Chapter 1: The problem, its setting and overview of the study

1.1 Introduction and setting of the problem

The worldwide obesity problem is increasing, even in developing countries that usually experience high rates of under-nutrition (Hoffman, Sawaya, Verreschi, Tucker & Roberts 2000:2). In a recent study by the Medical Research Council (MRC), it was found that approximately 45% of South Africans are overweight. Furthermore, this study indicates that 25% of people living in South Africa (SA) fall into the overweight category, with a Body Mass Index (BMI) in excess of 25%, while 20% fall into the obese category with a BMI of more than 30. Probably the most shocking fact is that 20% of children under the age of six are overweight (Bener 2006:1).

The causes of childhood obesity, like many public health problems, are complex. Dietary intake, levels of activity, meal patterns, genetic, ethnic, hormonal, psychological and sociological factors can all influence the prevalence and progression of obesity (Norris 2004:2-3). The presence of obesity and a sedentary lifestyle in turn help to explain the increased prevalence of cardiovascular disease, diabetes, hypertension, dyslipidaemia and certain cancers (Steyn, Bradshaw, Norman, Joubert, Schneider & Steyn 2006:5).

A review of the nutritional status of South Africans from 1975 to 1996 indicated that the total fat intake in white, coloured and Indian South Africans exceeded the recommended energy intake of 30% per day. It also indicated that although rural blacks normally had low fat intake, urban blacks followed diets much higher in fat than the rural diets, which included less than 30% of the recommended energy intake (Wolmarans & Oosthuizen 2001:48).

The Birth to Twenty (Bt20) study found that the nutrient intake of children appeared to deteriorate from 1995 to 2000, with the lowest intakes of most nutrients recorded

in 2000 despite adequate high-energy intakes. This would suggest that children are consuming energy-dense foods (high carbohydrates, high fat) that do not necessarily contain the appropriate levels of micronutrients. There is a clear evidence highlighting the transition to a more "Western" dietary habit – fast food, high in fat and carbohydrates, low in fibre and high in salt (Norris 2004:2).

Evidence from most cross-sectional studies as well as experimental studies on animals and humans has shown positive associations between the percentage of energy consumed from fat, and obesity. Although obesity is a multifactorial condition the intake of dietary fat plays an important role in its aetiology, but is probably not the primary cause (Wolmarans *et al.*, 2004:4).

Weak correlations between dietary energy, fat intakes and BMI of people living in SA have been reported, but still the kinds of foods consumed by urban subjects indicate a high fat intake and it seems that those facts are increasing obesity problems among South Africans (Kruger, Puoane, Senekal & van der Merwe 2005:493). A literature search using scirus.com, health 24.com, PubMed.gov, science direct and emerald.com did not produce any results on the snacking patterns of SA children.

The only study that indicated snacking patterns in South Africa (SA), was the National Food Consumption Survey (NFCS) undertaken in the late 1990s. In the top 25 foods that were most regularly consumed by children (n = 2868) in the NFCS, measured by a 24-hour recall, it was reported that "salty snacks" appeared as number 21 with an average daily intake of 30g. In the low-income households (≤ R12000 total income) "salty snacks" appeared as number 24 (n = 1738) compared to number 17 (n = 744) in the income bracket of > R12000. In both these groups, the total amount eaten per day was 30g. In another group (n = 1496) "salty snacks" appeared as number 19 (31g per day) eaten and sweets as number 25 (26g per day) (Labadarios, Steyn, Maunder, Swart, Gericke, Huskisson, Dannhauser, Vorster & Nesmvuni 1999:587-596).

In the same study, food consumption patterns were also measured by Quantitative Food Frequency Questionnaires (QFFQ) and similar results were found as follows:
It was reported that "salty snacks" appeared as number 14 with an average daily intake of 18g (n =2883). In the low-income households (≤ R12000 total income) "salty snacks" appeared as number 14 (n = 1748) and the total amount eaten per day was 15g. In another low- income group of ≤ R12000, "salty snacks" appeared as number 17 on the list (n = 1375) and 17g per day were eaten, with sweets at number 24 on the top 25 list. In the income group with ≥ R 12000 (n = 1508), salty snacks were number 11 and the total amount eaten per day was 18g (Labadarios *et al.*, 1999:587). These results provide evidence that snack foods are consumed by SA children; however, they do not provide "snack patterns".

Furthermore, the food supplies and diets of the world have been sweetened tremendously, and particularly in Asia, the Middle East and Africa, the intake of edible oil has grown very quickly (Popkin 2005:724-725).

Since obesity has been identified as one of the country's top killers of people, snacks are under attack. The latest statistics were compiled when the Centre for Disease Control and Prevention (CDCP) released facts in a study to indicate that, before long, more Americans will be dying of obesity than from smoking. In addition, dieticians indicate that healthy eating is not a trend, and that the epidemic of obesity is a perfect example of why snack makers should help people to change what they eat (Walters 2004:1-2).

Obesity prevention initiatives must focus on children to make sure they adopt more healthy lifestyles from a very early age (Kruger *et al.*, 2005:495). Treatment of obesity and its resultant diseases (cardiovascular disease, hypertension, dyslipidaemia, diabetes, and certain cancers) is a very costly alternative to prevention. Countries that are short of the financial resources, with little or no infrastructure, cannot implement effective treatment; this applies particularly to those countries that are experiencing a triple burden of continuing problems of prevalent

under-nourishment and infectious diseases, as well as the emerging problem of over-consumption of damaging nutrients (Dalmeny, Hanna & Lobstein 2004:11).

Therefore, prevention of obesity is essential, but definitely requires changes in patterns of food supply and needs. This means that there must be changes in the food marketing strategies and in the promotion of health-enhancing foods (Dalmeny *et al.*, 2004:11).

The prevention and treatment of obesity should be based on education, behaviour change, community participation, local action, the infiltration of existing initiatives as well as evidence-based planning with accurate monitoring and evaluation. Prevention should primarily be managed in the community (Kruger *et al.* 2005:491).

1.2 Rationale and motivation

Snacking is a way for people to obtain energy for their daily activities. But if people are watching their weight they should think about the type of snacks they consume and how often they snack on something during the day (Forslund, Torgerson & Sjostrom 2005:711).

No market share for snack foods could be found for SA, but in the United States of America (USA), sales of salty snacks increased by 6% between 1995 and 1999. Sales of snack foods increased by 11% between 1995 and 1999, while the sales of lower fat snack foods decreased by 6% in that same period. As a result, the average energy intake reported by Americans rose from 7 669 kilojoules (kJ) per day in 1977-1978 and 7 451 kJ in 1989-1991 to 8 408 kJ in 1994-1996. In the United Kingdom (UK) there is a greater need among people to snack between meals, as 75% of adults and 91% of children eat snack foods at least once a day (FMI Research & Prevention 2004:1). Another study conducted in Sweden also shows that obese people tend to snack between meals, and mostly on cakes, cookies, chocolate, desserts and other snacks (Forslund *et al.* 2005:1-2).

Prevention also requires a change in patterns of food supply and demand (Dalmeny *et al.* 2004:11) and must mainly be managed in the community (Kruger *et al.* 2005:491).

In this study, an acceptable, affordable and "healthy", low-fat, nutrient-dense snack food item was developed as an alternative to all the fatty, energy-dense snacks available on the market. The study therefore aimed to change the behaviour of children to eating a "healthier" alternative, resulting in the prevention of the early onset of obesity.

Owing to the growing epidemic of obesity, globally and in South Africa, it was necessary to conduct this study on the snack consumption patterns of children in two primary schools in the Vaal Region, South Africa.

The two primary schools are situated in two low income communities, Eatonside and Vanderbilpark in Gauteng.

1.3 Research aims

The main objective of this study was to develop a cost effective and nutrient dense snack food item for primary school children from nine to 13 years old by using locally-grown, cheap and affordable foods in order to improve their nutritional and health status.

The specific aims of this project were the following:

1. To perform an in depth literature review of all studies conducted in SA on the nutritional status of children.
2. To conduct a baseline survey to determine snack food consumption among primary school children to further determine the nutritional status of the children.
3. To formulate the specific criteria for the snack food item, based on the results of specific aims one and two, as well as to develop the snack food item,

including proximate and micronutrient analyses of nutritive values and optimisation.

4. To perform sensory analyses (colour, flavour, taste) in order to evaluate the overall acceptability of the snack food item.
5. To test the shelf life of the snack food item.

1.4 Conceptual framework

The conceptual framework in Figure 1 indicates the different phases of the study. Phase one was the baseline survey where the researcher was assisted by trained fieldworkers who helped to collect all the information needed in the specific areas. Phases two and three were the sole responsibility of the researcher. Phase 4 will not be described as this was the report- and article writing phase.

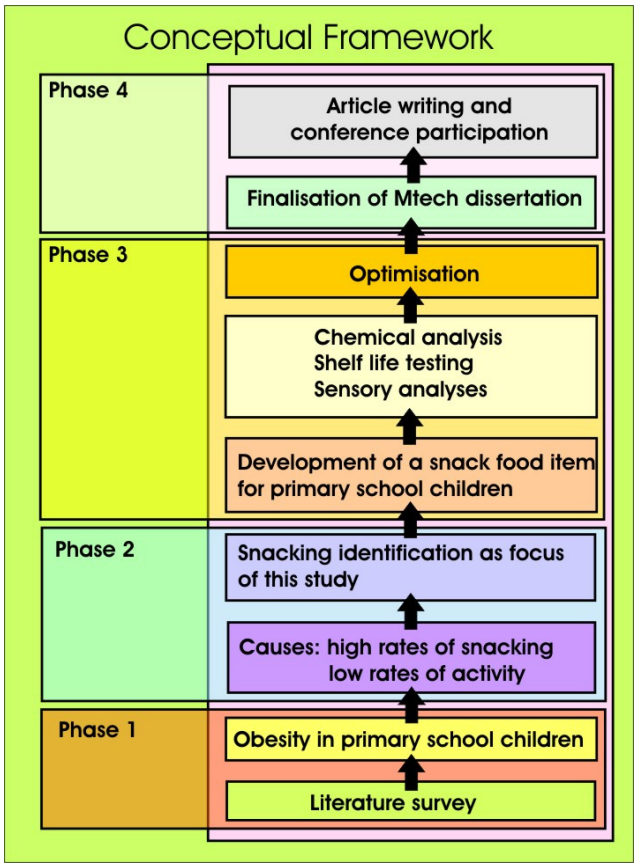

Figure 1 Conceptual Framework

1.5 Organisation of the report

In Chapter 1, the problem of obesity amongst primary school children globally and in SA is identified and discussed as part of the background to this study. The main objective of this study is to develop a cost-effective and nutrient-dense snack food item. In chapter 2, the theoretical basis is given for product formulation, development and testing. The product development factors are described in Chapter 3, followed by the methodology for this specific study in Chapter 4. The results and findings in Chapter 5 give an overview of how the study was conducted and the discussions in Chapter 6 conclude the study.

Chapter 2 Literature synthesis: Obesity in children

2.1 Introduction

People are becoming more obese, sicker and less healthy by the minute (Hoffman 2007:1).

People do not become obese overnight: more than 85% of the population gain weight because of an average kilojoule (kJ) excess of 25 kJ/day is consumed. This 25 extra kJ /day can become a big problem over the long term and such gradual problems seldom have instant solutions. Only reasonable steps can be taken to inform people about healthy eating patterns (Wansink 2007:34).

According to the World Health Organisation (WHO), obesity is not new but it is a growing problem, and the WHO estimate that around 1.2 billion people worldwide are overweight while more or less 300 million of them are obese (Jebb, Kopelman & Butland 2007:6). Consumers want a variety of tasty, inexpensive, convenient foods and public policy officials and activists believe that food companies should be more responsive in helping combat obesity. This can be the cause of Food Companies being split in two groups (Brownell & Horgen 2004:34). The growing epidemic of obesity is affecting not only adults; children and adolescents are also overweight and the increasing overweight problems in child and adolescent can be traced to the 1980s (NCHS US 2003:2). In reality, obesity is a major disease, in line with Human Immunodeficiency Virus (HIV) and malnutrition (Astrup 2004:1). For many years, AIDS has had the nickname "slim" in Africa, because it makes its victims literally waste away. As a result of this statement, the people living in Africa are not interested in losing any weight because others will assume that they are HIV-positive (Lichtarowicz 2004:1).

2.2 Definition of obesity

Obesity can be defined as having a large amount of body fat (Wolmarans *et al.* 2001:14). Jonathan Lowell referred to the Chambers' (1996) *21st Century Dictionary* definition that food is "a substance taken by a living organism that provides it with energy and materials for growth, maintenance and repair of tissues" and obesity is "the condition of someone who is overweight as a result of the accumulation of excess fat in the body". Obviously there is a relationship between the consumption of food and the state of obesity, but the level of obesity is "dependent on the balance between energy intake and energy expenditure" (Lowell 2004:240). People who eat more than they need to cover their nutrient needs are likely to become overweight or obese. Overweight means that the person is too heavy for his or her height. His or her weight is above the range of weights of healthy people. A few very active people (such as boxers and weight lifters) are overweight because they have developed large muscles, and are overweight because of muscles. Other people who are overweight are too fat and the condition of being too fat is called obesity (Savage & Burgess 2000:284).

2.3 Measuring overweight and obesity

If parents are concerned about their child's weight, then action must be taken to see a doctor or dietician, so that the children can be measured to tell whether it is overweight or obese. The child's weight and height can be compared and plotted on a growth chart. Furthermore a skin fold thickness should be measured at the triceps (back of the upper arm) with a calliper that pinches the skin and fat together to determine body fat composition. This will be higher than expected in an overweight child. Thus the best measurement to take is BMI (Boyse 2007:1).

The BMI of adults is measured as weight in kilograms (kg) divided by the square of the height in metres (m^2) and then categorised by using the WHO categories of underweight (BMI < 18.5 kg/m^2), normal weight (BMI 18.5 kg/m^2 to 24.99 kg/m^2), overweight (BMI 25.0 kg/m^2 to 29.99 kg/m^2) or obese (BMI ≥ 30.0 kg/m^2). Obese is

categorised into obese class I (BMI 30.0 kg/m² to 34.99 kg/m²), obese class II (BMI 35.0 kg/m² to 39.99 kg/m²) and obese class III (BMI ≥ 40.0 kg/m²) (Malhotra, Hoyo, Ostbye, Hughes, Schwartz, Tsolekile, Zulu & Puoane 2008:316).

2.3.1 BMI for age nine to thirteen years

For the purpose of defining overweight and obesity, the WHO has introduced the body mass index (BMI), which is calculated using the measured (as opposed to "assumed") body weight (in kg) divided by the body height in m². Norm values are defined for adult males and females: a person is considered overweight when his/her BMI is greater than 25 and less than 30; obesity can be further subdivided into: 1st degree obesity (BMI between 30 and 35), 2nd degree obesity (BMI between 35 and 40) and extreme obesity (BMI above 40). The most important thing to note is that BMI does not differentiate between body dry mass and body fat mass. As an end result, the BMI of a muscular bodybuilder can be just as high as the BMI of an obese man in the same height category. The definition of BMI also causes trouble when used for children and adolescents, seeing that they are in a phase where it is natural to grow and gain weight. Therefore, it is essential that boys and girls must be grouped according to their different ages. Also, the time in which the study is undertaken must be clearly specified. Based on the data that were captured from that study, it is then possible to draw percentile curves that show the BMI based on age and sex in the group that participated in a certain study. The cut-off mark for overweight, worldwide, is set at the 90th percentile. In Europe the cut-off mark for obesity is defined at the 97th percentile, while the cut-off mark in the USA is set at the 95th percentile. Owing to these definitional differences, there are 2% more obese children and adolescents in USA than in Europe (Lob-Corzilius 2007:586).

In the past the BMI reference data compiled by WHO started at the early age of nine years and limited the percentile range between 5th and 95th, while NCHS reference curves were constructed using a different method that involved children of birth to five years of age. The two organisations merged their data and a new set of reference data was drawn up by applying state-of-the-art growth curve methods. The new,

revised data from WHO Reference 2007 provide a smooth transition from the child growth standards for 0-5 years to the older group that also includes the records of the 18-71 year old standards. The data tables and charts cover the 1st to the 99th percentile and from –3 to +3 standard deviations (SD), also known as 2-scene.

< 3 underweight

≥3 <15 risk of underweight

≥15 <85 normal

≥85 <97 risk of overweight

≥97 overweight

(de Onis, Onyango, Borghi, Siyam, Nishida, Siekmann 2007:660).

2.3.2 Growth velocity

Calculating the growth velocity can be useful instrument in the evaluation and management of overweight children. The children's weight is measured at two points and the change in weight is divided by the length of time between measurements.

