SNACKING PREFERENCES OF PRIMARY SCHOOL CHILDREN AS A GUIDELINE TO DEVELOP A SENSORY ACCEPTABLE SNACK FOOD ITEM ENHANCED WITH *MORINGA OLEIFERA*

By

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DECLARATION

This work has never been previously accepted in substance for any degree and is not concurrently submitted in candidature of any degree.

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For teaching me more than any book could possibly have taught me.

"I can do all things through Christ who strengthens me"

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ABSTRACT

Introduction: South Africa, like many other developing countries, is challenged by malnutrition among children. Globally, the nutritional status of children is a cause for great concern. The nutritional shift towards diets laden with sugar, fat and salt contribute towards the burden of non-communicable diseases (NCDs). Snacking plays a pivotal role in the diets of children; however, the consumption of unhealthy snacks or 'junk' food poses a serious risk to a child's nutritional well-being. *Moringa oleifera* was selected for snack food development in this study, as this plant is a significant source of nutrients.

Aim: The aim of this study was to determine the snacking preferences of children (grades 4-7) in four schools in Verulam, KwaZulu-Natal (KZN), South Africa, in order to develop a sensory acceptable snack enhanced with *Moringa oleifera.*

Methodology: Two hundred primary school children between grades 4-7 were selected through stratified random sampling of schools in Verulam, KZN, South Africa through informed consent to participate in this study. In addition, ten parents/caregivers formed part of the preliminary study to determine the snacking habits of children in the selected grades. This information was reported in the form of themes. A Snack Food Frequency Questionnaire (SFFQ) was administered to children for the sole purpose of determining snacking preferences. This was supplemented by an observational study to assist with identifying the most frequent tuck shop purchases.

Thereafter, once the top three snack items were identified, the main study continued with the development of a healthy snack, through three cooking trials before an appropriate product was developed. The final product was made using three different amounts of dried *Moringa* leaves (1g *Moringa*, 2g *Moringa* and 3g *Moringa* per 22g portion) in a maize chip.

The developed product was then subjected to nutrient testing in order to determine the vitamin A, zinc, iron and calcium content of the three different variants. The carbohydrate, fat, energy and sodium values were calculated by using the Association of Official Analytical Chemists (AOAC) International standardised methods. Microbiological and shelf life testing were also conducted to ensure the chips were safe for human consumption.

Consumer acceptance sensory evaluation was conducted among the children (n=100) to determine the most preferred amount of *Moringa* leaf in the snack food item (either 1g of

Moringa or 2g *Moringa)*. To determine which of the two variants (sample 1 containing 1g of Moringa and sample 2 containing 2g Moringa) was preferred, two variants of the product were sampled by the participants; samples were coded in order to prevent bias.

Results: Overall, the results from the focus group study revealed that children consumed snacks frequently and were given money regularly to purchase snack items from the school tuck shop. Price was a trend noted in factors that affect snack selection. The parents/caregivers responded positively towards purchasing a snack that was nutrient-rich. However, it was noted that the price should be reasonable. Results of the SFFQ indicated that the most popular snack items were chips, cold drinks and sweets; therefore these items were reviewed to determine the most viable option for further development. It was decided by the researcher and the supervisor that chips would be the snack item enhanced with three different amounts of *Moringa*. The consumer acceptance sensory evaluation comprised two chip samples (123 and ABC). The results of the consumer acceptance sensory evaluation showed that sample ABC (2g *Moringa*/22g serving) was preferred to sample 123 (1g *Moringa*/22g serving) for most of the sensory attributes (taste and texture).

The *Moringa* chips (both samples) contain almost half the amount of sodium (52.8mg) when compared to a popular corn chip brand (100mg). *Moringa* chips contained almost less than 1 gram of fat compared to 8 grams of fat found in the corn chips children usually consume. One portion (22g) of the *Moringa* chips contributes a significant amount of non-haem iron (57.89%, 48.25% and 35.61% for sample 1, 2 and 3 respectively) for females aged between 9-13 years old.

Conclusion: *Moringa* chips (2g/22g serving) received a positive response from children in the sample population. The use of indigenous plants such as *Moringa,* could be beneficial in food based strategies aimed at addressing malnutrition.

Recommendations: This study concluded that food based strategies such as the development of the *Moringa* chips, should be considered as a means to create a healthy option for children in low socio-economic schools.

LIST OF ABBREVIATIONS

ADA	American Dietetic Association
AI	Adequate Intake
AOAC	Association of Official Analytical Chemists International
BMI	Body Mass Index
CHD	Coronary Heart Disease
CSR	Corporate Social Responsibility
CWS	Church World Service
DRI	Dietary Reference Intakes
EAR	Estimated Average Requirement
ECHO	Educational Concerns for Hunger Organisation
EO	Eating Occasion
FAO STAT	Food and Agriculture Organisation Statistics
FAO	Food and Agriculture Organization
FBDG	Food Based Dietary Guidelines
FFQ	Food Frequency Questionnaire
FNI	Food and Nutrition Insecurity
FOP	Front of Pack
HAKC	Healthy Active Kids Canada
HAKSA	Healthy Active Kids South Africa
HCS	Healthy Communities Study
HFSS	High Fat, Sugar and Salt
IFST	Institute of Food Science and Technology

LIST OF ABBREVIATIONS CONT.

ISHP	Integrated School Health Policy
IQ	Intelligence Quotient
KZN	KwaZulu-Natal
MDG's	Millennium Development Goals
NFCS	National Food Consumption Survey
NFP	Nutrition Facts Panel
NIDDM	Non-insulin-dependent diabetes mellitus
NSNP	National School Feeding Programme
PPE	Personal Protective Equipment
RDA	Recommended Dietary Allowance
SANHANES	South African National Health and Nutrition Examination Survey
SDG's	Sustainable Development Goal's
SES	Socioeconomic Status
SFFQ	Snack Food Frequency Questionnaire
SGB	School Governing Body
SO	Snacking Occasion
UNICEF	United Nations Children's Fund
US	United States
WFS	World Food Summit
WHO	World Health Organization

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CHAPTER 1

INTRODUCTION AND IMPORTANCE OF THE STUDY

1. Introduction

In this chapter, an overview of the research problem and the importance for this study which focuses on the snacking preferences of children, is documented. The significance of this study is noted in the prevalence of malnutrition (both overnutrition and undernutrition), as well as recent studies which highlight the importance of food based strategies directed towards addressing malnutrition.

1.1 Importance of the study

According to the World Health Organisation (WHO), results of the impact of the Millennium Development Goals (MDGs) indicated that between the period 1990 and 2015, the global prevalence of underweight among children aged less than 5 years declined from 25% to 14%, almost meeting the target of a 50% reduction in underweight among children (WHO 2015).
The Sustainable Development Goals (SDGs) attempts to build on the progress made by the previous MDGs (WHO 2015). The SDGs comprise 17 goals to be achieved by 2030. The third SDG aims to "ensure healthy lives and promote wellbeing for all at all ages" (WHO 2015).

Overall health and wellbeing starts at a young age and lifestyle practices adopted during childhood usually carry through to adulthood. Hence, there is a quintessential need to encourage, develop and imprint healthy eating choices and practices among young children. According to WHO (2015), non-communicable diseases (NCD's, such as diabetes, stroke, heart disease, cancer and chronic lung disease) are rapidly becoming prominent causes of death in most countries. Malnutrition and infectious diseases were previously regarded as major contributors to the death toll, but deaths due to NCDs are on the rise.

Two key South African surveys, namely, the National Food Consumption Survey (NFCS) 2005 (Labadarios, Swart, Maunder, Kruger, Gericke, Kuzwayo, Ntsie, Steyn, Schloss, Dhansay, Jooste, and Dannhauser 2008: 249-266), and the South African National Health and Nutrition Examination Survey-1 Report (SANHANES-1 2012) (Shisana, Labadarios, Rehle, T., Simbayi, Zuma, Dhansay, Reddy, Parker, Hoosain, Naidoo, Hongoro, Mchiza, Steyn,

Dwane, Makoae, Maluleke, Ramlagan, Zungu, Evans, Jacobs, Faber and SANHANES-1 Team 2013: 156-182) reported on the food consumption and food security status in South Africa (SA) from 2005 to 2012. The NFCS in 2005, surveying a population of 2413 participants, identified that 19.8% of the sample were food secure. A drastic increase in food security has thereafter been recorded by the SANHANES-1 report where the sample population included 6306 participants, of which 45.6% were reported to be food secure. The prevalence of overweight and obesity among children aged 10-14 years (males n=2123 and females n=2155) as documented by the SANHANES report revealed that a higher percentage of females were overweight (16.7%) and obese (5.6%) compared to males (7.5% and 2.7% respectively). This could possibly be due to the male participants living a more active lifestyle (Shisana *et al*. 2013: 28).

Interventions directed towards reducing childhood obesity are essential in curbing the obesity rates in adults. Health education during infancy and childhood can be used as a strategy to assist children in adopting healthy lifestyles that will continue into adulthood (Abound and Yousafzai 2015: 434-450). Children are exposed to obesogenic environments that encourage the consumption of energy-dense foods usually high in sugar, salt or fat. Increase in the frequency of snacking food items that have a poor nutrient content along with large portion sizes is a direct contributor to obesity (Rizk and Treat 2015: 121; Scholliers 2015: 3; Zizza, Siega-Riz and Popkin 2001: 303).

Snacking remains an integral part of a child's diet. It is important to pay careful attention to snacking options that are made available, especially at school tuck shops. The shift in gender roles and with women playing a bigger role in the world of business, results in little or no time left to packing healthy nutritious lunches; hence this is replaced with spending money (Bava, Jaeger and Park 2008: 489). Children, therefore, have more control over the foods consumed and this can be a challenge to ensure that healthy food choices are made. Tuck shop owners supply the demand for foods high in sugar, fat and additives. By placing the buying power in the child's hands, one cannot be sure that the choices made would be nutritious, especially since tuck shops do not necessarily stock healthy snack items. 'Knock-off' versions of well-known branded products such as chips, carbonated beverages and pastries such as pies are seen to be more attractive both on the palate and on the wallet (Leyden 2011: 68).

Spill, Birch, Roe and Rolls (2011: 735) reported that these foods high in sugar and fat are less than desirable for the optimum functioning of the body. Children either seemed lethargic or over active, depending on the type of foods consumed. The high fat and sugar content in some snack foods also affects concentration levels, as children become over-active and restless (Bey 2010: 14). Research conducted on dietary patterns and attention deficit/ hyperactive disorder among Korean adolescents revealed that a high intake of fried foods, sweetened desserts and salt is linked with a higher frequency of attention, behavioural and learning disorders, whereas a balanced diet reduces the likelihood of these disorders (Park Cho, Hong, Oh, Kim, Shin, Kim, Yoo, Cho and Bhang 2012: 469). In order for children to be able to concentrate and focus during class time, it is imperative that a nutritious lunch or snacks are consumed. A possible reason for the low intake of vegetables by children is the unappealing properties vegetables possess, namely, the texture and taste of vegetables**.**

An experimental study directed towards determining if repeated exposure and associative conditioning can be used as effective tools to increase the acceptance and consumption of vegetables by young children concluded that the liking of a vegetable that the children previously did not like increased after 'taking a taste' of a portion of the vegetable over a period of six occasions when the repeated exposure method was used (Frasca, Savage, Marini, Fisher, Birch 2012: 546). There is a need for healthy snacks that are sensory-acceptable to children, since many children have already acquired a preference for either sweet and/or salty snacks.

1.2 Food and nutrition solutions

Various strategies have been implemented in order to address the micronutrient deficiencies that may affect women and children. These strategies include changes to the diet, education regarding the importance of micronutrients, improving the availability of food, and the supplementation and fortification of various food products in an attempt to prevent these vulnerable groups from experiencing micronutrient deficiencies (Bhutta, Salam and Das 2013: 10).

The SANHANES-1 Report (Shisana *et al.* 2013: 170-175) as well as the United Nations Children's Fund (UNICEF 2009), have identified iron, vitamin A and zinc as three of the micronutrients that are of great importance for both women and children living in developing

countries. Goals have thus been set to implement fortification and supplementation of these micronutrients in foods that are both suitable and easily accessible to the group of individuals for whom it is intended.

1.2.1 *Moringa* as a food solution

The development of an appealing food product for children that is nutritionally enhanced with *Moringa oleifera* would assist children in meeting their daily nutrient requirements (Bey 2010: 15). In the context of this study, *Moringa oleifera* Lam. will be referred to as *Moringa*.

The use of *Moringa* (the leaves, fruit, flowers and pods) as a nutrient dense plant is seen in many countries, especially India, Philippines, Pakistan, Hawaii and various parts of Africa (Anwar, Latif, Ashraf and Gilani 2007: 21). The young leaves of the *Moringa* tree are generally cooked and eaten in a similar manner to spinach, or the leaves are used to make soups and salads (Foidl 2001: 25). However, according to research conducted by Nadeem, Javid, Abdullah, Arif and Mahmood (2012: 714), even though the *Moringa* tree is a popular tree grown in Pakistan, most of the individuals are unaware of the nutritional benefits that this tree possesses and merely use the tree as a source of shade and fencing.

According to Anwar *et al.* (2007: 18), *Moringa* is generally found growing wild; this tree grows easily especially in humid or dry areas. *Moringa* is also referred to as 'drumstick tree' which describes the long pods that hang from the tree. Practically, the tree requires a minimal amount of water and soil nutrients, thus the cultivation of this tree is low cost (Foidl 2001: 24). The *Moringa* tree possesses another advantage, that the tree is in 'full leaf' towards dry seasons, when other vegetative food sources are usually sparse (Fahey 2005: 6-7). A study conducted in Ghana revealed that *Moringa* trees have already been utilized in the fight against malnutrition, with special attention focused on infants and nursing mothers (Bey 2010: 13). The leaves of the *Moringa* tree can be consumed fresh, in a cooked form or even dried and crushed into a powder which can last months; in addition, refrigeration is not required. This is especially important as many rural households do not have refrigeration facilities (Fahey 2005: 10-11).

The arrival of *Moringa* in SA occurred many years ago, yet only recently has this super food gained popularity. A review of the herbal remedies used by the 1860 South African Indian

settlers (Naidoo and Coopoosamy 2011: 8534) reported on information collected by several authors. It has been established that not many settlers were knowledgeable about the nutritional value of plants and the Ayurvedic properties (India's natural and traditional system of medicine) these plants possesses. The *Moringa* tree was planted immediately upon arrival in SA, the trees grew quickly and a nutrient rich food source was made available to the settlers. Women would consume *Moringa* after child birth as a traditional method to increase milk production.

According to Lekgau (2012: 3), the provinces in SA that are cultivating the *Moringa* tree are Limpopo, KwaZulu-Natal (KZN) and Mpumalanga. Interestingly enough, these are provinces that are being affected by malnutrition. *Moringa* is grown on a subsistence level in these provinces. The first documented introduction of *Moringa* as a feeding scheme for children in rural South African communities was in 2006 (Lekgau 2012: 3).

The nutritional value of *Moringa* is well documented and there seems to be little, if no doubt of the numerous health benefits that one can attain by consuming *Moringa* leaves (Fahey 2005:7 and Bey 2010: 5). According to Fahey (2005: 9) and Ferreira (2008: 431), *Moringa* tree has been recorded to contain significant amounts of vitamin A, vitamin C, digestible protein, calcium and iron, There have been attempts made towards marketing the high vitamin A content of *Moringa* leaves (Ferreira 2008: 434). According to Fahey (2005: 2), "100g of *Moringa* leaves contain four times more vitamin A than the same quantity of carrots; four times the calcium in a cup of milk; more iron than 100g of spinach; seven times the vitamin C in 100g of oranges and three times the potassium in 100g of bananas. The protein quality of *Moringa* leaves also rivals that of milk and eggs".

Chemical analysis conducted by Gopalan, Rama Sastri and Balasubramanian (1971) shows that a 100g of dried *Moringa* leaves contain 18.9mg of Vitamin A, 2003mg of calcium, 28.2mg iron and 27g of protein. *Moringa* is also a source of other vitamins and minerals, such as vitamin C and potassium. Hence, *Moringa* can be viewed as a viable option to nutritionally enhance food items.

1.3 Purpose of the study

The nutritional enhancement of a sensory acceptable snack food item with *Moringa* would be an ideal food vehicle by which children can receive the essential vitamins and minerals that are required for growth and development.

1.4 Aim of the study

The research aims to identify the snacking preferences of primary school children in order to develop a snack food item nutritionally enhanced with *Moringa* to meet the sensory requirements of children in grade 4-7 in schools from Verulam, North of Durban.

1.5 Objectives

- To conduct a focus group study with parents/caregivers in order to determine the snack preferences of primary school children.
- To conduct an observational study at the school tuck shops to view the most popular snack items purchased.
- To develop a questionnaire based on snacking preferences as determined by the results from the focus group and observational study, and administer this to the participants.
- To develop a snack food product nutritionally enhanced with *Moringa oleifera* as determined by the results of the questionnaire administered.
- To determine the amounts of vitamin A, calcium, iron and zinc of the product, by means of nutrient analysis using the Association of Official Analytical Chemists International (AOAC) referenced methods (AOAC 2005) and compared to the Dietary Referenced Intakes (DRI's) for children aged 9-13 years.
- To determine the sensory appropriateness and acceptability of the snack product by means of consumer acceptance sensory analysis.

1.6 Study parameters

1.6.1 *Moringa oleifera* was the only variety of *Moringa* used in this study.

1.6.2 The development of the *Moringa* chips and preparation of the samples was done only at the Durban University of Technology (DUT), Department of Consumer Science: Food and Nutrition laboratories.

1.6.3 The Snack Food Frequency Questionnaire (SFFQ) and sensory analysis of the snack item was completed by children in grades 4-7 at four selected primary schools in Verulam, South Africa.

1.6.4 The three *Moringa* chip samples were analysed for vitamin A, zinc, iron and calcium only based on the current national micronutrient deficiencies and the inherent high content of these micronutrients in *Moringa.*

1.7 Assumptions

1.7.1 All the children from the four low socio-economic schools consumed snacks from the school tuck shop.

1.7.2 The responses given during the focus group discussion and data obtained from the SFFQ and consumer acceptance sensory evaluation was assumed to be honest and unbiased.

1.7.3 All the participants involved in the research understood English which was the language used to communicate with the participants (based on a grade 4 level of competence).

1.8 Structure of the dissertation

This dissertation is reported in the format described below.

Chapter 1: Introduction of the problem and its setting

This chapter includes a summary of the importance of the study.

Chapter 2: Literature Review

Chapter Two offers a summary of the research studies and relevant information pertaining to the topic.

Chapter 3: Methodology

The methods and tools used in the study are presented in detail in this chapter, with a rationale.

Chapter 4: Results

A compilation of results obtained is presented.

Chapter 5: Discussion

Discussion of the results in relation to literature available, is offered in Chapter Five.

Chapter 6: Conclusions and Recommendations

Finally, suggestions for future strategies to address malnutrition are made.

1.9 Research plan

The outline of the study which is depicted in Figure 1.1 was developed by the researcher under the assistance of the research supervisor.

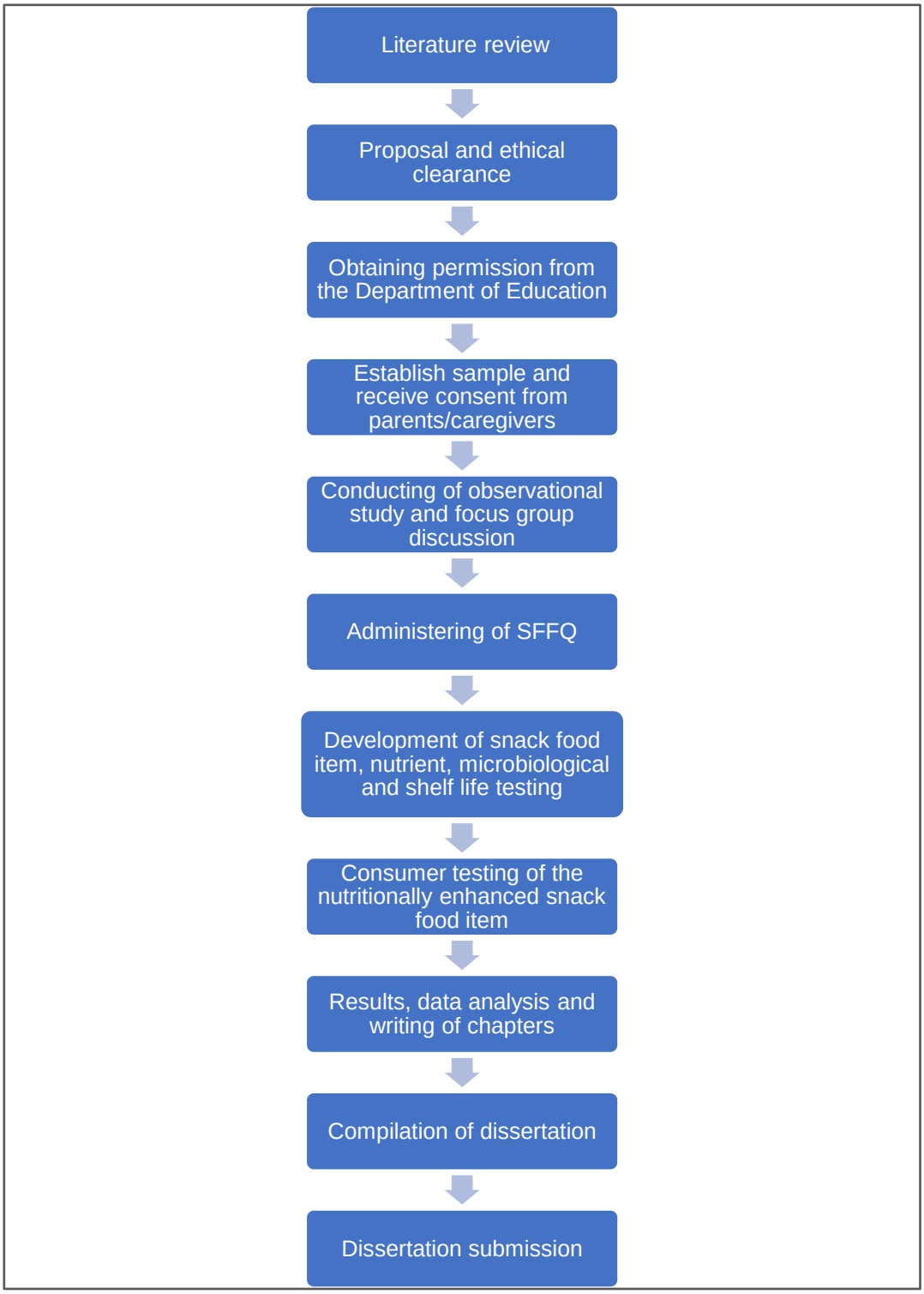


Figure 1.1: Framework of the study

1.10 Conclusion

Chapter 1 has outlined the importance of the study and the need for research to be conducted on this specific topic. A framework of the stages in the study is also included as a guide to the reader on the progression of the research (Figure 1.1). The nature of this research will be further explained in the chapters to follow.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is a collation of research conducted by various authors who have conducted studies and have analysed and interpreted the food security situation in South Africa (SA), as well as various factors that affect the dietary choices of children. The wealth of knowledge to follow is an attempt at gauging a better understanding of this scientific research, whether in the form of books or journals from different media. One can only understand the real state of undernutrition and overnutrition in this country by investigating studies done by other researchers, who also seek answers.

2.2 Food and nutrition security

According to the SA Department of Justice and Constitutional Development (DJCD, 1996: 15), food security is included in the SA Constitutional rights (Section 27): "Every citizen has the right to access to sufficient food and water". This right focuses on access to food; however, the nutritional quality of food consumed is equally important. The purpose of the Department of Health (DoH) in introducing the proposed Food and Nutrition Security Policy Implementation Plan in SA was to outline a plan of action to ensure the availability, accessibility and affordability of safe and nutritional food at both national and household levels (Department of Health 2014: 10-18).

Food security is defined as a condition "exists when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO 2010). However, undernutrition is seen to be on the rise in children in SA because many households are victims of food and nutrition insecurity. Nutrition security "encompasses the need for all people at all times to have adequate utilization and absorption of nutrients in food to be able to live a healthy life, as defined by nutrition security" (FAO 2010). These two definitions have merged to form the term "food and nutrition security" (Shetty 2015: 456).

A research report by Schonfeldt and Hall (2013: 514) on capacity building in food composition for Africa, concludes that effectiveness of strategies and programmes directed towards addressing malnutrition need to be based on food composition data. Africa is the continent with the second largest population in the world; sadly, it remains the poorest, most undernourished and under developed continent in the world (World Population Data Sheet 2013).

The SANHANES-1 Report in SA revealed that household food security was significantly lower in urban informal and rural formal areas, with only 32.4% and 37% of the respective localities being regarded as food secure. A substantial proportion of KZN was reported as being either 'at risk of hunger' (34.4%) or food insecure (28.3%). Only 37.3% of the population was regarded as being food secure (Reddy, Shisana, Labadarios, Rehle, Simbayi, Zuma, Dhansay, Parker, Naidoo, Mchiza, Steyn, Makoae, Ramlagan, Zungu, Evans, Faber, SANHANES-1 Team, Hoosain, Hongoro, Dwane, Maluleke, Jacobs 2014: 144).

A diet that consists of a variety of foods is said to be key in meeting nutritional requirements whereas diets based on starches are linked to food insecurity. Different foods contain different nutrients; hence a variety of foods must be consumed in order to meet nutrient requirements (Reddy *et al.* 2014: 167). A simple linear food security model can be effectively utilized in an attempt to improve food security and overall nutrition. This model places emphasis on ensuring that crops are grown throughout the year in order to ensure consistent harvest and consumption of food (Modi 2015: 947). A systematic review of urban agriculture and food security impacts in low income countries revealed that in most research studies, the majority of the food grown is consumed by the farming households as opposed to being sold (Poulsen, McNab, Clayton and Neff 2015: 132).

Fan and Brzeska (2014: 1193) wrote an article providing an outlay of opportunities and challenges regarding food and nutrition security in China. Recommendations on how the status of national and global food and nutrition security could be improved were also included. According to Fan and Brzeska (2014: 1194); Gómez, Barrett, Raney, Pinstrup-Andersen, Meerman, Croppenstedt, Carisma, and Thompson (2013: 3), many countries are now experiencing the triple burden of malnutrition, which is hunger (insufficient consumption of foods required to supply dietary energy), hidden hunger (micronutrient deficiencies) as well as overweight and obesity (a surplus intake of dietary energy and/or

nutrients). Growth in population size and a shift towards more urbanized demographics are some of the trends that affect the food and nutrition security balance in the world.

Strategies stemming from the 1996 World Food Summit (WFS) used to address Food and Nutrition Insecurity (FNI) vary according to different regions. The focus in the United States (US) is directed more towards obesity and the influx of processed foods, whereas the focus in Africa is on incorporating diverse agricultural practices and overall availability of food (Aliaga and Chaves-Dos-Santos 2014: 75). Hence, an increase in nutrition sensitive crops that are able to withstand harsh conditions as well as be a rich source of nutrition is key in combining nutrition and agriculture to tackle malnutrition (Fan and Brzeska 2014: 1202).

2.2.1 Childhood malnutrition in SA

According to Vorster (2010: 2) and Traill (2006: 305), SA is seen as being food secure on a national level. Malnutrition influences both the needs of the body as well as the child's ability to concentrate. Malnourished children tend to have a shorter attention span and seem to be restless; however, these are merely observable signs of possible malnutrition cases (Peterson 2009: 458).

The results of a study conducted by Puckree, Naidoo, Pillay and Naidoo (2011: 4) in the eThekwini district amongst 120 randomly selected children, showed that a substantial percentage (66%) of primary school children (10-12 years old) were found to be underweight. This confirms the need for food based interventions as a means to address nutritional inadequacies experienced by the children.

An attempt to reduce or eliminate nutritional deficiencies amongst children would be a crucial step towards reducing the number of deaths that occur during the most critical years of life, namely, childhood (Caballero 2002: 3). Infectious disease as a result of malnutrition is seen as one of the most crucial immediate causes of both death and disability of children (Rice, Sacco, Hyder and Black 2000: 1208). The importance of introducing adequate healthy eating interventions during the early stages of life was reinforced by a study conducted by Onge, Keller and Heymsfield (2003: 1072), in which it was noticeable that poor dietary practices adversely affected the health of children.

There is a distinctive link between the nutrient intake of children and the academic results obtained. This shows that in an attempt to improve the academic performance of children, a balanced diet must be followed (Rausch 2013: 67). A study done by Rossouw (2005: 5), showed that in primary and secondary school children in the North Western Province, the Recommended Dietary Allowance (RDA) and Adequate Intake (AI) requirements were not met for vitamin A, C, E, folate, panthothenic acid, biotin, calcium, magnesium, iron, zinc and copper. These are essential vitamins and minerals that are required for the functioning and development of the body.

According to Peterson (2009: 455-456), "Undernutrition is a form of malnutrition that includes both stunting (low height for age) and wasting (low weight for height) as well as micronutrient deficiencies". In under-developed areas, insufficient availability and consumption of nutrient rich foods due to the lack of availability leads to both stunting and underweight, two factors that bring about malnutrition (Vorster 2010: 2; Kimani-Murage, Kahn, Pettifor, Tollman, Dunger,Gómez-Olivé, and Norris 2010: 158). Malnutrition influences both the needs of the body as well as the child's ability to concentrate, which affects the learning process (Peterson 2009: 458).

Growing concern over the prevalence of obesity in developed countries has resulted in more focus on energy balance, energy intakes and energy expenditure. These are all important factors that play a crucial role in determining whether an individual is overweight or normal weight. Increase in physical activity has been reported to have a positive impact on energy expenditure; however, sedentary lifestyles and the 'couch potato' age of children did not assist in obtaining a negative energy balance, which is desirable. Interestingly, an increase in energy expenditure did not result in a subsequent increase in energy intake (Thivel, Aucouturier, Doucet, Saunders, Chaput 2013: 60).

The Healthy Active Kids Canada (HAKC) report card concept was replicated in SA as the Healthy Active Kids SA (HAKSA). A review article of some of the latest research on health habits by children aged 6-18 years revealed that at least half of South African children were not active enough, meaning that less than an hour a day was used on physical activity. Children spend more time watching television (three hours), contributing to a sedentary lifestyle (Draper, Basset, de Villers, Lambert and the HAKSA writing Group 2014: S99).

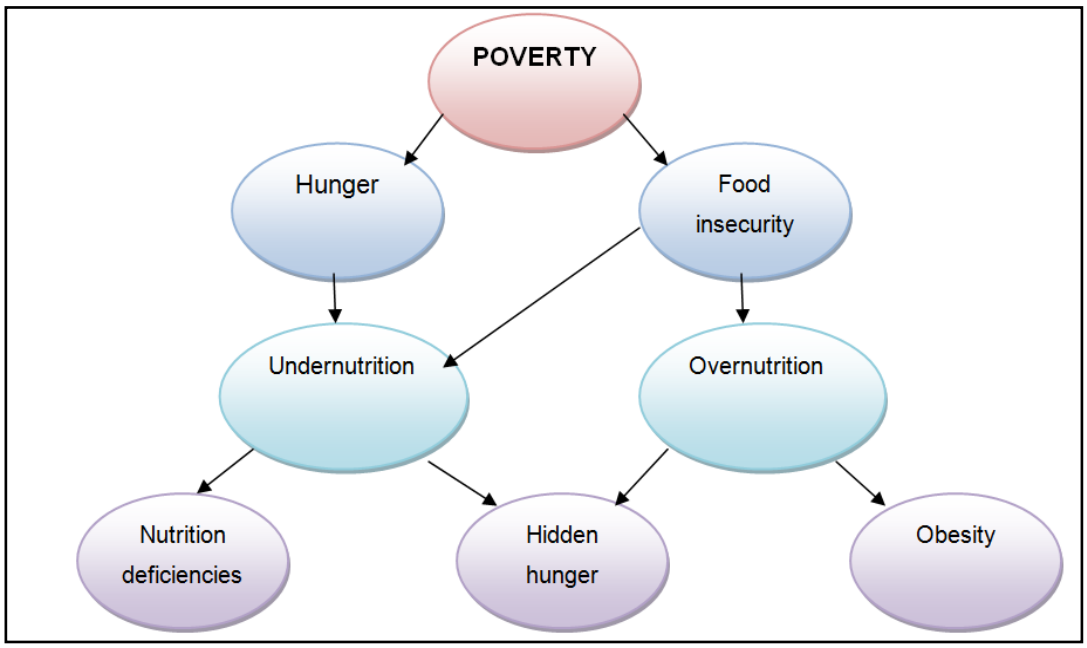


Figure 2.1: Two contradictory paths of poverty, undernutrition and overnutrition (Tanumihardjo, Anderson, Kaufer-Horwitz, Bode, Emenake, Haqq, Satia, Silver and Stadler 2007: 1967).

A review article reporting on research conducted by Hough and Sosa (2015: 335) reflected on articles published on food consumption in low income populations and reiterated that under- and over-nutrition can result from poverty (Figure2.1). Individuals in this situation consume the foods that are available to them. People experiencing food insecurity may be reliant on consuming energy dense foods that create satiety. Due to the state of poverty, nutrient rich foods may be limited or omitted from the diet completely (Hough and Sosa 2015: 335). The move towards urban areas is accompanied by reduced physical activity and increased consumption of processed foods which contribute towards creating an obesogenic environment (Vorster, Kruger and Margetts 2011: 432).

2.2.2 Obesity

Health organizations face the epidemic of obesity and its associated non-communicable diseases (NCDs). Instead of the undernutrition plague being eradicated, obesity, which is in stark contrast, has trickled across some of the poorest countries in the world (Boots, Tiggemann, Corsini and Mattiske 2015: 96).

This epidemic spreads through alluring inexpensive foods that are packed with large amounts of fats and carbohydrates, coupled with an inactive lifestyle, making these factors just some

that are fuelling overweight and obesity (Prentice 2006: 93-94). Koplan, Liverman and Kraak (2005: 131) found that childhood obesity has no boundaries and is likely to affect children regardless of race, gender and socio-economic background. However, according to Myers and Naledi (2007: 2), there was a significant difference between the average number of obese children living in the Western Cape City (7.5%) compared to those living in a farming area (2.5%).

