and the factors influencing their buying and selling behaviour of game meat. It was found that retailers sell and market the most game meat in winter months, especially May, as it is considered 'hunting season'. The two retailers' sales figures for game meat were also highest in winter months. The most important factors influencing their selling behaviour were availability, quality, media activity, fashion or trends, seasonality and consumer knowledge of game as meat. The retailers also indicated the factors that influence their decision to buy the game meat from distributors. The most important things they considered were quality of the

meat, shelf life, the type of supplier, the retailers' own knowledge of game meat, seasonality and fashion/trends.

3.2.4 Exotic meat products

Game meat in South Africa is commonly prepared in various ways. The following are the most popular versions available on the market (wild meat; South African game meat):

- Boerewors (and other sausages)
- Minced meat
- Biltong
- Droëwors (a thin dried spicy sausage)
- Patties
- Salami
- Whole topside or silverside
- Whole leg
- Kebabs
- Steak cuts
- Stewing meat cuts
- Loin
- Fillet
- Shanks

Most steak house restaurants serve game meat and as it is considered a luxury product and fine dining establishments feature it on their menus as well. The increasing demand for healthy protein sources and interest in new culinary products, large retailers are offering more game meat products as their popularity grows. Venison and ostrich are sold as biltong, wors, droëwors, steak cuts, minced meat and patties in major retail stores in South Africa. Marinades are often added to the processing of the product as they serve as a flavouring agent that consumers find desirable (Robbins, Jensen, Ryan, Homco-Ryan, McKeith & Brewer, 2002; Xiong, 2005).

3.2.5 Consumers and exotic meat

Game meat has been and is consumed widely among various demographic groups in South Africa (Hoffman, Muller, Schutte, Calitz & Crafford, 2005). International visitors to South Africa indicated in a documented study that they like to eat game meat as part of their 'African experience' (Hoffman *et al.*, 2003). There is also an emergence of young consumers with high incomes who still live with their

parents and have extra cash to spend. Considering the health benefits and organic production of game meat, consumers would be inclined to look for products like this.

Among consumers, certain speculations and viewpoints abound and examples from the literature are:

- prejudiced consumers who only like what they are used to
- people who cook at home are often not familiar with or are uncertain about the correct cooking method for preparing game meat
- unsuccessful preparation of a game meat product can lead to a bad experience and reluctance to try it again (Jansen van Rensburg, 2001)
- consumers perceive game meat as a luxury meat that is associated with socially high-class consumers.

These viewpoints suggest that away-from-home consumption where game meat culinary products are well-prepared, could sway a consumer's opinions about a certain product which, in turn, could increase its demand in the food market. Experiences can affect a person's opinion about something, but it can change over time. Information about a product's availability should be given to consumers so that they know about its attributes as this could help to dispel some existing misperceptions or a person's own traditional biases (Radder, 2002).

Jansen van Rensburg's (2001) research included these reasons why consumers choose a game culinary product on a menu:

- 'it offers a more unique dining experience'
- 'they like its taste'
- 'because of health attributes'
- 'they like to try something new'

The researcher also stated that these consumers would be willing to pay more for this product, especially if prepared by a professional. Wassenaar (2016) found that other important factors that make game meat acceptable to consumers are sustainable harvesting, environmentally friendly production, sustainable land use and the assurance of food security. These issues will be discussed in the section that specifically deals with crocodile meat.

3.2.6 Ethics of exotic meat

Consumers have some ethical concerns about the production systems and the origin of exotic meat. According to research done by Webb (2013), respondents felt that it is more ethical to consume the meat of animals that are free to move around in the wild, rather than the meat species of those with restrictive movement in a controlled production environment. In their view it was unethical to keep the wild animals fenced in as is the practice in cattle or sheep ranches. For exotic meats to be successful on the market, product developers and producers have to consider these ethical concerns. On the other hand, Ampt & Owen (2008) found that consumers who realised that kangaroos were harvested from their natural, wild environment were disgusted and unwilling to support that market. It is therefore important to supply South African consumers with reliable certification marks on the product itself with transparent and explicit marketing and production procedures.

Bothma and Du Toit (2016) believe that the South African government needs to invest in research and planning concerning the presentation, preparation and health benefits of game meat to consumers. The information given in this section makes it clear that deliberate marketing strategies should be developed for game meat in the local market. Increased exposure to game meat of consistently high quality and educating consumers about its beneficial attributes and uses, would effectively enhance the growth of this specialised game and exotic meat market. In this study, crocodile meat is considered an exotic meat and an assumption can be made that the same principles apply to all game meat. This issue is discussed in the next section.

3.3 CROCODILE MEAT

Many crocodile species have served as a source of protein for people across the globe although its consumption is generally the highest in human populations in tropical and sub-tropical regions (Klemens & Thorbjarnarson, 1995). The crocodile industry throughout the world concentrates mainly on crocodile leather/skin goods for trade for the fashion industry. Crocodile meat is seen as a by-product in most countries and the meat produced usually ends up recycled as unprocessed crocodile feed on the farms (Hoffman *et al.*, 2000). Reese (1917) noted early on that crocodile meat was quite palatable and pleasant to eat and should be considered as an alternate source of meat (Madsen, 1993; Reese, 1917). As the industry grew, farmers realised that production costs per unit of skin became very high and measures were taken to boost its profitability.

In recent years, the crocodile industry has grown considerably (Fuchs, 2008). Between 1990 and 2004, global trade was between 300 and 500 tons of crocodile meat annually. By 2007, trade had grown to

nearly 1 000 tons annually. Exports of *Crocodylus niloticus* meat, the only crocodile species farmed and traded within the Southern African region, was less than half a ton in 1990 and then peaked to 500 tons in 2007 (Caldwell, 2010). Although this information is not generally always very accurate, it is clear that the crocodile meat industry has started flourishing the past few decades.

3.3.1 History

The first crocodile farms have developed out of a demand for crocodile skins, as their value was a few hundred dollars apiece around the 1960s. Crocodile farming in Southern Africa started in Zimbabwe, in 1963, where crocodiles were reared to be slaughtered and to sell the crocodiles' skin on the international market. The practice spread to South African in the late 1960 and by 1992 there were already 40 crocodile farms in operation (Marais & Smith, 1992). As the industry grew, farmers realised that production costs per unit of skin became very high and measures had to be taken to boost profitability. Furthermore, it was becoming appreciated that crocodile meat could be effectively utilised as source of human protein instead of animal feed. By the 1980s, the crocodile farming industry had expanded extensively, due to these advances (McGregor, 2005). By the 1990s, 400 tons of crocodile meat were in circulation per year internationally (Tosun, 2013). South Africa started to export crocodile meat to overseas markets in 1988 and about 400 kg were delivered in 1990 (Madsen, 1993). Then by the year 2000, South Africa, Zimbabwe, Australia and some Asian countries had established very successful crocodile farming industries(Hoffman *et al.*, 2000). Quantities have fluctuated considerably, rising to an apparent peak of over 220 000 kg in 2005. By 2007, the market had grown to exporting over 250 000 kg per year(Caldwell, 2010; Fergusson, Larriera & Ross, 2004). A crocodile, 1.5 m long, can produce about 4–5 kg boneless flesh (Isberg, Nicholas, Thomson, Barker, Manolis & Moran, 2003).

3.3.2 Crocodile meat farms, retail outlets and products

There are a limited number of restaurants and outlets specialising in crocodile meat dishes and products. The number of crocodile farms offering crocodile meat products has increased and sometimes they are available to eat on the premises at certain restaurants. Some chefs at more exclusive restaurants offer specialty dishes that feature crocodile meat, but more often than not, it is not a permanent item. Figure 3.1 shows that Crocodile Farms are spread across South Africa except in the Northern Cape province in 2018. The table that follows (Table 3.1) is a list of examples of South African farms, restaurants and products that offer crocodile meat and their location.

Restaurateurs and chefs from some of these restaurants mentioned in Table 3.1 supplied the researcher with the following information regarding how they experienced working with crocodile meat and consumers' experience of their dish.

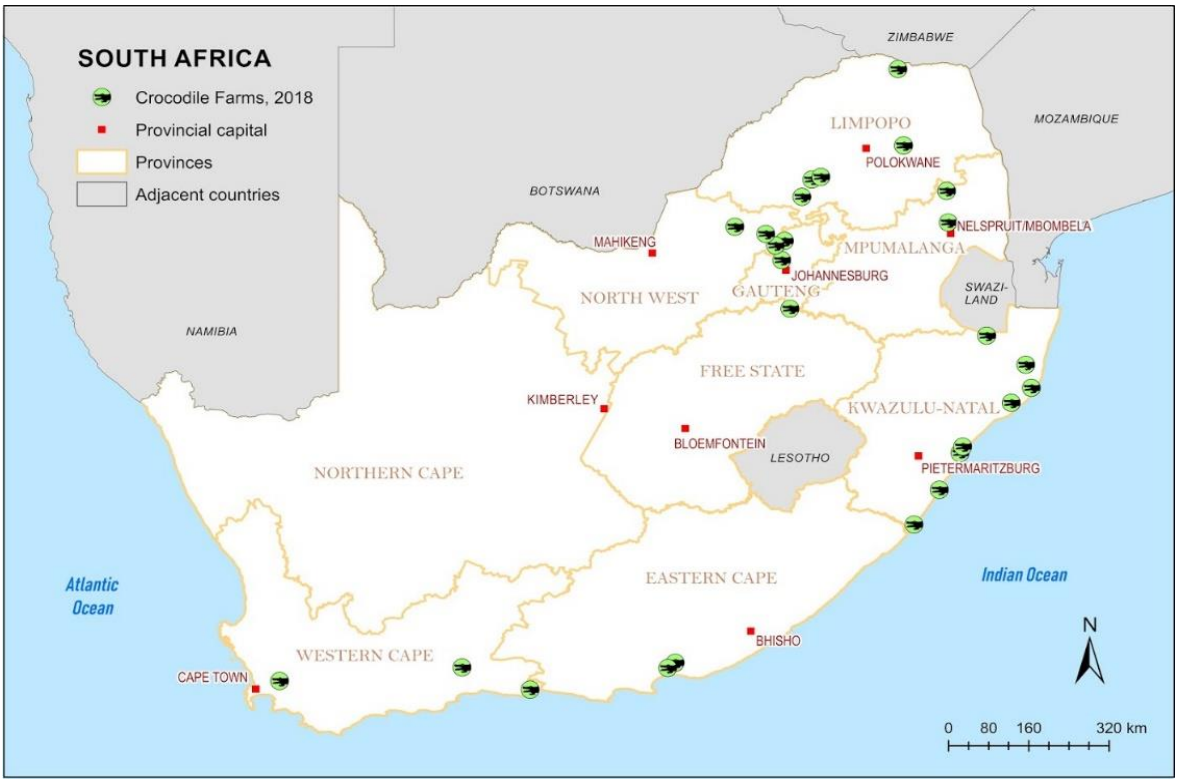

Figure 3.1: Crocodile farms, South Africa (Google Maps, 2018; accessed 08/12/2018)

Table 3.1: Farms, restaurants and products offering crocodile meat in South Africa

FARMS	RESTAURANTS	PRODUCTS
Izintaba Crocodile Farm	Moyo African Cuisine, nationwide branches	Crocodile pâté, African Savanah
Rakwena Crocodile Farm	Carnivore, Muldersdrift	Crocodile products from butcheries or farms
Thaba Kwena Crocodile Farm	La Pentola, Pretoria/Hermanus	Kebabs
Le Bonheur Crocodile Farm	Headlines Restaurant, Oudtshoorn	Patties
Crocodile Centre	Kream, Pretoria/Johannesburg	Sausage
Croc River Reptile Park (Pty) Ltd	Mama Africa, Cape Town	Fillets
Agatha Crocodile Ranch	Koornlands, Swellendam	Smoked crocodile carpaccio, Izintaba Crocodile Farm (Pty) Ltd
Croc City Crocodile Farm	City Grill, Cape Town	
Riverbend Crocodile Farm	Karibu Restaurant, Cape Town	
Crocodile Creek		
Lalele Crocodile Farm		
Seronera Crocodile Farm		

Guests are curious about the idea of the dish and are often surprised at what they are served. Most consumers think that it is a red meat product, whereas it is in fact a white meat. It is now a permanent menu item at most restaurants because consumers show so much interest in the dishes offered. Kream Restaurant at Mall of Africa, Johannesburg, serves 20 kg of crocodile meat per month, whereas Mama Africa in Cape Town goes through 300 kg in peak season. They have both a starter and a main dish featuring crocodile meat, the starter being the more popular. The speculation behind this is that guests might still be slightly hesitant and so order only a smaller portion, in case it is not their taste. Since crocodile meat is in itself bland, most restaurants add pungent flavours to the dish, such as Cajun spice, Asian flavours or serve it as a stew. The starter is said to be a 'top 5' dish in the restaurant. The most popular cuts used by the restaurants are the tail fillet and goulash-type meat. To the chefs it is relatively easy to work with crocodile meat and some refer to it as similar to raw fish or tough chicken (Jansen, 2018).

3.3.3 Ethics of crocodile farming

Animal welfare, manufacturing practices and the origin of food products are becoming increasingly important to consumers. Meat has always been a controversial product, and despite its high value, there are many prohibitions against the consumption of meat (Fessler & Navarrete, 2003). Since these vary from place to place and culture to culture, for convenience, two major procedures can explain this, namely, the functionalist and the symbolic approaches. First, functionalist explanations lie in the restriction for practical, health-related or ecological reasons. The possibility of meat being infected by parasites or microorganisms exists which is a health hazard thus prohibition could prevent human illness that arises from this source (Douglas, 2003). The second group of restrictions are symbolic with an emblematic connotation being associated with meat making it unacceptable. Religious and traditional beliefs have certain issues of purity and pollution or regard the animal as sacred (Douglas, 2003). Although there are many bans to eating or killing certain animals, many cultures promote consumption of such an animal because of magical or medicinal beliefs. In China, crocodile meat has many several interpretations such as the use of blood for pharmaceutical properties and the bones and fat as traditional medicines (Tosun, 2013). A specific example is that reptile or crocodile meat is prohibited in Islamic culture (Groombridge & Luxmoore, 1991). It is also forbidden in Jewish law, but most Christian religions are not opposed to it. For some Mexican Catholics red meat is prohibited, so crocodile and turtle meat are acceptable as a good alternative because it is often seen as a fish species (Nichols, 2003).

Another factor particularly applicable to crocodile farming is the production of fashion accessories using the skin of the crocodile. A representative body of the crocodile leather industry is *Exotic Leather South Africa* that supports the ostrich industry too. It is a non-profit sub-national cluster, sponsored by the Department of Trade and Industry and the *Exotic Leather Research Centre* at the University of Pretoria serves as its technical collaborator. *Exotic Leather South Africa's* mission is to position South Africa on the international exotic leather markets as a research-based, ethical and sustainable source for exotic leather products. This organisation has the primary objective of providing high-quality products; it does internationally accepted research throughout the value chain; it seeks to improve efficiency and quality through the value chain; and ensures sustainability of the crocodile leather industry. Research in animal production and health as well as sustainability issues have now been expanded to also include crocodile meat. In South Africa, crocodile meat for human consumption is processed in accredited abattoirs, some of which is also certified by the European Union (De Klerk, 2018).

3.3.4 Characteristics of crocodile meat

General characteristics. Crocodile meat has a firm texture, is light in colour, and has a delicate taste similar to chicken or veal (Spiegel & Wynn, 2007). In South Africa the tail is marketed as islets (cutting the tail transversely in 10±15 mm thick portions) to niche restaurants or exported to Europe. These 'islets' usually represent 10% of the whole tail. The fillet is separated from all the fat and bone of the tail and is a very tender and delicate piece of meat (Hoffman *et al.*, 2000). The carcass is then further deboned, and the meat exported as a lower-value product or cut into chunks ready for a goulash-type meat or is fed back to the crocodiles. Owing to the increasing meat production that being done on the farms themselves, the latter practice is declining (Cairns, Industries, Research, Corporation, Industry & Fisheries, 1996).

Processing of meat. Based on information collected from a big crocodile farm in the Gauteng region of South Africa, the following procedures are performed in the crocodile slaughtering process. Carcasses are available either eviscerated or uneviscerated. A skeletal diagram of the crocodile dorsal can be seen in Figure 3.2. A standard uneviscerated crocodile carcass is the whole body of a healthy slaughtered crocodile after bleeding, skinning and removal of the following:

- hind feet at the first joint between the tarsal bones, distal to the fibular tarsal but proximal to the tibial tarsal;
- the forefeet at the joint between the radius/ulna and the first carpal bones;
- the last 4-11 vertebrae of the tail;

- the head between the occipital bone (skull) and the first cervical vertebra (atlas); and
- minimum trimming to the degree which is needed to render the carcass fit for human consumption (Cairns *et al.*, 1996).

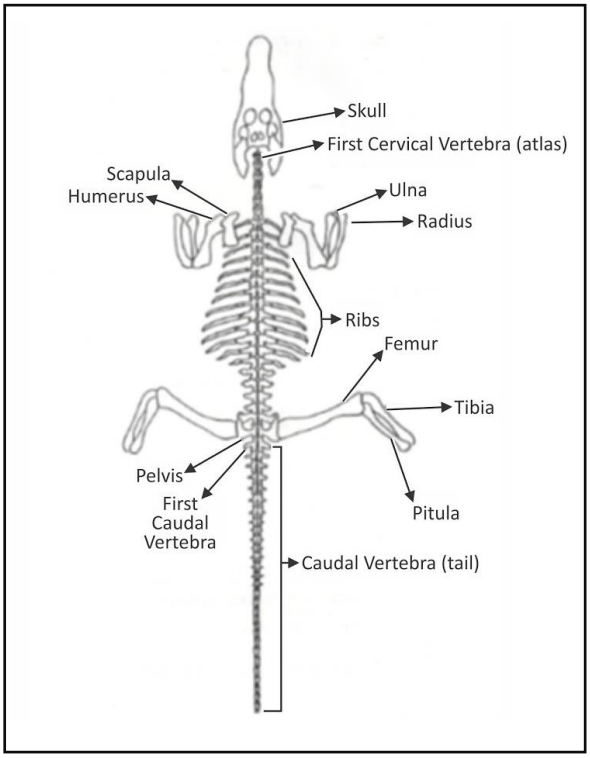

Figure 3.2: Crocodile dorsal skeletal diagram

A standard eviscerated crocodile carcass is the whole body of a healthy slaughtered crocodile after bleeding, skinning and removal of the following:

- hind feet at the first joint between the tarsal bones, distal to the fibular tarsal but proximal to the tibial tarsal;
- the forefeet at the joint between the radius/ulna and the first carpal bones;
- the last 4-11 vertebrae of the tail;
- the head between the occipital bone (skull) and the first cervical vertebra (atlas);
- internal digestive, excretory, respiratory, reproductive and circulatory organs; and
- minimum trimming to that degree which is needed to render the carcass fit for human consumption (Cairns *et al.*, 1996).

The following cuts are available from a standard eviscerated crocodile carcass and are packaged for export purposes or to sell to the public:

- Tail: a straight cut through first/second caudal (tail) vertebral joint at a point immediately distal to the cloaca.
- Tail fillet: derived from the tail by removal of the vertebral column. Tail eyes are removed, and all fat is trimmed away.
- Tail eye: derived from the tail, the tail eyes arise from the pelvis and run caudally under the tail on either side of the vertebrae.
- Tail cutlets: derived from the bone-in tail and comprised of the tail fillet and tail eye. A transverse cut is made through the vertebral junctions for the entire length of the tail.
- Back strap: consists of the muscles lying dorsal to the ribs and is derived from the body after removal of the tail. A cut medial to the scapula is made and further cuts are made on either

side of the vertebrae along the entire length of the body. The back strap (M. *longissimus dorsi)* is removed along the natural seam.

- Leg (bone-in): the hind legs are removed at the femoral/pelvic joint. The forelegs are removed at the humerus and capula joint. The hind legs can be separated at the femoral/tibial joint.
- Leg meat (bone-out): the leg meat is all the muscles removed from the fore and hind legs.
- Jowls are left attached to the body when the head is removed. They are detached from the body along the natural seams.
- Neck fillets: situated at the cranial end of the dorsal surface within the body cavity. They are cut away from the cervical vertebrae.
- Body meat: derived from the body after removal of the tail, legs and backstrap, it is the remaining muscles left on the outside of the carcass. The muscles are removed from the carcass in one piece.
- Trimmings: any portions of the meat remaining after preparation of the cuts. They may be diced or minced.

Since there is so little information about factors influencing meat quality in crocodiles, the focus has been on food safety. Abattoirs dip meat cuts in an antimicrobial solution prior to packing and freezing. Off-odours that sometimes occur, which are associated with a grassy or fishy taste, are believed to originate from hexanal and heptanal. Hexanal has been used as a biomarker for lipid peroxidation, a process that produces chemical compounds giving rise to off-flavours and off-odours in foods. Volatile heptanal is known for its characteristic sweet odour that is given off during oxidative processes (Spiegel & Wynn, 2007).

Composition of crocodile. In the case of exotic meat, consumers could be drawn to a meat product like crocodile meat because of increased awareness of health benefits that goes beyond basic nutritional properties (Hekmat & Reid, 2006). The meat is a rich source of essential amino acids, which indicate that crocodile meat could be appropriate for consumers with such preferences. The carcass of the crocodile comprises 60.8% meat, 12.2% fat and 26.6% bone. However, differences may occur with species, gender and size (Huchzermeyer, 2003). The mean cooking loss of the meat is 29.09%, calculated from the tail, legs, torso and neck (Hoffman *et al.*, 2000). Shear force values of tail meat samples (4.35 kg per 1.27 cm diameter) are similar to those for species such as beef, pork and ostrich (4.3, 3.2 and 3.35 kg per 1.27 cm diameter respectively). These values from cooking loss and shear force affect tenderness and juiciness, which will therefore influence the consumers' perception and acceptance of these meat products. Crocodile meat is high in protein (22,1 g/100 g), low in fat (6,2 g/100 g) and high in moisture (71,6 g/100 g) (Hoffman *et al.*, 2000; Huchzermeyer, 2003; Mitchell,

Reed & Houlihan, 1995). Its iron, magnesium and sodium levels are lower than that those of beef and chicken. The low sodium content is another indication of the health benefits that crocodile meat has. The nutritional value of crocodile meat (Table 3.2) compares well with those of beef, chicken and fish (Hoffman, 2008; Hoffman *et al.*, 2000; Probst, 2008; Revilla & Vivar-Quintana, 2006; Wang, Liu, Feng, Jiang, Kuang, Jiang, Li, Tang & Zhou, 2015; Wolmarans, Danster, Dalton, Rossouw & Schönfeldt, 2010). The meat of reptile species typically shares similar compositional characteristics with those of invertebrates, being high in moisture, with modest amounts of protein and reduced fat content (Southgate, 1991).

Table 3.2: Comparison of the nutritional value of conventional meats and crocodile meat

Meat per 100g portion	KJoules	Protein	Fat	Moisture
Unit of analyses	kJ	g	g	g
Lamb	491	20.8	3.7	71.5
Beef	508	21.2	4.0	74.8
Pork	448	22.0	2.0	75.5
Chicken	607	22.2	6.2	67.6
Salmon	842	19.9	13.6	65.4
Venison	474	20.6	3.3	75.3
Nile crocodile	415	21.5	2.9	71.6

3.4 NOVEL FOODS AND NEOPHOBIA

Food neophobia is defined as a rejection towards new or unfamiliar foods (Moreau *et al.*, 2001). Previous studies show that most people prefer foods that they are used to and reject those that they do not know. This is due to their perception of distaste, danger, inappropriateness and disgust of the food product (Jansen van Rensburg, 2001; Radder & Le Roux, 2005). It could also mean that the consumer dislikes sensory characteristics, believing that there will be negative consequences when consumed; and that the food product is inedible with the idea of it as also being offensive (Fallon & Rozin, 1983; Jansen van Rensburg, 2001; Radder & Le Roux, 2005).

Veeck (2010) found that consumers with neophobic tendencies dislike a certain food product because of its appearance and texture, rather than the taste. She found that seafood most often evokes negative emotions from its smell and texture. The description given with this reaction usually relates to their response to the image of the live animal. This observation could have been a potential obstacle

for this study, since consumers could visualise the carnivorous reptile, rather than an alternative meat product.

Different variables influence a consumer's behaviour towards a product, such as age, gender and education. Some consumers might not change their food consumption behaviours because they do not know how to change. It is important for a product developer to know that the acceptance of novel products does not happen overnight (Ulene & Prochaska, 2011). Previous experience and expectations also influence their learning of a new product. Consumers are more inclined to buy products that have familiar attributes. This could help the consumer to familiarise themselves with new products. The same principle goes for novel products offered by strong, well-known brands or retailers (Martinez & Bojnec, 2014; Smith & Park, 1992).

Many studies done on neophobia in children found that it can be reduced through exposure to novel foods (Addessi, Galloway, Visalberghi & Birch, 2005; Breen, Plomin & Wardle, 2006). Repeated exposure creates familiarity, which increases the likelihood of acceptability. This would also be relevant for adult consumers in the market (Pliner, Pelchat & Grabski, 1993). Today younger people have broader food selections compared to a few decades ago and fewer neophobic tendencies. Based on this theory, socio-demographic variables will play a role in the acceptance of novel foods (Fernández-Ruiz, Claret & Chaya, 2013; Meiselman, King & Gillette, 2010).

Food variety is also greater in cities than in rural areas, therefore people in rural areas might be more neophobic (Flight, Leppard & Cox, 2003; Tuorila, Lähteenmäki, Pohjalainen & Lotti, 2001). Many studies have shown that neophobia scores differ extensively between cultures. Studies include comparisons between Lebanese and American consumers (Olabi, Najm, Baghdadi & Morton, 2009) and Swedish and Finnish consumers (Ritchey, Frank, Hursti & Tuorila, 2003). Neophobia also decreases as education increases (Hursti & Sjödén, 1997; Meiselman *et al.*, 2010; Tuorila *et al.*, 2001) and as income increases (Meiselman *et al.*, 2010). The gender variable is, however, still unclear in these referred texts. The origin of the food product strongly influences the consumer's acceptance of a food product. They are more likely to trust products from their own country, rather than a foreign country (Martinez & Bojnec, 2014). Martinez and Bojnec (2014) advise product developers to introduce familiarity when a novel food product is developed. Sensory evaluations of these products should also be done with neophobic food consumers in mind to ensure success in the market.

3.5 FOOD ACCEPTABILITY

Food, the consumer, the economic and social environments and the attitude of a consumer together contribute to the acceptability, choice and preference of a food product. The whole food choice process is a cognitive process, which entails the person's belief in a certain product. Individuals also retain memories of food experiences and can understand and explain their own food choice behaviour. These attributes develop food preferences. Cardello (1996:1) referred to acceptability as the hedonic response to a food product, which is liking or disliking it or having a pleasant or unpleasant experience with it. This researcher (1996:2) also saw it as the combination and influence of the sensory attributes of a product, with their response as either a like or a dislike.

Consumers' perception and their expectation of food that they are about to eat has various sources, referred to as 'product intrinsic' and 'product extrinsic cues', respectively. Extrinsic cues are those characteristics that are somehow related to the product, but not physically part of it, such as labelling, packaging, the location where it is consumed or sold, its marketing or any external information about the product. Although these cues do not influence the physical properties of the food product, research has shown that it still has a significant influence on the consumers' perception of product's quality and performance (Agrawal & Kamakura, 1999; Bredahl, 2004; Liefeld, Heslop, Papadopoulos & Wall, 1996). Product intrinsic cues are those that are physically part of the product and cannot be changed without changing the physical properties of the food product itself (Piqueras-Fiszman & Spence, 2015). This study focuses on the sensory and physical attributes of a culinary food product and its intrinsic food cues.

According to Cardello (1996), sensory experience is the basis of our knowledge of objects in the real world. It also influences the emotional and behavioural responses to them. In the case of food acceptance, sensory experience functions to influence the emotional and behavioural responses to foods in a number of ways. First, many forms of sensory experience call up biologically inborn hedonic responses, for example, a preference for sweet taste. Second, it can alter the qualitative and quantitative character of other sensory experiences, thereby changing their hedonic and behavioural significance. These interactions can show how seemingly singular attributes can be and have complex effects on food acceptance. Third, olfactory and gustatory stimulants have the ability to elicit gastric, salivary and pancreatic secretions that influence the perception, consumption and absorption of foods. A fourth mode of influence is the acquired preference or aversion, whereby the sensory experiences are evoked by food served as a stimulus for food related behaviours. Lastly, the total

sensory experience can establish a set of hedonic and perceptual expectations that changes the emotional or behavioural response to any single element of that overall experience (Cardello, 1996).

Simplified, consumer response to a food product can be summarised as:

- A sensory component - the sensory characteristics of a food product
- An affective component - positive or negative response to a food product
- A cognitive component - from the knowledge and opinions about a product
- A behavioural component - intentions or actions defining how willing a consumer is to do something in a certain situation (Costell *et al.*, 2010).

3.5.1 Sensory expectation

The word 'expectation' has been described in psychology literature in various ways, such as 'subjective notions of things to come' (Anderson, 1972) or 'pre-trial belief about a product' (Olson & Dover, 1979). The cognitive construct of the word can be applied to both sensory and hedonic experiences. 'Sensory-based expectations' is the belief that the food product will have certain sensory attributes, each at certain intensities. Hedonic expectations would imply that the product would be both liked and disliked to a certain degree (Cardello & Sawyer, 1992). Sensory expectations are formed through a psychophysical transformation that occurs from the exposure to physicochemical energies of a food product. Psychophysics is broadly defined as 'the study of relationships among a set of physically defined variables and a set of variables presumed to be indicators of the psychological counterparts of the physical variables' (Stenson, 2014). The brain's sensory system receives the information and the individual recognises the basic sensory dimensions of a product. Learning and memory interact in combination with the different sensory systems and expectations of a food product form (Cardello, 1996:2). Everything we know prior to consumption, such as visual appearance, orthonal-olfactory cues and even distal food sounds, along with extrinsic factors, sets up strong expectations of what the consumer is about to eat (Piqueras-Fiszman & Spence, 2015; Woods, Poliakoff, Lloyd, Dijksterhuis & Thomas, 2010).

Two distinctions that can be made about the multisensory perception of food are to differentiate between exteroceptive and interoceptive cues. Exteroceptive cues include vision, the auditory function and orthonasal olfaction that have to be stimulated before they work. Interoceptive cues are those that are stimulated while the person is consuming the food product, namely taste, retronasal olfaction, and any sounds that might be associated with mastication and the consumption of the food product. Oral somatosensation, the exteroceptive cues, gives information before a consumer puts the

food product in their mouth. It is these actions that give rise to most of the expectations about the food products itself (Piqueras-Fiszman & Spence, 2015).

3.5.2 Perception

A consumer forms a perception of a food product as the information from memory and learning creates a framework of contextual information and expectations. The perceptual information of appearance, flavour and texture assumes a hedonic tone of like/dislike. Food acceptance depends on the integration of these perceptual attributes a food product has with hedonic information (Cardello, 1996).

Although it has been said that perception could only occur in the presence of sensation, James Gibson (1960) argued that perception could occur without sensation, but not without *information*. To predict to what degree the consumer will accept a product, it is necessary to combine information on different factors. For instance, the physical characteristics of the food product, product modification during oral processing, and sensory techniques make sure that flavour is perceived. It is perception that affects the final acceptance of the culinary food product. A consumer's perception of food quality does not solely depend on the intrinsic sensory characteristics of the food product, but also on extrinsic factors that include cognitive, cultural, social, contextual and attitudinal variables. The focus, however, will be on the intrinsic sensory characteristics that drive the consumer's acceptance of exotic meats, as very little research has been done on it thus far.

3.5.3 Sensory experience

Sensory experience underlies the emotional and behavioural responses to our knowledge of objects in the real world. Regarding food acceptance, sensory experience functions to influence the emotional and behavioural responses to food. The totality of sensory experience can serve to establish a context or set of perceptual and hedonic expectations that together alter the emotional or behavioural response to any single element of that overall experience (Cardello, 1996). There is a fundamental relationship between the physicochemical characteristics of a food product, their direct and interactive effects on sensory and perceptual experience, and the hedonic elements of food acceptance behaviour. Each of the sensory dimensions conveys a different message. Some information performs a task with a product whereas other information can evoke memories, emotions or associations. It is the ensemble of sensory dimensions that determine how a product is perceived, evaluated and experienced (Auvray & Spence, 2008; Bahrick & Lickliter, 2000).

3.5.4 Hedonic experience

Simply described, hedonic means 'having to do with pleasure'. As early as 1961, Wundt proposed that hedonism is inherent to all sensory stimuli, especially the olfactory (smell) and gustatory (taste) systems (Beebe-Center, 1932). However, regarding the nature of the hedonic dimension, it is not a sensory sensation. It accompanies sensory stimuli, but pleasure and displeasure are affective experiences in that they are emotional responses whose somatic effects are accompanied by a cognitive experience of emotion. Although sensory and hedonic dimensions can be theoretically described separately, they are often confused phenomenologically (Cardello, 1996). Consumers often give affective descriptions of a food when asked how it tastes, for example, 'it tastes bad' or 'the consistency is poor'.

The similarity between sensory and hedonic dimensions was drawn early on by (Beebe-Center, 1932) that developed a model of the basic relationship between sensory intensity and hedonic response. The model shows that as the sensory intensity of a product increases, the hedonic tone becomes increasingly pleasant until it reaches a maximum. It then decreases in pleasantness to a neutral hedonic tone and finally becomes unpleasant when the highest sensory intensities are reached.

3.6 CULINARY PRODUCTS AND PRACTICES

"Cooking is a craft which can rise, on occasion, to art", Arno Schmidt, once an executive chef at the Waldorf-Astoria Hotel in New York, said (Brown, 2018). In the culinary world, there are specifications that determine the ingredients and skills to prepare, combine and create foods for consumers. These are named culinary practices and include:

- Ingredients
- Preparation
- Flavouring
- Serving

These four elements form cuisine fare that will be discussed in the sections that follow. Since it is not clear yet what the sensory profile of crocodile meat is, the preparation methods, flavouring and serving of the food product will be based on poultry meat.

3.6.1 Ingredients

The first step in any culinary practice is to select the ingredients. Part of the preliminary phase of this study includes a sensory analysis to determine the sensory profile of crocodile meat. Spiegel and Wynn

(2007) suggest that crocodile meat has a firm texture, is light in colour and has a delicate taste similar to chicken or veal. Other information regarding meat cuts and characteristics of crocodile meat are discussed in section 3.3. South African ingredients with flavouring are dealt with in sub-section 3.6.3 after preparation.

3.6.2 Preparation

Heating food changes its molecular structure altering its texture, taste, aroma and appearance. Heat is transferred by dry-heat or moist-heat. Moist-heat refers to heat that is transferred by water, any water-based liquid or steam. Dry-heat cooking is a method in which heat is transferred through air, radiation, fat or metal (Brown, 2018). Recommended internal temperature for poultry breasts is 76 ^{o}C. Applying this heat level is important to ensure reliable, optimal consumption (McWilliams, 2017). If overcooked, however, poultry is prone to become dry, tough and stringy. This could also be the case with crocodile meat.

Moist-heat preparation methods include techniques such as poaching, simmering, stewing, braising, boiling, blanching, sous-vide and steaming, all of which can be applied to different meat food products. Moist-heat is most often used with tougher cuts of meat or meat products to break down the collagen. Tender cuts of meat should not be cooked for a long time when applying moist-heat. The large amount of muscle protein is toughened by the moisture and tends to counteract the breakdown of the collagen. The cooking time should be just long enough to coagulate the muscle proteins (McWilliams, 2017). Sous-vide is a modern moist-heat cooking method, that has been actively studied since 1990 (Mossel & Struijk, 1991; Ohlsson, 1994; Schellekens, 1996). In French it means ‘under vacuum’. It is mainly used to prolong the shelf life of minimally processed food products. Sous-vide cooking involves vacuum sealing the raw food in heat-stable, food-grade plastic bags and cooking it through as it is precisely controlled heating (Baldwin, 2012). Vacuum packing the food improves the flavour intensity and prevents undesired oxidative flavours forming (Church & Parsons, 2000; Schafheitle, 1990). Moist cooking at temperatures below 100 °C enhances tenderness and juiciness (Schafheitle, 1990). Precise temperature control ensures cooking benefits as reproducibility is precise, being overdone can be controlled and tough pieces of meat can be cooked to tenderness, while still being medium, medium-rare on the inside (Baldwin, 2010; Myhrvold, Young & Bilet, 2011).

Dry-heat preparation methods include baking, barbecuing, roasting, broiling and frying. These methods are designed to maximise the quality of muscle proteins. There is a lower quantity of collagen in tender meat cuts and these reacts better to dry-heat cooking methods. Roasting meat products is

usually done at 163 °C, which produces a juicy, tender and flavourful end result, with a low moisture loss. With methods such as broiling, pan-broiling, pan frying and deep fat frying meat is exposed to up to 190 °C. The product cooks quickly by these methods and can potentially be under-cooked, therefore the internal temperature must be checked before it is served (McWilliams, 2017:348). Meat products that are broiled or grilled are often marinated. These are to increase flavours used (Brown, 2018:181) or reduce cooking loss and increase quality (Smith & Acton, 2010:265). It is recommended that the product is refrigerated while marinating and heated sufficiently when cooking. Both these practices ensure food safety. Another value-added technique to dry-heat cooking is breading or crumbing the product. This adds texture and flavour and can prevent moisture loss (Brown, 2011:181).

3.6.3 Flavouring

The flavouring element in culinary practices depends the food itself, the ingredients added to the original flavour and the way it develops through the cooking process. The quantity, quality and concentration of these ingredients are also most important. Additionally, factors that influence flavouring are:

- **Temperature**: foods served at a higher temperature releases the most flavour. The perception of sweet and sour are lost at too high or too low temperatures and savoury flavour is most prominent at very low temperatures. Therefore, final flavouring ingredients should be added to a product at the temperature at which it will be served.
- **Consistency:** the perception of flavour intensity will differ in intensity and onset time as the consistency or texture differs. Products with a thicker consistency, for example, will have a longer onset time and will therefore be perceived as a less flavourful product.
- **Presence of contrasting tastes:** combining contrasting tastes, like sweet and sour, will enhance the product's flavour. The more dominant flavour will be complimented by the addition of its contrasting flavour, such as the case of adding a sweet element to a vinaigrette to reduce the sourness of the vinegar.
- **Presence of fats**: chemical compounds that create flavour and aromas are dissolved into the naturally occurring fats of the food product. Too little fat can prohibit the flavour from being released properly and too much fat can coat the tongue with a fat layer, which interferes with the taste receptor of the consumer.
- **Colour:** the appearance of a food product will influence the consumer's taste perception before it is even consumed. If a product does not appear as is customary, the consumer might perceive a lower intensity flavour. This might affect the consumer's appreciation of the actual

flavour of the food product, which will influence its acceptability (Labensky, Hause & Martel, 2015:123).

Modern South African cuisine has a rich heritage of specialities that originate from settler days when its population represented many different nations with their own cultures. Experimentation with local game meat was common place among the immigrants who came from Europe, Asia and other African countries such as Angola and Mozambique. The influence from the French, German and British immigrants as well as the Indian and Malay slaves spread widely from the Cape provinces northwards and eastwards. The Dutch settlers brought cooking methods, which are still used today, and the practice of cooking vegetables dotted with butter and sprinkled with nutmeg are still popular. Sweet treats that are Dutch inspired are 'koeksisters' and 'melktert' ('milk tart') (Van Wyk & Barton, 2015:2).

The French Huguenots introduced viticulture and the production of fruits. The production and use of raisins and preserves from local fruits are still popular today. Offal is also a popular dish in many South African cultures, some recipes of which stem from the French. Food products and dishes such as 'boerewors' (translated means a spicy, sausage farmers make in RSA) and hearty casseroles have been passed on from the Germans, who love their spicy 'wurst'. South African 'Sunday meals' are traditionally roast meats and roast potatoes and vegetables that were introduced by English and Dutch settlers. Savoury pies, chicken or beef pies; hot, filled puddings, like Malva Puddings, Roly Poly and Rice Puddings. Steamed puddings are also a British derivative.

The Malay slaves brought with them specialities that have probably had the greatest influence on South African cuisine. The dishes are characteristically both sweet and sour and include products such as spicy sauces, curries and chutneys, 'blatjangs' and 'atjars'. Among other popular curry dishes are curry-marinated pork and lamb kebabs, pickled fish and a variety of fish stews (Van Wyk & Barton, 2015:2). Spices and flavourings that stem from Malayan cooking appear in many South African dishes include turmeric, cumin seeds, cardamom, aniseed, fennel, star anise, dried ginger, dried coriander, garlic, saffron, red pepper, mustard, curry powder, lemon leaves and dried apricots (Afọlayan & Afolayan, 2004:164).