2.4 Prevalence of overweight and obesity in children globally

Globally, many people are now affected by obesity and governments all over the world spend rising amounts of money on treating or preventing obesity and the consequences of this epidemic. The rising worldwide obesity epidemic amongst children has reached alarming levels (Lowell 2004:238-248).

The prevalence of overweight and obese children and adolescents, worldwide, has drastically increased within the last 20-30 years, that is, within only one generation, in nearly all developed industrial nations. This is supported by data collected from the German Children and Adolescents Health Survey recently published (KIGGS 2006). Data showed that about 1.9 million children and adolescents (about 15%),

aged from three to 17 are overweight. About 800,000 (about 6.3%) of these children and adolescents are obese. Some of these children and adolescents remain overweight for the rest of their lives or will become more obese and modern societies will have to deal with a rising number of health consequences in the future (Lob-Corzilius 2007:585).

According to Dr Ilse Kerr, more than 22 million children younger than five, worldwide, are presently classified with obesity and it is an increasing problem. Figures increase to 155 million for school-going children and it is estimated that by 2020, overweight will affect half the girls and a third of all boys in the world (Kerr 2006:1). Obesity begins early: by the age of two years, nearly half of the children in New York City (NYC) are overweight or obese, and at the same time only half of day care and elementary school children are at a healthy weight level (List, Thorpe & May 2003:2). In most European Countries (EC), North America, and several South American and Asian countries, obesity has been observed. The number of obese people has more than doubled during the past twenty years and in the US, the total percentage of the population who struggle with obesity is more than 20%, while in England, Germany and Poland it goes beyond 15%. The increase in obesity applies to men, women and children in all age groups (Health Evidence Network (HEN) 2006:1). It is expected that life expectancy in Great Britain (GB) will be reduced by about five years for males by 2050 (WHO Europe 2006:3). Another effect will be a major increase in the consumption of economic resources by the health care sector (Lob-Corzilius 2007:586).

One of the most commonly identified nutrition problems among children in the USA is overweight, which contributes to the obesity epidemic in the USA, affecting children as young as two years old (Raynor, Jelalian, Vivier, Hart & Wing 2009:19).

According to the National Health and Nutrition Examination Survey (NHANES), as of 2002, a total of 65% of American adults over 20 years of age were overweight; of these, 30% were obese and 5% were extremely obese. The prevalence of obesity for African Americans is even higher: 77% of black women over the age of 20 are

overweight and 49% are obese while 63% of black men are overweight and 28% are obese (Henderson & Kelly 2005:191).

Nowhere in the world is obesity more prevalent that in the USA and an alarming aspect is that obesity is now the largest medical condition in childhood in that country. The prevalence has doubled over the past 20 years to the current one in every six children, and the rest of the world is not far behind (SASSO 2004:2). At the extreme, obesity kills!

2.4.1 Obesity in lower-income communities in the United States

Overweight as well as obesity affects people living in low-income communities (Molarius, Seidell, Sans, Tuomilehto & Kuulasmaa 2000:90). It is easier to be overweight if you have a small income or less education or are food insecure (Zhang & Wang, 2004:12). People with a low income have a tendency to purchase cheap, energy-dense, but nutritionally poor foods, which can lead to obesity. At the same time, low-income communities include an excessively higher number of racial and ethnic minorities, especially Hispanic and non-Hispanic black populations (Whitaker, Wright, Pepe, Seidal & Dietz 1997:337).

2.4.2 Obesity in South Africa

On 14 November 2004 the Minister of Health, Dr Manto Tshabalala-Msimang, pledged to fight obesity on World Diabetes Day (WDD). "This year we are concentrating on one of the major risk factors for type 2 diabetes which is obesity. Our slogan is: Fight Obesity Prevent Diabetes."

Dr Tshabalala-Msimang indicated that diabetes had affected older people in the past, but that more young people, including children and adolescents, are now affected, mainly because of the rising number of people who are overweight and obese. Childhood obesity in SA is also increasing and can be caused by poor eating habits and the lack of physical activity. Studies indicate that 6% of children from the age

one to nine years were overweight. Another quarter (25%) of adolescent females and 6,9% of adolescent males were overweight. The South African Demographic Survey (SADS), conducted in 1998, indicated that almost a third (29%) of adult men and more than half (55%) of adult women were also overweight, while 9% of adult men and 29% of adult women were obese (Tshabalala-Msimang 2004:1-2).

Results of two studies just published by the MRC indicate that South Africans are digging their graves with their teeth (MRC 2006:1). Studies conducted by the MRC's Chronic Diseases of Lifestyle (CDL), and the Burden of Diseases Research (BDR) units, showed that South Africans living in urban areas have become gluttons (people who eat much more than they need). They also found the following worrying changes in South African health statistics. The average life expectancy has decreased from 60 to 50 years and the average total kilojoule (energy) intake of South Africans has increased by 12%. Nearly 50% of people living in SA are overweight (BMI exceeding 25), or obese (BMI exceeding 30), while about 22% of our children in the age groups from one to nine years are either overweight or obese (Health 24.com:1).

The Youth Risk Behaviour Survey (YRBS) conducted a study in 2002 with 9 054 participants and found that 17% of adolescents were overweight and 4.2% were obese. In a survey which included nearly 5 000 children aged 12-18 years, they estimated that 37% of the black girls aged 18 were obese, compared to 10% and 20% of white girls and girls of mixed ancestry (First South African National Youth Risk Behaviour Survey 2002:1). More recent data from research done on South Africans indicate considerable problems of over-nutrition in adults as well as young women, and also that urban black women are at greater risk (Goedecke, Jennings & Lambert 2006:66).

South African children are living off the fat of the land – and their preference for fatty foods could turn them into a generation of fat kids: that is the message from the NFCS about children one to nine years old, which shows that one in ten children of well-educated mothers in urban areas of SA is overweight, compared with those who

are less advantaged (Labadarios, Steyn, Maunder, MacIntyre, Swart, Gericke, Huskisson, Dannhauser, Vorster & Nesmvuni 2001:62)).

Meriel Bartlett, spokeswoman of the Heart Foundation in SA, mentioned another frightening fact - that children's clothing sizes in SA are no longer appropriate for this bulging generation and has to be redesigned to accommodate their buttocks and thighs. According to Bartlett, South Africa is experiencing the same increase in obesity as the rest of the world (Bartlett 2003:2-3).

In October 2004, the first ever obesity conference for Africa addressed the growing problem of obesity in the region and was hosted by the International Association for The Study of Obesity (IASO). Already in 1998 the South African Demographic and Health Survey (SADHS) found high rates of overweight and obesity, affecting 29% of men and 56% of women. In the Gauteng province and in KwaZulu-Natal more than one-third of women were obese. The survey concluded: "Overall, these data suggest that the predominant pattern of malnutrition in adult South Africans, particularly in African and coloured women, is one of over-nutrition, with remarkably high rates of obesity" (SASSO 2004:3).

Data published recently in The South African Youth Risk Assessment Survey (SAYRAS) 2002, by the South African Medical Council (SAMC) indicate the prevalence of overweight (including obesity) among children aged 13-19 years to be 17% overall, affecting more girls (25%) than boys (7%). Prevalence was highest (over 20% for boys and girls combined) in white and Indian population groups (SASSO 2004:3).

Already in 2000, overweight and obesity was estimated to contribute to 36 504 deaths in South Africa. Certain risk factors were predictive of being overweight or obese including black ethnicity, low levels of education, inactivity and at least one overweight parent (Senekal, Steyn & Nel 2003:13).

Especially in SA, a large cultural diversity influences the perceptions of men and women about their body weight. Only 9.7% of men and 22.1% of women of all races and ages see themselves as overweight, while 29.2% of men and 56.6% of women are overweight. Of black SA women, 16% see themselves as overweight, compared to 34% of women of mixed origin, 31% of Indian women, and 54% of white women. Once they were analysed by gender and ethnicity, only the white women in SA were able to see their actual body weight precisely. These differences may be linked to cultural factors (Goedecke *et al.* 2006:72).

Apart from all the alarming information about overweight and obesity, the black women in SA report that an overweight body has positive connotations in their culture, because it symbolises beauty, happiness, affluence, health and a negative HIV/AIDS status (Goedecke *et al.* 2006:72).

2.5 Under- and over-nutrition in South Africa

2.5.1 Measuring malnutrition, underweight, stunting and wasting in children

WHO standards and growth charts are used to measure malnutrition in children.
Children in the preschool population show a high prevalence of stunting and underweight, which could be an indication of national food insecurity. In Southern Africa the prevalence of stunting ranges from 23% to 30%, and underweight from 9% to 26%, with the lowest prevalence of underweight among preschool children (9%). In SA, compared with other African countries, stunting remains unacceptably high at 23% (Steyn, Abercrombie & Labadarios 2001:100).

The Department of Health (DoH) in SA reported in 2008 that malnutrition in the country is not only marked as under-nutrition, but also over-nutrition, because studies show that obesity and overweight affect not only adults in SA, but also affect children, young people and adolescents. In fact, in 2005 the NFCS: Fortification Baseline survey indicated that overweight affects 4.8% children between the ages of one to nine years and is higher (at 5.5%) in urban formal areas. The highest

percentages were found in Gauteng (6.4%) and KwaZulu-Natal (6.3%). Another survey, the SAYRAS, was conducted nationally amongst high school learners (Grades 8, 9, 10 and 11) in 2002. It reported that 17% of learners were overweight and the prevalence of obesity was 4%. In terms of inactive behaviour, one in four learners (25.2%) watched television for three hours or more per day. An additional one in three (37.5%) did not take part in physical activities (DoH 2008:2-3).

A new report by the MRC, entitled "Dietary changes and the health transition in South Africa: Implications for health policy", they states that in the last 40 years the eating patterns of South Africans have shifted from under-nutrition to over-nutrition, with an increase of 1 260 kJ or 12%, as well as an increase in fat (from 61.2g to 79g), proteins (from 68.4g to 75.1g) and carbohydrates (from 445g to 478g). More food is available to the consumer particularly meals high in fat, which is not good for the health of the nation and will influence the emergence of chronic diseases. The MRC also noted in this report that under-nutrition and the associated outcomes of stunting and underweight as well as micronutrient deficiencies are still prevalent in children. On the other hand, there is also a high prevalence of obesity in children and adults, particularly in women but also in males, ranging from less than 10% in most population groups to 21% in white males (2006:50).
These findings help to explain the increase in lifestyle diseases caused by obesity.

2.6 Risks associated with obesity

2.6.1 Obesity and disease

In the past, a fat child tended to be a healthy child, and paediatricians and caretakers broadly accepted the concept of "bigger is better". This perception has radically changed as people have learnt that obesity in childhood causes a large range of severe problems and increases the risks of early illness and death later in life (Dietz 1998:520; Deckelbaum & Williams 2001:240).

Obesity has been linked to an increase in lifestyle cancers, while six million South Africans suffer from high blood pressure. Five million have high cholesterol levels and are at risk of heart disease, with nearly 1.5 million suffering from diabetes. While seven million South Africans are smokers, the average South African eats only half the WHO recommended daily allowance of 400g of fresh fruit and vegetables (MRC 2006:1). In addition, other lifestyle diseases such as coronary heart disease, hypertension, gall bladder disease, stroke, osteoarthritis, sleep apnoea, respiratory problems, endometrial, breast, prostate and colon cancers, dyslipidaemia, steatohepatitis, insulin resistance, breathlessness, asthma, hyperuricaemia, reproductive hormone abnormalities, polycystic ovarian syndrome, impaired fertility and lower back pain are all caused by obesity (van der Linden 2004:2). Being overweight or obese contributed to 36 504 deaths in 2000 in SA (Joubert, Norman, Bradshaw, Goedecke, Steyn & Puoane 2007:684).

2.6.2 Effect of obesity on self-esteem

Many overweight and obese children have lower self esteem, which can be linked to depression and be psychologically disturbing. If parents tease children about their weight problem, it also affects the child's self esteem. Most of these children are unhappy about their weight condition, and girls especially are more dramatically affected by weight and perceived weight problems more serious than boys are (Kirschenbaum 2007:1).

2.7 Causes of childhood obesity

Like many public health problems, the causes of childhood obesity are complex. Different factors can influence the prevalence and progression of obesity, like dietary intakes, levels of activity, meal patterns and genetic, ethnic, hormonal, psychological and sociological factors. However, obesity is ultimately the result of a positive energy balance – that is, an excess of energy consumed in relation to energy expended each day. Previous research clearly points to incorrect eating patterns, poor food choices with an over-consumption of fat in the diet, coupled with the lack

of physical activity (due to sedentary leisure activities), as the primary contributors to obesity (Norris 2004:2-3). Unchangeable human behaviours linked to such things as automobiles, personal computers (PC), cable television (TV), video games, remote controls, the Internet, and omnipresent convenience stores contribute to a more obese culture than we had 100 years ago. Food-related companies also make it easier and more efficient for us to do our "hunting and gathering"(Wansink 2007:34). Poor intake of food and inactivity are the major contributors to obesity and it is accepted that obesity will soon exceed smoking as the number one killer in the US (Mokdad, Marks, Stroup & Gerberding 2004:1241).

The more energy-rich food or kilojoules that people take in and the less they exercise the bigger they get, and the bigger they become the more susceptible they are to life-threatening conditions like hypertension, heart disease, diabetes and certain cancers. Certain types of foods containing high levels of salt and animal fats may also contribute to a person's lack of well-being (Lowell 2004:240). Levels of obesity have been rising since 1970, because of teenagers eating more fast foods. A number of things about fast food may lead to overeating and obesity. These include high kilojoules content, huge portion sizes, high amounts of refined starch and added sugar, high fat content, low levels of dietary fibre and tastiness (Ebberling, Sinclair & Pereira 2006:2830).

According to David B. Allison, PhD, director of the University of Alabama at Birmingham Clinical Nutrition Research Centre and his colleagues, there are ten "additional explanations" for obesity. These are summarised as follows:

- Too little sleep can be the cause of body weight increase;
- Hormones that control body weight are affected by pollution around us;
- People normally burn kilojoules when their environment is too hot or too cold, but since more people live and work in homes and offices with air conditioning, they gain weight;

- It is believed that smoking results weight loss, but advance health outcomes discourages smoking in the community, thus more ex-smokers are gaining weight;
- Different kinds of drugs – including contraceptives, steroid hormones, diabetes drugs, some antidepressants and blood pressure drugs – can cause increase in weight;
- Population age and ethnicity influence weight. Middle-aged people and Hispanic-Americans become more obese than young European-Americans, so as the American population becomes older and more Hispanic, it also gains weight;
- American women are giving birth at older and older ages. Some studies indicate that the older a woman is when giving birth, the higher the risk of obesity for the child;
- Ancestors' environment may affects descendants' weight. Changes in the environment that made a grandparent obese may "through a fatally driven positive feedback loop" visit obesity on the generation of the grandchildren;
- When obese women marry obese men an assumption can be made that there will be still more obese people in the next generation (DeNoon 2006:2).

Food provides the fuel that people's bodies use for energy. There are three main sources of fuel: carbohydrates, protein and fat. In the body these sources are changed into glucose for energy or stored as fat. As a vehicle uses fuel for energy, people use glucose. When people eat balanced meals daily that contain carbohydrates, protein and fat, they will keep their weight where they want it to be (The U.S. Department of Health and Human Services' National Diabetes Education Program (NDEP) 2005:1).

2.7.1 Family factors

Obesity runs in families. Findings from current research show that obesity in children of mothers that are also obese rises from 9.5% at a preschool-age to about 22% in early adolescence. In association with that, obesity in children of normal

weight mothers rose from 1.7% to 4% (KIGGS 2006). Yet, there is an even larger impact when taking into consideration the socio-economic background of the family (Langnase, Asbeck, Mast & Muller 2002:340). If the socio-economic status (SES) of the family is lower, along with one or two obese parents, the obesity rate of the children will be higher (Lob-Corzilius 2007:587).

2.7.2 Genetic factors

Minor cases of obesity are caused by chromosome abnormalities. Most cases of obesity are caused by an inadequately functioning appetite regulation and energy metabolism, where the energy density and fat content of food and drink are too high, mealtimes are irregular, daily physical activity is limited and inactivity become a characteristic of everyday life. Unlimited supplies of cheap, tasty foodstuffs and large portions also help to promote overweight and the risks of obesity. Recent studies suggest that severe overweight or excessive weight gain during pregnancy increases the offspring's predisposition to obesity within an obesity-inducing lifestyle (Astrup 2005:384).