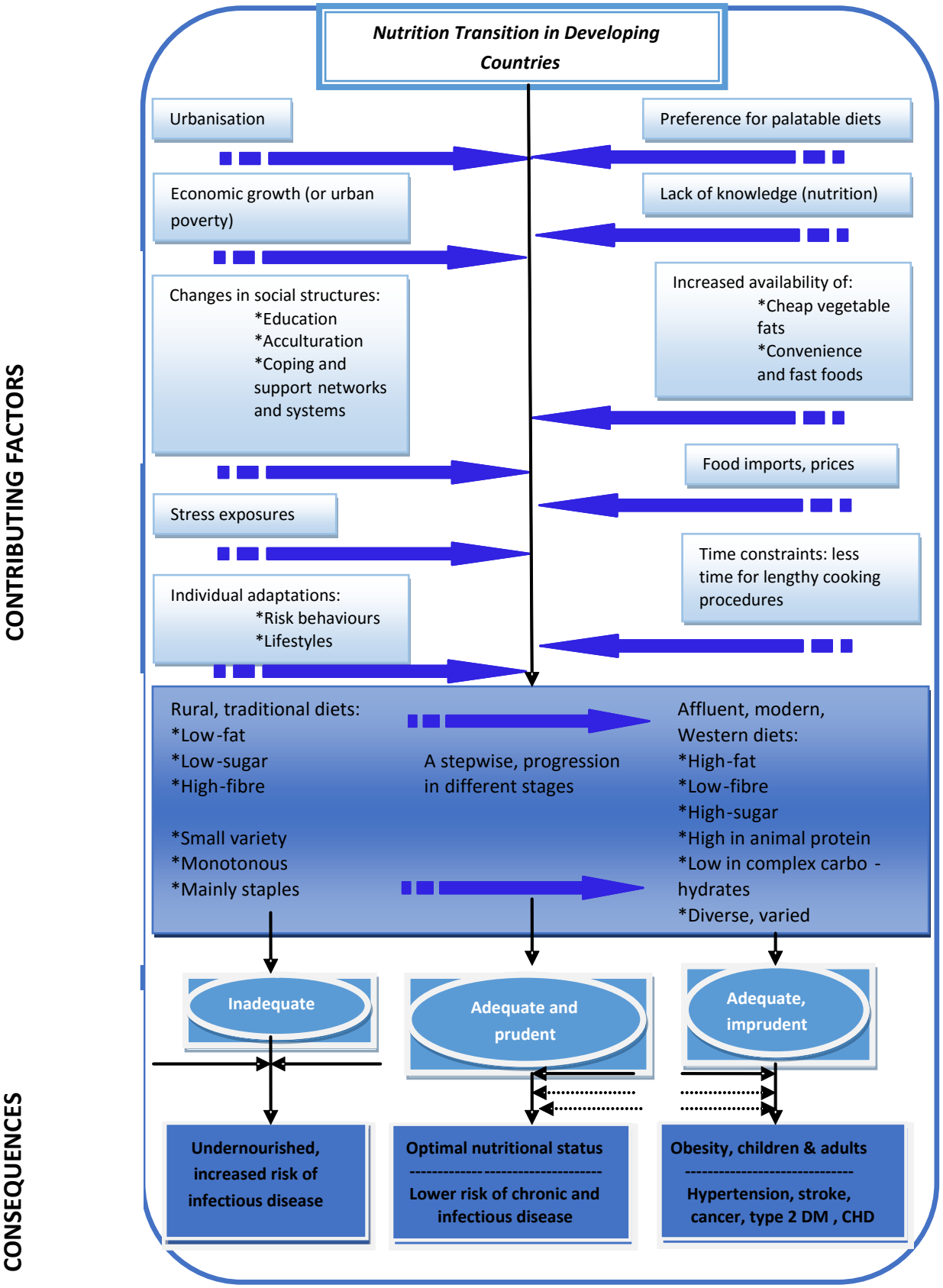
According to Black, Victora, Walker, Bhutta, Christian, Onis, Ezzati, Grantham-McGregor, Katz and Martorell (2013: 427), one of the main contributory factors of adult obesity is childhood overweight/obesity, as eating practices and food preferences are developed in childhood and continue into adulthood. Many factors contribute towards childhood obesity, where over-consumption of energy dense foods such as snacks plays a major role (Boots *et al.* 2015: 95). Research conducted by Totura, Figueroa, Wharton and Marsiglia (2015: 347) to assess the implementation of strategies used in schools aimed at preventing obesity concluded that the children's school environment and support structure influence the success of obesity prevention.

2.2.3 Nutrition transition in SA

A study conducted by Tathiah, Moodley, Mubaiwa, Dennyand Taylor (2013: 718) to determine the presence of malnutrition in rural KZN revealed that nutrition transition could be an attribute for the results found, namely, that 9% of the girls were overweight, 3.8% obese, 4% underweight and 9.2% stunted. This is a clear indication of how undernutrition and overnutrition can coexist. Undernutrition used to be more prominent in rural areas; however, the nutrition transition is responsible for the switch from consuming more processed foods and less traditional foods (Frayne, Crush and McLachlan 2011: 3).

Low household income is linked to a high incidence of underweight among children (Frayne, Crush and McLachlan 2011: 12). Micro-nutrient malnutrition is an important component of malnutrition. Individuals may have access to food, but if the food consumed has a poor nutrient composition, nutritional requirements of the body may not be met. Frayne, Crush and McLachlan (2011: 19) agree that overweight and obesity has emerged in rural areas, and can no longer be regarded as only an 'urban problem' in SA. Strategies to address the consequences of the nutrition transition (Figure 2.2) should encompass addressing both under

undernutrition and overnutrition with the focus on healthy and balanced dietary practices. In this regard, communities should be involved in the development of programs such as nutrition interventions. A committee comprising of stakeholders (private and public sector) and community representatives should work together to plan and develop effective strategies (Vorster, Kruger and Margetts 2011: 436).



Type 2 DM= Type 2 diabetes mellitus, CHD= coronary heart disease

Figure 2.2: Schematic diagram of the contributing factors to and consequences of the nutrition transition (Adapted from Vorster *et al*. 1999).

Previous explanations for the increase in sugar and fat consumption could be due to the decrease in the cost of sugar and fats. Globalisation has brought along with it changes in dietary patterns, mainly with a more Westernized diet being adopted commonly consisting of an increase in meat consumption and energy dense foods high in sugar, salt and fat (Drewnowski 2000: 487). Sensory aspects such as taste are important driving factors regarding food selection. Other contributors towards food selection include nutritional content, cost and convenience; however, taste supersedes these factors (Drewnowski 1997: S58).

Shung-King, Orgill and Stemming (2013: 59) reviewed the changes made regarding school health and future prospects that could be addressed. The review focused on the replacement of the National School Health Policy and Implementation guides of 2003 with the Integrated School Health Policy (ISHP) launched in October 2012. In KZN, 102 725 children in grade 4 are classified as being in the quintile 1 and quintile 2 category, with quintile 1 being the poorest and quintile 5 being the least poor. Schools are classified into quintiles in order to determine the no school fees allocation policy (Hall and Giese 2008: 35 and Joshua 2012).

The Healthy Communities Study (HCS) comprised a large number of different communities with different programs targeted towards improving the diet and physical activity and obesity linked outcomes among children (John, Gregoriou, Pate, Fawcett, Crawford, Strauss, Frongillo, Ritchie, Loria, Kelley, Fishbein and Arteaga 2015: 632). This study proposed strategies that could be implemented in order to address the obesogenic problem (John *et al.* 2015: 635).

2.2.4 Nutritional status of children in SA

The SANHANES-1 survey (Reddy *et al.* 2014: 146) as well as the United Nations Children's Fund (UNICEF 2009) identified iron, vitamin A and zinc as three of the micronutrients that are of great importance for both women and children living in developing countries. Tables 2.1 and 2.2 outline the various nutrients required by children aged 9-13 years, that are important as well as an example of some food sources that supply these nutrients.

2.2.4.1 Macronutrient and micronutrient requirements of children

Table 2.1: Dietary Reference Intakes: Macronutrient requirements for children aged 9-13 years old (Food and Nutrition Board 2000)

Nutrients	Examples of food sources	Functions	Male RDA/AI* (g/day)	Female RDA/AI* (g/day)
Carbohydrates Total digestible	Starches, for example, pasta, potatoes. Sugars, for example, those found in fruits, soft drinks and sweets.	Provides the body with energy and aids in maintaining adequate body weight.	130	130
Total fibre	Grains such as brown rice, bran and oats.	Aids in maintaining a healthy digestive system.	31*	26*
n-6 polyunsaturated fatty acids	Nuts, seeds, vegetable oils.	Required for membrane cells and for healthy skin cells.	12*	10
n-3 polyunsaturated fatty acids	Oils from vegetables such as canola and soy bean.	Is required for brain functioning and growth.	0.2	1.0
Protein and amino acids	Sources of protein are both from animal and plant products, for example, meat, fish, poultry, legumes and nuts.	Aids in the function, development and maintenance of cells and enzymes.	34	34

RDA- Recommended Dietary Allowances *AI- Adequate Intake

Table 2.2: Dietary Reference Intakes: Micronutrients for children aged 9-13 years old (Food and Nutrition Board 2000)

Nutrient	Examples of food sources	Functions	Male RDA/AI*	Female RDA/AI*
Vitamin A (µg/day)	Good sources of vitamin A are carrots, spinach and fortified foods such as cereals.	Aids in cell growth and cell differentiation. The main function is in reproduction, bone and teeth development. Vitamin A is also essential for the production of rhodopsin in the retina.	600	600
Calcium (mg/day)	Dairy products, broccoli, cabbage. Kale and tofu are all good sources of calcium.	Calcium is required for the formation of healthy bones and teeth, to allow for the normal clotting of blood and operation of the nervous system.	1300*	1300*
Iron (mg/day)	Meat, eggs, dark green leafy vegetables and legumes are all sources of iron.	Iron is needed for the formation for haemoglobin which carries oxygen from the lungs to the body cells.	8.0	8.0
Zinc (mg/day)	Zinc is present in shellfish, liver and eggs.	Required for the production of cells, tissue growth and repair.	8.0	8.0

RDA- Recommended Dietary Allowances *AI- Adequate Intake

2.2.4.2 Importance of vitamin A, iron and zinc

The SANHANES Report (Shisana *et al.* 2013: 40) revealed that undernutrition (stunting) and micronutrient deficiencies, also known as hidden-hunger, are still prevalent in SA. The introduction of the national food fortification programme in 2003 enforced the mandatory fortification of staples in wheat flour and maize meal products. The fortification programme included six vitamins and two minerals being added to these staples, namely, vitamin A, thiamin, riboflavin, niacin, pyridoxine, folic acid, iron and zinc.

According to the WHO (WHO 2016), vitamin A deficiency (VAD) is regarded as the main contributory factor towards preventable blindness in children. This deficiency also increases a child's risk of disease and mortality from severe infections. Hence, VAD is noted as being a public health problem observed in many low-income countries, with children and pregnant women being most affected. Vitamin A is required for the optimum functioning of various parts of the body as mentioned in Table 2.2.

A review article by Stevens, Bennett, Hennocq, Lu, De-Regil, Rogers, Danaei, Li, White, Flaxman, Oehrle, Finucane, Guerrero, Bhutta, Then-Paulino, Fawzi, Black and Ezzati (2015: e528) on vitamin A deficiency among children in low-income and middle-income countries (n=138) between 1991 and 2013, indicates that VAD deficiency still remains prevalent in both sub-Saharan Africa and South Asia. Overall, deaths due to VAD have decreased from 1991 to 2013; however, the effect of VAD in sub-Saharan Africa and South Asia still remains apparent. Recommendations have been made towards revising the priority list for countries most in need of vitamin A supplementation (Stevens *et al.* 2015: e529).

A study by Faber, van Jaarsveld, Kunneke, Kruger, Schoeman and van Stuivenberg (2015: 64-71) among South African children in rural (n=346) and urban areas (n=401), reported that the impact of the national food fortification program (bread and maize meal) was greater on the vitamin A status of children living in rural areas in comparison to those from urban areas. The study recommended that area-specific interventions should be implemented and these interventions should address the most vulnerable.

A study conducted by Motadi, Mbhenyane, Mbhatsani, Mabapa and Mamabolo (2015: 453) in Limpopo among preschool children (n=349) concluded that a high proportion of children

were deficient in zinc (42.6%) and iron (28%) to the point of being anaemic; the authors suggested that a possible explanation for the deficiencies could be the insufficient consumption of food rich in iron and zinc. The importance of iron and zinc is mentioned in Table 2.4 along with food sources that contain substantial amounts of these minerals.

2.2.5 Food consumption trends of children in SA

Various methods are available to identify food consumption patterns and changes that may occur over time. However, each method has a specific objective and reports on different degrees of dietary information. Food balance sheets contain a detailed report of a country's food supply during a specific period. This method of measuring dietary information does not contain information on actual quantities of food consumed by individuals. Household budget surveys would be used to identify food consumption at a household level and individual food intake by means of self-reporting (Ronquest-Ross, Vink and Siggie 2015: 4).

The Food and Agriculture Organization Statistics (FAOSTAT) conducted a Food Balance Sheet (FBS) data captured in a review of food consumption changes in SA since 1994. It reported that maize (104kg capita/year) and wheat (60.9kg capita/year) were two of the main contributors to total food and cereal consumption in SA (FAOSTAT FBS 2005; Ronquest-Ross, Vink and Siggie 2015: 4). The review indicated an increase of 33.1% (the period from 1999 to 2012) in consumption of sugar and sweeteners through processed foods that contain these ingredients during the period 1999 to 2012 (Ronquest-Ross, Vink and Siggie 2015: 5).

Processed foods and refined cereals with added sugar and fat are cheap sources of energy-dense foods in rural supermarkets. These food items such as biscuits and oil-heavy snacks are more reasonably priced when compared to healthier options such as fish, vegetables and fruit (Igumbor, Sanders, Puoane, Tsolekile, Schwarz, Purdy, Swart, Durao 2012: 3). An estimated 36504 deaths (7% of all deaths) in SA were due to excess body weight in the year 2000. Concern has now shifted towards the increase in per capita food supply of total energy, fat, protein and salt. Dietary patterns and changes in food preferences are a contributory factor to the increase in these items (Igumbor *et al.* 2012: 2).

Responses to health concerns resulted in the development of the concept and practice of corporate social responsibility (CSR), which is focused on health and often includes nutrition

education components. All major food manufacturers and retailers in SA have active CSR programs (Igumbor *et al.* 2012: 4).

Research indicates that one of the factors contributing towards overweight and obesity is the shift away from traditional foods and towards ready-to-eat or convenience products (Sparrenberger, Friedrich, Schiffner, Schuch and Wagner 2015: 535). Indications in the study showed that an increase in consumption of ultra-processed food affects both high and low income populations (Sparrenberger *et al*. 2015: 536).

Developing countries such as SA, are in the midst of the nutrition transition; diets are becoming more westernised and there is an increase in the consumption of processed foods and a decrease in physical activity. These factors contribute to the obesity epidemic and link directly with NCDs such as diabetes and hypertension (Vorster, Kruger and Margetts 2011: 430).

2.2.6 Factors affecting children's food choice

Factors that affect food consumption include food accessibility, availability and choice. South Africa experienced a shift in food consumption patterns, with a general increase in consumption of energy rich foods, sugar-sweetened beverages, snacks (sweet and savoury) (Ronquest-Ross, Vink and Siggie 2015: 9).

Picky eating and food neophobia (reluctance to eat/avoidance of new foods) may have serious implications on dietary diversity, which in turn may affect the overall nutrient intake of a child (Taylor, Wernimont, Northstone and Emmett 2015: 350). Picky eating may stem from various factors including, but not limited to, parental control and social influences. Picky eating may lead to a higher consumption of energy-dense foods (savoury snacks and sweets) (Tharner, Jansen, Kiefte-de Jong, Moll, van der Ende, Jaddoe, Hofman, Tiemeier, and Franco 2014: 4-9), whilst most research indicates that picky eating may in turn result in lower food consumption (Volger, Sheng, Tong, Zhao, Leung and Zhang 2013: 13; Cardona Cano, Tiemeier, Van Hoeken, Tharner, Jaddoe, Hofman, Verhulst and Hoek 2015: 580). Research conducted by Jones, Kervin, Reis and Gregory (2012: 290), noted that reported motivations for snack food purchases by children aged 6-12 years were contradictory to actual purchases made. Various factors affect the actual food choices that children make, thus understanding what drives purchasing of snacks is not a straight forward process. The

children in the study showed a positive attitude towards consuming healthy snacks (61.5% mentioned that healthy snacks were very important to them). However, actual snacking reflected otherwise, with a substantial percentage of the children choosing sweet and savoury snacks (22.2%) and takeaway foods (27.4%) as a favourite.

Income is an important factor when selecting food items. Energy dense foods are generally less expensive than nutritious or wholesome foods. This limits the choices regarding food selection and parents may be coerced into purchasing food items with poor nutrient density but which maintain satiety. Rural communities are unable to afford healthy foods thus limiting their food choices (Temple and Steyn 2011: 506).

2.2.6.1 Parental influence

According to Brown and Ogden (2004: 262), an effective method of improving dietary habits of children is to focus more on parenting (i.e. parents may use snacks to control behaviour), as opposed to attempting to control the dietary habits of the child. Results from the study conducted by Brown and Ogden (2004: 268) identified that the snacking habits of parents and their children were similar. Snack items such as crisps (chips), chocolates and biscuits were identified as popular snack items. Parents who reported eating healthier snacks were mirrored by their child's food choices. Research indicates that adolescents may know about healthy foods, as taught to them by their parents. However, this may not necessarily result in the consumption of healthy foods (Nørgaard, Sørensen and Grunert 2014: 227).

Time constraints faced by parents who have busy schedules has led to children eating more convenience foods. Along with eating habits, children tend to mimic the food choices made by parents and adopt these practices. These practices are not always ideal and can have a strong influence on decisions made by children in the future (FAO 2005 and Boots *et al.* 2015: 9).

Russell, Worsley and Campbell (2015: 124) conducted a study on strategies used by parents to influence their children's food intake. The research findings revealed that parents adopted various strategies (some effective and some ineffective); however, parents whose children displayed high food neophobic tendencies (where a dislike of new foods was apparent), used fewer effective strategies to increase diversity in the child's diet.

Parents play a key role in determining their child's attitude towards food. Behaviours used by parents can either be constructive, for example, encouraging the child to eat by explaining the benefits of the food item or allowing the child to help in the meal preparation. Destructive behaviour, whereby parents follow unhealthy diets and the child mirrors those eating patterns by limiting food choice/variety, can result in the child having a high affinity towards being neophobic (Russell, Worsley and Campbell 2015: 129).

Research by Eisenberg, Ayala, Crespo, Lopez, Zive, Corder, Wood and Elder (2012: 303) on the relationship between parenting behaviours and dietary fat consumption of young children revealed that controlling parenting behaviours was linked to a more frequent fat consumption (p<.01). However, parenting that models healthy eating practices were related to a less frequent consumption of fat (p<.01). Accessibility and availability of foods also influenced the foods children consumed; hence, children who lived in households where parents did not bring home fried snacks were reported to have a lower frequency of fat consumption as opposed to those children who had access to these foods.

Four types of parenting are linked to child obesity risk behaviours. These include beliefs and knowledge, modelling, accessibility and shaping. A study by Lopez, Ayala, Corder, Eisenberg, Zive, Wood and Elder (2012: 542) researched the link between these four categories and consumption of sugar sweetened beverages (non-diet soda, non-carbonated sugary drinks and sport drinks). Having more household food and greater parental support led to a lower consumption of sugary drinks. Eating away from home, eating fast food and eating while watching television were all linked to a greater consumption of sugary drinks (Lopez *et al.* 2012: 543).

Research by Yabancı, Kısaç and Karakuş (2014: 4478) revealed that mothers who displayed a higher level of nutritional knowledge, as identified by a nutrition knowledge questionnaire, correlated with their children being of normal weight (n=302). This suggests that the level of nutritional knowledge a mother possesses has a direct impact on the child's eating patterns and overall nutritional status.

2.2.6.2 Peer influence

Findings of research conducted by Wouters, Larsen, Kremers, Dagnelie and Geenen (2010: 16), among children aged 12-17 years old, noted that peers influenced snack and soft drink

consumption and this was also linked to the availability of these items at schools (vending machines/tuck shops). Nørgaard, Sørensen, and Brunsø (2014: 18) conducted research on 10-16 year olds in Denmark and their preference and intent to purchase novel healthy snacks. The results indicated that contrary to results of other studies, this study revealed that 'coolness' and peer influence had no significant impact on purchases made but rather a positive effect on snack preferences.

Research conducted by Salvy, de la Haye, Bowker and Hermans (2012: 370) with children aged 10-14 years old, supports the view that peers and friends are able to impact on one another's eating patterns and physical activity. This may result in an increase in overall energy intake, with the exception of instances where good impressions are a concern and the peers or friends display signs of healthy eating. Results of a study by Salvy, Romero, Paluch and Epstein (2007: 178) showed overweight girls eating in the presence of normal weight girls and how consumption differed according to the weight/visual appearance of the peer. The presence of others can result in an increase or decrease in food consumption. Research conducted by Salvy, Kluczynski, Nitecki and O'Connor (2012: 234) identified tax subsidies as having an influential effect on snack food purchasing. Subsidizing of healthy snacks could be a means of increasing the frequency with which healthy snacks are purchased.

2.2.6.3 Foods available at tuck shops

A study in Scotland was directed towards identifying if foods available in food outlets surrounding secondary schools had an impact on the purchasing decisions of pupils. The researchers conducted the study in secondary schools as these pupils are usually granted the opportunity to purchase food items outside of the school (Ellaway, Macdonald, Lamb, Thornton, Day and Pearce 2012: 1336). The study found that there were many food outlets surrounding the secondary schools in New Glasgow, making fast foods easily accessible to the pupils, thereby creating an obesogenic environment. No link was identified between the socio-economic status of the schools and the number of food outlets available. However, the clustering of the schools was more related to the category of the food outlet with takeaways being the highest number of food outlets within a 400m radius (n=873) and 800m (n=416) of the school (Ellaway *et al.* 2012: 1336).

In addition, a study conducted in 23 Vancouver schools in Canada, food-related promotions were found to be quite common, with branded products being advertised. A substantial percentage of food items (25%) marketed were nutrient deficient. Food choices of children in elementary and secondary schools also differ. Given the many hours spent in the school environment, food suppliers may regard schools as an opportunity to make mass sales; thus advertising in these schools was popular (Velazquez, Black and Ahmadi 2015: 757).

Similarly, a study that aimed to determine the impact that food retailers surrounding schools had on the nutritional status of children in three countries concluded that strategies aimed at changing the food environment surrounding Canadian schools could be effective in improving the nutritional status of children attending those schools (Héroux, Iannotti, Currie, Pickett and Janssen 2012: 1240).

In contrast, a South African study conducted showed similar trends to the international scenario. Wiles, Green and Veldman conducted a study in Pietermaritzburg, KwaZulu-Natal to determine the foods available and sold to children at 11 primary school tuck shops. The study revealed that there were few healthy options for children, with the energy content being almost half of the unhealthy counterpart. A lack of variety of healthy snacks also posed a barrier to increasing the consumption of healthy snacks (2011: 129).

A study by Faber, Laurie, Maduna, Magudulela and Muehlhoff (2014: 1214) aimed at determining the school food environment of poorly resourced primary schools in SA (n=90 schools). From the sample population, 57% of the children in grades 5-7 were given money to take to school. Tuck shops in these schools were reported to be vending mainly unhealthy food items. An important contributory factor to the purchases made at the tuck shops was money. Unhealthy food items were generally less expensive than the healthier counterparts.

A study conducted in Turkey by Ziyagil, Imamoğlu, Sarioğlu, Çekin, Ziyagil, Kabadayi, Eliöz and Çebi (2011: 591), reported no significant link between the canteen usage and change in body weight and Body Mass Index (BMI) among children aged 11-17 years old. The authors concluded that this may be as a result of the children belonging to low income families; therefore, money spent at the canteen would be very limited if available at all. Out of 2000 learners, a significant number (n=253) did not purchase items from the canteen during the week.

Contrary to the Turkey study, a study by Puckree, Naidoo, Pillay and Naidoo (2011: 4) identified that the majority (83.2%) of the children purchased 'junk food' items from the school tuck shop, namely, chips, sweets and chocolates. This information shows that the school tuck shop is an important factor in changing the snacking habits of children in schools. Children spend a substantial amount of time at school; therefore the snacks available at school would directly affect the food choices made.

An evaluation of the meals used for the South African National School Nutrition Programme (NSNP) in the Free State Province identified that carbohydrate and energy requirements for children aged 7-10 and 11-18 years were not met. Only 10% of the meals provided were able to meet the nutrient requirements for calcium and zinc. Reformulation of the meals would assist in improving the nutritional content of the meals (Nhlapo, Lues, Kativu and Groenewald 2014: 1 and Department of Education 2014). Tuck shops in South African schools are funded by the school governing bodies (SGBs). It is recommended that the SGB creates guidelines linked with the World Health Organization (WHO) in order to promote both the sales and purchase of healthy foods.

2.2.7 Snacking

Snack food consumption has increased along with the prevalence of obesity. It can, therefore, be assumed that a relationship exists between these factors. Snacks are not renowned for the high nutrient content; actually, the opposite is more likely. Snacks are synonymous with high fat and carbohydrate content and are generally not nutrient rich (Boyer, Laurentz, McCabe and Kranz 2012: 2). A study conducted with children in Ghana identified a relationship between the intake of high fat and sugar snacks in correlation with high BMI values (Asiedu, Jantuah and Anderson 2012: 46).

The prevalence of snacking has become more frequent in the United States (US) with preschool-aged children. Snacking has been identified to provide a substantial amount of the overall daily energy intake, which is of concern. Most, if not all, unhealthy snacks contain large proportions of sugar, fat and sodium and are generally energy dense. Frequency of snacking coupled with large portion sizes of unhealthy snacks has contributed to obesity amongst children and adolescents (Fisher, Wright, Herman, Malhotra, Serrano, Foster and Whitaker 2015: 62).

A study conducted on the snacking habits of 11392 adolescents (10-17 years old) from nine European countries concluded that habit strength played an important role in unhealthy snacking. Challenges exist in attempting to break unwanted habits; therefore, emphasis needs to be placed on the self-regulation of snacking (De Vet, Stok, De Wit and De Ridder 2015: 182).

The South African Youth Risk Behaviour Survey 2002 (Reddy, Panday, Swart, Jinabhai, Amosun, James, Monyeki, Stevens, Morejele and Kambaran 2003: 49-61) found that South African children in grades 8-11 revealed that there was frequent consumption of foods high in fat and sugar. Encouraging healthy eating practices among children could aid in maintaining healthy eating habits throughout adolescence and adulthood.

Compared to public schools, private schools have stricter rules in place regarding the sale of food. Some tuck shops are privately owned for the sole purpose of generating an income. Hence the hesitation to stock fresh fruit and vegetables due to possible spoilage. In rural schools, children also have access to street vendors located in close proximity to the schools. Controlling the foods sold by vendors is yet another challenge (Kruger and de Villers 2011: 122; Wiles, Green, and Veldman 2011: 129-131). SANHANES 2012, found that only 25.3% (n=423) of children aged 10-14 reported having taken a lunch box to school in the KZN province. Children from the KZN province were more likely to take spending money to school (71.6%), compared to the other provinces. The study revealed that 50.3% of the children received money to take to school ‘everyday’ (n=332). The mean amount of money taken to school daily by South African children (total population n=1514) was R5.75 (Shisana *et al.* 2013: 237).

2.2.7.1 Socio-economic status (SES) and food intake

A study focusing on the factors affecting underweight and obesity among elementary school children (10-14 years old) in South Korea identified that 59.3% of children who were classified as overweight/obese consumed snacks. Results of the study also concluded that children from rural areas were identified as being more likely to be overweight/obese in comparison to those in urban areas (Lee and Ham 2015: 299).

Borgogna, Lockhart, Grenard, Barrett, Shiffman and Reynolds (2015: 759) conducted research to identify if a link existed between technology use and cravings for snacks. Background research revealed that watching television was linked to consumption of unhealthy snacks. Childhood obesity is a growing concern in Australia (Nguo, Huggins, Barberm, Brown, Truby and Bonham 2014: 1). An Australian study conducted research to determine an objective measure of snacking. Eating occasion (EO) referred to all food and beverage items consumed at a unique time, whereas a snacking occasion (SO) was defined as EO occurring between meal times i.e. snacks consumed after lunch and before dinner. Snacking occasionally was reported not to have a direct impact on an increase in adiposity (Fayet-Moore, Ridges, Keighley and Petocz 2014: 2).

The food environment at home may affect the school environment, especially if children carry a packed lunch to school. However, socio-economic factors may prevent parents/caregivers from sending their children with lunch. Some schools benefit from the National School Feeding Programme (NSFP,) where food is made available at school. However, this is based on where the school is located (district) and the quintile bracket within which the school falls. This may be a false indicator on whether the school is in need of the programme (Shisana *et al.* 2013: 231).

Studies have revealed that healthier foods such as vegetable and fruit are generally more expensive when compared with processed foods. This coupled with the low socio-economic status of those living in rural areas, inhibits the consumption of healthier foods. Energy dense processed foods are cheaper and assist in attaining satiety (Schönfeldt, Gibson and Vermeulen 2010: 254; Brinkman, de Pee, Sanogo, Subran and Bloem 2010: 156; Temple and Steyn 2011: 506).

2.2.7.2 Nutrient poor foods in the market

The WHO has developed a global strategy on diet, physical activity and health, which is targeted towards curbing obesity and chronic disease. Recommendations made by the strategy are directed towards food and beverage manufacturers. Companies are urged to reduce the amount of fat, free sugar and sodium in current products as well as developing new products that contain higher levels of nutrients when compared to current products. The marketing of processed products also needs to be limited, especially to children (Monterio, Gomes and Cannon 2011: 975). The development of snacks that are cheap and nutritious is

recommended with the aim of addressing malnutrition in impoverished areas (Monterio, Gomes and Cannon 2011: 971).

Sparrenberger *et al.* (2015: 540) conducted a study in Brazil utilizing the 24-hour food recall questionnaire and a socio-demographic questionnaire. School aged children (7-10 years; n=83) reported a directly proportional relationship between consumption of ultra-processed foods and maternal age. The socio-demographic questionnaire identified that consumption of ultra-processed foods was linked to populations with both high and low economic status. School-based strategies aimed at curbing obesity include limiting the access of food items high in sugar and fat; therefore the overall consumption of these items will, in turn, be reduced (Totura, Figueroa, Wharton and Marsiglia 2015: 347). In addition, food advertising is regarded as an important influential factor towards obesity and poor nutritional status. Most marketing promotes energy-dense, nutrient poor food items that are pleasing to the senses yet lacking in the nutritional composition required to maintain adequate nutritional status (Folkvord, Anschütz, Boyland, Kelly and Buijzen 2016: 26).

Strategies that might assist in reducing obesity include a two-fold approach, viz., stronger restrictions on the types of food products that can be marketed to children as well as equipping children with the knowledge required to make sound choices regarding food purchases and consumption (Folkvord *et al.* 2016: 29). Marketing media such as magazines could be used as an effective tool to direct and influence dietary practices of children. A study conducted in New Zealand reviewed magazine advertising for a year. This revealed that branded unhealthy foods were marketed frequently (36%) in popular magazines aimed at children. Healthy food items were rarely marketed in the same magazines (3%; No, Kelly, Devi, Swinburn and Vandevijvere 2014: 80).

Marketing has broadened into different forms of media which are able to reach a large target audience (King and Hill 2008: 194 and Chambers, Freeman, Anderson and MacGillivray 2015: 32). A study by King and Hill (2008: 195) advises that more research should be conducted on more non-television related marketing, especially regarding food choices. Food and beverage products that are high in fat, sugar and salt (HFSS) are often marketed with a link in literature, indicating that HFSS foods coupled with insufficient physical activity contributes towards the obesity epidemic. Statutory regulations controlling the information

that children are exposed to can limit the consumption of HFSS foods due to limited exposure (Chambers *et al.* 2015: 33).

The objective of the Children's Food Bill by Debra Shipley in Britain is to improve children's current and future health and prevent food related ill-health. Children are subjected to the marketing of unhealthy foods on a continuous basis with constant access to junk foods and unhealthy foods being readily available, especially in schools. The Bill aims to control marketing directed at children in order to improve the quality of children's food. Nutrient and quality standards for school meals and foods sold at schools will also be carefully monitored to ensure all foods children access at school are both nutritious and safe for consumption (Powell and Longfield 2005: 3-7).

2.2.8 Food solutions aimed at improving nutritional status

Food-based approaches are directed towards improving both food and nutrition security and in some cases, generating an income. Various stakeholders such as the government and industry are indirectly tasked with the responsibility of developing and implementing such approaches in order to improve food and nutrition security (Faber and Wenhold 2007: 397).

In an attempt to determine factors that may affect consumption of raw snack vegetables, Olsen, Ritz, Kramer and Møller (2012: 558), reported in a study conducted among children aged 9-12 years, that vegetables cut into shapes (stars) were positively received by children ($p<0.0001$). Thus a simple measure such as cutting vegetables and fruit in different child-friendly shapes may be effective in increasing overall fruit and vegetable consumption.

Snacking is routine for most children and there is much demand for snacks that provide positive health benefits by including ingredients such as fruit and vegetables. A study conducted by Potter, Stojceska and Plunkett (2013: 537) developed an extruded snack that contained fruit powders. As with any new product development, organoleptic properties are extremely important, especially when children are the target market. The study revealed that the snack received a positive rating for appearance and taste, and recommendations were to increase the nutritional qualities by boosting the vitamin and mineral content.

2.2.8.1 Fortification, enrichment and supplementation

Enrichment refers to 'the restoration of nutrients found in the unprocessed product'; an example would be the enrichment of grains (Graham and Hertzler 1977: 167). According to the US Food and Drug Administration Code of Federal Regulations, fortification refers to the inclusion of nutrients in food and beverage products. A dietary supplement is a product specifically meant for ingestion that contains a "dietary ingredient" intended to add further nutritional value to (supplement) the diet (US Food and Drug Administration 2015).