During the 19th century 'dried' foods such as 'biltong', 'droëwors' and rusks evolved out of necessity as a preservation technique. Ingredients and flavours that are associated with the indigenous South African populations, like the Khoisan and Bantu, are milk and 'emasi' (cultured milk products), maize products and a variety of fermented beverages. Soured milk is a highly valued product. The whey is

separated to drink as it is the leftover curd is eaten or it is used in a variety of milk dishes and puddings. As a cereal, maize (on the cob or mealies or corn) is typically processed first by grinding it to a desired degree of fineness. It is then cooked and transformed into a porridge, differing in thickness and consistency. To enhance the flavour and add value to the food product, green vegetables, honey, herbs or fruit syrups are added to cooked maize meal as t the main meal of the day. Many South African ethnic groups ferment mealies to make beverages, each tribe doing it in a different way. Marula fruit and prickly pears are often also fermented and brewed into alcoholic beverages (Afọlayan & Afolayan, 2004:156).

Rozin (1984:xiv) wrote, "Every culture tends to combine a small number of flavouring ingredients so frequently and so consistently that they become definitive of that particular cuisine". These flavour principles are "designed to extract what is absolutely fundamental about a cuisine and, thus, to serve as a guide in cooking and developing new recipes".

3.6.4 Serving and environment

The serving of food involves various rules stipulating the number of meals served per day; whether the food is consumed on its own or with accompaniments; how the food is served; and what foods are served on special occasions (Rozin, 2007; Rozin & Tuorila, 1993). Food consumption patterns are influenced by the consumer's social environment, cultural traditions and religious beliefs.

The family structure in a consumer's social environment plays a significant role in the development of a child's food habits. They learn from an early age that food provides comfort and it brings the family together. Eating habits, however, are influenced by time constraints due to the increasingly rushed lifestyle that people lead today. Working parents, especially mothers, who need to prepare dinner in 30 minutes are particularly affected. One solution for time constraint problems are take-away fast foods or home meal replacements that are convenience foods (Beck, 2007; Todd, Mancino & Lin, 2010).

The **culture** in which a consumer grows up tends to influence their food habits. Food pairings and combinations are determined within and preserved by their cultural heritage. Food patterns differ extensively from one culture group to another and not even all individuals within the same ethnicity eat alike. An ethnic group has its own cuisine with distinctive flavouring of foodstuffs. Different culinary cultures can often be experienced at certain restaurants and are sometimes referred to as exotic foods on menus.

Many **religious** groups have sets of strict food laws and guidelines that dictate the foods that can be consumed, the processing of the food, the process of how it should be eaten, completely omit certain foods and control the frequency of consuming other foods (Bennion & Scheule, 2015). Product developers should keep the various cultural groups in mind when developing and introducing their product to the marketplace. There are some strong taboos against crocodile meat in certain cultural and religious groups, a fact that became an important consideration in this study.

3.7 INNOVATION

The terms 'innovation' and 'new product development' are often considered synonymous. The word 'innovation' derives from the Latin word '*innovare*' which means 'to create something new' (Tidd, Bessant & Pavitt, 1997). Fagerberg (2004) defined the concept as "innovation is typically understood as the successful introduction of something new and useful stated". Guerrero et al. (2009) conducted a study on the concept of innovation with 12 focus groups. From these groups, five main themes defining innovation arose, namely, novelty and change; variety, processing and technology; origin and ethnicity; and convenience. These authors then summed them up as describing innovation ''the addition of new or unusual ingredient; new combinations of products; different processing systems or elaboration procedures including packaging; coming from different origin or cultures; being presented and/or supplied in new ways; and always having temporary validity''.

Within the culinary world, the ever-changing concept of innovation is dynamic and assessing its performance is a challenge. Innovation contributes to the trends and consumer tastes. In addition to this, the life cycle of hospitality, services and catering too are also fluctuating as competition increases. The hospitality and food production industry need to develop new products to replace the ageing ones and introduce additional sensory elements to make the consumer experience better. The problem with new food product development and innovation, however, is that the failure rate of the new products is high (Ottenbacher & Gnoth, 2005) and the successful new products can be quickly imitated by competitors (Harrington, 2005).

A study done on the innovation process of Michelin-starred chefs in Germany (Ottenbacher & Harrington, 2007) revealed three key issues:

- *Successful Michelin-starred innovations are not only the result of creativity and talent*
  The product developer needs to combine their creativity, talent, experience and a high level of professional process management. Creativity and talent allow the development of new ideas and

discover ways to combine ingredients and processes. One needs innovation management to successfully implement these ideas.

- *Top quality ingredients are a must*

  Good quality food needs good quality ingredients. The quality of the ingredients affects the taste, texture and flavour. Therefore, it is a challenge that needs to be considered when developing and producing a new food product.

- *New cooking techniques*

  Specifically referring to molecular gastronomy, a novel cooking technique combines science and culinary art, and causes a diversion between perception and reality. It creates new tastes, forms and textures of food. Although it is more applicable to the development of new culinary dishes served at restaurants, these new cooking techniques can act as inspiration for the innovation process of product developers.

Harrington (2005) developed a culinary innovation model. It illustrates the feedback loops that are necessary when developing new products, both internally and externally. The internal loop provides a process of knowledge flows and development, increased innovation capacity and increased commitment to the innovation process. Consumer feedback, changing consumer behaviour and competitor reactions are part of the external loops. This model and its implementation process are discussed in the next section.

3.8 THE CULINARY INNOVATION PROCESS

For new culinary products to be developed, the synthesis of strategy, marketing, culinary techniques and food science and technology are required. The whole process is inter-functional. To ensure success, the innovation needs to consider customer needs, market structure, organisational capabilities and the innovator's competencies (Hardy & Dougherty, 1997). In food product development, quality guidance is the belief that food products should be developed and improved to reflect consumers' desires and tastes for which understanding, and measurement of the consumer's quality perception process is a prerequisite (Steenkamp, 1990). Such quality guidance consists of three steps, namely:

- Measurement of the quality judgements made by consumers
- Separating the quality judgements, such as the perceptions of intrinsic quality cues and quality attributes
- Linking consumer perceptions with respect to intrinsic quality cues and quality attributes to physical product characteristics.

It is important to be aware of the expectancies of the physical product characteristics that contribute most to the consumers' perception of high quality.

Figure 3.3 represents Harrington's (2005) culinary innovation model. The model reflects the repetitive, integrative and ambiguous nature of this process within the food service industry and consists of four phases:

- culinary innovation formulation
- innovation implementation
- evaluation and control
- innovation introduction

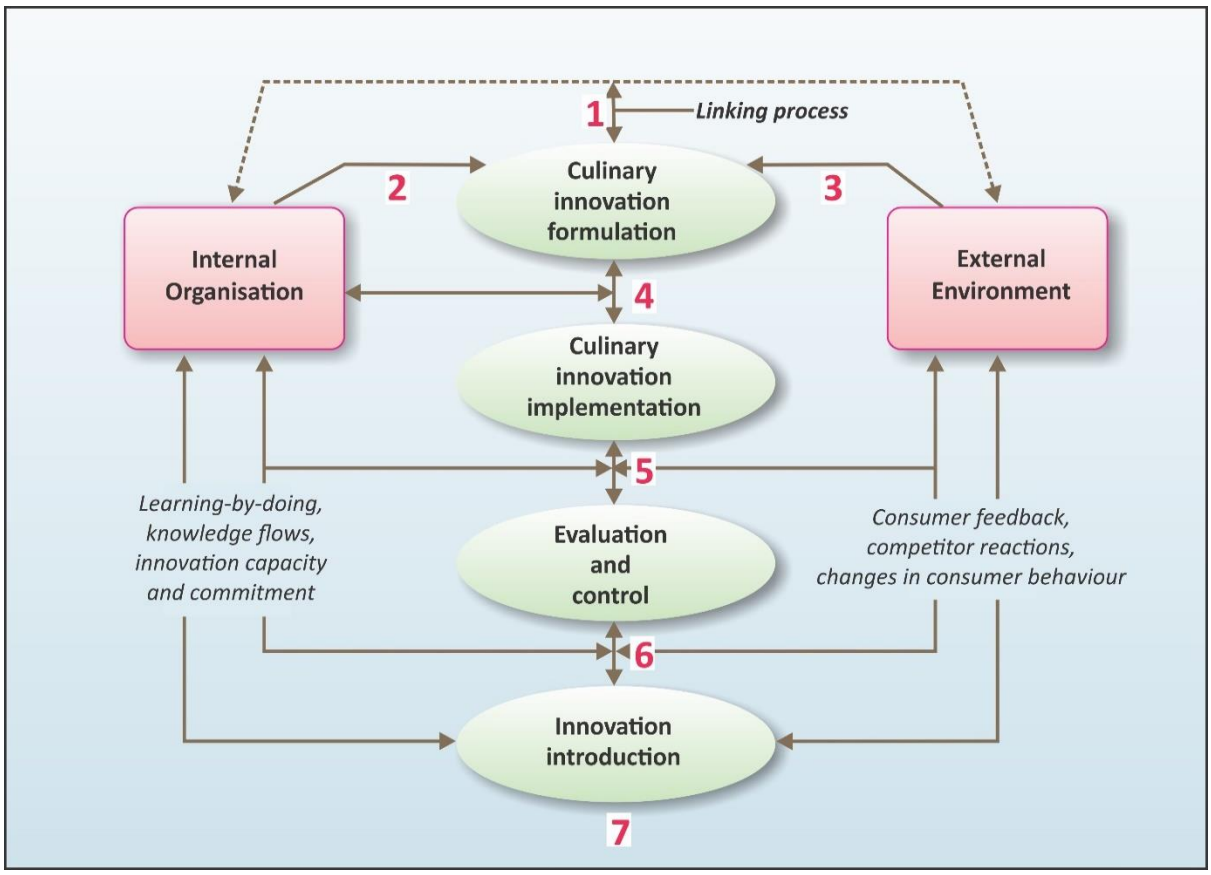

Figure 3.3: Culinary innovation model (Harrington, 2005)

The solid arrows in the model indicate direct relationships between the phases that represents its integrative nature; double-sided arrows indicate the repetitive and shared relationship between phases; and dotted arrows represent the direct relationship between elements of the model. Table 3.3 represents the steps involved in each of the phases. Phases 1 to 4 is shortly described below.

Table 3.3: Steps in the culinary innovation process

Phase	Elements in process
1. Culinary innovation formulation	• Setting the stage • Selecting the interdisciplinary team • Planning and linking process • Product definition • Chefmanship • Food science
2. Culinary innovation implementation	• Formulation(s) • Prototype benchmarking • Sensory analysis
3. Evaluation and control	• Consumer testing • Scale-up • Process development • Production transference • HACCP analysis
4. Innovation introduction	• Support • Continual feedback

3.8.1 Phase 1: Culinary innovation formulation

Product innovation involves the synthesis of internal and external considerations and the use of culinary and food science techniques (Hardy & Dougherty, 1997:425). Internal considerations include knowledge, capabilities, relationships and resource sharing, equipment, space and other limitations and culinary identity. External considerations include consumer behaviour, competitor analysis, trends, seasonality, food safety, regulations and demand analysis. Culinary techniques involve food preparation, presentation, flavour combination and ethnic influences, to name but a few. Food science techniques include consideration of the chemical properties of food, ability to use food preservation techniques, the use of speciality products and sensory analysis techniques (Harrington, 2005; Moskowitz, 2001; Pyne, 2007; Stewart-Knox & Mitchell, 2003).

3.8.2 Phase 2: Culinary innovation implementation

The success of culinary innovations depends on continuous evaluation. It is assessed through general preferences, production capabilities, consistency requirements, cost considerations, taste and appearance preferences, timing issues and process improvement considerations. These issues are assessed in the implementation phase by formulation testing, prototype development, benchmarking the proposed product against competing products, and sensory analysis. Culinary innovation formulations focus on the key characteristics of the product, those which are appealing to the consumers. Formulation testing, prototype creation, benchmarking and sensory analysis could be seen as one process. Although culinary staff or restaurant servers can do sensory analysis informally,

a more structured consumer panel is much more preferred to guarantee success (Harrington, 2005; Rudolph, 1995).

3.8.3 Phase 3: Evaluation and control

This phase involves customer feedback loops, revisions to be made to the innovation, learning and a control system to ensure consistent high-quality outcomes. The product has to be tested to ensure value-adding characteristics to the consumer. This also gives a competitive advantage. It can be done through consumer panel testing or through external considerations. This process gives an on-going flow of knowledge and learning. Up-scaling should be done to ensure the same results with a higher volume. Considerations of the robustness of the product has to be taken, i.e. how much variation the recipe the product can take to still make it acceptable to the consumer (Schonberger, 1994). Lastly, in this stage, health and safety hazards need to be identified and procedures should be put in place to eliminate them. A basic HACCP framework can be used to minimise and prioritise possible hazards (Harrington, 2005; Rudolph, 1995).

3.8.4 Phase 4: Innovation introduction

Not discussed or implemented in this study.

3.9 SENSORY EVALUATION

Sensory evaluation can be defined as “a scientific discipline used to evoke, measure, analyse and interpret reactions to those characteristics of foods and materials, as they are perceived by the senses of sight, smell, taste, touch and hearing" (Stone *et al.*, 2004). It has many purposes, for example, product development and improvement, cost reduction of recipe and food products, quality control, product grading, shelf life tests, consumer acceptance and preference, or the measurement of physical characteristics (Lawless & Heymann, 2010:17).

Sensory evaluation is an analytical test procedure, which is done with precision, accuracy and sensitivity (Meiselman, 1993). Precision can be ensured by controlling the environment in which the evaluation takes place, isolating the participant and preparing and presenting identical samples. This precaution is taken to avoid error variance and to obtain the same results if a test is repeated.

Accuracy is related to the principle of validity. Validity is the ability of a test procedure to measure what it was designed and intended to measure. Predictive validity is a criterion to ensure validity,

which means that the results of the sensory test should generalise to the larger population. The researcher has to look at the end use of the information that the tests will provide. Test methods might be relevant for some purposes but not work for others (Meiselman, 1993). External validity suggests that other factors such as suitability for use (Schutz, 1988), expected sensory properties (Moskowitz, Chandler, Moldawer & Laterra, 1979) and possibly observation of actual behaviour (Dijksterhuis, Bos, Nordgren & Van Baaren, 2006) should support the type of sensory and hedonic measurements used in a study.

A sensory test should not miss the important differences that are common between food products. 'Missing a difference' means that an insensitive test procedure has been conducted. Careful experimental control and screening and training panellists beforehand is recommended to ensure that a sensitivity error of variance is avoided. Sufficient repetitions of measurements is likely to yield a tight and reliable statistical estimate of the values (Lawless & Heymann, 2010:3).

There are three main types of sensory evaluation are discrimination tests, descriptive tests and affective tests (Lawless & Heymann, 2010:5). These methods are used to determine the human perception of the characteristics of foods (McWilliams, 2017:46). Difference or discriminative tests only attempt to determine if any perceptible difference exists between products. Most common methods are the triangle test, duo-trio tests, paired comparison tests and ranking tests. Triangle and duo-trio tests determine if a sensory difference exists between two samples. A paired comparison test establishes in which way the products differ (A is less juicy than B). Ranking tests organise a set of samples according to their intensities (from tough to tender meat). In this study, two of the three evaluation techniques were used, descriptive and affective tests. Descriptive evaluation is done in an objective manner and affective tests deliver subjective results. These methods are discussed below, starting with descriptive analysis as it was applied in the first phase of the study.

3.9.1 Descriptive sensory analysis

Descriptive tests determine how the products differ in specific sensory characteristics. They are one of the most sophisticated tools and can measure both quantitative and qualitative sensory components of a food product and are carried out by trained sensory panel. The panellists first compile a prepared descriptive vocabulary from a relevant lexicon. These chosen attributes describe the product that will be tested and will be used to evaluate changes noted. The five different descriptive test methods are flavour profile, texture profile, free-choice profiling, spectrum descriptive

method and quantitative descriptive analysis (QDA®). Only QDA® will be discussed as it was used in this study. The process of lexicon development is outlined in the sub-section (3.9.1.2) that follows.

3.9.1.1 Quantitative Descriptive Analysis®

QDA® resulted from a need to address the gaps that the other four recognised standard methods in use did not cover and which researchers had noticed (Sidel & Stone, 1993; Stone, Sidel, Oliver, Woolsey & Singleton, 1974). The biggest problem for sensory scientists was the lack of statistical analysis and the treatment of the data obtained (Meilgaard *et al.*, 2007b:180; Stone & Sidel, 2012:216). The method largely relies on statistical analysis to determine the components such as the appropriate terminology, procedures and panellists that are used in the process of evaluating the product (Meilgaard *et al.*, 2007b:180).

Selection and training of panellists should be considered carefully (Bárcenas, Elortondo & Albisu, 2000; Noronha, Damasio, Pivatto & Negrillo, 1995) as they are the instrumental tools in descriptive sensory analysis (Heymann & Lawless, 2013). Participants serving on the panel have to be motivated and interested in the research. A thorough screening process takes place to determine this. Their reliability and ability to follow instructions are also considered. Competence to carry out their tasks are important and factors such as colour blindness, allergies, smoking habits and health aspects too are judged (Heymann, King & Hopfer, 2014). When it comes to training the panellists, the goal is to familiarise them with test procedures, improve their ability to identify sensory attributes and to increase their sensitivity and memory for precise and consistent evaluation. The ideal number of panellists is 8-12 (Heymann & Lawless, 2013) but could be either more or fewer depending on the specific sample as they do differ (Mammasse & Schlich, 2012).

Samples can be evaluated in many ways, depending on the desired outcome of the study. If samples are evaluated visually or tactilely, up to 15 or 20 samples are possible. If the flavour or odour attributes are evaluated however, fewer samples can be done consecutively. This should be considered especially if a sample is highly astringent (wine, spirits, vinegar) or spicy (chillies, salsas, curries). In this case, palate cleansers or a rinsing regime should be used between samples to prevent carryover effects (Ball, 1997; Qannari, Wakeling & MacFie, 1995). As a rule of thumb, six samples are evaluated in this case (Heymann *et al.*, 2014).

The important features performed in the QDA® technique are:

- Introspection to develop perceived sensory attributes
- The development of language to structure a relevant vocabulary for an investigation (lexicon)

- Repeated judgements
- Interval scales to choose and define a 9-point Likert scale
- A multidimensional model as graphical representation

QDA® contributed to sensory science by using human subjects as measuring instruments, the use of graphic scales to reduce the occurrence of bias in scaling, the statistical treatment of data, the separation of panellists during evaluation and the graphical representation of the data (Meilgaard *et al.*, 2007b:180).

3.9.1.2 Lexicon development

Developing a lexicon means developing a sensory profile for a specific product. The goal is to determine, through consensus, the attributes that are different between the samples (Heymann *et al.*, 2014). First, panellists are presented with the product and then asked to compile a list of characteristics that they think are relevant to this specific commodity. These terms should be objective and actionable to give a reference standard of the word. A term such as “delicious” is not acceptable, but “green vegetable” is. “Delicious” is a subjective term that is more likely to be found in affective tests, performed by consumers (Heymann *et al.*, 2014).

A list is then compiled from the descriptive terms given by each panellist. Words that are considered similar are grouped together to form a shorter list of descriptive terms. This process is repeated several times. The whole list of descriptors is then rearranged and reduced to a working list of comprehensive terms. It is essential that consensus is reached among the panellists.

Sensory concepts are often different between individuals and therefore reference samples are necessary. Panellists could be using different words to describe the same underlying characteristic. One panellist can, for example, describe the aroma of a product as “woody” and another as “mushroom”. If both these items are presented to the panellist, a consensus is reached on which term best describe the sensory experience (Meilgaard *et al.*, 2007b:153). In the case of crocodile meat, a reference would be a cooked chicken breast or a piece of white fish. Crocodile meat is compared in literature to these terms (Huchzermeyer, 2003).

Second, reference standards are used for anyone who was not present at the training sessions and would need to evaluate the product. It is also acting as a translation device for those reading a report or article of the study (Heymann *et al.*, 2014). QDA® can then be performed using the developed

lexicon. A trained sensory panel evaluates the products using these sensory characteristics. The type of test will be described below.

3.9.2 Affective sensory analysis

Affective tests are used in consumer panel and their objective is to determine a personal response that can be either a preference or an acceptance, which represents a potential user's point of view (Heymann & Lawless, 2013). Producers of consumer goods as well as service providers like restaurants or hospitals, use affective tests. Hedonic rating scales on a nine-point scale are most commonly used and range from 1-9 representing *Dislike Extremely,* to *Like Extremely*. In this research the participants were mostly untrained consumers whose responses were subjective evaluations.

Affective tests can be classified in two categories namely preference and acceptance. Preference tests determine which sample the consumer prefers, or which sample do they like better. Acceptance tests determine how much they like the product, or how acceptable it is. There are also two methods to follow in affective tests – qualitative or quantitative. Qualitative affective methods are implemented in an interview or a small focus group. Some of the goals of qualitative tests are to identify consumers' unexpressed needs; to assess their initial responses to a specific product; to learn consumer terminology; and understand their use of a particular product (Meilgaard *et al.*, 2007b:269). In this study about food preferences, quantitative affective tests were conducted. The responses from a large group of consumers were analysed to determine the liking or experience of sensory attributes, as it was considered an appropriate evaluation method.

3.9.2.1 Consumer sensory evaluation

Consumer sensory evaluation is mostly done towards the end of the culinary innovation process. Usually at this stage, the researcher is interested in whether the consumers like the product and find it acceptable or not (Heymann & Lawless, 2013:303). Factors that influence the external validity of food acceptance are the types of respondents; the test environment; the measurement unit; and the type of stimuli (Van Trijp & Schifferstein, 1995). Although there are many arguments for and against consumer sensory evaluation in product development, Ares and Deliza (2010) have stated that consumer data will portray a better understanding of how consumers are likely to perceive the product on the market.

It is suggested that the environment in which the test is done is as natural environment as possible (Köster, 1981; Meiselman, 2008; Schutz, 1988; Van Trijp & Schifferstein, 1995). In this study, data was

collected for a consumer evaluation of products available at the main campus of the University of Pretoria, which is a controlled and not a natural consumption environment. A typical consumer test needs more participants than a trained sensory panel. The ideal number ranges from 100 to 500 consumers and targets the population for which the product is intended. Potential participants should be screened first by means of an interview over e-mail, telephone or at a shopping mall (if relevant to the study). Consumer tests mostly demand that the participant is a regular consumer of the product and adheres to predetermined criteria for the target population, chosen a characteristic of the target group regarding age, gender, income group and similar variables (Meilgaard *et al.*, 2007b:256).

The product should be screened before it is introduced to customers which should happen at the right time and at the right place. The compilation of the questionnaire has to be considered and pre-tested carefully (Meilgaard *et al.*, 2007b:256). Some guidelines for compiling a questionnaire are:

- The length of the questionnaire should be appropriate for the time the participants are expected or willing to stay to complete it properly. The minimum number of questions should be asked to reach the project objective/s.
- The questions should be clear and of a similar type. The scale should be consistent and should follow the same value sequence and direction, for example, if 1 represents *Dislike Extremely*, allocating a 9 would imply *Like extremely.*
- Questions regarding sensory attributes should address the attributes that are clearly detectable. Participants will not be able to answer questions about attributes properly if they are not able to perceive them clearly. This is why an initial descriptive test using a trained panel is important.
- Questions should allow the researcher to use data from the responses to take appropriate action that will yield meaningful results. Answers such as “the product is somewhat unattractive” do not give the researcher the information as to what needs to be changed or improved.
- Enough space on answer sheets should be left for consumers to answer open-ended questions or to elaborate on the answer they have given.
- The placement of the question of overall acceptance/preference answers should be carefully considered as it is usually the most important objective of a study. In most cases it is placed first, as that is the point at the beginning where the consumer tends to pay most attention. However, it can also be placed after consideration of all the separate attributes if thus designed, and only then is the final decision of overall liking made.

3.9.3 Sensory attributes

In order, there are mainly four attributes that are perceived in a food item, and they are appearance, aroma, texture and then flavour. In the process of sensory perception, all attributes overlap and support the experience of the others (Tuorila, 2007:34). It is nearly impossible, without training, to evaluate each attribute independently (Meilgaard *et al.*, 2007b:256). Multimodality of sensory attributes emphasises the importance of the initial and the entire impression of a product. To make a product acceptable, the initial impression of a product creates the expectation that has to either be confirmed or disconfirmed in a successful, positive manner (Tuorila, 2007:34). The sensory attributes that a person experiences are dealt with the in four sub-sections that follow.

3.9.3.1 Appearance

The appearance of a product is the first information that a consumer receives and in a commercial environment, it is often the only attribute that a purchase decision can be based (Meilgaard *et al.*, 2007b:8). Trained panellists also use the appearance of the product for inference. Products are often tested under coloured lights to prevent subjective evaluation. Appearance characteristics include the following

- Colour: is said to be the most important quality cue in foods and particularly relevant to meat products (Cardello, 1996:13). The hue, value and chroma of the Munsell colour system that comprises blue, green, yellow and red, is the visual system of light that stimulates the perception of the product. In food, evenness of colour is important and can indicate the quality of the product. Discolouration often indicates the deterioration of a food, for instance, bananas start browning. In the case of white meats, a pink or red appearance in its cooked form is associated with undercooking which, for some consumers, is highly unacceptable (Fletcher, 2002:132).
- Size and shape: the length, thickness, width, geometric and other shapes, and size could indicate defects of the product (Heymann & Lawless, 2013). The acceptance of products such as cookies, crackers, cereal, candy and fresh produce are influenced by their own characteristic identities and are judged accordingly (Cardello, 1996:13).
- Surface texture: the appearance of factors such as being shiny or dull; rough or even; wet or dry; hard or soft and similar descriptors. This also gives important clues to other sensory attributes of the product (Cardello, 1996:12).

3.9.3.2 Aroma

Aroma is the odour of a food product. Aromatics are volatiles that are perceived through the olfactory system from a substance in the mouth (Meilgaard *et al.*, 2007b:8). Aroma also plays a significant part

in the perception of flavour and contributes to the perception of the five taste sensations (Coggins, 2007:92). For an untrained person, such as a consumer, it is difficult to name a specific odour, but the hedonic perception is clear. Therefore, in product development and research, the affective dimension of odour is important (Larsson, 2002). When evaluating aroma with a trained panel, it is recommended to fan the air around the food product to direct the aromatic compounds towards the nose by hand. Meat products are best-evaluated warm, as the volatility of the aromatics are related to the temperature of the meat. Higher temperatures make it easier for judging (McWilliams, 2017:48) and, naturally, enhances the perception of flavour (Coggins, 2007:92).

3.9.3.3 Texture

Texture is a sensory attribute that is perceived by sensors in the mouth, assessed without chemical feelings and tastes. Texture experienced in the mouth is referred to as mouthfeel, which typically includes astringency, viscosity and oiliness (Lawless & Heymann, 1999). In contrast to aroma identification, there are many descriptive terms for texture. Szczesniak and Kahn (1971) found early on that crispness and crunchiness are commonly liked textures. Textures such as soggy, watery, lumpy, sticky, slimy, crumbly and tough are the least liked sensory characteristics. Generally, this is because of the lack of control in the mouth.

Tenderness and juiciness are part of texture perception and are important factors to consider in the production of meat products (Coggins, 2007:94). Connective tissue and muscle fibres (Koohmaraie, Babiker, Merkel & Dutson, 1988) determine tenderness. More connective tissue is present in muscles that are used in movement, as opposed to a loin that is only present for structural purposes. The older an animal is, the tougher the piece of meat is as well, due to increased collagen development (Coggins, 2007:94). Juiciness refers to the perception of moisture in the mouth upon mastication of the product that greatly contributes to the acceptability of the product, especially in the case of meat products (Coggins, 2007:95).

3.9.3.4 Flavour

Flavour is a combined impression of volatile components that originate from food in the mouth, the aromatics, and chemical feelings developing in the mouth (Meilgaard *et al.*, 2007b:256). Five basic taste types are stimulated in different areas in the mouth – sweet, bitter, salty, sour and umami which is savoury. The tip of the tongue is associated with sweet and sour sensations, the sides to sour and salty and the back to bitter taste perception (Brown, 2018:3). Flavour is also distinguished from taste in that it stems from a broader concept. Flavour involves the perception of aroma as well. If, for example, one cannot smell a food product due to nasal congestion, it interferes with the function of

the olfactory sense (De Roos, 1997:60; Porzio, 2007:22). Heat application is necessary for complete development and perception of white meats, as is the case with aroma perception (McKee, 2007:431). Consumers will mostly refer to the flavour of a product in a hedonic way, for example, “it tastes bad”. Trained panellists, however, should be able to objectively identify and evaluate flavour characteristics, as it is the most influential factor in the consumer’s selection and acceptance of a food product (Drewnowski, 1997).

3.10 THE CHECK-ALL-THAT-APPLY (CATA) TECHNIQUE

Food product developers need to know which sensory characteristics consumers like, but also what their expectations are. Their expectations indicate what the drivers of liking are (Guinard, Uotani & Schlich, 2001; ten Kleij & Musters, 2003). Consumers are not always able to phrase why they like a product, therefore preference mapping techniques are widely used (Greenhoff & MacFie, 1994; Guinard *et al.*, 2001; Murray & Delahunty, 2000; Schlich, 1995; van Kleef *et al.*, 2006). This technique attempts to correlate consumer preference ratings to perceived sensory characteristics with the intention of determining how these characteristics affect consumer liking (Arditti, 1997; van Kleef *et al.*, 2006). The limitation that preference mapping has, however, is that it assumes that consumers and trained panellists perceive a product in the same way. Consumers are asked how much they like the product, but not how they perceive the sensory characteristics (Faye, Brémaud, Teillet, Courcoux, Giboreau & Nicod, 2006). An alternative technique to determine consumers’ perception is to use the CATA technique.

The Check-All-That-Apply (CATA) method is a novel sensory evaluation technique that can be used to obtain rapid product profiles that is more representative of the consumer market than trained sensory assessors. A CATA test should have at least 50 participants, although it is recommended to have more (Meyners & Castura, 2014:275). This method is relatively simple and allows the consumer to give sensory information using the same terms without affecting hedonic responses and leading them to think in an uncharacteristically analytical manner (Adams, Williams, Lancaster & Foley, 2007). A list of characteristics that might be applicable to the product being assessed is presented to a consumer. They must then check the characteristics that they find describe the product appropriately. The terms on a written questionnaire can include sensory characteristics, hedonic responses, emotional responses, purchase, potential applications, product positioning, or other terms that the consumer might associate with the sample (Meyners & Castura, 2014:272).

CATA results are often supported by liking questions to relate it to consumer acceptance. It can also be combined with demographic and psychographic questions to provide a so-called All-In-One test (Giacalone, Bredie & Frøst, 2013). The researcher can be sure that terms that are checked have been carefully considered and are considered appropriate to describe the product. The unchecked terms, however, could indicate that it has not been experienced in the product, or that it has been experienced but the term is not considered the appropriate description for the product. It could also mean that the term has not been properly considered or the consumer feels undecided or uncertain. CATA tests also have the advantage of speed, as it is completed much quicker and with less instruction than other sensory tests. If it is combined with hedonic questions, the ideal product can be identified as well as insights into why it is considered the ideal product.

The negative aspect of CATA tests is that it does not provide intensity ratings of an experienced attribute. CATA frequencies, however, do correlate with intensities in some studies (Bruzzone, Ares & Giménez, 2012; Reinbach, Giacalone, Ribeiro, Bredie & Frøst, 2014). Assumptions are otherwise made that an increased frequency indicates the intensity of an experienced attribute, although it is not always accurate. Consumers might also understand an attribute differently than trained sensory panellists or product developers, which may result in inappropriate interpretation of results (Meyners & Castura, 2014:300).

CATA data can be analysed graphically and by means of statistical testing. Meyners & Castura (2014:280) provides this illustration of analysis methods (Table 3.4).

The counts from each sensory characteristic checked by each consumer has to be tabulated as a contingency table. These counts are merged and it can be expressed in percentages especially if comparisons between multiple studies are to be made. The contigency table is often presented as a bar chart to visually compare products and attributes. Significance testing will follow to determine if differences between the products exist, and if they are real or due to chance. Cochran's Q test is said to be the best to apply with such results (Meyners, Castura & Carr, 2013; Tate & Brown, 1970). Correspondence Analysis (CA) is another method used to present the contingency table visually, and can be seen as a generalisation of Principal Component Analysis (PCA), which is for ordinal or nominal data. As Meyners and Castura (2014:284) point out, CA gives a projection of the data in an orthogonal dimension so that as much of the variation in the data as possible is represented sequentially. It presents a 2D plot of the data, of the first two components. It can establish which attributes are normally go together and which are independently.

Table 3.4: Analysis options for CATA studies

Type of data available	Analysis methods
CATA data on real products only	Contingency tables
	Bar charts
	Significance testing
	Correspondence Analysis (CA)
	Multiple Factor Analysis (MFA)
	Multiple Discriminant Analysis
	Correlation of attributes (visualised via MDS)
CATA data + *liking* (or related)	Penalty-lift Analysis
CATA data + (hypothetical) ideal	Comparison of elicitation rates for real and ideal product with confidence intervals
CATA data + ideal + *liking*	Penalty Analysis
Metric can be based on the χ^2 distance or the Hellinger distance	

If liking data is collected with CATA data, Penalty-lift Analysis can be applied to determine how much liking of the product changes when an attribute is checked compared to if it has not been checked (Williams, Carr & Popper, 2011). Evaluation of an ideal and hypothetical product can accompany a CATA test. Cowden et al. (2009) compared the responses of the real product with the ideal product. The approach involves using a confidence interval for the ideal but not the real products, which ignores the statistical uncertainty about the ideal product. If liking data and ideal product is combined with a CATA test, penalty analysis can be used to determine gaps that exist between the real products and the ideal products and then analyse the effect it has on liking scores.

CATA is a valuable method to use for consumer research provided the advantages are optimised and the limitations are considered carefully. CATA is an ideal tool to use when a sensory profile must be developed for a new product. It is quick and easy to use, especially in the case of multiple products. The analysis can deliver immediate insights to consumer perceptions of a product. CATA was the ideal technique to use in this study because it was strategised to use novel food products. The design and application are presented in Chapter 4.

3.11 SUMMARY

In this chapter, literature regarding the main concepts supporting the research project were discussed. The literature available on exotic and crocodile meat was studied and it was evident that its value as

a meat product being acknowledged could be influenced by a consumer's reaction to novel foods. The stages and factors involved in food acceptance were explored. The product development and innovation process received attention, as did the experimental methods and analysis techniques involved in determining acceptability. This included the Check-All-That-Apply (CATA) sensory evaluation technique. The next chapter discusses the methodology followed in the study.

CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

This chapter introduces the research design and methodology. The plan on how the research was conducted, and procedures and tools were used are explained. The experimental design, data collection and analysis are presented. The matter of ethics, validity and reliability of the study are discussed as well.

4.1 INTRODUCTION

This chapter outlines the process the researcher followed, and the methods and techniques used to study the part crocodile meat could play in consumers' diets. It includes the study aims and objectives, conceptual framework, operationalisation, sampling and data capturing. The research design, which serves as a plan for how the study was completed is discussed first (Babbie, 2016:74).

4.2 RESEARCH DESIGN

The study is quantitative in nature. It comprises predetermined processes of validating relationships among objectively measured variables, and implementing standardised procedures to collect numerical data, a procedure Leedy and Omrod (2005:94) recommends. The study has two research approaches, exploratory and descriptive. According to Babbie (2008), exploratory research is done to study the field of knowledge that is available to gain new insights when formulating research objectives. The general motivation is to develop methods that can be repeated in further research on the subject, and also to test the feasibility of conducting current and other even larger studies (Babbie, 2016:92). In this study, the exploratory approach is supported by an extensive literature review that needed to be conducted as little information about the sensory properties of crocodile meat is available. This situation is developed and illustrated in the third chapter. The sensory profile of crocodile meat was determined through the results of administering sensory analysis tests that a trained sensory panel undertook, as explained in section 4.7.

Descriptive research entails making observations to analyse and the ideas Walliman (2011:12) documented for attempting to understand consumer behaviour were adapted for this study. The consumers' perception and experience of crocodile meat products will be discussed in section 4.9. An experimental design was adopted as a useful research strategy. The framework shown in a study, as

in Figure 4.1, must include independent and dependent variables, pre- and post-testing and experimental and control groups (Babbie & Mouton, 2001:209). The independent variables were the crocodile eye fillet, the ingredients and cooking methods used in the culinary innovation process. The dependent variables were all sensory variables and consumer perceptions that were measured. In this study the sensory attributes are flavour, aroma, appearance and texture and consumer perceptions expressed expectation, experience and acceptability.

The study was done in three phases with a preliminary phase to support the study. However, the steps followed in the preliminary phase are dealt with in this chapter. A trained sensory panel developed a sensory profile of crocodile meat using a word list and sensory evaluation forms (Addenda A and B).

In Phase 1, final year students at the University of Pretoria developed products using the culinary innovation process. The university supplied the ingredients, facilities and equipment. The products' sensory profile was developed using sensory evaluation forms completed by five expert panellists. Among the expert panellists were representatives from the food-manufacturing sector, experienced academic representatives and fellow students of the product developers with a broad knowledge of culinary food products. This evaluation process is dealt with more extensively in section 4.8.

Data was gathered in Phase 2 with an untrained consumer panel. The participating consumers' perception and expectations of crocodile meat products were ascertained from their completion of a prepared questionnaire (Addendum I). It also explored their demographic and psychographic characteristics that enabled the researcher to understand the typical lifestyle of the study's responding consumers.

In Phase 3, the consumer panel completed a sensory evaluation form (Addendum I) about the samples of each product they were served. This form mostly consisted of affective tests, which includes preference and acceptance evaluation. The ultimate aim of the set questionnaires was to determine the identified consumer's experience, liking and acceptability of the products. The layout of the research is explained in the next section.

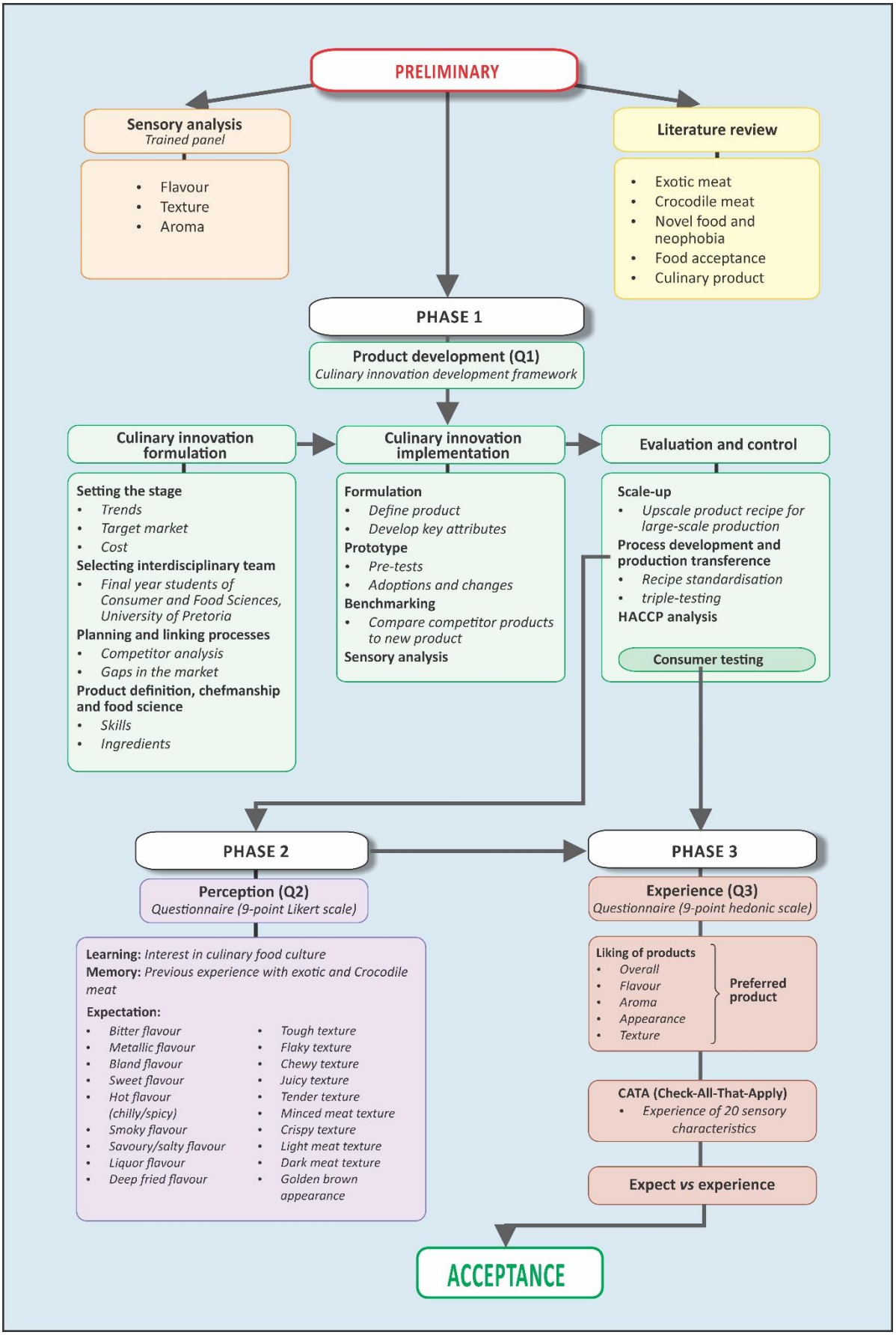

Figure 4.1: Experimental design of the study

4.3 RESEARCH AIMS AND OBJECTIVES

4.3.1 Aim of the study

The overall aim is to determine consumer perception of crocodile meat and to develop suitable, acceptable culinary products for the mainstream South African consumer. The following is the study's main and sub-objectives:

4.3.2 Research objectives

- **Objective 1:** To develop, test and standardise culinary products using crocodile meat applying the culinary innovation process.