2.7.3 Health factors and behaviour

According to Parizkova and Hill (2001:11), **"**Poor lifestyle behaviours are largely responsible for excess fatness in the majority of cases of obesity during childhood." If nutritional knowledge is distributed to the population, it will help parents and children to make healthier choices and increase their knowledge of nutrition. From 1975 to 1996, the fat intake in white, coloured and Indian South Africans has gradually exceeded the suggested 30% intake of energy (E). Also, boys and girls between the ages of 11-16 years, of all ethnic groups, follow diets in which fat supplies 30% or more energy (Wolmarans *et al.* 2001:S48).

2.7.4 Nutritional and physical habits

It is important for parents and children to get out and be active. Inadequate physical activity and poor nutrition due to the eating of energy-rich foods high in kilojoules are recognized as the major mechanisms underlying the increase in excess body weight; this is therefore the primary focus of health promotion initiatives intended to prevent or reduce childhood overweight and obesity (Nicklas & Johnson 2004:663). The nutritional and physical lifestyles of people are the two most important factors contributing to the rising levels of overweight and obesity. The nutrition of food contains high portions of fat and protein and is often accompanied by a high consumption of sweetened drinks and a much lower intake of fibre. An intake of high kJ and energy-dense foods fails to decrease the hunger sensations. These foods are sometimes the only food options offered in schools. What also contributes further is the fact that cooking food at home is less common than it was than a few years ago, because families do not enjoy their meal together and this is also linked with a loss of control in food intake. Besides the changes in nutritional habits, daily physical activities have also changed in the last few years. The new technology equipment in many households and the changes to motorisation in all the areas of life has contributed to a less physical generation with reduced energy intakes. It is further intensified by the existence of a variety of electronic devices such as TV, PCs and notebooks in children's bedrooms, which create more "passive" children. All these factors together contribute to the imbalance of energy intake and energy expenditure that leads to obesity (Lobstein, Bauer, Uany 2004:50; Lob-Corzilius 2007:587).

2.8 Obesity prevention and treatment

A population-based prevention approach is likely to hold the greatest promise of addressing the current worldwide epidemic of obesity. Obesity prevention may be achieved by any intervention that results in a balance between energy intake and energy expenditure. Although there are many possible ways to achieve such a goal, the three main venues suggested for childhood obesity prevention programmes are

primary care clinical settings, community settings, and school settings (Robinson 2001:44).

People have a huge selection of diet pills, diet books and diet mixtures to choose from, as well as advertisements that offer quick results as shown on television, in magazines and on the Internet. With so many options people try all these quick solutions. Products are very expensive and some claims on products do not always prove to be true; people often lose weight and then quickly regain it. Apart from the expensive solutions, there are many new ideas on the market for losing weight easily – many of them not requiring hard work or any effort. Like dieters worldwide, South Africans are also obsessed with losing weight, but they tend to choose all the quick and easy ways. These obsessions have increased and make the weight-loss industry a multi-billion rand business (Special Assignment, SABC 3 2005:1).

A much better understanding of interventions is needed to prevent and treat the obesity epidemic, which includes urgently needed information. The influence on obesity should include high quality descriptive and analytic studies of food and physical activity in the environment. Well planned studies are required to further document the impact of intervention strategies and policies to address environmental characteristics and risk factors, as well as a useful monitoring system that provides appropriate, suitable information about "upstream" measures, such as changes in the community, environmental changes and organizational conditions that drive poor diet and physical inactivity (Powell, Auld, Chaloupka, O'Malley & Johnston 2007:301).

Prevention and treatment of obesity requires a reduced energy intake and a increased physically active lifestyle. Reduced energy intake by dense portion sizes of meals, and avoiding drinks with high kilojoules. To achieve such a weight loss a reduced energy intake is pertinent, together with 30-60 minutes of daily physical activity to maintain weight. Low energy diets, consisting either of normal foods or meal replacements, are effective in achieving a weight loss of 5-10% in most people. Therefore the optimal diet is reduced fat, increased content of fibre-rich

carbohydrates and protein from meat and dairy products. There are also approved weight loss drugs available to further improve the mean weight loss of more than 5-10% (Astrup 2005:398).

2.8.1 Therapeutic obesity diets

Therapeutic obesity diets differentiate between a number of recognised weight regimes. Low energy diets (LED) providing 800-1500 kJ/d use fat-reduced foods. Diets providing 1200 kJ/d or more are classified as balanced deficit diets. Very low energy diets (VLED) that provide 200-800 kJ/d to replace normal foods, are the ultimate treatment for obesity, but are no longer used because of serious medical complications which are linked with prolonged starvation (Astrup 2005:396). An increase in daily exercise and activities is required.

2.8.1.1 The National Food Consumption Survey of South Africa (NFCS)

The NFCS of the food consumption patterns of children aged one to nine years, with particular emphasis on children living in low socio-economic areas, can be seen as an outstanding contribution regarding anthropometrics, dietary patterns and nutrient intakes in South African children (Labadarios *et al.* 2001:62). Information provided by the NFCS serves as a basis for the design and implementation of nutrition intervention programmes in SA.

2.8.1.2 Food-Based Dietary Guidelines of South Africa (SAFBDG)

One of the most sensible sets of health guidelines ever published in our country is the Food-Based Dietary Guidelines (FBDG).

The FBDG was compiled by Labadarios and Steyn and is the basis for an extensive review of the nutrition-related health concerns, mortality trends, and food consumption patterns of South Africans. The reason why these guidelines were compiled is to promote the health of South Africans older than five years of age. In order to grow normally and to develop, children have specific nutrient needs,

therefore the FBDG have separate guidelines for young children, which also include the following (Labadarios & Steyn 2001:42): Enjoy a variety of food, be physically active and make starchy foods the basis of most meals during the day. Eat lots of fruits and vegetables daily, as well as dry beans, peas, lentils and soy frequently. Food like meat, fish, chicken, milk and eggs can also be eaten daily, but food high in fats and salts must be used sparingly**.** Drink a lot of clean, safe water and if drinking alcohol, drink sensibly. Food and drinks which contain high levels of sugar must be taken sparingly and not between mealtimes (MRC 2006:2). Regarding the already existing FBDG, another guideline that may cause some concern is 'eat healthier snacks', with the possibility of subjective interpretation of both 'healthier' and 'snack' (Love, Maunder, Green, Ross, Smale-Lovely & Charlton 2001:17).

2.8.1.3 Integrated Nutrition Programmes (INP)

The INP of the DoH tries to prevent and manage malnutrition and ensure optimum nutrition for all South Africans. It focuses on certain areas and support systems such as disease-specific nutrition support, treatment and counselling, where the focus is on chronic diseases like overweight, obesity and severe malnutrition. Maternal nutrition includes nutrition for pregnant women and feeding for infants and young children, where it concentrates on early childhood nutrition and growth monitoring and promotion. Youth and adolescent nutrition includes nutrition in schools, eating disorders and obesity. There are also activities to prevent, reduce or control dietary deficiencies and to control micronutrient malnutrition. It also focuses on the activities of planning, development, control, implementation and evaluation of suitable food service systems to provide balanced and nutritious meals to groups and ill people in the communities. The focus is on nutrition education and the promotion and advocacy of such programmes. Community-based interventions are also one of the focus points of the INP. The INP fully supports nutrition information systems, human resource plans and financial and administrative systems. Their priority target groups on this whole programme are children at risk, especially those younger than two years of age, and women at risk, particularly those who are pregnant and

lactating, as well as, persons who have serious lifestyle-related, chronic diseases, and elderly and disabled persons, who are at risk (DoH 2008:1-2).

2.8.1.4 Government intervention

In October 2004, presenters at a symposium on "Kids, Nutrition and Healthy Lifestyle" recommended certain steps to reverse the childhood obesity epidemic. They recommended that the Department of Education (DoE) should bring back physical education as part of the school curriculum at all schools and that school sport, in which all children should take part, not just the top athletes, should be a right, not a privilege. There should be enough funding available to provide sports facilities that have the biggest impact on the physical fitness of all the children at a specific school; for example, rather than a swimming pool, a sports field should be developed where children can play a variety of sports, throughout the year. Above all, teachers in the school should be educated in physical activities so that they can encourage children to take part in sport and physical education and should be taught about balanced diets that can prevent weight gain in children (Caelers 2005:10).

The Minister of Health appointed in 1994 was tasked with developing a nutrition strategy for South-Africa. The INP aims to implement programmes that are integrated, sustainable, people and community-driven and are targeted at the most vulnerable groups of the population. Figure 2 indicates the goals, objectives, vision and mission of the INP.

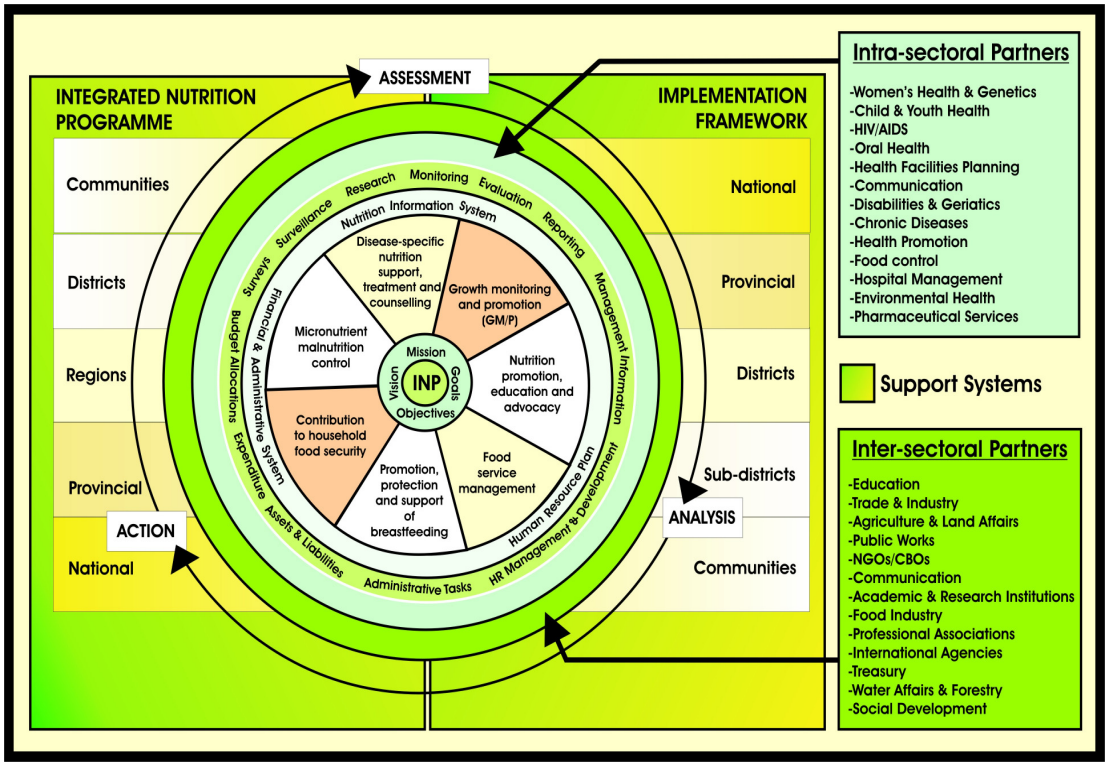

Figure 2 DoH Strategy (Adapted from Integrated Nutrition Programme. A foundation for life. Pretoria: DoH. 2004:6).

2.8.1.5 Achievements of DoH in SA to promote healthy lifestyles

The DoH launched the Move for Health Campaign in May 2005. This campaign started in Alexandra Township and the main objective was to promote physical activity and healthy behaviours. The campaign has been held every year and has created an opportunity for departmental staff and the community to participate in physical activities.

The DoH has been engaging with Quick Service Restaurants (QSR's) to provide and consume healthy meals since 2006. There was an increase in marketing and provision of healthy meal options, and some QSR's also provided nutrition information of meals to help the consumer to make healthy choices when ordering meals.

The DoH developed a draft implementation strategy on obesity, physical activity and health in 2008, that urges member states to develop strategies and action plans around healthy diets, physical activity and chronic diseases of lifestyle.

The DoH addresses the marketing of foodstuffs to children with a draft of regulations that relate to the labelling and advertising of foodstuffs. It includes banning advertising of foodstuffs that are not essential for a healthy diet and healthy lifestyle like soft drinks, candies, chocolates confectionary, savoury foodstuffs, desserts and sweet biscuits to children younger than 13 years. This is in line with the recommendations of the WHO global strategy. A change in marketing strategies must also change to promote health-enhancing foods to bring improvements in young peoples eating behaviours.

The DoH suggested also that messages that encourage healthy dietary practices and physical activities must be promoted. They interact with the community through the media, they use the South African Food Based Dietary Guidelines as the basis for a healthy eating plan. The Directorate: Nutrition has supported several healthy lifestyle campaigns outside the department by doing screenings (BMI, weight and height) and provides nutritional counselling. Departments that have already been supported already are the Department of Agriculture, Education, Correctional Services, Justice and Home Affairs (DoH 2008:3).

2.8.1.6 Parental intervention

Parents, particularly mothers must be aware of their child's overweight and physical activity levels – they must know what children do after school and must intervene if they do nothing but sit in front of the TV and computer. They should also know what physical activity is offered at the local school. If no sport facilities are available, or if no effort is made to ensure that children do something active on a daily basis, parents must help teachers to organise some type of exercise. For example, if parents can afford to buy a piece of rope that can be used for skipping, teachers can supervise the children's skipping for 20 minutes a day at school. If

there are no sport facilities in school, parents could try to raise money to build a sports field, as mentioned above, to encourage children. Another alternative is to help children to be active by finding a safe place where they can play with friends or with pets and, if it can be afforded allow the children to join a gym or a sports club (Caelers 2005:10).

2.8.1.7 Private sector intervention

According to media reports, there are a number of gyms and sports institutes that encourage children to get more active. A project undertaken by Virgin Active gyms is to provide workout facilities for children of all economic backgrounds. A recent media report announced that the Sports Science Institute of South Africa (SSISA) had started a Funky Fitness Programme for obese and inactive children (Caelers 2005:10).

There is also a lot of information in the media concerning nutrition, health and fitness, and news flashes can be seen daily on television. On the other hand, one can search for nutrition advice on the Google website which revealed over 46,000,000 sites (Wilson 2007:S13).

Possibly the most encouraging news to date is the introduction of a Charter for Physical Activity and Sport for Children and Youth under the leadership of Dr Karen Sharwood at the MRC Unit for Exercise Science and Sports Medicine in Cape Town.

The Charter includes the following points:

- All children and youth in SA have the right to be physically active and to play sport;
- Support between all role players including Government, parents and sporting organisations is needed to provide opportunities for children and youth to take part in safe physical and sport activities;

- The Government and the private sector are called on to make the infrastructure and safe access to sport and physical activity available;
- The protection of children and youth at all levels when taking part in sport and physical activity is necessary (Caelers 2005:10).

2.9 Conclusion

This chapter focused on the prevalence of obesity, its causes and the problems associated with overweight and obesity.

In the last 40 years the eating patterns of South Africans have shifted from under-nutrition to over-nutrition, with an increase of 300 kJ or 12%, as well as, an increase in fat (from 61.2g to 79g), proteins (from 68.4g to 75.1g) and carbohydrates (from 445g to 478g) per day.

The literature proved that obesity is a growing problem worldwide and is increasing at an alarming rate. Children are becoming obese at younger ages and the major contributing factor is poor eating habits especially unhealthy snacking patterns.

Therefore, this study focused on the snacking patterns of children and providing a low fat, high-density nutritious snack food item for children as an alternative to unhealthy snacks. The aim was to make people, especially children, aware of low fat snacks to fight the obesity problem in South Africa. Obesity affects children of all age groups and parents must help to choose snacks that are nutritious.

Chapter 3 Literature synthesis: Product development

3.1 Factors to consider in product development

Several factors must be considered when developing a product; these are consumer survey, sensory analysis, sensory evaluation and shelf life of a product, nutritional value, quality and the types of ingredients used. The product development processes are explained as a five- to eight-step process that involves ideas or concept, screening, research, development and product testing as well as marketing launch activities (Stewart-Knox & Mitchell 2003:2). According to Marx, van Rooyen & Bosch (2001:32), the product development revolves around two characteristics, which are:

- Specific product characteristics such as taste, recreation, value, prestige, quality, price and sensory analysis; and
- Certain quantitative and qualitative characteristics of possible target markets like nutritional value and shelf life (Marx *et al.* 2001:32).

According to Benner, Linnemann, Jongen & Folstar (2003:328), the product development process has to become more successful and capable of meeting or exceeding the customer's expectations to improve its success rate. There is a need for consumers orientated in the new development process to be consumer-orientated. The starting point of the product development has to describe the requirements and demands of the consumer (Benner *et al.,* 2003:328).