Peterson (2009: 460), Vorster (2010: 2), Labadarios, Swart, Maunder, Kruger, Gericke, Kuzwayo, Ntsie, Steyn, Schloss, Dhansay, Jooste and Dannhauser (2005: 249) noted that fortification of staple foods with micronutrients is a strategy that can be used to combat micronutrient deficiencies. Educating households on food storage and how to increase the life span of foods could ensure that food is available throughout the year. Key to combating malnutrition includes educating individuals on safe methods of cooking foods, which are essential in destroying harmful bacteria that may cause illness (Phometsi, Kruger and van Riet 2006: 533). Food fortification programs have been initiated in various countries, with the main objective of fortifying staple foods with specific nutrients to improve the nutritional status of children (Peterson 2009: 460).

The benefits of fortification can only be reaped if appropriate foods are fortified with significant amounts of micronutrients. The foods chosen to be fortified need to be easily accessible to the intended target group; hence the DoH ratified compulsory fortification of maize meal and wheat flour staples that are commonly consumed by South Africans (Steyn, Nel and Labadarios 2008: 22-23). Food fortification is therefore, an option which can be utilized to address malnutrition.

However, as with any food based strategy, limitations exist. Food fortification alone cannot fully supplement a poor diet, especially for young children who are unable to consume large amounts of foods (usually staples that are fortified) in order to meet the micronutrient requirements (Faber and Wenhold 2007: 398). Ramakrishnan, Goldenberg and Allen (2011: 2066) argue that it would be more favourable and cost-effective to introduce more than several micronutrient supplements at one time, as opposed to implementing individual supplements.

Children taking iodine or zinc supplementation due to these minerals being deficient in the foods eaten were reported to have a significant improvement in their intelligence quotient (IQ; Ogunmoyela, Adekoyeni, Aminu and Umunna 2013: 52). Hamer and Keusch (2015: e502) suggest that supplementation programmes should be introduced in areas where the programmes are inefficient or are not available.

Results of a Taiwanese study among elementary school children found that poor school performance could be attributed to poor eating practices. The study, along with others, encourages healthy eating practices for overall wellbeing (Ogunmoyela *et al.* 2013: 54). Berner, Keast, Bailey and Dwyer (2014: 1009) reported that children consuming foods that were not fortified displayed inadequate intake of many nutrients; excessive intakes or nutrient toxicity were not observed.

The position of the American Dietetic Association (ADA) regarding vitamin and mineral supplementation is that nutrients should firstly be obtained from food sources. If food access and the quality of food is insufficient to meet the nutrient requirements, fortification and supplementation can be used so long as this is deemed safe (Hunt 1996: 73). Problems related to nutrient fortification of foods include the concern of excessive intake, especially if numerous different foods are fortified (Graham and Hertzler 1977: 167).

Fortification of staple foods provides much needed micronutrients for individuals that have little or no access to a variety of foods. Food access and availability and affordability create numerous barriers preventing people from consuming a diversified diet. Supplementation and food fortification are two strategies that are used in an attempt to assist people in meeting certain micronutrient requirements (Berner *et al.* 2014: 1010).

2.2.8.2 Nutrition education

A systematic review of studies assessing the effect educational interventions on preventing/ treating obesity among children aged 6-12 years revealed that treatment studies and educational interventions were effective measures in treatment of obesity but did not influence prevention (Sbruzzi, Eibel, Barbiero, Petkowicz, Ribeiro, Cesa, Martins Marobin, Schaan, Souza, Schaan, Pellanda 2013: 255).

Strategies directed towards dealing with the obesity epidemic include taxes and banning of sugar-sweetened beverages, increase in physical education requirements and improving the nutritional quality of school lunches (Mytton, Clarke and Rayner 2012: 344). The effectiveness of these strategies relies on various factors and cannot be incorporated in isolation. Nutrition education coupled with healthier school meals and snacks available at schools can be an effective method of instilling healthy eating practices from an early age (Sandy, Tchernis, Wilson, Liu and Zhou 2013: 21). Research conducted by Zizza (2014: 36) recommends creating specific health messages that address both snacking and meal behaviour.

2.2.8.3 School feeding program

A study aimed at comparing the nutrient levels of meals supplied at school implemented an intervention approach where the nutrient levels of the original breakfast and lunch meals were analysed and compared to the changed menu items. This study revealed that changes in school menus can be an effective strategy towards encouraging children and adolescents to consumer healthier meals. The mean values for sugar, salt and energy dropped significantly when compared to the original meals provided (Cummings, Welch, Mason, Burbage, Kwon and Kuo 2014: S22).

A study conducted on children aged 2-5 years focused on the impact of the size of main meals and the time at which dessert was served revealed that the timing of when the dessert was served played an important role in the overall energy intake of the child. The results indicated that by serving the dessert with the main meal (regardless of the portion size), the total energy intake reduced significantly. Children were reported to be ‘full’ upon seeing both the main meal and dessert. This in turn reduced the amount of food consumed (Huss, Laurentz, Fisher, McCabe and Kranz 2013: 159).

A study directed towards determining the effectiveness of using a picture book that incorporated vegetables (carrots) as a means of increasing the vegetable intake of children aged 4-6 identified that the carrot intake of the experimental group increased in comparison to that of the control. The tool used was a story book that included two characters, both consuming carrots. This study recommended that in order for the tool to be effective it must include an element of nutritional education (i.e. the characters consumed the carrot and

displayed signs of strength), as well as contain an entertainment component which were the animated pictures (Droog, Buijzen and Valkenburg 2014: 75). National school lunch and breakfast programs play an integral role in an attempt to meet the nutritional requirements of children from rural or low socioeconomic schools (SES) areas (Pomeranz and Miller 2015: 51).

According to Buhl (2012: 1), school feeding programs are introduced to improve the nutritional status of one of the most vulnerable groups, viz., children. The benefits of school feeding are numerous, ranging from increased concentration levels as well as improved behaviour during lesson time. Children who have access to food are more likely able to concentrate and learn more effectively.

2.2.8.4 Labelling and legislation

According to Pomeranz and Miller (2015: 53), food labels are generally directed more towards adult requirements and for this reason, parents may be unaware of correct portion size to age ratio. Portion size refers to how much one chooses to eat as opposed to serving size, which is classified as a measured amount of food or drink.

Wasowicz-Kirylo and Stysko-Kunkowska (2011: 722) suggest that by including nutritional information on the packaging of products, consumers would be equipped with the required knowledge to make healthy choices. Nutritional information labels should attract the consumer's attention and be structured in a simplified manner which is easy to understand (Laquatra, Sollid, Edge, Pelzel, Turner 2015: 1758). Wasowicz-Kirylo and Stysko-Kunkowska (2011: 726) conducted a study on the attributes of nutritional information labelling that determine the attractiveness of nutritional labelling. The study revealed that consumers (n=90 mothers) felt that visual aspects of the labels were important. When considering if a product is healthy or not, consumers preferred that certain nutrients such as fats and salt be displayed in grams for direct comparisons.

The regulations relating to trans fat in foodstuffs was implemented in 2011 in SA, which prohibits the manufacture, importation and sale of any foods containing more than 2g of trans fat per 100g of artificially created fats. Children are regarded as being vulnerable, hence the necessity of regulations on junk food and processed foods (Mills 2012).

Nutrition information found on packaging in the form of food labels (Figure 2.3) and ingredient lists are not fully utilized as a source of information. Consumers can compare one product to another in terms of being nutritionally superior which would affect dietary intake (Figure 2.3; Miller and Cassady 2015: 209). However, it has been reported that consumers with some health knowledge would be more receptive to this information (Miller and Cassady 2015: 207).

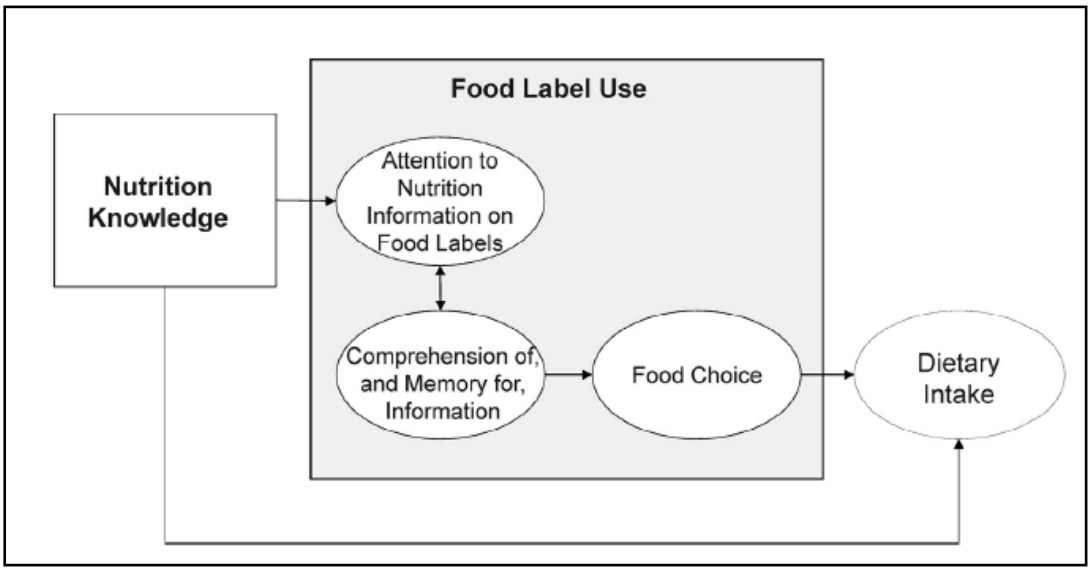


Figure 2.3: Cognitive processes underlying use of food labels (Miller and Cassady 2015: 208).

A study aimed at determining if front of pack (FOP) nutrition labelling was more effective in making consumers more aware of nutritional information concluded that FOP was successful in capturing the attention of participants. This was due to the positioning (front panel of the product) as well as the use of colour which is more attractive than the mandatory Nutrition Facts Panel (NFP), which is a US requirement, was also successful in capturing the attention of the participants (Becker, Bello, Sundar, Peltier and Bix 2015: 76).

Statements made on nutrition labelling must be clear and not ambiguous. The term 'added sugar' was misinterpreted in a study conducted by Laquatra *et al.* (2015: 1762). Fifty eight point four percent of the participants interpreted the term 'added sugars' as referring to an additional amount of sugar being added to the amount of 'sugar' reported on the label. Confusion regarding terminology can drastically affect how a product is perceived and whether it is purchased or not. In SA, regulations pertaining to the labelling and advertising

of foodstuffs (R146) has been in place since 2010. A revised version of the R146 which is R429 is still in the draft phase but is said to be more strict in terms of how fast food manufacturing consumer goods are marketed and advertised, especially information displayed on brand labels. One of the main purposes of the revision in the regulation is for the purpose of providing the consumer with more information (Food Stuff SA 2015).

2.10 *Moringa oleifera*

Moringa oleifera Lam. is referred to by many names around the world. The tree is also referred to as a 'miracle tree' because of the nutrient value it possesses. Every part of the tree can be eaten, but the leaves, drumstick pods and flowers are preferred for consumption. A common name in Southern parts of India for *Moringa oleifera* is 'Murungaikeerai' (*Moringa* leaves), also commonly known as 'drum stick tree' as the tree's pods resemble the shape of a drum stick. This plant has been highly regarded due to the high nutritional value that it boasts. A tree that is versatile in its uses from culinary, nutritional and medicinal use as well being a water clarifier (Mishra, Singh and Singh 2012: 28-30; Dubey, Dora, Kumar and Gulsan 2013: 415; Maheshwari, Yadav, Malhotra, Dhawan, Mohan and Rajnee 2014: 11 and Palada 1996: 795 and Razis, Ibrahim and Kntayya 2014: 8571, Asiedu-Gyekye, Frimpong-Manso, Awortwe, Antwi, Nyarko 2014: 3).

The nutritional benefits of *Moringa* have been recognized by three non-governmental organizations: Church World Service (CWS), Educational Concerns for Hunger and the Trees for Life Organization (ECHO). These organizations refer to *Moringa* as being 'natural nutrition' for the tropics because of the many uses that the tree boasts (Fahey 2005: 3).

2.10.1 Genus and species

According to Price (1985: 1), *Moringa oleifera* is one of the 14 species from the Moringaceae family (Table 2.3). All of these species are native to India, but have successfully naturalized in many places throughout the world. Given the spread of the 'miracle tree' as it is referred to by some, *Moringa* is called by various names according to the location. Ranging from 'malunggay' meaning 'mother's best friend' in the Philippines, as mothers feed the cooked leaves to babies, to 'horse radish tree' in Florida and 'drumstick tree' in India because the pod of the tree resembles a drumstick (Paliwal, Sharma and Pracheta 2011: 317).

Table 2.3: Scientific classification of *Moringa oleifera*

Kingdom	**Plantae**
Division	Magnoliophyta
Class	Magnoliosida
Order	Violes
Family	Moringaceae
Genus	Moringa
Species	Oleifera

The Table above indicates the classification of *Moringa* used in this research study (Adapted from Paliwal, Shrama and Pracheta 2011: 318).

2.10.2 Physical characteristics of the *Moringa* tree

The *Moringa* tree is a deciduous slender tree with branches of light to dark green droopy leaves (Figure 2.4). The flowers are creamy-white and are mildly fragrant. Pods from the tree are long and triangular, containing approximately 20 seeds per pod. Each seed is encased in three paper-like wings which serve as a propeller. Flowers, pods and seeds are produced throughout the year (Palada 1996: 794).

Young *Moringa* pods, referred to as 'drumstick pods,' are cooked and consumed by Indian communities. The pods which are said to be similar to green beans, are canned and exported from India, Sri Lanka and Kenya to Asia and Europe (Price 1985: 9). Green seeds from the pods can be removed from the pod casing and either boiled or fried in a similar manner as with peas. Dry seeds are not eaten by humans but rather utilized for different industrial and agricultural applications (Price 1985: 10). The tree begins to flower after being planted for approximately 8 to 12 months. Flowering continues throughout the year (Figure 2.4). The flowers have been used in Haiti to prepare tea used to treat colds (Price 1985: 10).

Moringa branches are soft and can easily be bent. In certain places the branches have been used to make fences or trees have been grown around the perimeter of a house/shack as a form of 'live fencing' (Price 1985: 11). Fresh young leaves are eaten in a similar manner to spinach (Joshi and Mehta 2010: 5).

The roots from young *Moringa* trees can be harvested and substituted for horse radish, hence one of the alternative names for *Moringa.* The bark covering the root must first be removed before being eaten. Consumption of the root should be limited as excess can be harmful (Price 1985: 12).

2.10.3 Growing conditions and reproduction

The growing conditions most suited to *Moringa*, is in hot, semi-arid tropics (Figure 2.5). The tree is drought tolerant; however, excessively windy conditions may result in the tree drying out. The recommended amount of rainfall is 10-60 inches per year and the most preferred altitudes range from 600m to 1200m (Price 1985: 13; Broin and Saint Sauveur 2010: 20). The tree is able to withstand light frost; should there be extreme frost, a mature tree may die but the tree is capable of re-growing. *Moringa* trees are able to survive in most soil types but the tree prefers loam or well drained sandy soil (Price 1985: 13).

Moringa trees grow rapidly and can reach up to 4m per year, with a maximum height of between 6-15m once fully grown. Periodical pruning encourages new growth with an abundance of leaves that are easily accessible for harvesting (Price 1985: 14 and Palada 1996: 796). Propagation of *Moringa* can easily be done from seed or via cuttings. Germination of the seeds usually occurs within 1-2 weeks. Shaded conditions yield the best germination rates. Cuttings can successfully be grown to produce healthy trees. The recommended length is 45-100cm of a healthy stem. The preferred method of propagation is by seeds or seedlings as cuttings tend to have a shorter root system which may affect the anchoring ability of the tree in windy conditions (Price 1985: 15; Broin and Saint Sauveur 2010: 21).

Figure 2.4: *Moringa* stem with leaves and flowers (Agyepong 2009: 11).

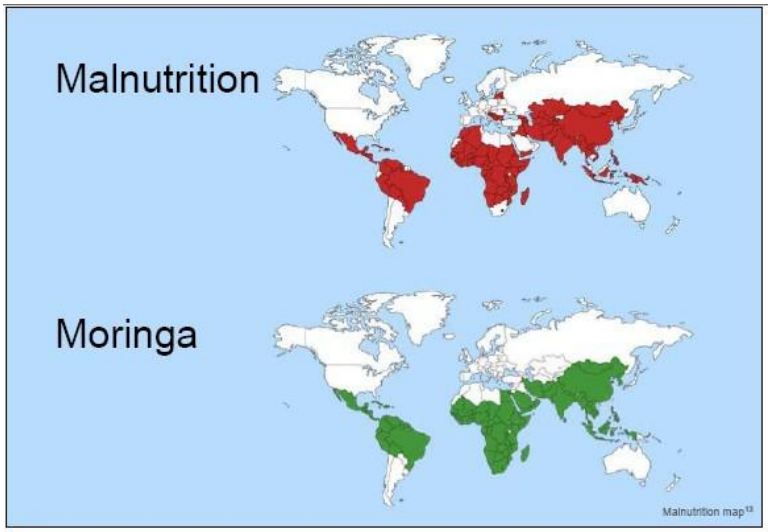


Figure 2.5: Places where malnutrition is prevalent and areas where *Moringa* grows wild (Bey 2010: 14).

2.10.4 Harvesting and drying of *Moringa* leaves

Both young and mature leaves can be used to make dried *Moringa* leaf powder. The conditions under which the *Moringa* leaves are dried play an important role in the final nutrient content. Before the *Moringa* powder can be made, certain quality assurance checks need to be carried out to ensure food safety of the final product. Leaf selection is the first stage, where only healthy, disease-free and fungi free leaves are selected for the drying process. Damaged and yellow leaves are also excluded from the process. Pests that may compromise the quality of the leaves include crickets, grasshoppers and caterpillars. Manual selection of the leaves is pivotal in ensuring only the best leaves are used (Mishra, Singh and Singh 2012: 29).

Washing/cleaning of the leaves must be done in order to prevent contamination. Potable water is used to wash the leaves. The leaves are then soaked in a 1% saline solution (NaCl) for 5 minutes in order to remove microbes. The second washing cycle involves submerging the leaves in 70% ethanol; thereafter it is rinsed in distilled water. The washing process is critical in the removal of pathogens, microbes and dust on the surface of the leaves (Mishra, Singh and Singh 2012: 30).

Dehydration is an age old method of preservation; it also allows nutrients to be available in a more concentrated form. A study comparing different methods of *Moringa* leaf drying and nutrient retention revealed that the highest nutrient retention was obtained by shade drying, followed by sun drying and oven drying with significantly lower nutrient values ($p<0.001$) (Joshi and Mehta 2010: 9).

Air circulation is also important; mosquito nets can be used to cover the leaves that are placed on a sterilized surface in a well ventilated room. It is recommended that the leaves are turned over using sterile gloves to ensure that even drying takes place. Leaves should be fully dried within four days (maximum). Persons involved in the drying process must be fully equipped with personal protective equipment (PPE) and ensure proper sanitation and cleanliness must be adhered to (Mishra, Singh and Singh 2012: 30).

Moringa leaf powder is highly hydroscopic and can reabsorb humidity before, during and after the grinding process. Therefore, once the powder is ground, it should be dried at 50°C

for 30 minutes to lower the moisture content. Proper storage of the prepared powder will assist in prolonging the shelf life. The powder must be stored in air tight containers or vacuum sealed and kept away from light (dark containers) and humid conditions. The recommended storage temperature is 24°C at which the powder can be stored for 6 months (Mishra, Singh and Singh 2012: 30).

2.11 Nutritive value of *Moringa*

Depicted in Table 2.4 is a comparison of the nutrient contribution made by the *Moringa* pods, fresh leaves and leaf powder.

Table 2.4: Nutritional value of *Moringa* pods, fresh leaves and leaf powder per 100g (Adapted from Fuglie 2001).

Parameter	Pods	Fresh leaves	Leaf powder
Moisture (%)	86.9	75.0	7.5
Calories	26.0	92.0	205.0
Protein (g)	2.5	6.7	27.1
Fat (g)	0.1	1.7	2.3
Carbohydrate (g)	3.7	13.4	38.2
Fibre (g)	4.8	0.9	19.2
Minerals (g)	2.0	2.3	-
Ca (mg)	30.0	440.0	2003.0
Mg (mg)	24.0	24.0	386.0
P (mg)	110.0	70.0	204.0
K (mg)	259.0	259.0	1324.0
Cu (mg)	3.1	1.1	0.6
Fe (mg)	5.3	7.0	28.2
S (mg)	137.0	137.0	870.0
Oxalic acid (mg)	10.0	101.0	0.0
Vitamin A- Beta carotene (mg)*	0.11	6.8	16.3
Vitamin B (mg)	423.0	423.0	-
Vitamin B1 (mg)	0.05	0.21	2.6
Vitamin B2 (mg)	0.07	0.05	20.5
Vitamin B3 (mg)	0.2	0.8	8.2
Vitamin C (mg)	120	220.0	17.3
Vitamin E (mg)	-	-	113.0

*Fugile reported beta carotene in terms of milligrams (mg)

Many organizations such as the Trees for life ECHO and CWS have promoted *Moringa* as a good source of nutrition in the tropical areas. This is because *Moringa* trees are in full leaf during the dry season. When most food sources are exhausted, *Moringa* is available as a nutrient rich food source (Mishra, Singh and Singh 2012: 30). It is recommended that 8g of *Moringa* leaf powder could meet 14% of the protein, 40% of the calcium, 23% of the iron and almost all the vitamin A requirements for children aged 1-3 years old (Mishra, Singh and Singh 2012: 30).

A study of *Moringa's* ethanol extract potential as an anti-diarrheal agent concluded that further research needs to be conducted on the medicinal properties of *Moringa*, especially regarding common diseases that may be experienced by young children in rural areas (Misra, Srivastava and Srivastava 2014: 43). *Moringa* serves as both a nutritional supplement to meals as well as a natural source of medication for treating diabetes, hypertension, anaemia and many other diseases/disorders (Maheshwari *et al.* 2014: 12).

Research conducted by Sankhyan, Sharma, Seth, Chauhan and Kulshrestha (2013: 68) found that the highest amount of vitamin C was obtained from fresh *Moringa* leaves as opposed to dry leaves due to vitamin C being a water soluble nutrient (Table 2.7). Fuglie (2001) reported that *Moringa* leaves are high in protein and contain all of the nine essential amino acids in varying amounts.

2.12 Use of *Moringa* internationally

Moringa forms part of the traditional diet in many countries, including but not limited to Sri Lanka, Thailand, Cambodia and India. The plant serves as a valuable source of 46 types of antioxidants, 92 verifiable cell-ready nutrients and 36 anti-inflammatories all easily available to the human body (Maheshwari *et al.* 2014: 11; Paliwal, Sharma and Pracheta 2011: 323).

The *Moringa* tree is grown around animal sheds as a form of live fencing in certain parts of India. Tender pods are cooked like green beans while mature pods are used to prepare stews and soups. *Moringa* leaves are prepared in a similar manner to other green leafy vegetables like spinach. The flowers are also eaten, once dipped into batter and deep fried (Pandey, Pradheep, Gupta, Nayar and Bhandari 2011: 457).

A study conducted in the Philippines on *Moringa* leaves that are dried revealed that the leaves contain good sources of iron, zinc and calcium which were easily available for absorption by the human body. The fruits (pod) and leaves also provide a good source of dietary fibre (Mallillin, Trinidad, Sagum, Leon, Borlagdan, Baquiran, Alcantara and Aviles 2014: 245). A study in Fiji which aimed at identifying the effectiveness of *Moringa* seeds to remove heavy metals (cadmium, copper, chromium, lead and zinc) from water concluded that *Moringa* seeds were effective in absorbing the heavy metals, with the percentage of removal being more than 50% for all of the heavy metals (Nand, Maata, Koshy and Sotheeswaran 2012: 125).

A study in India sought to identify if ground nut oils or *Moringa* Jaffna variety seed oil displayed better characteristics. The *Moringa* seed oil showed positive results with good thermal stability, and a higher oxidative stability was observed compared to groundnut oils. The *Moringa oleifera* Jaffna variety seed displayed good potential as a healthier and more stable alternative to groundnut oils (Ogunsina, Indira, Bhatnagar, Radha, Debnath and Krishna 2014: 509).

A study conducted in London aimed to test the effectiveness of *Moringa* leaf powder as an anti-bacterial hand wash product by purposively contaminating the hands of participants (n=15) with *E. Coli* and using different amounts of *Moringa* as a hand wash instead of soap. The results of the study revealed that the *Moringa* leaf was able to reduce the bacterial load on the participants artificially contaminated hands. An amount of 4g of *Moringa* leaf powder in a wet or dried application was as effective as non-medicated soap; therefore, *Moringa* leaf powder could be used in rural areas as an alternative to soap (Torondel, Opare, Brandberg, Cobb and Cairncross 2014: 6).

2.13 Use of *Moringa* in Africa

Rural communities in Uganda utilize *Moringa* leaves for the treatment of common medical aliments; however, a small percentage (10.8%) use the leaves as a preventative or treatment measure for addressing malnutrition. From the sample size (n=120), the majority (90%) of respondents reported to have used Moringa leaves to treat hypertension and diabetes (Kasolo, Bimenya, Ojok, Ochien and Ogwal- Okeng 2010: 757).

A study conducted in Nigeria (n=745) by Popoola and Obembe (2013: 682) to identify the local knowledge and use of *Moringa* revealed that there were three main categories in which *Moringa* leaves were used, namely, medicinal use (FL=93%) food and nutritional (FL=71.1%), fodder plant (FL=60.9%), fencing (FL=53.2%), gum (FL=38.9), coagulant (FL=38.8%) and firewood (27.9%; FL=Fidelity Level refers to the use frequency in percentage form). It is clear that *Moringa* is well utilized in Nigeria, with *Moringa* being used mostly for medicinal, food and nutritional purposes (Popoola and Obembe 2013: 684).

Contrary to studies that reported an improvement in iron levels after consuming *Moringa* leaf powder, a Senegal experimental study conducted on lactating women found no improvement in the iron status of the experimental group. The control group was given two iron tablets per a week and the experimental group was given 100g of *Moringa* leaf powder per week. Although the results of the study did not observe an improvement in the iron status of the experimental group, the experimental group was able to maintain weight better than the control group (Idohou-Doussou, Diouf, Gueye, Guiro and Wade 2011: 4993).

A study conducted in Nigeria (n=100) to determine consumer usage and awareness of the benefits of *Moringa* revealed that 52% of the participants did not use *Moringa* products. One of the main reasons for this was lack of awareness (87%; Williams, Animashaun, Ibrahim and Toye 2013: 169). Another objective of the study was to determine the willingness of people to purchase *Moringa* products based on benefits, researchers found that most of the participants (74%) knew at least one of the nutraceutical benefits of *Moringa* (Animashaun, Williams and Toye 2013: 19). In addition, an article reviewing the benefits and cultivation of *Moringa* advised that the Nigerian government should consider the benefits of *Moringa* and motivate farmers to grow this multi-beneficial plant on a commercial scale (Zaku, Emmanuel, Tukur and Kabir 2015: 460).

2.14 Other uses of *Moringa*

Every part of the plant is regarded as useful, whether for high nutritional content or other functional properties that makes it suitable for industrial and agricultural purposes (Table 2.7). Industrial applications include using the pulp from the wood to produce paper and utilizing the seeds to make biofuel feedstock (Mulugeta and Fekadu 2014: 58-60).

Good quality oil that does not turn rancid or smoke can be obtained from the *Moringa* seed. *Moringa* seeds are a good source of edible oil as the seeds contain a high amount of oil (48.79%).The nutritional value of this oil has been compared favourably with olive oil. The oil is almost tasteless and odourless, thereby making it suitable for numerous food applications, from deep fat frying to salad dressings (Mulugeta and Fekadu 2014: 58-60).

Khattab and Shakak (2012: 85) also conducted a study on the quality of *Moringa* seed oil compared to groundnut oil. The overall composition of the oil makes it a good alternative to groundnut oils as it contains 57% oleic acid and 13.28% omega 3 fatty acids. *Moringa* leaves also display good antioxidant properties (Reddy, Urooj and Kumar 2005: 318). Oil extracted from the *Moringa* seeds is referred to as 'Ben oil'. This product can be used for cooking or even blended with diesel to produce biofuel. Ben oil has been quite effective as an ingredient in soap production due to its ability to produce a stable lather. By products from the oil production can be used as a form of fertilization for crops (Mulugeta and Fekadu 2014: 58-60). Gum sourced from the *Moringa* tree is reported to possess gel forming abilities which can be utilized for topical application in the pharmaceutical industry (Panda *et al.* 2006: 777). The Table below is a brief tabulation of the numerous benefits the *Moringa* tree possesses.

Table 2.5: *Moringa* parts and the uses (Broin and Saint Sauveur 2010: 14).

Tree Part	Use or benefit
Leaves	Nutritional, forage, medicinal
Flowers	Nutritional, medicinal, honey
Fruit/pod	Nutritional, medicinal, oil
Roots	Medicinal
Seed	Cosmetics, food, water treatment, medicinal
Wood	Paper, alcohol production, animal feed, medicinal
Bark	Rope making, gum for tanning hides, medicinal

2.14.1 Product fortification using *Moringa*

The plight of malnutrition is one that cannot be overlooked. Key measures need to be enforced in order to prevent the nutritional status of children from being compromised. The nutritional enhancement of foods consumed by children with a nutrient rich plant source such as *Moringa* could indeed be a route to meet the nutritional requirements of children.

An experimental study by Giridhari, Malathi and Geetha (2011: 3), on the effect *Moringa* capsules would have on diabetes mellitus revealed that the experimental group had a significantly lower blood glucose levels in males and females when compared to the control. The prandial glucose level dropped by 191mg/dl (first month), 174mg/dl (second month) and 150mg/dl (third month). This clearly indicates that *Moringa* supplementation had a positive effect in lowering the blood glucose levels of the experimental group (Giridhari, Malathi and Geetha 2011: 4).

In addition, a study by Madukwe, Ezeuhwu and Eme (2013: 102) concluded that dry *Moringa* leaf extract contains an array of nutrients and can be used as a food supplement. A beverage containing *Moringa* powder steeped in water and then strained, was regarded as being sensory acceptable by college students in Nigeria (n=30). The sensory acceptability was conducted using a nine point hedonic scale, where the average rating was 7.5 for the sample. A similar method of preparing *Moringa* was utilized by Williams *et al.* (2013: 171) most of the participants favoured *Moringa* tea bags (60%) as a more acceptable form of consuming *Moringa*. This was probably due to the high consumption of herbal teas amongst the participants (almost 2-3 times a day).

In a Pakistan study on *Moringa,* leaf extract was successfully incorporated in butter in order to increase the shelf life given the plant's antioxidant properties. The study concluded that 600 ppm of *Moringa* extract could be added to the butter, as sensory analysis (n=5) reported that 80% of the respondents found this sample acceptable (Nadeem, Abdullah, Hussain, Inayat, Javid, Zahoor 2013: 337).

Research on the nutrient content of raw, germinated and fermented *Moringa* seed flour revealed that fermentation and germination of the seeds before processing into flour, improved the overall amino acid, phytochemical and fatty acid profile of the flour. It is therefore suggested that this flour could be used to improve the nutrient content of products it is used in (Ijarotimi, Adeoti and Ariyo 2013: 461).

Another study in Nigeria focused on child nutrition. The study intended to develop a complementary food for infants using yellow maize, soy and *Moringa.* Interestingly, the study obtained successful results considering the many challenges previous researchers have experienced regarding the palatability of *Moringa*. The gruel made using a ratio of maize

(60%), soy (30%) and *Moringa* (10%) was regarded as sensory acceptable by the intended target population. An improvement in the nutritional status, weight and length of the children was observed (Odinakachukwu, Ngozi, Ngozi and Aloysius 2014: 297).

Similar to the previous study, Shiriki, Igyor, Gernah, Yadav, Dhasmana, Sharma and Kumar (2014: 12) supplemented a maize, soybean and peanut complementary food by adding different amounts of *Moringa* (5%, 10% and 15%). Nutrient analysis indicated that the sample supplemented with 15% *Moringa* had a significant effect on improving the micronutrient content of the complementary food (the control). However, the sample including 5% *Moringa* was more acceptable in terms of sensory attributes. Considering this, it is therefore suggested that sensory acceptable food formulations including *Moringa,* could be effective in addressing malnutrition.

A product development study which developed a fresh *Moringa* leaf beverage included *Moringa* leaf extract (50%), pineapple extract (38%) and carrot extract (12%). The beverage contained significant amounts of protein (2.9g/100ml), iron (1.02mg/100ml) and vitamin C (159.14mg/100ml). Shelf life analysis on the beverage revealed that 78% of the vitamin C content was still present even after being stored in sunlight (Otu, Saalia and Amankwah 2013: 32). Nadeem *et al.* (2012: 714) also conducted a beverage study to determine the overall nutrient content and acceptability of buttermilk enhanced with *Moringa* leaves. The study concluded that 3% of *Moringa* was acceptable in terms of sensory attributes.

Taste is regarded as one of the most important sensory characteristics. This was observed in a study by Manaois, Morales and Abilgos-Ramos (2013: 3-6) where *Moringa* (fresh and dried) was added to rice crackers (1%, 2% and 5%). Sensory acceptability tests were conducted by children in grade 6 (11-12 years; n=30). Results indicated that the sample with 2% *Moringa* (dried and fresh) was regarded as acceptable by all the participants. The children indicated intent to purchase all the samples if made available once they were aware of the nutritive value (significant amounts of calcium and vitamin C were reported).

A study by Mbah, Eme and Ogbusu (2012: 214), aimed to determine the effect of different cooking techniques (boiling and roasting) on the nutrient value of *Moringa* seeds. Results of the study indicated that boiling and roasting increased the availability of fibre, protein,

vitamin A, iron and zinc. These results are promising, as not only can the *Moringa* leaves be used as a source of nutrition, but the seeds are also nutritionally beneficial.

2.15 Product development

"Food product development is an integrated, systematic qualitative and quantitative techniques used in developing new or existing products from conceptual ideas through to successful and sustainable products in the market place"(Winger 2009: 448).

Reasons that may promote the introduction of new products include the need to grow the business and increase the number of products offered to consumers. Secondly, product developers desire to gain a competitive position and also to attract consumers by providing innovative products that meet the ever changing consumer demands (Winger 2009: 447).

Companies may be deterred from new product development due to the numerous risks involved in the process. There is a high risk for failure resulting in financial loss; therefore there is a need for a well-structured product development plan. A systemized approach is required in order to manage potential risks that may be encountered throughout the development process (Food a Fact of Life 2009: 3).