  Sub-objective 1.1*: To develop culinary products using crocodile meat as main ingredient.*

  Sub-objective 1.2: *To determine sensory attributes of the products during the culinary innovation process.*

- **Objective 2:** To explore, describe and understand consumers' perception of exotic meat products, specifically referring to crocodile meat.
- **Objective 3:** To determine the consumers' sensory evaluation and hedonic reaction toward the new culinary meat products, which will determine acceptability.

  Sub-objective 3.1: *To determine the liking of sensory attributes of the culinary products.*

  Sub-objective 3.2: *To determine the consumers' experience of the culinary meat products.*

  Sub-objective 3.3*: To determine the relationship between the consumers' demographic characteristics and their acceptability of crocodile meat.*

4.4 CONCEPTUAL FRAMEWORK AND EXPERIMENTAL DESIGN

The conceptual framework for this study on the development of acceptable culinary products is presented in Figure 4.2. It shows the preliminary phase up to the final phase of acceptability of crocodile meat as a food. The first two stages, physical attributes and sensory characteristics were established by conducting a literature review and the sensory profiling was in the hands of a trained panel. The innovation stage was added to the original model, which forms the culinary innovation phase, Phase 1. Objective 1 was also achieved in this phase. The perceptual stage followed in which the consumer's expectations were identified. This formed part of Objective 2 in Phase 2 with data collected from a consumer panel. The stage of sensory and hedonic experience led to the determining the acceptability of the products in response to the stated Objective 3 in Phase 3. The researcher combined two frameworks to achieve the goals of this study, resulting in a new conceptual framework

as presented in Figure 4.2. This framework indicates how culinary innovation can play a role in consumers' acceptance of a food product.

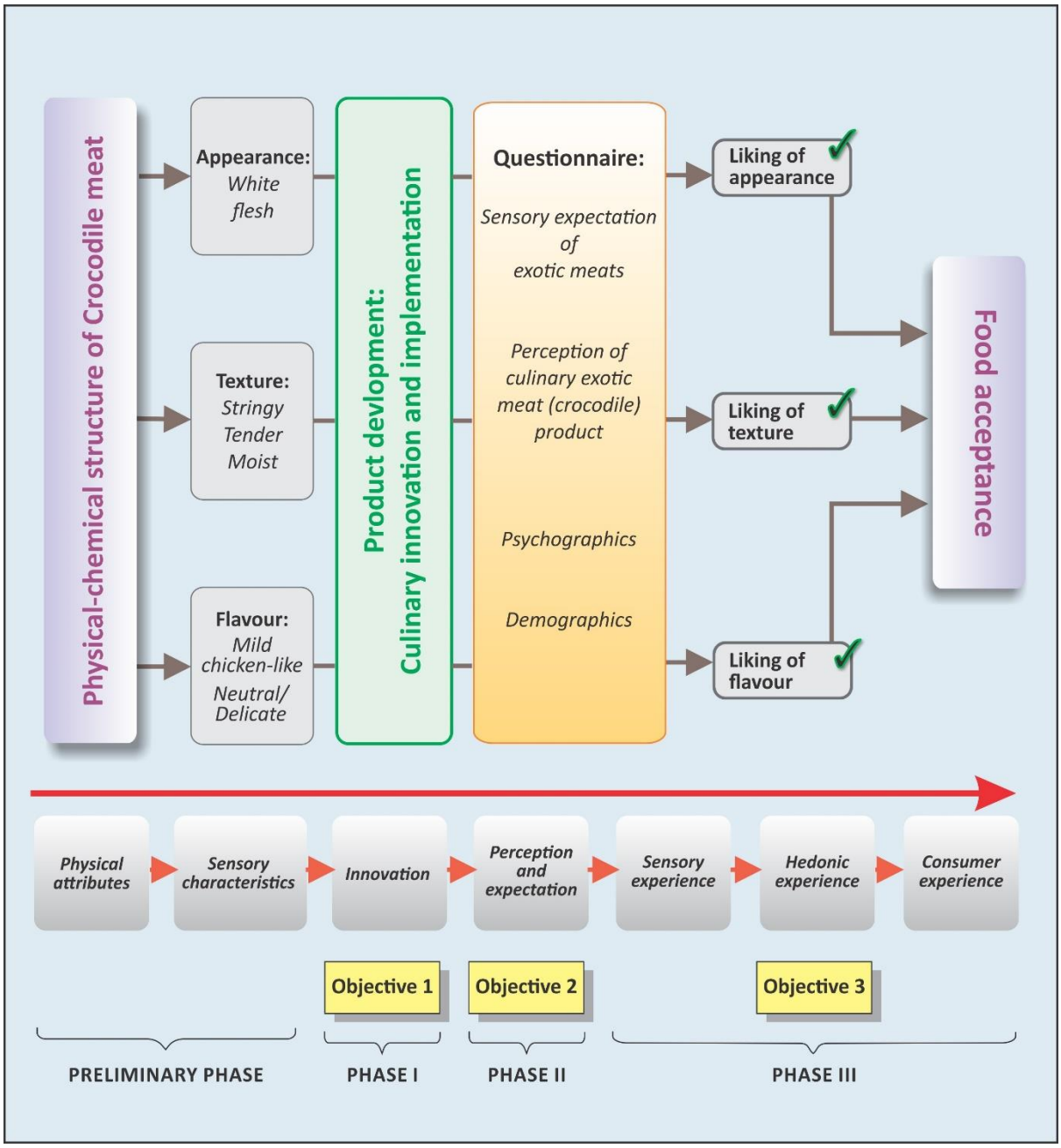

Figure 4.2: Conceptual framework

4.5 OPERATIONALISATION

Operationalisation indicates in which way the concepts in the conceptual framework are measured, as shown in Table 4.1 (adapted from Babbie and Mouton, 2001:128). It is, in essence, the map used for the study, which lays out the objectives, what is measured, how it is measured, the indicators and the data analysis techniques that assist in interpretation of the data to produce the results.

Table 4.1: Operationalisation

OBJECTIVES	MAIN CONCEPTS	DIMENSIONS	INDICATORS	MEASURING INSTRUMENT	DATA ANALYSIS
Objective 1: To develop, test and standardise culinary products using crocodile meat applying the culinary innovation process					
To develop culinary products using crocodile meat as main ingredient	Culinary innovation formulation/ product development process	• Formulation(s) • Prototype • Benchmarking	• Cooking method Ingredients Flavouring Presentation • Adjustment of product throughout process • Target market Pricing Gap in market Competition in market	• Dry-heat/moist heat Crocodile meat Food trends Flavour pairings Food photography • Supervisor evaluation Change in method Change in ingredients • Mainstream South African consumer Food cost Food trends & consumer wants/needs • Restaurants/retail outlets offering exotic meat products	• Informal sensory evaluation
To determine sensory attributes of the products during the culinary innovation process.	Evaluation and control / product development process	• Sensory analysis • Scale-up • Process development and production transference • HACCP analysis	• Flavour Aroma Texture Appearance • Increase recipe to 24 portions Change in equipment Change in method • Standardization Reproducibility • Possible hazards in production and development process	• Salt/ sweet/ bitter/ sour/ umami Tender/ tough/ crispy/ flaky Colour/ shape/ presentation • Factor method Percentage method • Triple testing • Biological, chemical or physical hazards	• Star diagrams • Descriptive sensory analysis

continues …

Objective 2: To explore, describe and understand consumers' perception of exotic meat products, specifically referring to crocodile meat					
	Perception	(Psychographics) • Memory • Learning • Expectations	• Previous experience with exotic meats Previous experience with crocodile meat Quality of previous experience • Interest in culinary food culture • Expectation of sensory characteristics: - Flavour - Aroma - Texture - Appearance	Questionnaire Section A 9-point Likert-type scale • Participants with previous experience: - quality of their experience - willingness to buy/eat the product - willingness to recommend such a • Interest in culinary food culture Interest in novel foods Familiarity with exotic meats • Flavour: Bitter, metallic, bland, sweet, hot, smoky, salty, liquor, deep fried • Aroma: Chicken-like • Texture: Tough, flaky, chewy, juicy, tender, minced meat, crispy • Appearance: Light meat colour, dark meat colour, golden brown	• Descriptive statistics: ○ Means ○ Standard deviations ○ Graphical presentations • ANOVA • Exploratory factor analysis
Objective 3: To determine the consumers' sensory evaluation and hedonic reaction toward the new culinary meat product, which will determine acceptability					
To determine the liking of sensory attributes of the culinary products	Consumer hedonic experience	Consumers' overall liking of sensory attributes of the different products	• Crocodile meat products - Smoked crocodile - Crocodile dumplings - Sous-vide crocodile - Crocodile strips • Liking of sensory attributes - Overall - Flavour - Aroma - Texture - Appearance • Willingness to purchase a product in future • Confirmation/ disconfirmation of expectation of the products	Questionnaire Section B • Sensory evaluation - Affective sensory tests - Consumer panel - 80< participants • 9-point Likert-type scale to score liking (1-disagree completely; 9-agree completely) • 9-point Likert-type scale; "I would buy this product at a supermarket" • 9-point Likert-type scale; "My experience of this product was as I expected"	• Descriptive statistics: ○ Means ○ Standard deviation ○ Graphical presentations • t-tests • Analysis of Variance (ANOVA)

continues …

Objective 3: To determine the consumers' sensory evaluation and hedonic reaction toward the new culinary meat products, which will determine acceptability *(continued)*					
To determine the consumer's experience of the culinary meat products	Consumer sensory experience	Experience of sensory attributes: • Flavour • Aroma • Texture • Appearance	• Flavour: Bitter, metallic, bland, sweet, hot, smoky, salty, liquor, deep fried • Aroma: Chicken-like • Texture: Tough, flaky, chewy, juicy, tender, minced meat, crispy • Appearance: Light meat colour, dark meat colour, golden brown	Questionnaire Section B • Sensory evaluation - Objective sensory tests - Consumer panel - 80< participants • Check-All-That-Apply (CATA) • Panellists indicate which of the sensory characteristics they experience with each product	• Descriptive statistics: ○ Means ○ Standard deviation ○ Graphical presentations ○ Frequencies • Cochran's Q-test • Correspondence analysis (CA)
To determine the relationship between the consumers' demographic characteristics and their acceptability of crocodile meat	Profile of consumers who find crocodile meat acceptable (target market)	Demographics Hedonic reaction toward sensory attributes	• Gender • Age • Population group • Qualification • Overall liking • Liking of flavour • Liking of appearance • Liking of texture • Liking of aroma	Questionnaire Section C • Male Female • 18-65 years • Caucasian Non-Caucasian • < Grade 12 Grade 12 Degree/diploma Post-graduate Questionnaire Section B Questions relating to overall liking of the products (Q4.1.1-Q4.5.4)	• Graphical presentation • Descriptive statistics – mean, standard deviation • Least square means • t-tests • Analysis of Variance (ANOVA)

4.6 RESEARCH METHODOLOGY

Figure 4.3 presents a summary of the research process to be followed and how it will be divided into three phases. This includes the measuring instruments and what will be measured. The figure indicates where each objective is addressed and makes the layout of the study clearer. The research will have a preliminary phase and then proceed with three phases that address the stated objectives:

- **Preliminary phase:** An extensive literature review was done before starting the planning and development of the products. This was to gain insight into available literature on the sensory properties of crocodile meat. Physico-chemical properties were explored (refer to Chapter 3.3). A sensory pilot study was conducted at the Agricultural Research Council (ARC) with a trained panel to develop a lexicon to describe a sensory profile for crocodile meat. This was necessary, as product developers have to understand what sensory properties they would need when working with a specific product. It follows the product definition, chefmanship and food science step of the product innovation process (Harrington, 2008:50).
- **Phase 1:** Culinary products using crocodile meat were developed using different cooking methods, each one with different ingredients and flavours, and the product had to be suitable for mainstream South African consumers. Harrington's (2005) culinary innovation framework was followed as a guideline for the development of the product and the steps followed were:
    - formulating the idea
    - developing a prototype
    - standardising the recipe and
    - conducting a sensory analysis.
- **Phase 2:** The consumer perception and sensory expectation of crocodile meat was established from participants who answered questions that related to their knowledge of exotic and/or crocodile meat. This was based on a previous experience of having encountered it. Randomly recruited consumers, who were not trained beforehand, completed a paper-based questionnaire answering questions on a nine point Likert-type scale.
- **Phase 3:** Sensory evaluation was done with the same consumers who participated in Phase 2. Their acceptability of the products was determined from their answers to questions, given on a nine point hedonic scale, about liking or disliking the specified culinary products. The consumer's physical experience of the sensory characteristics was determined using the Check-All-That-Apply (CATA) sensory technique.

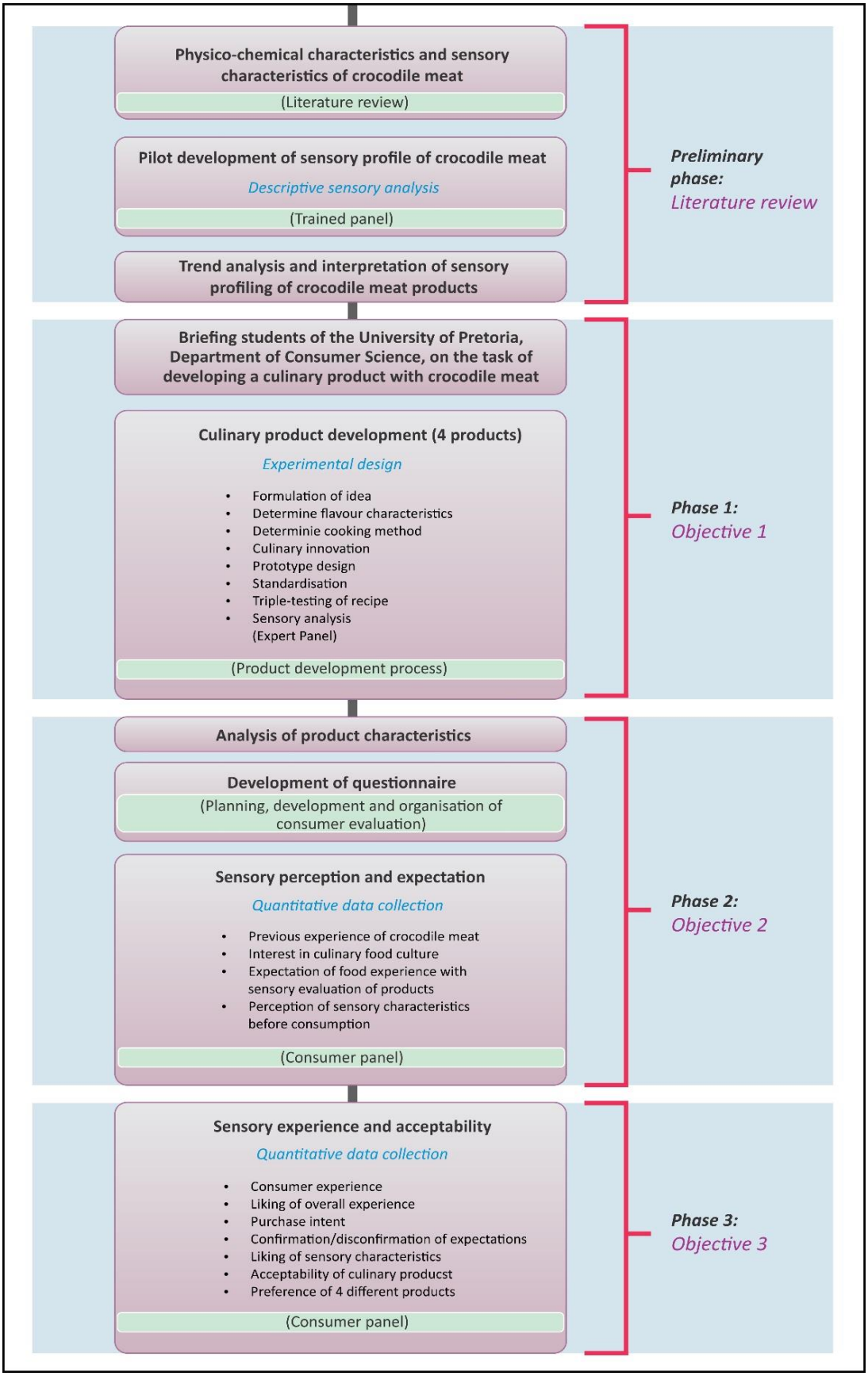

Figure 4.3: Methodological framework

Prior to finalising this research report, the manner in which the potential errors and ethical issues were dealt with in this study will be addressed. The research will have a preliminary phase and then proceed with three phases that address the stated objectives.

4.7 METHODOLOGY: PRELIMINARY PHASE

The aim of the preliminary study was to determine the sensory attributes of crocodile meat, since very little scientific information is available about it. Moreover, as detailed in Chapter 3, a thorough literature review was carried out to determine what is known about exotic and crocodile meats. Before starting the main research programme, a pilot survey was done prior to data collection for the main study. Results of the preliminary study were needed to finalise the decision concerning the type of products that could be developed. Discussion on the two main techniques applied in this research follows.

4.7.1 Descriptive sensory analysis

Seven trained panel members from the Agricultural Research Council participated in the lexicon that was required to describe the sensory profile of crocodile meat. The panellists selected had considerable experience in tasting and evaluating a variety of food types and were keenly interested in this project. This panel has extensive knowledge of and experience with chicken, beef, lamb and pork meat. They are familiar with sensory descriptors that might be present in many meat products and also consider off-notes therein. The researcher first outlined the panel's task, which was to identify the appearance, aroma, texture and flavour characteristics of the crocodile meat samples they were to be served. Reference samples of cooked chicken breasts, raw chicken breasts, cooked white fish fillets and raw white fish fillets were given. Crocodile tail eye fillets were baked in the middle rack of an oven at 190 °C for 20 minutes. Once cooked through at an internal temperature of 75 °C, the fillets were cut up into 1 x 1 cm portions and were wrapped in foil to keep warm. The samples were put in glass beakers that were pre-heated at 100 °C and then served to each panel member.

Each participating trained panellist in this objective evaluation received a cooked sample of crocodile meat without any additional flavour treatment. This first step was done in an interactive manner to come up with the correct words for the meat sample, as well as its descriptors and references. The panellists considered the meat and wrote descriptive words for each of the attributes, appearance, aroma, flavour and texture. The researcher and the panellists discussed each of the given words and finally one agreed similar descriptive term was chosen. Once consensus was reached about the descriptive word and its definition, a lexicon was developed for the crocodile meat. A sensory

evaluation sheet was compiled with these terms and the panellists evaluated another round of crocodile meat samples. A Quantitative Descriptive Analysis® followed to evaluate each of the identified sensory characteristics of the crocodile meat. Students were briefed about the ingredient that they had to work with to develop the crocodile meat products. Once Phase 1 was done, the study focus shifted to the consumer questionnaire dealt with in Phases 2 and 3 (refer to Figure 4.3).

4.7.2 Quantitative Descriptive Analysis®

With Quantitative Descriptive Analysis (QDA® - for more detail see sub-section 3.9.1.1), sensory experts could identify and quantify the sensory properties of a product. According to Stone and Sidel (2012:28), when this technique is used, data about the concepts and an ideal product is generated before and during the culinary innovation process. Hence, the trained sensory panel evaluated the crocodile meat sample objectively to understand what attributes the product developers should work with. The evaluation was done on a nine point Likert scale that ranged in intensity for each identified attribute. One (1) on the scale indicated the lowest intensity level and nine (9) was the most intense. Refer to Addendum A and Addendum B for detailed results and lexicon developed.

In the evaluation process, communication between the researcher and the panellists was minimal as the panellists evaluated the samples individually in taste booths that were located in a secluded area. The evaluation environment was controlled with regard to temperature, (room temperature set at 22^{o}C) odour (ventilation in preparation area) and noise (tasting booths in secluded area, closed doors and minimum communication between researcher and panellists). Panellists evaluated the samples individually under white light in taste booths, so as not to influence each other and form biased judgements. The evaluation was repeated three times, to ensure validity of data. The results were analysed and communicated to the product developers to continue with their innovation process. QDA® has been discussed in more depth in Chapter 3, sub-section 3.9.1.1. They also had doors that could be closed properly with only enough space for one person to move in freely. This meant that the evaluators were not disturbed by external noise and could not influence each other, which limited the possibility of judgements becoming biased and not true. Ventilation in the preparation area was controlled so that other odours could not penetrate further and affect a panellist's sense of smell and other receptors. Importantly the preparation room temperature remained set at 22^{o} C. The evaluation was repeated three times, to ensure the validity of the data. The results were analysed and communicated to the four product developers who then continued with the innovation process as dealt with in the next sub-section.

4.8 METHODOLOGY: PHASE 1

The results from the preliminary phase supplied the product developers with information to start the innovation process that had to follow a clearly defined procedure. It also formed a basis for the development of the preparation methods and the selection of ingredients. Four final year students in the Department of Consumer and Food Sciences studying food management degrees at the University of Pretoria developed the products as part of their curriculum for the successful completion of their undergraduate degree. Before starting the development process, the students were briefed on what is expected of them. They were also informed on the sensory characteristics of the crocodile meat that were determined in the preliminary phase. This gave them a good starting point to develop the new products.

4.8.1 Measuring instruments

Descriptive sensory analysis was used in Phase 1. The motivation behind this technique is that objective data has to be collected to develop the idealised product. QDA® was discussed in the preliminary phase (refer to section 4.7), therefore only the application to Phase 1 will be discussed below. With QDA®, sensory expert individuals identify and quantify the sensory attributes of a product (Stone & Sidel, 2012:28). The steps applied in Phase 1 are discussed below:

4.8.1.1 Baseline recipe

The baseline recipe serves as a starting point for a food product developer and is acquired through thorough research that considers the target market, trends, costs, the design of the brief and consumer wants and needs. The baseline recipe functions as a point of reference for the further development of a product. The students responsible for the product development used recipe books, internet-featured recipes and food magazines as resources. The range of the products offered at large retail stores and in restaurants were investigated to access novel ideas as well. The types of ingredients, ingredient measurements, the recipe yield, use of equipment and cooking times were adjusted to comply with an acceptable standard concept for the final recipe. Harrington's (2005) culinary innovation process was followed while building a prototype for the baseline recipes (refer to section 4.8.3.2). They were adjusted after each development session. Self-analysis of the baseline recipe took place as the product developer created a sensory profile of the food product in similar vein (see section 4.8.1). The sensory characteristics the student identified at this point became the criteria used for the standardised evaluation sheets made for the entire development process. The sensory expert panellists then evaluated them as explained in the next sub-section.

4.8.1.2 Expert panel evaluation

Five expert panellists were selected at the start of the culinary innovation process. This panel consisted of fellow students, an expert from the industry and experienced lecturers. These panellists evaluated the products after every development session, to ensure that reliable data was collected. The appearance, aroma, texture and flavour characteristics were identified from the baseline recipe. The judgements were made on a five-point Likert-type scale on standardised evaluation forms. An example of this form appears in Addendum C. At the end of each product development session, the panellists evaluated each characteristic from 1 “undesirable/no” to 5 “desirable/yes”. The products were then adjusted according to the comments received in the next session. The same panellists did further assessments which is why the products changed numerous times throughout the development process. This was done to improve the products and keep the judgements accurate. Using the same panellists throughout the development process ensured objective and reliable results.

4.8.1.3 Recipe standardisation

The baseline recipe each student used might not have given the desired yield. Therefore, the quantities had to be decreased or increased to reach the desired yield. This might have led to alternate cooking times, cooking methods or equipment used. The product developers had to consider their actions thoroughly and constantly keep regular notes of these points throughout the development process. Comments and recommendations from the expert panel observing the students also had to be carefully and fully recorded. This is an essential part of the standardisation process. Spears and Gregoire (2007:225) point out that it is important to know that each repeated evaluation brings with it an improved standard of quantity and quality of the product.

In this study, triple testing the final recipe enhanced the total view of the judgements the evaluators made. After the expert panellists’ evaluation of the products, and careful adjustment of the ingredients, methods, yield and portion sizes, meant the recipe was tested thrice. This was to ensure product transference (refer to discussion in sub-section 4.8.2) and allow the recipe to be considered as having been standardised.

4.8.1.4 Scaling up

In the third stage of Harrington’s (2005) innovation framework, product recipes are scaled up. The ingredients of standardised recipes can be scaled up using the factor and/or percentage method. It is essential to do this to maintain a consistent quality in product preparation. The factor method is applied by dividing the desired yield by the known yield to obtain the basic factor. Multiplication of the known yield by this factor provides the desired yield (Swanepoel, Loubser & Visser, 1992:9). The

percentage method gives the amount in weight of each ingredient as a percentage of the total weight of all the ingredients used in the recipe. To gain the desired yield, the percentage of each ingredient is multiplied by the new total yield required (Swanepoel *et al.*, 1992:10). Such recipes are used for large-scale production, which can be implemented in a restaurant environment or for food retail purposes as was the case in this study.

A list of all the sensory characteristics identified for each product during the culinary innovation process was compiled. Terms from the lexicon developed for crocodile meat for this study were added to this list, resulting in 20 sensory characteristics in total. These characteristics were used in the consumer evaluation questionnaire for Phases 2 and 3. The formulation of the questionnaire will be discussed in sub-section 4.9.1.

4.8.2 Sample and sampling

4.8.2.1 Unit of analysis

The crocodile tail fillet was the unit of analysis for all products in which the appearance, aroma, texture and flavour characteristics of the samples were evaluated. The handling, preparation and cooking of the sample are explained in the next sub-section.

4.8.2.2 Sampling

Samples of the crocodile meat were obtained from a well-known crocodile farm in Limpopo, South Africa, namely the Thaba Kwena Crocodile Farm. All students used the tail eye from the crocodile carcass. This cut was specifically selected, as its characteristics are closest to a chicken breast. In addition, it is also known to be easy to prepare using both moist and dry heat cooking methods. The samples received were already portioned and in a frozen state. The meat was kept in a freezer at the University of Pretoria at -18 °C. For each product development session, portions of between 150 g – 500 g were defrosted at 4 °C and the recipe of the student determined the weight.

4.8.3 Data collection

Harrington (2005) defines culinary product innovation as “the conceptualization, development, launch and on-going management of a new culinary innovation”. For an innovation to succeed in the development of a new product for the market, it is necessary to ensure that the operational design reflects customer needs, the structure of the market, organisational capabilities and other unique competencies within the firm (Hardy & Dougherty, 1997). Harrington’s (2005) ‘Culinary innovation model’ was used for this research, as described in Chapter 3.6. To achieve the study’s first objective

of developing, testing and standardising culinary products using crocodile meat, the practical task was given to final year students of the Department of Consumer Science at the University of Pretoria as part of their final year subject Product Development. The students were given a brief for developing the products required. The students also helped in the consumer evaluation phase by preparing the samples and helping in the serving process. This is discussed later in section 4.9.

4.8.3.1 The brief

The brief given to the four students was to develop mainstream culinary products using crocodile meat, which would be acceptable to the South African everyday consumer. Two of the products had to be prepared using dry-heat cooking methods and the other two moist heat cooking methods. The students had to focus on African flavours, while keeping current trends in mind.

4.8.3.2 The culinary innovation process

This study was based on the culinary innovation development framework of Harrington (2005). Below the part relevant to phase one of the study will be discussed, based on the culinary innovation development framework of Harrington (2005), culinary innovation formulation.

This sub-section dealing with data collection links the relationship between internal and external distinguishing the role they play during the culinary product formulation and definition phase of the process as Harrington (2005) documents.

- ***Setting the stage***. Before formulating an idea of a culinary product, a variety of decisions have to be made to increase the likelihood of a successful product (Harrington, 2005). Taking the internal and external environment (refer to Table 4.2) into consideration, as well as the product brief, the following issues are applicable and significant for data collection methods.
- ***Selecting the interdisciplinary team.*** It is advisable that, in a commercial environment, team members for the culinary innovation process represent each of the multiple functions done within the firm. This normally ensures that many other factors are taken into account such as customer needs, market knowledge and overcoming technical difficulties as Stewart-Knox et al. (2003) advice. Only the students from the University of Pretoria, Consumer Science Department were selected to develop the crocodile meat products. Each one received a relevant brief for their role in the culinary innovation process. Other parties included in the implementation of this selected procedure were lecturers and the researcher of this study. The product developers, lecturers, industry expert and researcher of the study participated in the evaluation of the product development process and was defined as the 'expert panel'. Each student worked independently on their own product and had to do their own market research and trend analysis.

Table 4.2: Internal and external environment (Harrington, 2005)

The internal organisation	
Knowledge	The capabilities and knowledge of the product developer needs to be taken into consideration.
Exploitation	• This would involve how much experience he/she has and in the case of the students, their theoretical knowledge. • It needs to be determined if the product developer has the innovative abilities to carry out this task.
Development	• The students should also be able and willing to develop more knowledge as the process progresses.
Capabilities	The product developer needs to have a relative ability of creative problem solving, tacit know-how, situated judgment, monitoring and evaluation. • The students had to be committed to the development of an innovative product, which could be a challenge especially with an unconventional meat type such as crocodile meat.
Creative problem solving and know-how	• Creative problem-solving and know-how is discussed previously, which is concerned with experience and theoretical knowledge.
Situated judgment	• Judgement and advice from experts are very important in product development. In this study, the five expert panelists evaluated and feedback on their products with each session. This was done to improve the products. This advice was communicated as recommendations, rather than commands.
Monitoring and evaluation	• The products were monitored and evaluated throughout the whole product development process. • Change, risk-taking and continuous learning were valued. • The needs of present and future customers had to be considered.
Relationships and resource sharing	Relationships have to be built and used between suppliers, education facilities, and agricultural research centres. This was done by: • Sourcing the crocodile meat from Thaba Kwena crocodile farm • Developing the product as part of both an undergraduate and postgraduate degree • Developing a sensory profile of the crocodile meat at the ARC, Irene.
Equipment, space and other limitations	The equipment, facilities and ingredients that was made available by the University of Pretoria had to be taken into consideration.
Culinary identity	Geography, history, ethnic diversity, culinary etiquette, prevailing flavors and recipes are critical elements that defines a country's culinary identity (Danhi, 2003). • Geography is a defining factor for culinary identity as it is critical in determining the definitive ingredients of a specific region, which includes indigenous food products and staple agricultural products that are readily available. • In this study, the focus was on African flavours. Historical events have a significant impact on identifiable characteristics through the introduction of additional ingredients or cooking techniques to a region. • The cultural influences on South African cuisine have been discussed in Chapter 3. • The ethnic diversity in a particular location has a profound impact on the traditional foods prepared and the fusion of cuisine that creates unique and identifiable products over time. • Culinary etiquette is defined by how and what a particular culture eats. • The five basic taste sensations of sweet, sour, bitter, salty and umami provide a range of prevailing flavour profiles to identify culinary characteristics.
The external environment	
Consumer behaviours (past, present and future)	Prior to deciding on a possible product, a clear understanding of consumer behaviours and needs should be determined. • This evaluation process can be completed using quantitative or qualitative methods and with a formal or informal process. • Past, present and anticipated consumer wants, needs and behaviours should be taken into consideration. • A trend analysis should be done before formulating a product idea.
Competitor analysis	Food product developers should consider competitor behaviour to the introduction of new culinary products in the marketplace. • There must be an understanding of the possibility of imitation from the competitor or changing the pricing structure. • Cost analysis is also important.
Trends and seasonality	Issues such as food trends and ingredient seasonality are significant issues that influence the success rate of a new product innovation. • Consumers have an increasing desire for variety and quality food products. • Trends and seasonality were important factors that the students had to consider in this study.
Ethics, food safety, nutrition and dietary considerations	The product developer should take note of ethics and trends in food safety, nutrition, and regulations during the development process. • Population gropability and origin of the meat has to be taken into consideration and communicated to the consumer in the final product. • These trends may be consumer, government or competitor driven. • The students had to put a HACCP framework in place for the production of their new products.
Demand analysis	Customer demand can cause uncertainty in the food production industry. • Changes in demand have to be anticipated by the company that develops the new products. • In this study, it was not of specific concern to the students. It was important however, that they take future wants and needs into account.

- ***Planning and linking processes.*** This part of the process involves external and internal considerations. External considerations include consumer research, competitor analysis, food safety and dietary issues, regulations, food trends, seasonality and demand analysis. Internal considerations include organisational knowledge, relationships, culinary identity and possible limitations capabilities in terms of problem-solving, situated judgement and commitment to the project (Ottenbacher & Harrington, 2007). As food product developers-in training assisting the researcher in a practical way, the given instructions were to identify and profile the South African consumer and
    - consider psychological factors, environmental factors, and consumer buying behaviour, their needs and demographic characteristics
    - perform a trend analysis, focusing on ingredients and cooking methods
    - had to educate the consumer to try the new products by emphasising the product benefits and unique characteristics.
- ***Product definition, chefmanship and food science.*** The final step in Stage 1 of the culinary innovation model is defining the product. Internal and external factors that were identified were considered and combined with chefmanship and food science. Chefmanship entails many aspects of culinary knowledge including food preparation, presentation, flavour combinations and ethnic influences (Ottenbacher & Harrington, 2007). As final year Consumer Science students, they had to apply the knowledge they had gained during their studies by examining these four factors: chefmanship, the chemical properties of food, preservation techniques and sensory analysis techniques.

The students focused on preservation techniques since the products should be able to last on the shelves of retail outlets. Continuous adaptations were made over a seven-week period to improve the quality of the products by paying attention to ingredients, flavour balances and methods. With each adaptation, an expert panel evaluated the sensory properties of the products and recommended changes.

Culinary innovation implementation

Continuous changes are assessed during the implementation stage (Stage 2), through evaluating perceptual preferences, production capabilities, consistency requirements, cost considerations, taste and appearance preferences and process improvement. Formulation testing and analysis, the development of a prototype, benchmarking and sensory analysis are involved (Ottenbacher & Harrington, 2007).

- ***Formulation.*** A culinary product is a bundle of key attributes that consumers experience. The students had to consider not only the sensory characteristics, but also the origin and characteristics of the meat itself, packaging, product presentation, use of unique ingredients, target market, pricing and outlet area and type of retailer where the product could be sold.
- ***Prototype.*** According to Ottenbacher and Harrington (2007), prototype creation and sensory analysis can go hand in hand. Throughout the development process, the products were evaluated and adjusted continuously. As required for experimental studies, the students recorded precise temperatures, cooking times, chilling times and ingredient measurements. What had to be changed and what should be left unchanged was done in the next session. After all changes had been made and the product developer and expert panellists were satisfied, a standardised recipe could be formulated. After the adaptations of the products, a prototype of the product was developed. It was triple tested to ensure accuracy and product transference. Product transference is discussed as a separate item in Stage 3 that concerns evaluation and control. The students then determined a price and the product were sold to an interested customer.
- ***Benchmarking.*** The products were compared with similar competitors' products. This was done before developing the product to define a gap in the market, gain design ideas, compare and improve on flavour, texture or sensory balance as well as pricing.
- ***Sensory analysis.*** An expert panel conducted the development process and improved and adapted the product throughout its implementation basing them on flavour, texture and appearance according to ratios, portion sizes, different cooking methods and use of ingredients.

Evaluation and control

The third stage of the culinary innovation process involves a repetitive process based on internal and external feedback loops, revision to address any problems, learning as part of the process and control systems that have to be put in place to ensure consistent quality (Ottenbacher & Harrington, 2007).

- ***Consumer testing.*** This aspect will be discussed in detail in section 4.9 as part of Phase 3.
- ***Scale-up.*** The developed product is scaled up to test it in a larger production situation This action would facilitate the production of a product at a consistently high-volume level, the use of different equipment and the possibility of using different processes. (Ottenbacher & Harrington, 2007). The students had to scale the recipe up to 24 portions, using the yield factor and percentage method; consider the method of preparation; and accommodate adjustments to equipment necessary for changing from small- to large-scale production.

- ***Process development and production transference.*** This assessment step stresses the robustness of the product design. Schonberger and Knod (1994) defines this criterion as how much variation in the manufacturing process the product can withstand and still be found acceptable to the consumer. The students had to consider all the factors of the execution of the production of the culinary products and areas that might have needed improvement on to ensure consistency. While developing the product, the final product recipe also had to be written in such way that it could be reproduced by anyone who read it, possibly in a commercial environment. A standardised recipe was carefully formulated to include pre-preparation, mise-en-place, and other preparation steps, a yield percentage, garnishing and the serving of the dish. Portion sizes had to be included too.

- ***Hazard Analysis and Critical Control Points HACCP analysis.*** A basic HACCP framework needed to be followed to prioritise and minimise possible hazards during the development and production (Rudolph, 1995). Each step of the development of the product was analysed and hazards were identified in this study. Quality checks were done especially in the following areas:

    - Receiving: the cold chain of the raw meat had to be maintained from the abattoir to the preparation area at the University of Pretoria.
    - Storing: raw meat had to be stored in a freezer at -18 °C, to prevent thawing and growth of bacteria such as salmonella.
    - Thawing: raw meat had to be thawed in a refrigerator at 4 °C, not at room temperature. It was also important not to freeze the raw meat again after thawing.
    - Preparation: the working surface had to be disinfected. Cross-contamination had to be prevented by using the correct colours of chopping boards. This ensured not preparing raw and cooked meat on the same surface, and not allowing the vegetables to be in contact with raw or cooked meat.
    - Cooking and heat application: meat had to be cooked at the ideal temperature, approximately 75 °C, which is out of the temperature danger zone.
    - Assembly: cooked food items should not be assembled on surfaces that has not been cleaned from preparation of the dish.

Innovation introduction

Since this finalising aspect of introducing an innovation as novelty is beyond the scope of this research, it was excluded from study.

4.8.4 Data analysis

From the sensory evaluation data, means were calculated for each sensory characteristic. A graphic presentation in the form of star diagrams was used to see where improvement was needed. The students themselves did this in Excel 2010. The improvement of the product could be seen from these diagrams and where adjustments were needed, they were indicated.

4.9 METHODOLOGY: PHASE 2

Phase 2 is devoted to the evaluation of the sampled consumers' expectation of crocodile meat products. Expectations can be defined as "hypotheses about future events, and perception itself is the testing of the hypothesis, resulting in new experiences, which then form the basis for further expectations" (Jantathai, Sungsri-in, Mukprasirt & Duerrschmid, 2014). Food expectations form from previous experiences and the familiarity with similar products (Johansen, Laugesen, Janhøj, Ipsen & Frøst, 2008). The researcher explored the type of consumer who participated in the study, by gathering psychographic information (see also sub-section 4.9.3), which included their interest in culinary food culture, their previous experience of exotic meats and their liking of novel foods.

The trained sensory panel identified eight sensory characteristics of the plain crocodile meat in the preliminary phase. The profile that was developed can be seen in section 5.2. It included terms such as 'flaky texture', 'chewy texture', 'bland flavour' and 'chicken-like aroma'. These characteristics gave the students an indication of which cooking methods and ingredients could be applied to the crocodile meat. It would for instance be important to add flavour to the product since it has a bland taste. The cooking time and process would also be important due to the fact that it can become chewy and tough. After preparing the baseline recipe for their products, the product developers identified another 12 sensory characteristics of their products and added it to the lexicon that was developed in the preliminary phase. These characteristics were very product specific. Finally, a word list of 20 sensory characteristics were developed. In Phase 2 the 20 characteristics were evaluated in terms of its perceived appropriateness in a culinary crocodile meat product, whether the panellist has consumed crocodile meat before, or not. A part of Section A of the questionnaire also related to general psychographical questions, determining the consumers' perception of exotic meats. An example of the questionnaire is included in this document as Addendum I. The measuring instrument, a self-administered questionnaire (sub-section 4.9.1.1) is discussed in the next section, followed by the sampling and data collection process.

4.9. 1 Measuring instruments

4.9.1.1 Questionnaire

A self-administered questionnaire was designed, based on similar research from Giacalone, Bredie and Frøst (2013), to identify the aspects that were applicable to determine sensory perception and acceptability, within the framework of the objectives of the study. A self-administered questionnaire was chosen as it allows the participants to complete it on their own, while the researcher is available in case problems are encountered. This is especially necessary in the case of consumer evaluation, seeing as the questionnaire and the environment might intimidate them or misunderstandings could occur (Delport & Roestenburg, 2011:188). The questionnaire was developed in English, being a commonly understood language by most South Africans.

The questionnaire consisted of three sections, all of which were closed questions that were seen as being more advantageous for this study, as all respondents would find the questions as phrased easy to follow. As Delport and Roestenburg (2011:198) state, this form of questioning also benefits the researcher as it is easy to code and analyse statistically. An indemnity form accompanied the questionnaire to inform the participants about the project and made them aware of certain ethical issues that they needed to consider, such as religious taboos.