3.2 Product development for children

3.2.1 Food choices and preferences of children

The following points are a general consensus of opinions that influence food preference, consumption and behaviour patterns of children.

Psychosocial factors like food preferences, the meanings of food and food knowledge can influence children's food choices. In addition, biological factors like heredity, hunger and gender contribute to food choices. Behavioural factors like time, convenience, meal patterns and dieting play a big role as do the income, working status of the mother, family eating patterns, parental weight, diet and knowledge of the family. The conformity, norms and peer networks of friends are also very important, together with school meals, sponsorship and vending machines at schools, which can also influence their choices. Commercial sites such as fast food restaurants and stores will also contribute to the daily food choices, as well as consumerism such as the youth market and pester power. The media is one of the great influences in children's food choices, because of the large number of food promotions, including television advertising, that definitely influence children (Story, Neumark-Sztainer & French, 2002:40).

A base for healthy food habits can already be created in early childhood, although food habits and choices can change rapidly during a person's lifetime. An assumption can be made that parents influence these choices by acting as models for their children, because normally children are afraid of new foods (Koivisto 1999:26). Some parents are well informed about healthy eating, but there are many barriers to nutritional food choices, such as a lack of sense of urgency, taste preferences for some foods, as well as complaints that such healthy foods are time-consuming to prepare and are not convenient (Contento, Williams, Michela & Franklin 2006:576). All these factors need to be taken into account when considering dietary interventions (Shepherd 2005:36).

3.2.2 Children's snacking patterns

The majority of children snack some time throughout the day and there is an increasing tendency amongst Western populations to move away from the traditional eating pattern of three meals a day to eating snacks instead of meals. The causes of increased snacking include rapid urbanisation with changes in lifestyle, family fragmentation with more fathers working away from home and more working

mothers, more snack foods available on the market and more freedom for children to buy their own snacks (Kruger 2002:4).

Already in August 2002 Information Resources Incorporated (IRI) reported in its White Paper that snacking was increasing, owing in part to busier lifestyles. In September 2003, a year later, IRI stated that despite high costs, in Europe, GB is the largest promoter of savoury snacks (Information Resources Inc).

Children are the target of the junk food industry which aims to displace healthy local eating habits with its own which include high kilojoules, high added fat and high added sugar. These foods contain few vitamins, minerals, protein or fibre. If sweetened drinks are the main supply of added sugar in the children's diets, one 330 ml can of carbonised cold drink contains the equivalent of 10 teaspoons of sugar, which not only contributes to overweight and obesity but also displaces milk consumption, resulting in calcium deficiency with associated long-term risk of osteoporosis and fractures. Dental cavities and enamel erosion are further consequences. Figures from the USA, which are probably more or less the same in SA show that up to 85% of school children drink at least one soft drink per day and among male teenagers, 20% consume four or more servings per day (SASSO 2004:3).

By eating regular, balanced meals and reducing snack food items, the risk of early preventable diseases and childhood obesity can be prevented (Munro 2005:10).
Don't ban snacks – plan snacks!

Snacks that can be considered as luxury items include cakes, biscuits, potato crisps, chocolates, ice cream, pizza and pies, which have a very low nutritional value and are eaten by people between mealtimes or every time they feel the need for something to chew on (Love, *et al.* 2001: 17).

Potato chips and related savoury snacks such as extruded products belong to a highly competitive, innovative, and growing sector of the food market. In the UK, they are

categorized as snack products, which are generally, understood as ready-to-eat ambient, "shelf stable" (6 to 12 weeks) savoury products, pre-packed, and offered through a variety of outlets including supermarkets and other food retailers as well as catering establishments (Blenford 1990:146). Although the term "snack food" can mean very many different products in different countries within the European Union, and indeed in North America, in 1991, the UK consumed some 234K tonnes of snacks, which equated to just over 4 kg per head per annum. In financial terms, the UK savoury snack market was worth around R16 billion in 1997 and is still growing (Food and Drink Statistics 1998:11).

3.2.2.1 Snack food types

Snack food products may be divided into the following categories, based on the process technology associated with their manufacture.

3.2.2.2 Deep fat fried. This includes potato chips and potato strips/sticks/rings, and represents by far the major portion of the snack food business worldwide.

3.2.2.3 Quick fried. Pre-formed partly cooked pellets derived from potato, potato starch, and/or cereal materials are fried at high temperatures (for example, of the order of 200ºC) for a short time (10-15 seconds) giving expanded, light-textured products.

3.2.2.4 Extrusion cooked. Cereal/potato powder mixes are extruded through dies at high pressure and temperatures to give an expanded base, which, after further drying, is enrobed with oil and flavour. A large number of products are available in this category and they display varying sizes, shapes, textures, and flavours.

3.2.2.5 Roasted. This is primarily represented by nuts, particularly in the form of dry roasted peanuts.

3.2.2.6 Baked. While products such as cakes, savoury mini-snack biscuits, pizzas and pies have always been popular products, baking is increasingly being used to produce savoury snacks that can have a much lower fat content (Burdon 1989:162).

3.3 Snacking in South Africa

South Africa's number 1, most popular, most loved maize snack (Nik Naks) advertisement (quoted): "Never been anything like it, never will be. And it's been a part of our snacking lives since 1972. It's the real maize snack that smacks of the new South African spirit – bright, vibey, smile on the face, good times with new friends and non-stop fun" (Niknaks 2006:1).

An alternative to this advertisement is that, Simba (part of the Pepsico group), the leader of snacks in SA, introduces a new "better for you" line of snacks – SUNBITES. Because of the increasing problem of obesity around the world, and the awareness of the value of a snack that is portion-controlled, free of fatty acids and lower in total fat and sodium, this company started on a different approach to snacks. The new product, Sunbites Pretzels, are baked and not fried, are free of fats and also lower in energy, total fat, saturated fat and sodium than the traditional savoury snack. It is packed in a convenient portion-controlled packet and is free from added mono sodium glutamate (MSG), artificial colourants, contains no tartrazine and is high in fibre (Simba Proprietary Limited).

3.3.1 Most popular snacks eaten by children

Back in 1996, a study completed by Ruxton amongst Scottish children of seven to eight years old, found that potato chips were the most popular snack – one individual consumed a maximum of 42 packets per week. Chocolate confectionary is a popular snack worldwide, because of its high availability, heavy advertising and the high palatability of chocolates to consumers generally. Fruit and biscuits are more popular among girls than boys and are the foods most likely to be brought from home, rather than self-purchased (Oakley 2000:16).

In the North-West (NW) province in SA a study was conducted, called the Transition and Health during Urbanisation in South Africa (THUSA), and was named the THUSABANA Study. Savoury snacks (potato crisps and maize-based snacks) were reportedly eaten by about one-quarter of the children, at a mean amount of nearly two packets per day. Toffees were eaten by more of the children than apples. Cold drinks, including carbonated beverages and squash, was sixth on the list of most frequently consumed foods, with a mean intake of 381 millilitres (ml) (one and a half glasses) daily, compared to milk, which was the second most frequently consumed food, but at a mean intake of only 194 ml (less than one glass) per day (Ngwenya, 2001:4).

The Primary School Nutrition Programme (PSNP) in SA operates only at schools in low socio-economic areas. The provincial DoH in each province is responsible for the regulation of the PSNP and for ensuring that nutritious snacks are being provided (Kloka 1999:4). DoE authorities in SA do not have regulations about snack food available at school tuck shops, since these tuck shops are privately owned. Some nursery schools have a policy about the content of lunch boxes, suggesting that mothers pack sandwiches and fruit only. The THUSABANA Study in NW province showed that about one third of children between the ages of ten and 15 took lunchboxes, but that three-quarters of children regularly bought snacks from the tuck shops. The most popular lunchbox items were sandwiches. The most popular snacks bought at school tuck shops were chips and cold drinks (Matshego 2001:4).

A survey was done by Hampl (1999:582) to highlight the need for nutrition education of schoolchildren. On the day of the survey, 40% of the children ate no vegetables, except for potatoes or tomato sauce; 20% ate no fruit; and 75% snacked at least twice. Some 36% of the students ate at least four different types of snack foods. Another study showed that only 2% of about 3300 children from two to 19 years old had consumed their recommended servings from all the five Food Guide Pyramid groups (Hampl 1999:582).

3.3.1.1 Nutritional value of snacks available on the South African market

Milk products are concentrated sources of calcium (Ca), with 160 milligram (mg) Ca in a 20 gram (g) cheese portion, 250 mg Ca in 175 ml fruit yoghurt and 325 mg Ca in a 250 ml glass of malted milk. Children disliking milk can eat cheese sandwiches, cheese and biscuits or yoghurt as snacks. Good sources of iron (Fe) include biltong (1,6 mg per 30 g), raisins (1 mg per 50 g) and dried apricot bars (0,9 mg per 30 g), as well as iron-fortified breakfast cereal (2,5 mg per 40 g), which can be eaten as a dry snack. Dried fruit sticks, rice flake bars and muesli bars are also good sources of most B vitamins, such as thiamine, riboflavin, niacin, vitamin B6 and folate. Some fruit bars and energy bars are fortified with a complete vitamin and mineral mixture, including zinc (Zn), magnesium (Mg), iron (Fe), calcium (Ca), vitamin B12, biotin and pantothenic acid. Most of these snacks are also good sources of zinc. Dried fruit bars (0 g fat per 20 g) and rice grain bars (2 g fat per 20 g) are nutrient-dense, but also low in fat. These snacks, together with fresh fruit and vegetable sticks, are particularly appropriate for overweight children who need nutritious snacks, but their energy intakes should be limited to their daily energy requirement.

Snacks with a high fat content include potato and maize crisps (8 g fat per 25 g), dried sausages (8 g per 30 g), biltong (8 g per 30 g), chocolate bars (15 – 29 g per 50 g), crispy salt biscuits (1, 4 g per 5 g), shortbread (11 g per 40 g) and fried fat cakes and doughnuts (9 g per 60 g). Overweight children should consume limited servings and only snack occasionally. Although these snacks are high in fat, some of them contribute valuable micronutrients in the diet. One packet (25 g) of potato crisps provides 11,5 mg vitamin C, 4 mg of calcium and small amounts of most B vitamins. Sour cream and onion-flavoured potato chips have a slightly higher content of B vitamins, pantothenic acid and riboflavin than other flavours. One packet of most flavours of potato crisps has a sodium (salt) content of 250 mg, but salt and vinegar and barbeque-flavoured crisps have a higher salt content of up to 400 mg per packet. The majority of healthy children have normal kidney function and salty snacks should not be a problem, but children may develop a preference for salty foods.

Studies showed an association between normal salt intakes and blood pressure in salt-sensitive persons (Law, Morris 1998:551).

Children need healthy food for energy to learn, play and live and above all to grow at a healthy pace according to their age. They also need to keep glucose levels and blood sugar levels in balance throughout the day, so that these levels do not become too high or too low. Consuming healthy foods helps them to lose weight gradually if they need to and to keep their body working, as it should. It also helps them to avoid other health problems caused by diabetes (The U.S. Department of Health and Human Services' National Diabetes Education Program (NDEP 2005:1).

3.3.1.2 Type of ingredients used in the development of healthy food

For the purpose of this study, soy was identified as a possible ingredient for food products to be developed for obese children because soy protein has been studied for its possible health benefits and the information is promising; as a result it may be an excellent option for obese patients to consume when trying to lose weight. Allison and colleagues did a 12 week trial, testing the effect of soy-based meal replacements in 100 volunteers. They reported that the soy-based meal replacement group lost considerably more weight and fat mass than the control group. The treated group also had a better change in total cholesterol levels (Allison, Gadbury, Schwartz, Murugesan, Kraker & Heshka 2003:520).

Soy products are a source of high quality protein that provides all essential amino acids. They can be used as the most important, individual source of protein for children (Young 1991:829). Soybeans and soy products are high in iron but also contain phytate, a substance that inhibits iron absorption. Iron absorption from soy products can therefore be improved (Siegenberg, Bayness, Bothwell, Macfarlane, Lamparelli, Car, MacPhail, Schmidt, Tal & Mayet 1991:537). Soy proteins have been reported to be helpful in lowering blood cholesterol levels in children (Lauren, Jacques & Moorjani 1991:100). If meat and full fat dairy products are replaced with

soy products, the total saturated fat content of a child's diet can be reduced (Lino, Gerrior, Basiotos & Anand 1998:9).

For many centuries, Asian nations have consumed soy because of it is a low-cost source of protein. It contains fibre, minerals, and isoflavones (a type of flavonoid), all beneficial nutrients that may contribute to a decreasing risk in chronic diseases of lifestyle (Messina 2002:275). Soybeans contain all three of the macronutrients that are essential for good nutrition, which include complete protein, carbohydrate and fat, as well as vitamins and minerals, including calcium, folic acid and iron. Soybeans are the only vegetable that contains complete protein. Soybeans are often called the miracle crop because it provides protein and oil. Mature soybeans are about 38% protein, 30% carbohydrates, 18% oil and 14% moisture, ash and hull. Soy milk can be substituted for cow's milk in baking, and soy flour can also replace some of the flour (WISHH 2006:12).

3.4 Soy flour

Full-fat soy flour is used in breads, pasta and other foods. It is prepared from roasted soybeans ground into a fine powder; it contains more than 15% fat. Defatted soy flour comes from the grinding soy flakes that have had the oil removed, usually through solvent extraction. This product has less than 15% fat. Defatted soy flour is 50% protein and can be stored for three to twelve months in a dry, cool environment (WISHH 2006:6). Soy flour is gluten free and therefore cannot replace all of the flour in a recipe. It can be substituted for 15-25% of the flour in almost any recipe, improving the nutritional content (WISHH 2006:33). Soy flour needs to be sifted or stirred before use as it tends to get compacted down in the container. Products baked with soy flour may brown more quickly, so lowering the oven temperature slightly is recommended. Full-fat soy flour must be stored in the refrigerator or freezer, but defatted soy flour can be stored on the shelf for three to 12 months in a dry, cool place. Soy flour can be used to thicken cream, sauces and gravies (WISHH 2006:33).

3.4.1 Why soy is healthy

Soybeans are a good source of protein and fibre, low in saturated fat and contain no cholesterol. They also contain a special type of polyunsaturated fat called omega-3 fatty acid, which is a good fat that may help decrease the risk of cancer and heart disease. They also are rich in macronutrients and micronutrients essential to the body. Macronutrients in soy are protein, fat and carbohydrates, and micronutrients are vitamin B, zinc, calcium, vitamin E, vitamin K and iron. Soybeans are higher in protein than other legumes (WISHH 2006:12-13).

3.5 Quality control in product development

Quality control (QC) is an important part of any business that processes foods. It is essential for the survival of any food business and for adding value to their products (Axtell 2009:1). Food processing businesses make use of QC to protect the consumers from dangers, such as foods that can be contaminated and to make sure that consumers get the weight and quality that they pay for. It also protects companies from suppliers who try to cheat as well as from any damage to equipment and ensures that they comply with a country's food laws. To do QC on a product can be time-consuming and expensive, but will save money in the long run. It should be kept as effortless as possible and only provide the necessary amount of information. Furthermore, the QC component predicts and controls the quality of foodstuff that is processed and controls the quality processes that are achieved for every batch of the foodstuffs (Axtell 2009:2).

3.5.1 Quality specifications in product development

Specific ingredients and the quality of food are measured in different ways, like a written specification and agreement with the supplier or seller, which lists things like colour, size, shape, kind of damage, if any, and the hardness of the product. Such specifications can also include a representative sample of the tested foodstuffs to ensure that the entire batch meets the specifications. A percentage of an item that

causes a batch to fail can be added to or reduced, depending on how trustworthy the supplier is or how important the quality is to the supplier or the producer (Axtell 2009:3).

3.5.2 Control points in product development

Control points are not the only process that plays an important role in the quality of the final process. The quantity of heating that is used can influence the colour of the final product, the flavour and the storage life. Stages like this are defined as control points and quality checks are completed at these stages to control such processes. It is the job of the manufacturers to recognize the control points in these processes by using outside technical assistance if needed, and only then can they can set up a specification for the final product. These checks at control points are used to control these processes and to make sure that each batch of the product is of similar quality (Axtell 2009:5).

3.5.3 Good Manufacturing Practice (GMP) in product development

The GMP is there to create a suitable environment for the production of food of an acceptable quality and is the fundamental principle for this procedure. They make sure that the basic hygienic principles are in place to ensure the safety, cleanliness and wholesomeness of the environment in which the food products are produced. It should also have a well-established record of personal cleanliness and conduct, hand washing, waste facilities, general protection from contamination, water quality control and humidity control (FoodBiz).