Input from consumers during the product development process is viewed as a cost-effective strategy towards gauging what consumers actually want and if products meet their requirements (Franke, von Hippel and Schreier 2006; Nørgaard, Sørensen, and Brunsø 2014: 19).

2.15.1 Stages of product development

The new product development process comprises eight stages which are depicted in a process flow chart (Figure 2.6). Development occurs in some stages while other stages are regarded as 'evaluative' stages (Rudolph 1995: 5).

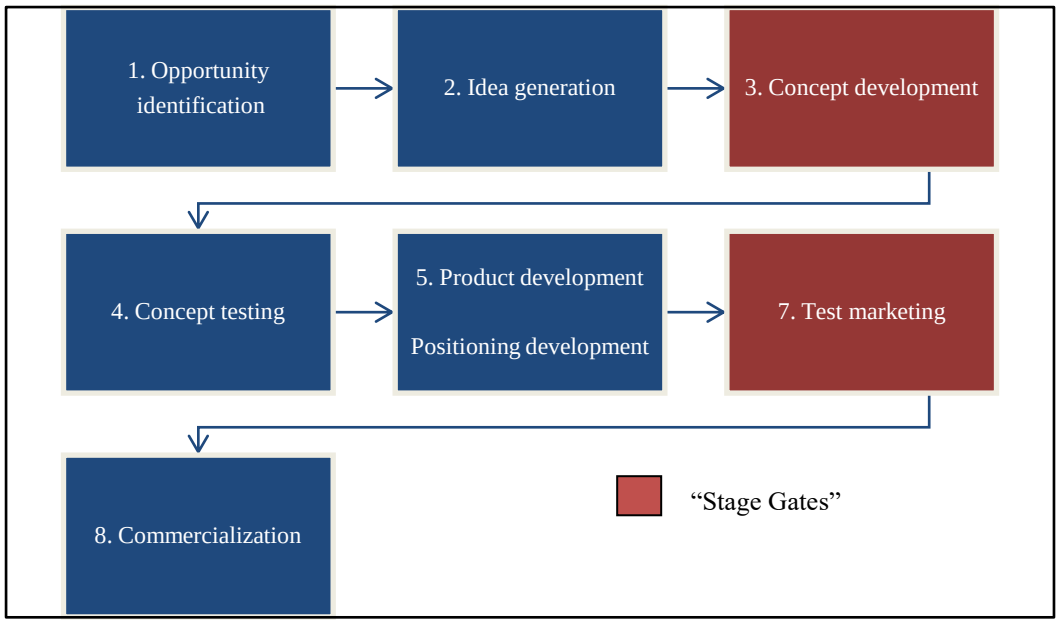


Figure 2.6: New product development stages (Food a Fact for Life 2009: 5).

The two main categories of stages are therefore developmental and evaluative stages. Developmental stages focus on identifying opportunities and the generation of ideas and concepts. Research involving consumer needs and utilizing creative thinking is also key in this stage. Evaluative stages also referred to as 'stage gates' (Figure 2.6) are basically allotted in order to determine if the subsequent stage may continue or not. This stage requires objective decision-making and is pivotal to the overall success or failure of a new product. Important questions are raised during these stages: is the company equipped (financial, manufacturing and distribution capabilities) to produce the item? Will the product meet consumer expectations? Market research is usually required in order to answer these questions. Ideas/concepts need to be feasible and show potential for success in order to obtain approval from senior management (Food a Fact for Life 2009: 4).

The new product development team comprises of experts in a broad range of fields all of whom report to the new product development manager who is able to then convey progress to senior management. Members of the team may include but are not limited to, employees from the research and development department, finance, marketing research, promotions and sales. Gathering expertise from the different departments assists in developing a product that is ultimately able to meet the requirements of the different sectors. For example, triangular packaging may seem an innovative idea that will draw consumer attention; however, the sales

and store managers may disagree given the challenges with shelf displays and transporting (Winger 2009: 457).

The first stage of new product development, opportunity identification comprises market information. Both primary and secondary research can be used in this stage. Primary research is when research is conducted with the objective of finding out specific information, whereas secondary research draws information from data that has been previously collected for a general use. This information may be obtained from sources such as the internet sites, syndicated databases, and trade/industry associations. Idea generation involves the brainstorming of ideas, commonly referred to as ideation. Members of the product development team are included in this process as well as other stakeholders. Numerous ideas can be generated but a challenge exists in determining the most viable ideas or concepts [(Institute of Food Science and Technology (IFST) 2015)].

Concept development includes a series of steps to decipher the actual concept in terms of what the product actually is; the information is then displayed on what is known as a 'concept board'. This includes identifying the consumer benefits, how the product is different to others available in the market, the ingredients used, packaging and price. Once the concept is established, a stage gate is introduced, which is referred to as concept testing. The stage gate at this point is critical as it will determine if there is sufficient demand for the product to continue development. Online consumer polls may be used to determine consumer attitudes regarding the concept behind the product. Results are then compared to a database and the concept is either selected or rejected for further development (IFST 2015).

Once the concept/idea is finalised via the gate keeping process, the next step is the development of the product. This stage involves the actual creation of the product. In new food product development, this involves numerous small scale kitchen trials by a number of recipes using different ratios of ingredients; this means that the products are 'prototyped' in the company's test kitchen by a chef/food consultant/food scientist.

In-house sensory evaluations are conducted using a small number of staff trained in sensory evaluation. Sensory evaluation may be conducted at various stages in the developmental process. The trained panel will evaluate sensory attributes such as appearance, taste, texture and odour to test the product. The results will provide the product developer/chef with

valuable insight on characteristics of the product that may require improvement in order to be accepted by consumers (Winger 2009: 457).

Thereafter, a pilot plant is setup; this is basically a smaller version of the intended manufacturing plant. This allows for the product development team to determine if the product will be able to be successfully produced on a large scale. A sufficient quantity of the product is then made for market research; changes may still be made to the product in the quest to perfect the recipe. Once problems are identified at the pilot plant stage, changes are easier to implement as opposed to making changes to a fully fitted manufacturing plant (Winger 2009: 459). According to the IFST (2015), on completion of testing and improving the product, product specification is established. Precise details including the finalised recipe with ingredients and methods are used at this stage. Specifications are crucial as consistency is paramount to overall product success. Numerous manufacturers first conduct consumer testing before large scale production.

Consumer testing must be done on the intended target market in order to gauge a true reflection of the acceptance or rejection of the product. For example, a company would purposively select children if the product is a child food option. If the product has a general appeal such as convenience foods, broad spectrums of consumers from different backgrounds are included in the testing. Once the company is confident that the product is likely to be successful, the product is manufactured on a larger scale and commercialized, which involves a product launch and marketing campaigns, both of which are essential in capturing the consumer's attention and ultimately, their buying power(Food a Fact for Life 2009: 5-7).

2.16 Sensory evaluation

The IFT sensory division defines sensory evaluation as, "A scientific discipline used to evoke, measure, analyze and interpret reactions to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch and hearing". This definition has been simplified to a means of measuring a product's attributes as perceived by the human senses (Gengler 2009: 7). According to Gengler (2009: 8), sensory evaluation started in the 1940s and the first trained panel was established with the intent to make the measurement of food items more objective, considering the innate variability of human assessors (Lawless and Heymann 2010: 35).

Food and beverage items should be tested on the target group the product is intended for (Guinard 2001: 273). Guinard (2001: 281) suggests that qualitative methods such as focus group discussions are an effective means of obtaining valuable information from children. According to Popper and Kroll (2008: 383), children are seen to have more buying power than in the past. Therefore sensory evaluation with children is an important aspect in the product development process.

2.16.1 Ethical considerations in sensory evaluation

According to Kemp, Hollowood and Hort (2010: 32-35), ethical considerations are an integral part of sensory evaluation. This is especially so when children are involved. Informed consent must be received from all assessors in the case of the assessor being a minor; consent must be obtained from the parent/guardian as well as written verbal assent from the child. All necessary information pertaining to the risk and confidentiality must be known to the assessor before commencement of the evaluation. Withdrawal from the study can be done at any time and without any penalty/negative action being taken.

2.16.2 Types of sensory evaluation

Sensory evaluation can be classified into two groups, namely, objective and subjective (Kemp, Hollowood and Hort 2010: 1). Objective testing involves a trained panel whereas subjective testing comprises of measuring the reactions of the respondents. The purpose of sensory testing is to identify if a difference exists amongst samples. Descriptive analysis focuses on the attribute intensities and does not assess the panel's liking for the item (Gengler 2009: 9).

Two main types of sensory evaluation exist: descriptive and analytical testing. The main difference that exists between the two testing types is that analytical testing is done by a trained sensory panel and descriptive testing is done by an untrained panel and are more often referred to as affective or consumer testing (Kemp, Hollowood and Hort 2010: 66). Due to the study's focus on children, subjective testing will be discussed in this section. Once the type of testing is decided upon, choosing the correct test method is vital to obtaining the answers required, as different tests are designed to answer specific questions. For example, the acceptance test methods are used to identify the degree to which a product is accepted

(Gengler 2009: 7). Below is a summary of the different types of sensory tests that are conducted as well as the objective of each test.

Acceptance tests are a method by which to test whether a product is accepted or unaccepted. It is usually conducted using a large group of respondents due to the varying nature of human perception (Gengler 2009: 7). Key to this method of testing is to ensure that the sensory panel comprises of individuals for whom the product is intended. Discrimination tests are aimed at identifying the degree to which two samples are perceived as being different. An example of this would be the triangle test (Gengler 2009: 9). Triangle tests are used to determine if an obvious difference exists between two samples. Three coded samples are presented to the panel members and the members have to pick out the odd sample. The panel members are required to identify the odd sample and hence the only noticeable difference should be the one that is being tested for (Kemp, Hollowood and Hort 2010: 7).

Duo-trio tests comprises of three samples which are presented to the panellists. One sample is the reference sample and the other two samples are coded. This test is used when samples with strong flavours are being compared because less tasting is required (Kemp, Hollowood and Hort 2010: 7). Consumer testing is done through a panel of untrained users of the product to determine the level of 'liking' to the product. This testing method may be used with children (Guinard 2001: 273). Guinard (2001: 274) advises that when conducting sensory evaluation with children, the procedure of the test should be explained to the child.

Various factors may affect the validity of the sensory evaluation results, therefore, certain precautions must be taken in order to eliminate or prevent the results from being biased or skewed (Kemp, Hollowood and Hort 2010: 8).

2.17 Food selectivity (neophobia)

According to Rozin (1976), neophobia is a protective mode that prevents animals and humans from consuming something that could be harmful to them. This in turn directs people to constantly choose food that they are familiar with as these are regarded as safe. Previously, food safety was of great concern and the neophobia concept was useful. However, this concept now has a negative connotation associated with it as new food experiences may be

avoided and the diet may lack variety due to food neophobia, which is also known as the fear of novel foods (Laureati, Bergamaschi and Pagliarini 2014: 27).

Children generally reject eating vegetables that are nutrient rich; this could be explained by a possible imprinting of sweet and glutamate flavours because of breast milk containing both free glutamate and free sugars (Breslin 2013: R415). According to Laureti, Bergamaschi and Pagliarini (2014: 31), neophobia is more likely to be reduced in children 9 years or younger as the child is still in the process of developing food preferences. Therefore, interventions directed towards introducing children to healthy foods should be done during the early stages of childhood.

A study by Siegrist, Hartmann and Keller (2013: 294) aimed at identifying the relationship between socio-demographic factors and food neophobia. The study found that food neophobia may encourage consumption of more familiar foods which may be of a lower nutritive value, for example, cookies. Neophobia may restrict or limit the effectiveness of programs aimed at increasing food diversity and healthy food choices. A paucity of information is available on neophobia among 10-16 year old adolescents which could affect dietary diversity (Nørgaard, Sørensen and Brunsø 2014:18).

2.18 Conclusion

Malnutrition and poverty have devastating effects on a country as a whole; disease and infection are present in those that have weakened immune systems due to a lack of food, be it in quality or quantity. With this grim picture, one may think that hope to tackle the malnutrition-poverty cycle and improve child health and wellness is lost. However, with the implementation of various strategies such as the sustainable development goals (SDGs), school feeding programs and food based strategies, there is hope for the future. Researchers and scientists work consistently to make a difference in the battle against the scourge of malnutrition. Undernutrition and overnutrition co-exist and a two-fold approach is necessary to address this situation. The literature reviewed in this chapter is merely a summary of what the problem is and how a positive difference can be made by utilising *Moringa* as a food-based solution.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will discuss the research design and methodology in four separate phases. Research design refers to an in-depth discussion on the process followed throughout the course of the research (Joubert and Katzenellenbogen 2007: 470). The first phase focused on the preliminary data collection (focus group study and observational study); the second phase involved the development and administering of a snack food frequency questionnaire (SFFQ) which was based on information gathered in the first phase. During the third phase, a snack food item enhanced with *Moringa* was developed, and lastly, consumer acceptance sensory evaluation was conducted.

3.2 Context of research

Research was conducted in four schools located in Verulam (Figure 3.1); a total number of 2546 children between grades 4-7 attended these schools. Verulam is a town located 28 kilometres from Durban on the North Coast of KZN (Figure 3.1), SA, and is now part of the eThekwini Metropolitan area. The town is home to a population of more than 60,000 people. The eThekwini population makes up 33% of KZN, of which individuals within the 0-14 year age cohort comprise 25% (Verulam, eThekwini 2015). Dietary preferences were identified as being 'well established' by the age of 13. With this being said, it is essential for interventions to take place during the earlier years in order to instil healthy eating habits. Hence, this research study conducted in Verulam focused on children in grades 4-7 (estimated age is between 9-13 years old; Feeley, Musenge, Pettifor and Norris 2012: e1).

Figure 3.1: Map of eThekwini including Verulam (source: eThekwini – Durban Accommodation 2002).

3.3 Study design

This was a developmental study which involved a *Moringa*-enhanced snack item being produced for children in grades 4-7. The research design chosen was mainly quantitative, with a qualitative aspect (Johnson, Onwuegbuzie and Turner 2007: 113). The qualitative aspect of the research included the focus group discussion as well as the observational study. The snack food frequency questionnaire (SFFQ) and consumer acceptance sensory evaluation questionnaire formed the quantitative portion of the research. The purpose of including the qualitative aspect of the research was to obtain valuable insights on parent/caregivers' views of their child's snacking practices and preferences. The quantitative aspect was included in the research in order to ascertain the snacking preferences of children as well as the sensory acceptability of a snack enhanced with *Moringa* (consumer acceptance sensory evaluation questionnaire).

3.4 Study population and sampling

The study population for the qualitative aspect comprised ten parents who had children in grades 4-7. The sample size for the SFFQ was determined in order to observe a medium effect size with 80% power. A total sample of 211 was needed, of which 200 formed part of the SFFQ and eleven participants comprised the pilot study (six for SFFQ and five for

consumer sensory acceptance evaluation; sample size calculator: GPower version 3.1.9.2). Stratified random sampling which involved dividing the population into strata (in terms of grades 4-7) was used in determining the sample population (Joubert and Katzenellenbogen 2007: 94). The research study was divided into phases (Figure 3.2) in order to create a cohesive flow of the progression of the research.

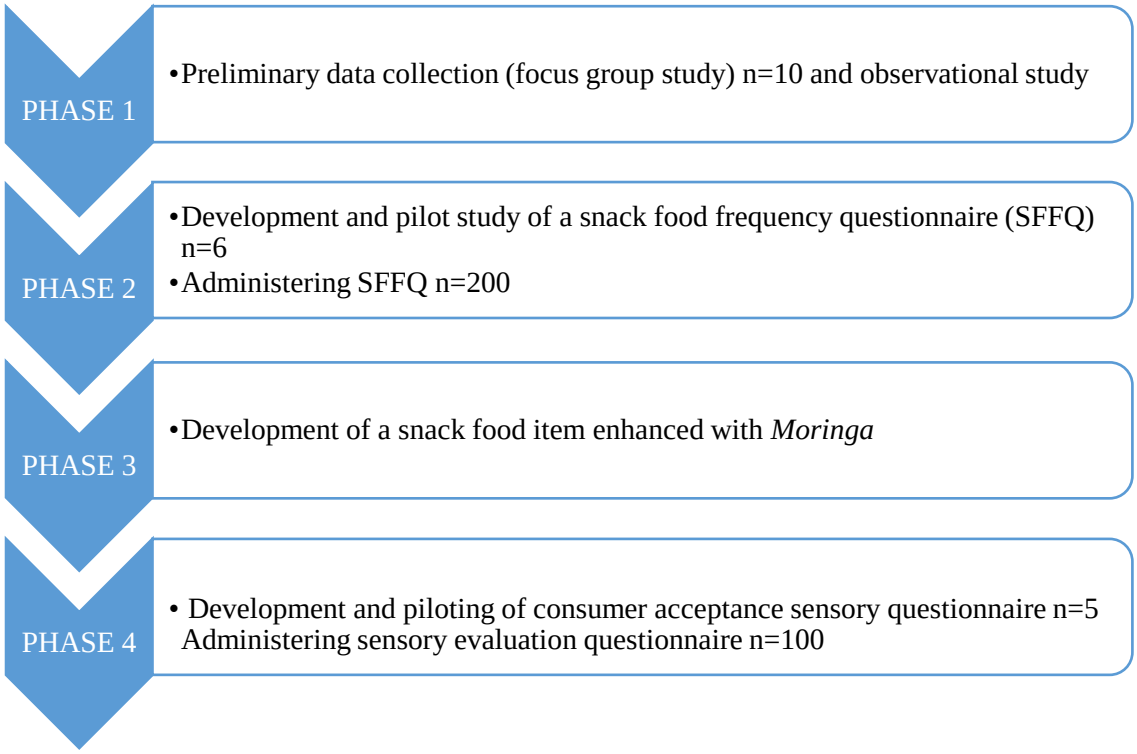


Figure 3.2: Progression of research in phases

3.4.1 Inclusion and exclusion criteria

Focus group study:

Inclusion criteria

- All parents/caregivers of primary school children/wards in grades 4-7

Exclusion criteria

- Individuals that did not have children/wards in grades 4-7

SFFQ and Consumer acceptance sensory evaluation questionnaire:

Inclusion criteria

- All male and female children in grades 4-7
- The participants should attend schools based in the sample selected schools in Verulam

Exclusion criteria

- Children below grade 4
- Children with known allergies to wheat gluten as reported by parents/caregivers in consent forms

3.5 Research process

3.5.1 Phase one: Focus group discussion and observational study

Preliminary data collection (focus group discussion and observational study)

The qualitative component of this study was in the form of a focus group discussion with ten parents/caregivers from the community and the observation of the tuck shop purchases. According to Delport, Roestenburg, De Vos, Strydom, and Fouche (2011: 175), a focus group study should ideally consist of between six and ten participants. This preliminary data collection is essential in identifying the snack foods which children in grades 4-7 prefer, so that a suitable *Moringa*-enhanced snack food item could be developed.

Planning and administration

The focus group discussions comprised 10 female participants. The discussions were conducted in the school library away from possible interference. Permission to participate in the study was obtained from the participants (Annexure A). The participants were comfortable with English being the language chosen for the discussions. During the focus group discussion, an interview schedule with themes (Annexure B) and semi-structured in depth interview questions were used as a probe to obtain as much information as possible. The researcher used a voice recorder and scripted notes were taken in English; the results were later tabulated and are reported in Chapter 4. The initial time-frame for the focus group discussion was 15-20 minutes; however, the discussion could progress to more than 20 minutes based on a positive response from the participants.

The discussions were recorded on a digital recorder for analysis by the researcher. The participants were requested to sit in a circle and the digital recorder was placed on a chair located at the centre of the circle. Prior to the commencement of the discussion, the rules/ etiquette required of the focus group were explained to each participant, namely:

- Do not speak when another participant is speaking.
- Allow the participant to complete speaking before you comment on the point under discussion.
- Speak freely and honestly about the questions that are discussed.

Once focus group discussions were concluded, the participants were thanked for attending and refreshments were provided.

The observational study was conducted at two of the schools that were included in the study. The researcher compiled a list of the main snack items stocked (Annexure C) at the tuck shop before the school breaks (10H00–10H30 and 12H00–12H45) and used a tally table to record the number of purchases for each item. This information indicated the most popular snacks purchased from the school. All children from grades 1-7 were included in the observational study. A total of 536 children were included in the observation study.

Data analysis

The focus group study was recorded on a digital voice recorder and the researcher also transcribed notes during the focus group discussion. The voice recordings were transcribed and verified by a fieldworker.

The findings of the focus group study (qualitative aspect) were grouped into themes and reported as such in order to identify the snacking preferences of children in the study sample (Chapter 4). The observational study results on snacking preferences were captured onto an Excel®spread sheet and are reported in the form of descriptive statistics in Chapter 4.

3.5.2 Phase two: Snack Food Frequency Questionnaire (SFFQ)

Development, piloting and administering of SFFQ

Once the focus group discussion was completed, the information was analysed and the ten most commonly purchased snack food items formed part of the SFFQ. The SFFQ was developed, piloted and administered in order to identify a suitable snack item for development. Prior to the pilot study, the questionnaire was evaluated by experts (researcher and supervisor) to ensure the linguistic and technical aspects were correct. A pilot study using the SFFQ was conducted before being administered to the sample population. The questionnaire was piloted on a sample of children (n=6) who met the requirements of the sample population. The researcher used the class register as a means of recording the children who participated in the pilot study. The children who participated in the pilot study were excluded from the main study. The main objective in piloting a research tool/measuring instrument is to ensure that the tool does not contain any errors, is easy to understand and is not ambiguous. Piloting also makes certain that the tool is structured correctly. Irrelevant questions can be identified and removed from the questionnaire during this stage (Kimmie, Delany and Khumalo 2007: 195).

Planning and administration

The results from the focus group discussion were used to compile the draft SFFQ. The purpose of developing and administering the SFFQ was to direct the researcher towards developing a suitable snack food item. The basis of the information for the SFFQ was obtained from the results of the focus group discussion. The format of the Food Frequency Questionnaire (FFQ) was used as a guideline for the SFFQ (Joubert and Ehrlich 2007). Once the SFFQ was developed, it was piloted (n=6) to ensure the formatting and phrasing of the questionnaire was suitable for the intended age group. Parents/caregivers provided consent for the six children in grades 4-7 who participated in the pilot study. The children mentioned a few key points that resulted in the questionnaire being redesigned, as follows:

- ‘We cannot remember what we have eaten throughout the whole week’.
- ‘There are different types of chips and sweets that we eat, but there is no place for us to write it’.
- ‘The table is confusing’.

As the questionnaire was not entirely positively reviewed by the children, it was decided by the researcher and the supervisor that another questionnaire would be designed and piloted with the same six children. The edited SFFQ was then piloted with the same participants and the responses from the children were positive as the style of questions and layout was more 'user-friendly'. The final SFFQ (Annexure D) was then used in the consumer acceptance sensory evaluation.

In total, 275 consent forms were despatched and 211 were returned which gave a 72% response rate. Two hundred children formed the sample population for the SFFQ. The sample for the SFFQ consisted of 50 children from each of the four grades. Upon establishing the sample, the SFFQ which forms the quantitative component, was administered to the 200 children in the respective schools and grades during the lunch break on days stipulated by the principals of the school. This was to ensure that the school program was not disrupted in any way. The researcher administered the SFFQ to groups of 15 children at a time. The children were given the following instructions:

- Please be seated and turn over the questionnaire placed on the table.
- Answer the questions as honestly as possible.
- If you have any questions, please raise your hand and I will come and help you.

Each child took approximately ten minutes to complete the SFFQ. Once the questionnaires were completed the children were given a fruit each as a token of appreciation before leaving the venue.

Data analysis

The Statistical Package for Social Sciences (SPSS) version 23® was used to analyse the data collected. The results are presented in Chapter 4 as descriptive statistics in the form of graphs, cross tabulations and other figures. To determine whether the differences between the means were significant, non-parametric tests were used as the distributions were not normal (Kolmogorov- Smirnov; test $p< 0.05$). The ***Kruskal-Wallis*** H test was used to determine if there were statistically significant differences between two or more groups of an independent variable. Therefore, this test was used to measure differences between the grades. ***Fisher's exact test*** ($p<0.05$) was used to determine whether significant relationships existed between row and column variables (in a contingency table).

3.5.3 Phase three: *Moringa* chip development

Development of a snack food item enhanced with *Moringa*

Product development was extensively discussed in Chapter 2 and the methods explained in Chapter 2 were utilised to complete the product development process. The results of the snack food frequency questionnaire were analysed to identify the most commonly consumed snack items. The most commonly consumed items were then reviewed to determine the snack item that should undergo further development (Figure 3.3). The review of a suitable snack item was conducted by the research team (researcher and the supervisor), using specific criteria to determine the most viable snack.

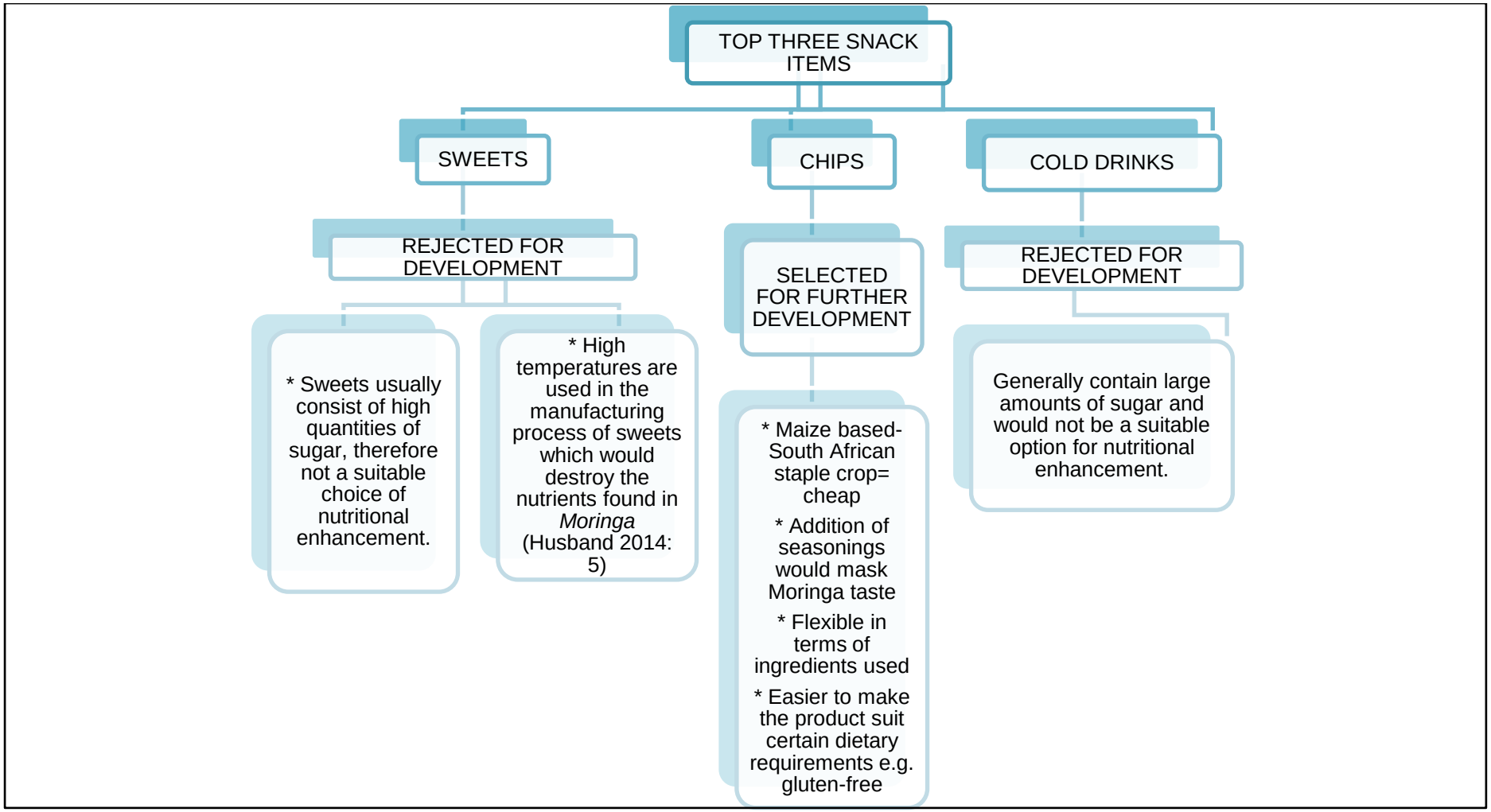


Figure 3.3: Flow diagram of snack selection for product development

Development process

The most viable snack food item as identified from the results of the SFFQ, was maize chips. The researcher and supervisor analyzed the ingredient statements of different brands of maize chips (since maize is a staple in SA). The base ingredients used in the different brands were similar. Wheat and gluten were omitted from the recipe development process making the chips gluten-free due to the allergy risk. The researcher and supervisor decided that polenta (yellow ground maize) would be included in the recipe as polenta is slightly sweet with a nutty undertone. The natural sweetness present in polenta assisted in masking the inherent bitterness of the *Moringa*. Creamy maize, which is finely ground white maize, was included in the recipe. Different ratios of ingredients were used, with the main purpose of keeping the recipe as affordable and practical as possible. The amounts of *Moringa* used were 1g, 2g and 3g per a 22g serving of chips (Figure 3.4). A standard portion of maize chips that was usually purchased by the children was 22g; hence this determined the portion size used for this study.

Traditional methods of chip cooking use large amounts of fat, hence the researcher and research supervisor decided to use technology in order to reduce the fat content of the chips. The Philips AirFryer HD9220/56™was used to cook the chips. According to Shaker, (2015: 1558), air frying reduces the fat content whilst still maintaining acceptable sensory scores. The air fryer cooks by using both a heat element and a fan that circulates the air, hence the name ‘air fryer’.

Three cooking trials were undertaken before an appropriate maize chip enhanced with *Moringa* was developed (Annexure E). All trials were conducted by the researcher and supervisor in a laboratory (test kitchen). The trial items were prepared and sensory evaluation was conducted by the supervisor, researcher and food science specialists in the Department of Consumer Science: Food and Nutrition at the Durban University of Technology (DUT). The feedback included gauging if the appearance, taste and texture seemed acceptable in comparison to a popular brand of maize chips. Changes were made in order to improve the recipe until the chips were viewed as being sensory acceptable.

During the trial phases, it was identified through sensory evaluation by the researcher, supervisor and a pilot study of a group of children representative of the sample (n=5), that the

3g *Moringa*/22g sample would not be included in the consumer acceptance sensory evaluation.

The chips containing 3g of *Moringa* were not included in the consumer acceptance sensory evaluation because the sensory attributes were unacceptable (the sample was referred to as being 'bitter') by all the pilot study participants (n=6).

Figure 3.4: Three variants of the *Moringa* chips

The final product for consumer acceptance sensory evaluation was made using two different amounts of dried *Moringa* crushed leaf (1g and 2g), and is presented in Chapter 4. As previously mentioned, the chips containing 3g of *Moringa* leaf were not included in the consumer acceptance sensory evaluation.

Data analysis

The three products developed were subjected to nutrient testing in order to determine the vitamin A, zinc, iron and calcium content. The micronutrient analysis of the products was conducted by a South African National Accreditation Systems (SANAS) laboratory using AOAC(Association of Analytical Chemists International 2002) standardised methods of analysis. Macronutrient testing was only conducted on the samples intended for the consumer acceptance sensory evaluation. Laboratory technicians from the Department of Food Technology at the DUT calculated the carbohydrate, fat, energy and sodium values using

AOAC standardised methods. Microbiological testing (total plate count and yeast and mould) was also conducted to ensure that the snack food item was safe for human consumption. There are no known allergens in *Moringa*, therefore it is assumed that *Moringa* is safe to be consumed (Pakade, Curowska and Chimuka 2013: 6). A shelf life test was also conducted using an accelerated shelf life incubator (Mermmert™).

3.5.4 Phase four: Consumer acceptance sensory evaluation

Consumer acceptance sensory evaluation

The samples used for the consumer acceptance sensory evaluation included 1g and 2g of dried *Moringa* leaf, crushed. The pilot study revealed that the 1g *Moringa* leaf chip was accepted by all the participants (n=6), as the participants rated the appearance, taste and texture as being either 'super good' (n=4) or 'good' (n=2).

The samples for the consumer acceptance test were made by the researcher assisted by five trained laboratory assistants (First year Food and Food Science students from the Department of Consumer Science: Food and Nutrition at DUT). The students were equipped with knowledge of basic food hygiene and therefore deemed qualified to assist (IFT 2015: 9). The consumer acceptance sensory evaluation questionnaire (Annexure G) consisted of relevant questions pertaining to the sensory aspects of the products developed, such as appearance, taste and texture. A 5-point facial Hedonic rating scale was used with 'faces' as a representation as to whether the specific attributes were liked or disliked. According to Davies and Tuleu (2008: 601), a 5-point facial Hedonic rating scale is suitable to be used with children aged between the ages of six and twelve.

Validation of the consumer acceptance sensory evaluation questionnaire was reaffirmed by conducting a pilot study consisting of five participants who were reflective of the sample population. The participants were each given a copy of the questionnaire and were asked if the verbal anchors and corresponding images were easy to understand. Results from the pilot study indicated that the consumer acceptance sensory evaluation questionnaire was appropriate for the intended age group.

Planning and administration

The principals of the schools provided the researcher with a copy of all the class registers for children in grades 4-7. The researcher then randomly selected potential participants from the class register for the research. The children were provided with an information letter and consent form (Annexure H), to give to their parents to complete in the event the child was allowed to participate in the research. Once the completed consent forms were collected, the researcher created a register to ensure that only those children who received parental permission participated in the consumer acceptance sensory evaluation. The sample for the consumer acceptance sensory evaluation comprised of 25 children per/grade from the four schools (n=100).

The researcher arranged a suitable date and time with the principal to avoid disruption of the academic programme. Teachers were informed of the consumer acceptance sensory evaluation and send those children included on the researchers register (completed consent forms) to the school library. A registered nurse in possession of a first aid kit from the South African Nursing Council was present as a precautionary measure. This precautionary measure is in keeping with the principles of research where no harm should come to participants from their participation in research (IFST 2015: 13).