As used in Phase 2, the measuring instrument was Section A of the questionnaire that was pre-tested (sub-section 4.9.1.2) to ensure reliability and elimination of error. The aim was to find out about the respondents' previous experiences, expectations, memory, learning, context and sensory perception. Responses were gathered on a 9-point Likert-type scale, which ranged from 'disagree completely' (1) to 'agree completely' (9). Overall, consumer evaluation of the following twenty characteristics that were grouped as four categories were expected to be appropriate for a crocodile meat product:

- Appearance: light meat colour, dark meat colour, golden brown
- Aroma: chicken-like
- Texture: tough, flaky, chewy, juicy, tender, minced meat, crispy
- Flavour: bitter, metallic, bland, sweet, hot, smoky, salty, liquor, deep fried

4.9.1.1.1 Pre-testing

A questionnaire should be pre-tested before using it in a research study. This is usually for two reasons, namely, to ensure face and content validity and to estimate the time it takes to complete the questionnaire (Delport & Roestenburg, 2011:195). Eight staff members at the Meat Industry Centre of the ARC-Animal Production Institute agreed to complete the first draft of the questionnaire the

researcher compiled as a pre-test. The estimated completion time of the questionnaire was expected to be approximately 30minutes and this task was undertaken in June 2017. Its content, the terminology used, grammar and layout were reviewed and, where necessary, were corrected. Comments and input about the ease of comprehension were heeded and adjustments effected. The participants involved in this preparatory exercise also had experience in and were knowledgeable about sensory analysis, evaluation processes and scientific research. From a consumer perspective, this group of participant evaluators could assess ease of reading competently from a sensory perspective as experts and improve the content. A general impression of feasibility was obtained by also allowing the participants to make suggestions and remark on their observations.

4.9.2 Sample and sampling

4.9.2.1 Unit of analysis

Schurink, Fouché and de Vos (2011:93) define units of analysis as "specific objects or elements whose characteristics we wish to describe or explain and about which we will collect data". Usually the selection of units of analysis almost automatically happens once the research problem has been identified. Applicable units for this study are given in Table 4.3.

Table 4.3: Unit of analysis

All racial groups	To discover which racial group is more inclined to accept such an exotic product.
Both genders	To discover which gender group is more inclined to accept such an exotic product.
Ages 18-65	For this study an assumption is made that this age interval would be most likely to buy their own food and be interested in new food products.
Resides in Tshwane district	Consumers that participated in the consumer evaluation had to have easy access/transport to the University of Pretoria. Also, to limit the scale of the study.
Familiar with exotic meat products	Familiarity with speciality food products will make the participant more willing to try a new product and deliver an opinion about it.
Interest in culinary culture	Consumers with a greater interest in food and drink culture would be more open to new culinary products.
No religious or cultural objections against the consumption of crocodile/reptile meat	Due to ethical reasons.

4.9.2.2 Sampling

The researcher chose a sample that was most characteristic of the target population and served the type of study being done, in which the sampling method followed both non-probability and purposive sampling principles. Rubin and Babbie (2005:247) point out that judgemental sampling is based entirely on the judgement of the researcher. This technique was used and endorsed in this work. Similarly, some snowball sampling occurred, as the recipients of the invitations were encouraged to forward the information to other potential participants to peruse and respond in case they met the required criteria, a strategy Grinnell and Unrau (2008:153) recommended.

The researcher sent invitations out electronically to consumers selected for inclusion, and participants who willingly volunteered to participate in the study too were included. One hundred eligible contributors to the investigation were recruited. The criteria set out in Table 4.3 were adhered to throughout the sampling procedure, and applied to all participants. Lawless and Heymann (2010:7) said that a typical hedonic test should involve 75-150 consumers. Meilgaard, Civille and Carr (2007:212) agreed that this could be regarded as an appropriate number of participants to obtain significant differences when analysing the data statistically. A sample size of 100 was taken as representative of the population group targeted for this research. Moreover, this would be large enough to allow for the slight deviation that generally arises when incomplete questionnaires have to be discarded, a situation that will be addressed in the following chapter.

4.9.3 Data collection

An experimental research design was used for this study. This type of design needs to be controlled to prevent errors from occurring (Babbie & Mouton, 2011:645). During data collection, standardised, pre-tested questionnaires were used to ensure elimination of these errors. The researcher went to great lengths to eliminate external factors that could influence the participating consumers as well. These measures are discussed in sub-section 4.9.3.2. Data collection for Phase 2 and Phase 3 were done consecutively and therefore the consumers immediately entered an environment that was similar to that used for sensory testing. The first part of the questionnaire however (Phase 2), did not require the food samples yet.

4.9.3.1 Recruitments

Consumers were recruited by means of Google Forms. Recruited consumers represented the sampled target population. The invitation they received provided detailed information about the project, the activities in which they would be engaged as participants, and the venue where and when they would

meet. Various sessions were scheduled, and the respondents were requested to indicate when they would be able to attend. A maximum of twenty participants per session was feasible and they were held over three days. The invitation reached 112 consumers who complied with the stipulated criteria (Table 4.3) of whom 101 committed to participate. After scheduling each respondent, a comfortable number of 4 to 12 participants per session attended.

4.9.3.2 The testing environment

The consumer evaluation was conducted at the University of Pretoria's Consumer and Food Sciences Department. This setting was chosen because of its proximity to the food sample preparation area. The researcher organised access to the university grounds for the participants according to the time slots allocated to them. A room adjacent to where the food sample was prepared and used as a test location. The participants were seated at least 1.5 m from each other, to prevent communication between them. Should the opinion of others influence their submitted evaluation it could be regarded as being biased. The room was temperature controlled, effective lighting was ensured, and all external odours and noise were eliminated. At the beginning of each session each participant received a questionnaire with their personal indemnity form, a pencil and a glass of water. On the indemnity page, the consumers were informed that they were allowed to stop and leave the evaluation at any point if they felt uncomfortable. Anonymity and confidentiality were also guaranteed.

4.9.3.3 Perceptual evaluation

The researcher introduced herself at the start of each session. Although clear instructions were on the questionnaires, it was also explained verbally. The participants were instructed to indicate once they have completed Section A, in order for the assistant to serve the food samples for the next phase of the evaluation. The main aim of the questionnaire for Phase 2 was to determine the consumers' perception of crocodile meat products (refer to sub-section 4.9.1.1 for discussion of main concepts).

Perception draws from memory, learning, context and expectation (Cardello, 1994:4). Memory was measured by determining the respondents', as consumers, familiarity and previous experience of exotic meats in this study. The individual's interest in culinary food culture was the context and their willingness to try new food products showed interest in learning new things. The sensory characteristics recorded gave an indication of the expectation of a crocodile meat product they were tasting based on either previous experience or information they had acquired. They also represented the concept of appropriateness and use of this food item. The concept of appropriateness is used with

regard to appropriateness by use of the food product, to add information to a sensory evaluation (Giacalone *et al.*, 2013).

The information gathered through sensory evaluation yielded available data for analysis methods dealt with in the next sub-section.

4.9.4 Data analysis

A statistician from the University of Pretoria assisted with the analysis of the data collected in Phase 2. The statistical techniques used were descriptive statistics (observed means, standard deviations, frequency distributions), and inferential statistics (EFA). Graphs and tables illustrate the data that was processed on the Statistical Analysis Programme SAS 9.4, and Excel 2016 with add-on software XLSTAT (2016). Meilgaard *et al*. (2007:314) point out that visualisation often reveals a better picture of the data that would have been lost with the computation of test statistics and probabilities. Least squares means (LS Means) were calculated based on ANOVA. Further details about the implemented analyses are given in the sub-sections that follow.

4.9.4.1 Descriptive statistics

Descriptive statistics are procedures used to summarise and describe the important characteristics of a set of measurements (Mendenhall, Beaver & Beaver, 2013:4).The data was organised into various demographic groups from information collected after completion of Sections A and B of the questionnaire. The groups included gender, age, education level and population group. Age was divided into generational cohorts as Baby Boomers, Generation X and Millennials. Although the option choice given was Asian, Black, Coloured, Caucasian and 'Other', the data for analysis was grouped as 'Caucasian' and Non-Caucasian' to give statistically significant results in this study. In the case of this study, to address the stated problem to be investigated, the data associated with demographic variables when analysed can yield unexpected descriptive results. The consumer's previous experience of crocodile meat was also evaluated from everyone's given information. Each sampled consumer was placed in their demographic group for the researcher to work with the study's demographic profile when analysing the data collected. Consequently, it gave an indication of the possible target market for selling novel crocodile meat products.

Apart from N totals, means and standard deviations were calculated from the psychographic information, including their interest in culinary food culture, their knowledge of exotic meats and their liking of novel foods. The psychographic profile of the participants supplied the researcher with enough information to confirm that correct sampling was done. The desired results would be high

scores on the Likert-type scale, as consumers with an interest in culinary food culture and liking to try novel foods are usually eager to accept novel food products (Huotilainen, Pirttilä-Backman & Tuorila, 2006).

Sensory appropriateness ratings were also statistically analysed by calculating means and standard deviations. This was necessary to interpret the influence and previous experience of a crocodile meat product and how marketing and advertising affected the consumer's expectation of the product's sensory characteristics. More importantly, this information can be related to their actual response when evaluating the product. It should indicate what they liked in the product according to what they expected from it. With the mean values of each sensory characteristic, the data could be ranked from most appropriate to least appropriate. This indicated which sensory characteristics would be most desired in a crocodile meat product and hence the possibility of the success of the product could be established.

4.9.4.2 Inferential statistics and Analysis of Variance (ANOVA)

Inferential statistics consists of procedures used to make conclusions or deductions about population characteristics from information contained in a sample drawn from a population (Mendenhall, Beaver and Beaver, 2013:4). Analysis of variance (ANOVA), at $p \leq 0.05$, and t-tests were used to determine the effects of independent variables on the dependent variables. The independent variables in this research were selected demographics, namely, gender (male/female), age (Baby Boomers/Generation X/Millennials), population group (Caucasian/non-Caucasian) and level of education (Grade 12/ a higher education degree or diploma/postgraduate qualification). These differences could indicate if there were certain demographic groups on which to focus marketing strategies. For example, it has previously been found that younger people are more willing to try new foods than older generations (Fernández-Ruiz *et al.*, 2013).

Previous experience was also tested for significant differences, the variables being either with or without previous experience of dealing with crocodile meat. This is where neophobia comes into play. Consumers are new to eating crocodile meat and/or might have a more neophobic tendency towards it. On the other hand, they might be more inclined to try such a new product, so would have neither a negative or a positive previous experience about it.

Regarding the expected sensory characteristics, ANOVA tests ($p \leq 0.05$) were done to test the significance of differences between the levels of appropriateness. It was hypothesised that highly significant differences existed; and some were considered very appropriate to crocodile meat; and

some not appropriate at all. The researcher also aimed to find out if underlying relationships existed between the identified sensory characteristics that exploratory factor analysis suggested or not.

4.9.4.3 Factor analysis

Exploratory factor analysis (EFA) gives a graphical presentation of the analysed data. In this study, it presented the coordinates and plots of all the sensory characteristics and gave the percentage and significance of the contribution as well as the relationship between the different characteristics involved in the analyses. The use of factor analysis was to determine which characteristics the consumers favoured in terms of their expectation of crocodile meat products. The results from the factor analysis were also compared to the results from the mean appropriateness ratings to see if they corresponded. Plotting the coordinates calculated by EFA gave a visual representation of the results, which would not only reveal which characteristics were found to be the most or least appropriate but also which made the most significant contribution to them.

4.10 METHODOLOGY: PHASE 3

The evaluation of the consumers' sensory and hedonic experiences of crocodile meat products is presented in **Phase 3** and concerns food acceptance and how a sensory experience functions and influences the emotional and behavioural responses to food. Cardello (1996) contends that the totality of sensory experience can serve to establish a context or set of perceptual and hedonic expectations that alter the emotional, or behavioural, responses to any single element of that overall experience. The participating consumer's hedonic experiences were measured by answers to questions about their overall liking of each product, as well as its aroma, appearance, flavour and texture. The Check-All-That-Apply (CATA) technique, as a measuring instrument, provided information about their sensory experience. The sensory characteristics were evaluated for appropriateness. Since the same questionnaire was used for both **Phases 2** and **3**, the researcher will simply refer to other sections and sub-sections to avoid repetition of methodology information already given. Sub-sections to follow concern questionnaire analysis as the measuring instrument for Phase 3, the sample and sampling, data collection procedures and the data analysis techniques applied.

4.10.1 Questionnaire analysis for Phase 3

The measuring instrument used in **Phase 3** was Section B of the self-administered questionnaire. It was pre-tested to ensure reliability and elimination of errors (discussed in 4.8 for Phase 2). It consisted of questions related to the respondents' experience of the products they tasted as consumers when they were served samples of the products during the session they attended. This second part of the

questionnaire continued to follow the format of a study done by Giacalone *et al.* (2013). It measured the participants' overall liking of the four sensory attributes, appearance, aroma, flavour and texture, as well as their willingness to buy the product again. These hedonic experiences were measured on a nine-point hedonic scale, ranging from 'Dislike extremely' to 'Like extremely'. Closed questions were set as this made coding and data analysis easier for the researcher.

Following this exercise, a new and dynamic sensory analysis technique, namely Check-All-That-Apply (CATA), was done. A complete description of this technique is given in the literature review chapter (3.10). However, its main feature is that it is easy and quick for someone to do. The consumers were presented with the same sensory characteristics that were used for rating appropriateness in Section A of the questionnaire. Adams, Williams, Lancaster and Foley. (2007) found it worked well for the consumers they had sampled, as they only needed to tick the appropriate words that described the product under investigation. The participants in this study marked all the characteristics they experienced with each of the products they tasted. In doing so, the acceptability of the product could be determined based on the confirmation or disconfirmation of their expectations. Moreover, the researcher could generate a sensory profile for each product as experienced by each consumer in this survey. The signed indemnity form was especially relevant in this part of the evaluation.

4.10.2 Sample and sampling

The same sampling procedure and 100 sampled consumers were used in Phase 2 and Phase 3 to evaluate the food product samples and the participants had willingly volunteered to participate in the study. Before each session began, they were once again reminded that they were free to leave the evaluation session at any time, should they feel uncomfortable about completing it as required.

4.10.3 Data collection

After completing Section A of the questionnaire, the focus turns to reporting on the content of **Phase 3** and the actual tasting and evaluation of the products. Consumer testing falls under Stage 3 of Harrington's Culinary Innovation Framework. Ottenbacher and Harrington (2007) stresses how essential it is to get feedback from the consumers as well as acknowledging the criteria for sustainable competitive advantage.

- **Product preparation**

Students from the Department of Consumer and Food Science at the University of Pretoria helped to prepare the products according to the standardised recipes. Refer to Phase 1 for preparation methods of the products. The food products were prepared in the food laboratory facilities and with equipment

of this department. The quantities prepared depended on the expected number of panellists on the specific day. Samples were prepared as needed to ensure freshness and accurate evaluation. Where necessary, the samples were kept warm in bain-maries to prevent a 'warmed-up taste'.

- **Serving procedure**

The product samples were served to the consumer participants, approximately 30 g portions each and all were given out simultaneously. Each product was assigned and marked with a code so that a name or description would not influence an evaluator's judgement that might then be a biased opinion (as presented in Figure 4.4). The prepared samples were served in foil bowls in the same order for all participants, namely, smoked, sous-vide, dumplings and lastly strips. To prevent a carry-over taste, palate cleansers were served to eat between each sample.

- **Evaluation process**

The sensory attributes were evaluated on a nine-point hedonic scale, from 1 "Like extremely" to 9 "Dislike extremely". This scale is widely considered to be the best rating scale to evaluate the degree and liking of individual sensory attributes and to measure overall product acceptance (Heymann & Lawless, 2013; Lawless & Klein, 1991; Meilgaard *et al.*, 2007b; Stone *et al.*, 2004). Each product was evaluated on its overall performance, appearance, aroma, texture and taste. From this, the most liked product was determined, based on the consumer's actual preference.

A consumer's willingness to purchase the products again was evaluated, as well as their expectation vs. their actual experience of the samples. Thereafter, each respondent had to answer a series of CATA questions with 20 sensory characteristics that they found described the crocodile meat sample. Refer to Chapter 3 for information on the Check-All-That-Apply technique. The CATA characteristics were the same as the ones used in the Section A of the questionnaire. This approach made a comparison between expected sensory properties and actual sensory experience possible, as Giacalone *et al.* (2013) explain.

Following the evaluation of the products, the respondents were required to give demographic information relating to their age, gender, population group and education level. Once the required forms were completed, the participants could leave the facilities, and each one was presented with a token of appreciation.

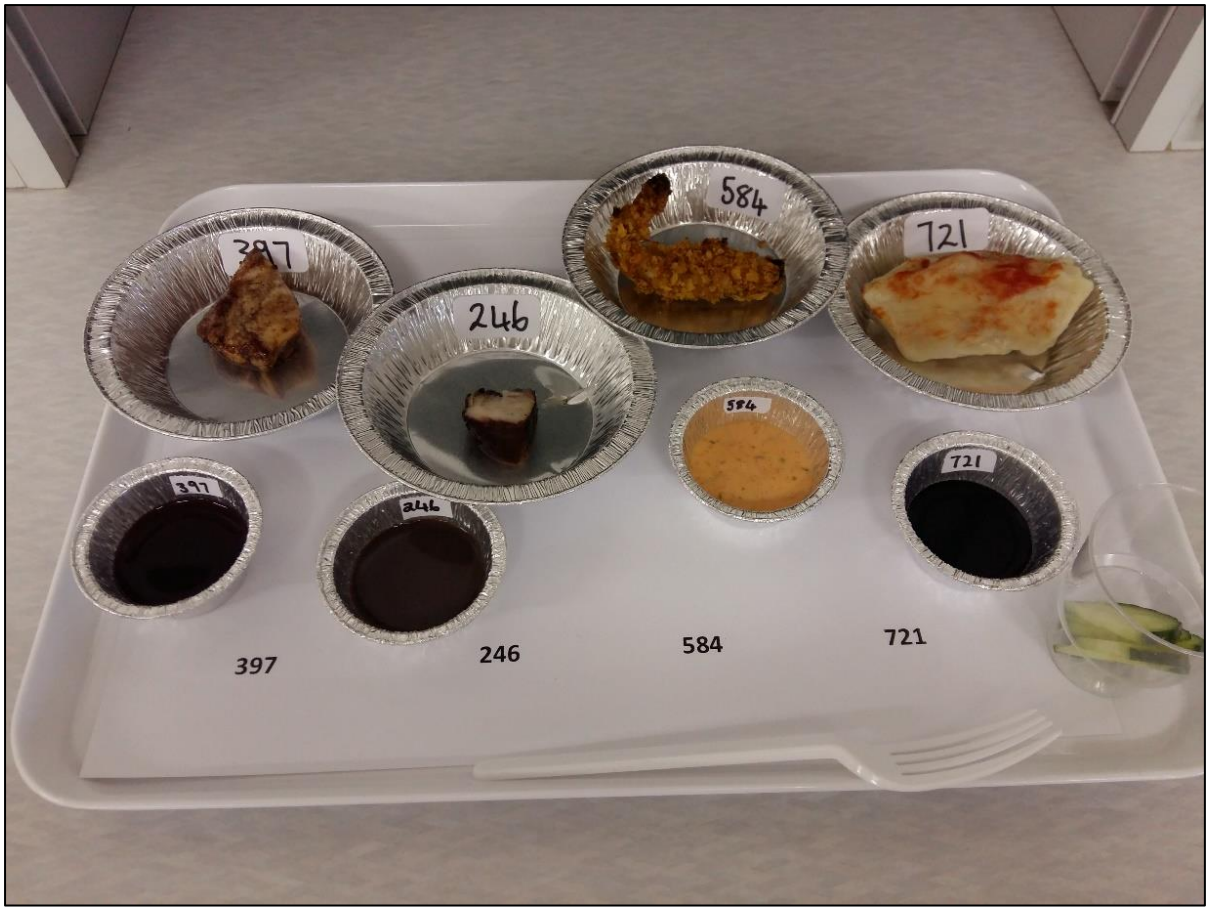

Figure 4.4: Serving of crocodile meat samples for consumer sensory evaluation

4.10.4 Data analysis

The results collected from the questionnaire were analysed with the assistance of a statistician from the University of Pretoria's Department of Statistics using the SAS 9.4 statistical programme. The data from the Check-All-That-Apply (CAT) questions were analysed with Excel 2016 with add-on software XLSTAT (2016). Some results are also presented in graphs and tables in accord with the opinion Meilgaard *et al.* (2007:314) have that the visualisation of data can reveal findings that would have been lost with simple computation of collected data, statistics and probabilities. Least squares means (LS Means) were calculated based on ANOVA models. Cai (2014) documents that this is done when data results are unbalanced, which is the case when demographic variables come into play.

The statistical methods used for data analysis in Phase 3 (section 4.10) are detailed in the following three sub-sections: descriptive statistics (observed means, standard deviations, frequency distribution), multivariate statistics (ANOVA) and inferential statistical techniques, and correspondence analysis.

4.10.4.1 Descriptive statistics

Descriptive statistics are procedures used to summarise and describe the important characteristics of a set of measurements (Mendenhall *et al.*, 2013:4). The data collected for this researched was organised in various demographic groups according to each respondent's gender, age, education level and population group. Age was divided into three generational cohorts described as Baby Boomers, Generation X and Millennials. The option for population group was analysed as 'Caucasian' and Non-Caucasian' based on the classification and reasoning of Le Grange, Telch and Tibbs (1995) that it would provide statistically significant results from data collected as a choice of Asian, Black, Coloured, Caucasian and 'Other'. The total number of subjects sampled (n) regarding each demographic group was determined. This allowed the researcher to see what the demographic profile of the participants of the study was. This observation could give an indication of the possible target market for crocodile meat products. The consumers' previous experience with crocodile meat was also taken into consideration.

Means and standard deviations were also calculated for the sensory liking of each product, including overall liking, liking of aroma, appearance, flavour and texture. For this study, scores were grouped in categories in which 1-3 represented 'unsatisfactory'. 4-6 as 'average' and 7-9 'good/excellent'. Bar graphs illustrated the liking scores, to visualise the most and least liked products for each attribute. Demographic effects on the mean liking scores for each product and each attribute were calculated. The mean values were tested for significant differences that are discussed in sub-section 4.10.4.2.

The CATA data is displayed as a frequency table to show the occurrence of each sensory characteristic checked by the evaluators for each product. This allowed for the sensory profiling of the products. The frequency counts indicated which product received the most checks for the least appropriate characteristics and which were associated with the most appropriate characteristics, as was discussed in sub-section 4.9.1.1., Cochran's Q test was used to analyse the frequency counts. According to Giacalone *et al.* (2013), the most liked product normally receives the most checks overall, whereas the least liked product receives the least checks. This will be confirmed or denied in Chapter 5.

4.10.4.2 Inferential statistics and ANOVA

Mendenhall, Beaver and Beaver, (2013:4) point out that inferential statistics are used to make conclusions or deductions about the targeted population's characteristics from information obtained from a sample drawn from this population. Analysis of variance (ANOVA), at $p \leq 0.05$, and t-tests were used to determine the effects of independent variables on the dependent variables. The independent variables in this analysis were the demographics [gender (male/female), age (Baby

Boomers/Generation X/Millennials), population group (Caucasian/non-Caucasian)] and level of education (Grade 12/degree or diploma/postgraduate qualification). Dependent variables included the sensory attributes and characteristics (liking of flavour, aroma and appearance). Least square means (LS means) were applied to the ANOVA scores to correct the unbalanced data that was detected.

ANOVA tests were done on the differences of attribute liking (overall, aroma, appearance, flavour and texture) between the products. These results indicate each product's strengths and its least liked attributes and how they compare with the other products. Moreover, the overall liking score for identified attributes shows which one has the most influence. Additionally, the researcher will be able to establish which attributes for each product should be improved and suggest this option for future research studies.

Cochran's Q test was done on the CATA scores to test if there were significant differences ($p \leq 0.001$) between products with respect to their sensory characteristics. These were the defining features of the respective products. They showed the effect of different preparation methods and adding ingredients had on the development of such characteristics.

4.10.4.3 Correspondence analysis

From the results of the frequency table, Correspondence Analysis (CA) was done using the Chi square-distance. As defined by McEwan and Schlich (1991), Correspondence Analysis is a multivariate technique that looks at the correspondence and/or association between row and column variables. Using CA, sensory profile analysis results in a data matrix where the rows represented the samples being evaluated (the crocodile meat products); and the columns represented the characteristics used to describe the samples. Twenty characteristics were evaluated in the CATA test. The data points in this matrix each represented a rating of perception of a particular attribute for a given sample. From this analysis, a plot mapping the position of the products with the characteristics, was obtained. It is important to note that CA gives a relative indication of results, and therefore conclusions should be supported by also studying the raw data. The results from this analysis will indicate the sensory profile of each product, and it will be possible to see which of the most appropriate and which of the least appropriate characteristics are associated with each product. The researcher will also record an observation of the association between the most liked product (as determined in sub-section 4.10.4.1) and the characteristics of the profiles.

4.11 ELIMINATION OF ERROR

The value and application of the results of a research project depends on its precision and accuracy. There are two technical measures that need to be taken into account in research, namely validity and reliability (Creswell, 2014:201). These concepts are discussed below, as they are applicable to this study.

4.11.1 Validity

Validity refers to the use of an effective measuring technique to measure a specific concept (Mouton & Babbie, 2001). Construct, content, face and theoretical validity were applicable in this study and their concern focuses on the ability of a test procedure to measure what it was intended to measure.

Construct validity is based on statistical procedures and logical relationships among variables (Kumar, 2014:180). It refers to the extent to which a scale, an index or list of items measure the relevant construct and not something else (Mouton, 1996:128). In Phase 1, the measurement, preparation methods and steps were accurately recorded. Evaluation done on a five-point Likert scale and the adaptations made to the products were also recorded. Steps followed in the culinary innovation process was done according to Harrington's (2005) Product Innovation Framework and the culinary innovation processes developed by Hullah (1984). Carefully following these steps ensured construct validity in Phase 1. In Phase 2, a standardised questionnaire was completed based on respondents' responses to questions that were set to comply with a Likert scale using a nine-point scale. The questionnaire and its scales were based on a consumer study done by Giacalone *et al.* (2013) and it delivered successful results. In Phase 3, a standardised sensory evaluation test was done on a nine point hedonic scale to determine acceptability. Lawless and Heymann (2010:31) recognise it as a standard sensory evaluation test. An adequate sample of 100 participants was used to contribute to the validity. Owing to the uniqueness of the CATA technique, thorough research and review of associated literature was done to understand and correctly apply it to this study.

Face validity is a subjective judgement of the operationalisation of a construct and is based on the logical link between the questions and objectives of the study (Kumar, 2014:180). It relies on the physical appearance of the measuring instrument that is used (Bryman & Cramer, 2012:171). Using multiple sources to collect information contributed to the triangulation of measurements that enhanced the study's validity. Additional sources that used similar scales were consulted for the constructs of psychographics, appropriateness ratings and hedonic reaction, a method Giacalone *et*

al. (2013) supports. The paper-based questionnaire was also designed with the University of Pretoria's branding to reinforce the researcher's affiliation with the institution.

Content validity refers to the sampling adequacy of the study's content as an instrument. The measuring device covers the full range of meanings being measured (De Vos, 2011:162; Mouton & Babbie, 2001:123). To identify aspects related to food acceptability the researcher consulted a wide variety of sources and these were addressed in the questionnaire, a major measuring tool in this study. It had been pre-tested and a statistician was tasked to evaluate the measurement of validity. Individuals who had the same demographics as the intended sample group did the pre-testing.

Theoretical validity relies on the nature of the literature reviewed for doing the research. Different relevant and current literature sources were reviewed to identify the concepts known to contribute to the development of a new food product and consumer food acceptance. The constructs to be measured in the questionnaire were based on the development of a lexicon, and the sensory profile of the products that were chosen. It was also important to apply the CATA tests correctly, as it is regarded as a novel statistical measuring technique. This was confirmed by reviewing other studies and understanding the theoretical concept portrayed.

4.11.2 Reliability

Reliability is to ensure that the same results are obtained if the same technique is followed (Babbie, 2016:146). It is very important for the successful outcome of a project and it is dependent on consistency (Babbie, 2016:119). All the concepts in this study have been clearly defined through doing a proper and thorough literature review. In Phase 1, the development and standardisation process of the products were repeated three times. All procedures were recorded until the same results for authenticity, portion sizes and sensory characteristics were achieved with each adaptation of the recipes. These methods reflect evidence of reliable results.

A pre-test was conducted prior to the commencement of the consumer participant's completion of the final standardised questionnaire that was used for the sensory evaluation. This questionnaire was also given to a statistician and revised by a capable person to be certain that acceptable, understandable language, questions and concepts were used, a strategy Salkind (2012:160). Moreover, this scholar also recommends and maintains that clear and standardised instructions as to how to correctly complete the questionnaire should be given to the respondents. The researcher did

this too and while these data collection sessions were taking place, the sensory evaluation process was being designed and organised.

To ensure reliability with the consumer group, standardised sensory evaluation procedures were applied following the work Lawless and Heymann did in 1998. This was achieved by conducting the tests in a physical setting that was free from distractions, odours from food preparation and was air-conditioned. The sample serving procedures and sample preparation techniques were standardised, portion sizes were identical, as well as identical presentation and food preparation. The layout of the testing environment was structured in a way that the participants were not able to interact with each other. Furthermore, quality was assured by using the same cuts of the crocodile carcass, and the meat was sourced from the same farm.

4.12 ETHICS

The proposal of the study was prepared and presented to the Head of Department, lecturers and students of the Department of Consumers Science. After approval of its continuation, ethical clearance was received from the Ethics Committee of the Faculty of Natural and Agricultural Sciences, University of Pretoria (Addendum J).

Only consumers who expressed a willingness to participate were included in the study. The purpose of the study was explained before they consumed the products for testing and the completion of the questionnaire and required forms. Consumer panellists who participated in the evaluation of the new culinary products, gave voluntary consent and were able to freely exercise their own choice to participate in this study or not. Giving their consent legally was also an option.

The researcher protected all rights of the participants and made sure that all participants had a right to adequate and informed consent without undue pressure, as Lawless and Heymann (2013:109) specifically mention. Recruited consumers were guaranteed confidentiality and anonymity and assured that the information collected would be dealt with impersonally and would not harm them in any way. Generally, sensory studies of food do not create any above daily life risks. Participants were, however, informed about the possible risks associated with participation, such as dealing with their personal cultural and religious taboos associated with consuming crocodile meat and the effect of allergens.

All information used and mentioned in this study is accounted for, acknowledged through proper citations, and recorded in the reference list. Necessary acknowledgements prevented plagiarism. Practices conducted throughout the study attempted to honestly disallow false information in every possible way.

4.13 CONCLUSION

This chapter provided an overview of the design of the research, the measuring instruments, the sample and the sampling procedure as well as the data collection and analysis methods. The research consisted of three phases, namely product development, data collection of consumer expectation and the final stage of consumer experience of crocodile meat. Phase 1 concerned the development of crocodile meat products, in which four final year students of the University of Pretoria assisted in carrying out the preparation aspect of the study under supervision of the researcher. The main data collection method used in Phases 2 and 3 was a questionnaire. In total 101 participants completed the questionnaires. The data collected from the questionnaire was analysed by interpreting calculated descriptive and inferential statistics. Validity and reliability measures were addressed, and a proper ethical code was followed. The next chapter will present the results, according to the objectives set for this study. The results will be discussed, starting with the product development, continuing to the participating consumers' expectations of the products and ending with an outline of the sensory experience.

CHAPTER 5: RESULTS AND DISCUSSION

The results from the product development, determination of acceptability and sensory evaluation are introduced and an in depth discussion will follow, addressing its connection to the main aim and objectives.

5.1 INTRODUCTION

The results are presented in the three phases and objectives set for this study. In Phase 1, the results from the product development and each product are presented. Thereafter, the consumers' psychographics and their expectations of the crocodile products are discussed, as explored for Phase 2. The results of Phase 3 included hedonic likings of the products, analysed by means of ANOVA. The CATA results will also be discussed, which have been analysed by Cochran's Q test and CA. From the results of these three phases, the overall acceptability is discussed.

5.2 BASIC LEXICON DEVELOPMENT

A basic sensory profile was developed for the tail fillets of the crocodile. This was done by a trained sensory panel at the Agricultural Research Council. Table 5.1 indicates the 'word list' of the sensory characteristics of the crocodile meat sample. The process that was followed in this preliminary stage has been discussed in Chapter 3, Section 3.9.1.2 and Chapter 4, section 4.7.1.

Each trained panellist that participated in this objective evaluation received a cooked sample of crocodile meat, without any flavour treatment. The panellists considered the meat in terms of appearance, aroma, flavour and texture, and wrote down descriptive words for each of these attributes. Overall, 16 words were identified. After discussing these, similar descriptive words were identified under one term. This resulted in 14 words. A sensory evaluation sheet was compiled with these 14 words and can be seen in Addendum C. A 9-point intensity scale was used. Reference samples of cooked chicken breasts and cooked hake fillets were served. After comparing these samples with the crocodile meat samples, the word list was narrowed down to 10 terms. The data was analysed using descriptive statistical methods. From these analyses, eight final terms were identified, which formed the sensory lexicon of crocodile meat. These terms were considered valid to be part of the lexicon if the characteristic scored 5 or higher on a 9-point Likert scale, as used during the evaluation process. These terms can be seen in Table 5.1.

These sensory characteristics were provided to the students who developed the crocodile meat products, in order to understand the ingredient they are working with. Furthermore, it was incorporated into the consumer questionnaire (Addendum I) in phase two and three.

Table 5.1: Basic sensory profile of crocodile meat

AROMA	Descriptor	TEXTURE	Descriptor
Boiled chicken	Aroma of chicken that has been boiled in water, slightly milky aroma, very neutral	Chewy	Tough to bite through, high shear force, often presence of connec-tive tissue
		Flaky	Similar to the flaky texture of fish, flesh fibres separating easily
		Tender	Easy to bite through, low shear force, little to no connective tissue
FLAVOUR	**Descriptor**	**APPEARANCE**	**Descriptor**
Bland	Very neutral taste, often due to limited sodium or addition of aromatics	Pale, white meat	Similar to that of chicken breast meat, no colouration
Metallic	Taste associated with iron or a metal-based substance	Dark brown	Similar to that of chicken thigh, slight brown colouration

5.3 PRODUCT DEVELOPMENT

Product development was performed in Phase 1, which was also the goal set for objective 1. The results are discussed according to culinary innovation framework (Harrington, 2005), as described in Chapter 3 and Chapter 4. It starts with the culinary innovation formulation, followed by the culinary innovation implementation and concluded with evaluation and control. The consumer testing is discussed in the next section.

5.3.1 The brief

The brief given to the four students was to develop mainstream culinary products using crocodile meat, which would be acceptable to the South African everyday consumer. Two of the products had to be prepared using dry-heat cooking methods and the other two moist-heat cooking methods. The students had to focus on African flavours, while keeping current trends in mind.

5.3.2 The culinary innovation process

The part relevant to phase one of the study is discussed below, based on the culinary innovation development framework of Harrington (2005).

5.3.2.1 Culinary innovation formulation

This section involves linking the relationship between internal and external considerations during the culinary product formulation and definition phase of the process (Harrington, 2008:50). The steps followed in this stage are discussed in Table 5.2. Refer to section 4.8.3.2 for definition of these steps.

Table 5.2: Culinary innovation formulation

Setting the stage	
Trends	A trend analysis was done to gain insights into consumer purchasing tendencies and popular products that are on the market. Trends were researched by making use of food magazines, popular features in culinary TV programs and online sources such as EatOut and Forbes. The following trends were identified (as in March 2017): - Colour foods - On-the-go products - Environment-kind packaging - Health conscious - Waste not, want not - Convenience foods - Local flavours and ingredients - Local sourcing - Nose to tail eating - Low-carbohydrate - Usage of spices
Target markets	As per the brief given to the students from the researcher, the target consumer group for the products had to be the main-stream South African consumer.
Selecting the interdisciplinary team	
Product developers	In this study, only the students from the University of Pretoria, Consumer Science were selected. Each student received the brief and had to follow the culinary innovation process. Other parties included were lecturers and the client (the researcher of this study). Each student worked separately on their own product and had to do their own market research and trend analysis.
Expert panelists	Part of the culinary innovation process includes evaluating the products continuously, until it has been perfected. The individuals to whom this task was assigned were industry professionals, experienced lecturers and fellow student assessors.
Planning and linking processes	
Competitor analysis	Not only did the students compare their ideas to the competitors' ideas, packaging, price and product ingredients, but they also considered the possibility of competitors imitating their products. This was done in the retail environment as well as in restaurants.
Gaps in the market	Gaps included health conscious consumers that are looking for products that are high in protein, but low in fat. Free-range products and sustainability is also a major concern for consumers, which crocodile meat can deliver. Fast pace living requires all of these factors, which should be put in a snack form that might even contribute to a main meal. Development of new food products keeps consumers captivated in the culinary world.
Product definition, chefmanship and food science	
Skills	As final year consumer science students, they had to apply the knowledge they have gained during their studies to interpret these four factors. Continuous adaptations have been made over 7 weeks to improve the quality of the products, in terms of ingredients, flavour balances and methods.
Ingredients	Ingredients form an integral part of the culinary identity of a culture. Local ingredients and produce were used as far as possible. SA products such as Cape Ruby Port, SA wine, traditional Rooibos tea, familiar spices. Main ingredient was from a crocodile species that only exists in Southern Africa, namely *Crocodylus Niloticus*.
Preparation	Preparation methods form an integral part of the culinary identity of a culture. The students focused on preservation techniques since the products should be able to last on the shelves of retail outlets.
Flavouring	Ingredients and preparation methods form flavours. These form an integral part of the culinary identity of a culture. Local flavours, e.g. Cape-Malay, Rooibos, familiar spice flavours. Familiar flavours were incorporated into a novel product, to adhere to wants and needs of mainstream South African market.
Serving	Selling the products in a retail environment was a factor the students had to consider before developing the products. Products were served as a packaged product. Three products were products that were easy to eat on the go. The sous-vide product was packaged in a way that the consumer could cook it further at home and serve it as a novel product.

Table 5.3: Internal and external organisation

The Internal Organisation	
Knowledge	The students' knowledge from 3 years of studying Food and Hospitality management, complying with the criteria to advance to the product development subject in their fourth year were taken into consideration.
Exploitation	The students' innovative abilities and experience were confirmed in the following way: • Students (product developers) had at least 3 years academic and practical experience. • Completion of subjects such as business management, consumer aspects of food, consumer behaviour, consumer food research, food safety and hygiene, integrated food science, nutrition. • Subjects completed by the students such as experiential training, large-scale production and experimental product development have developed innovative thinking.
Development	Students gained more knowledge on the subject of product development and innovation by being led by experienced lecturers and industry experts.
Capabilities	The students showed good ability of creative problem solving, tacit know-how, situated judgment, monitoring and evaluation. The students saw this as a challenge, since they had to work with such an unconventional meat product. The results were, however, excellent.
Situated judgement	Judgement and advice from the five expert panellists were received. This was done on a 5-point Likert scale. Lecturers and industry experts made comments and discussions. This was done to improve the products.
Monitoring & evaluation	The products were monitored and evaluated throughout the whole culinary innovation process. Records were kept of the adaptions made, and precise repetitions were ensured.
Relationships & resource sharing	Relationships were built and used between suppliers, education facilities, and agricultural research centers, including the following: • Sourcing the crocodile meat from ThabaKwena crocodile farm. • Developing the products as part of both an undergraduate and postgraduate degree. • Developing a sensory profile of the crocodile meat at the ARC, Irene.
Equipment, space & other limitations	• The equipment, facilities and ingredients that were made available by the University of Pretoria was taken into consideration. • Volume of pots and pans, size of sous-vide machine, equipment and available apparatuses, working space/bench space for each student were carefully considered before and during development.
Culinary identity	Geography, history, ethnic diversity, culinary etiquette, prevailing flavors and recipes are critical elements that defines a country's culinary identity (Danhi, 2003). These factors were taken into consideration in the following way: • Indigenous and local food products were used in the products. These included Rooibos tea, Cape Ruby Port, Cape Malay spices and buttermilk. More detail on the specific products and ingredients will follow. • These ingredients delivered familiar South African flavours that have been adjusted to meet the modern consumer's needs.
The External Environment	
Consumer behaviours (past, present and future)	Prior to deciding on a possible product, a clear understanding of consumer behaviours and needs were determined. Past, present and anticipated consumer wants, needs and behaviours were taken into consideration. It was done by means of a short questionnaire, distributed to the intended target market. The following needs and possible target market were identified: • Those who have limited time to spend in retail environment. • Necessary to make the products appealing visibly and appealing in taste. • Saving – price for value. • Pleasure seekers – looking for new/fun. • Elite – looking for quality products, high in nutrition.
Trends and seasonality	Trends that were identified can be seen in Table 5.2, in the step 'Setting the stage'.
Food safety, nutrition, & dietary considerations	The product developer took note of ethics and trends in food safety, nutrition, and regulations during the development process. These trends were consumer, government and competitor driven. The students put a HACCP framework in place for the production of their new products, which included the following: • Maintain cold chain from abattoir to kitchen. • Storage of meat at -18 °C. • Thaw frozen crocodile at 4 °C. • Sanitize all surfaces and equipment. • Cook up to internal temperature of 75 °C. • Use separate preparation surfaces for different food groups, as well as raw and cooked meat.

