CHAPTER 1

THE STUDY IN PERSPECTIVE

"A knowledge of the chemical composition of foods is the first essential dietary treatment of disease or in any quantitative study of human nutrition"

(McCance and Widdowson, 1940)

1.1 Background to the Study

Vitamin and mineral deficiencies adversely affect a third of the world's people (Darnton-Hill, et al., 2005). The International Congress on Nutrition (ICN) World Declaration and Plan of Action for Nutrition recommended steps in order to eliminate iodine and vitamin A deficiencies before the end of this decade (FAO, 1992; Clarke, 1995). These pledges have been reaffirmed at the World Summit in Johannesburg, South Africa in September 2002 (United Nations, 2002). Food-based approaches were recognised by the ICN as the most effective way to address existing micronutrient deficiencies. These approaches can include strategies to assure dietary diversification, improved food availability, food preservation, nutrition education and food fortification (Clarke, 1995). A combination of food based strategies, food fortification and supplementation is advised (WHO, 2009).

Since 1994, remarkable progress has been made in reaching optimal levels of iodine nutrition in a majority of populations. Close to 70% of households in the developing world have access to iodised salt through iodine fortification. The World Health Organisation (WHO) database on iodine deficiencies shows that the number of countries with iodine deficiency as a public health problem has decreased from 110 in 1993 to 54 in 2003 (Mangasaryan et al., 2005; WHO, 2009). On the other hand little progress has been made in eliminating vitamin A deficiency (VAD). According to WHO (2003) between 100 and 140 million children are vitamin A deficient. An estimated 250 000 to 500 000 vitamin A deficient children become blind every year, half of them dying within 12 months of losing their sight (WHO, 2009). To successfully combat VAD, short-term interventions and proper feeding in infancy must be supported by long-term sustainable solutions. These interventions include a combination of breastfeeding and vitamin A supplementation, coupled with enduring solutions, such as the promotion of vitamin A-rich diets and food fortification.

Fortification is defined by the Codex Alimentarius (1991) as the addition of one or more essential nutrients to a food, whether or not it is normally contained in the food, for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients in the population or specific population groups. Most staple foods are not complete foods and are deficient in one or more micronutrients. Food fortification of staple foods with micronutrients may help in overcoming deficiency problems in a population. Fortification has the advantage of requiring fewer changes in consumer behaviour and food habits than other interventions (Darnton-Hill and Nalubola, 2002). The major challenges involved in fortifying foods include the identification of suitable vehicles, selection of appropriate fortificant compounds, the level of fortification, determination of technologies to be used in the fortification process and the implementation of appropriate monitoring mechanisms to determine whether the goals of the programme are being met. Reliable methods for determining micronutrient status are required both in establishing the need for food fortification and in monitoring its nutritional impact (WHO, 2006).

A holistic approach to food fortification should be taken, and this emphasises many supporting activities that would facilitate efficacious fortification. Considerations other than only the methodologies employed in the addition of micronutrients to foods greatly influence the potential of food fortification to meet its nutritional objectives. These include: current technologies for determining micronutrient status of target population groups; bioavailability of certain micronutrients in fortified foods and impact of traditional cooking and preparation practices on the stability of nutrients in fortified foods (Clarke, 1995).

1.2 The South African context

In South Africa, refined white maize meal is currently the main staple food due to consumer demand (NFCS, 2000). Ironically, the preferences of today's African consumers for white as opposed to yellow maize as is consumed by the rest of the world, was initially created by the influence of the British starch market. Since 1911, the British starch market provided a premium for white maize and local legislation was passed in some parts of Eastern and Southern Africa requiring that only white maize be accepted for export. The influence of mines, plantations, and cattle enterprises on to the local economy expanded the demand for food in the country. Eventually the domestic demand for maize grew as Africans left their farms to work on settler farms, in mines or industrial plants. Food consumption preferences were influenced by the rations that employers used as in-kind payments. Diets adapted as "people got used to what they consumed" (Shopo 1985 cited Smale & Jayne, 2003: 11).

Micronutrient deficiencies are prevalent in the country and primarily affect vulnerable groups such as children and women. The National Food Consumption Survey (NFCS) of 1999 showed that most children appear to consume a diet low in energy and poor in protein quality and micronutrient density. It also found that one out of two children aged 1-9 years have an intake of approximately less than half the recommended level for vitamin A, vitamin C, riboflavin, niacin, vitamin B_6, folate, calcium, iron and zinc. Iron deficiency and anaemia are common problems among children in rural communities. Although anaemia could be a result of malaria and parasite infestations, dietary deficiency in iron is also a major concern (NFSC, 2000).