The time allocated for the consumer acceptance sensory evaluation of the study was approximately 10–15 minutes per child. Each child rated the snack food items according to appearance, taste and texture (two samples each with different amounts of *Moringa*) by means of a validated facial Hedonic scale, with the P & K verbal anchors ranging from "super good" to "super bad" (Stone and Sidel 2007; Guinard 2001: 256). The purpose of this was to determine the most preferred amount of *Moringa* leaf in the snack food item either 1g or 2g.

Two variants of the product were sampled by the participants; samples were coded in order to prevent bias. The sample containing 1g of *Moringa* was labelled 123, and the 2g of *Moringa* sample, ABC. The tables were setup with water (palate cleanser) as well as the two samples (Figure 3.5), prior to conducting the tasting (IFST 2015). Participants were requested to answer as honestly as possible, and were informed that there were no incorrect answers. The

researcher then proceeded with the tasting. Sample 123 was rated first as this sample contained a lower amount of the *Moringa*.

The following instructions were given;

- Please be as honest as possible.
- Drink a sip of water.
- Open the container labelled 123, remove a chip, and look at the chip. Now tick under the face that you think best describes the chips appearance.
- Next take another chip from the container labelled 123 and taste it. Now tick under the face that you think best describes the chip's taste.
- Take another chip from the same container and place it in your mouth. Now tick under the face that you think best describes the chip's 'mouth' feel/ texture.

Prior to the sensory evaluation, the researcher explained the different sensory attributes to the children without introducing any bias towards the samples presented. Participants were required to take a sip of water before the same procedure was conducted with sample ABC (2g *Moringa*/22g serving).Potable water was also placed on the table as a palate cleanser between the tasting of each sample (Figure 3.5). Participants were encouraged to eat as many chips as they wished from the two samples presented to them in order to decide on the response.

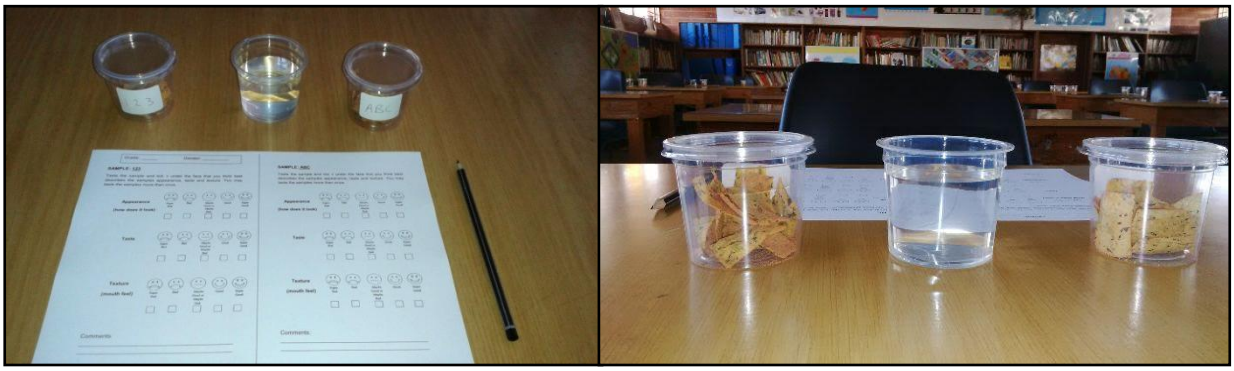


Figure 3.5: Set-up for consumer acceptance sensory evaluation

The set-up for the consumer acceptance sensory evaluation comprised two *Moringa* chip samples, namely, sample 123 (1g *Moringa*/22g serving) and sample ABC (2g *Moringa*/22g

serving), and potable water. The children were also given a pencil to use to complete the questionnaire.

Data analysis

Statistical analysis was done by using SPSS version 23® to analyse the differences in the acceptance of the sensory attributes of the snack food item containing different ratios of *Moringa* leaf, with assistance from a statistician. The results are presented using inferential techniques including the use of correlations and chi-square test values ($p<0.05$ is regarded as significant). Figure 3.6 depicts a summary of the phases that occurred in the research study.

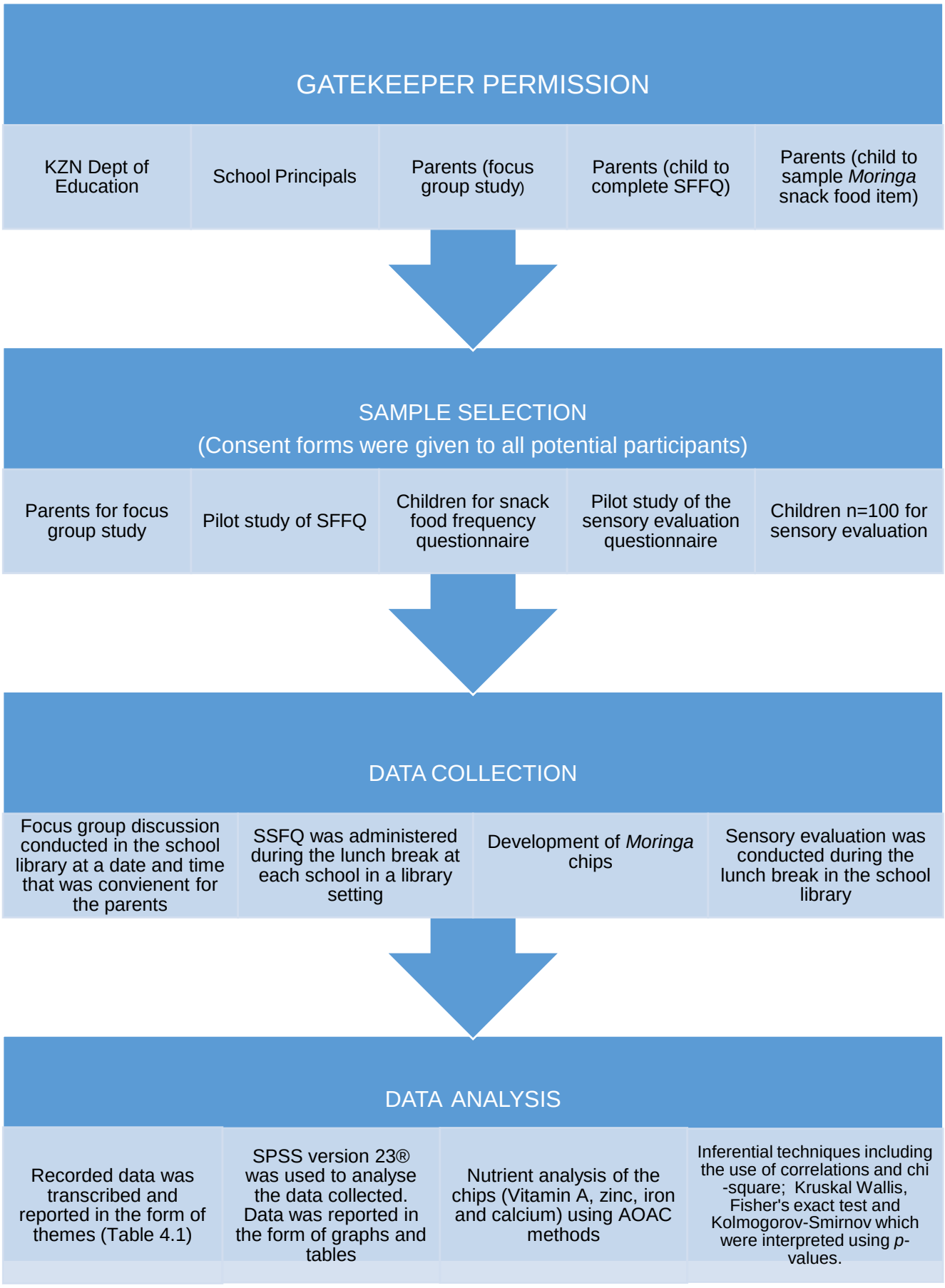


Figure 3.6: The research design

3.6 Validity

Validity, referred to as accuracy, can be described as how close a measurement or study finding can come to the truth (Myer and Karim 2007: 156). The validity of a measurement instrument, therefore, refers to the degree to which the instrument measures what it is required to measure (Delport *et al.* 2011: 172). Content validity of the data collection tool was strengthened by using the FFQ as a basis on which the structure for the SSFQ was developed (Joubert and Ehrlich 2007). A validated Hedonic scale was used for the consumer acceptance sensory evaluation, and reliability was checked by means of a pilot study. This was done in order to ensure that the visual and verbal anchors used were suitable for the intended age group.

3.7 Reliability

Reliability can be defined as the measuring instrument's ability to obtain consistent numerical results each time it is applied (Delport *et al.* 2011: 177). The primary concern of reliability is not with what is being measure, but how well it is being measured (Delport *et al.* 2011: 178). Reliability was maintained by piloting the questionnaire and removing those questions that were deemed 'confusing' or ambiguous.

3.8 Data quality control and reduction of bias

The focus group discussions were recorded using a digital recorder and notes were taken by the moderator during the discussion. The SFFQ was piloted to ensure there was no ambiguity and it was easy to understand. The consumer acceptance sensory evaluation questionnaire was also piloted by children in the same grades used in the study. These children were not included in the main study.

Nutritional analysis of the three samples was conducted three times; the average results are reported in the study. All the equipment (calibrated scale, measuring jug, pots, and wooden spoons) used in the different sample preparation of the chips were the same for every batch prepared. The same brand of ingredients was used for all samples prepared. Once the chips were cooked in the air fryer, the samples were placed in a plastic zip lock bag that contained seasoning (each batch that was seasoned contained the same seasoning flavour and the same amount of seasoning used). All the samples weighed 22g each and each sample was stored in

an airtight plastic tub. The tubs were labelled with the sample name 123 for the sample with 1g of *Moringa*/22g serving, and ABC for the sample with 2g *Moringa*/22g serving, and the date for quality purposes. During the consumer acceptance sensory evaluation, the children were seated approximately one metre away from one another. This ensured that no copying of responses occurred. The children were also instructed not to communicate in any way during the session.

3.9 Ethical considerations

Strydom (2011: 129) refers to ethics as "a set of widely accepted moral principles that offers rules for, and behavioural expectations of, the most correct conduct towards experimental subjects and respondents, employers, sponsors, other researchers, assistants and students". In order to ensure that the procedures and methods used were ethically sound, permission was obtained from the relevant gatekeepers:

- The research proposal was reviewed and approved by the Durban University of Technology (DUT) Institutional Research Ethics Committee (IREC) and the KZN Department of Education (DoE) research office ethics committees. An ethical clearance number (IREC 040/14) was issued by the research office to conduct research in schools (Annexure I). A safety, monitoring and annual recertification report (Annexure J) to continue the study was also obtained from the DUT IREC.

- Once approval was obtained from the KZN DoE (Annexure K), the researcher then scheduled meetings with the principals of five schools to discuss the nature of the study as well as to obtain permission to conduct research. Unfortunately, one out of the five schools refused to participate as it considered the research a cause of 'disruption' to the academic programme. Permission was granted by the other (four) principals to conduct research (Annexure L).

- Information letters and consent forms were given to all potential participants to pass on to the parent/guardian to grant consent to be involved in the study. Verbal assent was obtained from all the participants before commencing with the SFFQ and the consumer acceptance sensory evaluation. Participants were made aware that should they wish to discontinue participation during any phase, they may do so without any penalties/ negative repercussion.

- In addition, confidentiality was maintained during every phase by use of a coding system as opposed to names. Laboratory assistants involved in preparing the samples were briefed on basic sanitation and dressed in full chef's uniform to avoid possible contamination. The consumer acceptance test consent form included key information such as asking the participants to indicate allergies or intolerances (IFST 2015). Participants with common food allergies were excluded from the study to prevent compromise of the participants' well-being.

3.10 Conclusion

Overall, the researcher ensured that every effort was taken to critically analyse similar research studies in order to report on the research study in an academically and scientifically sound manner; hence the methods and procedures used to conduct this study were also ethically, academically and scientifically sound. This chapter explained in detail the research process used in the study. The next chapter will present the results of this study.

CHAPTER 4

RESULTS

4.1 Introduction

This chapter presents the results and findings obtained from the qualitative and quantitative data in this study. The data collected from the focus group study was grouped into themes and reported in order to identify snacking preferences of children in the study sample. The statistics program, SPSS version 23®was used to analyze the data from the SFFQ and the consumer acceptance sensory evaluation. Results are presented as descriptive statistics in the form of graphs, cross tabulations and other figures. Inferential techniques including the use of correlations and chi square test values are interpreted using *p*-values.

4.2 Focus group discussion and observational study results

The focus group discussion and observational study tie in with objective one and two. The first objective was to conduct a focus group study with the parents/caregivers in order to determine the snacking preferences of primary school children. The results for the focus group study were grouped into themes as presented in Table 4.1. The observational study (objective two) was conducted at two of the primary schools in order to determine the most popular snack items purchased. These results are reported in Figure 4.1. The results from the focus group discussion and the observational study were utilized to compile the SFFQ. The demographic profile of the participants in the focus group discussion comprised of all female participants (n=10), including both the Indian (n=6) and African (n=4) race groups.

Table 4.1: Focus group discussion conducted with parents/caregivers of children in grades 4-7, reported in the form of themes (n=10)

Themes	Focus group questions	Discussion	Direct quotes
Consumption of snack items	How often do you purchase snack foods for your child? Does your child often purchase snack food items from their school tuck shop?	The majority of the participants said snacks were packed with the lunch every day. The children receive spending money almost every day to purchase items from the tuck shop.	'I do make lunch for my kids but they are spoilt, they get spending everyday'.
Choice of snack item	What snack foods does your child prefer? Why do they prefer that specific snack food?	Varieties of snack items that the children preferred included; spookies, snappers, jiggies, thunders, fresh fried chips, popcorn, popsicle. Children purchased these snacks mainly because they are cheap and the taste is addictive.	'Fried chips is the easiest snack for me to give my children when they come home'. 'Spookies and snappers are yummy… I myself love the taste'.
Factors that affect selection of snack item	Is the price of the snack food items important? Are the snack foods your child prefers sold at the school tuck shop? Do your child's friends influence the snack foods your child eats?	Price was viewed as a very important factor; the average amount of spending that is sent is usually between R2.00-R5.00. All the snacks are sold at the school tuck shop. The children usually join a group of friends and they each buy an item and share with each other.	'I have three children, I can't afford to give them a lot of spending' 'The tuck shop has all the things my kids like to eat'. 'My son buys what the other boys like'.
Purchasing of a healthy snack item	Would you purchase a snack food for your child if it were nutritious? Would price play an important factor as to whether you would purchase it or not?	Overall, the majority of the parents were interested in purchasing a healthy snack for their children. The price of the snack would be an important factor however, if the snack was nutritious the parents indicated that they would want their children to eat a healthier snack.	'I don't mind giving my daughter extra spending if I know she will be buying a healthy snack but money is important, the price must be reasonable'.

Findings from the focus group discussion reflect that children were given spending money along with a packed lunch. The snack preferences varied, hence the SFFQ was conducted. Price was identified as an important factor and parents/caregivers responded positively towards purchasing a healthy snack item.

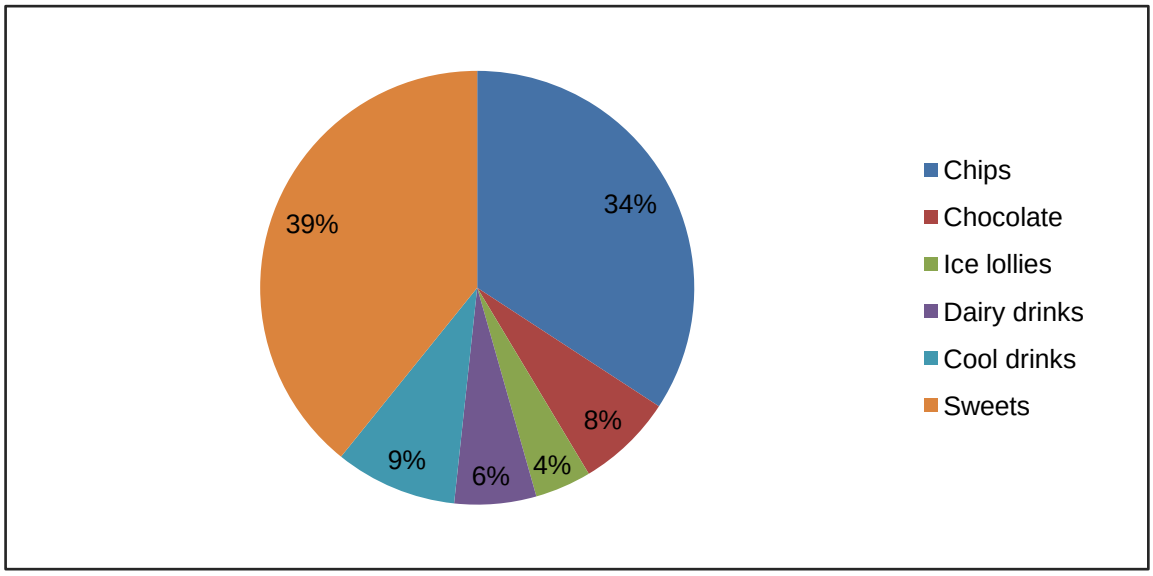


Figure 4.1: Tuck shop snack items reported as the percentage of children (grades 1-7) that purchased items during the school breaks at two schools located in Verulam (n=536)

Figure 4.1 reflects the most common items purchased by children, namely, sweets (39%; n=207). Chips (34%; n=180) were also a popular snack choice. These two snack items were identified as the two most purchased products by children in grades 1-7 during the observational study.

4.3 Snack Food Frequency Questionnaire (SFFQ) results

Objective three of the study was to develop and administer a questionnaire based on snacking preferences as determined by the results from the focus group discussion and observational study. The results obtained from the SFFQ assisted in determining the snack item to be developed.

Table 4.2: Demographic characteristics of the SFFQ participants (n=200)

Demographics	Grade 4	Grade 5	Grade 6	Grade 7
n (%)	50 (25)	50 (25)	50 (25)	50 (25)
Gender				
Male	17 (34)	13 (26)	16 (32)	22 (44)
Female	33 (66)	37 (74)	34 (68)	28 (56)
Race				
Indian	26 (52)	23 (46)	30 (60)	29 (58)
African	23 (46)	27 (54)	19 (38)	21 (42)
Coloured	1 (2)	0	1 (2)	0
Total	100	100	100	100

There was an equal percentage (25%) of children from each of the respective grades. Overall, the ratio of males to females was approximately 1:2 (34.0%: 66.0%). Distribution of race was predominantly Indian (54%), followed by the African (45%) race group. Children from the coloured race group comprised of only 1% of the sample population. The differences in the patterns displayed in Table 4.2 were not significant (Fisher's Exact Test p= 0.302).

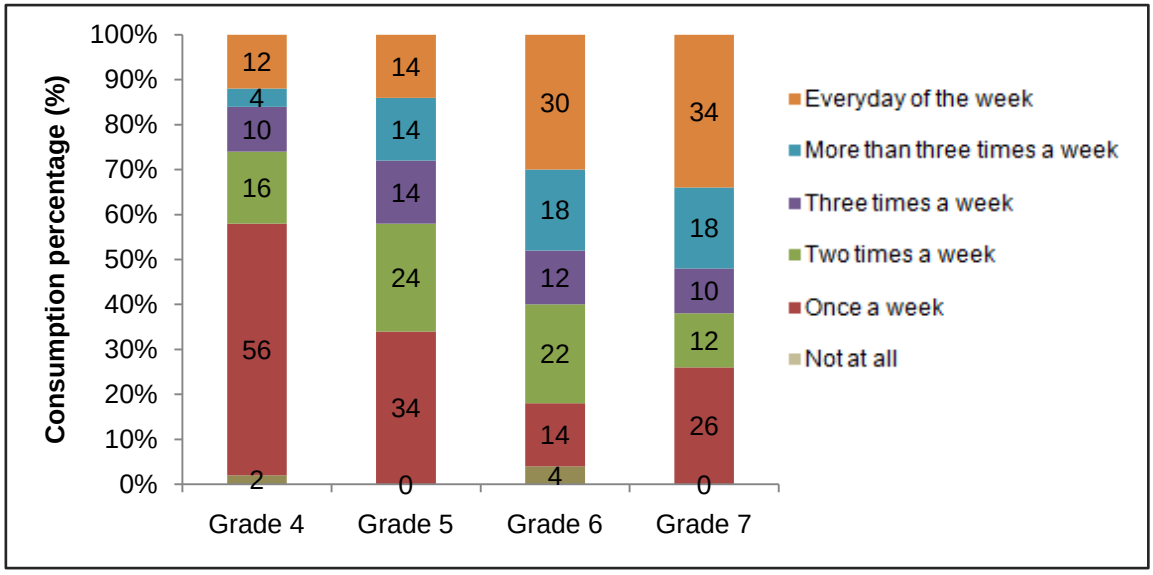


Figure 4.2: Frequency of chip consumption by children (n=200), in grades 4-7 in schools located in Verulam, North of Durban

Consumption of chips as a snack item varied among the grades, with 34% (n=68) of grade 7 children eating chips everyday of the week as opposed to a mere 12% (n=24) of children in grade 4. Trends in the results show the visible increase in the eating of chips 'everyday of the week' from grade 4 (12%; n=24), grade 5 (14%; n=28) and grade 6 (30%; n=60) to grade 7 (34%; n=68). This indicates that the older children in the sample (grades 6-7) consumed chips on a more frequent basis. The consumption of chips was significant throughout the grades (Kruskal-Wallis test; p=0.001).

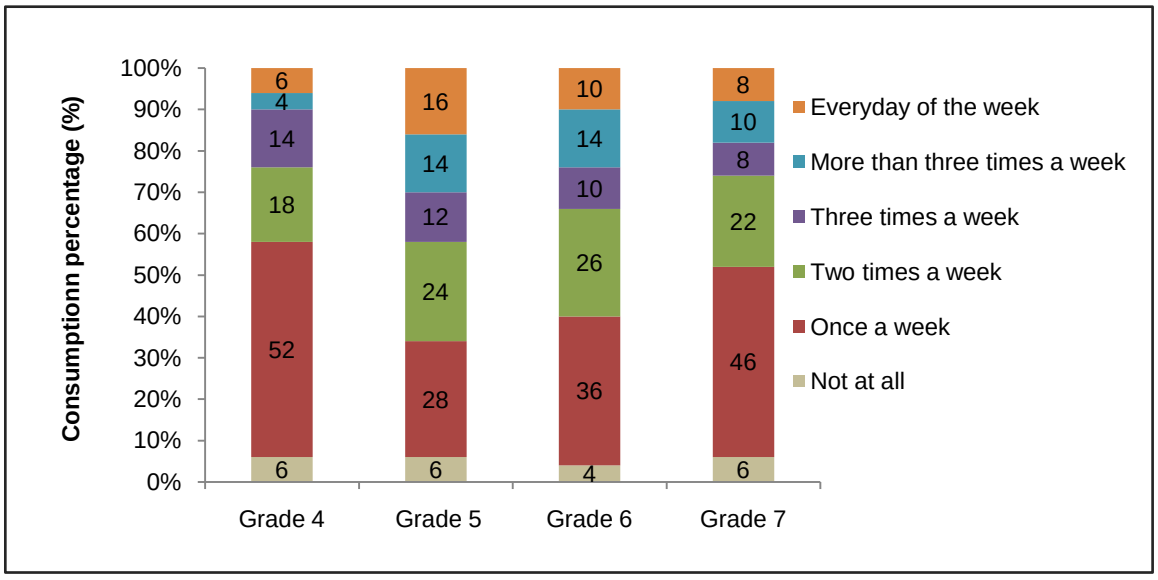


Figure 4.3: Frequency of chocolate consumption by children (n=200), in grades 4-7 in schools located in Verulam, North of Durban

The consumption of chocolate was not significant throughout the grades (Kruskal-Wallis test; *p*=0.058). Almost half of the sample population (40.5%; n=81) consumed chocolate 'once a week'. A small percentage of the children did not eat chocolate at all (5.5%; n=11). According to Figure 4.3, eating trends with regards to chocolate was not varied, the consumption pattern was observed to be fairly uniform across the grades.

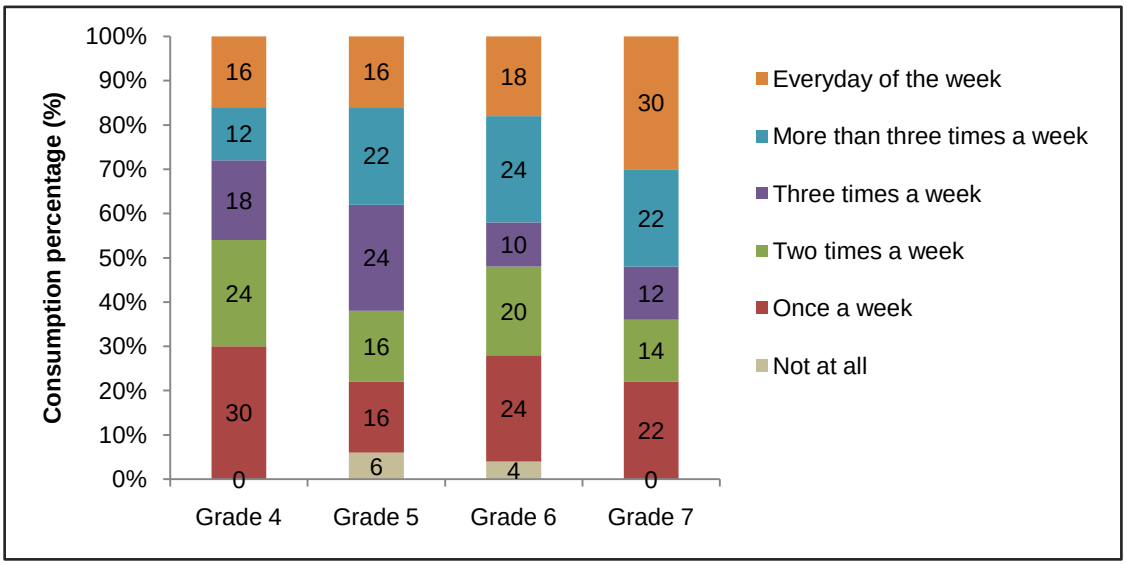


Figure 4.4: Frequency of cold drink consumption by children (n=200), in grades 4-7 in schools located in Verulam, North of Durban

Cold drinks were consumed by almost all the participants (97.5%; n=195) and the consumption of cold drinks was not significant across the grades (Kruskal-Wallis test; *p*=0.206). Figure 4.4 indicates that participants in grade 7 had the highest consumption with 64% (n=128) of the participants in this grade reporting cold drink consumption three times a week or more. A mere 2.5% (n=5) of the sample indicated not consuming cold drinks at all.

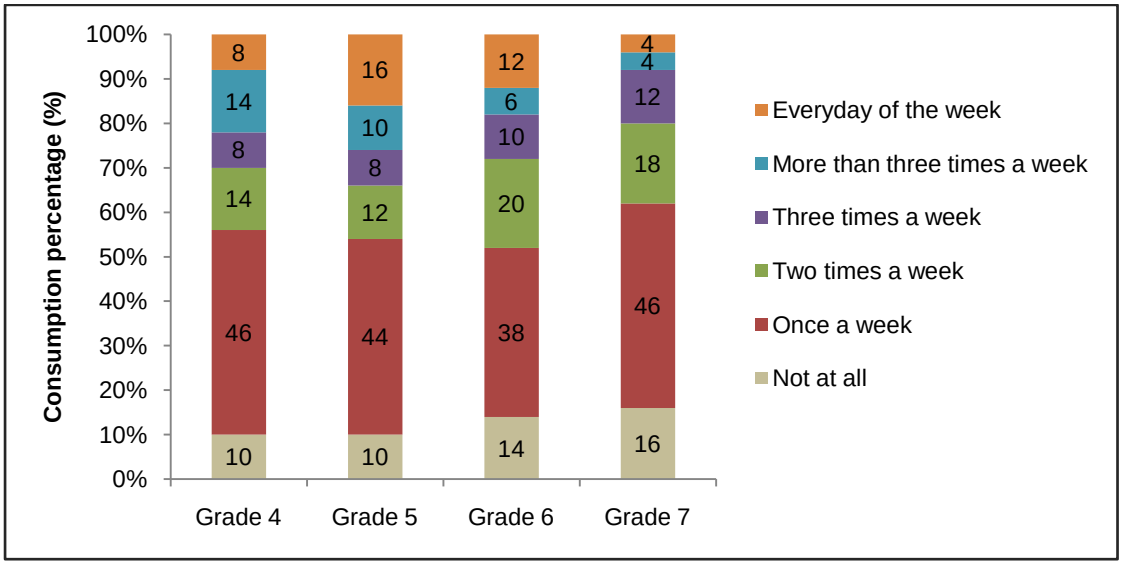


Figure 4.5: Frequency of dairy drink consumption by children (n=200), in grades 4-7 in schools located in Verulam, North of Durban

Consumption of dairy drinks was not significantly different among the grades (Kruskal-Wallis test; p=0.444). Figure 4.5 shows the number of children who did not consume dairy drinks at all increased as the grades progressed (10% in grade 4 and 5 to 16% in grade 7). The lowest frequency of dairy drink consumption was among the grade 7 children, with only 38% (n=76) of this grade consuming dairy drinks three times or more a week. Only 10% (n=20) of the total sample consumed dairy drinks every day.

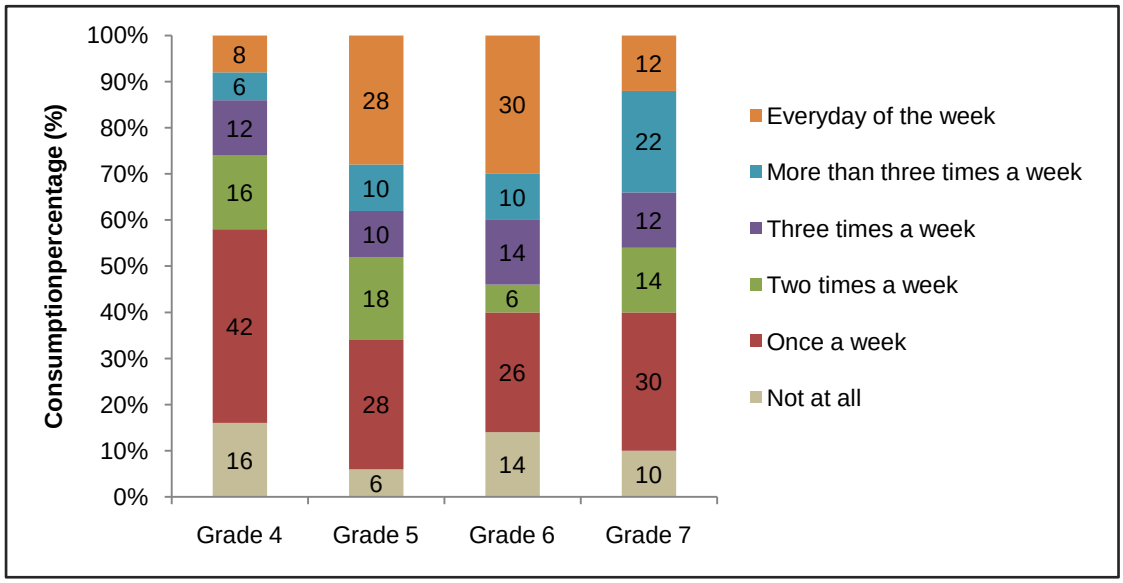


Figure 4.6: Frequency of ice lollies/popsicle consumption by children (n=200), in grades 4-7 in schools located in Verulam, North of Durban

Consumption of ice lollies/popsicles was significant among the grades (Kruskal-Wallis test; *p*=0.017). Figure 4.6 shows that a total of 11.5% (n=23) of the participants did not consume ice lollies/popsicles at all. The highest percentage (16%; n=32) of participants that did not consume ice lollies/popsicles at all were from grade 4. This grade also reported the lowest percentage (8%) with regard to eating these items 'every day of the week'.

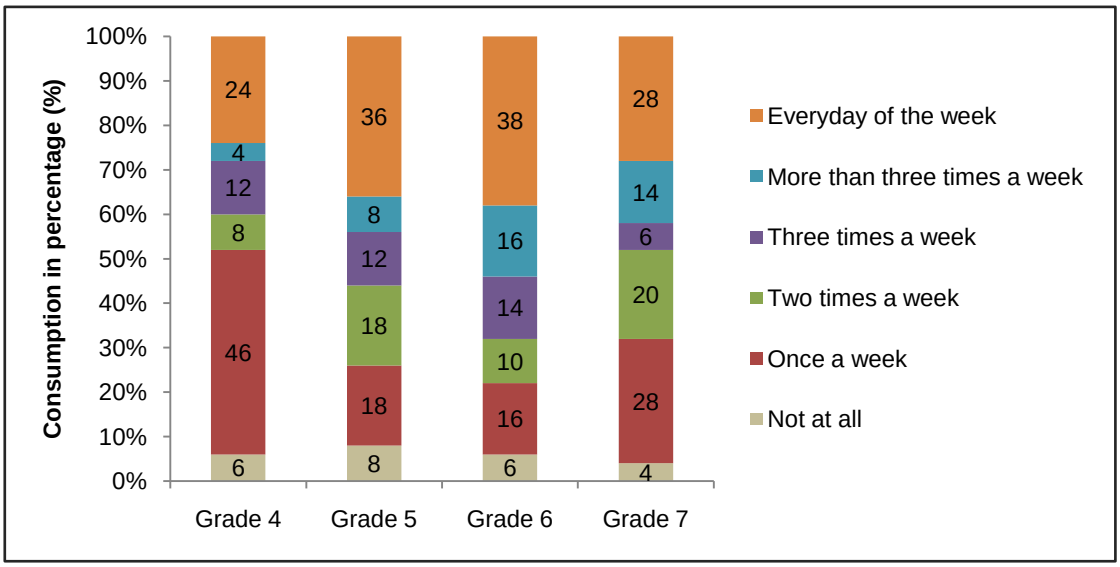


Figure 4.7: Frequency of sweet consumption by children (n=200), in grades 4-7 in schools located in Verulam, North of Durban

The consumption of sweets was not significant among the grades (Kruskal-Wallis; p=0.044). Children in grade 4 consumed sweets less frequently (52% once a week or less) in comparison to the higher grades (grade 5=26%; grade 6=22% and grade 7=32%). Figure 4.7 shows the highest frequency of sweet consumption was by children in grade 7 (38%, n=76 every day). No pattern or trend was observable with regard to the consumption of sweets.