5.3.2.2 Culinary innovation implementation

As discussed in Chapter 4, sub-section 4.8.3.2, continuous changes were assessed during the formulation stage, through evaluation of perceived preferences, production capabilities, consistency requirements, cost considerations, taste and appearance preferences and process improvement considerations. This was done for each product through formulation testing and analysis, development of a prototype, benchmarking and sensory analysis (Ottenbacher & Harrington, 2007). The results from these four steps are presented below, discussing the following aspects:

- Product criteria
- Desired sensory characteristics
- T-structure
- Preparation techniques
- Examples of the prototypes
- Packaging
- Competitor products and prices
- Sensory analysis from expert panel
- Final sensory profiles
- Adaption of ingredients and methods

The desired sensory characteristics for each product were determined after preparing the baseline recipe. The product developer and the expert panel evaluated the products and formed a final 'ideal' profile.

5.3.2.2.1 Rooibos-smoked crocodile kebabs

Table 5.4: Culinary innovation implementation of Rooibos-smoked crocodile kebabs (Kotze, 2017)

Formulation
The criteria for the rooibos-smoked crocodile kebabs were: • It must be tasty and infused with a smoky rooibos flavour • Should be moist and it should not be dry • Should be served with a sauce that complements the smoky flavour • It should have a tan, golden brown colour on the surface of the crocodile • Should be sustainable and versatile • South African inspired fine dining dish that has a mainstream twist • Interesting rustic flavours • Dry heat cooking methods like smoking • Special and exiting snack
***Desired sensory characteristics*:** • Golden brown • Glossy • Charred • Sweet • Seasoned • Variety of flavours • Fresh • Balanced • Tender • Juicy

continues …

continues …

T-structure:

Ingredients that determine character	**Ingredients that contribute to the support**
Major flavour: Rooibos and Smokiness **Body**: Crocodile meat **Texture**: Texture of crocodile meat and Sticky Sherry and Orange Sauce	**Flavour builders**: Lemon Honey Worcestershire sauce Ginger Garlic Orange concentrate Lime **Seasonings**: Salt & Pepper

Preparation technique:

- Marinating
- Smoking

.

Prototype

- See adaptions in Table 5.5
- Packaging:

Figure 5.1: Prototype and packaging of Rooibos-smoked crocodile kebabs

Benchmarking

Competitor products (Woolworths, 2018):

- BBQ chicken pancakes
  R44.99/8 pancakes (28g/1 pancake)
- Sweet Chilli Chicken Mini Fillets
  R79.99/250g
- BBQ Chicken Kebabs
  R99.99/300g

Developed product:

- Rooibos-smoked crocodile kebabs (Addenda E1 & E2)
  R29.00/2 kebabs (137g/1 kebab)

Sensory analysis

Adaptions were made based on sensory analysis by the expert panel. Adaptions can be seen in Table 5.5.

continues …

The final sensory profile as evaluated by the five expert panels can be seen in Figure 5.2.

The product developer successfully met all the sensory criteria of the crocodile kebabs that was initially set. One panellist scored tenderness lower than the other four experts. The developer could consider this, although it was a near perfect score. Figure 5.3 indicates a presentation of the final product.

Figure 5.2: Sensory analysis of Rooibos-smoked crocodile kebabs by expert panel

Figure 5.3: Rooibos-smoked crocodile kebabs with sherry and red wine sauce

Table 5.5: Adaptions of ingredients and method for smoked crocodile kebabs

Original	Adaption 1	Adaption 2	Adaption 3	Final recipe
Ingredients				
210g Crocodile tail eye	137g Crocodile tail eye	550g Crocodile tail eye		550g Crocodile tail eye
500ml Soya sauce	60ml Soya sauce			60ml Soya sauce
250ml Water	-	-	-	-
200g Honey	120g Honey			120g Honey
60g Ginger	7g Ginger	50g Ginger		50g Ginger
40g Garlic	2g Garlic	4g Garlic		4g Garlic
60g Brown sugar	23g Brown sugar			23g Brown sugar
125g Lemon	125g Lime	40g Lime		40g Lime
30ml Orange juice	50ml Orange concentrate			50ml Orange concentrate
30g Lime	-	-	-	-
			5g Salt	5g Salt
			2g Pepper	2g Pepper
Smoking				
10 Rooibos tea bags				10 Rooibos tea bags
250ml Rice				250ml Rice
80ml Brown sugar				80ml Brown sugar
Sauce				
250ml Port	-	-	-	-
	250ml Sherry			250ml Sherry
	250ml Red wine			250ml Red wine
60ml Rice wine vinegar		120ml Rice wine vinegar		120ml Rice wine vinegar
		30g Red onions		30g Red onions
		40g Ginger		40g Ginger
		50ml Orange concentrate		50ml Orange concentrate
		40g Lime		40g Lime
		10ml Soy sauce		10ml Soy sauce
		2g Garlic		2g Garlic

continues …

Original	Adaption 1	Adaption 2	Adaption 3	Final recipe
Method				
Pierce skin with a fork so that the flavour of the marinade can penetrate the meat.	Pierce the crocodile fillets.			Pierce the crocodile fillets.
In a large bowl whisk together the soya sauce, water, honey, ginger, garlic and brown.	Mix the soya sauce, water, honey, ginger, garlic, orange concentrate and brown sugar.			Mix the soya sauce, honey, ginger, garlic, orange concentrate and brown sugar.
Squeeze in the juice of the orange, lemon and lime, reserving the rinds.	Add the juice of the lime and reserve the rinds.			Add the juice of the lime and reserve the rinds.
Place the meat in a plastic storage bag, with the marinade. Marinate for 24 hours 2.	**Vacuum pack** the crocodile fillets with the marinade and rinds, seal and leave to marinade for **an hour** in the refrigerator.			Vacuum pack the crocodile fillets with the marinade and rinds, seal and leave to marinade for an hour in the refrigerator.
	In the meantime, put the sherry and wine into a medium saucepan and reduce for about an hour.	In the meantime, put the sherry and wine into a medium saucepan and reduce for about an hour along with the **sliced onions**.		In the meantime, put the sherry and wine into a medium saucepan and reduce for about an hour along with the sliced onions.
	Remove the fillets from the packet.			Remove the fillets from the packet.
Line the bottom of the wok with heavy-duty aluminium foil. Spread the rice, tea and sugar on the foil and place on the stovetop.	Line a **pot** with aluminium foil; add the rice, sugar and **Rooibos** to the bottom of the pot.			Line a pot with aluminium foil; add the rice, sugar and Rooibos to the bottom of the pot.
Place the steamer rack inside the wok and lay the meat on top.	Place a **ramekin and a plate**, both covered **in tin foil**, in the pot and place the fillets on the plate. Cover with an **aluminium covered lid**.			Place a ramekin and a plate, both covered in tin foil, in the pot and place the fillets on the plate. Cover with an aluminium covered lid.
Lower the heat to medium and smoke for 20 minutes.	Put the stove on low heat and allow to smoke for **15 min.**	Put the stove on low heat and allow smoking for **7min**.		Put the stove on low heat and allow smoking for 7min.
Take the lid off the wok and set the meat on a plate. Transform the wok into a roasting pan.	Remove the fillets and put them on a **baking tray.**			Remove the fillets and put them on a baking tray.
Roast the meat for one hour until the skin is golden and crisp	Bake fillets for **15min** until cooked. Cooking time depends on the thickness of the fillets.	Bake fillets for **12min** until cooked. Cooking time depends on the thickness of the fillets.		Bake fillets for 12min until cooked. Cooking time depends on the thickness of the fillets.

5.3.2.2.2 Red wine and rosemary-marinated sous-vide crocodile

Table 5.6: Culinary innovation implementation of red wine and rosemary-marinated sous-vide crocodile (van Zyl, 2017)

Formulation

The criteria for the red wine and rosemary-marinated sous-vide crocodile were:

- Crocodile meat is dark brown-red colour
- Crocodile meat is firm after cooking
- Port wine and rosemary is very prominent with after taste of beef stock
- Sparks an interest in the cooking method
- Ingredients used are available and easy to find

Desired sensory characteristics:

- Mouth feel
- Texture
- Practicality
- Appearance
- Moistness
- Adequate flavour

T-structure:

Ingredients that determine character	Ingredients that contribute to the support
Major flavour: Port wine **Body**: Crocodile meat Beef stock **Texture**: Texture of crocodile meat Onion Garlic	**Flavour builders**: Garlic Onion Vinegar Rosemary **Seasonings**: Salt Pepper

Preparation technique:

- Marinating
- Sous-vide
- Pan grill

continues …

Prototype

- See adaptions in Table 5.7
- Packaging (Figure 5.4):

Figure 5.4: Prototype and packaging of red wine and rosemary-marinated sous-vide crocodile

Benchmarking

Competitor products (Woolworths, 2018):

- Easy to Cook Free Range Slow Cooked Duck Legs
  R 179.99/kg
- Easy to Cook Slow-Cooked Springbok Shanks
  R 153.99 (R 139.99/kg)
- Sweet Chilli Ostrich Steaks
  R 49.50 (R 164.99/kg)

Developed product:

- Rosemary-marinated sous-vide crocodile
  R 50.00/200g

Sensory analysis

Adaptions were made based on sensory analysis by expert panel. Adaptions can be seen in Table 5.6.

The final sensory profile as evaluated by the five expert panels can be seen in Figure 5.5. The product developer successfully fulfilled most of the sensory criteria of the sous-vide crocodile that was initially set. Panellist 5 scored overall lower than the other panellists, namely the product's mouthfeel, flavour and appearance. Results show that there might be a gap in practicality of the recipe, scored lower by two panellists. The developer could consider this, although scores were high overall. Figure 5.6 indicates a presentation of the final product.

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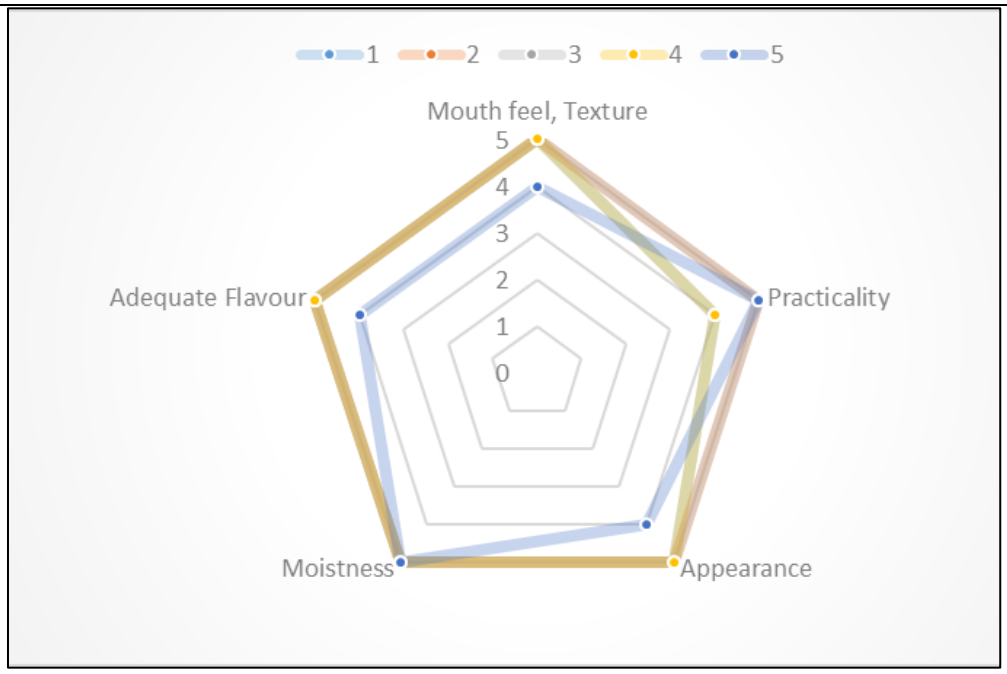

Figure 5.5: Sensory analysis of red wine and rosemary-marinated sous-vide crocodile by expert panel

Figure 5.6: Red wine and rosemary-marinated sous-vide crocodile

Table 5.7: Adaptions of ingredients and method for sous-vide crocodile

Original	Adaption 1	Adaption 2	Adaption 3	Final recipe
Ingredients				
80g Brown onion				100g Brown onion
10g Garlic cloves				10g Garlic cloves
3ml Black peppercorns		5ml Black peppercorns		10ml Black peppercorns
		5ml Salt		10ml Salt
30ml Fresh rosemary		15ml Fresh rosemary		15ml Fresh rosemary
250ml Muscadel wine	250ml Port wine			250ml Port wine
30ml Vegetable oil				30ml Vegetable oil
45ml Apple vinegar				45ml Apple vinegar
130ml Beef stock				125ml Beef stock
30ml Water				30ml Water
150g Crocodile tail eye				150g Crocodile tail eye
Method				
Peel and fine chop onions, garlic and rosemary, mix well and set aside.				Peel and fine chop onions, garlic and rosemary, mix well and set aside.
	Add oil to a sauté pan and sauté onion, garlic and rosemary until golden brown.			Add oil to a sauté pan and sauté onion, garlic and rosemary until golden brown.
	Add the Port wine and allow to reduce until half original volume, 125ml.			Add the Port wine and allow to reduce until half original volume, 125ml.
In a bowl add all ingredients	Remove the pan from heat and add the rest of the ingredients, mix well.			Remove the pan from heat and add the rest of the ingredients, mix well.
Place the crocodile inside the marinade and seal the marinade and crocodile in a vacuum sealed bag, allow to marinade for one hour in the refrigerator.	Add the crocodile meat and seal in a vacuum sealed bag, allow to marinade for one hour in the refrigerator.			Add the crocodile meat and seal in a vacuum sealed bag, allow to marinade for one hour in the refrigerator.
Fill the sous-vide machine with water and heat the water.	Fill the sous-vide machine with water and heat the water until 55 degrees Celsius.			Fill the sous-vide machine with water and heat the water until 55 degrees Celsius
After one hour, place the marinade bag in the water and sous-vide for three hours.	After one hour, place the marinade bag in the water and sous-vide for one hour.			After one hour, place the marinade bag in the water and sous-vide for one hour.
Turn off the machine after three hours and remove the bag.	Turn off the machine after one hour and remove the bag.			Turn off the machine after one hour and remove the bag.
		Place marinade in sauté pan. Reduce the marinade until almost all the moisture is evaporated, stirring constantly it must reach a syrup consistency.		Place marinade in sauté pan. Reduce the marinade until almost all the moisture is evaporated, stirring constantly it must reach a syrup consistency.
		Place the meat under the salamander for 5 minutes.	Place the meat on a smoking hot griddle pan for 15 seconds on each side.	Place the meat on a smoking hot griddle pan for 15 seconds on each side.
Place the crocodile on a hot plate and serve.	Place the crocodile on a hot plate and serve.			Place the crocodile on a hot serving plate and serve.

5.3.2.2.3 Cape-Malay crocodile curry filled dumplings

Table 5.8: Culinary innovation implementation of Cape-Malay crocodile curry filled dumplings (Els, 2017)

Formulation

The criteria for the Cape Malay crocodile filled dumplings were:

- To develop a dumpling that is filled with a Cape Malay crocodile filling that is fresh and spicy
- Natural colouring
- To develop a dumpling that is coloured with tomato puree after boiling
- To develop a dumpling that consists of two medium bites
- To develop a dumpling that incorporates a wide range of flavours

Desired sensory characteristics:

- Uniform colour
- Wonton fold -attractive
- Size
- Spicy
- Curry
- Pocket: soft
- Filling: smooth

T-structure:

Ingredients that determine character	**Ingredients that contribute to the support**
Major flavour: Cape Malay spices/curry **Body:** Crocodile meat Dumpling dough **Texture:** Texture of crocodile meat Texture of dumpling dough Onion Sugar snap peas Radish	**Flavour builders:** Red chillies Fresh coriander Fresh ginger Turmeric Cumin **Seasonings:** Salt Pepper

Preparation technique:

- Steaming
- Boiling

continues …

Prototype

- See adaptions in Table 5.9
- Packaging (Figure 5.7):

Figure 5.7: Prototype and packaging of Cape-Malay crocodile curry filled dumplings

Benchmarking

Competitor products (Woolworths, 2018):

- Chicken Pot stickers Dumplings
  R 59.99/12 dumplings
- Mini Chicken Puff Pies
  R 52.99/8 pies

Developed product:

- Cape-Malay crocodile curry filled dumplings (Addenda C1 & C2)
  R 15.00/3 dumplings

Sensory analysis

Adaptions were made based on sensory analysis by expert panel. Adaptions can be seen in Table 5.8.

The final sensory profile as evaluated by the five expert panels can be seen in Figure 5.8. The product developer successfully fulfilled all the sensory criteria of the crocodile dumplings that was initially set. Figure 5.9 indicates a presentation of the final product.

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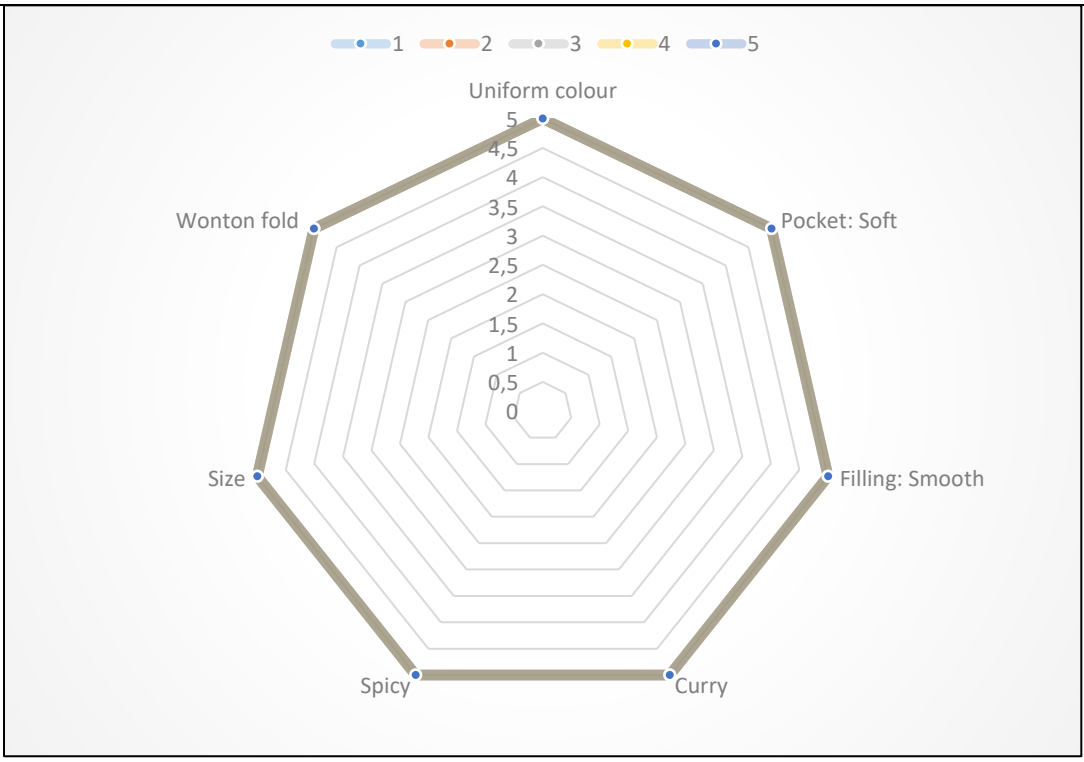

Figure 5.8: Sensory analysis of Cape-Malay crocodile curry filled dumplings by expert panel

Figure 5.9: Cape-Malay crocodile curry filled dumplings

Table 5.9: Adaptions of ingredients and method for Cape Malay crocodile curry filled dumplings

Original	Adaption 1	Adaption 2	Adaption 3	Final recipe
Ingredients				
340g Crocodile tail eye	360g Crocodile tail eye	200g Crocodile tail eye		200g Crocodile tail eye
1 small Carrot	500g Carrot	250g Carrots		250g Carrots
1 x 3cm Mouli	-	-	-	-
0,5 small Chilli, red	10g Chilli, red			10g Chilli, red
1 x 5cm Ginger, fresh	2.5g Ginger			2.5g Ginger
50g Sugar snap peas				50g Sugar snap peas
15 ml Coriander leaves				20 ml Coriander leaves
2.5ml Turmeric powder			5ml Turmeric powder	5ml Turmeric powder
2.5ml Cumin powder			5ml Cumin powder	5ml Cumin powder
TT Salt	2ml Salt		2ml Salt	2ml Salt
TT Pepper	2ml Pepper		3.5ml Pepper	3.5ml Pepper
25ml Vegetable oil				25ml Vegetable oil
1 Egg white	-	-	-	-
1,5 l Oil, for frying	-	-	-	-
	30g Radish			30g Radish
	2.5ml Garam Masala			2.5ml Garam Masala
		80g Brown onion		80g Brown onion
Wonton wrappers				
1 Egg	2 Eggs			2 Eggs
83 ml Water	250ml Water	80ml Water		80ml Water
500ml Cake flour	190g Cake flour	200g Cake flour		200g Cake flour
	2.5ml Salt			2.5ml Salt
	375ml Carrots, grated	-	-	-
		10ml Tomato purée		10ml Tomato purée
Method				
				Combine the turmeric and cumin in a sauté pan and roast about 30 seconds until the spices start to smoke and remove
Julienne all the vegetables for the filling	Grate all the vegetables for the filling			Peel the carrots, top and end the radish. Grate both and add to a medium bowl. Seed and finely chop the red chillies, add to the bowl. Cut the ends off the sugar snap peas and chiffonade very finely, add to the bowl Peel and finely chop the ginger, add to the bowl
				Peel and small dice the onion. Sauté the onions. Once the onions are translucent, add the rest of the filling ingredients and sauté.
	Mix all the filling ingredients and season with salt and pepper. Sauté to partially cook the filling.			Mince the crocodile and precook in a separate sauté pan with vegetable oil, approximately 6 minutes.
Mix all the filling ingredients and season with salt and pepper.				Add the roasted spices to the bowl. Combine the crocodile with the other filling ingredients and mix well.

continues …

Original	Adaption 1	Adaption 2	Adaption 3	Final recipe
Lay half the wonton wrappers on a flat surface and divide the filling mixture between them.	Lay the dumpling wrappers on a flat surface and divide the filling mixture between them.			Place 30ml of filling in the center of the dough.
Brush the edges of the wrappers with beaten egg white and carefully place another wonton wrapper on top. Press the edges together firmly	Brush the edges of the wrappers with beaten egg white and carefully bring the edges together. Press the edges firmly.			Brush one-half of the edges of the circle with egg whites. Fold the one-half of the circle over the filling to match the other half. Take a fork and lightly press the edges to help the dumpling seal. Twist and fold the two corners underneath the dumpling
Half-fill a large pan with oil and heat until a cube of bread browns in 20 seconds.	Half-fill a medium pot with boiling water. Place the bamboo steamer on top.			Half-fill a medium pot with boiling water. Place the bamboo steamer on top.
			Brush the dumplings with tomato purée.	
Fry the wonton parcels a few at a time, until crisp and brown.	Steam the dumplings until done and half-transparent.			Boil the dumplings in a medium pot filled ¾ with water for precisely 8 min.
Remove from the oil with a slotted spoon and sprinkle with a little salt. Keep warm.	Remove from the steamer and sprinkle with a little salt. Keep warm.			Remove and sprinkle with a little salt. Keep warm.
				Add 10ml of water to the tomato puree and mix well to reach a runny smooth consistency. Brush the tomato mix over the dumplings to give them colour.
Wrappers				
	Peel and puree carrots. Strain through a sieve. only a liquid must remain			
In a medium bowl, beat the egg. Mix in the water.				
Create a well in the center of the mixture and slowly pour in the egg and water. Mix well. If the mixture is too dry, increase the amount of water, one teaspoon at a time until a pliable dough has formed.	Sift the flour with the salt and water, to make a nice silky dough.	Add egg to the mixture. Sift the flour with the salt and water, to make a nice silky dough.		In a large bowl, sift the flour and salt together. Create a well in the center of the dry ingredients. Whisk the egg and water together and slowly pour the liquid into the well and mix. If the mixture is too dry, increase the amount of water, one teaspoon at a time until a pliable silky dough has formed.
On a lightly floured surface, knead the dough until elastic. Cut dough into two separate balls. Cover the balls with a damp cloth for a minimum of 10 minutes.	Knead well and cover with a damp cloth for 10 minutes.			On a lightly floured surface, knead the dough until elastic. Cut the dough in half to inspect if there are any air pockets in the dough. There must be no air pockets. Continue to knead until it is reached. Cover for a minimum of ten minutes under a damp cloth.
	Add the natural orange colourant until the dough is a pastel orange colour.	Add tomato purée instead of carrot colouring.		
Cut each ball into four equal pieces. Roll the pieces into 10 ½ by 10 ½ inch squares. Cut each into nine 3 ½ by 3 ½ inch squares.	Tear of a 30mL size of dough and roll out to 1mm thickness. Using a cookie cutter with a diameter of 10cm, cut out a circle of dough.			Tear of a 30mL size of dough and roll out to 1mm thickness. Using a cookie cutter with a diameter of 10cm, cut out a circle of dough.

5.3.2.2.4 Cornflake crumbed crocodile strips

Table 5.10: Culinary innovation implementation of Cornflake crumbed crocodile strips (van den Berg, 2017)

Formulation

The criteria for the Cornflake-crumbed crocodile strips were:

- Spiciness – savoury and spice flavour must be the main flavour component
- Golden brown – overall golden brown evenly baked
- Crust – the crust must be crispy with in contrast with the inner flesh of the strips
- Size / Proportion – Bite size and easy to eat
- Crust -the crust must be crispy with in contrast with the inner flesh of the strips
- Preferable over chicken –the overall appeal must be favourable
- Easy to eat –bite size and easy to consumer.
- Grab & on the go -must be able to consume the strips while on the move

Desired sensory characteristics:

- Appearance
- Texture
- Flavour
- Taste
- Overall appeal
- Practicality

T-structure:

Ingredients that determine character	Ingredients that contribute to the support
Major flavour:	**Flavour builders**:
Cornflake	Coriander
Crocodile meat	Paprika
Buttermilk	Thyme
Body:	Origanum
Crocodile meat	Garlic powder
Buttermilk	Parsley
Texture:	Cayenne pepper
Texture of crocodile meat	Cumin
Texture of cornflake crumb	**Seasonings**:
	Salt
	Pepper

Preparation technique:

- Marinating
- Crumbing
- Baking

Prototype

- See adaptions in Table 5.11
- Packaging (Figure 5.10):

continues …

Figure 5.10: Prototype and packaging of Cornflake crumbed crocodile strips

Benchmarking

Competitor products (Woolworths, 2018):

- Crumbed chicken strips with chips and dipping sauce
  R 62.00/5 strips
- Mini Chicken Puff Pies
  R 52.99/8 pies

Developed product:

- Cornflake crumbed crocodile strips (Addenda F1 & F2)
  R10.00/3 strips

Sensory analysis

Adaptions were made based on sensory analysis by expert panel. Adaptions can be seen in Table 5.10.

continues …

The final sensory profile as evaluated by the five expert panels can be seen in Figure 5.11. The product developer successfully fulfilled most of the sensory criteria of the crocodile strips that was initially set. Panellist 1 and 2 gave a perfect score for the product. The taste of the product received high scores, except for panellist 5. The practicality of consumption and preparation and the flavour of the product was well executed. Results show a good mean score, although some characteristics can still be considered to adjust. This product received highest hedonic ratings in the consumer evaluation panel. Figure 5.12 indicates a presentation of the final product.

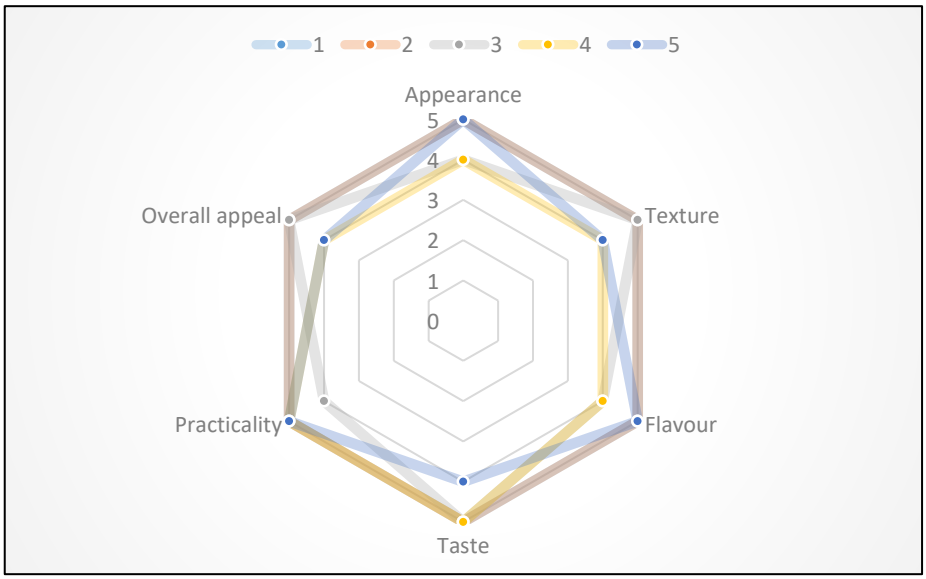

Figure 5.11: Sensory analysis of Cornflake crumbed crocodile strips by expert panel

Figure 5.12: Cornflake crumbed crocodile strips

Table 5.11: Adaptions of ingredients and method for crocodile strips

Original	Adaption 1	Adaption 2	Adaption 3	Final recipe
Ingredients				
300g Crocodile tail eye	300g Crocodile tail eye	500g Crocodile tail eye		500g Crocodile tail eye
Marinade				
100ml Buttermilk	125ml Buttermilk	200ml Buttermilk	250ml Buttermilk	250ml Buttermilk
5ml Chilli flakes				
	15ml Cumin powder	10ml Cumin powder	5ml Cumin powder	5ml Cumin powder
			2ml Coriander powder	2ml Coriander powder
2ml Peppercorns				2ml Peppercorns
2ml Paprika		5ml Paprika		5ml Paprika
		2ml Thyme		2ml Thyme
		5ml Parsley		5ml Parsley
2ml Salt		5ml Salt		5ml Salt
		2ml Fennel seeds		
Crumb				
140g Cornflakes	150g Cornflakes	180g Cornflakes	200g Cornflakes	200g Cornflakes
5ml Paprika		2ml Paprika		2ml Paprika
	2ml Origanum			2ml Origanum
	5ml Chilli flakes	2ml Chilli flakes		
		2ml Cayenne pepper	1ml Cayenne pepper	1ml Cayenne pepper
5ml Sugar		2ml Sugar		2ml Sugar
	2ml Garlic powder	1ml Garlic powder		1ml Garlic powder
	5ml Cumin powder	2ml Cumin powder		
5ml Salt	2ml Salt			2ml Salt
Method				
Pour the buttermilk in a bowl; add the salt and pepper.				Pour the buttermilk in a bowl; add the spices for the marinade.
	Slice crocodile into bite size pieces.			Slice crocodile into bite size pieces
Add the crocodile to the buttermilk. Marinate for at least 30 min or up to 4 hours.	Add the crocodile to the buttermilk. Marinate 8-24 hours.			Add the crocodile to the buttermilk. Marinate for 8-24hours.
Preheat the oven to 200 °C.				Preheat the oven to 200°C.
Line a sheet pan with foil and spray it with a coating of cooking spray.				Line a sheet pan with foil and spray it with a coating of cooking spray.
In a food processor and pulse the cornflakes, smoked paprika, onion powder, sugar, salt and pepper until a coarse crumb.		(Modification of crumb size)		In a food processor and pulse the cornflakes, sugar and spices until a coarse crumb.
Pour the cornflakes mixture into a plate.				Pour the cornflakes mixture into a plate.
Remove each piece of crocodile from the buttermilk and roll it evenly in the crumb mixture.				Remove each piece of crocodile from the buttermilk and roll it evenly in the crumb mixture.
Place in a baking sheet.				Place in a baking sheet.
Bake for 15 min or until crocodile is cooked through.		Bake for 20 min or until crocodile is cooked through.		Bake for 20 min or until crocodile is cooked through.
Serve immediately.				Serve immediately.

5.3.2.3 Evaluation and control

The third stage of the development process involved a repetitive process based on internal and external feedback loops, revision to address any problems, learning as part of the process and control systems that had to be put in place to ensure consistent quality (Ottenbacher & Harrington, 2007). Steps the evaluation stage consisted of are presented below, as applied to each product.

Table 5.12: Evaluation and control of crocodile meat products (Els, 2017; Kotze, 2017; van den Berg, 2017; van Zyl, 2017)

Scale-up

Upscaled recipes can be seen in Addendum –D - G.

Rooibos-smoked crocodile kebabs

The product developer's desired amount was 2kg product for large-scale production. The calculations made to up-scale the recipe can be seen below. The smoking ingredients remained the same.

Ingredient	Amount	X factor	Final amount
Crocodile	550g	X 5.71	3141g
Soya sauce	50g	X 5.71	285g
Honey	130ml	X 5.71	742ml
Ginger	50g	X 5.71	285g
Garlic	4g	X 5.71	23g
Brown sugar	24ml	X 5.71	137ml
Orange concentrate	50ml	X 5.71	285ml
Lime	40g	X 5.71	228g

Red wine and rosemary-marinated sous-vide crocodile

The product developer's desired amount was 3.4kg product for large-scale production. The calculations made to up-scale the recipe can be seen below. The up-scaled recipe was for 25 whole crocodile tail eyes. Refer to Addenda D1 &D2.

Ingredient	Amount	X factor	Final amount
Crocodile	150g	X 25	3750g
Onions	100g	X 25	2500g
Garlic cloves	10g	X 15	150g
Black peppercorns	10ml	X 3	30ml
Fresh rosemary	15ml	X 13.4	200ml
Port wine	250ml	X 25	6250ml
Vegetable oil	30ml	X 3.4	100ml
White vinegar	45ml	X 25	1125ml
Beef stock	125ml	X 25	3125ml
Water	30ml	X 25	750ml

Continues …

Scale-up

Cape Malay crocodile curry filled dumplings

The product developer's desired amount was 72 dumplings product for large-scale production. The calculations made to up-scale the recipe can be seen below.

Ingredient	Amount	X factor	Final amount
Crocodile tail eye	200g	X2	400g
Carrots	250g	X2	500g
Chilli, red	10g	X2	20g
Ginger	2.5g	X2	5g
Sugar snap peas	50g	X2	100g
Coriander leaves	20ml	X2	40ml
Turmeric powder	5ml	X2	10ml
Cumin powder	5ml	X2	10ml
Salt	2ml	X4	8ml
Pepper	3.5ml	X2	7ml
Vegetable oil	25ml	X2	50ml
Radish	30g	X2	60g
Garam Masala	2.5ml	X2	5ml
Brown onion	80g	X2	160g
Eggs	2	X2	4
Water	80ml	X2	160ml
Cake flour	200g	X2	400g
Tomato purée	10ml	X2	20ml

Cornflake crumbed crocodile strips

The product developer's desired amount was 2.6kg product for large-scale production. The calculations made to up-scale the recipe can be seen below.

Ingredient	Amount	X factor	Final amount
Crocodile	500g	X 4	2000g
Buttermilk	250ml	X 4	1000ml
Cumin, ground	5mL	X 3	15ml
Coriander, ground	2mL	X 2.5	5ml
Paprika	5mL	X 3	15ml
Peppercorn, coarse	2mL	X 2.5	5ml
Thyme, dried	2mL	X 2.5	5ml
Parsley, dried	5mL	X 3	15ml
Cornflakes	200g	X 4	800g
Organum, dried	2mL	X 5	10ml
Cayenne pepper	1mL	X 5	5ml
Garlic powder	1ml	X 5	5ml
Salt	5mL	X 3	15ml

Process development and production transference

Recipes has been standardised and triple-tested

HACCP analysis

Procedures identified by all four students can be seen in Table 5.3, under *Food safety, nutrition, & dietary considerations*.

Consumer testing

Discussed in section 5.5. Data collection: Phase 3.

5.4 DEMOGRAPHIC PROFILE OF PARTICIPANTS

The participating consumers were asked a series of psychographic questions in the last section of the questionnaire. This included the variables of age, gender, population group and level of education. Nearly 100 consumers participated and completed the questionnaires, but only 87 questionnaires were usable for further analysis. This was due to some participants not completing the whole questionnaire, or not completing it correctly. Table 5.13 indicates the profile of the 87 respondents.

Table 5.13: Demographic profile of respondents (N=87)

Gender		**Male**	**Female**		
	n	38	49		
	%	43.7%	56.3%		
Age		**Baby Boomers**	**Generation X**	**Millennials / Generation Y**	
	n	15	23	49	
	%	17.2%	26.4%	56.3%	
Level of education		**Grade 12**	**Degree / Diploma**	**Post-graduate**	
	n	19	37	31	
	%	21.8%	42.5%	35.6%	
Population group		**Black**	**Coloured**	**Other**	**White**
	n	18	2	2	65
	%	20.7%	2.3%	2.3%	74.7%
		Non-Caucasian			**Caucasian**
	n	22			65
	%	25.3%			74.7%

5.4.1 Gender

The majority of the participants that were willing to participate in the evaluation were female (56.3%). Both men and women were approached during the recruitment process but according to the data, it seems that women were more inclined to participate.

5.4.2 Age

Consumers had to be between the ages of 18 and 65 years to participate in this study. This target group was selected as the City of Tshwane Municipality considers them as “working age”. The majority of the population of Tshwane (68%) falls in this age group (Statistics South Africa, 2015b). The mean

age of consumers was 36 years with a standard deviation of 15.2. The youngest respondent was 18 years and the oldest 65 years of age.

Respondents were divided into generational cohorts for further analyses. The categorisation of the age structure of consumers is often used in research regarding consumer decision-making (Bakewell & Mitchell, 2003). The method of Gursoy, Maier and Chi (2008) was followed, who distinguished generations groups as Baby Boomers (born between 1943–60), Generation X (born between 1961–80) and Millennials/Generation Y (born between 1981–2000). More than half the consumers were Millennials while Baby Boomers and Generation X represented 17.2% and 26.4% of the consumers, respectively.

5.4.3 Level of education

Four categories of educational levels were distinguished, namely 'Lower than Grade 12', 'Grade 12', 'Degree/diploma' and 'Post-graduate level of education'. None of the participants had a lower education than Grade 12. The sample size of participants that held only a Grade 12 education was 21%. Consumers that had a degree/diploma were 34% of the participants and 34% had a post-graduate qualification. Therefore, the study sample was highly educated with 68% participants that had completed tertiary education.

5.4.4 Population groups

Five categories were presented to the participants to indicate to which ethnic group they belonged. These were Asian, Black, Coloured, Caucasian and an option for 'Other' was given. Respondents who indicated that they were Asian, Black, Coloured or 'Other', were grouped as 'non-Caucasian' to provide statistically significant results (Le Grange *et al.*, 1998). This division resulted in 25.3% non-Caucasian and 74.7% Caucasian.

5.5 CONSUMER PERCEPTION AND EXPECTATION OF CROCODILE MEAT PRODUCTS

Perception draws information from memory, learning, context and expectation (Cardello, 1996:2). These concepts are discussed first, referring to it as the consumers' psychographics. It is followed by expectations, which will include a discussion on the appropriateness ratings of the sensory characteristics. The following are the results of Phase 2, which also addresses objective two. Be reminded that the results (Section A) draws upon the respondent's perception.

The statistical techniques used were descriptive statistics (observed means, standard deviations, frequency distributions), multivariate statistics (ANOVA), and inferential statistics (EFA). Graphs and

tables were developed to better visualise the data. Such visualisation often reveals a better picture of the data that would have been lost with computation of test statistics and probabilities (Meilgaard, Civille & Carr, 2007a). The data processing was done on the statistical program SAS 9.4 and Excel 2016 with add-on software XLSTAT (2016). Least square means (LS Means) were calculated based on the ANOVA models. This is done when data results are unbalanced, which was the case when demographic variables came into play (Cai *et al.*, 2014).

For the purpose of the interpretation of the means (M), the following applied:

M= ≥7: High score

M= ≥4 <7: Moderate score

M= ≥1< 4: Low score

5.5.1 Psychographic profile of participants

Memory was measured by determining how familiar the consumers were with exotic meats, as well as their previous experience with exotic meats. Context was measured in terms of the individual's interest in culinary food culture. Learning was measured through determining their willingness to try new food products. Memory, learning and context are discussed below as the psychographics of the consumers. These have been summarized in Tables 5.14 and 5.15. For the different demographic variables, group means on interest, knowledge and previous experience were compared using two-sample t-tests or ANOVA (in the case of three groups). Significant differences are highlighted.

