

Sensory characteristics of native Muscovy duck meat in Malawi

***J. Tanganyika^{1,2} and E. C. Webb¹**

¹Department of Animal and wildlife Sciences, Faculty of Natural and Agricultural Sciences,
University of Pretoria, Private Bag X20, Hatfield 0028, South Africa

²Animal Science Department, Faculty of Agriculture, Bunda Campus, Lilongwe University of
Agriculture and Natural Resources, P. O. Box 219, Lilongwe, Malawi.

jtanganyika@gmail.com

Abstract

The current research was conducted to study the effect of production systems, cooking methods and post-mortem ageing time on the sensory attributes of duck meat. Breast muscles of drakes from three production systems (intensive, duck rice and free range) were collected after chilling at 4°C for 24 h. The determination of the effect of cooking methods and ageing time used duck breast muscles of drakes from the free range system which is the common production system in Malawi and was conducted after either one-hour and 12 h post-mortem ageing period by a trained taste panel. Sensory attributes evaluated were colour, tenderness and juiciness using a 9 point – Hedonic scale rating. Data were subjected to multivariate analysis of variance (MANOVA) for completely randomized design. The overall results indicated that the panellists preferred duck meat from duck-rice integration and free range system. Analysis of cooking methods, indicated a preference for grilling and ageing duck meat for 12 h rather than cooking after 1 h post-mortem. It is concluded that, ducks can be raised under duck-rice integrated systems as an improvement to free range system, provided that a 12 h post-mortem ageing period for better sensorial attributes of colour, tenderness and juiciness is maintained.

Keywords: Ageing, cooking methods, evaluation, palatability

Introduction

Duck production is one of the alternative source of animal protein alongside chicken meat and other non-conventional livestock species in Malawi. Ducks are mostly raised together with indigenous chickens under traditional system (free-range extensive system), backyard extensive system, semi-intensive system and intensive system (FAO, 2008 and Gondwe 2004). Apart from being tolerant and hardy to most viral diseases such as Newcastle than chickens, ducks are able to survive, grow and lay eggs in free range environments and contribute significantly to the food security and protein intake of human populations (FAO 2017). It is estimated that meat consumption for Malawi is at 8.3 kg (FAO 2013) per person per year which is below 10 kg (FAO 2017) and considered insufficient which often leads to under-nourishment and malnutrition. . The average supply of protein of animal origin for Malawi still remains at 6 g/capita/day (FAOSTAT 2017). UNICEF (2015) indicated that malnutrition levels are at 46% among under five children and underweight at 21% in most growing children particularly in those households with low socio-economic status which is mainly determined by protein levels. The problem of ensuring sufficient protein in the Malawi diet is made difficult by the rapidly increasing human population, which is growing at 2.8% per annum (NSO 2008) and is projected to reach 26, 584, 000 in 2030, 43,155, 000 in 2050 and 87, 056, 000 in 2100 (UNICEF 2015). Therefore, production of conventional livestock species like goats, cattle, pigs, sheep and chicken is not sufficing the increasing population. Ducks could be an alternative livestock species which augers well in integrated farming systems. Despite the advantages of ducks, its production is still low due to lack of knowledge in proper feeding and management by the smallholder farmers and the preference of farmers for chickens to ducks (Njunga et al 2010) due to absence of health and extension services which promote duck production (Mwanza and Mapemba 2008). Generally, duck meat consumers are unaffected by cultural or religious taboos. So duck meat provides a huge opportunity for sustainable food security, but requires consumer awareness through sensory evaluation, a science of measurement (Lawless and Heymann 2010) which assesses meat quality attributes such as colour, juiciness and tenderness which are the most important features of meat for consumers.