3.5.4 Hazard Analysis Critical Control Points (HACCP) in product development

The HACCP is a food safety management system and requires a description of the product, the distribution method, intended use and they target consumers. It also requires an assessment of food hazards, the establishment of acceptability limits, the monitoring process, the implementation of corrective action and the documentation

and verification of the product. Businesses that make use of the HACCP can ensure that the best possible food safety system is followed (Brewer 2006:1).

3.5.5 Consumer satisfaction

It is essential that manufacturers attend to changing requirements, and market research is often called on to collect information in order to meet certain trends. Market research attempts to forecast the future, while new technology is presented that is critical to achieving a particular item for consumption. Suppliers are often asked to supply the latest information in order to assist food companies with designing or conducting consumer focus groups. Market research could also aid in predicting the consumer feedback to changes on labels dictated by a new or novel food ingredient (Hood, Lundy & Johnson 1995:12).

3.6 Sensory analysis

3.6.1 Definition

Sensory analysis is the identification, scientific measurement, analysis and interpretation of the properties (attributes) of a manufactured food, as they are perceived through the five senses of sight, smell, taste, touch, and hearing (Carpenter, Lyon, & Hasdell 2000:19). Obviously, perception contributes to a major function in the science of sensory analysis. Perception, in its own right is defined as the ability of the mind to transfer sensory information to an external object as its cause. Both the mind (psychology) and the body (physiology) play an integral part in the processes of sensory analysis (Carpenter *et al.* 2000:13). Sensory analysis is used to answer questions about product quality, questions relating to discrimination, description, or preference (Carpenter *et al.* 2000:1). Sensory analysis is the assessment of a product through organoleptic properties (the five sense organs) by utilising humans as measurement instruments. The significance of sensory analysis is enormous in many domains to enhance quality of products throughout the development process, to explain sensory properties of products, and to contrast products with competitor's products (Meilgaard, Cicille & Carr 1991:26; Latreille

2005:369; Piana, Oddo, Bentabol, Bruneau, Bogdanov, & Guyot Declerck 2004:S26). Sensory analysis is used in many fields to establish the organoleptic profile of diverse products (foods, cosmetic, pharmaceuticals, textiles, household products) and can be useful in knowledge on how they are perceived by the consumer (Meilgaard *et al,* 1991:26; Piana *et al.* 2004:26). In simple terms, sensory evaluation is separated into two methods like subjective and objective panellists, while objective testing implements the use of laboratory instruments with no involvement of the senses. Both tests are vital in sensory evaluation and essential in diverse conditions (Meilgaard *et al.* 1991:26).

3.7 Sensory evaluation

Sensory evaluation is the science of judging and evaluating the quality of a food by the use of the senses, like taste, smell, sight, touch and hearing. It has been developed into an accurate, formal, structured methodology that is frequently being updated to refine existing techniques. The methods developed serve economic interests and can establish the worth or acceptance of a commodity. Sensory evaluation is used as a practical application in product development by aiding in product matching, improvements and grading, which is another area where sensory evaluation is frequently used in research. Evaluation of a product may be required to establish the effects an experiment has on its subject. Quality control and marketing is yet another application of sensory testing. Sensory evaluation is divided into two methods, subjective and objective testing. Subjective tests involve panellists, while objective testing employs the use of laboratory instruments with no involvement of the senses. Both tests are important in sensory evaluation and necessary in various conditions. Sensory evaluation carried out by trained sensory panellists is called objective testing. Sensory evaluation utilising consumer panellists is subjective testing (FDC, 2006:2). As far as the consumer is concerned, the most vital element of any product is taste perception and eating qualities (Boobier, Baker & Davies 2006:3).

3.8 The hedonic scale

The hedonic scale method is one of the simplest forms of testing and is a rating scale method utilised to measure the level of the liking of foods, or any other product where an affective tone is necessary (O'Mahony 1986:12). Tests, like the above-mentioned depend on people's ability to write down their feelings of like or dislike. Hedonic testing is used among unskilled people as well as with skilled panel members and is very popular (Meilgaard *et al.* 1991:28). A minimum amount of verbal ability is necessary for reliable results (Food Resource Nutrition and Food Management (FRNFM) 1998:12; Stone, 2006:1).

According to the American Society for Testing and Materials (ASTM), as cited by Meilgaard *et al.* (1991:27), in hedonic testing, samples are offered in succession and the subject is told to make a decision as to how much he/she likes or dislikes the product and to mark the scale accordingly. Although the nature of these tests is relatively easy to understand, the instructive information to the panellist is limited to procedures, and no attempt is made at direct response. The subject is allowed to make his own inferences about the meaning of the scale categories and decide for himself how he will apply them to the samples. The hedonic scales are anchored verbally with nine different categories ranging from "like extremely" to "dislike extremely". All these phrases are placed on a line-graphic scale either horizontally or vertically. Many different forms of the scale may be used with success; however, variations in the scale form are likely to cause marked changes in the distribution of responses and ultimately in statistical parameters such as means and variances (ASTM 1968:5).

Theses ratings are converted to scores and treated by rank analysis or analysis of variance. Hedonic scales are used with both experts and untrained consumers, with the best results obtained with an untrained panel. The ratings labels obtained on a hedonic scale may be affected by many factors other than the quality of the test samples. Characteristics of the subjects, the test situation, attitudes or expectations of the subjects can all have a profound effect on results. A researcher needs to be

cautious about making inferences on the basis of comparison of average ratings obtained in different experiments (Meilgaard *et al.,* 1991:27).

A lot of other tests besides hedonic scales are used in the sensory evaluation of a food product. To obtain accurate results for a project, it is crucial to decide on the kind of research that is done and the kind of evaluation that is needed. The wide range of informative tools used in sensory analyses includes the descriptive sensory analysis techniques. These techniques can offer complete sensory descriptions of products to find out how ingredients of process changes affect product characteristics, and identify key sensory attributes that promote product acceptance. Specific uses for descriptive sensory analysis include:

- Product "fingerprinting".
- Shelf life determination.
- Competitive product comparison.
- Product development testing.
- Quality control monitoring (FDC 2006:2).

3.9 Shelf life of a product

Foods are perishable by nature. Numerous changes take place in foods during processing and storage and it is well known that conditions used to process and store foods may influence the quality attributes in foods. Upon storage for a certain period of time, one or more quality attributes of a food may reach an undesirable state. At that instant, the food is considered unsuitable for consumption and it is said to have reached the end of its shelf life (Singh 2000:3).

The purpose of a shelf life study is to find out how long a food product may be stored before there is an unacceptable deterioration in its sensory quality. According to the UK and EC food laws, the manufacturer must label most pre-packed foods with a "use by" or "best before" date. Ever since the first of January 1991, it has been an offence in the U.K. to sell products that have passed their "use by" date. Obviously,

therefore, manufacturers must be able to predict accurately the shelf life of their products, to ensure that the consumer receives the product in a satisfactory condition, and that there is sufficient "unexpired" shelf life for normal distribution and retail purposes (Carpenter, *et al.* 2000:3).

The more recent guidelines from the Institute of Food Science and Technology (IFST) provide a more workable definition of shelf life, which is a specified period during which the product must:

i. Remain safe;
ii. Be certain to retain desired sensory chemical, physical and microbial characteristics;
iii. Comply with any label declaration of nutritional data, when stored under recommended conditions (Kilcast & Subramaniam 2000:1).

Shelf life testing is investigation to verify the length of time that the food product will keep its safety and quality. Shelf life differs according to the type of packaging, method of storage and conditions of storage of a product (FDC 2006:1). The better method to describe shelf life is to understand the changes that occur in product quality over time. The change of quality over time is a function of storage temperature, humidity, package protection, product composition, water activity, processing conditions, and ingredient quality (FDC 2006:1).

Survival analysis is a branch of statistics utilised widely in clinical studies, epidemiology, biology, sociology and reliability studies inclusive sensory evaluation. Hough, Langohr, Go'mez and Goria (2003), applied survival analysis statistics to sensory shelf life of foods. This was used to calculate acceptance limits for sensory defects by Hough, Garitta and Sa'nchez (2004), which can be applied to setting quality control specifications (Calle, Hough, Curia & Gomez 2006:307).

The useful storage of food is represented by shelf life. Food develops characteristics such as changes in taste, aroma, texture or appearance that are intolerable or

undesirable at the end of shelf life. The fundamental reason for the adjustment may be microbial, chemical or physical. Rancidity and freezer burn are typical examples of chemical and physical deterioration. The determination of the microbial shelf life of many foods may be required during product development (Curiale 1998:1). The components of shelf life testing may comprise assessing the physical, microbial and sensory attributes of the products.

During the shelf life of a product there are many factors that are likely to affect its sensory quality and its acceptability to the consumer, like temperature, light, packaging, atmosphere, storage, distribution and retail procedures (Carpenter *et al.* 2000:4-5).

Throughout the shelf life of a snack, a number of deterioration processes take place simultaneously. They are texture loss due to moisture pick-up, rancidity development that requires oxygen and may be light-induced, and gradual loss of flavour in flavoured varieties. In general, although all of these need to be controlled, relatively speaking, texture loss is more important to potato chips and related snacks, and rancidity development to nuts because of their compositional differences (Man 2000:161).

Additionally, in recent years, largely as a result of consumer demand and demographic changes, low-fat and low-salt versions of some of the above categories have appeared and become popular. The primary raw material for savoury snacks is therefore potato, either fresh or dehydrated, cereals (maize, rice, wheat, etc.), and nuts. Despite the important influence these raw materials have on the quality of the final products, by far the most important ingredient that can affect product shelf life is the oil used, either in frying or as a carrier for seasoning. Snack products as a group can be consumed principally for pleasure, because of their unique texture and the enormous variety of flavours available. As such, well planned and conducted consumer acceptability tests, in the form of appropriate sensory analysis, are an important part of the shelf life evaluation of any snack product (Man 2000:158).

Table 1
The components of shelf life (FDC 2006:1; Matiwane 2008:99)

Physical Attributes	Chemical Attributes	Microbial Attributes
Colour	Peroxide value (rancidity value)	Standard plate count
Moisture content	Free fatty acid content (rancidity indicator)	Testing for yeast and mould
Water activity	Vitamin retention or loss	Presence of coliforms
Brix value		
Viscosity		

3.9.1 Testing the shelf life of a product

The shelf life testing of a product is essential to contrast the effects of processing and/or formulation changes on the product safety and quality. Cost saving may be achieved by preventing product recalls and excessive waste. Product storage conditions and packaging are carefully selected. Unstable raw materials, which inhibit the final product shelf life, may be relatively identified. During the preliminary stages of the development of the product the safety and degeneration problems can be identified. The best storage environment for expensive or unpreserved raw materials can also be recognised (FDC 2006:2).

3.9.1.1 Spoilage susceptibility

Micro-organisms have specific growth requirements for temperature, moisture, acidity, nutrients and time. They grow at a certain range and if minimum conditions are not satisfactory the growth will not occur. Generally microorganisms develop at temperatures between 0° and 55°C, at Ph values between 2 and 10, and water activity levels greater that 0,6 (Curiale 1998:1; McSwane, Rue & Linton 2003:6).

Food processing techniques can be utilised to prevent, reduce or control microbial contamination. Pathogens can be eliminated by heat treatment (boiling, roasting, frying and baking). The most common and effective method to ensure microbial

safety is heating food above the temperature of microbial viability for a sufficient time span. Pathogenic microorganisms are destroyed at temperatures above 70°C. Heat treatment simultaneously enhances the shelf life, the organoleptic and the nutritional characteristics of food (WHO/NUT 1998:129).

3.9.1.2 Safety concerns in bakery products

Bakery products are an important part of any balanced diet; therefore, a wide range of such products can be purchase from supermarket shelves. They include unsweetened goods (bread, rolls, buns, bagels, crumpets and muffins), sweet goods (pancakes, doughnuts, waffles and cookies) and filled goods (fruits, meat pies, sausage rolls, pastries, sandwiches, cream cakes, pizza and quiche). Bakery products, like a lot of other processed foods, are subject to physical, chemical and microbiological spoilage (Smith, Daifas, Khoury, Koukoutis & El-Khoury 2004:19).

While physical and chemical spoilage restricts the shelf life of bakery products with low and intermediate moisture, microbiological spoilage of bacteria, yeast and moulds is the concern in high moisture products, like products with a water activity (a (w)) > 0.85. Furthermore, several products also have been implicated in food borne illnesses involving *Salmonella spp., Listeria monoctyogenes* and *Bacillus cereus,* while *Clostridium botulinum* is a concern in high moisture bakery products packaged under modified atmosphere (Smith *et al.* 2004:1).

3.9.2 Factors influencing shelf life

The three factors that are involved are microbiological changes, moisture and water vapour transfer and chemical or biochemical changes.

3.9.2.1 Microbiological changes

Unless a food has undergone a commercial sterilization process (like canned foods) or has low water activity, which will not permit microbial growth (like sugar,

breakfast cereals), the rate of growth of spoilage microorganisms is likely to be the major factor determining shelf life. This rate is determined by a number of factors including food properties (like pH, total acidity, water activity, presence of preservatives either natural or added), environmental factors (temperature, relative humidity, gaseous atmosphere), any process designed to kill or restrict growth of micro-organisms (thermal processing, freezing, packaging) and the type of microflora on the food, and the initial population (Steele 2004:2; Sewald & Devries 2003:3).

3.9.2.2 Moisture and water vapour transfer

Not only is water (measured as water activity) a critical factor which determines which, if any, micro-organisms will grow in a food, many foods are sensitive to loss or gain of water. This in turn can be affected by the choice of packaging and in many instances will determine which packaging is used. Many biscuits and savoury snacks, including nuts, suffer in quality from moisture gain. Some baked foods such as cakes may suffer from moisture loss (Steele, 2004:2; Sewald *et al.* 2003:3).

3.9.2.3 Chemical or biochemical changes

There are numerous possible reactions that could limit shelf life in this category. The most important are oxidants, non-enzymic browning, enzymic browning and, in some cases, food and packaging interaction (Steele 2004:2). Oxidation of fat and oils leads to the development of rancidity marked by odour and flavour. This may limit shelf life of fats and oils but can also limit the shelf life of many other foods containing fats and oils. Examples of foods stored at ambient temperatures that can develop rancid, "off" flavours are nuts, potato crisps and biscuits. Storage of these foods in high oxygen atmosphere can sometimes be used to accelerate shelf life studies but atmospheric oxygen is not the only initiator of oxidative spoilage. Many frozen foods can also have their shelf life limited by fat oxidation. While freezing arrests microbial activity, chemical reactions proceed at a much-reduced rate even at recommended storage temperatures (Steele 2004:2; Sewald *et al.* 2003:3).

Vitamins such as vitamin C (ascorbic acid) and vitamin B (thiamine) are sensitive to oxygen and when these vitamins are added to fortified foods like breakfast cereals or sport drinks and a label declaration is made, then the shelf life determinations will have to take account of any vitamin degradation which will occur with time in addition to any other changes in quality (Steele 2004:2).

3.10 Chemical analyses of food products

Chemical analyses are an extremely expensive process and not always possible, but the chemical analysis of foods is the "gold" standard to analyse foods and their nutrients for inclusion in a study. It must be accurate and repeatable, and should be conducted by trained analysts in well-equipped laboratories. The most important aspect when food is analysed chemically is to ensure that the correct sampling procedures are used. These include representativeness of the sample, seasonality, condition of ripeness at harvest, geographical area, types of cultivars and breeds that are used for analyses (Wolmarans & Danster 2008:311). Table 2 indicates the different methods that can be applied for the chemical analyses when analysing snack food items to determine the specific nutrient content.

Table 2

Examples of methods that can be applied for the chemical analyses of the snack food item to determine the nutrient content (Oldewage-Theron & Amuna 2002)

Nutrient	Method	Basic principle
Protein	Total Kjedahl digestion method (Modified Berthelot reaction)	Acid is used to release nitrogen from the sample, which is then measured and used to derive protein value by using a conversion factor
Fat ASM 004	Acid-hydrolysis	Hydrochloric acid is used to digest the sample of fat and ether is added to dissolve the fat
Ash ASM 048	Direct	Organic matter is removed by heating the sample in a furnace at 550 ºC
Moisture ASM 013	Drying	Drying the sample in an oven at 105 ºC evaporates water
Carbohydrate ASM 075	Derived	100% – (% protein + % fat + % ash + % moisture)
Energy	Derived	(Protein x 16.8 kJ) + (Carbohydrate x 16.8 kJ) + (Fat x 37.8 kJ)
Minerals (Ca and Fe)	Atomic absorbance spectroscopy (AAS)	Sample is digested in acid to release minerals. AAS atomises sample then passes a beam of radiation through it. Absorption is measured at wavelength corresponding to mineral of interest
Minerals (Cu, Mg and Zn)	Inductively Coupled Plasma Mass Spectroscopy (ICP-MS)	Sample is digested in acid to release minerals. ICP-MS ionises sample, then separates ions according to mass and counts the ions
Vitamins (B's, A, C and folate) *Vit A *ASM 072	High Performance Liquid Chromatography (HPLC)	A procedure for the separation of non-polar solutes. Non-polar solutes are chromatographed on a column having non-polar liquid immobilised on an inert matrix. A more polar liquid that serves as a mobile phase is passed over the matrix; solute molecules are eluted in proportion to their solubility
Vitamins (other)	Theoretical calculations	SA food composition tables and FoodFinder/Dietary Manager®.