5.5.1.1 Interest in culinary food culture

According to the results portrayed in Table 5.14, participating consumers had a high interest in culinary food culture. These types of consumers would refer to themselves as 'foodies'. According to Chapman-Novakofski (2011), a foodie is someone who is very aware of what they eat, which ingredients are used in a dish they prepare or eat, what it looks, taste and smells like. They are also said to consistently follow a set of food trends. These types of consumers are important when introducing novel foods to a market, as they will be the ones setting the new trends and exposing it as a worthwhile product. There were no significant demographic effects on the consumers' interest in culinary food culture, except for a trend towards participants that hold a degree or diploma tending to be more interested in culinary food culture than those with a post-graduate level of education (p=0.0747).

Table 5.14: Table of means of psychographic data showing consumers' interest in and knowledge of culinary food culture

	N	Mean	SD	p-value	N	Mean	SD	p-value	N	Mean	SD	p-value	N	Mean	SD	p-value
	Interest in culinary food culture				*Willingness to try new foods*				*Familiarity with exotic meats*				*Expectation*			
	87	7.5	1.55		87	7.9	1.371		87	5.5	2.453		87	7.5	1.45	
Gender																
Male	38	7.2	1.78	0.1493	38	7.8	1.59	0.8518	38	5.4	2.32	0.7766	38	7.4	1.46	0.9392
Female	49	7.7	1.31		49	7.9	1.19		49	5.5	2.58		49	7.5	1.47	
Age																
Baby Boomers	15	7.7	1.75	0.2638	15	7.7	1.75	0.8654	15	5.3	2.84	0.4074	15	7.5	1.21	0.7170
Generation X	23	7.8	1.19		23	7.8	1.19		23	6.0	2.20		23	7.2	1.21	
Millennials	49	7.2	1.61		49	7.9	1.34		49	5.2	2.44		49	7.6	1.24	
Ethnicity																
Caucasian	65	7.6	1.50	0.9522	65	7.9[a]	1.42	0.0332	65	5.5	2.54	0.8398	65	7.4[b]	1.55	0.0189
Non-Caucasian	22	7.3	1.67		22	7.8[b]	1.26		22	5.3	2.23		22	7.6[a]	1.12	
Education																
Grade 12	19	7.7[ab]	1.49	0.0747	19	7.8	1.64	0.7886	19	4.7	2.80	0.6434	19	7.3	1.30	0.1967
Degree/ diploma	34	7.5[a]	1.56		34	7.0	1.04		34	5.5	2.15		34	7.5	1.58	
Post-graduate	34	7.4[b]	1.56		23	7.8	1.51		23	5.8	2.51		23	7.5	1.39	
Experience																
Previous experience	42	7.6	1.64	0.8126	42	7.9	1.35	0.9148	42	6.2[a]	2.37	0.0058	42	7.8[a]	1.01	0.0215
No previous experience	45	7.4	1.47		45	7.9	1.40		45	4.8[b]	2.34		45	7.1[b]	1.74	

Continues...

Continues ...

[a-b]Scores of psychographics with different letters differed significantly (P<0.05)

5.5.1.2 Willingness to try novel foods

Participants were very willing to try new foods. This would expand their culinary experience and knowledge, which is something that is associated with food neophillia and 'foodies' strive toward it. Yet again, there were not many prominent demographic effects on their willingness to try new food

products, apart from Caucasians scoring it higher than non-Caucasians (p=0.0332). Although area of residence has not been determined in this study, one could consider that there is a correlation between population group and area of residence. Literature states that food variety is broader in cities than in rural areas, therefore people in rural areas might be more neophobic (Flight *et al.*, 2003; Tuorila *et al.*, 2001). Many studies have shown that neophobia scores differ extensively between cultures (Olabi *et al.*, 2009; Ritchey *et al.*, 2003). However, very few studies have compared Caucasian and non-Caucasian consumers regarding neophobia. Neophobia also decreases as education increases (Hursti & Sjödén, 1997; Meiselman *et al.*, 2010; Tuorila *et al.*, 2001). Although there was no significant effect in this study, the mean score for willingness to try novel foods was higher for consumers with a post-graduate degree than those with only a degree or diploma. Interestingly, consumers with a Grade 12 level of education scored the same as those with post-graduate level of educations. According to Fernández-Ruiz *et al.* (2013) and Meiselman *et al.* (2010), younger people will have lower neophobic tendencies due to broader food selections today compared to a few decades ago. This trend can be seen in the results of the current study, although minimally. Millennials had a slightly higher mean score for willingness to try novel foods than Baby Boomers and Generation X. These Millennials would be classified as "innovative consumers", which are the best to target for novel products. Rogers and Shoemaker (1971) defined these consumers as "the degree to which an individual adopts a new product relatively earlier than other members in the social system. These 'innovators' enjoy talking about their new experiences, which could be highly effective to introduce the novel food products to others.

5.5.1.3 Familiarity of exotic meat products

Consumers were only moderately familiar with exotic meats. Participants commented that they were uncertain how 'exotic' would be defined, as it could be different for each individual. This result also showed a high standard deviation, which would explain the uncertainty. Consumers with previous experience of crocodile meat were more familiar with exotic meat overall than those with no previous experience of crocodile meat (p=0.0058). Previous experience and expectations influence consumers' learning of a new product. Consumers are more inclined to buy products that have familiar attributes. This could help the consumer to familiarise him or herself with new products. Martinez and Bojnec (2014) advises product developers to introduce familiarity when a novel food product is developed. The same principle goes for novel products offered by strong, well-known brands or retailers (Smith & Park, 1992). According to Schupp, Gillespie, O'Neil, Prinyawiwatkul and Makienko (2005), consumers feel more comfortable with a new food product if they are presented with more information. This kind of information would include health and safety, nutritional value, ingredients

etc. Familiarity of sensory attributes and acceptance of products are discussed later in this chapter. Martinez and Bojnec (2014) found that the origin of the food product strongly influences the consumer's acceptance thereof. They are more likely to trust products from their own country, rather than a foreign country.

5.5.2 Previous experience

The participants' previous experience was also explored to determine if it has an influence on their expectations (Table 5.15). Forty eight percent of the participants (42 of 87) had previous experience with crocodile meat.

Table 5.15: Table of means of consumers with previous experience of crocodile meat describing previous experience and impressions of crocodile meat

Consumers with previous experience of crocodile meat	N	Mean	SD	p-value	N	Mean	SD	p-value
	Quality of previous experience				*Willingness to buy crocodile meat again*			
	42	**6.45**	**1.728**		**42**	**5.86**	**2.148**	
Gender								
Male	21	6.86	1.82	0.1306	21.00	6.67 [a]	2.03	0.0127
Female	21	6.05	1.56		21.00	5.05 [b]	1.99	
Age								
Baby Boomers	8	5.13 [b]	1.81	0.0168	8.00	4.75	1.58	0.1609
Generation X	10	7.40 [a]	1.26		10.00	6.70	2.21	
Millennials	24	6.50 [a]	1.64		24.00	5.88	2.19	
Ethnicity								
Caucasian	31	6.4	1.75	0.7472	31.00	5.8	2.13	0.4352
Non-Caucasian	11	6.7	1.75		11.00	6.5	2.35	
Education								
Grade 12	8	5.88 [b]	1.67	0.0224	8.00	5.75	2.19	0.1682
Degree/diploma	17	6.05 [b]	1.65		17.00	6.00	2.14	
Post-graduate	17	7.58 [a]	1.79		17.00	5.76	2.19	

[a-b] *Scores of psychographics with different letters differed significantly (P<0.05)*

5.5.2.1 Quality experience

Based on the 9-point Likert-type scale (1=disagree completely and 9=agree completely), the participants gave a moderately high score (6.4) for their previous experience. Baby boomers rated

their previous experience with crocodile meat significantly lower than Generation X and Millennials (p=0.0168). Consumers that hold a post-graduate degree seemed to have a better previous experience than those with a grade 12 qualification or a degree or diploma level of education (p=0.0224). These results could give an indication of what the researcher could expect from the reaction to her newly developed products. According to Raats, Daillant-Spinnler, Deliza and MacFie (1995); Schupp *et al.* (1998), previous experience with a product leads to prior expectations. Therefore, the researcher can be sure that the experience of these 42 consumers are influenced by their previous experiences.

5.5.2.2 Willingness to buy

Consumers' willingness to buy crocodile meat again received moderately low scores (5.9). Males were more willing to buy crocodile meat products again, based on their previous experience (p=0.0127). Similar results were found by Schupp, Gillespie and Reed (1998), and confirmed more recently by Schupp *et al.* (2005).

According to Raats *et al.* (1995), consumers with negative previous experience are likely to have lower expectations of repeat use of a product and can therefore reject the product immediately. If the previous experience was positive, their expectations will be high and they will make the choice to consume the product again. Since the consumers' previous experience was moderately high, their expectations of consuming a crocodile meat product again should be leaning toward high expectations. Considering the response for experience and willingness to buy, the challenge would therefore be to change their liking through delivering good quality products.

5.5.3 Consumer expectations

The possible effect of prior experience as well as information on product expectation has been discussed in the previous section. In short, the consumers' previous experiences were good enough to make the choice to participate in this study, leading to high expectations. Be reminded that the results (Section A) draws upon the respondent's perception.

5.5.3.1 Expectation

Table 5.14 indicates that participants had a high expectation (7.5) of the samples that they were about to taste. It should be noted that disconfirmation of these expectations could have a negative effect on the acceptability of crocodile meat products. Non-Caucasians rated their expectation of the crocodile meat products higher (p=0.0189). Their expectations of the crocodile meat products were significantly

higher as well (p=0.0215). Non-Caucasians also expected to have a slightly better experience than Caucasians.

Those with no experience had enough positive information to develop high expectations of the products. The consumers' experience of the sensory characteristics of the products will result in confirmation or disconfirmation of their expectations. According to Deliza (1995), disconfirmation as well as confirmation of their expectations can have either positive or negative effects. Disconfirmation of those with low expectations will lead to satisfaction and repeated use, whereas disconfirmation of those with high expectations will reject the products and not consume the product again. The results of confirmation of expectations will then be vice versa of the previously stated scenario.

5.5.3.2 Appropriateness of sensory characteristics associated with crocodile meat

The concept of appropriateness is used with regard to appropriateness by use of the food product, to add information to a sensory evaluation. Consumers conceptualise their expected sensory characteristics of the crocodile meat products, based on their previous experience thereof, or information acquired. Results of the appropriateness ratings are related to their actual hedonic experience of the products, later in this chapter. This was done to explore if the consumers in reality like the characteristics that they previously found appropriate on a conceptual level.

Consumers responded using a 9-point Likert scale, the two anchors being "1=extremely dissatisfied" and "9=extremely satisfied". These characteristics were based on a lexicon developed by trained sensory panellists at the ARC, as well as the product developers of the new products.

Table 5.16 shows the mean ratings, sorted from most to least appropriate. An ANOVA compared the mean satisfaction ratings and showed significant differences in the perceived appropriateness of the characteristics ($P<0.05$). Multiple comparisons showed that consumers found the attribute 'tender texture' most appropriate followed by 'golden brown appearance, chicken-like aroma, light meat colour, juicy texture, salty flavour, crispy texture, smoky flavour and deep-fried flavour, all scoring above 6. Metallic flavour was least appropriate to describe the expected product, followed by bitter flavour, bland flavour and tough texture all scoring below four. Golden brown colour and light meat colour were equally rated concerning colour, while chicken-like aroma, salty flavour and smoky flavour were not scored significantly different. Juicy and crispy textures were scored similar but lower than tender texture. The characteristics that were rated have been grouped into attributes 'appearance', 'texture' and 'flavour'. These results are discussed below.

Table 5.16: Mean satisfaction ratings and standard deviation of sensory characteristics

Sensory descriptors	Mean satisfaction rating	SD
Tender texture	7.35[a]	1.64
Golden brown colour	6.88[ab]	1.74
Chicken-like aroma	6.87[ab]	1.64
Light meat colour	6.76[b]	1.78
Juicy texture	6.75[b]	1.95
Salty flavour	6.66[bc]	1.70
Crispy texture	6.53[bc]	2.0
Smoky flavour	6.41[bc]	1.78
Deep fried flavour	6.12[c]	2.09
Flaky texture	5.30[d]	2.13
Sweet flavour	5.23[d]	2.01
Minced meat texture	5.21[de]	2.20
Hot flavour	5.14[de]	2.34
Dark meat colour	5.03[def]	2.25
Chewy texture	4.64[ef]	2.07
Liquor flavour	4.52[f]	2.35
Tough texture	3.70[g]	2.14
Bland flavour	3.15[gh]	1.99
Bitter flavour	2.82[hi]	1.83
Metallic flavour	2.32[i]	1.58

[a-i] Scores of attributes with different letters differed significantly (P<0.05)

Hedonic scale: 1 "extremely dissatisfied" – 9 "extremely satisfied"

i. Appearance

Fletcher (2002) revealed that the flesh colour or appearance is one of the most important cues in choosing meat of any type. Appearance characteristics that were rated for appropriateness are discussed below.

Golden brown colour: Meat products with golden brown toasted colours can be the result of a Maillard reaction, i.e. an interaction between a protein and a sugar. It results in the formation of brown complexes upon the application of heat or the result of breading and crumbing of the food product. These products are generally golden brown as it is the most accepted by the consumers (Chen, Wang & Dyson, 2016:176), which also supports the colour's high appropriateness scores found in this study. *Light meat colour*: Research done in the UK found that its consumers prefer a white, non-pigmented skin when it comes to poultry or fish (Fletcher, 2002). As crocodile meat is most similar to these two meat types, it could be assumed that the same would be said about crocodile meat.

ii. Texture

As mentioned previously, texture has a major effect on acceptability of a food product.

- *Tenderness:* The level of tenderness drives the acceptability of the meat product by creating the perception of freshness and quality (Coggins, 2007:94). Pearson (2013:3) also states that consumer surveys most often reveal that this is a problem in meat products; therefore, it is important to focus on this characteristic when developing new products.
- *Juiciness:* It is an important contribution to acceptance of texture, and although it is difficult to measure, it has a profound effect on other sensory attributes of meat products. Dryness, for example, is associated with lack of flavour and toughness (Winger & Hagyard, 1994:94).
- *Crispiness:* As early as 1971, a study done by Szczesniak found that characteristics of crispness and crunchiness stimulates the consumers and prompts further eating. At the bottom of the list compiled by this authors findings were the characteristics tough (as in this study), lumpy and slimy, confirmed by Szczesniak in 2002.

iii. Flavour

Food preferences are already developed at childhood age.

- *Salty & sweet flavour*: Young consumers have an attraction to sweet and salty tastes, and less to bitter and sour. Liking of bitter and sour flavours have to be learned, but most energy intake still comes in the form of sweet and savoury food sources (Birch, 1999:94).
- *Deep-fried flavour:* Zainun (2008), who confirms that batters and breading for poultry has increased due to the increased popularity in fried chicken, supports the high appropriateness score for deep fried flavour.
- *Blandness:* Sørensen, Møller, Flint, Martens and Raben (2003) does suggest however, that consumers eat more of previously bland food if it is made more appetizing through the addition of sweetness, salt, spices or herbs. Kennedy, Stewart-Knox, Mitchell and Thurnham (2004) supports this by saying that consumers find bland meat products functional, as it lends itself to the addition of sauces and pre-prepared flavouring.
- *Spiciness/Hotness:* Regarding the characteristic “hot”, Silver and Finger (1991) stated that “without pungency, many foods would be bland, so it is obvious that the sense of chemesthesis plays a crucial role in evaluation of palatability”. It is also said that the level of pungency leads flavour and taste attributes of a food product (Kostyra, Baryłko-Pikielna & Dąbrowska, 2010).

5.5.3.3 Exploratory factor analysis to determine the appropriateness of 20 expected sensory characteristics in a crocodile meat product

Factor 1 (F1): Most appropriate sensory characteristics

Factor 2 (F2): Least appropriate

Exploratory factor analysis (EFA) was used to find possible existence of underlying relationships between measured variables, i.e. to show association or division among the variables and give an overview of the information contained in the measured sensory characteristics.

The eigenvalue criterion was used to determine the number of underlying factors. Four factors had eigenvalues greater than 1 but with the exception of two, all attributes had largest loadings on the first two factors. In Table 5.17 the factor loadings on the first two factors are given. Values in bold correspond for each variable to the factor for which the squared cosine is the largest. Loadings close to -1 or 1 indicate that the factor strongly influences the variable. Loadings close to 0 indicate that the factor has a weak influence on the variable. The largest loadings are indicated in bold and identify the two sets of variables which respectively contribute most to the two underlying factors. They indicate those characteristics that contribute significantly to the interpretation of the expected appropriate characteristics of the product.

Table 5.17: Table of coordinates for F1 and F2

Sensory descriptors	F1	F2
Bitter flavour	-0.025	-0.427
Metallic flavour	0.009	**-0.689**
Bland flavour	-0.129	**-0.571**
Sweet flavour	**0.511**	-0.128
Hot flavour	**0.458**	-0.022
Smoky flavour	**0.429**	-0.154
Salty flavour	**0.503**	-0.116
Liquor flavour	**0.461**	-0.077
Deep fried flavour	**0.616**	0.144
Tough texture	-0.241	**-0.784**
Flaky texture	**0.299**	0.013
Chewy texture	-0.027	**-0.647**
Juicy texture	**0.617**	-0.228
Tender texture	**0.537**	-0.030
Minced meat texture	**0.520**	-0.150
Crispy texture	**0.735**	0.180
Light meat colour	0.308	-0.111
Dark meat colour	0.343	-0.092
Golden brown colour	**0.743**	0.108
Chicken-like aroma	**0.511**	-0.104

From this can be seen that Factor 1 is associated with sensory characteristics generally seen as positive (large, positive loadings are indicated in bold) and Factor 2 with sensory characteristics generally seen as negative (the loadings, indicated in bold, are also large but negative). Only bitter flavour (positive loading) and light meat colour (negative loading) did not load on the first two factors. This may be explained by these attributes being perceived as not applicable at all ('bitter flavour'), or always applicable ('light meat colour'). The factor loadings are used as the coordinates to visually present all the characteristics simultaneously and are presented in Figure 5.13.

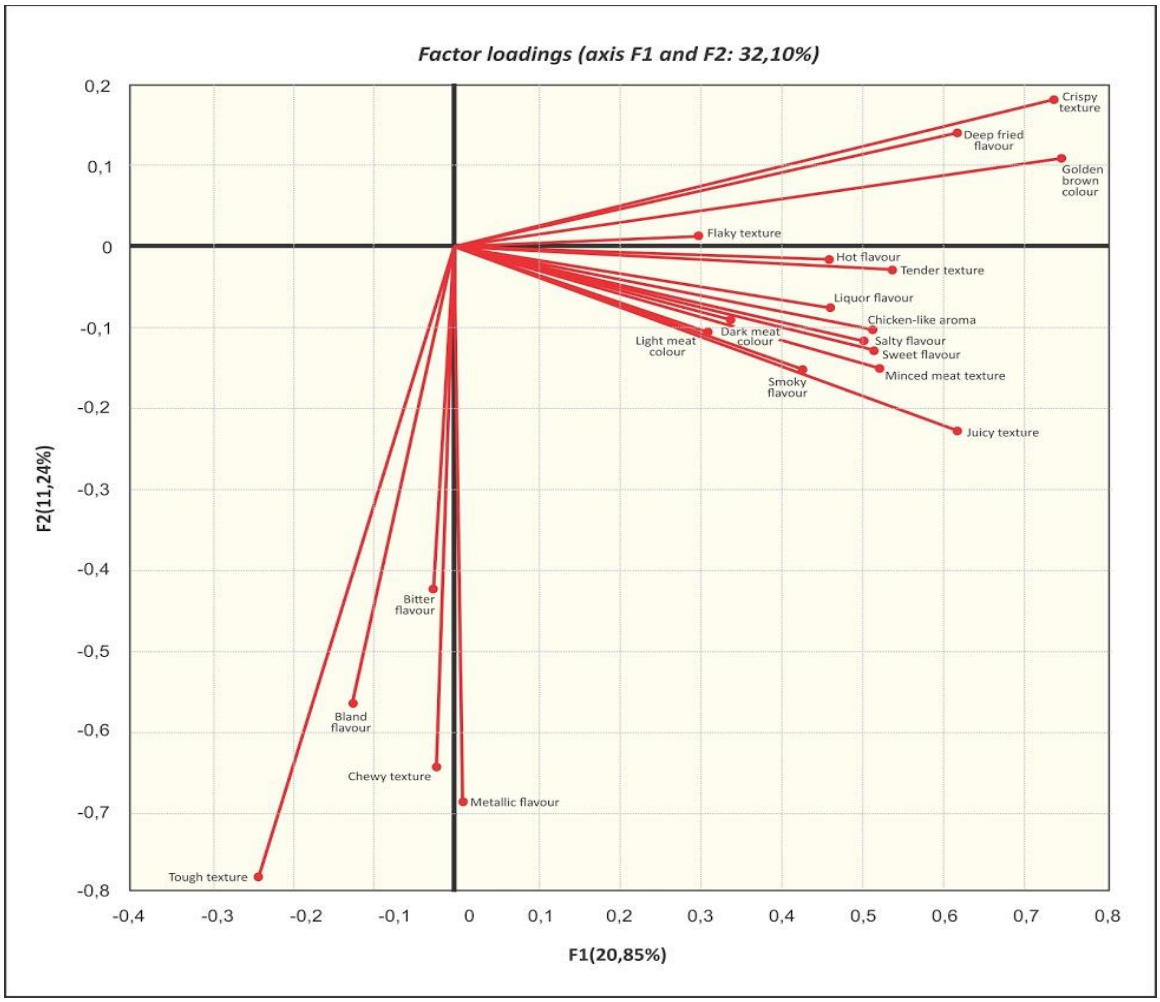

Figure 5.13: Consumer expectation of crocodile meat products

A total of 32.1% of the variation in the data is explained by two factors. In the figure Factor 1 (most appropriate characteristics) accounts for 20.85% and factor 2 (least appropriate characteristics) 11.24% of the variation. Related characteristics have high squared cosine values. Based on this analyses, crispy texture, golden brown colour, deep fried flavour shows significantly high values for F1 and are grouped in the top right quadrant. These characteristics are related to each other in that they describe a similar type of characteristics. Juicy texture also shows a high value in the first dimension

F1 but is situated in the bottom right quadrant and the F2 level opposite to the four characteristics just mentioned. All five characteristics were favoured by consumers as expected characteristics in crocodile meat products (based on F1 dimension) and also scored sensory values above 6. For the second dimension, F2, the negative values indicated in bold for metallic flavour, bland flavour, tough texture and chewy texture can be interpreted as the expected characteristics consumers would be least satisfied with. This showed the same trend as the mean scores. All characteristics in bold (Table 5.17) in the F1 dimension showed mean scores of ≥4.5. Light meat colour and dark meat colour, however, had a high mean score but low squared cosine.

5.6 CONSUMER HEDONIC AND SENSORY EXPERIENCE

The third objective is aimed at determining consumers' hedonic reaction toward crocodile meat products, through sensory evaluation. Consumers tasted the crocodile meat products that were developed by students. Their experience was measured on hedonic scales and analysed with ANOVA and EFA. Thereafter, CATA analysis was done to relate the consumers' experience to their expectations as discussed in the previous section. The influence of demographics on product liking and acceptance was analysed to study possible target markets for the products to be introduced to.

5.6.1 Hedonic experience of culinary crocodile meat products

For the purpose of the interpretation of the means (M), the following applied:

M= ≥7: Good/excellent

M= ≥4 <7: Average/neutral

M= ≥1< 4: Unsatisfactory

The products developed by the students were evaluated on a 9-point hedonic scale, with anchors of "1=disagree completely" to "9=agree completely". These questions related to the overall liking as well as the liking of flavour, aroma, texture and appearance of each of the products. Figure 5.14 shows the differences in liking of four sensory attributes and overall liking of the products. Table 5.18 summarises the ANOVA results. Mean scores for the products with each sensory attribute were compared and each presented in the rows of Table 5.18. The product with the highest scores for each of the attributes was the strips, followed by the smoked. Strips were scored overall more acceptable ($p<0.0001$), with better aroma ($p=0.008$), texture ($p=0.0975$), flavour and appearance ($p<0.0001$) than dumplings and sous-vide. The smoked product did not differ from the strips except for appearance. The overall liking and flavour of the smoked product was also favoured above that of the dumplings and the sous vide

product. The dumplings' overall liking score was the lowest. The flavour, aroma and appearance of the sous-vide was least liked, but sous-vide and dumplings did not differ significantly for any of the four attributes. It is clear that the crocodile strips were highly preferred over the other products. Although the dumplings received the lowest overall score, there were some concerns regarding the separate sensory attributes of the sous-vide product. No scores were, however, in the 'unsatisfactory' category.

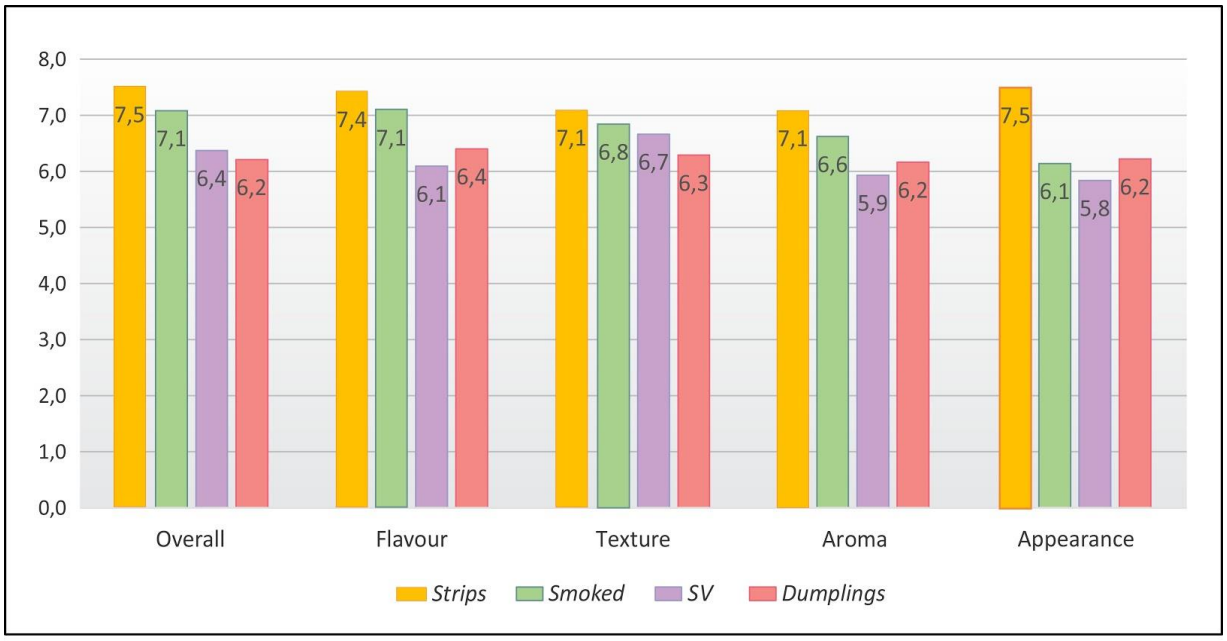

Figure 5.14: Sensory liking of crocodile meat products

Table 5.18: Mean scores and standard deviations for liking of sensory attributes of products

	Strips		Smoked		Sous-vide (SV)		Dumplings		p-value
	Mean	Std dev	Mean	Std dev	Mean	Std dev	Mean	Std dev	
Overall	7.50^{a}	1.62	7.06^{a}	1.61	6.35^{b}	2.06	6.21^{b}	2.47	<0.0001
Aroma	7.08^{a}	1.69	6.62^{ab}	1.83	5.93^{c}	1.0	6.16^{bc}	2.48	0.0008
Texture	7.08^{a}	1.96	6.84^{ab}	1.88	6.66^{ab}	1.83	6.29^{b}	2.40	0.0975
Flavour	7.41^{a}	1.58	7.09^{a}	1.61	6.09^{b}	1.95	6.40^{b}	2.42	<0.0001
Appearance	7.51^{a}	1.63	6.14^{b}	2.35	5.84^{b}	2.16	6.22^{b}	2.47	<0.0001

$^{a\text{-}c}$ *Scores of attributes with different letters differed significantly (P<0.05)*

The results from the sous-vide product and the dumplings are interesting seeing that the overall score was lowest for the dumplings, but three of the four individual sensory attributes were lower for the sous-vide product. This could be explained by a study done by Moskowitz and Krieger (1993) according to which a consumer cannot distinguish between the sensory attributes of appearance, flavour and

texture when evaluating overall liking. On average, the relative importance of the sensory attributes for foods is always in the order of flavour, then texture, then appearance. The importance of different sensory attributes differs between individuals, which drives overall liking. Some consumers are more reactive to texture experience and then only to flavour. Thus, individuals exhibit different criteria for what is important to them. Appearance is the characteristic that is considered most important in the case of novel foods. Consumers first 'eat' with their eyes, therefore it is the determining factor of the choice they make to eat the product (Borgogno, Favotto, Corazzin, Cardello & Piasentier, 2015). Product developers should therefore be aware of these different categories of consumers and develop products with the objective of satisfying each consumer's actual sensory preference.

Based on this theory, the hedonic scores for the dumplings can be explained. Seeing that the texture scores of the dumplings were the lowest, a relation could be made that this attribute played the most important role in the decision of its overall liking.

Consumers like what they are used to. Schupp *et al.* (2005) found that exotic meat products associated with chicken were considered more acceptable than those associated with a conventional red meat type. The crocodile strips resembled familiar crumbed chicken strips that are found in many retail outlets in South Africa and is a product sold in a highly popular chicken fast-food chain. Bain (2016) found that chicken fast-food restaurants are the most-visited among all establishments that were studied. Therefore, the assumption could be made that one of the factors motivating the consumers' preference of the crumbed strips, was due to this association.

5.6.2 Sensory experience of crocodile meat products

The sensory characteristics of these products and the consumers' experience thereof are discussed in this section. The CATA analysis will give an indication of the specific sensory characteristics that influenced the liking of these products. The sensory characteristics presented before the tasting and the characteristics during the tasting were the same. The XLSTAT program was used to analyse the CATA data. Two tests were performed with the CATA data. First Cochran's Q test to compare the different crocodile meat products. Secondly a correspondence analysis (CA) is performed with the goal of positioning the products on a map to analyse how the products are relatively positioned (XLSTAT, 2017).

5.6.2.1 Sensory characterisation of products

The consumers were requested to check all the characteristics that they experienced to apply to each product. They checked between 0 and 15 characteristics to describe each sample. Highest frequencies are highlighted. The most liked sample, crocodile strips, was the one for which consumers used the highest number of terms to describe, whereas the product that was least liked, crocodile dumplings, received the least number of characteristics (Table 5.19).

Table 5.19: CATA frequency table

Products	Bitter	Metallic	Bland	Sweet	Hot	Smoky	Salty	Liquor	Deep fried	Tough
Sous-vide	12	11	36	25	1	41	27	16	4	16
Smoked	9	2	9	47	7	45	38	14	7	22
Strips	3	3	7	20	60	9	38	4	50	22
Dumplings	9	6	22	6	54	9	47	1	15	15
Total	**33**	**22**	**74**	**98**	**122**	**104**	**150**	**35**	**76**	**75**
Range	**9**	**9**	**29**	**41**	**59**	**36**	**20**	**15**	**46**	**7**

Products	Flaky	Chewy	Juicy	Tender	Minced meat	Crispy	Light colour	Dark colour	Golden brown	Chicken aroma	Total
Sous-vide	23	36	31	47	4	1	59	21	8	22	**189**
Smoked	16	35	28	39	6	3	56	23	15	30	**200**
Strips	22	35	17	21	6	59	52	3	57	39	**216**
Dumplings	17	40	22	25	33	12	41	5	21	24	**184**
Total	**78**	**146**	**98**	**132**	**49**	**75**	**208**	**52**	**101**	**115**	**789**
Range	**7**	**5**	**14**	**26**	**29**	**58**	**18**	**20**	**49**	**17**	**103**

The sous-vide product received the most checks for blandness, tenderness and dark meat colour. The smoked product received the most checks for sweetness. The results for smokiness, liquor flavour and dark meat colour were the highest for both the smoked and sous-vide products. The strips were considered to have a deep fried taste, as well as being crispy and golden brown in colour. It also received the least checks for blandness. The strips and dumplings were considered equally hot and the dumplings had the most checks for having a minced meat texture.

Cochran's Q test was performed to test if there are significant differences (highlighted in Table 5.20) between products with respect to its characteristics. The first column contains p-values which compares products independently for each attribute. The remaining of the table contains proportions of 1's across consumer participants for each combination of products and characteristics. A high proportion means the characteristic is frequently 'checked' by consumers for the considered

product. For a given characteristic, Cochran's Q test allows to test the effect of an explanatory variable (the crocodile meat products) on whether the consumers feel the characteristic or not. A low p-value beyond p≤0.001 indicates that products significantly differ from each other (Meyners *et al.*, 2013).

From the table it can be seen that the products differed in the characteristics bland, sweet, hot, smoky, liquor, deep-fried, tender, minced meat, crispy, dark colour and golden brown colour. These were the characteristic features of the respective products and were developed by their different cooking or preparation methods and added ingredients.

Considering overall results in Table 5.20 there seems to have been many similarities experienced between the sous-vide product and the smoked crocodile on the one hand and between the crocodile strips and the dumplings on the other hand.

Table 5.20: Cochran's Q-test for characteristics of crocodile products

Characteristics	p-values	Sous-vide	Smoked	Strips	Dumplings
Bitter	0.131	0.048 ^{a}	0.036 ^{a}	0.012 ^{a}	0.036 ^{a}
Metallic	0.024	0.044 ^{a}	0.008 ^{a}	0.012 ^{a}	0.024 ^{a}
Bland	0.000	0.145 ^{b}	0.036 ^{a}	0.028 ^{a}	0.088 ^{ab}
Sweet	0.000	0.100 ^{b}	0.189 ^{c}	0.080 ^{b}	0.024 ^{a}
Hot	0.000	0.004 ^{a}	0.028 ^{a}	0.241 ^{b}	0.217 ^{b}
Smoky	0.000	0.165 ^{b}	0.181 ^{b}	0.036 ^{a}	0.036 ^{a}
Salty	0.096	0.108 ^{a}	0.153 ^{a}	0.153 ^{a}	0.189 ^{a}
Liquor	0.000	0.064 ^{b}	0.056 ^{b}	0.016 ^{ab}	0.004 ^{a}
Deep fried	0.000	0.016 ^{a}	0.028 ^{a}	0.201 ^{b}	0.060 ^{a}
Tough	0.479	0.064 ^{a}	0.088 ^{a}	0.088 ^{a}	0.060 ^{a}
Flaky	0.576	0.092 ^{a}	0.064 ^{a}	0.088 ^{a}	0.068 ^{a}
Chewy	0.907	0.145 ^{a}	0.141 ^{a}	0.141 ^{a}	0.161 ^{a}
Juicy	0.163	0.124 ^{a}	0.112 ^{a}	0.068 ^{a}	0.088 ^{a}
Tender	0.001	0.189 ^{b}	0.157 ^{ab}	0.084 ^{a}	0.100 ^{ab}
Minced meat	0.000	0.016 ^{a}	0.024 ^{a}	0.024 ^{a}	0.133 ^{b}
Crispy	0.000	0.004 ^{a}	0.012 ^{ab}	0.237 ^{c}	0.048 ^{b}
Light colour	0.238	0.237 ^{a}	0.225 ^{a}	0.209 ^{a}	0.165 ^{a}
Dark colour	0.000	0.084 ^{b}	0.092 ^{b}	0.012 ^{a}	0.020 ^{a}
Golden brown	0.000	0.032 ^{a}	0.060 ^{a}	0.229^{b}	0.084 ^{a}
Chicken aroma	0.074	0.088 ^{a}	0.120 ^{a}	0.157 ^{a}	0.096 ^{a}

$^{a-b}$ *Scores of attributes with different letters differed significantly (P<0.05)*

Based on the frequency table shown in Table 5.19, correspondence analysis (CA) was performed using the χ2-distance. The objectives of the CA are to study the association between two variables (rows and columns of a contingency table) and the similarities between the categories of each variable respectively (rows and columns respectively). A contingency table has been formulated by means of performing Cochran's Q test, as discussed previously. The two variables in the case of this study are the sensory characteristics (rows) and the crocodile meat products (columns). The results position the products on a map to analyse how the products are relatively positioned. If for some characteristics the marginal sums are null, the corresponding characteristics are removed from the correspondence analysis (XLSTAT, 2017). From this analysis the graphical display in Figure 5.15 was obtained. The two-dimensional plot explains 92.87% of the total inertia. The display represents association between products and characteristics. The closeness of a sensory characteristic or product on the plot indicates that they have similar profiles or share certain attributes. Products or sensory attributes that are plotted further from the centre of the figure declares more of the variance than those that are close

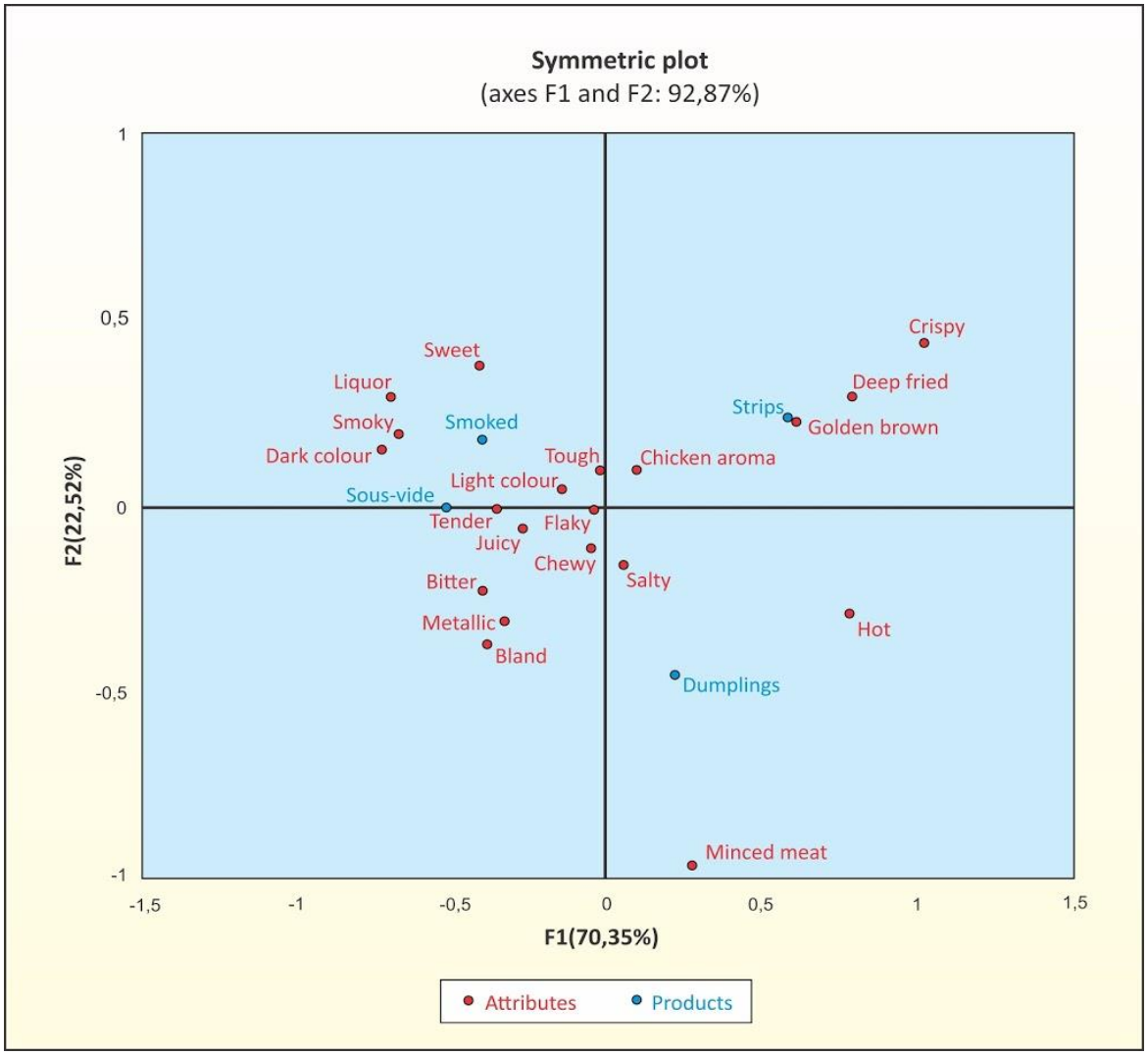

Figure 5.15: Correspondence analysis for products and characteristics

to the centre of the axis (McEwan & Schlich, 1991). It is important to note that CA gives a relative indication of results and therefore conclusions should be backed up by also studying the raw data.