Nowadays, consumers are not only concerned with product safety, but palatability attributes as well. These sensory features are affected by several factors such as rearing systems, cooking methods and post-mortem ageing period in addition to age, breed, and sex among others. Worldwide, consumers believe that products from ecological rearing systems have higher nutritive quality and better taste (Andree et al 2010; Horsted et al 2010). On the other hand, cooking method has an effect on the nutritional value, appearance and eating quality of meat (Omojola 2014). In addition, post-mortem aging period has been found to affect sensory characteristics. Due to limited cold chain facilities, consumers usually purchase meat and cook immediately after dressing or within 4–5 h of slaughter or after storage in refrigerator for 10–12 h (Mendiratta et al 2012). While more studies have been conducted on chicken, no studies were done on the relationship of duck production systems, late alone the best cooking method as well as the best post-mortem ageing period of duck meat. Therefore, the aim of this study was to assess how production systems, cooking methods and post-mortem ageing period affect sensory characteristics of duck meat.

Materials and methods

Location

The study was conducted in November 2017 at the laboratory of the Department of Human Nutrition and Health, in the Faculty of Food and Human Sciences at Bunda Campus of the Lilongwe University of Agriculture and Natural Resources in Malawi.

Experimental animals

One-week old ducklings were raised up to ten weeks in this study under three production systems (Intensive, Duck rice integration and Free-range). The main feed ingredients (maize, soy beans) were analysed for proximate before formulating the feed for the ducks using the Pearson Square method based on the protein requirements and all other nutrients calculated. The ducks were fed a ration containing 20% crude protein from second to fourth week and a 17% percent ration from fifth to the end of the experiment (10 weeks). After the feeding period, the ducks

from each production system were randomly selected based on their closeness to the group mean and slaughtered at Kanengo abattoir in Lilongwe. The ducks were stunned electrically and slaughtered by neck cutting. They were then scalded with hot water (60°C for 3 min), and feathers removed mechanically using the rolling drum which had rubber feather pluckers and then hands finalised the removal of any remaining feathers on the carcass. After plucking, the carcasses were eviscerated as described by Ali *et al.* (2007).

Meat samples and preparation

Assessment of palatability factors in this study used breast muscles of drakes. The effect of cooking methods involved boiling, pan frying and grilling the duck breast meat. Samples for assessing effect of post-mortem ageing period on eating quality attributes were prepared one hour and 12 h after slaughter while keeping them at chilling temperature of 4°C. The cooking temperatures for all the methods were around 200 °C till well done. Pan frying and grilling methods were done as described by Omojola (2007).

Taste panel evaluation

A total of eleven taste panellists who were familiar with taste of duck meat and ate at least once a week or more often were recruited according to their responses to a brief screening questionnaire about their; age, sex and availability to carry out the test. The taste panel comprised of six males and five females of ages between 20 and 25 years old who were final year undergraduate students and two Technicians from the Food Science Department. The panellists were selected using a triangle test where three coded samples were presented at the same time, two were identical and the third sample was the odd (Heinz and Hautzinger 2007) by using three samples of sugar solution and three other samples of salt solution for the panellists to identify. After this test, the panellists were provided with duck meat samples to assess based on colour, tenderness and juiciness for duck meat from three production systems, three cooking methods and two aging periods.

Experimental design

Sensory scores of palatability factors such as visual colour, tenderness and juiciness of duck meat were determined by trained taste panelists who scored the duck meat using the 9 point – Hedonic scale rating (*1=Dislike extremely.....5=neither like nor dislike.....9=Like extremely*) which is also known as *affective test method* (Lawless and Heymann 2010) and assesses Quality Attributes (QA) that consumers want in a product, subjectively (Becker 2000). On the first day, the panellists assessed the effect of production systems on duck meat quality and meat samples from free ranging systems which were prepared by boiling, the common cooking method in Malawi. Effect of cooking methods involved boiling, pan frying and grilling the meat and finally, duck meat samples were prepared after 1 h and 12 h post-mortem to assess the effect of ageing period on duck meat quality. The samples were labelled as A, B and C and the panellists were instructed to cleanse their palates between samples using warm water (Kim 2017).