4.4 *Moringa* chip development results

Objective four was to develop a snack food product nutritionally enhanced with *Moringa oleifera* as determined by the results of the SFFQ. Table 4.3 describes the developmental process with regards to recipe formulation.

Table 4.3: *Moringa* chip recipe formulation

INGREDIENT	TRIAL 1 (202g)	TRIAL 2 (196g)	FINAL PRODUCT (228g)
Water	75ml	100ml	125ml
Salt	1g	2g	3.5g
Sugar	-	0.35g	0.35g
Sunflower oil	1.25ml	1.25ml	1.25ml
Polenta	100g	70g	60g
Creamy maize	20g	30g	50g
***Moringa* leaf (dried)**	5g or 10g	5g or 10g	5g or 10g
Cooking spray	Lightly sprayed over chips	Lightly sprayed over chips	Lightly sprayed over chips
BBQ Seasoning	1g	2g	4g

*The amount of *Moringa* for the sample containing 1g *Moringa*/22g serving included 5g of *Moringa* in the dough and the 2g *Moringa*/22g serving included 10g *Moringa* in the dough.

Table 4.4: Methods used to prepare the *Moringa* chips

METHOD	TRIAL 1	TRIAL 2	FINAL PRODUCT
1.	Place the water, salt and sunflower oil in a pot and bring to a boil.	Place the water, salt, sugar and sunflower oil in a pot and bring to a boil.	Same as trial 2.
2.	In a bowl, mix the polenta and creamy maize until well combined.	Same as trial 1.	Same as trial 1.
3.	Slowly add the polenta and creamy maize to the boiling water while constantly stirring to prevent lumps.	Same as trial 1.	Same as trial 1.
4.	Reduce the heat to low and stir for 7 minutes or until the mixture forms a skin on the bottom of the pot.	Same as trial 1.	Same as trial 1.
5.	Place the mixture into a bowl and add the dried *Moringa* leaf, mix until combined.	Place the mixture into a bowl and **leave to cool before adding the dried *Moringa* leaf.**	Same as trial 2.
6.	Using a rolling pin, roll out the dough to a thickness of 0.5cm	**Divide the dough into smaller portions and pass through pasta machine (Jamie Oliver setting 4).**	Same as trial 2.
7.	Cut the chips into 4cmx2.5cm rectangle pieces; spray a light coating of cooking spray over the chips.	Same as trial 1.	
8.	Lightly spray the chips with cooking spray and place in the air fryer basket and then into the air fryer. Set the timer for 11 minutes at 140°C.	Lightly spray the chips with cooking spray and place the chips in the air fryer basket and then into the air fryer. Set the timer for 9 minutes at 160°C **(short time & high temp = crisp chip).**	
9.	Remove from the air fryer and place in a bowl and stir in the seasoning. Store in an air tight container.	Remove from the air fryer and place into a plastic packet with the seasoning. Shake the packet allowing for the chips to be evenly coated with the seasoning. Store in an air tight container.	Remove from the air fryer; **spray the chips with cooking spray** and place into a plastic packet with the seasoning. Shake the packet allowing for the chips to be evenly coated with the seasoning.

In the first trial it was identified that the maize mixture was too dry (insufficient amount of water to cook the polenta and creamy maize). The mixture was extremely crumbly and it was difficult to roll out the dough once cooked. The ratio of polenta to creamy maize was also adjusted because polenta is slightly grainier than the creamy maize. This required a longer cooking time which was not practical. Once the chips were cooked in the air fryer, seasoning was documented as being insufficient during the first and second trial (1g and 2g of seasoning, respectively). Therefore, the amount of seasoning (salt) was increased in the dough. In addition, the amount of BBQ seasoning used to coat the chips was increased.

Table 4.4 focuses on changes made to the recipe method during the trials. The method for steps one to four were kept consistent throughout the trials, with only an ingredient change taking place in trial two (step one). Sugar was added in the second trial to complement the natural sweetness of the polenta and assist in masking the inherent bitterness of *Moringa*. During the first trial, the *Moringa* was added to the dough whilst the dough was still hot. This resulted in the *Moringa* leaves becoming soggy, making it difficult to ensure an even distribution of the leaf throughout the dough. Therefore, it was recommended that the dough is first allowed to cool before the *Moringa* was added in the second trial. The change in step five proved to be successful as the distribution of the *Moringa* was more homogenous compared to the first trial.

The method of using a rolling pin to roll out the dough was ineffective, as the researcher was unable to obtain an even level of thinness. This method of flattening the dough was also time-consuming and neither a feasible nor reliable method for large scale production of the chips. The researcher then decided to experiment with rolling the dough through a pasta machine (Jamie Oliver brand). The dough was divided into smaller portions and then rolled through a pasta machine, starting from setting seven (the thickest) then through setting six, five and lastly, setting four. The width of the dough after being rolled through setting four was acceptable. Using setting three resulted in the dough breaking and not forming a sheet which was required. This method of using a pasta machine to roll the dough proved to be far more successful as the desired thinness was achieved using minimum effort.

The cooking of the *Moringa* chips in the air fryer in the first trial was set at 140°C and the *Moringa* chips cooked for 11 minutes (Table 4.4, Figure 4.8). The researcher and supervisor identified the texture of the chip as being both texturally hard and dry. This could be due to

insufficient water being added during the cooking of the dough, uncontrolled evaporation and the length of cooking time. An article on vitamin A loss during heat processing (Lešková, Kubíková, Kováčiková, Košická, Porubská and Holčíková 2006: 254) reported that vitamin A was fairly stable at temperatures ranging from 120-180°C. Different temperature and time settings were used, keeping in mind that some nutrients are heat sensitive, hence the temperature setting did not exceed 160°C. The ideal cooking time was recorded as 9 minutes as the *Moringa* chips were both crisp and golden. Hence, it can be concluded that a higher temperature (160°C) and shorter cooking time (9 minutes) yielded a *Moringa* chip that was both golden brown and crisp.

The researcher experienced problems regarding the coating of the seasoning on the *Moringa* chips. In the first trial the chips were placed in a bowl with the seasoning and mixed using a spoon. The seasoning did not evenly coat the surface of the chips resulting in most of the seasoning remaining in the bowl. In the second trial, cooking spray was applied over the chips and then placed in a plastic packet with the seasoning. The cooking spray formed an adhesive which assisted the seasoning to evenly coat the chips, deeming this method effective.

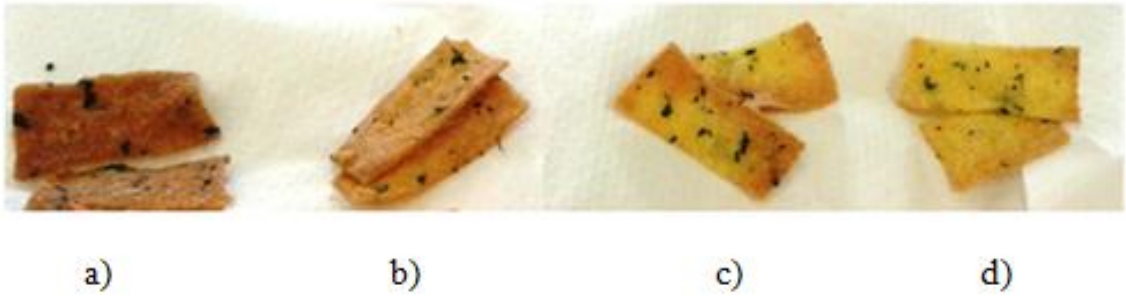


Figure 4.8: *Moringa* chips cooking trials conducted in the air fryer

Figure 4.8 depicts the variance in appearance of the *Moringa* chips cooked at different time intervals. From left to right; image a (11 minutes at 160°C); image b (9 minutes at 160°C); image c (7 minutes at 160°C) and image d (5 minutes at 160°C). The ideal qualities of the chips were obtained after cooking at 160°C for 9 minutes in the air fryer.

The final recipe was standardized including an image of the cooked chips (Annexure E) as well as the detailed process involved in making the chips (Annexure F). The costs involved in making the chips were fairly reasonable, as a 22g portion containing 1g of *Moringa*/ 22g

serving costs R0.88. Considering that the chips would be manufactured in bulk, production costs would be even lower. The selling price of a popular brand of maize chips is R1.50 per 22g portion.

4.4.1 Shelf life and Microbiological test

The shelf life test indicated that the *Moringa* chips were still sensorially acceptable even after having 12 days of accelerated shelf life at 55°C. This translates to 12 weeks room temperature storage (18-25°C) in sealed packaging.

According to the Foodstuffs, Cosmetics and Disinfectants Act, and regulations governing microbiological standards for foodstuffs and related matters (2002: 4), both samples of the *Moringa* chips were safe for human consumption (Table 4.5). The number of colonies present in both sample 123 (1g *Moringa*/22g serving) and sample ABC (2g *Moringa*/22g serving) are lower than the permitted limits. The aerobic bacteria and yeast and mould colonies were lower in sample ABC compared to sample 123. However, both the samples were reported to be safe for consumption.

Table 4.5: Results of the microbiological testing of the *Moringa* chips

	*Permitted number of colonies/1g	Sample 123 (number of colonies/1g)	Sample ABC (number of colonies/1g)
Aerobic bacteria	10^6	328	272
Yeast and moulds	10^4	2568	2128

*Foodstuffs, Cosmetics and Disinfectants Act, Regulations governing microbiological standards for foodstuffs and related matters (2002: 4).

4.4.2 Nutrient analysis

The nutrient analysis meets the requirements of objective five. This was to determine the amounts of vitamin A, calcium, iron and zinc in the product, by means of nutrient analysis using the AOAC referenced methods and compared to the Dietary Referenced Intakes (DRIs) for children aged 9-13 years.

Table 4.6: Nutrient analysis of *Moringa* chip, samples 1, 2 and 3, each containing different amounts of *Moringa* leaf per a 100g sample

Nutrient (100g)	Sample 1 (Sample 123) (1g *Moringa*/22g)	Sample 2 (Sample ABC) (2g *Moringa*/22g)	Sample 3 (3g *Moringa*/22g)
Total Fat (g)	1.85	2.5	-
Total carbohydrates (g)	90.9	88.5	-
Protein (g)	0.4	0.4	-
Sodium (mg)	120	120	-
Vitamin A as retinol (µg)	84.9	100.2	114.3
Calcium (mg)	220	273	234
Iron (mg)	15.0	12.5	9.2
Zinc (mg)	2.05	1.9	2.09

Table 4.6 reflects the nutrient composition of the *Moringa* chip sample containing 1g, 2g and 3g of *Moringa*/22g of chips. Each of the tests conducted used a 100g of the *Moringa* chip sample. There was a proportional increase in the amount of vitamin A as the quantity of *Moringa* increases. The highest amount of calcium was present in sample ABC which contained 2g *Moringa*/22g serving (273mg), with the least amount in sample 123 containing 1g *Moringa*/per 22g serving of chips (220mg of calcium). Iron decreased with an increase in the quantity of *Moringa* from 15.0mg in sample 1 to 9.21mg in sample 3. Zinc however, increased with the largest quantity present in sample 3 (2.09mg). The total fat content was lower in sample 123 containing 1g *Moringa*/22g serving (1.85g) compared to sample ABC

containing 2g *Moringa*/22g serving (2.85g). Nutrient analysis was only conducted for samples included in the consumer sensory evaluation (sample 123 and ABC).

Table 4.7: Nutrient composition of the *Moringa* chips in relation to the percentage of the DRI values for both males and females aged 9-13 years old per 22g serving of chips

	DRI	Sample 1 (Sample 123) 1g *Moringa*/22g (% of DRIs)	Sample 2 (Sample ABC) 2g*Moringa*/22g (% of DRIs)	Sample 3 3g *Moringa*/22g (% of DRIs)
Males (9-13yrs)				
▲Total fat (%)	25-35	1.6-1.2	2.2-1.6	-
Δ Total carbohydrates (g)	130	15.4	14.9	-
Δ Protein (g)	34	0.3	0.3	-
Sodium (mg)	< 2000	1.3	1.3	-
Δ Vitamin A (µg)	600	3.1	3.7	4.2
***Calcium (mg)**	1300	3.7	4.6	4.0
Δ Iron (mg)	8	41.3	34.4	25.3
Δ Zinc (mg)	8	5.6	5.1	5.8
Females (9-13yrs)				
▲Total fat (%)	25-35	1.6-1.2	2.2-1.6	-
Δ Total carbohydrates (g)	130	15.4	14.9	-
Δ Protein (g)	34	0.3	0.3	-
Sodium (mg)	< 2000	1.3	1.3	-
Δ Vitamin A (µg)	600	3.1	3.7	4.2
***Calcium (mg)**	1300	3.7	4.6	4.0
Δ Iron (mg)	8	41.3	34.4	25.3
Δ Zinc (mg)	8	5.6	5.1	5.8

*Adequate intake levels (AI)
Δ Recommended Dietary Allowance (RDA)
▲Acceptable Macronutrient Distribution Range (AMDR)

Table 4.7 reflects that one portion (22g) of the *Moringa* chips contributed a small amount of fat for both samples [sample 123 contained 1g *Moringa*/22g serving (1.6-1.2%) and sample ABC contained 2g *Moringa*/22g serving (2.2-1.6g)]. The sodium content of a 22g serving of the chips contributed only 1.32% of sodium for both males and females. The chips

contributed a substantial amount of non-haem iron (41.3%, 34.4% and 25.3% for samples 1, 2 and 3 respectively) for both males and females aged between 9-13 years. Macronutrient analysis was only conducted for samples included in the consumer sensory evaluation (sample 123 and ABC). Nutrient analysis was only conducted once due to financial limitations.

Table 4.8: Nutritional comparison of a popular brand of maize chips and the *Moringa* chips per a 22g serving.

	Energy (kJ)	Protein (g)	Total carbohydrates (g)	Total fat (g)	Sodium (mg)
Sample 123	336	0.1	20	0.4	52.7
Sample ABC	333	0.1	19.5	0.5	52.8
***Popular maize chips**	504	1.4	12	8	100

*The nutritional information of a popular brand of maize chips consumed by the sample was used as reference

Table 4.8 is a comparison of the nutritional composition of three different types of chips namely, sample 123 (1g *Moringa*/22g of chips), sample ABC (2g *Moringa* per 22g of chips) and a popular brand of maize chips. The results indicated that the energy, total fat and sodium content of both the *Moringa* chips were superior to the maize chips. Remarkably, the sodium content of sample 123 (52.7mg) and ABC (52.8mg) was almost half that of the popular brand of maize chips (100mg). The *Moringa* chips were significantly lower in fat (less than 1g of fat per 22g serving). The popular brand of maize chips contained a higher amount of protein due to the inclusion of hydrolysed vegetable protein (soy) added by the manufacturer. The sodium values are represented as per the WHO recommended guidelines (WHO 2003).

4.5 Consumer acceptance sensory evaluation results

The consumer acceptance sensory evaluation was conducted in order to investigate objective six, which was to determine the sensory appropriateness and acceptability of the snack product by means of consumer acceptance sensory evaluation. The results below indicate the demographic data as well as the preferred sensory attributes for each sample (123 and ABC).

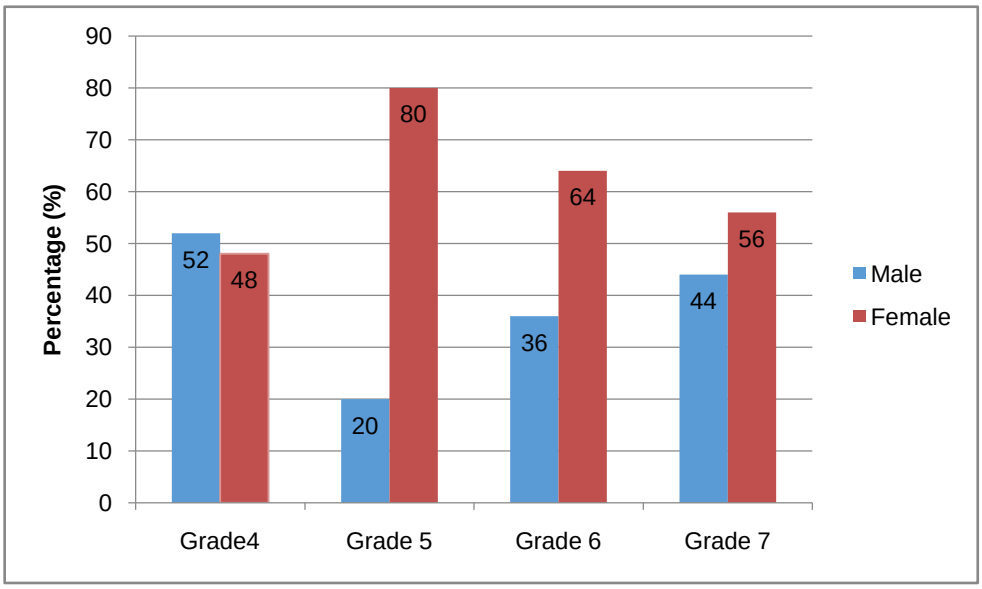


Figure 4.9: Gender distribution among grades 4-7 (n=100) for consumer acceptance sensory evaluation

Generally, there were more females (62%) who participated in the consumer acceptance sensory evaluation as compared to males (38%). Figure 4.9 shows a considerable difference in gender distribution in the grade 5 cohort with the highest percentage of female participants (80%). Gender distribution was fairly equal in grades 4 and 7. Variations in gender distribution among the grades were due to more girls attending the schools as opposed to boys. Limitations also existed where permission to participate in the research study was not obtained from certain children, which could also contribute to the lack of participation of boy children.

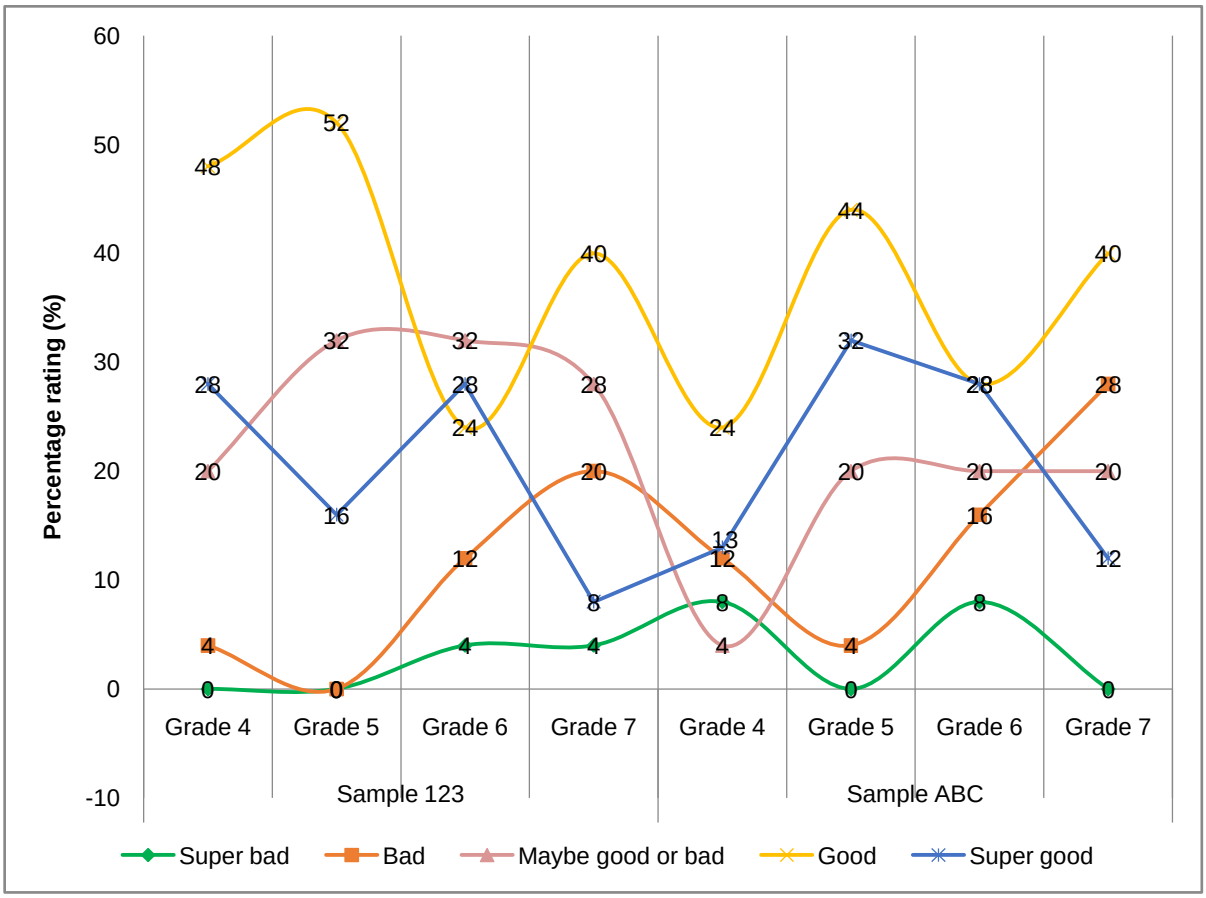


Figure 4.10: Rating of the appearance by children (n=100) in grades 4-7 from schools located in Verulam, North of Durban

Clearly visible on Figure 4.10 is that the appearance of both samples were rated as being 'good' by majority of the children in grade 4-7. A smaller percentage of children rated the appearance of sample 123 (1g *Moringa*/22g serving) as being 'super bad' (2%) as compared to sample ABC (2g *Moringa*/22g serving, 4%). Children in grade 7 were similar in the rating with 40% rating both samples as 'good'. The children in grade 6 were more approving of sample 123, with 28% regarding the sample as 'super good'. Overall, sample 123 was observed as being more acceptable than sample ABC.

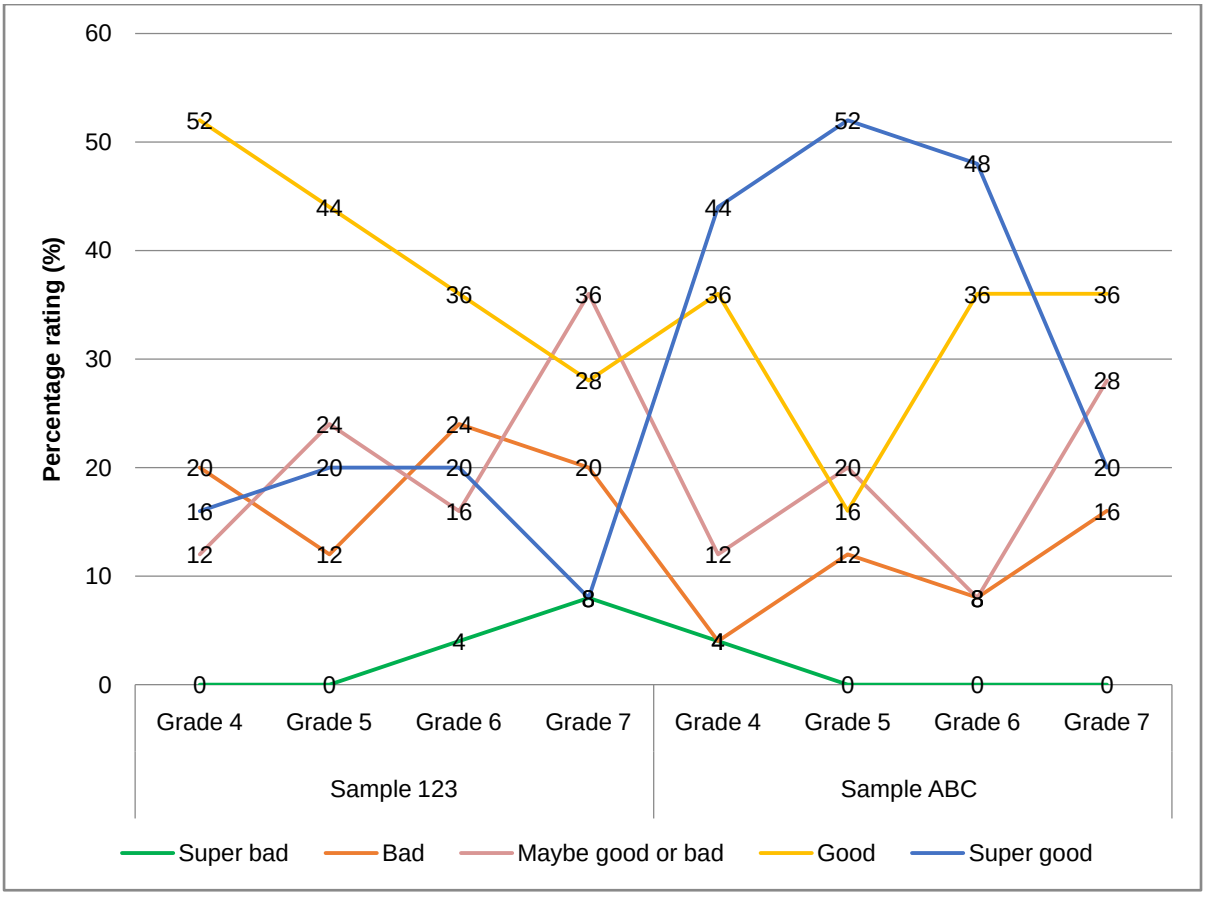


Figure 4.11: Rating of the taste by children (n=100) in grades 4-7 from schools located in Verulam, North of Durban

More than half of the grade 4 children (52%) rated the taste of sample 123 (1g *Moringa*/22g serving) as 'good' as opposed to 'bad' (20%). Figure 4.11 depicts that there was an increase in preference for sample 123 (16% rating 'super good') to sample ABC (40% rating 'super good). An increase was also noted among the 'super bad' rating scale with sample 123 and ABC being rated 'super bad' by 3% and 1% respectively.

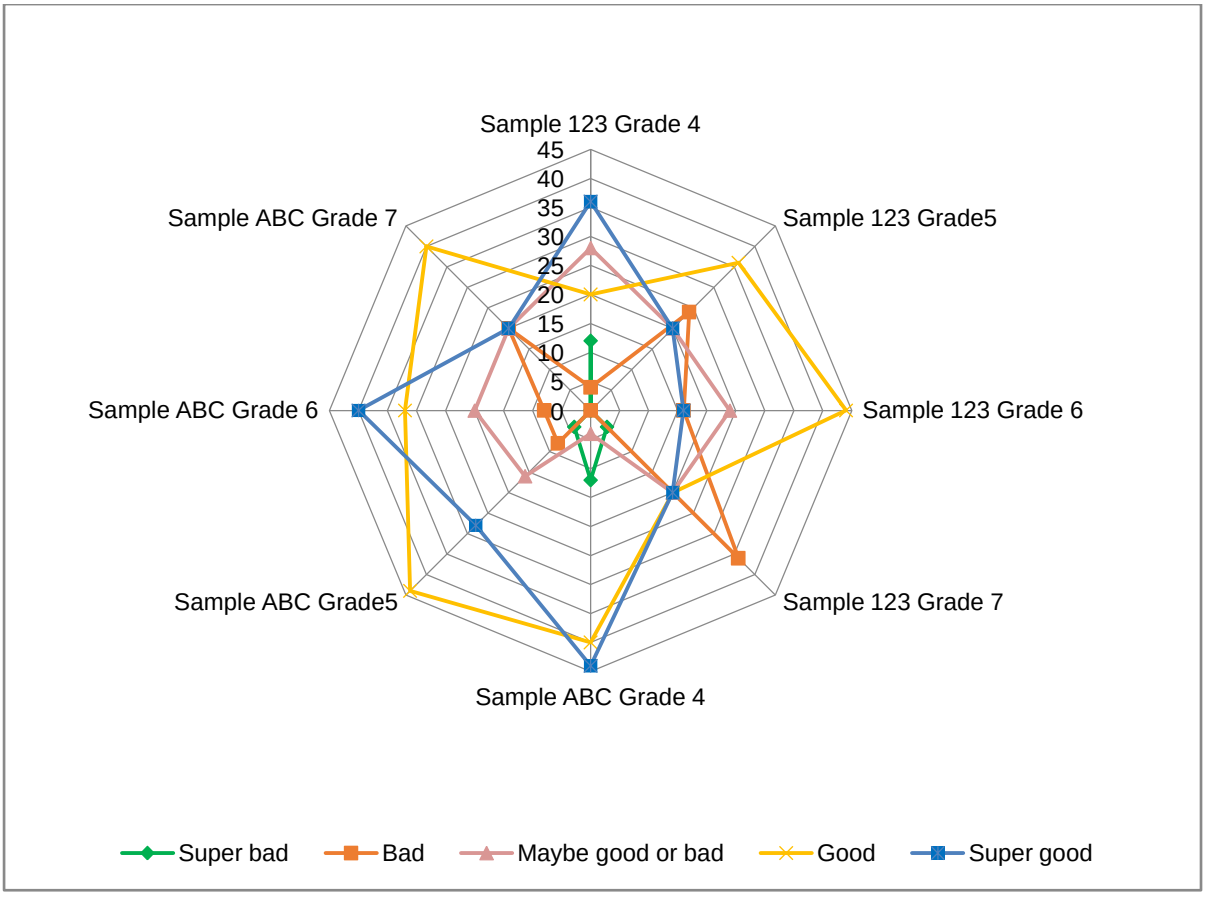


Figure 4.12: Rating of the texture by children (n=100) in grades 4-7 from schools located in Verulam, North of Durban

According to Figure 4.12, generally a better response was shown towards sample ABC (2g *Moringa*/22g serving) for texture (39%). The majority of the children from grades 4 and 5 rated sample ABC as being either 'super good' (44% and 28%) or 'good' (40% and 44%). Sample 123 (1g *Moringa*/22g serving) received a higher percentage of the 'bad' and 'super bad' rating by all the grades (22%). It can be concluded that the texture of sample ABC was more acceptable than sample 123.

Table: 4.9: Sensorial relationship (Fisher's Exact Test) between sample 123 (1g *Moringa*/22g serving) with gender and grade (n=100)

	Grade (*p value*)	Gender (*p value*)
Appearance	0.141	0.436
Taste	0.490	0.471
Texture	0.096	0.755

Fisher's Exact Test

According to the sensory results (Table 4.9), none of the sensory attributes displayed a significant relationship with either the learner's grade or gender (p>0.05).

Table: 4.10: Sensorial relationship (Fisher's Exact Test) between sample ABC (2g *Moringa*/22g serving) with gender and grade (n=100)

	Grade (*p value*)	Gender (*p value*)
Appearance	0.040*	0.863
Taste	0.197	0.132
Texture	0.141	0.040*

*p value < 0.05 is considered significant

Fisher's Exact Test

The grade of the learner did play a role in terms of how appearance appealed to them (p=0.040). The gender of the learner influenced the acceptance of the texture of sample ABC (2g *Moringa*/22g serving) (p=0.040). These relationships are further explained in Table 4.11.

Table: 4.11: Sensory acceptance stratified by grade and gender for the appearance of sample 123 and sample ABC (n=100)

Category		Appearance123 (n=100)					Appearance ABC (n=100)				
Grade	**Gender**	**Super bad %**	**Bad %**	**Maybe good/bad %**	**Good %**	**Super good %**	**Super bad %**	**Bad %**	**Maybe good/bad %**	**Good %**	**Super good %**
Grade 4	♂	0.0	7.7	15.4	53.8	23.1	0.0	23.1	0.0	23.1	53.8
	♀	0.0	0.0	25.0	41.7	33.3	16.7	0.0	8.3	25.0	50.0
Mean	♂ **&** ♀	0.0	3.8	20.2	47.8	28.2	8.4	11.5	4.2	24.0	51.9
Grade 5	♂	0.0	0.0	60.0	20.0	20.0	0.0	20.0	20.0	40.0	20.0
	♀	0.0	0.0	25.0	60.0	15.0	0.0	0.0	20.0	45.0	35.0
Mean	♂ **&** ♀	0.0	0.0	42.5	40.0	17.5	0.0	10.0	20.0	42.5	27.5
Grade 6	♂	0.0	33.4	11.1	33.3	22.2	11.1	0.0	11.1	33.4	44.4
	♀	6.3	0.0	43.8	18.8	31.1	6.3	25.0	25.0	25.0	18.7
Mean	♂ **&** ♀	3.1	16.7	27.5	26.0	26.7	8.7	12.5	18.1	29.2	31.5
Grade 7	♂	9.1	18.2	36.4	27.2	9.1	0.0	18.1	27.3	36.4	18.2
	♀	0.0	21.4	21.4	50.1	7.1	0.0	35.7	14.3	42.9	7.1
Mean	♂ **&** ♀	4.5	19.8	28.9	38.7	8.1	0.0	26.9	20.0	39.6	12.7
Total mean%	♂ **&** ♀	1.9	10.1	29.8	38.1	20.1	4.3	15.2	15.8	33.8	30.9
Mean%	♂	2.3	14.8	30.7	33.6	18.6	2.8	15.3	14.6	33.2	34.1
Mean%	♀	1.6	5.4	28.8	42.6	21.6	5.7	15.2	16.9	34.5	27.7

On average, the majority of the participants (64.7%) rated the appearance of sample ABC (2g *Moringa*/22g serving) as being acceptable (33.8% good; 30.9% super good). Only 19.5% of the participants collectively rated the sample as being 'bad' (15.2%) and 'super bad' (4.3%). Approximately 15% of the participants rated sample ABC as being neutral. The appearance of sample 123 (1g *Moringa*/22g serving) was rated acceptable by 58.2% of the participants (38.1% good; 20.1% super good). A slightly higher percentage of the participants showed a liking towards the appearance of sample ABC (64.7%) compared to sample 123 (58.2%). In terms of gender, Table 4.11 shows that there was a 2% difference in liking towards the appearance of sample 123 (64.2%), compared to sample ABC (62.2%) by the female

participants. Male participants collectively selected the appearance of sample ABC as the first choice (67.3%) over sample 123 (64.2%). The mean percentage of female participants (7.0%) rated the appearance of sample 123 as ‘super bad’ (1.6%) and ‘bad’ (5.4%), whereas, 17.1% of the male participants rated the appearance as ‘super bad’ (2.3%) and ‘bad’ (14.8%).

The mean percentage indicates that both genders selected the appearance of sample ABC (females=62.2%; males=67.3%) and sample 123 (females=64.2%; males=52.2%) as the first choice. Female participants indicated a mere 2% difference in preference for sample 123 (32.1%) over sample ABC (31.1%). Overall, on average the appearance of sample ABC (64.7%) was selected as the first choice slightly over sample 123 (58.2%).