The closeness of a sample and a sensory characteristic has a high correspondence with each other. This means that this sample received higher relative values than others for this particular characteristic (McEwan & Schlich, 1991). The profiles of the products have been identified as follows, based on this principal:

- In the quadrant that the **smoked** product lies, the characteristics sweet, liquor, smoky, light colour and tough appear.
- Chicken aroma, golden brown, deep fried and crispy is associated with the crocodile **strips**.
- Salty, hot and minced meat characteristics appear in the same quadrant as the **dumplings**
- Tender, flaky, juicy and chewy are associated with the **sous-vide** product.

These characteristics correspond with the sensory profile the product developers identified in Phase 1. There was no significant difference between the products concerning 'bitter' and 'metallic'. As can be seen in Table 5.20, none of the products received a particularly high count for these two attributes. The reasoning can be made that these characteristics were not significantly present in any of the products. It can also be seen from Figure 5.15 that the characteristics are plotted far from any of the products and would therefore not be profiled in any of the products.

The characteristics 'minced meat', 'hot', 'crispy', 'deep-fried', 'sweet', 'liquor' and 'smoky' is highly discriminative, due to its length of distance from the centre axes. Products and characteristics that are plotted further from the centre of the axis and lie close to each other have higher implications (McEwan & Schlich, 1991). They are highly associated with the respective products that lie in its close vicinity. The characteristics 'tough', 'light colour', 'flaky', 'chewy', 'chicken aroma' and 'juicy' are less distinctive. It is clear that similar characteristics are associated with the sous-vide and smoked product. This is in consensus with the sensory profiles formed during the culinary innovation process. The type of ingredients used in the recipes were also very similar. The strips are plotted on the opposite side of the least appropriate characteristics such as 'bitter', 'bland' and 'metallic', and are therefore considered negatively associated with them. This is just another confirmation of the strips receiving the best response in terms of acceptability.

The crocodile strips, which received the highest overall liking, were associated with three of the sensory characteristics that were considered highly appropriate, namely crispy texture, golden brown

colour and deep-fried flavour. Characteristics that were rated low in appropriateness, metallic, bitter and bland flavour as well as tough texture are associated with the smoked product and the sous-vide product. These two products are also plotted close to each other and therefore share many characteristics. The profile of the products could have been experienced differently between consumers with different demographic profiles. To give an indication of possible target markets for these crocodile meat products, the influence of the consumers' demographics are discussed in the next section.

5.7 INFLUENCE OF DEMOGRAPHICS ON PRODUCT ACCEPTANCE

ANOVAs indicated no significant differences ($p \leq 0.5$) between demographic groups and have therefore not been included. Small differences in mean scores are discussed below. The dumplings and sous-vide product received moderate scores ($5.36 \leq \bar{x} \leq 6.87$). The strips and smoked product received moderately high to high mean scores ($6.88 \leq \bar{x} \leq 7.82$). Since the demographic groups were not balanced, LS Mean were determined, as well as its standard deviations. The analysis was conducted to determine the potential target market for the crocodile meat products. Table 5.21 presents these scores for the demographic effect on product liking.

Table 5.21: Mean scores for demographic effects on product liking

	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Smoked		Sous-vide		Dumplings		Strips	
Gender								
Male	6.92	1.6	6.19	2.32	6.26	2.36	7.53	1.52
Female	7.21	1.62	6.51	1.86	6.17	2.58	7.48	1.71
Age								
Baby Boomers	7.64	1.65	6.87	1.88	6.13	2.72	7.43	2.14
Generation X	7.17	1.15	6	2.58	5.36	2.72	7.22	1.83
Millennials	6.88	1.76	6.4	1.84	6.61	2.22	7.66	1.32
Ethnicity								
Caucasian	7	1.67	6.66	1.9	6.39	2.49	7.49	1.61
Non-Caucasian	7.33	1.43	5.55	2.34	5.68	2.4	7.52	1.69
Education								
Grade 12	6.95	1.69	6.37	1.77	6.44	2.2	7.82	1.19
Degree/diploma	7.05	1.87	6.58	1.86	6.27	2.4	7.78	1.49
Post-graduate	7.2	1.21	6.13	2.46	6	2.74	7	1.86

Table 5.22 presents the demographic effects on sensory attributes. For the different demographic variables, group means on liking of sensory attributes were compared using two-sample t-tests or ANOVA (in case of three groups). Significant differences between the demographic groups are highlighted. The relation between psychographics and demographics can be seen in sub-section 5.5.1 of this chapter. Mean value of all attribute liking scores were moderately high ($\bar{x} \geq 6.01$).

5.7.1 Gender

Table 5.21 indicates that there were no prominent differences in liking of specific sensory attributes regarding gender groups. In general, females scored liking of attributes higher than males. Gender effects in sensory studies differ extensively. House (2016) and Verbeke (2015) refer to young male adults as “early adopters” and are the sub-population that will determine the acceptance of a novel product. Verbeke also found that males are more adventurous when it comes to novel foods. In contrast, Guerrero *et al.* (2009) found that men are more conservative in nature when it comes to innovative foods than women.

5.7.2 Age

ANOVA ($p \leq 0.5$) results showed a significant difference among age groups in liking of flavour ($p=0.0266$). Generation X scored lower for flavour than the Baby Boomers and Millennials. The same was found for Baby Boomers. Millennials, however, scored highest for texture liking. As discussed previously, strips are liked best overall. However, considering mean scores per demographic group, Baby Boomers scored slightly higher for overall liking of smoked products. Studies done on acceptance of novel foods indicate that younger consumers are the more willing parties to adopt new eating habits (Schösler, De Boer & Boersema, 2012; Tuorila *et al.*, 2001; Verbeke, 2015). This is in accordance with the current study, seeing that Millennials’ hedonic ratings of the products were high (although Baby Boomers scored marginally higher). On the other hand, Pliner and Salvy (2006) found that younger adults accept fewer novel foods than older adults do.

5.7.3 Population group

Population group groups showed an effect on appearance scores ($p=0.0383$), Caucasians liking it more than non-Caucasians. Differences in attribute perception and product liking could be explained by the influence of ethnic traditions, regional cuisine and the environment the consumer grew up in (Popkin, Siega-Riz & Haines, 1996). Since this was not part of the main aim of the research project, further investigation was not done.

Table 5.22: Mean scores for demographic effects on sensory attributes

	N	Mean	Std dev	p-value	Mean	Std dev	p-value	Mean	Std dev	p-value	Mean	Std dev	p-value	Mean	Std dev	p-value
	87	Overall			Aroma			Texture			Flavour			Appearance		
Gender																
Male	38	6.72[a]	2.03	0.5918	6.30[a]	2.11	0.2599	6.63[a]	2.09	0.4892	6.67[a]	2.02	0.4963	6.31[a]	2.35	0.3761
Female	49	6.83[a]	2.03		6.55[a]	2.01		6.78[a]	1.99		6.80[a]	1.96		6.51[a]	2.18	
Age																
Baby Boomers	15	7.00[a]	2.16	0.1279	6.61[a]	2.28	0.5268	6.71[a]	2.15	0.8841	7.00[a]	2.03	0.0266	6.58[a]	2.49	0.4423
Generation X	23	6.45[a]	2.26		6.26[a]	2.18		6.63[a]	1.99		6.28[b]	2.30		6.18[a]	2.12	
Millennials	49	6.88[a]	1.86		6.488[a]	1.92		6.75[a]	2.03		6.88[a]	1.77		6.49[a]	2.25	
Ethnicity																
Caucasian	65	6.88[a]	1.97	0.1383	6.56[a]	1.93	0.0726	6.72[a]	1.95	0.8504	6.83[a]	1.87	0.1557	6.56[a]	2.17	0.0383
Non-Caucasian	22	6.50[a]	2.18		6.11[a]	2.38		6.68[a]	2.28		6.50[a]	2.26		6.01[b]	2.45	
Education																
Grade 12	19	6.87[a]	1.81	0.3349	6.47[a]	1.81	0.3318	6.78[a]	1.65	0.4785	6.64[ab]	1.71	0.0569	6.47[a]	2.30	0.1158
Degree/Diploma	34	6.91[a]	1.99		6.60[a]	2.12		6.82[a]	2.19		7.02[a]	1.96		6.66[a]	2.13	
Post-graduate	34	6.57[a]	2.19		6.24[a]	2.11		6.54[a]	2.06		6.48[b]	2.13		6.11[a]	2.35	
Experience																
Previous experience	42	6.84	1.93	0.5702	6.53	1.96	0.4368	6.69	2.01	0.8301	6.88	1.86	0.1938	6.39	2.26	0.7859
No previous experience	45	6.73	2.13		6.36	2.14		6.73	2.07		6.62	2.08		6.45	2.26	

5.7.4 Level of education

Education effect showed that consumers with a post-graduate education tended to score lower for flavour of the products than those with a degree or diploma (p=0.0569). Consumers that hold a degree or diploma scored all the attribute likings higher than the other two groups. The consumers with post-graduate degrees scored higher for overall liking of the smoked product.

5.7.5 Previous experience

Previous experience with crocodile meat did not show a significant effect on liking scores. These results are surprising, since many studies found that consumers that are familiar with a certain food product has an increased positive hedonic response toward it (Borgogno *et al.*, 2015; Tuorila, Meiselman, Bell, Cardello & Johnson, 1994). There is, however, a slightly higher score for mean overall liking of consumer with previous experience.

Results show that a specific target market could not be identified for crocodile meat products in this study. Consumers reacted positively toward the products, but further research should be done to identify specific consumer groups who would show interest in buying such novel products.

5.8 CONCLUSION

This chapter presented the results and it was discussed according to main concepts. It consisted of the three phases, namely product development, consumer perception and consumer experience of the products. In the first phase the results of the products' development process was presented, according to Harrington's culinary innovation framework. The students developed crocodile dumplings, crumbed crocodile strips, smoked crocodile kebabs and sous-vide crocodile. The second phase analysed the perception and expectation data by means of EFA, ANOVA and descriptive statistical analysis. The results showed what the participating consumers' psychographic profile was as well as the sensory characteristics they found most appropriate to be associated with crocodile meat. The most appropriate characteristics were 'tender texture', 'golden brown colour', 'light meat colour' and 'juicy texture'. The characteristics they found least appropriate were 'bland, bitter and metallic flavour. Phase 3 involved consumers' hedonic and sensory experience of the products. These were presented with descriptive statistics, ANOVA and CATA analysis. CA and Cochran's Q tests were conducted as part thereof. The results showed the most liked product and what influences the acceptance thereof. The results from these findings will be concluded in the next chapter. Acceptance will be discussed, and this will include the discussion of the results that have been compiled to

determine acceptance of the products. Research limitations and future research recommendations will also be presented.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

This chapter highlights the main findings. Implications of this study are discussed. A conclusion and recommendations for future research are made.

6.1 INTRODUCTION

The following chapter concludes the findings of this study, as pertaining to the research objectives and research problem. The research processes are reviewed to confirm if the correct procedures were followed and if it was done in an ethical manner. The limitations of the study are also discussed. The conclusions are followed by recommendations made for future research regarding viability and acceptance of crocodile meat products on the market.

6.2 THE FINDINGS OF THE STUDY

This three-phase study was conducted with the aim of developing acceptable innovative culinary products using crocodile meat as a sustainable protein source. The researcher intended to determine the South African consumers' perception and experience of these developed products. Positive hedonic reaction toward these products established acceptance thereof. The potential target market was studied by means of determining the demographic effects on liking of the sensory attributes and the products. Their psychographic profile gave insights into what type of consumer participated in the study and how it would influence acceptance.

The study also contributed to the lack of knowledge and information regarding crocodile meat in South Africa. It formed a baseline for future research on the potential of a novel food product on the market, especially considering it is an alternative protein source for the ever-decreasing food resources and increasing global population.

6.2.1 Preliminary study

A preliminary study was conducted before the product development and data collection of the main study. The purpose of the preliminary phase was to gain as much information about crocodile meat as possible. It posed a challenge, since there is very little literature available on this subject, especially in South Africa. The physical and chemical properties of *Crocodylus Niloticus* could be identified by studying research by Hoffman (2000). The sensory profile of crocodile meat could be briefly identified

by developing a lexicon with a trained sensory panel. These panellists were from the Agricultural Research Council and had extensive experience in the field of meat quality. Aroma, appearance, flavour and texture characteristics of plain cooked crocodile meat were identified and evaluated on a 9-point Likert-type scale. Eight basic characteristics were identified. These results were given to the product developers as baseline information on the product they would be working with. This word list was also used as part of the measuring instrument of the study for Phase 2 and Phase 3.

6.2.2 Development, testing and standardisation of culinary products using crocodile meat (Objective 1)

The first objective, also the first phase, followed the culinary innovation framework, which was used as guideline to develop culinary products using crocodile meat. The innovation framework allowed for the products to be developed that have a sustainable competitive advantage, while keeping internal and external forces in mind. The three phases followed to develop the products were culinary innovation formulation, culinary innovation implementation, evaluation, and control.

Four final year students of the University of Pretoria performed the development of crocodile meat products. The final products the students developed were Cape Malay crocodile curry filled dumplings, Cornflake crumbed crocodile strips, Rooibos smoked crocodile kebabs with sherry and red wine sauce and Port and rosemary marinated sous-vide crocodile fillets. The product innovation formulation included the identification of the general target market for the products, which were the mainstream South African consumers, who showed an interest in culinary food culture and innovative products. More information on the findings regarding the target market will be discussed in sub-section 6.2.3. The demand and interest from these consumers were healthy meat products (low sodium, low fat and high protein), with an innovative edge and that they can have on the go, especially during their busy, fast-paced working day. The products met these demands in the following way:

- *Crocodile dumplings*: The dumplings were bite-sized, and easy to eat just by hand if so preferred. Very little added fat and added sugar. The filling consisted of various vegetables, that was mixed together with the lean minced crocodile meat. The product was a fusion of South African flavours in an Asian-style dumpling.
- *Smoked crocodile kebabs*: The meat was smoked to add flavour to the mild meat. Rooibos tea leaves were used for smoking, to give it a delicately familiar taste. Smoking is still seen as an innovative cooking method by many and adds flavour without adding any extra ingredients. The kebabs were shaped in such a manner that it is easy to eat by hand.

- *Sous-vide crocodile fillets*: Sous-vide is a novel concept for the South African consumer, many are not even familiar with it. The product was made to quickly cook further at home, for those households that do not have time to spend hours on preparation of a meal. The sous-vide process is also a preservation method for such a meat product. It guarantees a moist and tender product.
- *Crumbed crocodile strips*: The strips deliver a novel meat product in a familiar way. Consumers commented that it reminds them of any chicken strip that can be bought in retail outlets or restaurants. The strips are baked, not fried, as they appear to be. Baking the product makes it much healthier, cutting out the added fat when frying. The strips are bite-sized and easy to eat by hand. Seeing as it looks familiar, the consumer is immediately drawn to it, which will make it a very successful product on the market.

In addition to each of the products' individual attributes, crocodile meat in itself is very healthy, especially the cut used in the product development, i.e. tail eye fillets, which is low in fat and sodium.

The retail price of the raw meat is low in comparison with that of conventional meat and venison in retail stores. The average price of crocodile meat from the farms and ranches are R55/kg. This gives another competitive edge to value-added crocodile meat products, if it can be sold at a lower price than the conventional meats.

The products were defined in the culinary innovation implementation phase. Sensory evaluation was conducted with five expert panellists, evaluating the products on a five-point Likert-type scale. From this, it was found that the sensory profiles of the products differed considerably. The following was concluded to be the most prominent attributes of the products.

- *Crocodile dumplings:*
    - Hot/curry flavour
    - Minced meat texture
    - The original form of meat was masked by mincing it
    - Cape-Malay-Asian fusion of flavour and appearance
- *Smoked crocodile kebabs:*
    - Smoky flavour
    - Appealing golden brown colour
    - Sweet flavour from orange and sherry glaze
    - Appeared like a familiar meat product

- *Sous-vide crocodile fillets*:
    - Red wine flavour
    - Deep red appearance
    - Tender and juicy meat
    - Sweet from Port and rosemary marinade
    - Novel, unfamiliar product
- *Crumbed crocodile strips*:
    - Hot/spicy flavour
    - Crunchy texture
    - Familiar sensory properties
    - Appears to be like a deep-fried product, i.e. golden brown, crumbed and crunchy.

The recipes were triple-tested to ensure production transference in terms of reproducing them consistently in quantity and quality. Once a standardised recipe was approved, the large-scale production adjustments were made. All products were up-scaled without encountering problems. Both the factor and percentage method were used to upscale the recipes. Large-scale equipment was used, and ingredients increased accordingly. The factor method and percentage method were used to gain accurate results for each ingredient. It can be concluded that clear preparation steps and standardized measurements can produce culinary crocodile meat products that can be repeated in all situations.

6.2.3 Consumers' perception and expectation of crocodile meat products (Objective 2)

The second phase followed an experimental, quantitative research design, collecting data with a self-administered paper-based questionnaire. Untrained consumer panellists completed these on a 9-point Likert-type scale. The data from the questionnaire was analysed through interpretation of descriptive (mean values, standard deviations, frequency tables and graphs) and inferential statistics (ANOVA and EFA). Validity and reliability measures were taken, and a proper ethical code was followed. More information on elimination of error can be seen in Chapter 4, section 4.11.

6.2.3.1 Psychographics

There is a demand from South African consumers for novel, innovative products that are still healthy and easy to consume. The products were developed in such a manner that it adhered to this demand. The consumer profile had to be explored first, before determining their sensory acceptance thereof. This comprised of their interest in culinary food culture, liking of novel foods, their previous experience

with exotic meats and their sensory expectation of the products. Upon analysis the results were grouped into completely disagree (1-3), moderately agree (4-6) and completely agree (7-9). Conclusions were made that the participating consumers showed high interest in culinary food culture, were very willing to try novel foods and had high expectations of the crocodile meat products they were about to evaluate. There were slight differences in demographics, non-Caucasians showing lower levels of experience with exotic meats and willingness to try novel products. Other than the latter, there were very little demographic effects on psychographic profiles. They were however not very familiar with exotic meats, these results being due to consumers having different perceptions of exotic meat. Consumers with this psychographic profile are ideal targets to whom novel food products can be introduced.

6.2.3.2 Sensory expectation

Nine flavour, one aroma, seven texture and three appearance characteristics were identified from the product development phase, as well as the sensory analysis that was done with the trained panel (refer to sub-section 4.9.1.1 and section 5.2 for the identified characteristics). These 20 characteristics were evaluated on a 9-point Likert scale. The consumers rated the characteristics from not appropriate at all to very appropriate relating to a crocodile meat product. In total 101 untrained consumers completed the questionnaires, but only 87 delivered complete usable data.

At the data analysis stage, the characteristics were ranked in the order of least appropriate to most appropriate. The least appropriate characteristics were found to be metallic flavour, bitter flavour, bland flavour and tough texture. It should be noted that the least appropriate characteristics were found to be flavour characteristics. According to literature, the relative importance of the sensory attributes for foods is generally in the order of flavour, then texture, then appearance (Moskowitz & Krieger, 1993). The product developers should take care to eliminate these characteristics in their new products, since the consumers will not receive products with unacceptable characteristics positively.

The most appropriate characteristics were tender texture, golden brown colour, chicken-like aroma, light-meat colour and juicy texture. Two of these characteristics, tenderness and juiciness, are considered to be two of the most important characteristics determining meat quality, and influence the sensory perception of other attributes (Winger & Hagyard, 1994:94).

The consumers' experience of these sensory characteristics in each of the crocodile meat products will be discussed in the next section.

6.2.4 Consumers' sensory evaluation and hedonic reaction toward the new crocodile meat products (Objective 3)

The third phase followed an experimental, quantitative research design, collecting data with a paper-based questionnaire. Untrained consumer panellists completed these on a 9-point hedonic scale. The data from the questionnaire was analysed through interpretation of descriptive (mean values, standard deviations, frequency tables and graphs) and inferential statistics (ANOVA, Cochran's Q test and CA). Validity and reliability measures were taken, and a proper ethical code was followed by informing the participants what they are agreeing to do and that they are allowed to leave the evaluation at any time that they feel uncomfortable.

6.2.4.1 Liking of sensory attributes

The final objective aimed to determine the liking of the sensory attributes of the products, namely overall, aroma, texture, flavour and appearance. The purpose was to compare the difference in the consumers' liking of the products and consequently the most liked product. For the purpose of this study, the hedonic scores were divided into unsatisfactory (1-3), average (4-6), excellent (7-9), to gain a better understanding and draw logical conclusions of the results. Differences were present in the sensory liking of the products. The Cornflake-crumbed crocodile strips received scores in the 'excellent' category for all attributes that were measured. The Rooibos-smoked crocodile kebabs received excellent results for overall liking and liking of flavour. On average, flavour is perceived to be the most important of the sensory attributes for foods, which would motivate the high overall score for this product. The Port and rosemary-marinated sous-vide crocodile and Cape-Malay crocodile curry filled dumplings received average scores for all evaluated attributes, the dumplings being least liked overall. Curiously, the other attributes of this product did not receive the lowest scores, except for texture liking. Therefore, it can be presumed that the texture played a significant role in the evaluation of the participants' overall experience. Considering these hedonic scores, the crocodile strips were the most successful, whereas the dumplings were least successful, not implying that the dumplings were not acceptable at all. As stated in literature, the experience of products can differ significantly in terms of the context that it is eaten. The consumers were not served a whole dish and it was not in a natural eating environment. The evaluation was done in a controlled environment, without any social interactions, and could have been intimidating to some individuals. Refer to 6.5 for reflection on the methodology and recommendations. The crocodile strips resembled familiar products the most, namely crumbed chicken strips that can be found in many popular restaurants and retail outlets. This conclusion is made based on previous studies that found consumers being most approving of products they are used to or are familiar with (Caparros Megido, Sablon, Geuens,

Brostaux, Alabi, Blecker, Drugmand, Haubruge & Francis, 2014; Martins & Pliner, 2005; Tan, Fischer, Tinchan, Stieger, Steenbekkers & van Trijp, 2015). The sous-vide product is prepared using the most novel technique and can therefore affect some consumers' acceptance thereof negatively. This would especially be applicable to the neophobic participants, who have a prejudiced hedonic experience of the novel products, even without experiencing the product yet. The following sub-section concludes how the sensory profile of the products influenced the liking thereof.

6.2.4.2 Sensory experience of products

To conclude the consumers' acceptance of the products, the relation between the products' characteristics and the consumers' liking thereof, were studied. The sensory profiling was done using CATA. The 20 characteristics that were rated according to appropriateness in Phase 2, were used to profile the products in Phase 3. Participants checked the characteristics they experienced to be applicable to a specific product. These checks were summarized in a frequency table from which Cochran's Q test and correspondence analysis determined the characteristics relatively associated with the respective products. The products differed significantly in eleven of the characteristics. The smoked product was related to the characteristics sweet, liquor and smoky flavour, light colour and tough texture. The crocodile strips were associated with chicken aroma, golden-brown colour, deep-fried and crispy texture. Salty and hot flavour and minced meat texture were related to the dumplings. Tender, flaky, juicy and chewy texture and bitter flavour was associated with the sous-vide product. These characteristics correspond with the sensory profile each of the product developers identified for their products in Phase 1. Once again, it was concluded that the crocodile strips were most preferred since this product received the highest frequency checks for the characteristics previously rated as highly appropriate. Previous studies also indicated that the products that received the most checks tended to be most preferred (Giacalone *et al.*, 2013). These included golden-brown colour, crispy texture and chicken-like aroma. The least appropriate characteristics corresponded to the sous-vide products, although not strongly.

6.2.4.3 Demographic effects

The intention of studying the demographic effect on product acceptance was to reveal the potential target market for novel crocodile meat products. Seeing as recruitment of consumer participants was a challenge, demographic groups were not balanced, except for gender groups. Analysis of unbalanced data was a limiting factor when determining demographic effects. These limitations are discussed in 6.4. Putting these limitations aside, the conclusions were made as follows. The demographic effect was determined on the psychographic profile of the participants, discovering their perception when relating the results with expected appropriateness of characteristics. The effect was

also studied on the consumers' hedonic experience of the products. These effects were determined by means of t-tests and ANOVA. A few significant effects were found, however none were more significant than $p \leq 0.01$, and no trend could be found to make a conclusion of which demographic groups the crocodile meat products would most appeal. There were single differences found in all four groups. Non-Caucasians were less willing to try novel foods, but their expectations were higher for the products before consumption. Therefore, the confirmation of their expectations is highly important for this group to accept the products, especially since there could be neophobics in the non-Caucasian group causing the lower score in their willingness to try new foods. Females were less inclined to buy crocodile products again based on their previous experience (before participating in this study). Participants with only a Grade 12 qualification had lower quality previous experiences with crocodile meat than the other qualification groups. The same was applicable to the Baby Boomer group, whose quality of previous experiences were lowest of the age groups. Further research could determine the reason for these results, as it could not have been determined in this study. Similar to the latter, participants with a post-graduate degree and the Generation X group, liked the flavour of the products less than the other groups. Insights into these results could be found in future studies. It should be noted that some of these results could be random due to the population size or the unbalanced demographic groups. Overall, there can be no conclusion on a specific target market for the developed products. Therefore, further research is recommended, and all demographic groups can be targeted.

6.3 RESEARCH IN RETROSPECT

6.3.1 Validity

The steps that were taken to ensure that the instruments used was able to accurately measure what it was intended to measure, are discussed below. Each phase in the study will be reflected on thereafter.

6.3.1.1 Theoretical validity

This study followed a deductive approach, by means of doing a thorough literature review regarding information that is available on crocodile meat and processes to be followed in order to guide the researcher to achieve the objectives set for the study. Very little information was found pertaining to crocodile meat in South Africa. Some literature is available on crocodile meat in Australia and alligator meat in the USA. A gap was thus identified that indicated a need for information on the sensory profile of crocodile meat and how it can be utilised as a sustainable meat source. The lack of information on consumers' perception of crocodile meat was also identified and the researcher considered it

necessary to contribute to the scientific knowledge in this area. The correct application of CATA was ensured by reviewing other studies and to which scenarios it was applied. The main theoretical concepts of this technique were structured in such a way to fit this study.

In addition to formulation of the objectives of the study, the literature allowed the researcher to identify the main concepts that would be relevant to the research problem. The conceptual framework was constructed to guide the research process. Cardello's food acceptance model and Harrington's culinary innovation model were combined and followed to ensure that a product was developed that consumers would find acceptable. The food acceptance model enables the product developer to understand how the food product will be perceived and what would influence its acceptance. The innovation framework allows for a product to be developed that has a sustainable competitive advantage, while keeping internal and external forces in mind. After much deliberation and consideration of the conceptual framework, the study was structured into three phases, namely product development, consumer perception and consumer experience of the products.

6.3.1.2 Content validity

Content validity refers to the sampling adequacy of the study's content as an instrument. The measuring device covers a full range of meanings being measured (Babbie, 2016:123; De Vos, 2011:162). In this study a wide variety of sources from literature and similar studies were consulted in order to identify aspects applicable to determining food acceptability. The researcher ensured that these aspects were addressed in the questionnaire. Content validity was ensured by checking that the scales reflect the aspects that were measured logically. The measuring tool was also evaluated by a statistician as measurement of validity and was thereafter pre-tested. Individuals who possess the same characteristics as the intended sample group did the pre-testing. The measurement of psychographic information in Section A of the questionnaire allowed the researcher to make valid conclusions regarding the consumers' perception of exotic meats and their neophobic / neophillic inclinations.

6.3.1.3 Construct validity

Construct validity is based on statistical procedures and logical relationships among variables (Kumar, 2014:180). It refers to the extent to which a scale, index or list of items measure the relevant construct and not something else (Mouton, 1996:128). In Phase 1, the measurement, preparation methods and steps of the culinary innovation process were accurately recorded. Sensory evaluations done in this phase on a 5-point Likert-type scale and the adaptation made to the product were also recorded. Steps followed in the culinary innovation process was done according to Harrington's (2005) Culinary

Innovation Framework and culinary innovation processes developed by Hullah (1984). In Phase 2, a standardised questionnaire was completed on a 9-point Likert-type scale to evaluate the consumers' expectations of the crocodile meat products. The questionnaire and its scales were based on a consumer study done by Giacalone et al. (2013), which has delivered successful results. In Phase 3, a standardised sensory evaluation test was performed on a 9-point hedonic scale to determine acceptability. Lawless & Heymann (2010:31) recognise it as a standard sensory evaluation test. An adequate sample of 100 participants was used to contribute to the validity. Due to the novelty of the CATA technique, thorough research and review of literature was done to understand and correctly apply it to this study. Furthermore, construct validity was further assessed by calculating Cronbach's alpha coefficients. Performing CA on the data also confirmed that profiles developed by the product developers in Phase 1, were in line with how the consumers experienced it in Phase 3.

6.3.1.4 Face validity

Face validity is a subjective judgement of the operationalisation of a construct and is based on the logical link between the questions and objectives of the study (Kumar, 2014:180). It relies on the physical appearance of the measuring instrument that is used (Bryman & Cramer, 2012:171). Additional sources that used similar scales were consulted for constructs of psychographics, appropriateness ratings and hedonic reaction (Giacalone *et al.*, 2013). The questionnaires were divided into sections to clearly separate the different questions and concepts that were measured. It also allowed better organisation of the questionnaire. Each question in the questionnaire was linked to either Objective 2 or Objective 3. By implementing Harrington's (2005) framework, validity of reaching the first objective was ensured. The paper-based questionnaire was also designed with the University of Pretoria's branding to reinforce the researcher's affiliation with it.

6.3.1.5 Inferential validity

Inferential validity refers to logical inferences that are drawn during the research process. With the assistance from a statistician, the inferential validity and internal consistency was ensured throughout the process of data analysis.

6.3.2 Reliability

Reliability is to ensure that the same results are obtained if the same technique is followed. It is very important for the successful outcome of a project and it is dependent on consistency (Babbie, 2016:119). The following precautions were taken to eliminate possible sources of error during data collection of this study:

- In Phase 1, the development and standardisation process of the products were repeated three times. This confirmed that the recipe could be reproduced in any food preparation environment, delivering the same results every time.
- All procedures were recorded until the same results in terms of authenticity, portion sizes and sensory characteristics were achieved with each adaptation of the recipes.
- A pre-test was conducted prior to the commencement of the consumer evaluation in order to standardise the questionnaire that was to be used for the sensory evaluation. This step allowed the researcher to identify possible problems that could have occurred (Salkind, 2013:160).
- The questionnaire was also given to a statistician to ensure that viable data could be collected and analysed from the measuring instrument.
- Clear and standardised instructions as to how to correctly complete the questionnaire were given to the respondents (Salkind, 2013:160). This was ensured by doing the pre-test, as mentioned above.
- To ensure reliability with the consumer group, standardised sensory evaluation procedures were applied (Lawless & Heymann, 2010).
    - This was achieved by conducting the tests in a physical setting that is free from distractions, air-conditioned and no odours from food preparation.
    - The sample serving procedures and sample preparation techniques were standardised, portion sizes were identical, as well as identical presentation and food preparation.
    - The layout of the testing environment was structured in a way that the participants were not able to interact with each other.
- Quality was further ensured through using the same cuts of the crocodile carcass, and the meat was sourced from the same farm.

6.3.3 Ethics

The proposal of the study was prepared and presented to the Head of Department, lecturers and students of the Department of Consumers Science. After approval of continuation, ethical clearance was received from the Ethics Committee of the Faculty of Natural and Agricultural Sciences, University of Pretoria (Addendum J). The ethical requirements below were followed to:

6.3.3.1 Voluntary participation and informed consent

- Before consumption of the products and completion of the questionnaire, the purpose of the study was explained to the participating consumers.

- Consumer panellists that participated in the evaluation of the new culinary products, gave voluntary consent and were able to exercise free power of choice to participate in this study and also had legal capacity to give consent.
- The researcher protected all rights of the participants and ensured that all had the right to adequate and informed consent without undue pressure (Lawless & Heymann, 2010:109).

6.3.3.2 Anonymity and confidentiality

- Consumers were guaranteed confidentiality and anonymity and assured that the information collected would be dealt with impersonally and would not harm them in any way.
- Sensory studies of food do not create any added risks above those of daily life. Participants were, informed however, about the possible risks associated with the products such as cultural and religious taboos against consuming crocodile meat as well as allergens.

6.3.3.3 Plagiarism

- All the sources collected from literature in this study can be accounted for, are acknowledged through proper citations, and are recorded in the reference list.
- Necessary acknowledgements prevented plagiarism.
- Honest practices were conducted throughout the study to disallow false information in any way.

6.3.3.4 Data and interpretation

- At the point of data analysis, a statistician, using appropriate statistical programs to ensure the data was accurately analysed and interpreted, assisted the researcher.
- There was no attempt to manipulate the data in any way.
- Under the guidance of the study leader and the statistician, the interpretation of the data was reviewed to ensure accurate reporting thereof.

6.4 LIMITATIONS

As this study was conducted, care was taken to ensure reliability and validity. There are, however, always limitations when doing a research project, and this study was no different. The limitations are discussed below. These limitations could, however, be used as guidance for future research opportunities.

Considering a relatively novel sensory profiling technique was used (CATA), limited literature was available on how it should be interpreted. At the time of collecting the data, in 2017, this measuring

technique has not been utilised in many product development studies in South Africa before. Despite these limitations, the crocodile meat products were accurately profiled, and contributed to fulfilling the objectives of this study. It also made a contribution to scientific information on crocodile meat products on the South African market, since such a study has not been done before.

Due to time, context and financial constraints, a demographically balanced group of participants could not be recruited for the consumer panel. The sample size was influenced by consumer willingness to participate, and due to the products being so exotic, many consumers were unwilling or reluctant to participate. The consumers that were willing to participate defined themselves as having a high interest in culinary culture, which were the type of consumers the product developers targeted from the start. The sample size (N=87) was acceptable however, and useful conclusions could be drawn from the data. In future, it would be recommended that an external party recruit a larger population group. From a market research perspective, this would also give more insight into a specific target market for crocodile meat products.

6.5 RECOMMENDATIONS

During the process of conducting this study, a few future research topics presented itself. The current study could be the baseline for a future study, or it could be supported by a future study.

6.5.1 Questionnaire

Many consumer research studies were inspected to determine the best category scale to use. A 9-point Likert-type scale was decided on, as it occurred in many previous studies. After conducting the sensory evaluation phase of the study, the researcher discovered the RATA (Rate-All-That-Apply) technique. RATA follows the same basic principal as CATA, with the addition of rating the intensity of each chosen characteristic (Ares, Bruzzone, Vidal, Cadena, Giménez, Pineau, Hunter, Paisley & Jaeger, 2014). To the researcher's knowledge, this technique has not been used extensively in South Africa. Applying RATA to a similar study, more descriptive data that is easier to analyse, could be collected. Comparing the results from the two different techniques would also contribute to South African research in sensory science. Although valuable data was collected from the questionnaire, and its findings met the objectives of this study, a way to shorten such a questionnaire could be explored. Consumers have a shorter attention span than a trained panel, which is a factor that should be taken into account for future product development and consumer evaluation studies.

6.5.2 Methodology

It is always of value to hear directly from consumers what they want or need from a product. The current study found a generalised opinion from a group of consumers, which is a good way to introduce the idea of a new product. Specific market research has to be done once the general idea has been formed. Market research will pinpoint the specific target groups for these kinds of products. Focus groups should be done to gain a different perspective on who to develop these products for or what kind of product they would like. Focus groups allow interaction between consumers, who might generate creative ideas themselves. However, since this study aimed at determining the acceptability of the idea of a crocodile meat product, a general consumer evaluation was sufficient. As stated before, there has been a very small presence of crocodile meat on the South African market and therefore much research is still to be done to fulfil its potential.

6.5.3 Crocodile meat research

In this study, a trained sensory panel briefly developed a sensory profile of crocodile meat. This was just to give the product developers an idea of what they would be working with. It is recommended that a full study be done on the sensory properties of crocodile meat, evaluating multiple cuts of the crocodile. This will enable future product development studies to waste as little of the carcass as possible, contributing to the sustainable use of crocodile meat. The more research is done on the meat quality characteristics of crocodile meat, the more potential it will have on the South African market. More extensive research has been done on crocodile meat in Australia and the USA. The topics of studies done in Australia and the USA can be applied to *Crocodylus Niloticus* as well. Research that is focused on the viability of products on the South African market is definitely recommended. The positive feedback on the crocodile meat products developed in this study shows that there are consumers who find it acceptable and will therefore buy it if available. This can be done with identification of a specific target market and proper marketing. As concluded before, the crocodile strips delivered the best results and could therefore be the best starting point for such research.

6.6 IMPLICATIONS

This study was justified by the contribution to crocodile meat literature and how it can be used as an acceptable, sustainable meat source. The theoretical, practical and consumer implications are discussed below.

6.6.1 Theoretical implications

Most importantly, this study contributed to literature in terms of sensory characteristics of crocodile meat. Although more in depth studies can be done on this topic, it has already delivered a baseline for future research. Characteristics were identified that consumers find favourable in crocodile meat products they would eat, and it compared well with that of meat quality characteristics of conventional meat products. Future research can be built on observations of characteristics the consumers experienced to be positive and avoid those that were experienced to be negative. Findings from this study regarding sensory characteristics can also contribute to future innovations in terms of possible cooking methods that can be applied and ingredients that can pair well with the crocodile meat.

CATA was well applied to the evaluation of the newly developed products. The study contributed to the examples of how this method can be applied. This study also opened many possibilities and recommendations for future research. It also revealed the potential to use novel sensory evaluation techniques that has not been applied to South African studies before, such as RATA.

Final year undergraduate students of the Department of Consumer Science at the University of Pretoria developed the products as part of the completion of their degree. Therefore, it contributed to their training/education and gave them skills to use for future endeavours. From the development of their products, flavour pairings with crocodile meat were also established. In future studies researchers or product developers can just build on the findings from this project.

6.6.2 Industry implications

Using other parts of the crocodile than the skin, is beneficial to crocodile farmers. A larger part of their product can be used, meaning less waste and more income. Since hygiene standards are already very high in abattoirs and crocodiles are only fed pellets, just an extra process of portioning the carcass has to be implemented. These can then be sold to food retailers or manufacturers.

The food industry can also benefit from the findings. Retailers are always looking for novel products that will give them a competitive edge. The findings of this study showed that consumers are more inclined to try novel products with familiar characteristics. The strips have been found to be the best option to introduce crocodile meat to the South African consumers. It could be marketed as a healthy alternative meat option and easy to prepare and eat. Should the product be successful, a larger, less

familiar range can be introduced. These novel products can be included in the same range as venison, ostrich or other unconventional meat products.

6.6.3 Consumer implications

Since crocodile meat is seen as an exotic product, there are consumers who will be reluctant to try it. Even the participants who were curious about the products commented that they were still cautious of consuming it. Therefore, it is important to advertise the product properly in terms of making the consumers aware of the ethical considerations, but also the health and safety measures taken to ensure top quality products. The positive factors of the crocodile meat products should be emphasised, i.e. the health benefits, being an alternative meat protein source and the novelty of the product. If the products become popular in retail stores, the consumers might even be more inclined to order it from a restaurant menu, thereby also benefiting the restaurants that already offer crocodile meat dishes.

6.7 OVERALL CONCLUSION ON ACCEPTANCE

Since determining acceptability of crocodile meat products is the final goal of the study, one has to refer back to Cardello's (1994) Food Acceptance Model. There are four stages in the process of acceptance of a food product, namely physical, sensory, perceptual and finally hedonic.

Physical. The physico-chemical structure of crocodile meat has been studied and determined by authors such as Hoffman (2000), Tosun (2013), Spiegel and Wynn (2007) and Cairns (1996). The work of these authors, and others, have been studied to understand the physical characteristics of crocodile meat. These characteristics have been conveyed to the product developers. It was discovered that crocodile meat is low in fat and sodium and high in protein. These characteristics adhere to the South African consumers' need for healthy meat products.

Sensory. The sensory stage encompasses both the lexicon development from the preliminary stage, as well as the sensory characteristics identified by the product developers. The product developers identified the ideal sensory characteristics of their products at the beginning of the development process, and all have been perfected in all products. These characteristics were also evaluated by the consumers in the perceptual and hedonic stages.

Perceptual. The participating consumers' perception was evaluated in terms of learning (interest in culinary food culture), memory (previous experience with crocoidle meat), context (liking of novel foods) and expectation (appropriateness). It was found that the consumers had a high interest in culinary culture, moderate previous experience, and high liking of novel foods. Expectations were high and therefore it was important to focus on the appropriateness of each sensory characteristic during evaluation of the products. The most appropriate characteristics the consumers identified were similar to those from studies done by authors such as Cardello (1994:254), Shepherd and Raats (1996:347) and Fletcher (2002). The same applied to the least appropriate characteristics. After evaluating the products, the appropriateness ratings were compared to the CATA frequencies. It was found that very few checks were given to the least appropriate characteristics and the most appropriate characteristics received a larger amount of checks. Therefore it can be concluded that the products were successfully developed from a sensory perspective.