Statistical Analyses

The data collected were analysed by SPSS statistical software package using MANOVA. Duncan multiple range test on production systems and cooking methods were used while Tukey test was used to analyse data for effect of aging time. Critical differences were determined at 5% significance level (Snedecor and Cochran 1989).

Results and discussion

Effect of production system on colour, tenderness and juiciness of duck meat

The panelists failed to distinguish juiciness among the production systems (Table 1) but found differences in meat colour and tenderness. They found that duck meat from free range system was less tender than that from intensive and duck rice integrated systems. Though, duck rice integrated and intensive systems were not different ($p>0.05$), intensive system produced tender meat that duck rice integrated system.

On meat colour, the panelists preferred meat from free range and duck-rice integrated systems because it appeared reddish which is considered the normal colour of meat preferred by many consumers when purchasing meat from the market.

Table 1: Effect of production system on eating quality attributes of duck meat

| Attribute | Intensive | Duck rice | Free range | Overall | SEM | <i>p</i> |
|-----------|-------------------|-------------------|-------------------|---------|------|----------|
| Colour | 6.82 ^a | 7.36 ^b | 7.29 ^b | 7.16 | 0.09 | 0.04 |
| Texture | 7.09 ^a | 7.00 ^a | 6.50 ^b | 6.86 | 0.09 | 0.03 |
| Juiciness | 7.27 | 7.36 | 7.21 | 7.28 | 0.08 | 0.73 |

^{abc} Means with different superscripts within the row differ at $p < 0.05$

The present results on effect of production systems on meat colour and tenderness whereby panelists scored meat from duck-rice and free-range system to be more brighter than intensive system (Table 1), agree with Ponte et al (2008) who demonstrated that chickens on free range system had a brighter colour of meat which could be due to the content of natural carotenoids in green forage ingested from the environment. Fanatico et al (2007) also stated that meat colour was affected by rearing system and affect consumers' choice preferences. In another study, Lacin et al (2008) found that different rearing systems had an effect on the meat colour of the ducks. However, Michalczuk et al (2014) found no differences in sensorial attributes for different rearing systems of chickens and concluded that access to free range or other rearing systems has no influence on the quality of poultry meat. The difference could be due to differences in muscle fibers since duck breast has inherently high iron, haem and type IIA (Kim et al 2008), in addition to more forages consumed in the rice field and in free range may have influenced the outcome.

Effect of cooking method on colour, tenderness and juiciness of duck meat

The sensory evaluation of cooking methods affected meat colour and juiciness but the panellists failed to distinguish the difference on meat tenderness among the cooking methods (Table 2).

The best colour was observed on grilling method followed by pan frying and boiling. Though no

significant differences were noted on tenderness, the panellists preferred duck meat cooked under grilling followed by pan frying and boiling in that order. Further interview revealed that overall acceptability was on grilling method.

Table 2: Effect of cooking method on eating quality attributes of duck meat

| Attribute | Boiling | Pan frying | Grilling | Overall | SEM | p |
|------------------|-------------------|-------------------|-------------------|----------------|------------|----------|
| Colour | 6.73 ^a | 7.18 ^b | 7.73 ^b | 7.21 | 0.09 | <0.001 |
| Tenderness | 6.91 | 7.09 | 7.18 | 7.06 | 0.11 | 0.58 |
| Juiciness | 6.73 ^a | 7.27 ^b | 7.36 ^b | 7.12 | 0.08 | <0.01 |