Standard laboratory hygiene and safety measures will be followed at all times. Safety clothing must be worn at all times when handling the snack food item ingredients.

3.11 Conclusion

In this chapter, the product development and the several factors affecting this process were analysed. The factors discussed in this chapter included: types of ingredients used, quality control testing, sensory analyses and the shelf life of the developed product. The literature emphasises the importance of soy in product development, because it is a good source of protein and other nutrients and adds variety to children's diets. Therefore, it was decided to include soy as an ingredient in the

product that was developed because soy contains potential health benefits and may be a good choice for obese patients to consume when trying to lose weight. A better understanding of obesity is essential to ensure healthier children in the future.

Chapter 4 Methodology

4.1 Introduction

The research was carried out in four phases. Phase one included the literature-analyses as well as the baseline survey in a randomly selected sample of primary school children to determine snack food consumption among these children, after obtaining ethics approval and permission from the Department of Education.

The purpose of this study was to determine the nutritional status and snack consumption patterns of children aged nine to 13 in the Vaal Region at two purposively selected primary schools in order to develop a healthy snack food item that will address obesity in children from a very young age. The methods for each of these phases will be discussed in this chapter.

4.2 Study design

This was a cross-sectional analytical study and was carried out in phases, however Phase 3 was a experimental study

Phase 1: Planning the study design.

Phase 2: Baseline survey to determine snack food consumption among the children.

Phase 3: The development of a snack food item, sensory analysis and data analysis.

Phase 4: The report writing, recommendations for field use and doctoral studies in future.

4.3 Phase 1: Planning study design

4.3.1 Initial planning and administration

The planning procedure consisted of three steps:

1 Analysing the available scientific literature;
2 Writing the research proposal;
3 Holding a planned participatory workshop with the headmasters of the schools.

The initial step was to visit the two primary schools to obtain permission for conducting the research and prior evaluation. Prior to the data collection, the researcher visited the two primary schools to explain the survey to the principals and other teachers involved in this study. Introductory visits were made to gain their assistance and for observation purposes prior to the base line survey, to determine whether there were overweight and obese children in these two schools in the Vaal Region, as well as to get adequate information about the respondents' snack food consumption patterns, and to assess their knowledge of what healthy food is. The study and its benefits were explained to the respondents (children nine to 13 years old). The consent of the respondents attending these two schools was gained.

4.3.2 Sampling strategy

One hundred and forty five respondents in each of the two purposively selected schools were randomly selected for the baseline survey. In total, 290 respondents selected randomly took part in this study.

To determine the sample size of this study, the 2007 mid-year population estimates (Statistics South Africa 2007:4) showed that in SA the total number of children aged ten to 14 years old, was 50 90600. This was calculated as a total percentage of the total SA population of 47 850 700 (Statistics South Africa 2007:4). This resulted in an assumption that 10.6% of any population in SA would be children aged ten to 14 years (more or less the same age group of this study).

In the Vaal Region, the population is 794 599 (McIlrath & Slabbert 2003:10). To calculate the number of children in the Vaal Region, 10.6% of 794 599 resulted in 84 227 children, aged ten to 14 years. To determine a representative sample size that would result in statistically significant results, the following sample size formula (The Survey System) was applied:

Sample size

$$ss = \frac{Z^2 * (p) * (1-p)}{c^2}$$

Where:

Z = Z value (1.96 for 95% confidence level)

p = 50%, expressed as decimal, was used (worst case scenarios)

(.5 used for sample size needed or 50% of the targeted population)

c = 6.14 confidence interval

This resulted in a sample size of 254. However 10% was added to make provision for possible dropouts during the study. A sample size of 290 children was thus used for the baseline survey and these children were equally distributed between the two schools.

4.3.3 Inclusion and exclusion criteria

The inclusion criteria applied were that respondents should be nine to 13 years old, both boys and girls, residing in the area and attending the school. The sample population consisted of 145 randomly selected school children in each of the two schools in the Vaal Region.

4.4 Phase 2: Baseline survey

A baseline survey was carried out in 2008 to determine the snack food consumption patterns of 290 respondents, nine to 13 years old, in the Vaal Region. Snack food patterns of a randomly selected group of respondents were assessed. The results of

the baseline survey and meta-analyses were applied in the formulation of the snack food item, and was developed, analysed biochemically and optimised.

The randomly selected sample was selected in two different primary schools. One school is situated in a semi-urban area in Gauteng, SA, (Figure 3), and is attended only by children from the informal settlement. The second school is situated in an urban area in Gauteng, SA (Figure 4) and is attended by children from the nearby community in an urban setting.

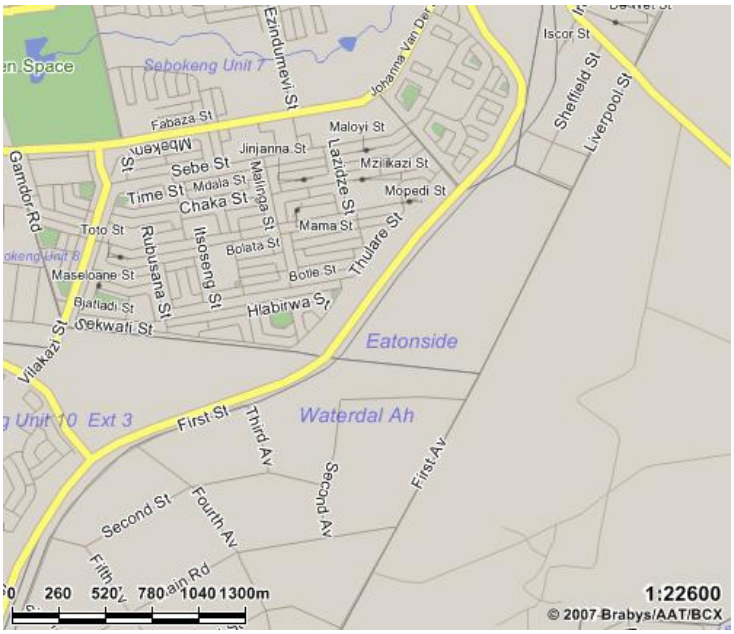

Figure 3 Map of Eatonside in the Vaal Region

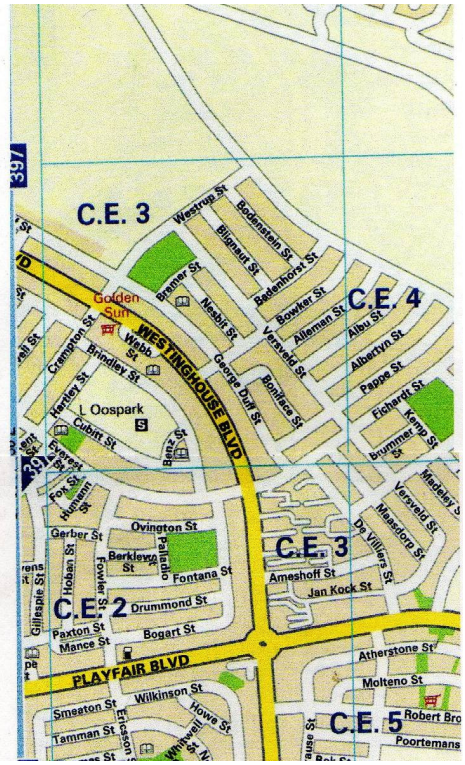

Figure 4 Map of Vanderbijlpark in the Vaal Region

In phase two, the results of the cross-sectional analytical survey and a literature review were applied in the formulation of the snack food item. The snack food item was developed, analysed biochemically and optimised during this phase.

4.4.1 Fieldworkers

Third-year and BTech students currently involved in studies in Food and Beverage Management (FBM) in the Departments Hospitality and Tourism and Institute of Sustainable Livelihoods (ISL) of Vaal University of Technology (VUT) were trained as fieldworkers. All of them were able to speak and understand the local languages and therefore overcome the language barriers. The fieldworkers were trained through demonstrations and role-play in how to approach the respondents, administer the questionnaires and how to take anthropometric measurements. The fieldworkers were trained by the researcher, on how to distribute and complete the questionnaires accurately. English was the medium of instruction for the training sessions and

fieldworkers' guidelines were also printed in English. Emphasis was placed on ensuring that fieldworkers were aware of the objectives and the importance of this specific study.

4.4.2 Measuring instruments

The questionnaires were compiled and the information was used to estimate the types and amounts of snack foods and beverages consumed by children and how these influenced their lifestyles.

4.4.2.1 Food consumption questionnaires

The questionnaires were compiled in English and tested for reliability (Annexure A). The participants in Figure 5 had to answer all the questions just by ticking the correct answer. The researcher requested the children to be honest with themselves. The researcher also stated that there were no correct or incorrect answers and that every questionnaire was confidential and would be reported as statistics only. The questionnaires were divided into different sections. These sections follow in Chapter 5 and can be followed according Annexure B. Section A concentrated on general information about the participant. Section B focused on the eating and meal patterns of the participant. In Section C, the snacking patterns were reported, while activities were reported in Section D. Section E showed a snack food item list on which the participants had to indicate whether they ate the specific snack food items and portion size was tested in Section F.

Figure 5 Respondents completing food consumption questionnaires

Two questionnaires were used for this specific study. They were kept simple and easy to read, because some of the respondents were very young and did not understand English very well. The fieldworkers assisted the researcher in explaining the questionnaires to the respondents in their own language.

For the Pilot study, questionnaires were tested with ten randomly selected respondents in two purposively selected schools in the Vaal Region, SA. Participants completed questionnaires weekly for four consecutive weeks on the same day of the week and at the same time of day. The questionnaires were then tested for validity and to ensure the respondents understood the questions. After this the final questionnaire were drawn up and the researcher, together with the fieldworkers, went back to each of the schools to test 145 respondents in each school. Frequencies were done by an expert and the researcher drew up a consumption pattern (frequency table) of healthy and unhealthy foods consumed by respondents. These results also showed the researcher whether the respondents knew what healthy food items were and also indicated their physical activities.

4.4.2.2 Sensory evaluation

For the sensory evaluation the respondents filled in two of the same questionnaires (hedonic scales), but on two differently coloured forms. The first form (Annexure C) was for the snack food item, developed by the researcher, and the second form (Annexure D) was for a commercial snack food item (Pro-Vita). The idea was to determine the respondent's thoughts regarding both the products and their acceptance of the snack food item developed by the researcher. The second aim of the sensory evaluation was to determine the perceived difference between the original snack food item and the developed snack food item regarding smell, colour and texture and whether the respondents would like the snack as part of their school feeding programme. The respondents had to follow all the steps to test the first snack food item and fill in the form. After the first tasting, the respondents cleared the mouth with water and then tested the second snack food item, following the same

procedure. The sensory evaluation was conducted in both schools with 145 respondents in each of the schools.

4.4.2.3 Anthropometric measurements

Anthropometric measurements included weight and height measurements of every chosen participant (145 in each of the two schools) chosen for this study.

4.4.2.3.1 Weight

One fieldworker filled in the name of each respondent on the questionnaire form. The respondents then went to the researcher who did the height measurement and then they moved on to the second fieldworker who weighed them and recorded these results.

All the respondents were measured for weight wearing school clothes without their shoes. The body weight was determined to the nearest 0.1 kg using a standardised clinical scale. The weight measurements were conducted using a digital bathroom scale as follows:

The scale was placed on an uncarpeted area with the spirit level indication in the middle.

The scale was switched on and the fieldworker waited until the zero indication (0,0) appeared, as well as the stable indicator (° in the top left-hand corner of the display panel).

The respondents were weighed with clothes, without shoes. Each had to stand upright on the platform, facing the fieldworker and looking straight ahead. The feet had to be flat and slightly apart. Each one had to stand still until the measurements were recorded in the space provided on the questionnaire form. The respondent had to step down from the scale and wait for the zero reading to show on the digital

display. Then the process was repeated (SAVACG 1995:100-101, Whitney & Rolfes 2005:6). The weight was determined to the nearest kg and the BMI was calculated as weight (kg) divided by height squared (m^2).

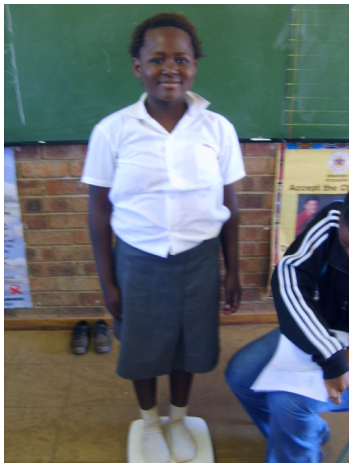

Figure 6 Weight measurements

4.4.2.3.2 Height

All the respondents were measured for height without their shoes and were positioned to face the fieldworker/researcher. Shoulders had to be relaxed and shoulders, buttocks and heels touching against the wall. Arms had to be relaxed and legs straight with knees together, feet flat and heels touching. The respondent had to look straight ahead while the fieldworker / researcher recorded the reading in mm in the anthropometric measurements space provided on the questionnaire. The procedure was repeated twice. If the two readings did not vary by more than 5 mm, these measurements were taken to the nearest 0,5 cm by using a stadiometer (SAVACG 1995:103, Whitney *et al.* 2005: E6).

4.4.3 Data analyses

Questionnaires and anthropometric measurements were captured on an Excel® spreadsheet by the researcher, assisted by a research assistant.

4.4.3.1 Questionnaires

After the fieldwork was completed, questionnaires were sorted and checked for completeness, accuracy and sustainability by the researcher and n=145 for each school were usable. The data on the questionnaire were captured on an Excel® spreadsheet by the researcher. Descriptive statistics, (frequencies, means, and standard deviations) were completed by a trained statistician. Tables were drawn up with the percentages of the different variables included on the questionnaire. Standardised methods were used. Data were presented in terms of frequencies and percentages for the various sections.

4.4.3.2 Anthropometric measurements

All weight and height averages (average of the two readings) were captured on an Excel spreadsheet by the researcher assisted by a research assistant. As described in Chapter 2, the WHO standards were used for analysis and were captured on an Excel spreadsheet.

4.5 Phase 3: Development of snack food item

The procedure carried out in the development of the snack food item will be discussed according to the steps in the Figure 7. It involves all the stages occurring during development of the snack food item and the processing.

Phase three will include the sensory evaluation and acceptance testing of the snack food item by means of reliable and valid Hedonic questionnaires in a randomly selected, trained sample of primary school children, as well as the testing of shelf life of the snack food item, measured by means of microbial tests with the assistance of a BTech (Biotechnology) student.

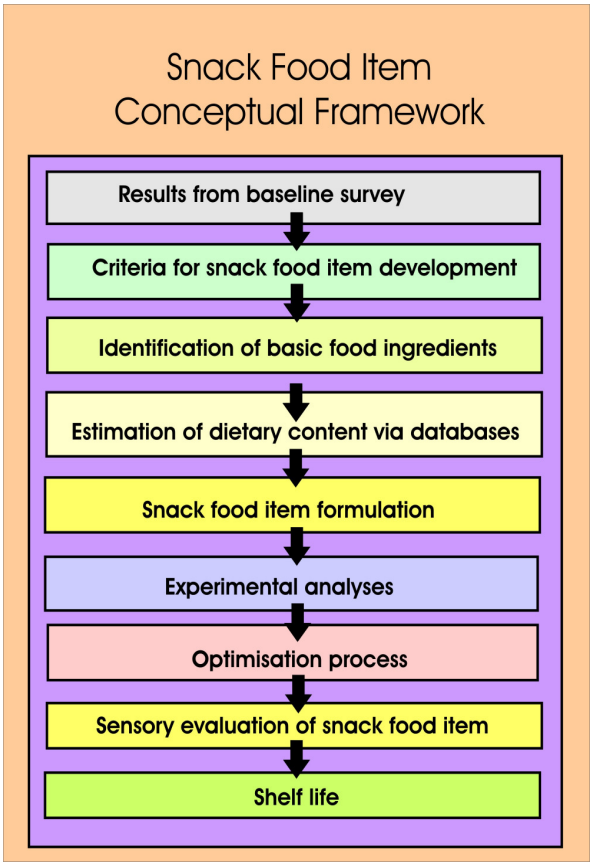

Figure 7 Snack food item conceptual framework: phase three

(Adapted from Amuna, Zotor & Tewfik 2004:130, Matiwane 2008:127).