Hedonic. The hedonic experiences, i.e. liking/disliking of a food product, received moderately high, to high ratings (all mean scores being above 6 on the 9-point hedonic scale) for all products. The experience was measured for overall liking and liking of flavour, aroma, texture and appearance. The highest score for the crocodile strips was for its appearance. Seeing as consumers first 'eat with their eyes', it was a significant contribution to the acceptance of this product. The dumplings and smoked product both received their highest scores for flavour. As stated by many previous authors, flavour often plays the most significant role in the acceptance of a food product (Borgogno *et al.*, 2015; Moskowitz & Krieger, 1993). Therefore, seeing as they were most liked in flavour, it drove the consumers' acceptance thereof. The highest score of the sous-vide product was its texture. Moskowitz and Krieger (1993) found that texture experience trumps flavour experience for some consumers, when it comes to overall acceptance. The experience of the most and least appropriate characteristics naturally influenced the consumers' hedonic scores. As mentioned in the perceptual stage, the experience was positively concluded. Based on the discussion from the food acceptance stages, the conclusion can be made that all products were acceptable. Although the Cornflake-crumbed crocodile strips received the highest overall scores and the most positive feedback, there would be place for the other products on the future South African market. It is deliberated that the consumers will be more inclined to purchase novel products with familiar components. Once crocodile meat has found its place on the market with this kind of product, product preparations that are more novel can be introduced.

6.8 CONCLUSION

Crocodile meat has the potential to contribute to many needs in South Africa, e.g. sustainable meat/protein source, demand for novel products, a healthy protein source and reduction of waste in crocodile leather production. It was clear that there is a considerable lack in information and knowledge on crocodile meat in South Africa. Extensive review of literature and brief sensory profiling of crocodile meat allowed innovative products to be developed, prepared in a variety of methods and ingredients. Consumers had high expectations of the products and were very accepting thereof. Consumers favoured products with familiar characteristics. The viability and acceptance of crocodile meat products on the South African market was positively concluded. This researched opened many possibilities for future studies and improvements, by scientific researchers as well as product developers of retail stores.

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ADDENDUM A

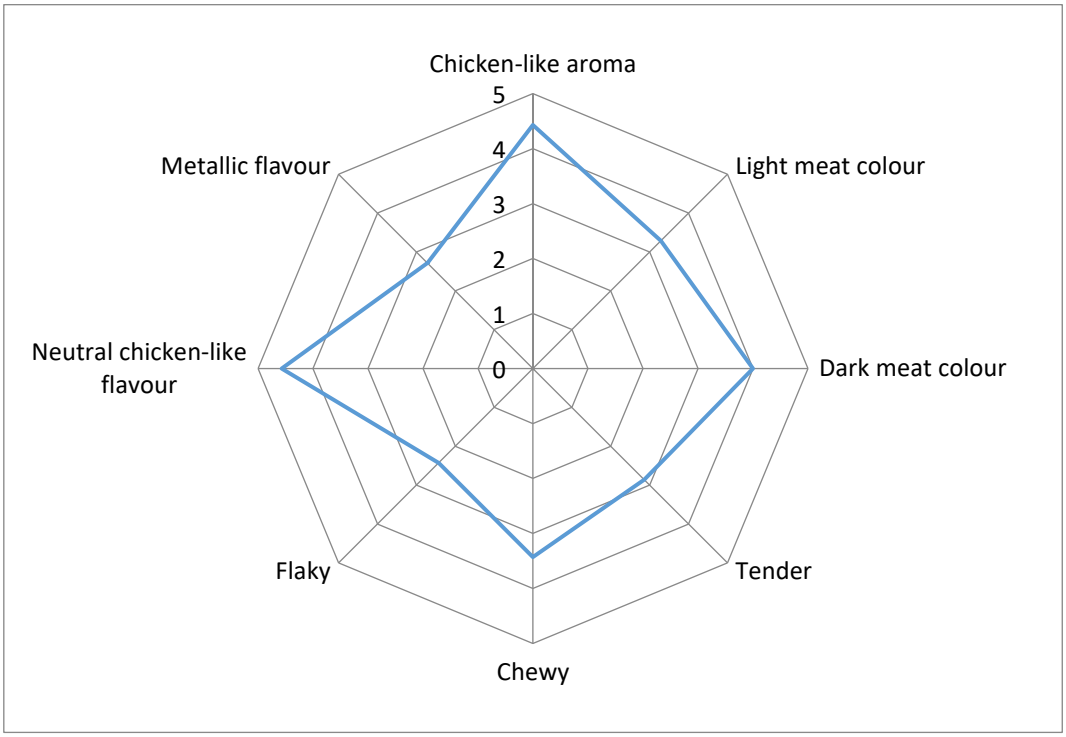
Preliminary Phase report. Sensory evaluation of crocodile meat with trained sensory panel. Seven trained sensory panellists evaluated unflavoured crocodile tail fillets. The meat was roasted in the oven. The panellists considered references to associate the new product with. The table below indicates the cooking details, initial word list, as well as the reference samples associated with it.

Cooking temperature	190˚C
Time	20 minutes
Internal temperature	75˚C
Scale for evaluation	9-point intensity scale
Reference/association samples	Raw hake fillet
	Raw chicken breast fillet, skinless
	Cooked hake fillet
	Cooked chicken breast fillet, skinless
Appearance	Milky white
	Fish-like
	Chicken-like
	Two-toned colour (white with brown 'marbling'
Aroma	Boiled chicken
Texture	Firmness
	Juiciness
	Tenderness
	Chewiness
	Flakiness
Flavour	Cooked white fish
	Cooked chicken
	Metallic
	Sour

After the first round of evaluation, the panellists and the researcher objectively discussed the results and formed a final word list. The characteristics that were eliminated from the initial word list were considered not to be applicable or appropriate for a crocodile meat tail fillet. A final sensory evaluation test was performed on a 9-point intensity scale to validate the chosen lexicon. The table below indicates the mean scores as well as the standard deviation of each of the characteristics.

CHARACTERISTICS	MEAN	STD. DEV.
Chicken-like aroma	4	1,0
Pale white colour	3	0,5
Dark meat colour	3	1,0
Chewy	2	0,5
Flaky	3	1,7
Tender	3	0,8
Neutral chicken-like flavour	3	1,5
Metallic flavour	4	1,0

The star diagram below illustrates the sensory profile of a typical, unflavoured crocodile tail fillet. From these results it is clear that crocodile meat does not have a very intense sensory profile and therefore proper ingredients and cooking methods need to be applied to optimise a final product that would be acceptable to South African consumers.



ADDENDUM B

SENSORY EVALUATION OF CROCODILE SAMPLES

Name: ..... Training day 4 Date: 9 June 2017

AROMA	Bland							Extremely intense
Boiled chicken	1	2	3	4	5	6	7	8
OVERALL APPEARANCE	Not at all							Extremely
Milky white	1	2	3	4	5	6	7	8
Fish like (raw hake)	1	2	3	4	5	6	7	8
Chicken like (cooked)	1	2	3	4	5	6	7	8
Two toned (brown stripes between pale meat)	1	2	3	4	5	6	7	8
TEXTURE AND FIRST BITE	Not at all							Extremely
Firmness	1	2	3	4	5	6	7	8
IMPRESSION OF JUICINESS	Extremely dry							Extremely juicy
	1	2	3	4	5	6	7	8
OVERALL TENDERNESS	Extremely tough							Extremely tender
Tenderness	1	2	3	4	5	6	7	8
Chewy	1	2	3	4	5	6	7	8
Flakiness								
OVERALL FLAVOUR	Not at all							Extremely
Cooked hake	1	2	3	4	5	6	7	8
Cooked chicken	1	2	3	4	5	6	7	8
Sweet	1	2	3	4	5	6	7	8
Metallic	1	2	3	4	5	6	7	8
Sour	1	2	3	4	5	6	7	8
Comments:								

ADDENDUM C

SCORING TEST SHEET

Date:	Product: Cornflake Crocodile Shoes						
Participant:							
Evaluate the product by rating the following characteristics out of 5							
1= Undesirable / No 5= Desirable / Yes							
Characteristics	Points to consideration	1	2	3	4	5	Comments
Appearance	Golden brown						
	Crust						
	Size / Proportion						
	Uniformity						
	Overall appearance						
Flavour / Taste	Sweetness						
	Spiciness						
	Saltiness						
	Balanced						
	Flavour strength						
	After taste						
	Can you taste the difference between crocodile / chicken?						
Texture	Crust - chunky						
	- soggy						
	Tender						
	Moist						
	Mouthfeel						
Practicality	Easy to eat						
	Grab & on the go						
	Will you try it again?						
	Will you buy it for yourself?						

ADDENDUM D1

CAPE-MALAY CROCODILE FILLED DUMPLINGS: SMALL-SCALE RECIPE	
Yield	**4 portions**
Portion size	**3 dumplings**
Preparation time	**1 hour 50 minutes preparation and cooking**
Ingredients	
Filling	
200g	Crocodile tail eye
250g	Carrots
30g	Radish
50g	Sugar snap peas
3ml	Fresh ginger
10g	Chillies
20ml	Fresh coriander
80g	Brown onion
5ml	Turmeric powder
5ml	Cumin powder
2ml	Salt
4ml	Pepper
Dumpling dough	
1	Egg, lightly beaten
200g	Cake flour, sifted
2ml	Salt
80ml	Water
15ml	Tomato paste

continues …

Method	
1.	To make the dough, sift the flour and salt together. Create a well in the center of the dry ingredients.
2.	Whisk the egg and water together and slowly pour the liquid into the well and mix. If the mixture is too dry, increase the amount of water, one teaspoon at a time until a pliable silky dough has formed.
3.	On a lightly floured surface, knead the dough until elastic.
4.	Cut the dough in half to inspect if there are any air pockets in the dough. There must be no air pockets. Continue to knead until it is reached. Cover for a minimum of ten minutes under a damp cloth.
5.	Combine the turmeric and cumin in a sauté pan and roast about 30 seconds until the spices start to smoke and remove.
6.	Peel the carrots, top and end the radish. Grate both and add to a medium bowl.
7.	Seed and finely chop the red chillies, add to the bowl.
8.	Cut the ends off the sugar snap peas and chiffonade very finely, add to the bowl.
9.	Peel and finely chop the ginger, add to the bowl.
10.	Peel and small dice the onion.
11.	Sauté the onions. Once the onions are translucent, add the rest of the filling ingredients and sauté.
12.	Mince the crocodile and precook in a separate sauté pan with vegetable oil, approximately 6 minutes.
13.	Add the roasted spices to the bowl.
14.	Combine the crocodile with the other filling ingredients and mix well.
15.	Tear of a 30mL size of dough and roll out to 1mm thickness. Using a cookie cutter with a diameter of 10cm, cut out a circle of dough.
16.	Place 30ml of filling in the center of the dough.
17.	Brush one-half of the edges of the circle with egg whites.
18.	Fold the one-half of the circle over the filling to match the other half.
19.	Take a fork and lightly press the edges to help the dumpling seal.
20.	Twist and fold the two corners underneath the dumpling.
21.	Half-fill a medium pot with boiling water. Place the bamboo steamer on top.
22.	Boil the dumplings in a medium pot filled ¾ with water for precisely 8 min.
23.	Remove and sprinkle with a little salt. Keep warm.
24.	Add 10ml of water to the tomato puree and mix well to reach a runny smooth consistency.
25.	Brush the tomato mix over the dumplings to give them colour.

ADDENDUM D2

CAPE-MALAY CROCODILE FILLED DUMPLINGS: LARGE-SCALE RECIPE	
Yield	**24 portions**
Portion size	**3 dumplings**
Preparation time	**1 hour 50 minutes preparation and cooking**
Ingredients	
Filling	
400g	Crocodile tail eye
500g	Carrots
60g	Radish
100g	Sugar snap peas
6g	Fresh ginger
20g	Chillies
40ml	Fresh coriander
160g	Brown onion
10ml	Turmeric powder
10ml	Cumin powder
4ml	Salt
7ml	Pepper
Dumpling dough	
2	Eggs, lightly beaten
400g	Cake flour, sifted
4ml	Salt
160ml	Water
30ml	Tomato paste

continues …

Method	
1.	To make the dough, sift the flour and salt together. Create a well in the center of the dry ingredients.
2.	Whisk the egg and water together and slowly pour the liquid into the well and mix. If the mixture is too dry, increase the amount of water, one teaspoon at a time until a pliable silky dough has formed.
3.	On a lightly floured surface, knead the dough until elastic.
4.	Cut the dough in half to inspect if there are any air pockets in the dough. There must be no air pockets. Continue to knead until it is reached. Cover for a minimum of ten minutes under a damp cloth.
5.	Combine the turmeric and cumin in a sauté pan and roast about 30 seconds until the spices start to smoke and remove
6.	Peel the carrots, top and end the radish. Grate both and add to a medium bowl.
7.	Seed and finely chop the red chillies, add to the bowl.
8.	Cut the ends off the sugar snap peas and chiffonade very finely, add to the bowl.
9.	Peel and finely chop the ginger, add to the bowl.
10.	Peel and small dice the onion.
11.	Sauté the onions. Once the onions are translucent, add the rest of the filling ingredients and sauté.
12.	Mince the crocodile and precook in a separate sauté pan with vegetable oil, approximately 6 minutes.
13.	Add the roasted spices to the bowl.
14.	Combine the crocodile with the other filling ingredients and mix well.
15.	Tear of a 30mL size of dough and roll out to 1mm thickness. Using a cookie cutter with a diameter of 10cm, cut out a circle of dough.
16.	Place 30ml of filling in the center of the dough.
17.	Brush one-half of the edges of the circle with egg whites.
18.	Fold the one-half of the circle over the filling to match the other half.
19.	Take a fork and lightly press the edges to help the dumpling seal.
20.	Twist and fold the two corners underneath the dumpling
21.	Half-fill a medium pot with boiling water. Place the bamboo steamer on top.
22.	Boil the dumplings in a medium pot filled ¾ with water for precisely 8 min.
23.	Remove and sprinkle with a little salt. Keep warm.
24.	Add 20ml of water to the tomato puree and mix well to reach a runny smooth consistency.
25.	Brush the tomato mix over the dumplings to give them colour.

ADDENDUM E1

PORT WINE AND ROSEMARY MARINATED CROCODILE TAIL EYE: SMALL-SCALE RECIPE	
Yield	**1 portion**
Portion size	**150g**
Preparation time	**1 hour pre-preparation; 2 hours preparation and cooking**
Ingredients	
100g	Brown onion
10g	Garlic cloves
10ml	Black peppercorns
10ml	Salt
15ml	Fresh rosemary
250ml	Port wine
30ml	Vegetable oil
45ml	Apple vinegar
125ml	Beef stock
30ml	Water
200g	Crocodile tail eye

Method	
1.	Peel and fine chop onions, garlic and rosemary, mix well and set aside.
2.	Add oil to a sauté pan and sauté onion, garlic and rosemary until golden brown.
3.	Add the Port wine and allow to reduce until half original volume, 125ml.
4.	Remove the pan from heat and add the rest of the ingredients, mix well.
5.	Add the crocodile meat and seal in a vacuum sealed bag, allow to marinade for one hour in the refrigerator.
6.	Fill the sous-vide machine with water and heat the water until 55 degrees Celsius.
7.	After one hour, place the marinade bag in the water and sous-vide for one hour.
8.	Turn off the machine after one hour and remove the bag.
9.	Place marinade in sauté pan. Reduce the marinade until almost all the moisture is evaporated, stirring constantly it must reach a syrup consistency.
10.	Place the meat on a smoking hot griddle pan for 15 seconds on each side.
11.	Place the crocodile on a hot serving plate and serve.

ADDENDUM E2

PORT WINE AND ROSEMARY MARINATED CROCODILE TAIL EYE: LARGE-SCALE RECIPE	
Yield	**25 portions**
Portion size	**150g**
Preparation time	**1 hour pre-preparation; 2 hours preparation and cooking**
Ingredients	
2500g	Brown onion
150g	Garlic cloves
30ml	Black peppercorns
30ml	Salt
200ml	Fresh rosemary
6250ml	Port wine
100ml	Vegetable oil
1125ml	Apple vinegar
3125ml	Beef stock
750ml	Water
3750g	Crocodile tail eye

Method	
1.	Peel and fine chop onions, garlic and rosemary, mix well and set aside.
2.	Add oil to a sauté pan and sauté onion, garlic and rosemary until golden brown.
3.	Add the Port wine and allow to reduce until half original volume.
4.	Remove the pan from heat and add the rest of the ingredients, mix well.
5.	Add the crocodile meat and seal in a vacuum sealed bag, allow to marinade for one hour in the refrigerator.
6.	Fill the sous-vide machine with water and heat the water until 55 degrees Celsius.
7.	After one hour, place the marinade bag in the water and sous-vide for one hour.
8.	Turn off the machine after one hour and remove the bag.
9.	Place marinade in sauté pan. Reduce the marinade until almost all the moisture is evaporated, stirring constantly it must reach a syrup consistency.
10.	Place the meat on a smoking hot griddle pan for 15 seconds on each side.
11.	Place the crocodile on a hot serving plate and serve.

ADDENDUM F1

ROOIBOS-SMOKED CROCODILE KEBABS WITH SHERRY AND RED WINE SAUCE: SMALL-SCALE RECIPE	
Yield	**4 portions**
Portion size	**137g**
Preparation time	**1 hour pre-preparation; 1 hour preparation and cooking**
Ingredients	
550g	Crocodile tail eye
60ml	Soya sauce
120g	Honey
50g	Fresh ginger
4g	Garlic
23g	Brown sugar
40g	Lime
50ml	Orange concentrate
5g	Salt
2g	Pepper
Smoking	
10	Rooibos tea bags
250ml	Rice
80ml	Brown sugar
Sauce	
250ml	Sherry
250ml	Red wine
120ml	Rice wine vinegar
30g	Red onion
40g	Fresh ginger
50ml	Orange concentrate
40g	Lime
10ml	Soy sauce
2g	Garlic

continues …

Method	
1.	Pierce the crocodile fillets.
2.	Slice the onion, finely chop the garlic and grate the ginger.
3.	Mix the soya sauce, honey, ginger, garlic, orange concentrate and brown sugar.
4.	Add the juice of the lime and reserve the rinds.
5.	Vacuum pack the crocodile fillets with the marinade and rinds, seal and leave to marinade for an hour in the refrigerator.
6.	In the meantime, put the sherry and wine into a medium saucepan and reduce for about an hour along with the sliced onions.
7.	Remove the fillets from the vacuum sealed bag.
8.	Line a pot with aluminium foil; add the rice, sugar and Rooibos to the bottom of the pot.
9.	Place a ramekin and a plate, both covered in tin foil, in the pot and place the fillets on the plate. Cover with an aluminium covered lid.
10.	Put the stove on low heat and allow smoking for 7min.
11.	Remove the fillets and put them on a baking tray.
12.	Bake fillets for 12min until cooked. Cooking time depends on the thickness of the fillets.

ADDENDUM F2

ROOIBOS-SMOKED CROCODILE KEBABS WITH SHERRY AND RED WINE SAUCE: LARGE-SCALE RECIPE	
Yield	**25 portions**
Portion size	**137g**
Preparation time	**1 hour pre-preparation; 1 hour preparation and cooking**
Ingredients	
3141g	Crocodile tail eye
285ml	Soya sauce
742ml	Honey
285g	Fresh ginger
23g	Garlic
137ml	Brown sugar
228g	Lime
285ml	Orange concentrate
15g	Salt
12g	Pepper
Smoking	
10	Rooibos tea bags
250ml	Rice
80ml	Brown sugar
Sauce	
250ml	Sherry
250ml	Red wine
120ml	Rice wine vinegar
30g	Red onion
40g	Fresh ginger
50ml	Orange concentrate
40g	Lime
10ml	Soy sauce
2g	Garlic

continues …

Method	
1.	Pierce the crocodile fillets.
2.	Slice the onion, finely chop the garlic and grate the ginger.
3.	Mix the soya sauce, honey, ginger, garlic, orange concentrate and brown sugar.
4.	Add the juice of the lime and reserve the rinds.
5.	Vacuum pack the crocodile fillets with the marinade and rinds, seal and leave to marinade for an hour in the refrigerator.
6.	In the meantime, put the sherry and wine into a medium saucepan and reduce for about an hour along with the sliced onions.
7.	Remove the fillets from the vacuum sealed bag.
8.	Line a pot with aluminium foil; add the rice, sugar and Rooibos to the bottom of the pot.
9.	Place a ramekin and a plate, both covered in tin foil, in the pot and place the fillets on the plate. Cover with an aluminium covered lid.
10.	Put the stove on low heat and allow smoking for 7min.
11.	Remove the fillets and put them on a baking tray.
12.	Bake fillets for 12min until cooked. Cooking time depends on the thickness of the fillets.

ADDENDUM G1

CORNFLAKE-CRUMED CROCODILE STRIPS: SMALL-SCALE RECIPE	
Yield	**4-6 portions**
Portion size	**100g**
Preparation time	**8-24 hours pre-preparation; 30 minutes preparation and cooking**
Ingredients	
500g	Crocodile tail eye
Marinade	
250ml	Buttermilk
5ml	Cumin powder
2ml	Coriander powder
2ml	Peppercorns
5ml	Paprika
2ml	Thyme
5ml	Parsley
5ml	Salt
Crumb	
200g	Cornflakes
2ml	Paprika
2ml	Origanum
1ml	Cayenne pepper
2ml	Sugar
1ml	Garlic powder
2ml	Salt

Method	
1.	Pour the buttermilk in a glass bowl; add the spices for the marinade.
2.	Slice crocodile into bite size pieces.
3.	Add the crocodile to the buttermilk. Pour contents into a vacuum bag and seal. Refrigerate for 8-24hours.
4.	Preheat the oven to 200 °C.
5.	Line a sheet pan with foil and spray it with a coating of cooking spray.
6.	In a food processor, pulse the cornflakes, sugar and spices until a coarse crumb forms.
7.	Pour the cornflakes mixture into a plate.
8.	Remove each piece of crocodile from the buttermilk and roll it evenly in the crumb mixture.
9.	Place on a baking sheet.
10.	Bake for 10 minutes, and then turn each strip. Bake for another 10 min or until crocodile is cooked through.
11.	Serve 100g portions per person immediately.

ADDENDUM G2

CORNFLAKE-CRUMBED CROCODILE STRIPS: LARGE-SCALE RECIPE	
Yield	**24 portions**
Portion size	**100g**
Preparation time	**8-24 hours pre-preparation; 30 minutes preparation and cooking**
Ingredients	
2000g	Crocodile tail eye
Marinade	
1000ml	Buttermilk
15ml	Cumin powder
5ml	Coriander powder
5ml	Peppercorns
15ml	Paprika
5ml	Thyme
15ml	Parsley
15ml	Salt
Crumb	
800g	Cornflakes
15ml	Paprika
10ml	Origanum
5ml	Cayenne pepper
5ml	Sugar
5ml	Garlic powder
15ml	Salt

Method	
1.	Pour the buttermilk in a large glass bowl; add the spices for the marinade.
2.	Slice crocodile into bite size pieces.
3.	Add the crocodile to the buttermilk. Pour contents into a vacuum bag and seal. Refrigerate for 8-24hours.
4.	Preheat the oven to 200 °C.
5.	Line a large sheet pan with foil and spray it with a coating of cooking spray.
6.	In a food processor, pulse the cornflakes, sugar and spices until a coarse crumb forms.
7.	Pour the cornflakes mixture into a plate.
8.	Remove each piece of crocodile from the buttermilk and roll it evenly in the crumb mixture.
9.	Place on a baking sheet.
10.	Bake for 10 minutes, and then turn each strip. Bake for another 10 min or until crocodile is cooked through.
11.	Serve 100g portions per person immediately.

ADDENDUM H

Faculty of Natural and Agricultural Sciences

Department of Consumer Sciences

June 2017

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Natural and Agricultural Sciences

RESEARCH STUDY:

The development of an acceptable culinary product using crocodile meat Urban Consumer

Masters Consumer Science student, Nerike Uys, is doing a project on the sensory acceptability of a culinary product using crocodile meat.

The objective of the sensory evaluation is to rate the sensory characteristics of the culinary food product, as well as to determine consumer perception and acceptability of a culinary crocodile meat product.

What will you be asked to do?: You will receive 4 small portions of different crocodile culinary products. For each item, we will ask you some questions on a scorecard. You will be asked to rate the sensory characteristics, the liking or disliking of each of the products as well as give an indication of willingness to eat the final culinary menu item.

How long will it take? The tasting will take a maximum of 60 minutes.

Why should you participate? This project will help position a sustainable meat source in South Africa. Research has shown that game meat and particularly relevant, crocodile meat, is lower in fat, sodium and cholesterol than conventional meat types. To develop an acceptable culinary product from unconventional meat sources, will not only contribute to the health of consumers, but also help the country's decreasing livestock production to be supplemented with a sustainable alternative. For this reason, it is an ideal opportunity to try to introduce an unconventional product such as crocodile meat. You will get a chance to give your opinion about the crocodile products that have been developed.

Are there any risks? According to literature, crocodile meat has a mild flavor like veal or chicken and has a flaky texture like fish. In some cultures, crocodile meat is considered to be a taboo food product. If this is considered taboo in your culture or religion, it is recommended that you do not participate in this study.
Although crocodile meat is consumed in many countries and cultures and considered completely safe to consume, some consumers do have personal ethical objections or dislike to eat such an exotic meat product. If you have any such objection, we would suggest that you do not continue to participate in this project.

*Please note that the products have been developed in an environment which also produces products that contain certain allergens, such as dairy, eggs, nuts, fish and shellfish, wheat and soy.

continues …

ADDENDUM H *(continued)*

Participation is completely voluntarily and **at your own risk**. The University of Pretoria, nor any of its representatives, can be held responsible in the unlikely event of any injury or illness as a direct or indirect result of your participation in this tasting session.

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Faculty of Natural and Agricultural Sciences

Do you have to participate? You do not have to participate in this study. Even if you do volunteer to participate, you can withdraw at any time without penalty.

What will we do with your answers?: Answers to questions are tracked using numbers only. These numbers are not in any way linked to your identity. The answers will be used for research purposes and to assist in developing a novel culinary product that consumers find acceptable.

Should you have any questions, please do not hesitate to ask the researcher or her assistant.

I HAD THE OPPORTUNITY TO READ THIS CONSENT FORM, ASK QUESTIONS ABOUT THE STUDY AND HEREBY AGREE TO PARTICIPATE.

Please indicate whether you give your consent to participate further in the study by indicating your choice with an X.

I agree	I disagree

Participant's signature _____ Date _____

Nerike Uys _____ Date _____

Dr GE du Rand _____ Date _____

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ADDENDUM I

Section A						Respondent number:					Office use:
What do you know about crocodile meat? ***Please indicate your agreement/disagreement with the following statements and mark only the most relevant answer***											
1. Please rate the following three statements from 1 (disagree completely) to 9 (agree completely)											
1.1 I am interested in culinary food culture											
	1	2	3	4	5	6	7	8	9		V1.1
1.2 I like to try new foods											
	1	2	3	4	5	6	7	8	9		V1.2
1.3 I am familiar with exotic meats											
	1	2	3	4	5	6	7	8	9		V1.3
1.4 If **you have consumed crocodile meat before**, please rate your experience on a scale from 1 (extremely bad experience) to 9 (extremely good experience)											
N/A	1	2	3	4	5	6	7	8	9		V1.4
1.5 If **you have consumed crocodile meat before**, please indicate to which extent you are willing to buy crocodile meat again, from 1 (I will never buy it again) to 9 (I will buy it as often as I could)											
N/A	1	2	3	4	5	6	7	8	9		V1.5
1.6 If **you have consumed crocodile meat before**, please indicate to which extent you would recommend it to others from you will 1 (not likely at all) to 9 (extremely likely)											
N/A	1	2	3	4	5	6	7	8	9		V1.6
1.7 Please rate your expectation of your food experience today from 1(not a good experience at all) to 9 (an excellent experience)											
	1	2	3	4	5	6	7	8	9		V1.7
2. You will be presented with a list of sensory characteristics that the crocodile products might have. Please indicate to which extent you would be satisfied with the following characteristics in a crocodile meat product. Please rate from 1 (extremely dissatisfied) to 9 (extremely satisfied).											
2.1 Bitter flavour											
	1	2	3	4	5	6	7	8	9		V2.1
2.2 Metallic flavour											
	1	2	3	4	5	6	7	8	9		V2.2
2.3 Bland flavour											
	1	2	3	4	5	6	7	8	9		V2.3
2.4 Sweet flavour											
	1	2	3	4	5	6	7	8	9		V2.4
2.5 Hot flavour (chilli/curry)											
	1	2	3	4	5	6	7	8	9		V2.5
2.6 Smoky flavour											
	1	2	3	4	5	6	7	8	9		V2.6
2.7 Salty flavour /(savoury)											
	1	2	3	4	5	6	7	8	9		V2.7
2.8 Liquor flavour											
	1	2	3	4	5	6	7	8	9		V2.8
2.9 Deep fried flavour											
	1	2	3	4	5	6	7	8	9		V2.9
2.10 Tough texture											
	1	2	3	4	5	6	7	8	9		V2.10
2.11 Flaky texture											
	1	2	3	4	5	6	7	8	9		V2.11

2.12 Chewy texture											
	1	2	3	4	5	6	7	8	9		V2.12
2.13 Juicy texture											
	1	2	3	4	5	6	7	8	9		V2.13
2.14 Tender texture											
	1	2	3	4	5	6	7	8	9		V2.14
2.15 Minced meat texture											
	1	2	3	4	5	6	7	8	9		V2.15
2.16 Crispy texture											
	1	2	3	4	5	6	7	8	9		V2.16
2.17 Light meat colour/(appearance)											
	1	2	3	4	5	6	7	8	9		V2.17
2.18 Dark meat colour/ (appearance)											
	1	2	3	4	5	6	7	8	9		V2.18
2.19 Golden brown appearance											
	1	2	3	4	5	6	7	8	9		V2.19
2.20 Chicken-like aroma											
	1	2	3	4	5	6	7	8	9		V2.20
3. Please indicate in the following statement if you 1 (do not agree at all) to 9 (I agree completely)											
3.1 The texture of a food product is important in my food choice process											
	1	2	3	4	5	6	7	8	9		V3.1
3.2 The flavour of a food product is important in my food choice process											
	1	2	3	4	5	6	7	8	9		V3.2
3.3 The aroma of a food product is important in my food choice process											
	1	2	3	4	5	6	7	8	9		V3.3
3.4 The appearance of a food product is important in my food choice process											
	1	2	3	4	5	6	7	8	9		V3.4

Section B																						
How did you experience each of the 4 crocodile products tasted?																						
Please indicate your agreement with the following statements and mark only the most relevant answer with an X in the relevant box.																						
You will now be presented with a portion of 4 crocodile meat products. Each product has been prepared in a different way. Please evaluate the meat sample for the designated statements and sensory attributes. Refresh your mouth with a small bite of cucumber and rinse with water between each sample. Comments always welcome, even if not specifically requested. If at any point you feel uncomfortable, you can stop tasting and withdraw from the sensory evaluation.																						
4. You will be presented with a list of statements that is related to the crocodile products you have tasted. Please indicate your agreement with the following statements from 1(disagree completely) to 9(agree completely)																						
	397											**246**										
4.1 I liked the overall experience of this product	1	2	3	4	5	6	7	8	9		V4.1.1	1	2	3	4	5	6	7	8	9		V4.1.2
4.2 I liked the overall flavor of this product	1	2	3	4	5	6	7	8	9		V4.2.1	1	2	3	4	5	6	7	8	9		V4.2.2
4.3 I liked the overall aroma of this product	1	2	3	4	5	6	7	8	9		V4.3.1	1	2	3	4	5	6	7	8	9		V4.3.2
4.4 I liked the overall appearance of this product	1	2	3	4	5	6	7	8	9		V4.4.1	1	2	3	4	5	6	7	8	9		V4.4.2
4.5 I liked the overall texture of this product	1	2	3	4	5	6	7	8	9		V4.5.1	1	2	3	4	5	6	7	8	9		V4.5.2
4.6 I would buy this product in a supermarket	1	2	3	4	5	6	7	8	9		V4.6.1	1	2	3	4	5	6	7	8	9		V4.6.2
4.7 I would recommend this product to others	1	2	3	4	5	6	7	8	9		V4.7.1	1	2	3	4	5	6	7	8	9		V4.7.2
4.8 My experience of this product was as I expected	1	2	3	4	5	6	7	8	9		V4.8.1	1	2	3	4	5	6	7	8	9		V4.8.2
4.9 I liked the condiments served with the product	1	2	3	4	5	6	7	8	9		V4.9.1	1	2	3	4	5	6	7	8	9		V4.9.2
	721											**584**										
4.1 I liked the overall experience of this product	1	2	3	4	5	6	7	8	9		V4.1.3	1	2	3	4	5	6	7	8	9		V4.1.4
4.2 I liked the overall flavor of this product	1	2	3	4	5	6	7	8	9		V4.2.3	1	2	3	4	5	6	7	8	9		V4.2.4
4.3 I liked the overall aroma of this product	1	2	3	4	5	6	7	8	9		V4.3.3	1	2	3	4	5	6	7	8	9		V4.3.4
4.4 I liked the overall appearance of this product	1	2	3	4	5	6	7	8	9		V4.4.3	1	2	3	4	5	6	7	8	9		V4.4.4
4.5 I liked the overall texture of this product	1	2	3	4	5	6	7	8	9		V4.5.3	1	2	3	4	5	6	7	8	9		V4.5.4
4.6 I would buy this product in a supermarket	1	2	3	4	5	6	7	8	9		V4.6.3	1	2	3	4	5	6	7	8	9		V4.6.4
4.7 I would recommend this product to others	1	2	3	4	5	6	7	8	9		V4.7.3	1	2	3	4	5	6	7	8	9		V4.7.4
4.8 My experience of this product was as I expected	1	2	3	4	5	6	7	8	9		V4.8.3	1	2	3	4	5	6	7	8	9		V4.8.4
4.9 I liked the condiments served with the product	1	2	3	4	5	6	7	8	9		V4.9.3	1	2	3	4	5	6	7	8	9		V4.9.4

5. Please check all characteristics that you experienced to be applicable in these products.												
	397			**246**			**721**			**584**		
5.1 Bitter flavour			V5.1.1			V5.1.2			V5.1.3			V5.1.4
5.2 Metallic flavour			V5.2.1			V5.2.2			V5.2.3			V5.2.4
5.3 Bland flavour			V5.3.1			V5.3.2			V5.3.3			V5.3.4
5.4 Sweet flavour			V5.4.1			V5.4.2			V5.4.3			V5.4.4
5.5 Hot flavour (chilli/curry)			V5.5.1			V5.5.2			V5.5.3			V5.5.4
5.6 Smoky flavour			V5.6.1			V5.6.2			V5.6.3			V5.6.4
5.7 Salty/savoury flavour			V5.7.1			V5.7.2			V5.7.3			V5.7.4
5.8 Liquor flavour			V5.8.1			V5.8.2			V5.8.3			V5.8.4
5.9 Deep fried flavour			V5.9.1			V5.9.2			V5.9.3			V5.9.4
5.10 Tough texture			V5.10.1			V5.10.2			V5.10.3			V5.10.4
5.11 Flaky texture			V5.11.1			V5.11.2			V5.11.3			V5.11.4
5.12 Chewy texture			V5.12.1			V5.12.2			V5.12.3			V5.12.4
5.13 Juicy texture			V5.13.1			V5.13.2			V5.13.3			V5.13.4
5.14 Tender texture			V5.14.1			V5.14.2			V5.14.3			V5.14.4
5.15 Minced meat texture			V5.15.1			V5.15.2			V5.15.3			V5.15.4
5.16 Crispy texture			V5.16.1			V5.16.2			V5.16.3			V5.16.4
5.17 Light meat colour			V5.17.1			V5.17.2			V5.17.3			V5.17.4
5.18 Dark meat colour			V5.18.1			V5.18.2			V5.18.3			V5.18.4
5.19 Golden brown appearance			V5.19.1			V5.19.2			V5.19.3			V5.19.4
5.20 Chicken-like aroma			V5.20.1			V5.20.2			V5.20.3			V5.20.4
OTHER			V5.21.1			V5.21.2			V5.21.3			V5.21.4

6. Please rank your preference of these 4 products from most liked (1) to least liked (4)			
584			V6.1
397			V6.2
246			V6.3
721			V6.4

Section C **PLEASE TELL US MORE ABOUT YOURSELF** ***Answer every question and mark only the most relevant answer with an X***										Office use	
7. What is you gender?											V7
Male	1	Female	2								
8. What is your age on your last birthday?											V8
		Years									
9. What is you highest level of qualification?											V9
Lower than grade 12	1	Grade 12	2	Degree/diploma	3	Post-graduate qualification	4				
10. To which population group do you belong to according to the SA Population Act?											V10
Asian	1	Black	2	Coloured	3	White	4	Other	5		
11. What is your personal approximate total monthly income?											V11
<R5000											
R5000-R9999											
R10000-R14999											
R15000-R19999											
R20000-R24999											
R25000<											

Thank you for your participation and valuable contribution to this research.
Your information will remain anonymous throughout the research process.

ADDENDUM J

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences
Ethics Committee

E-mail: ethics.nas@up.ac.za

Date: 23 November 2016

ETHICS SUBMISSION: LETTER OF APPROVAL

Dr GE du Rand
Department of Consumer Science
University of Pretoria

Reference number: EC 161103-078
Project title: The development of an acceptable culinary menu item using crocodile meat

Dear Dr Du Rand

The submission conforms to the requirements of the NAS EC.

I hereby wish to inform you that permission is granted to conduct interviews with researchers from the Faculty to collect data for the abovementioned research project. It is the prerogative of each NAS staff member to agree or not to take part in the interviews that are planned. This approval does not imply that the researcher is relieved of any accountability in terms of the Codes of Research Ethics of the University of Pretoria, if action is taken beyond the approved proposal.

According to the regulations, any relevant problem arising from the study or research methodology as well as any amendments or changes, must be brought to the attention of any member of the Faculty Ethics Committee who will deal with the matter. You are required to submit annual progress reports no later than two months after the anniversary of this application as indicated by the reference number. The progress report document is accessible on the NAS faculty's website: Research/Ethics Committee. You are also required to notify the NAS EC upon the completion or ending of the project using the form Project Completed. Completion will be when the data has been analysed and documented in a postgraduate student's thesis or dissertation, or in a paper or a report for publication.

The digital archiving of data is a requirement of the University of Pretoria. The data should be accessible in the event of an enquiry or further analysis of the data.

Yours sincerely,

Chairperson: NAS Ethics Committee

ADDENDUM K

DECLARATION OF ORIGINALITY
UNIVERSITY OF PRETORIA

The Department of ……**Consumer and Food Sciences**…… places great emphasis upon integrity and ethical conduct in the preparation of all written work submitted for academic evaluation.

While academic staff teach you about referencing techniques and how to avoid plagiarism, you too have a responsibility in this regard. If you are at any stage uncertain as to what is required, you should speak to your lecturer before any written work is submitted.

You are guilty of plagiarism if you copy something from another author's work (e.g. a book, an article or a website) without acknowledging the source and pass it off as your own. In effect you are stealing something that belongs to someone else. This is not only the case when you copy work word-for-word (verbatim), but also when you submit someone else's work in a slightly altered form (paraphrase) or use a line of argument without acknowledging it. You are not allowed to use work previously produced by another student. You are also not allowed to let anybody copy your work with the intention of passing if off as his/her work.

Students who commit plagiarism will not be given any credit for plagiarised work. The matter may also be referred to the Disciplinary Committee (Students) for a ruling. Plagiarism is regarded as a serious contravention of the University's rules and can lead to expulsion from the University.

The declaration which follows must accompany all written work submitted while you are a student of the Department of **Consumer and Food Sciences**..... No written work will be accepted unless the declaration has been completed and attached.

Full names of student: ….**Nerike Uys**.....

Student number: …**10010042**.....

Topic of work: … **M Consumer Science: Food Management**.....

Declaration

1. I understand what plagiarism is and am aware of the University's policy in this regard.
2. I declare that this …**dissertation**…… (e.g. essay, report, project, assignment, dissertation, thesis, etc) is my own original work. Where other people's work has been used (either from a printed source, Internet or any other source), this has been properly acknowledged and referenced in accordance with departmental requirements.
3. I have not used work previously produced by another student or any other person to hand in as my own.
4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

SIGNATURE …….....

ADDENDUM L

TO WHOM IT MAY CONCERN

I hereby declare that I language edited the second, third and fourth chapters of the original dissertation text of **Ms Nerika Uys** substantively. I sent draft edited versions suggesting changes that did not alter the meaning of the original words used. Recommendations and adjustments concerning the use of English grammar, spelling and clarity of expression were made and the "Track Changes" mode in MSWord 16 was applied. The documents were received and returned electronically.

U J Fairhurst (not signed for security reasons)

U J Fairhurst (DPhil)
Professor Emeritus (University of Pretoria)
Academic Associate (University of South Africa)

Freelance academic editor
Full Member: Accredited by the Professional Editors' Guild
Member: South African Translators' Institute
Life Member: Society of South African Geographers
Canberra Society of Editors: Australian National Mentoring Program: voluntary member

29 January 2019

Digitally signed by Joan Fairhurst
Date: 2019.01.31 08:41:42 +02'00'