Table: 4.12: Sensory acceptance stratified by grade and gender for the taste of sample 123 and sample ABC (n=100)

Category		Taste 123 (n=100)					Taste ABC (n=100)				
Grade	**Gender**	**Super bad %**	**Bad %**	**Maybe good/bad %**	**Good %**	**Super good %**	**Super bad %**	**Bad %**	**Maybe good/bad %**	**Good %**	**Super good %**
Grade 4	♂	0.0	15.4	7.7	53.8	23.1	7.7	7.7	15.4	23.1	46.2
	♀	0.0	25.0	16.7	50.0	8.3	0.0	0.0	8.3	50.0	41.7
Mean	♂ **&** ♀	0.0	20.2	12.2	51.9	15.7	3.9	3.8	11.9	36.5	43.9
Grade 5	♂	0.0	0.0	20.0	60.0	20.0	0.0	0.0	40.0	40.0	20.0
	♀	0.0	15.0	25.0	40.0	20.0	0.0	15.0	15.0	10.0	60.0
Mean	♂ **&** ♀	0.0	7.5	22.5	50.0	20.0	0.0	7.5	27.5	25.0	40.0
Grade 6	♂	11.1	11.2	11.1	44.4	22.2	0.0	0.0	0.0	33.6	66.4
	♀	0.0	31.2	18.8	31.3	18.7	0.0	12.5	12.5	37.5	37.5
Mean	♂ **&** ♀	5.6	21.2	14.9	37.8	20.5	0.0	6.2	6.2	35.6	52.0
Grade 7	♂	9.0	27.3	27.3	18.2	18.2	0.0	0.0	45.4	27.3	27.3
	♀	7.1	14.3	42.9	35.7	0.0	0.0	28.6	14.3	42.9	14.2
Mean	♂ **&** ♀	8.1	20.8	35.1	26.9	9.1	0.0	14.3	29.8	35.1	20.8
Total mean%	♂ **&** ♀	3.4	17.4	21.2	41.7	16.3	1.0	8.0	18.9	33.0	39.1
Mean%	♂	5.0	13.5	16.5	44.1	20.9	1.9	1.9	25.2	31.0	40.0
Mean%	♀	1.8	21.4	25.8	39.2	11.8	0.0	14.0	12.5	35.1	38.4

According to Table 4.12, only 9% of the participants collectively rated the sample as being 'bad' (8%) and 'super bad' (1%). The majority of the participants in all the grades (72.1%) rated the taste of sample ABC (2g *Moringa*/22g serving) as being acceptable (33.0% good; 39.1% super good). The taste of sample 123 (1g *Moringa*/22g serving) was rated positively by 58% of the participants (41.7% good, 16.3% super good). With regard to gender, the mean values indicate a greater percentage of females selected sample ABC (73.5%) as the first choice in comparison to sample 123 (50.9%). The male participants, however, had a similar liking for both sample ABC (71.0%) and sample 123 (65%). On average, only 20.8% of the participants rated sample 123 as being 'super bad' (3.4%) and 'bad' (17.4%). However, the

taste for sample ABC was rated as ‘super bad’ (1.0%) and ‘bad’ (8.9%) by only 9% of the participants.

The results presented in Table 4.12, indicate that the taste of sample ABC was preferred slightly more by the female participants (73.5%) than the males (71.0%). In contrast, majority of the participants who displayed a liking towards the taste of sample 123 were males (65.0%), compared to the females (51.0%). Overall it can be said that a much higher percentage of the participants preferred the taste of sample ABC (72.0%) compared to sample 123 (58.0%). An average of 73.5% of female participants selected the taste of sample ABC as the first choice compared to males (71.0%).

Table: 4.13: Sensory acceptance stratified by grade and gender for the texture of sample 123 and sample ABC (n=100)

Category		Texture123 (n=100)					Texture ABC (n=100)				
Grade	**Gender**	**Super bad %**	**Bad %**	**Maybe good/bad %**	**Good %**	**Super good %**	**Super bad %**	**Bad %**	**Maybe good/bad %**	**Good %**	**Super good %**
Grade 4	♂	7.7	7.6	30.8	23.1	30.8	15.4	0.0	7.6	30.8	46.2
	♀	16.7	0.0	25.0	16.7	41.6	8.3	0.0	0.0	50.0	41.7
Mean	♂ **&** ♀	12.2	3.8	27.9	19.9	36.2	11.9	0.0	3.8	40.4	43.9
Grade 5	♂	0.0	20.0	0.0	60.0	20.0	20.0	0.0	0.0	60.0	20.0
	♀	0.0	25.0	25.0	30.0	20.0	0.0	10.0	20.0	40.0	30.0
Mean	♂ **&** ♀	0.0	22.5	12.5	45.0	20.0	10.0	5.0	10.0	50.0	25.0
Grade 6	♂	0.0	11.1	11.1	55.6	22.2	0.0	0.0	11.1	22.2	66.7
	♀	0.0	18.8	31.3	37.4	12.5	0.0	12.5	25.0	37.5	25.0
Mean	♂ **&** ♀	0.0	14.9	21.2	46.5	17.4	0.0	6.2	18.1	29.9	45.8
Grade 7	♂	9.0	36.4	18.2	27.3	9.1	0.0	18.1	0.0	45.5	36.4
	♀	0.0	35.7	21.4	14.3	28.6	0.0	21.4	35.7	35.8	7.1
Mean	♂ **&** ♀	4.5	36.1	19.8	20.8	18.8	0.0	19.8	17.9	40.6	21.7
Total mean%	♂ **&** ♀	4.2	19.3	20.4	33.0	23.1	5.5	7.8	12.4	40.2	34.1
Mean%	♂	4.2	18.8	15.0	41.5	20.5	8.9	4.5	4.7	39.6	42.3
Mean%	♀	4.1	19.9	25.7	24.6	25.7	2.1	10.9	20.2	40.8	26.0

A high percentage of the participants (74.3%) rated the texture of sample ABC (2g *Moringa*/22g serving) as being acceptable (40.2% rated 'good'; 34.1% rated 'super good'). Approximately 56% of the participants rated sample 123 (1g *Moringa*/22g serving) as 'good' (33.0%) and 'super good' (23.1%). Only 13.2% of the participants collectively rated the texture of sample ABC as 'bad' (7.8%) and 'super bad' (5.5%), compared to sample 123 which was rated 'bad' by 19.3% of the participants and 'super bad' by 4.2%.

In terms of gender, both the male and female participants rated the texture of sample ABC favourably (74.3%) (Males=89.1%; females=66.8%) as compared to sample 123 (56.1%) (Males=62%; females=50.3%).A higher percentage of the participants rated the texture of sample 123 as ‘bad’ (19.3%) and ‘super bad’ (4.2%). Slightly more females (24.0%) than males (23.0%) rated the texture of sample 123 as either ‘bad’ or ‘super bad’. The same can be said for sample ABC, as 13.0% of female participants rated the sample as ‘bad’ (10.9%) and ‘super bad’ (2.1%), compared to 13.4% males that rated ‘bad’ (4.5%) and ‘super bad’ (8.9%).

The results depicted in Table 4.13 indicate that the texture of sample ABC (74.3%) was rated more positively compared to the texture of sample 123 (56.1%).

Table 4.14: Sensory acceptance stratified by grade for the appearance of sample 123 and sample ABC (n=100)

Category	Appearance 123 (n=100)					Appearance ABC (n=100)				
Grade	Super bad (%)	Bad (%)	Maybe good/ bad (%)	Good (%)	Super good (%)	Super bad (%)	Bad (%)	Maybe good/ bad (%)	Good (%)	Super good (%)
Grade 4	0.0	4.0	20.0	48.0	28.0	8.0	12.0	4.0	24.0	52.0
Grade 5	0.0	0.0	32.0	52.0	16.0	0.0	4.0	20.0	44.0	32.0
Mean Grade 4 & 5	0.0	2.0	26.0	50.0	22.0	4.0	8.0	12.0	34.0	42.0
Grade 6	4.0	12.0	32.0	24.0	28.0	8.0	16.0	20.0	28.0	28.0
Grade 7	4.0	20.0	28.0	40.0	8.0	0.0	28.0	20.0	40.0	12.0
Mean Grade 6 & 7	4	16.0	30.0	32.0	18.0	4.0	22.0	20.0	34.0	20.0

A significant percentage of the participants in grades 4-5 (72%) rated the appearance of sample 123 (1g *Moringa*/22g serving) ‘good’ (50%) and ‘super good’ (22%), with 26% rating the sample as ‘maybe good or bad’. Sample ABC (2g *Moringa*/22g serving) received a higher percentage of positive responses from the grades 4-5 (76%); however, more children rated the appearance of sample ABC as ‘bad’ (8%) and ‘super bad’ (4%) when compared to sample 123.

The results presented in Table 4.14 indicate that the younger participants (grades 4-5) rated both samples similarly (sample 123=72%) and sample ABC=76%). A lower percentage of the participants in grades 6-7 indicated a positive response towards sample 123 (50%) and sample ABC (54%). The younger children rated sample ABC more favourably than the older children.

Table 4.15: Sensory acceptance stratified by grade for the taste of sample 123 and sample ABC (n=100)

Category	Taste 123 (n=100)					Taste ABC (n=100)				
Grade	Super bad (%)	Bad (%)	Maybe good/ bad (%)	Good (%)	Super good (%)	Super bad (%)	Bad (%)	Maybe good/ bad (%)	Good (%)	Super good (%)
Grade 4	0.0	20.0	12.0	52.0	16.0	4.0	4.0	12.0	36.0	44.0
Grade 5	0.0	12.0	24.0	44.0	20.0	0.0	12.0	20.0	16.0	52.0
Mean Grade 4 & 5	0.0	16.0	18.0	48.0	18.0	2.0	8.0	16.0	26.0	48.0
Grade 6	4.0	24.0	16.0	36.0	20.0	0.0	8.0	8.0	36.0	48.0
Grade 7	8.0	20.0	36.0	28.0	8.0	0.0	16.0	28.0	36.0	20.0
Mean Grade 6 & 7	6.0	22.0	26.0	32.0	14.0	0.0	12.0	18.0	36.0	34.0

The older participants (grades 6-7) rated sample ABC (2g *Moringa*/22g serving) (70%) more favourably than sample 123 (1g *Moringa*/22g serving) (60%). However, according to Table 4.15, a higher percentage of grades 6-7 participants rated sample 123 as 'bad' (22%) and 'super bad' (6%). The majority of the participants (74%) in grades 4-5 rated sample ABC favourably (2g *Moringa*/22g serving) as 'super good' (48%) and 'good' (26%).

There was no significant difference between the liking for the taste of sample 123 (p=0.490) and sample ABC (p=0.197). Both samples were rated similarly for taste.

Table 4.16: Sensory acceptance stratified by grade for the texture of sample 123 and sample ABC (n=100)

Category	Texture 123 (n=100)					Texture ABC (n=100)				
Grade	Super bad (%)	Bad (%)	Maybe good/ bad (%)	Good (%)	Super good (%)	Super bad (%)	Bad (%)	Maybe good/ bad (%)	Good (%)	Super good (%)
Grade 4	12.0	4.0	28.0	20.0	36.0	12.0	0.0	4.0	40.0	44.0
Grade 5	0.0	24.0	20.0	36.0	20.0	4.0	8.0	16.0	44.0	28.0
Mean Grade 4 & 5	6.0	14.0	24.0	28.0	28.0	8.0	4.0	10.0	42.0	36.0
Grade 6	0.0	16.0	24.0	44.0	16.0	0.0	8.0	20.0	32.0	40.0
Grade 7	4.0	36.0	20.0	20.0	20.0	0.0	20.0	20.0	40.0	20.0
Mean Grade 6 & 7	2.0	26.0	22.0	32.0	18.0	0.0	14.0	20	36.0	30.0

The majority of the participants (78%) in grades 4-5 rated the texture of sample ABC (2g *Moringa*/22g serving) favourably with 'good' (42%) and 'super good' (36%) ratings. According to Table 4.16, the older participants (grades 6-7) also rated sample ABC (70%) more positively than sample 123 (1g *Moringa*/22g serving, 60%). However, a higher percentage of grades 6-7 participants rated the texture of sample 123 as 'bad' (22%) and 'super bad' (6%).

There was no significant difference between the liking for the texture of sample 123 (p=0.096) and sample ABC (p=0.141). Both samples (ABC and 123) received similar ratings for texture by the participants.

4.6 Summary of results

Overall, the results from the focus group discussion revealed that children consumed snacks frequently and were given money to purchase snack items from the school tuck shop. Price was a trend noted in factors that affected snack selection. The parents/caregivers responded positively towards purchasing a snack that was nutrient-rich to send with the children's lunch pack. However, it was noted that the price should be reasonable. The participants of the SFFQ were mainly of the Indian and African race group, with an equal number of participants in each grade. Results of the SFFQ indicated that the most popular snack items were chips, cold drinks and sweets; therefore these items were reviewed to determine the most viable option for further development.

It was decided by the researcher and the supervisor that maize chips would be the snack item enhanced with three different amounts of *Moringa*. The consumer acceptance sensory evaluation comprised two samples of chips, sample 123 (1g *Moringa*/22g serving) and sample ABC (2g *Moringa*/22g serving). The results of the consumer acceptance sensory evaluation showed that sample ABC (2g *Moringa*/22g serving) scored higher for the sensory attributes (taste and texture) compared to sample 123 (1g *Moringa*/22g serving).

4.7 Conclusion

Chapter 4 comprised the results of the study for the various phases, namely, observational study the focus group study, SFFQ, recipe development, nutrient analysis as well as the consumer acceptance sensory evaluation of the two samples containing *Moringa*. The results from Chapter 4 will be discussed in detail with supporting literature in Chapter 5.

CHAPTER 5

DISCUSSION

5.1 Introduction

In the previous chapter, the results of the main study were presented. In this chapter, the results of the study are discussed in relation to the objectives, and comparisons are made with published studies. The purpose of this chapter is to identify similarities and differences with reference to studies of a similar nature.

5.2 Snacking preferences of school children

A number of methods can be used to identify the snacking preferences of children, as objective one of this study is conducting a focus group study with parents/caregivers in order to determine the snacking preferences of primary school children Almost all the participants agreed that should an enhanced snack item be available, price would definitely be a factor to be considered. A study conducted by Temple, Steyn, Myburgh and Nel (2006: 252) in Cape Town, SA, on food items consumed by students aged 12-16 years attending schools in different socio-economic areas revealed that 72.9% of the participants purchased food at school. The school setting may be an ideal environment to encourage the consumption of healthy snack items. Literature has shown that younger children are still developing food preferences, so an intervention at this stage may prevent poor food choices in adulthood (van der Horst, Timperio, Crawford, Roberts, Brug and Oenema 2008: 218).

The focus group discussion identified important factors that may influence the snacking preferences of children (Table 4.1). The theme entitled ‘Factors that affect selection of snack foods’, aimed at understanding the force (parental or peer) that drives the purchase of certain snack items. Parental influence may affect snacking choices of children but peers have a stronger impact on snacking choices children make (Giese *et al.* 2015: 1). In the school setting, children are surrounded by peers who play an influential role in purchasing decisions. In the focus group study (Table 4.1), a parent stated: “My son will buy what his friends buy”; this reinforces the results of the study conducted by Giese *et al.* 2015: 1). Focus group studies conducted with mothers of preschool-aged children from low socio-economic school (SES) backgrounds revealed that they also had an affinity towards salty and sweet snacks (Fisher *et al*. 2015: 68). Similarly, the results in this study also showed that some parents/caregivers

indicated that they thought certain snacks were salty and sweet; however some indicated that these snacks tasted ‘yummy’.

5.3 Characteristics and eating habits of children in primary schools

The type and variety of snack food items available at school tuck shops have a direct impact on the characteristics and eating habits of children in primary schools. The results of the observation study (objective 2) showed a limited number of healthy snacks, hidden (possibly due to a lack of popularity) among an array of unhealthy snacks. Most of the snacks were high in sugar, salt and/or fat. Cheaper snack items are generally high in fat and/or carbohydrates (sugar) and salt. The observational study indicated that the most popular snacks purchased from the tuck shops were sweets (39%) and chips (34%). Given the amount of time children spend at school (approximately 8 hours), the purchases made at the school tuck shop may play an influential role in unhealthy eating practices. In this study, snack items were packed with the child’s lunch and the child was also given money to purchase snacks at the school tuck shop. A study in the Netherlands focusing on snacking showed that snack items available at the tuck shops may either encourage or deter purchasing of healthy snacks because of limited variety and high prices (van der Horst *et al.* 2008: 217). In addition, snacking is linked with an increase in body mass which is mainly due to the high fat and/or energy content. Essentially children may experience a sense of satiety; however, these snack items lack the nutrients needed for optimum growth (Bleich and Wolfson 2015: 9).

Focus group participants were posed the question, “Why do your children prefer that specific snack food?” A participant replied, “Spookies and snappers are yummy. I myself love the taste”. Eating practices and food preferences are often mirrored by children. Overweight is indicative of a positive energy balance, meaning that energy intake is greater than energy expenditure. Factors affecting the intake of energy-dense snack foods need to be determined before an effective intervention can be put into place (Gevers *et al*. 2015: 184). Parenting plays an imperative role in the eating habits of children. Set rules and boundaries regarding what the child is allowed and not allowed to eat has shown a positive result in terms of these children being of a healthier weight (Sleddens, Gerards, Thijs, Vriesand Kremers 2011: e12-15). Results from a study conducted by Brown and Odgen (2014: 268) identified that the snacking habits of parents and their children were similar. Snack items such as crisps (chips), chocolates and biscuits were identified as popular snack items. Similarly, in this study,

children's food choices could be mirrored by those of parents/caregivers who reported eating healthy snacks.

The results of this study showed that there was an increase in the eating of chips 'everyday of the week' from grade 4 (12%), grade 5 (14%), and grade 6 (30%) to grade 7 (34%). This indicates that the older children in the sample (grades 5-7) consumed chips on a more frequent basis, representing a sense of ownership in terms of buying behaviour. It is simply not snacking that poses a problem, rather the actual types and quantities consumed (Asiedu, Jantuah and Anderson 2012: 42). Notably, as a child grows older, a sense of ownership and need for independence results in the child having more control over food choices (Nørgaard, Nørgaard, and Grunert 2013: 176).

The SFFQ results in this study identified cold drinks as being consumed by almost all the participants (97.5%) and the consumption of cold drinks was not significant across the grades (Kruskal Wallis; p=0.206). The international FAOSTAT FBS survey on popular foods identified soft drinks (cold drinks) as the second most commonly purchased street food (fruit being the most common). This is a cause for concern as studies have linked high sugar intake (commonly from sugar sweetened soft drinks) with obesity and NCDs. In SA, total soft drink consumption increased by 68.9% from the year 1999 to 2012 (FAOSTAT 2005).

The results of the SFFQ in this study provided a clear indication that the three most popular snacks that children purchased were cold drinks, chips and sweets. Modifications to snack items would only be effective if the snack item was popular to begin with. A literature review by Ronquest-Ross, Vink and Siggie (2015: 5) indicated that significant shifts (>30% increases) towards increased consumption of certain foods existed in the following categories: meat, fats and oils, sauces, dressings and condiments, sweet and savoury snacks and soft drinks. In addition, a decrease in vegetable consumption was also noted.

The findings from the focus group discussion with the parents/caregivers in this study clearly showed that children were given spending money if the parents had 'change' (money) to give the child. The cost of snacks also played a crucial role in whether a snack is purchased or not. Research conducted by Morar, Coopoo, Shaw and Shaw (2014: 103) identified that children from high SES backgrounds tend to snack more than those from underprivileged/low SES backgrounds. This is an essential factor when considering the frequency of snack items being

purchased and consumed. A study in Soweto, Johannesburg by Feeley *et al*. (2012: e1) aimed at identifying changes in dietary habits and eating practices of adolescents aged 13, 15 and 17 years (n=1451). The lunch box usage decreased with age, contrary to the increase in number of tuck shop purchases. This research revealed that chips were a popular snack, as 94% of the sample population consumed chips at least once a week. An alarming increase in the number of snack food items and sweetened beverages consumed has become a cause for concern (Skatrud-Mickelson, Adachi-Mejia and Sutherland 2011: 1385). Americans consume more energy rich foods; however, these food items have poor nutrient-density. Research conducted by Skatrud-Mickelson, Adachi-Mejia and Sutherland (2011: 1386) confirms that one of the most popular snacking categories includes salty/savoury snacks such as pretzels and chips. The results of the HAKSA study correlates with the findings of Skatrud-Mickelson, Adachi-Mejia and Sutherland (2011: 1386), as children were observed purchasing energy- dense food items that were also high in sugar, fat and salt (Nossel 2014: 33).

Sugar-sweetened beverages contain a large amount of energy, and consumption may lead to high energy intakes thus contributing to the obesity epidemic (Zheng, Rangan, Olsen, Andersen, Wedderkopp, Kristensen, Grontved, Reid-Larsen, Lempert, Farinelli and Heitmann 2015: 38). A study searching for an association between sugar sweetened drinks and other snack items, identified that children and adults who drank sugar sweetened beverages were more likely to consume salty and sweet snack food items (Bleichs and Wolfson 2015: 13). This was indicative in the results found as cold drinks were consumed by the majority of the participants (97.5%), with only 2.5% not consuming cold drinks at all.

According to Temple *et al.* (2006: 253), 'Junk foods' such as chips; soft drinks and candy are widely available at schools. These items are generally, if not always, high in fat and/or sugar and contain little/no nutritional value. These results correlate with the results of this study. The top three snack items from the SFFQ were chips, cold drinks and sweets. Grade 4 children in the Verulam study consumed sweets less frequently (52% once a week or less), in comparison to the higher grades (26% grade 5, 22% grade 6 and 32% grade 7). The highest frequency of sweets consumed was from the grade 6 children (38% every day). No trend pattern was observable with regard to the consumption of sweets.

Results from the SFFQ revealed that consumption of dairy drinks was not significant (Kruskal Wallis; p=0.444). There was a decrease in the consumption of dairy drinks from

grade 4 (10%) to grade 7 (16%). Only 10% (n=20) of the sample population consumed dairy drinks every day. A possible reason for this could be that some tuck shop owners do not have the facilities to stock highly perishable items such as dairy products. The cost of food is higher in rural areas due to transportation costs, low or no volume discounts for rural shops and stock loss due to spoilage, products going beyond the expiry date and theft. School tuck shop owners are usually profit based; hence, products that are in demand are supplied. These items are usually high in sugar, fat and/or sodium. Owners may fear loss of profits if healthy snacks (fruits and vegetables) are stocked and not purchased by the children, or tuck shop owners may lack the resources to stock items such as yoghurt and milk products (Pereira 2014: 9).

Access to unhealthy foods at school needs to be strictly controlled and the promotion of fruits and healthy snacks should be encouraged by educating children and making these items affordable and readily available at school (Bekker 2012: 12). In SA, the HAKSA report for 2014 revealed that children are purchasing items from the school tuck shops, most of which stock unhealthy items (sweets, chocolates, sugar sweetened beverages and chips) (Nossel 2014: 30). The report also noted that SA still has not implemented statutory regulations regarding the marketing and promotion of food to children (Nossel 2014: 38).

A study by Kubik, Wall, Shen, Nanney, Nelson, Laska and Story (2010: 1045) noted that a school food policy which was implemented in 2006-2007 in the US was effective in promoting healthy food choices in the school environment. Healthy food choices were made available at the school (tuck shops and vending machines) and children were encouraged to make healthier food choices. In SA, healthier options cost between 10-60% more per 100g than foods generally consumed. Tuck shop owners may be deterred from stocking healthy foods due to the high food prices (Temple *et al.* 2011: 56).

According to the HAKSA report (Nossel 2014: 32), there are no policies in place to regulate the sale of items in tuck shops in SA. With this being said, the NSNP developed guidelines for tuck shop operators; however, these are not mandatory. The objectives include: promoting the availability of healthy food alternatives at school tuck shops; nutrition education at schools focusing on good nutrition and healthy lifestyles; guidance to tuck shop owners on promoting healthy food, and limiting the portion size of unhealthy foods (sweets, chips and chocolates).

5.4 Nutrition interventions at schools

Nutrition interventions at schools are very popular in developed countries, while few are implemented in SA. The effectiveness and sustainability of the intervention needs to be reviewed.

An intervention study was introduced in Canada aimed to compare the trends before and after introduction of a nutrition policy at schools involving a population-level approach among grade 5 students (n=5508) from 2003 to 2011. The nutrition policy was effective in terms of an increase in milk consumption being reported. However, fruit and vegetable intake did not increase after the policy implementation. In addition, there was an increase in the sugar sweetened beverage consumption which in previous studies (Fung, McIsaac, Kuhle, Kirk and Veugelers 2013: 937), including this study, found that almost all children consumed cold drinks; this was a cause for concern.

A study investigating the impact of school gardening and a healthy snack program for children determined that interventions such as these may be able to increase a child's liking for fruit and vegetables. However, the sustainability and maintenance of these gardens may be a challenge in low SES communities (Triador, Farmer, Maximova, Willows and Kootenay 2015: 176). An intervention study conducted by Øverby, Klepp and Bere (2012: 1100) concluded that by incorporating fruit programs in Norwegian schools (grades 6-7), a significant decrease ($p<0.001$) in the consumption of unhealthy snacks could be achieved. Educating children on the difference between healthy and unhealthy snacks is not merely enough to change snacking behaviour (Joseph 2014:36). Marketing and brand orientation play an influential role in the food/snack items that children prefer.

Fast food marketing aims to lure children with 'meal and a toy' marketing campaigns. These fast food items are high in sugar and/or fat and can be regarded as a contributory factor to excessive weight gain (Jackson-Leach, Moodie, Hall, Gortmaker, Swinburn, James, Wang and McPherson 2015: 2516). A study conducted by Baker, McCabe, Swithers, Payne and Kranz (2015: 202) found that individuals with children were willing to pay more for fruit and vegetable cut into child-friendly shapes. The visual aspect of the fruit and vegetable may be reviewed as a marketing strategy by which to increase fruit and vegetable intake of children.

In order for nutrition interventions and strategies to be effective, the preferred foods consumed by the intended target group must first be identified. Objective three was to develop and administer a questionnaire based on snacking preferences as determined by the results from the focus group and observational study. Food policies aimed at improving the nutritional quality of foods consumed by children need to take into consideration the foods that children prefer and, thereafter, develop healthier alternatives. In the US, out of school time programs have been viewed as an opportunity for interventions in snacking habits of children. A study among 5-10 year old children aimed at determining if children would choose healthy snacks if they were given a choice revealed that children preferred salty/sweet snacks. However, when a healthy snack was the only option, a significant increase in consumption was observed. This emphasizes that in order to promote healthy snacks, unhealthy snacks should not be given as an option (Beets, Tilley, Kyryliuk, Weaver, Moore and Turner-McGrievy 2014: 1441).

This research study first identified the snacking preferences of children which led to the development of *Moringa* chips. Studies show that the most popular snacks provide large amounts of sugar and fat. Interventions directed towards changing the composition of these snacks may aid adolescents in following healthier diets (Sebastian, Cleveland and Goldman 2008: 503).

Food-based approaches such as fortification can be used to improve the nutritional status of individuals. Objective four of the research study utilized a food-based approach by aiming to develop a snack food product nutritionally enhanced with *Moringa* as determined by the results of the questionnaire administered. The *Moringa* chips were prepared in a laboratory setting and precautions were taken in order to prevent contamination of the samples during preparation and storage. The microbiological analyses indicated that the samples were safe for consumption. The shelf life test indicated that the *Moringa* chips were still sensory acceptable after being stored for 12 weeks (accelerated shelf life tests).

The development of the chips was based on the concept of taking a snack that children like and improving the nutritional content. In doing so, the researcher ensured that the chips developed were similar to those consumed by children. This meant that the shape and size of the chips remained as close as possible to other maize-based chips sold at the school tuck shop. The appearance of the chip was preferred by most of the participants across the

different grades (58.2% chose either ‘super good’ or ‘good’ for sample 123 (1g *Moringa*/22g serving and 64.7% selected either ‘super good’ or ‘good’ for sample ABC).

5.5 Nutritional composition of the *Moringa* chips

The nutritional composition of food items more especially snacks, are pivotal to the overall nutritional status of children. Snacks contribute a significant part of a child’s food consumption; therefore, nutritional composition cannot be ignored. Objective five of this research study was to determine the amounts of vitamin A, calcium, iron and zinc of the product by means of nutrient analysis using AOAC referenced methods and comparing the results to the DRIs for children aged 9-13 years.

The *Moringa* chips (both samples) contained almost half the amount of sodium (52.8mg) when compared to a popular maize chip brand (100mg). Sodium reduction in foods is necessary in order to reduce the number of NCDs in SA. The mandatory sodium legislation implemented in 2013 is directed towards reducing the quantity of sodium in items such as bread, soups and gravies. The first phase of the legislation requires manufacturers to reduce the sodium to acceptable limits by June 2016 (Bertram, Steyn, Wentzel-Viljoen, Tollman and Hofman 2012: 744; SA 2013).

Diets high in fat, especially saturated fats, are said to contribute to the obesity epidemic (Lobstein *et al.* 2015: 2516). The results of the nutritional analysis reported that both variants of the *Moringa* chips contained almost less than 1g of fat compared to 8g of fat found in the maize chips children usually consume. Considering that one 22g portion of the *Moringa* chips cost R0.88, it could be said that the *Moringa* chips would make a suitable low fat and sodium option compared to other maize chip brands available on the market.

One portion (22g) of the *Moringa* chips contributes a substantial amount of non-heme iron (41.3% and 34.4% of the RDA for sample 1 and 2 respectively) for females aged between 9-13 years old. Therefore, it can be concluded that the *Moringa* chips contain a substantial amount of iron which could be used to address iron deficiency anaemia. A study conducted by Motadi *et al.* (2015: 453) in Limpopo among preschool children (n=349) concluded that a high proportion of children were deficient in zinc (42.6%) and iron (28%); the authors explained that the deficiencies were possibly due to the children consuming insufficient

sources of foods rich in iron and zinc. Napier and Oldewage-Theron (2015: 12) conducted a study in Durban, KZN, SA on the nutritional status of girls aged 14-18 years (n=156) and women aged 19-28 years (n=367). The study revealed that even though 52.6% of the girls displayed an adequate intake of iron, the girls did not meet the total DRI values for iron. This could be as a result of a diet lacking in iron rich sources.

A study on the food consumption of African- American males identified that a large percentage of the children aged 14-16 years reported consumption of chips (66%), sweetened juices (62%) and carbonated beverages (62%). The dietary assessment also revealed that the children did not meet the Estimated Average Requirement (EAR) for zinc (Kolahdooz, Butler, Christiansen, Diette, Breysse, Hansel, McCormack, Sheehy, Gittelsohn and Sharma 2015: 4).

The low vitamin A content of both samples of the chips (84.9µg and 100.2µg for sample 123 and ABC respectively) may be attributed to the drying and storage conditions of the *Moringa* leaves post-harvest. Drying of the leaves takes place once the leaves are clean. Several studies have compared the nutrient difference between sun drying, shade drying and oven drying. Shade drying is the best conditions for drying the leaves as direct sunlight has been reported to only retain 20-40% of the vitamin A content as opposed to 50-70% by shade drying (Price 2000: 8-12; Mishra, Singh and Singh 2012: 29).

5.6 Sensory acceptability of foods aimed at children

Sensory acceptability of food among children dictates whether a food item will be successful in the market or not. Objective six was to determine the sensory appropriateness and acceptability of the snack product by means of consumer acceptance sensory analysis. The consumer acceptance questionnaire used in this study was a five point facial hedonic scale with verbal anchors. Validity was ensured by conducting a pilot study with children (n=5) representing the sample population. Self-administered sensory tests can be used with children older than six years of age. Five point hedonic scales consisting of 'faces' and verbal anchors can produce valid data (Issanchou 2015: 53).

Both male and female participants in this study displayed a similar preference for sample ABC (2g *Moringa*/22g serving) compared to sample 123 (1g *Moringa*/22g serving). A study

in Finland displayed similar results with 11 year old children, where the aim was to identify whether a child's (n=424) gender affected the liking of fruit and vegetable. The study concluded that various determinants influenced fruit and vegetable intake; however, no gender differences were observed in terms of preference for vegetables (Lehto, Ray, Haukkala, Yngve, Thorsdottir and Roos 2015: 286).

Moringa is naturally bitter; therefore, it was imperative that sensory analysis was conducted in order to determine whether the product would be accepted or rejected. From the consumer acceptance sensory evaluation of the *Moringa* chip sample, 123 (1g *Moringa*/22g serving) was regarded as more acceptable with regard to appearance. Only 1.9% of the sample population rated sample 123 as being 'super bad'. Contrary to these results, Sengev, Abu and Gernah (2013: 270) developed bread fortified with *Moringa* leaf powder. The nutritional analysis revealed an increase in the nutrient content along with an increase in the amount of *Moringa* added to the bread; however, the addition of the *Moringa* resulted in poor sensory acceptability scores, suggesting that bread fortified with *Moringa* would not be an ideal fortification vehicle.

The younger participants (grades 4-5) rated for both sample 123 (72%) and sample ABC (2g *Moringa*/22g serving, 76%) favourably, whereas, a lower percentage of the participants in grades 6-7 indicated a positive response for sample 123 (1g *Moringa*/22g serving, 50%) and sample ABC (54%). The younger children rated sample ABC more favourably than the older children. A study by Liem, Zandstra and Thomas (2010: 72) revealed that younger children (3-6 years old) are still determining flavour preference, whilst older children (7-10 years old) have already started to establish a fairly stable liking or disliking of certain flavours.

A review by Dominguez (2014: 2) on the flavour and food preferences of children identified some key findings. Children displayed an inherent predisposition towards sweet and salty tastes and generally rejected bitter and sour tastes. However, early introductions of vegetables, including bitter compounds, could result in a broader array of tastes being accepted, hence modifying flavour preferences as the child grows older. The results of a cross sectional study by Lanfer, Bammann, Knof, Buchecker, Russo, Veidebaum, Kourides, Henauw, Molnar, Bel-Serrat, Lissner and Ahrens (2013: 129) indicated a link between age and preference for sweet, salt and umami taste among children 2-9 years old. Younger

children displayed a stronger preference for sweet and salty flavour profiles when compared to the older children.