^{abc} Means with different superscripts within the row differ at $p < 0.05$

Comprehensive review of literature by Pathare and Roskilly (2016) found that cooking methods play a major role in eating quality attributes of food products. According to Bisceglia et al (2013), cooking process of meat must provide a final product with desirable sensory characteristics as well as microbiological safety. Nowadays, meat cooking in a convection oven (grilling) which was preferred in the current study is a common cooking method not only in the industrial production of ready-to-serve meals but also in the catering industry (Bisceglia 2013). The present results on colour of the meat for pan frying and grilling (Table 2) are in agreement with Omojola (2014) who also found no significant difference between the treatments. In the current study, the panelists preferred grilling than pan frying and Omojola (2014) indicated that the possible reason behind this preference could be the high temperature and the oil used in pan frying might have affected the colour of the product resulting to a lower score compared to grilling. However, oil is a superb medium for transition of heat and the food is swiftly heated and prepared when it is plunged within the oil (Alvis et al 2009). This also agrees with a study on rabbit meat by Apata et al (2012) who reported that the colour of rabbit meat was greatly affected by different cooking methods. Mir-Bel et al (2012) reported that frying involves contact between the pan and the meat coupled with heat and mass transfer between meat and frying medium. In the process, there is mass transfer of oil and air which results in among others,

protein denaturation and colour change via maillard reactions, hence, the difference in colour among cooking methods in the current experiment. The current study is also in agreement with Christensen et al (2011) who reported that physical properties of meat and eating quality are largely affected by cooking methods which are determined by temperature and time. However, Adam and Abugroun (2015) found that cooking methods did not significantly affect meat colour, juiciness and texture of beef topside cuts, the differences could be due to species involved.

Effect of aging period on colour, tenderness and juiciness of duck meat

Differences were observed in all the three parameters whereby the panellists preferred duck meat prepared and consumed after 12 hours post-mortem (Table 3). Colour scores were 7.6 and 6.8 for 12 hrs and 2 hrs, respectively; tenderness had scores of 7.3 and 6.5 for 12 hrs and 2 hrs while juiciness scores were 7.4 and 6.7 for 12 hrs and 2 hrs aging period, respectively.

Table 3: Effect of aging period on eating quality attributes of duck meat

| Attribute | 2 hrs | 12 hrs | Overall | SEM | <i>p</i> |
|------------------|------------------|------------------|----------------|------------|-----------------|
| Colour | 6.8 ^a | 7.6 ^b | 7.2 | 0.12 | <0.001 |
| Tenderness | 6.5 ^a | 7.3 ^b | 6.9 | 0.14 | <0.01 |
| Juiciness | 6.7 ^a | 7.4 ^b | 7.0 | 0.10 | <0.01 |

^{ab}Means with different superscripts within the row differ at $p < 0.05$

The current study found that duck meat prepared and consumed after 12 hours of storage time was tenderer than meat consumed after 1-hour postmortem (Table 3). This is in agreement with observations by Suwattitanun and Wattanachant (2014) who found that longer chilling storage time induced lower shear force value and cooking losses in broiler breast meat. Longer storage time results in degradation of myofibrillar proteins by proteolytic enzymes, thereby increasing meat tenderness (Carroll et al 1981). A study by Santos (2004) on influence of post-mortem aging on tenderness of chicken breast fillets also found that samples with higher period of aging (8, 12 and 24 hours) were preferred in sensorial analysis by consumers. Therefore, eating quality

factors improve with an increase in aging period since animal muscle does not suddenly stop its functions, there are physical and chemical changes over time (hrs/days), a process known as conversion of muscle to meat. The more time elapsing between slaughter and consumption, the carcass cools, becomes stiffer, the surface dries, fat becomes firmer and texture and flavour improves (Warriss P 2010). . These effects accompanied by biochemical changes results in acidification, rigor mortis development, resolution rigor and tenderisation of meat (Sams and Janky 1991). So, meat requires to be allowed to complete this conversion of muscle to meat before consumption by proper storage. Therefore, storage time and chilling conditions have an effect on meat quality characteristics.

Conclusion

The current study has generally found that production systems, cooking methods and post-mortem aging period have an effect on sensory characteristics (colour, tenderness and juiciness) of duck meat. From the results, ducks may be raised under duck rice integration and get same acceptability attributes of meat as in free range system. In relation to post-mortem ageing period, the best is to prepare duck meat after 12 hrs and cooked by grilling which was the most preferred method in the current study. Therefore, further on-farm studies need to be conducted to compare different cooking methods that uses locally available heat sources so that consumers at all levels have informed choices.

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