4.5.1. Criteria for snack food item formulation

In 2002, Reed and Schuster developed criteria for product development. These criteria were utilised in choosing the recipe and are summed up in the following guidelines. A recipe must:

1 Use low-cost readily available ingredients.
2 Use basic equipment and appliances.
3 Be easy to read.
4 Be successfully tested by at least three people minimum.
5 Teach at least one dietary meaning (Reed & Shuster 2002:2).

According to the National Food Consumption Survey-Fortification Baseline (NFCS-FB-I) South Africa, 2005, one out of five women and one out of seven children on national level were found to have a poor iron status. Women were most affected most in Gauteng, Mpumalanga and Limpopo and children were most affected in the Free State, Mpumalanga, Limpopo and the Western Cape. The poor iron status in children has increased from previous national data and is indeed a cause of concern.

A panel of experts recommended additional amounts of zinc and iron in premixes in collaboration with the millers to ensure that the correct amount of iron reaches the consumer on a household level. According to the (NFCS-FB-I) South Africa, 2005, 45.3% of children on national level had an inadequate zinc status and children of the age group of one to nine years should be considered to be at a risk of zinc deficiency. Young children and those living in rural formal and urban formal areas are more at risk, although those living in the Western Cape had the highest prevalence of inadequate zinc status (Labadarios, Swart, Maunder, Kruger, Gericke, Kuzwayo, Ntsie, Steyn, Schloss, Dhansay, Jooste, Dannhauser 2007:262-263).

The baseline results and the questionnaires indicated that there was a need for a savoury snack food item that would help children to snack healthily.

Accordingly, the product development was based on the following criteria: affordability, easily consumed, low in fat, high in fibre and must contain at least 20% DRI of zinc and iron. The snack food item was developed using inexpensive easily available ingredients.

4.5.2 Ingredients

The developed snack food item had to be attractive to children consuming snack food items. There must be a reduction of unhealthy ingredients like sugar and fat, and it must be low in energy, but still contain nutrients that are highly desirable.

It was essential that the product was as acceptable to the children as the snacks mostly commonly consumed and eaten by children. The ingredients in the recipe were low cost and readily available and the equipment utilised was basic equipment and appliances. The recipe was developed for a snack food item that was low in fat, and high in fibre to partially address the obesity problem amongst children nine to 13 years old in both primary schools. After the recipe had been developed following the above guidelines, it was nutritionally analysed.

4.5.3 Estimation of Food Composition Data Bases

The South African Food Data System (SAFOODS) was used for the calculation of the theoretical nutrient values of ingredients of the snack food item available in the food composition database, but these represent only average values and are not an exact reflection of the nutrient content of a specific food item. There is improvement for a total of 146 food components in The South African Food Composition Database (SAFCD), which include moisture, ash, energy, macronutrients, micronutrients, amino acids and fatty acids. The unit of measurement for the different nutrients in SAFOODS is given per 100g of edible food. When a zero value is present, it only indicates that the specific nutrient is not present in the specific food item. Sometimes it is available in the specific food, but in such low concentrations that it was not possible to determine the content by chemical analyses. In this case the value is indicated by the abbreviation 'tr', which means that a trace of the nutrient is available in the specific food item. If the chemical analyses, calculations or "best guess" value is not available, a blank space appears in the food composition tables, indicating missing information.

When calculating the energy content of a food or diet by means of the food composition database, the conversion factors for carbohydrates, protein and fat should be used. To calculate the total carbohydrates by using the food composition databases, subtract the moisture, protein, fat and ash value from 100 to give the percentage of total carbohydrates. To calculate the available carbohydrates by using

the food composition databases, subtract the total dietary fibre value from the total carbohydrates value.

The SA food consumption tables were incorporated into a nutritional analyses software program, namely FoodFinder®, which was developed by the MRC of South Africa. This program was used to calculate the theoretical nutrient value of the adjusted recipe, taking into consideration all the factors mentioned by Wolmarans *et al.* (2008:312). The recipe was re-adjusted and theoretical nutrient values re-calculated until the nutritional criteria were met, and thereafter called the "final recipe."

4.5.4 Snack food item formulation

The recipe was prepared and baked and the total yield determined. The product was then sensory tested by ten Hospitality Management staff members for acceptability of taste, aroma, texture, colour, overall acceptability and portion size. Based on these results, the recipe was re-adjusted and nutrient value re-calculated until the general acceptability was good. The costing of the recipe was also calculated.

4.5.5 Experimental analyses

The final recipe of the snack food item was then prepared and baked on three consecutive days. After each session a sample size of 30g was vacuum packed. After the last baking session all three packets of the snack food item were then couriered to the ARC for the chemical analyses of the product.

Table 3 indicates the dates that the sample was baked. Table 4 below shows the different methods that were used for the chemical analysis of the snack food item to determine the nutrient content.

This laboratory test report holds SANAS accreditation for analyses with an ASM number and the results are expressed on a wet basis, therefore as samples were received.

Table 3

Sample types and dates

Sample	Sample type	Date analysis commenced
1	Biscuit	28/10/2008
2	Biscuit	29/10/2008
3	Biscuit	03/11/2008

Table 4

Test report 2008-S-404 methods used to do chemical analyses of the snack food item (ANNEXURE E)

Analyses	Accreditation number
Ash	ASM 048
Dry matter	ASM 013
Moisture	ASM 013
Fat (Mojonnier)	ASM 004
**Protein	Not SANAS accredited
Energy (calculated)	ASM 076
Carbohydrates (calculated)	ASM 075
Vit A	ASM 072
**Calcium	Not SANAS accredited
**Iron	Not SANAS accredited
** Zinc	Not SANAS accredited

4.5.6 Optimisation process

On receiving the ARC results, the actual and theoretical nutrient compositions were compared and shortfalls addressed by re-formulating the snack food item theoretically to compensate for the nutrient shortfalls as shown by chemical analyses (Annexure E).

4.5.7 Sensory evaluation

This section presents a descriptive version of sensory evaluation of the snack food item.

Sensory panels of 145 children in each of the two primary schools were randomly recruited in order to evaluate the snack food item. The samples were handed out to the children by the researcher and fieldworkers. The evaluation forms (Annexures C & D) and a pencil was also distributed. The questionnaire consisted of sensory properties and hedonic faces to describe acceptability. The children (panel) were given a chance to profile the product for its aroma, appearance, flavour and texture. For each serving, pieces of the snack food item were placed on a paper plate and the children were allowed to take one piece each to evaluate. A little bit of water was given to the children afterwards, to clear their taste buds and mouth before they tasted the next sample. The children evaluated the snack food item by marking the questionnaire, with the help of the researcher and fieldworkers, according to how much they liked or disliked the snack food item. The procedure for both products was carried out on the same day.

The hedonic scale method with different ratings was utilised to measure the level of liking of the foods. In hedonic testing, samples are offered in sequence and the respondent is told to make a decision on how much he or she likes or dislikes the product and to mark the scale as a result. The nature of this test is its relatively easy. The instructions to the respondents were limited to procedures, and no effort was made at direct response. The subject is allowed, however, to make his or her own inferences about the meaning of the scale categories and determine for her/himself how he or she will apply to the product. A separate scale was provided for each sample in the test session. The scale was printed on two different colours of paper. Hedonic ratings were changed to scores and treated by analysis of variance. The data were analysed directly with no modifications being required. The scores were based on the ratings of each face, with the mark given for each sensory characteristic. The children were also asked to give an approval of the product in the following question about whether they would like it as part of the school feeding programme. This

question was asked in order to indicate whether in future the product could be prepared commercialised.

4.5.8 Shelf life testing of the snack food item

The shelf life testing of the snack food item was carried out at the ARC an accredited laboratory, for better verification and better results. The snack food item (product) was analysed by the ARC an accredited laboratory (Microbiology section), the product was kept at temperatures of ±25°C and analysed on the day of arrival, day 0, then 14 days from day 0, and then on 28 days after arrival. Products were stored in sealed airtight plastic containers on the shelf in the laboratory at room temperature and in the refrigerator and were monitored over time for signs of moulds, colour changes and change in the appearance and odour (aroma).

4.5.8.1 Microbiological analyses of snack food item

- **Enumeration of micro-organisms**

For this study, 10 ±2g of the biscuit samples were weighed into a suitable stomacher bag and 90ml of Maximum Recovery diluent (Oxoid CM 733) was used to dissolve the biscuit. It was then placed in a stomacher for 1 minute. (This was treated as the 10^{-1} dilution). A series of further dilutions up to 10^{-2} were prepared from the initial suspension (primary dilution). To prepare further dilutions, 1ml columns of the diluted bacterial count solution were transferred into a Petri Dish. Each dilution was plated out in duplicate. Plate Count Agar (Oxiod CM 325) at 49 ± 2 °C was poured into each dish and mixed immediately by rotating the dish sufficiently to obtain evenly dispersed colonies after incubation. The plates were allowed to cool on a horizontal surface. The prepared plates were incubated aerobically in an incubator at 30 ± °C for 72 ± 3 hours. The number of colonies on each plate was counted. The number of micro-organisms per gram of product is calculated by multiplying the count obtained from the selected dilution by the reciprocal of the dilution. The

results were reported as the estimated number of micro-organisms per gram of product (Cfu/g).

- **Enumeration of Coliforms and *Escherichia coli***

For this study, 10 ± 2g of the biscuit samples were weighed into a suitable stomacher bag and 90ml of Maximum Recovery (Oxoid CM 733) was used to dissolve the biscuits. It was then placed in a stomacher for 1 minute. This was treated as the 10^{-1} dilution. A series of further dilutions up to 10^{-2} was prepared form the initial suspension (primary dilution). To prepare further dilutions, 1ml columns of the diluted bacterial count solution were transferred into a Petri Dish. Each dilution was plated out in duplicate. Violet Red Bile Mug Agar (Oxoid CM 978) at 49 ±2°C was poured into each dish and mixed immediately by rotating the dish sufficiently to obtain evenly dispersed colonies after incubation. The plates were allowed to cool on a horizontal surface. The prepared plates were incubated aerobically in an incubator at 30 ±1°C for 24 ± 2 hours. The number of all dark red coloured colonies having a diameter of at least 0.5mm, which are characteristic of coliforms, on each plate was counted. For *Escherichia coli* enumeration, the plates were examined under a 366nm ultra violet light. All colonies showing a blue fluorescence in the surrounding medium were counted and were considered to be *Escherichia coli.* The number of coliforms and Escherichia coli per gram of product is calculated by multiplying the count obtained from the selected dilution by the reciprocal of the dilution. The results were reported as the estimated number of coliforms and *E Coli* per gram of product (Cfu/g). The *E. coli* was also reported as negative or positive.

- **Enumeration of Yeasts and Moulds**

For this study, 10 ±2g of the biscuit samples were weighed into a suitable stomacher bag and 90ml of Maximum Recovery diluent (Oxoid CM 733) was used to dissolve the biscuit. It was then placed in a stomacher for 1 minute. (This was treated as the 10^{-1} dilution). A series of further dilutions up to 10^{-5} was prepared from the initial suspension (primary dilution). To prepare further dilutions, 1ml volumes of the

diluted bacterial count solutions were transferred into a Petri Dish. Each dilution was plated out in duplicate. Rose Bengal Choloramphenicol Agar base (Oxoid CM 549) + Choloramphenicol selective supplement (Oxoid SR 78) at 48 ±2 °C was poured into each dish and mixed immediately by rotating the dish sufficiently to obtain evenly dispersed colonies after incubation. The plates were allowed to cool on a horizontal surface. The prepared plates were incubated aerobically in an incubator at 25 ± 1°C for 3-4 days. The number of colonies on each plate was counted. The number of yeast and moulds per gram of product was calculated by multiplying the count obtained from the selected dilution by the reciprocal of the dilution. The results were reported as the estimated number of yeast and moulds per gram of product (Cfu/g).

- **Detection of presumptive Salmonella**

For this study, 25 ± 2g of the biscuit samples were weighed into a suitable stomacher bag and 225ml of Buffered Peptone Water (Oxoid CM 509) was used to dissolve the biscuits. It was then placed in a stomacher for 1 minute. This was incubated for 24 hours at 37 ± 2°C (this was treated as the pre-enriched stage). 0.1 ± 0.02ml of the pre-enriched culture was then transferred into 10ml of sterile RVS medium (Oxoid CM 8660, which was incubated for 24 hours at 42 ± 2°C (selective enrichment stage). The culture obtained in the RVS medium after incubation was streaked out on the surface of two Petri Dishes containing selective XLD (Oxoid 469) and Brilliant Green Agar (Oxoid 329) respectively. These inoculated plates were incubated for 24 hours at 37 ± 2°C. The incubated plates were examined for the presence of typical colonies of Salmonella. The results were reported as Salmonella absent or present in 25 g of the product (Positive/25g or Negative/25g).

4.6 Packaging materials

A BTech (Graphic Design) student did research in different types of packaging materials that would be cost-effective, eco-friendly and suitable for this snack food

item. Although this did not directly form part of this researcher's study, the results are included as the researcher and the BTech student worked together on this.

4.7 Conclusion

In this chapter the methodology employed in this study was discussed. All questionnaires that were used to collect data in this research, tests, information on the development, optimisation and nutritional analyses of the snack food item, sensory evaluation and its analyses, and the information on the shelf life of the product were provided. In the next chapter a discussion of the results and findings will be given.

Chapter 5 Results and findings

5.1 Introduction

In this chapter the data collected from questionnaires and tests will be discussed.

5.2 Data analyses of results

5.3 Phase 1: Results of planning

Permission for conducting research was granted by the principals in both primary schools. The children were informed about the study and how they should take part in this study. Prior to data collection, the primary school children were told that participation was voluntary and that the data were captured as statistics only and that all data would be treated with strict confidentiality.

Questionnaires were drawn up, approved by the study supervisors and tested in both primary schools. Trained fieldworkers administered the questionnaires. Data collectors who spoke at least two local languages were utilised. Two hundred and ninety, randomly selected respondents in both schools were selected. They came together at a certain point and then the fieldworkers and the researcher handed out the questionnaires and pencils to them. They completed the questionnaires in their own time and the fieldworkers were available to answer questions and to help the younger ones with difficult questions. Once a week, for five weeks, always on the same day of the week and at the same time, the different groups filled in these questionnaires. In the first week the group of children aged nine years filled in the questionnaires, in the second week the ten years olds, during the third week the 11-year-old group was questioned, followed by the group of 12-year-old group and then the 13-year-olds, until all five different age groups for this study had completed the questionnaires. An average of 30 children was present in each class.

5.4 Phase 2: Baseline survey

5.4.1 Questionnaires and general information data

The following results were compiled from the pilot study to test the reliability and validity of the questionnaires.

Table 5

Reliability results

Question	Cronbach's Alpha	Internal validity
A3 Yoghurt	0.73	Yes
A3 Simba Chips	0.34	No
A3 Cheesecurls	0.83	Yes
A3 Peanuts	0.89	Yes
A3 Fruit	0.02	No
A3 Nik Naks	1.00	Yes
A3 Popcorn	1.00	Yes
A4 Amazi	0.99	Yes
A4 Coke	0.87	Yes
A4 Milo	0.71	Yes
A4 Juice	0.87	Yes
A4 Water	0.94	Yes
A4 Milk	0.83	Yes
B4 Tea & coffee	0.90	Yes
B5 Sugar	0.87	Yes
C1 Snack food item	-0.16	No
C3 Snack food item	0.86	Yes
C7 Monday	0.67	No
Tuesday	0.67	No
Wednesday	0.58	No
Thursday	0.65	No
Friday	0.68	No
Saturday	0.79	Yes
Sunday	0.84	Yes
C9 Money	0.89	Yes
C22 Snack & drink	0.85	Yes
D4 Walk	0.94	Yes

Yes = Internal validity exists

No = No internal validity exists

As a result of most of the questions having an internal validity according to the Cronbach's Alpha reliability analyses it was concluded that the questionnaire could

be used for this study. However, the questions with a Cronbach-Alpha reading of ≤ 0.7 were adjusted before the questionnaire was used in the study.