The results of this study reflect that just more than half of the grade 4 children (52%) rated the taste of sample 123 as 'good' as opposed to 'bad' (20%). There was an increase in liking from sample 123 (16% rating 'super good') to sample ABC (40% rating 'super good'). An increase was also noted among the 'super bad' rating scale, with sample 123 and ABC being rated 'super bad' by 3% and 1% respectively. A study in the US aimed at testing the effectiveness of using different shapes of fruit items to increase consumption revealed no significant difference from the control results. Hence, it can be said that sensory attributes such as appearance, taste and texture are important but these factors must work in unison in order to be effective fortification vehicles (Boyer, Laurentz, McCabe and Kranz 2012: 6).

Generally, sample ABC scored higher regarding texture (39%). The majority of the children from grades 4 and 5 rated sample ABC as being either 'super good' (44 and 28%) or 'good' (40% and 44%). Sample 123 received a higher percentage of the 'bad' and 'super bad' rating by all the grades (22%). It can be concluded that the texture of sample ABC was more acceptable than sample 123. From the results, it is apparent that sample ABC (2g *Moringa*/22g serving) was preferred to sample 123 (1g *Moringa*/22g serving).

Identifying sensory preferences is essential to the food sector. The need to develop products that are innovative and sensorially acceptable is pivotal to the success of food products (Issanchou 2015: 53). Kar, Mukherjee, Gosh and Bhattacharyya (2013: 25-29) conducted consumer acceptance sensory evaluation on biscuits enhanced with *Moringa* leaf. The ratio of wheat flour to *Moringa* was 50g: 5g; the biscuits were baked at 160°C and cooled before being stored in air tight containers. Results of the sensory analysis indicated that the store available biscuit (control) was preferred over the experimental biscuit (*Moringa* leaf enhanced), mainly due to the off-putting colour of the *Moringa* biscuit. The texture and colour of the *Moringa* biscuit were acceptable; however, the 'leafy' flavour and slightly bitter taste of the enhanced biscuit resulted in a decline in consumer preference. The author recommended using stronger flavours in order to mask the natural bitterness of the *Moringa*. As identified in previous studies, children do not like bitter flavours, and naturally have an affinity towards sweet or salty tastes (Joseph 2014:36).

5.7 Conclusion

Nutritional programming begins in early childhood and develops as the child matures into an adult through a number of influences. Essentially, the eating habits during childhood play a crucial role in the food choices made in the latter part of life. Poor food choices may result in an array of complications (Asiedu, Jantuah and Anderson 2012: 42). Strategies directed towards increasing the consumption of healthy snack foods should target individual behaviour (personal preferences), as well as other factors such as peer influence (Nørgaard, Nørgaard and Grunert 2013: 177). These may include curbing unhealthy snacking and implementing regulations to limit the sale of unhealthy snacks at schools (Temple *et al.* 2006: 257).

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter includes the conclusions of the study and recommendations to various stakeholders that may be able to contribute to improving the dietary quality of food consumed by children. The researcher highlights the strengths and limitations of the study and concludes with recommendations for future research studies.

6.2 Main findings

Literature clearly states that the nutritional status of children around the world is a cause for concern. The nutrition shift towards diets laden with sugar, fat and salt contribute towards the prevalence of NCDs. Marketing and other environmental factors contribute towards the dietary intake of children and hence play a significant role in food preference.

Snacking, especially unhealthy snack consumption, is on the rise in both low and high SES communities. Children are faced with limited choices which are mostly cheap and energy-dense. Food-based strategies directed towards improving the nutritional status of children can be effective in addressing overweight and obesity. Results of this study showed a visible increase in the eating of chips 'everyday of the week' from grades 4-7. This indicates that the older children in the sample (grades 6-7) consumed chips on a more frequent basis, representing a sense of ownership in terms of buying behaviour. The SFFQ results from this study identified cold drinks as being consumed by almost all the participants and that the consumption of cold drinks was similar across the grades. The study showed that the most popular snacks that children purchased were cold drinks, chips and sweets.

The findings from the focus group discussion with the parents/caregivers in this study clearly showed that children were given spending money based on whether the parents had 'change' (money) to give the child. This research study first identified the snacking preferences of children which led to the development of *Moringa* chips. The development of the chips was

based on the concept of taking a snack that children liked and improving the nutritional content.

The nutritional content of the *Moringa* chips was generally better than the market chips for all the nutrients except for protein. This may be due to the market maize chips containing soya (hydrolysed protein), which is sometimes used as a bulking agent. The salt content of the *Moringa* chips was almost half that of the market maize chips and the fat content was remarkably much lower. The difference in the fat content could be attributed to the *Moringa* chips being air fried as opposed to deep fat fried.

Sensory evaluation is a valuable component of product development. The consumer acceptance sensory evaluation testing revealed that both male and female participants in this study displayed a similar for sample ABC (2g *Moringa*/22g serving) compared to sample 123 (1g *Moringa*/22g serving). In addition, younger children showed a slightly higher liking for sample ABC over 123. Overall, it could be said that both the *Moringa* chip variants were fairly well accepted by the participants.

The nutritional quality of the *Moringa* chips coupled with a general sensory acceptance and reasonable production cost of the product may provide reason to believe that this product may be used (in conjunction with physical activity), as an effective food based strategy to address overweight and obesity among children in low SES communities in SA.

6.3 Recommendations

A food-based approach is regarded as one of the most effective strategies to address obesity. Food policies as mentioned in an article by Hawkes *et al.* (2015: 2410) refer to actions that aim to improve the human diet. Various stakeholders need to contribute to making a positive change in the dietary practices followed by children. Below are suggestions that can be considered in an attempt to provide children with good quality nutritious snacks and food.

6.3.1 Recommendations for Africa

Africa as a continent has the ability to share and disseminate valuable information regarding indigenous knowledge. The diversity of the diets followed by different African countries

form the basis of exploring exciting new ingredients/foods and methods of preparation, all directed towards following a healthier diet.

6.3.1.1 Indigenous knowledge and plants need to be utilized in food preparation so that communities can have access to nutritious foods that are locally cultivated.

6.3.1.2 Different countries use *Moringa* to prepare a variety of dishes. Knowledge and cooking practices need to be openly shared in order to spread awareness on how *Moringa* can be prepared for consumption.

6.3.1.3 *Moringa* has recently gained popularity; hence, the farming of *Moringa* should be encouraged, as well as the preparation of value-added products containing *Moringa*. A food-based approach encompassing agriculture is required.

6.3.1.4 *Moringa* should to be incorporated into familiar dishes or staple foods to improve acceptability. This needs to be encouraged either by means of using the dried *Moringa* leaf powder or the fresh *Moringa* parts.

6.3.1.5 Women that breast feed should be encouraged to consume *Moringa* to improve breast milk production. This indigenous knowledge was used by Indians as a natural means of increasing breast milk production.

6.3.2 Recommendations for government

Government is the highest authority in a country; hence changes enforced by the government are bound to start a ripple effect of change. Various strategies adopted by the government in conjunction with industry are required. As a country, there is a need for both the poor and élite to be guided towards healthier eating; however, the approach differs.

6.3.2.1 Several departments need to work in collaboration to address the concerns regarding false advertising of food items. Monitoring and regulatory checks need to be regularly conducted to ensure the integrity of food sold.

6.3.2.2 The DoE and the DoH need to enforce stricter regulations regarding the sale of food items in schools, more especially in semi-rural and rural schools. Tuck shop owners need to be audited to ensure the stock sold at the school promotes a healthy diet and that portion sizes are taken into consideration.

6.3.2.3 Taxes need to be applied to snacks/foods high in sugar, salt and fat, to deter children from purchasing those items. A research study in Finland suggests that overall health costs could be significantly reduced by implementing a tax increase on sugar (Härkänen, Kotakorpi, Pietinen, Pirttilä, Reinivuo, and Suoniemi 2014: 204).

As stated by the Strategic Plan for the Prevention and Control of Non-Communicable Diseases (2013: 30), the use of food taxes on unhealthy foods (foods high in fat and sugar) and subsidies on healthy foods such as fruits and vegetables, is useful. This approach is directly targeted towards addressing the diet and obesity. The SA Food Based Dietary Guidelines (FBDG) should be consulted when determining foods sold at schools.

6.3.2.4 Strategies such as the SDGs need to be implemented in order to address issues such as food and nutrition insecurity. Improving health and wellness is one of the goals to which this study is directly aligned. The SDGs are designed to address 17 areas of concern.

The Food and Nutrition Security Policy Implementation Plan will provide the structure necessary to effect the changes required to improve the food and nutrition security status in SA. One of the interventions proposed in this draft policy is to promote and support diversified household food production; in doing so, the variety of food people have access to will increase, improving the nutritional quality as well.

The R146 legislation provides some protection to consumers regarding the labelling and descriptions of products. These regulations are enforced to protect the consumer from manufacturers who may provide misinformation or omit information from the packaging altogether (SAFOODS 2015). A revised version of the R146, R429, is still in the draft phase but is said to be more strict in terms of how fast food manufacturing consumer goods marketers advertise products, and especially information displayed on brand labels (Food Stuff SA 2015).

6.3.3 Recommendations for industry

Industry plays an important role in terms of the foods to which consumers have access. Changes at industry level are essential. Although these stakeholders are profit-orientated,

there is a rapidly emerging market of consumers ready to welcome affordable food items that are both healthy and sensory acceptable.

6.3.3.1 More emphasis needs to be placed on marketing affordable nutritious snacks to low SES communities. Research shows that healthy foods have the stigma of being expensive. Research by Newson, van der Maas, Beijersbergen, Carlson and Rosenbloom (2015: 65) on international consumer desires and the barriers of diners in choosing healthy restaurant meals revealed that healthy meals were associated with lower taste and generally higher prices. By making these foods more affordable, people may be more likely to make healthy dietary changes. Using plants that are nutrient rich and grown locally, such as *Moringa,* can be a cost- effective strategy towards improving the nutrient content of snacks/food.

6.3.3.2 Manufacturers should attempt to develop products that are both healthy and sensorially acceptable. Appearance of the product is a very important factor in determining if the child will accept or reject the product. Although consumer sensory acceptability tests may be costly, companies should consider the potential benefits of this stage in product development, especially if *Moringa* is to be used.

6.3.3.3 New technologies such as a large scale air fryer should be investigated to reduce the amount of fat used in processes such as deep fat frying. Technologies able to yield a healthier product that is both sensorially acceptable and cost efficient would be welcomed in the food market. This would be a step forward in an attempt to reduce the sugar, fat and salt content of foods.

6.3.3.4 The stigma related to snacking being ‘bad’ needs to be questioned. Snacking is encouraged; however, snack items must be healthy as opposed to high in fat, sugar and salt. Industry can assist in doing so by promoting reasonably priced snacks that are healthy. False advertising and promotion of snacks children want being disguised as being ‘healthy’, needs to be addressed. Nutrition labels should be designed in a manner that would encourage consumers to reassess the purchases made at the point-of-sale areas. Information depicted must not be misleading (Hawkes *et al*. 2015: 2413).

6.3.4 Recommendations for schools and parents

Parents play a pivotal role in shaping a child’s dietary habits. It is therefore necessary that any strategy directed towards a child is jointly aimed at the parent. Children spend a large

amount of time at school, making schools an ideal venue to disseminate information pertaining to healthy food choices.

6.3.4.1 More focus needs to be placed on nutrition and healthy eating in schools. By equipping children with knowledge on healthy eating and lifestyle practices, it is more likely that this will be followed through to adulthood. Healthy snacking needs to be encouraged and enforced by the items available at the tuck shops. Research by Totura, Figueroa, Wharton and Marsiglia (2015: 347) reported that the school environment and support from schools were essential in implementing an effective obesity prevention strategy.

6.3.4.2 The reward system should comprise of healthy food items as opposed to junk food. Parental control may utilize food as a means of reinforcement to encourage children to behave in a certain manner. Since high fat/sugar foods are reported as providing sensory pleasure, these foods are usually chosen as the reinforcement instrument. This in turn may encourage the consumption of certain foods that are not nutritious (Lu, Xiong, Arora and Dube 2015: 95). Children need to be able to understand the reasons parents do not want something to be eaten. Eventually the child should understand the reasoning behind this and comply (conditioning).

6.3.4.3 Food neophobia experienced by children needs to addressed and not avoided. Parents need to be educated on food neophobia and not merely give in to a child's demands or refusal to eat certain foods. 'Bribing' a child to eat new foods is also not ideal as the child will grow to associate eating with rewards (Russell, Worsley and Campbell 2015: 128).

6.4 Limitations of the study

6.4.1 The study was only conducted in four primary schools in Verulam, therefore the results are not representative of all the primary schools in this area.

6.4.2 Favourite attributes were determined for each sample; however, a question regarding the overall acceptability was not included in the sensory questionnaire.

6.4.3 Dried *Moringa* leaf powder used in some studies allowed for a more homogenous mixture to be formed. This study used dried *Moringa* leaves in a crushed form (Ijarotimi *et al.* 2013: 461; Williams *et al.* 2013: 171; Odinakachukwu *et al.* 2014: 29).

6.5 Strengths of the study

6.5.1 According to the researcher's knowledge, this is the first study in SA where maize chips have been enhanced with *Moringa* and have undergone sensory evaluation by school children in grades 4-7. This has contributed to the creation of new knowledge.

6.5.2 Use of crushed *Moringa* leaves made the chips more acceptable to children as the chips merely had green specks (similar to dried herbs), unlike a study by Sengev, Abu and Gernah (2013: 270), where sensory acceptability scores were low for bread fortified with *Moringa*, giving bread a green colour.

6.5.3 This study focused on children between grades 4-7, a critical phase as these children will soon be in secondary school where they would be exposed to more food choices.

6.5.4 Air fryers, a fairly new technology, were utilized in the study to prepare the chips, thus reducing the fat content. A study by Shaker (2015: 1558) reported on the amount of oil used for traditional deep fat frying and air frying. The results indicated that a lower amount of oil was used in air frying of potato chips compared to deep fat frying. This implies that air frying is a healthier method of food preparation.

6.5.5 The study comprised of three components that are pivotal in determining the success or failure of a product introduced into the market. These include the snacking preferences of children (market research) which were identified, a solution to snacking which was developed (product development) and tested for consumer acceptance (sensory evaluation).

6.6 Recommendations for future research

6.6.1 Researchers should investigate more ways in which *Moringa* could be included in food items and also conduct consumer acceptance sensory evaluations to determine the acceptability of the enhanced product.

6.6.2 Different variants of snacks with higher amounts of *Moringa* could be tested for sensory acceptability.

6.6.3 A study to determine if the *Moringa* chips are able to improve the nutritional status of children could be considered by including both pre- and post-tests of blood biochemistry data of a control and experimental group.

6.6.4 *Moringa* could be used in conjunction with other indigenous plants in the form of a recipe book targeted at rural schools/nutrition feeding schemes.

6.7 Conclusion

This study identified the snacking preferences of children in order to develop a product enhanced with *Moringa* that would be sensorially acceptable to children. The strengths and limitations reported by the research should be considered when conducting similar research.

The researcher has included numerous recommendations for stakeholders that may be able to contribute to improving the dietary practices of children. Using indigenous knowledge to create nutritious products that are sensorially acceptable to children is recommended. It is important to note that this study links directly with strategies that are in place to improve overall health and wellness (SDGs). A food-based approach such as the *Moringa* chips could be implemented in conjunction with other interventions to assist in realising the goals planned in the mentioned strategies. Overall, it is noted that the objectives of this study have been met.

This comprehensive research study involved combining pivotal phases from the product development process in order to critically determine the suitability and appropriateness of a *Moringa* enhanced snack for children. Therefore, it can be said that *Moringa* enhanced chips can be utilized (in conjunction with other nutrition related strategies) as a means of addressing malnutrition among children in a low SES community.

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LETTER OF INFORMATION FOR FOCUS GROUP PARTICIPANTS

Dear Focus group participant

Kindly read the following letter regarding participation in my research study.

The title of my study is as followed:

Snacking preferences of primary school children as a guideline to develop a sensory acceptable snack food item enhanced with Moringa oleifera

Principal investigator / researcher

I, Karina Govender, (qualification; B-Tech: Consumer Science Food and Nutrition) will be the main researcher within this study and will be under the supervision of Dr Ashika Naicker, (PhD: Nutrition).

Snacking plays an important role in the diets of children, it is therefore important to that research that focuses on nutritionally enhancing snack food items is conducted. Moringa oleifera (drumstick herbs) contains substantial amounts of important vitamins and minerals that essential for growing children and can therefore be used as a source of nutritional enhancement. The snack food item will undergo nutrient and microbiological testing in order to ensure the product is safe for consumption before the snack is eaten by the children.

By taking part in this study and allowing your child to participate, you would be assisting in the process of identifying and developing a snack food item that is both healthy and acceptable to children. This study will also compile valuable information relating to snack foods that children prefer, so that healthier alternatives can be considered.

For this study to be viable, a sample group of 200 children in grade 4-7 will be required to complete a snack food frequency questionnaire and 100 children in grade 4-7 to participate in a consumer acceptance sensory analysis. Please note that all information collected will be private and confidential. Ethical clearance has been granted from Durban University of Technology.

What will the study involve?

Each participant will be asked to

- Sign the assent form attached to this letter, agreeing that they are willing to take part in the study.

- Be a part of a focus group study which involves a discussion regarding snacking preferences of children in grade 4-7. This discussion will be recorded.

You will not feel any discomfort

No discomfort will be experienced during the focus group study. The final results of this study will be shared with Durban University of Technology for research purposes only.

Please note the following:

- Participation is voluntary and you can withdraw at any time with no penalty.
- No payment will be given to any participants.
- There is no participation fee in this study.
- No names will be mentioned and only statistical numbering will be used.
- This is a non invasive study therefore no injuries are to be expected.

For any questions or concerns please feel free to contact my supervisor or our Ethics committee.

Your participation in this study would be appreciated and would contribute to gaining new knowledge regarding snacking and the development of a nutritionally enhanced snack food item that would benefit children in the future.

Kind regards

Karina Govender

Persons to Contact in the Event of Any Problems or Queries:
Researcher: Karina Govender
Researcher contact: 0746457004, karinagovender1@gmail.com
Supervisor: Dr Ashika Naicker
Supervisor contact: 031 373 2323 ashikan@dut.ac.za
The Institutional Research Ethics administrator: 031 373 2900.
Complaints can be reported to the DVC: TIP, Prof F. Otieno on 031 373 2382 or dvctip@dut.ac.za.

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC) CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, **Karina Govender**, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature**

I, **Karina Govender**, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**

_____	_____	_____
Full Name of Witness (If applicable)	**Date**	**Signature**

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ANNEXURE B

INTERVIEW SCHEDULE: FOCUS GROUP STUDY

Themes	Focus group questions	Discussion	Direct quotes
Consumption of snack foods	How often do you purchase snack foods for your child? Does your child often purchase snack food items from their school tuck shop?		
Choice of snack foods	What snack foods does your child prefer? Why do they prefer that specific snack food?		
Factors that affect selection of snack foods	Is the price of the snack food items important? Do you consider the cost of snack foods when you purchase these items? Are the snack foods your child prefers sold at the school tuck shop? Do your child's friends influence the snack foods your child eats?		
Purchasing of an enriched snack food	Would you purchase a snack food for your child if it were nutritious? Would price play an important factor as to whether you would purchase it or not?		

ANNEXURE C

OBSERVATIONAL STUDY CHECKLIST

Item	Number of children that purchase the snack item (tally table)								
	First break (tea break)					Second break (lunch break)			
Chips	10-15	16- 20	20- 25	>25		10-15	16- 20	20- 25	>25
Chocolate	10-15	16- 20	20- 25	>25		10-15	16- 20	20- 25	>25
Ice lollies	10-15	16- 20	20- 25	>25		10-15	16- 20	20- 25	>25
Cold drinks	10-15	16- 20	20- 25	>25		10-15	16- 20	20- 25	>25
Sweets	10-15	16- 20	20- 25	>25		10-15	16- 20	20- 25	>25
Dairy drinks	10-15	16- 20	20- 25	>25		10-15	16- 20	20- 25	>25

Observations:_____

_____

_____

_____

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SNACK FOOD FREQUENCY QUESTIONNAIRE

Name: _____ **Grade:** _____

Please tick the most appropriate block

1. Gender

Boy	
Girl	

2. Race

Black	
Indian	
White	
Coloured	
Other	

3. How often do you eat chips?

Not at all	
Once a week	
Two times a week	
Three times a week	
More than three times a week	
Every day of the week	

4. Write down the name of your favourite chips_____

5. How often do you eat chocolates?

Not at all	
Once a week	
Two times a week	
Three times a week	
More than three times a week	
Every day of the week	

6. Write down the name of your favourite chocolate_____

7. How often do you drink cool drinks?

Not at all	
Once a week	
Two times a week	
Three times a week	
More than three times a week	
Every day of the week	

8. Write down the name of your favourite cool drink_____

9. How often do you drink milkshakes/ dairy drinks?

Not at all	
Once a week	
Two times a week	
Three times a week	
More than three times a week	
Every day of the week	

10. Write down the name of your favourite milkshake/ dairy drink_____

11. How often do you have ice lollies/ popsicles?

Not at all	
Once a week	
Two times a week	
Three times a week	
More than three times a week	
Every day of the week	

12. Write down the name of your favourite ice lolly/ popsicle/ice cream_____

13. How often do you eat sweets?

Not at all	
Once a week	
Two times a week	
Three times a week	
More than three times a week	
Every day of the week	

14. Write down the name of your favourite type of sweet_____

15. Which flavour do you like more?

Sweet	
Savoury	

16. Which is your favourite **sweet flavour**?

Vanilla	
Chocolate	
Strawberry	
Banana	
Cream soda	

Other_____

17. Which is your favourite **savoury flavour**?

Tomato sauce	
Tomato chilli	
Fruit chutney	
Beef	
Barbeque	
Chicken	
Peri peri	
Cheese	
Cheese and onion	

Other _____

18. If there are any other snacks that you like, that are not included above, please write down the name of the snack

_____

_____

THANK YOU

Recipe Yield:	228g cooked dough 122g of cooked chips
Equipment:	Kitchen scale, wooden spoon, pot, pasta machine, air fryer, metal ruler, paper towel
Cooking temperature:	100°C over the stove, 160°C in the air fryer
No. of servings:	122g of cooked chips/ 5 portions of chips (22g/ packet) (1g/2g *Moringa* in each packet)
Preparation time:	10 minutes
Cooking time:	Cooked dough= 7 minutes over the stove. Air fryer= 9 minutes

(1g *Moringa*/22g serving)

Ingredient	Qty	Unit	Step	Method
Water	125	ml	1	Place the water, salt, sugar and sunflower oil in a pot and bring to a boil
Salt (Cerebos)	3.5	g		
Sugar (Hulettes)	0.35	g		
Sunflower oil (Helios)	1.25	ml		
Polenta (Woolworths)	60	g	2	In a bowl, mix the polenta and creamy maize until well combined
Creamy maize (Ace)	50	g	3	Slowly add the polenta and creamy maize blend to the boiling water whist constantly stirring to prevent lumps
Moringa leaf (dried)	5 or 10	g	4	Reduce the heat to low and stir for 7 minutes or until the mixture forms a skin on the bottom of the pot
Spray n cook				
BBQ seasoning	4	g	5	Place the mixture into a bowl and leave to cool. Once cool, add the *Moringa* (either 5g or 10g) and mix until well combined
			6	Divide the dough into smaller portions and pass through a pasta machine (Jamie Oliver setting 4)
			7	Cut the chips into 4cm x 2.5cm pieces, spray a light coating of cooking spray over the chips
			8	Place the chips into the air fryer basket and then into the air fryer. Set the timer for 9 minutes and leave to fry
			9	Once golden and crisp, remove from the air fryer and place into a plastic packet with the seasoning. Shake the packet allowing for the chips to be evenly coated with the seasoning. Store in an air tight container.

MORINGA CHIP RECIPE STEP BY STEP

1. Weigh all ingredients

2. Bring water, salt and oil to a boil

3. Add polenta and creamy maize

4. Cook for 7 minutes over low heat

5. Once dough is cooked, cool to room temperature

6. Mix in the dried *Moringa* leaves

7. Roll the mixture through a pasta machine

8. Cut into rectangles 4cmx2.5cm

9. Spray with cooking spray and cook in air fryer

10. Place cooked chips in a plastic packet

11. Add seasoning to the packet and shake the bag to coat chips

12. Weigh and package chips in plastic tubs

Grade: _____ Gender: _____

SAMPLE: 123

Taste the sample and tick √ under the face that you think best describes the samples appearance, taste and texture. You may taste the samples more than once.

	Super Bad	Bad	Maybe Good or Maybe Bad	Good	Super Good
Appearance (how does it look)	 ☐	 ☐	 ☐	 ☐	 ☐
Taste	 ☐	 ☐	 ☐	 ☐	 ☐
Texture (mouth feel)	 ☐	 ☐	 ☐	 ☐	 ☐

Comments:

_____

_____

CONSUMER ACCEPTANCE SENSORY EVALUATION OUESTIONNAIRE

SAMPLE: ABC

Taste the sample and tick √ under the face that you think best describes the samples appearance, taste and texture. You may taste the samples more than once.

	Super Bad	Bad	Maybe Good or Maybe Bad	Good	Super Good
Appearance (how does it look)	 ☐	 ☐	 ☐	 ☐	 ☐
Taste	 ☐	 ☐	 ☐	 ☐	 ☐
Texture (mouth feel)	 ☐	 ☐	 ☐	 ☐	 ☐

Comments:

_____

_____

DUT DURBAN UNIVERSITY OF TECHNOLOGY

LETTER OF INFORMATION

Dear Pupil / Parent

Kindly read the following letter regarding participation in my research study.

NB Should your child have any known allergens please disclose this information, as the child will not be able to participate in this study.

The title of my study is as followed:

Snacking preferences of primary school children as a guideline to develop a sensory acceptable snack food item enhanced with Moringa oleifera

Principal investigator / researcher

I, Karina Govender, (qualification; B-Tech: Consumer Science Food and Nutrition) will be the main researcher within this study and will be under the supervision of Dr Ashika Naicker, (PhD: Nutrition).

Snacking plays an important role in the diets of children, it is therefore important to that research that focuses on nutritionally enhancing snack food items is conducted. Moringa oleifera (drumstick herbs) contains substantial amounts of important vitamins and minerals that essential for growing children and can therefore be used as a source of nutritional enhancement. The snack food item will undergo nutrient and microbiological testing in order to ensure the product is safe for consumption before the snack is eaten by the children.

By taking part in this study and allowing your child to participate, you would be assisting in the process of identifying and developing a snack food item that is both healthy and acceptable to children. This study will also compile valuable information relating to snack foods that children prefer, so that healthier alternatives can be considered.

For this study to be viable, a sample group of 200 children in grade 4-7 will be required to complete a snack food frequency questionnaire and 100 children in grade 4-7 to participate in a consumer acceptance sensory analysis. Please note that all information collected will be private and confidential. Ethical clearance has been granted from Durban University of Technology.

What will the study involve?

Each child that participates will be asked to

- Sign the assent form attached to this letter, agreeing that they are willing to take part in the study
- Ask their parent/ guardian to sign consent for the child to participate.
- Complete a snack food frequency questionnaire (200 children and approximately 5-10 minutes).
- Sample the snack food item (consumer acceptance sensory analysis) (100 children and approximately 15-20 minutes).

The completing of the snack food frequency questionnaire and sampling of the snack item will only be once. This will not interfere with the children's learning.

You will not feel any discomfort

No discomfort will be experienced during the completion of the questionnaire or during consumption of the snack food item. Before the snack food item is eaten, testing will be conducted to ensure that the snack is safe for consumption.

The final results of this study will be shared with Durban University of Technology for research purposes only.

Please note the following:

- Participation is voluntary and you can withdraw at any time with no penalty.
- No payment will be given to any participants.
- There is no participation fee in this study.
- No names will be mentioned and only statistical numbering will be used.
- This is a non invasive study therefore no injuries are to be expected.

For any questions or concerns please feel free to contact my supervisor or our Ethics committee.

Your participation in this study would be appreciated and would contribute to gaining new knowledge regarding snacking and the development of a nutritionally enhanced snack food item that would benefit children in the future.

Kind regards

Karina Govender

Persons to Contact in the Event of Any Problems or Queries: Researcher: Karina Govender
Researcher contact: 0746457004,
karinagovender1@gmail.com **Supervisor:** Dr Ashika Naicker
Supervisor contact: 031 373 2323 ashikan@dut.ac.za
The Institutional Research Ethics administrator: 031 373 2900.
Complaints can be reported to the DVC: TIP, Prof F. Otieno on 031 373 2382 or dvctip@dut.ac.za,

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)
CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, **Karina Govender**, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____.
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature**

I, **Karina Govender**, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**

_____	_____	_____
Full Name of Learner (If applicable)	**Date**	**Signature**

_____	_____	_____
Full Name of Parent/ Legal Guardian (If applicable)		**Signature**

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Institutional Research Ethics Committee
Faculty of Health Sciences
Room MS 49, Mansfield School Site
Gate 8, Ritson Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2900
Fax: 031 373 2407
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

ANNEXURE I

19 June 2014

IREC Reference Number: **REC 24/14**

Ms K Govender
25 Croton Road
Brindhaven
Verulam
4340

Dear Ms Govender

Snacking preferences of primary school children as a guideline to develop a sensory acceptable snack food item enhanced with Moringa oleifera

I am pleased to inform you that Full Approval has been granted to your proposal REC 24/14.

The Proposal has been allocated the following Ethical Clearance number IREC 040/14. Please use this number in all communication with this office.

Approval has been granted for a period of one year, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's. In addition, you will be responsible to ensure gatekeeper permission.

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

[redacted]

Prof J K Adam
Chairperson: IREC

Institutional Research Ethics Committee
Faculty of Health Sciences
Room MS 49, Mansfield School Site
Gate 8, Ritson Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2900
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Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

ANNEXURE J

13 April 2015

Ms K Govender
25 Croton Road
Brindhaven
Verulam
4340

Dear Ms Govender

Snacking preferences of primary school children as a guideline to develop a sensory acceptable snack food item enhanced with Moringa oleifera
Ethics Clearance Number: IREC 040/14

The Institutional Research Ethics Committee acknowledges receipt of your Safety Monitoring and Annual Recertification report.

I am pleased to inform you that the study has been approved to continue.

Please note that ethical approval has been extended till 19 June 2016, if the research is not complete within this time, you will be required to apply for recertification three months before the expiry date.

Yours Sincerely

[redacted]

Professor J K Adam
Chairperson: IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY
2015 -04- 13
INSITUTUTIONAL RESEARCH ETHICS COMMITTEE
P O BOX 1334 DURBAN 4000 SOUTH AFRICA

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Sibusiso Alwar | Tel: 033 341 8610 | Ref.:2/4/8/1/132

Miss K Govender
25 Croton Road
Brindhaven
Verulam
4340

Dear Miss Govender

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"SNACKING PREFERENCES OF PRIMARY SCHOOL CHILDREN AS A GUIDELINE TO DEVELOP A SENSORY ACCEPTABLE SNACK FOOD ITEM ENHANCED WITH MORINGA OLEIFERA"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 01 June 2014 to 30 June 2015.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Mr. Alwar at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report / dissertation / thesis must be submitted to the research office of the Department. Please address it to The Director-Resources Planning, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education:

Dianthus Primary School	Everest Primary School	Verulam Primary School
Redcliff Primary School	Dawn Crest Primary School	

[redacted]

Nkosinathi S.P. Sishi, PhD
Head of Department: Education
Date: 02 July 2014

Department of Food and Nutrition: Consumer Science

Tel: 031 373 2326

Request to conduct the study: Snacking preferences of primary school children as a guideline to develop a sensory acceptable snack food item enhanced with Moringa oleifera

To: Principal_____

School: _____

Date: _____

I, Karina Govender am currently doing my Master of Technology qualification in Consumer Sciences: Food and Nutrition at Durban University of Technology. I would like to request permission to conduct my study at your school.

The title of the study I am conducting is: **Snacking preferences of primary school children as a guideline to develop a sensory acceptable snack food item enhanced with Moringa oleifera.** The aim of the study is to develop an acceptable snack food item that is enhanced with Moringa oleifera to suit the sensory requirements of children in primary schools from the Central Verulam, in order to advise suitable snack food items for possible enrichment in the future.

The study consists of three stages:

Stage 1:

A pilot study will be conducted to determine the snack food preferences amongst grade 4-7 children through a questionnaire, involving 10 children. This questionnaire will take no longer than 15 minutes per a child. The children can complete this during their tea/ lunch break in an available classroom. I will be supervising the completion of the questionnaires.

Stage 2:

Completing a snack food frequency questionnaire, involving 200 children in grade 4-7. This questionnaire will take no longer than 15 minutes per a child. The children can complete this during their tea/ lunch break in an available classroom.

The administering of this questionnaire can be done in groups of 20 children over a period of 10 suitable days. I will also be supervising the completion of these questionnaires. Suitable days can be discussed so that there is no inconvenience to the school staff or children.

Stage 3:

Sensory evaluation (eating the snack to determine if the children like or dislike it) of the snack food item enriched with Moringa oleifera (drumstick herbs), involving 100 children in grade 4-7.

This stage of the study involves 100 children eating the snack item and thereafter commenting as to whether the item is liked or disliked. The sensory evaluation will take no longer than 10 minutes, and the children will be divided into 10 groups (10 children per a group). Suitable days can be discussed so that there is no inconvenience to the school staff or children. The venue for the sensory evaluation will be a classroom (so the children are in familiar surroundings).

The children do not have to put their names on the questionnaires and participation is fully voluntary, in addition a consent letter will also be sent to the parents of the children for further consent.

I hope you can accommodate me in doing this project.

Kind regards

_____

Karina Govender

Contact number: 074 645 7004

Email address: karinagovender1@gmail.com

_____ _____

Principal's Signature Date

MORINGA CHIPS COSTING (1g)

INGREDIENT	QUANTITY (MASS/VOLUME)	PRICE PER MASS/VOLUME/ NUMBER*	COST
Salt (Cerebos)	5g	R5.98/1kg	R0.52
Sunflower oil (Helios)	2.5ml	R60.00/5L	R0.03
Polenta (Woolworths)	148g	R14.95/500g	R4.43
Creamy maize (Ace)	100g	R6.99/1kg	R0.70
Moringa oleifera leaf (dried)	13g	R85.50/300g	R3.71
Spray n cook (Colman's)	5ml	R28.99/300ml	R0.48
BBQ seasoning (Kerry Foods)	7g	R12.99/60	R1.51
TOTAL COST	13 portions		R11.38
PORTION COST	1 portion (22g)		R0.88