The NFCS findings support the results from the 1994 South African Vitamin A Consultative Group (SAVACG) survey among children 6-71 months which found that 33.3% of children are vitamin A deficient, a prevalence which indicates that vitamin A deficiency is a serious health problem in this country. The SAVACG survey also found a 21.4% prevalence of anaemia, 10% prevalence of iron deficiency and 5% prevalence of iron deficiency anaemia (SAVCG, 1996).

As part of a food based approach to alleviate micronutrient malnutrition the Directorate of Nutrition initiated a food fortification program (FFP). A multi-sectoral Food Fortification Task team (including members from UNICEF, Micro Nutrient Initiative, the National Chamber of Milling, the South African Chamber of Baking and independent millers) were tasked to investigate the critical components of such a food fortification program (FFP). The Council for Scientific and Industrial Research (CSIR) were contracted to conduct stability tests and sensory evaluation of fortified food vehicles for the FFP (Kuyper, 2000). Some of the concerns raised in the study were the level of fortification needed to compensate for losses due to storage, packaging and cooking. These concerns motivated the funding for the present project through the National Research Foundation.

1.3 Motivation for the study

Fortification of maize meal and white and brown bread flour with vitamin A, thiamine, riboflavin, niacin, pyridoxine, folic acid, iron and zinc became mandatory in South Africa since 7 October 2003 (Department of Health, 2003). While it is generally possible to add a mixture of vitamins and minerals to relatively inert and dry foods such as cereals, interactions can occur between fortificant nutrients that adversely affect the sensory qualities of the foods (Allen et al., 2004; Clarke, 1995), or the stability of the nutrients (Mehansho et al., 2003; Allen et al., 2004; Clarke, 1995). There is a lack of knowledge regarding the quantitative impact of the interactions among nutrients added as a mixture, on the stability and absorption of the individual nutrients (Allen et al., 2004). The effects of cooking and exposing the fortification mix to moisture and heat for a period of time, also need to be ascertained. It is also important to consider the vehicle for fortification, in this instance, maize meal's inherent nutrients and anti-nutrients such as fibre and phytate and its interaction with the fortification mix.

Few vitamin A fortification programs have been appropriately evaluated, often because of resource constraints. Most of the evaluations that have been done relied on serum retinol concentrations to assess change in vitamin A status in individuals in response to an intervention. Because serum retinol concentration is not an optimal indicator for assessing change in status, the results of these evaluations are difficult to interpret (Vitamin A Tracer Task Force, 2004). Measuring the true change in vitamin A status in response to an intervention is important so that program managers and policy makers can avoid drawing incorrect conclusions about the efficacy or effectiveness of interventions. It is also important to understand if levels and vehicles identified are adequate to improve micronutrient status, and policies should be adopted to in order to ensure the effectiveness of fortification.

1.4 Objective of the study

The aim of the research described in this thesis was to quantify the content and relative absorption of vitamin A in fortified maize meal as purchased from the shelves of retail outlets, as well as in the cooked products that are traditionally prepared and consumed. These data will enable nutritionists and policy makers to make informed decisions on choice of fortificant as well as the vehicle and level of fortification.

The ultimate project objective is to provide policy makers with information that can assist them in implementing food policies leading to improved household food security and growth and well-being of South Africans. Access to such information will assist decision making towards improving efficiency in the application of the South African food fortification program.

1.5 Presentation and structure of the thesis

The structure and outline of the thesis is as follows:

CHAPTER 1: THE STUDY IN PERSPECTIVE

An overview of the study was provided in this chapter.

CHAPTER 2: LITERATURE REVIEW

A literature review is presented on vitamin A deficiency and fortification. This is followed by a discussion of factors that may have an influence on the success of such a program.

CHAPTER 3: VITAMIN A CONTENT OF FORTIFIED WHITE MAIZE MEAL AS PURCHASED AND CONSUMED IN SOUTH AFRICA

A method to determine vitamin A in maize meal was optimised and validated. The method was accredited by the South African National Accreditation Services (SANAS). This method was subsequently used to determine the vitamin A content of maize meal samples, as well as of the corresponding maize porridge samples. Retention of vitamin A in cooked porridge was calculated.

CHAPTER 4: EFFECT OF DIFFERENT MAIZE MEAL DIETS ON THE GROWTH AND VITAMIN A STATUS OF CHICKENS

The relative efficacy of the daily consumption of fortified maize meal in sustaining or improving vitamin A status was evaluated. Although children could be used to evaluate their vitamin A status after consumption of fortified maize meal, this was beyond the financial means of the project and such an approach also has limitations. Consequently, chickens were used as the biological model. Growth and vitamin A status were evaluated using the weight, feed conversion and liver retinol stores of the chickens on different diets over a six week period.

CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

The last chapter summarises the main findings of the described research. The implications of these findings and recommendations to consider in the future are presented and discussed.

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