5.4.1.1 Section A: General information results

Table 6

Healthy food items and drinks (n=290), for both schools

Food and drink	Percentage
Fruit	77.5
Water	74.2
Milk	54.2
Yoghurt	51.3
Juice	32.5
Peanuts	15.5
Milo	14.4
Coke	11.8
Amazi	11.1
Popcorn	9.6
Nik Naks	8.9
Simba Chips	8.9
Cheesecurls	7
Milkshake	6.6

According to the information above, the sample group knew what healthy foods and drinks were, but they did not make healthy choices. Although they still drank a lot of carbonated drinks (11.8%), more chose juice (32.5%), which is healthier than the carbonated drinks. More children chose peanuts (15.5%), which, they knew, are healthier than Nik Naks (8.9%), Popcorn (9.6%) and Cheesecurls (7%). According to the questionnaires filled in by the sample group (n=290), 77.5% of the sample group knew what a healthy snack food item was, while 74.2% of the sample group knew what a healthy drink was. They also knew that water and milk is good (healthy) because percentages were very high for water, 74.2% and milk, 54.2%. But at home, 50.2% of the sample group snacked on crisps, 38% on sweets and 42.8% on unhealthy cold drinks (Table 15). Although 95.2% reported that they got snacks in their lunch boxes, 22.9% had cold drinks and only 12.9% had fresh/dried fruit and 4.8% got fresh vegetable sticks in their lunch boxes for school (Table 11). According to the information that the sample groups filled in on the questionnaires, 34.3% had an excellent appetite, 23% a very good appetite, 34% a good appetite, 6.4% a fair appetite and only 2.3% a poor appetite.

Healthy eating patterns must begin at home and parents must control the intake of too many snacks.

Table 7

Living and travel conditions (n=290), for both schools

Travelling to school	**Percentage**
Walk	56.5
Bus	4.4
Taxi	18.1
Bicycle	1.8
Car	19.2
After-school care	
Home (parents)	60.8
Home (alone)	20
Friend	9.1
Grandparents	6.8
After school centre	3.4
Where child is staying	
Both parents	56.9
Mom	23
Dad	3
Family members	17.1

The majority (56.5%) of the sample group walked to school, which is very good exercise for them as well as for the 1.8% who rode bicycles to school. The rest of the sample group made use of transport facilities, which could be an indication that they had to travel further than the rest in the sample group. After school, 60.8% of the sample group went home to their parents, while 20% stayed home alone after school. It can be inferred that the 20% that were home alone did snack on unhealthy food, because there is no adult supervision at home and children can eat what they want and as much as they want. It is possible that parents felt guilty that the children were alone in the afternoons and they bought more snacks and other convenience foods, which can just be warmed up in the afternoons. More than half of the sample group stayed with both their parents in the household, while only a small percentage (17.1%) stayed with other family members.

Table 8

Items available in bedroom and sleeping habits (n=290), for both schools

Items available in bedroom	Percentage
TV	31
PC	10
Cell Phone	42.8
MP 3	15.5
Hi-Fi	16.6
Playstation	11.1
Going to bed Mon-Thurs	
7-8	27.7
8-9	47.9
9-10	24.3
Wake up time Mon-Thurs	
5-6	70.7
6-7	29.3
Going to bed Fri-Sun	
7-8	9.7
8-9	21
9-10	30
10-11	24.7
Later than 11	13.9
Wake up time Fri-Sun	
5-6	14.4
6-7	19.6
7-8	29.6
8-9	25.6
Later	10.7

In this question 42.8% of the sample group answered that they had cell phones, which is a good indication that they probably spent hours on the phone to chat to friends and they were not active. Also, 31% had TV sets in their rooms, which could indicate that they spent hours in the rooms, watching programmes, DVDs, videos or playing games, indicating low physical activity. Going to sleep and wake up times during weekdays looked "normal" and only a percentage of (24.3%) of the sample group went to bed between 9- and 10 o'clock during weekdays. The majority (70.7%) of children rose early during the week, possible because they have to walk to school. On weekends, the percentages that went to bed very late were 13.9% and only 10.7% rose late over weekends.

Table 9

Portions of fruit and vegetable eaten per day (n=290), for both schools

Portions per day	Percentage
0	4.5
1-2	37.5
3-4	39.8
5-6	11.5
More than 6	6.7

Out of the questionnaires completed by the sample group, 37.5% ate 1-2 portions fruit and vegetables per day and 39.8% ate 3-4 portions per day. There were also indications of 5-6 portions per day (11.5%) and 6.7% ate more than 6 portions a day – which is highly recommended. The minority 11.5% and 6.7% consumed the prescribed portion size of five or more than 5 per day.

5.4.1.2 Section B: Eating and meal patterns results

Table 10

Breakfast patterns (n=290), for both schools

Eating breakfast	Percentage
Yes	89.2
No	10.8
Eat for breakfast	
Porridge (eg. Oats)	74.5
Cereals (eg. Rice Crispies)	27.7
Margarine	7.4
Sugar	11.8
White/Brown bread	48.7
Jam/Marmite/Peanut butter	14.8
Pro-vita/Cream Cracker	1.5
Egg	17.7
Cheese	11.4
Fruit	10.7
Coffee	28.4
Tea	21.8
Milk	33.2
Nesquick	2.2
Milo	5.5
Fruit Juice	13.7
Water	15.5
Yoghurt	10

A high percentage of 89.5% of the sample group indicated that they ate breakfast in the morning – which is very good. Porridge is the most frequently eaten food for

breakfast at 74.5% and second on the list is bread at 48.7%, cereals are eaten by 27.7% of the sample group and together with that a percentage of 33.2% used milk, either with the cereal, porridge, in coffee, tea, Nesquick or Milo or just milk alone. Although it was not a balanced breakfast, at least, some ate breakfast. A very small percentage of the group, (1.5%) ate Pro-Vita / Cream Crackers, which is more expensive than bread but is a healthier substitute for bread. Only 17.7% indicated that they ate eggs for breakfast and only 11.4% had cheese, which showed that they ate too little protein and also far too little fruit (10.7%). Also a very small percentage (10%) of the sample group ate yoghurt, which is also a very good source of protein needed during the day. In the whole sample group only 13.7% indicated that they drank fruit juice. The sample group were also asked about their coffee/tea and sugar drinking habits during the day and according to the information that the sample group filled in on the questionnaires, 46.8% indicated that they drank one cup of coffee or tea during the day. A percentage of 44.7% used 2-3 teaspoons of sugar in their coffee or tea, and more in winter (when this study was compiled) because it gives some heat to the body and the sugar gives energy.

Table 11

School lunch information (n=290), for both schools

Get lunch at school	**Percentage**
Yes	81
No	17.8
What do you get at school?	
White/Brown bread	99.5
Margarine	8.9
Jam/Marmite/Peanut butter	15.1
Fruit	19.9
Yoghurt	9.2
Cold drink	22.9
Milk	4.4
*Other – specify (Polony)	70
Get lunchbox to school	
Yes	50.9
No	44.3
What's in the lunchbox?	
White/Brown bread	53.1
Margarine	11.4
Jam/Marmite/Peanut butter	12.9
Pro-vita/Cream Cracker	3.3
Cheese or Cheese spread	15.9
Other spreads – specify	4.8
Yoghurt	14
Fresh vegetable sticks	4.8
Fruit fresh/dried	12.9
Snack – specify (Simba Chips)	95.2
Cold drink	22.9
*Other – specify (Polony)	94.5

***** A lot of Polony was given to the sample group, either by the schools or by their parents. In both cases the sample group indicated that they ate a lot of Polony and Atchar, Polony and Cheese, Polony and Chips, Polony and Margarine (on bread) and then a few indicated that they ate sweets and biscuits, drank cold drinks and got meat and rice in their lunch boxes.

A percentage of 81% of the sample group received lunch at school, which consisted of bread (99.5%), the highest percentage of food that they got. In comparison, the percentages of fruit (19.9%) and yoghurt (9.2%), were very low although so important in the feeding of children. They also got a lot of cold drinks (22.9%) compared to only 4.4% who got milk. A percentage of 50.9% of the sample group brought a lunch box to school, which contained bread (53.1%), the highest percentage of food that they got. A small percentage of 3.3% got Pro-vita in their lunch boxes, while a high percentage of 95.2% had a snack in their lunch box, which most of them indicated as Simba Chips. There were a very high percentage of snacks in the lunch boxes (95.2%) compared with the percentage of fresh vegetable

sticks (4.8%), fresh/dried fruit (12.9%) and yoghurt (14%). The percentage of cold drinks brought to school was also very high (22.9%). When the sample group had to indicate if they received interesting food in their lunch boxes, 71.8% reported that their food was interesting, while the remaining 28.2% said that they got the same food to take to school every day.

Table 12

Dinner patterns (family) (n=290), for both schools

Type of food	Percentage
Cooked meals (meat,vegetable, starch)	59
Mealie Pap and Milk	30.3
Mealie Pap and Meat	42.1
Pasta dishes	17.7
Convience foods (Take-aways)	11.4
Bread with every meal	10.7

The sample group had to tick all the options that they ate during the week with their families at home. A good indication is that 59% of families had cooked meals in the evening, and 42.1% ate mealie pap and milk. Many families as indicated in the table above ate high quantities of starch at night, 11.4% ate convenience foods, and 10.7% ate bread with every meal.

Table 13

Frequency of different types of food eaten (n=290), for both schools

Food item	Daily	Weekly	Seldom	Never
Fried Meat, Chicken, Fish, Sausages	27.7	42.4	26.1	3.4
Bacon, Polony, Viennas, Cold Meats	25.3	31.4	31.8	11.1
Meat with fat	18.9	17.1	30.2	33.3
Fried potatoes (Chips)	29.4	29.8	35.1	5.7
Margarine/Butter	40.2	23	23	13.1
Mayonnaise/Salad Dressing	20.5	32.3	32.3	14.6
Fresh cream in food, on dessert	13.3	27.3	25.4	32.4
Fried eggs	29.9	33.8	27.8	7.7
Gravy over food	40.7	22.1	19	17.1

In table 13, above, the sample group indicated all the different foods that they consumed on a daily and weekly basis as well as the types of food seldom or never eaten by them. A high percentage of animal protein is eaten daily (27.7%) and weekly (42.4%) by them, as well as processed meats, where 25.3% consume it on a

daily basis and 31.4% on a weekly basis. A good sign is the fact that 30.2% on a daily basis and 33.3% on a weekly basis do not eat meat with fat. Although the percentage that eats meat with fat daily or weekly is not very high. The same group indicated that they ate fried potatoes (chips) daily (29.4%) or weekly (29.8%). Margarine/butter was eaten by 40.2% daily. Another high in fat product that is eaten by the group was mayonnaise/salad dressing, with a daily intake of 20.5% and a weekly intake of 32.3%. Also interesting is that exactly the same percentage (32.3%) of the consumers seldom used mayonnaise/salad dressing. Only 13.3% used fresh cream on a daily basis and 27.3% on a weekly basis, either in their food or on dessert. It is also good to see that the percentage of the group that used cream seldom or never was 23.4% and 32.4% respectively. Fried eggs, on the other hand, were eaten by 29.9% daily and 33.8% weekly, which is high. The most consumed food item was gravy over food, which was eaten by 40.7% of the sample group.

5.4.1.3 Section C: Snack patterns results

In answer to whether they consumed snack food items in the afternoon, 77.4% answered yes and the remaining 22.6% answered no – so a very large percentage of the group snack in the afternoon as well.

Table 14

Types of snack food items eaten in the afternoon (n=290), for both schools

Hotdog	18.8
Hamburger	14
Simba Chips	52.4
Toasted Sandwich	14.8
Chocolate Bar	33.6
Yoghurt	28.8
Amazi	9.2
Cold drinks / Juice	43.2
Ice Cream	25.5
*Other – specify (Biscuit, Carrot, Polony)	96.7

*A high percentage specified that they consumed other items, like biscuits, carrots and Polony as well as the other snacks mentioned in the table above.

Although 95.2% of the ample group indicated that they were given a snack food item in their school lunch boxes (Table 11), 52.4% of them indicated that they also ate

Simba Chips as a snack in the afternoon, 33.6% ate chocolate bars and another 43.2% had a cold drink or fruit juice. They also consumed items with high levels of fat, such as hotdogs (18.8%), hamburgers (14%) and toasted sandwiches (14.8%) in the afternoons, as well as yoghurt (28.8%) and ice cream 25.5%. When the sample group specified what other snacks they ate in the afternoon, they indicated that they ate biscuits, carrots and Polony. The question is, how often do they snack on these types of food? Is it every afternoon, or just on certain days and are there many snack food items available in their homes or perhaps a tuck shop nearby where certain items can be bought? The next question (availability of snack food items especially after school) will supply some answers.

Table 15

Availability of snack food items especially after school (n=290), for both schools

How often available after school	
Monday	56.1
Tuesday	11.4
Wednesday	10.6
Thursday	2
Friday	20
Tuck shop, café or supermarket near home	
Yes	75.8
No	24.2
Lots of snack food items at home	
Yes	49.4
No	50.6
Kind of snacks eaten at home	
Simba Chips/Popcorn	50.2
Peanuts	18.8
Sweets/Chocolates/Toffees	38
Coke/Juice/Oros	42.8
Biscuits, salty, with dips	29.2
Biscuits	14
Cakes/Tarts	14
Condensed Milk	12.2
Desserts with custard	15.1
*Other – specify (Carrots)	98.9
How often do you eat snacks?	
Never	2.2
Seldom	24.4
Everyday	25.5
Once a week	12.2
Only weekends	15
Afternoons	14.4
Evenings	2.2

* Other snacks that the sample group eat at home are carrots that are a very good source of vitamin A. Respondents also indicated others on their questionnaires, but did not specify the type of snack.

What is interesting is that snack food items were mostly available on Mondays (56.1%), which could suggest that there were more snack food items available over weekends and parents kept some to give to the children in the sample group to take to school on Mondays. On Fridays snacks were also available to 20% of the respondents, because this is the start of the weekend and part of the treats for the weekend. During the week there were not so many snacks available. On Tuesdays 11.4% had snacks available, 10.4% on Wednesdays and 2% on Thursdays. This indicated that although they snacked a lot during weekends, there was not so much available during the rest of the week.

Tuck shops, cafés and supermarkets also played an important role in availability of snack food items. There was an indication that 75.8% lived in walking distance from these facilities and only 24.4% were not in walking distance from these facilities. A very interesting response was that 49.4% indicated that there was many snack food items in their homes and 50.6% answered that there were not.

The most frequently eaten snack food item at home was Simba Chips, again, with a total of 50.2%; the second most frequently consumed snack in this specific question was cold drinks (42.8%). Sweets/chocolates and toffees were high on the favourites list (38%) and then salty biscuits with dips, with a percentage of 29.2%. The rest of the items were not as high, but if they were eaten every day, then this result must be reconsidered. When the respondents were asked when they snacked most, 25.5% indicated that they snack everyday. Only 2.2% answered that they never snack, while 24.4% indicated that they seldom snack which is a very good thing; 12.2% snacked only once a week, 15% snacked only over weekends, 14.4% snacked in the afternoons and only 2.2% snacked in the evenings.

Table 16

Snack food items available at schools (n=290), for both schools

Kind of snack food items at tuck shop	
Simba/Nik Naks/Cheesecurls	100
Peanuts	100
Chocolates	54
Sweets	100
Toffees	100
*Other – specify (Schambane)	100
Pies	54.6
Toasted Sandwiches	100
Cold Drinks	54.6
Doughnuts	100
Soup	100
Do you get money to buy at tuck shops?	
Yes	89.9
No	10.1
How often do you get money to buy?	
Daily	50
Weekly	21.8
Seldom	22.6
Never	5.6
How much money do you get?	
R2	30.8
R5	28.5
R10	21.5
R15	5.8
R20	9.6
R30	3.8
How often do you buy?	
Monday	43.9
Tuesday	38.4
Wednesday	39.1
Thursday	33.6
Friday	66.8

*A total of 100% of the sample group indicated that Schambane are available at school tuck shops.

There are only unhealthy snack food items available at school tuck shops. Eight out of eleven items on the list were 100% available, and all the items were available to all the children in schools to consume during school time. The three remaining items were also more than 50% available to all the children in the school. A large percentage (89.9%), of the sample group got money to buy snack food items at school tuck shops while only 10.1% did not have money to buy items at the school tuck shop. Half of the sample group (50%) that answered the question on how much money they got specified that they got money daily to buy from these shops, another 21.8% weekly and 22.6% seldom bought from these shops, while 5.6% never bought

from school tuck shops. Most of the sample group (30.8%) got R2 to buy from these shops, while 28.5% reported that they got R5 to spend and 21.5% got R10. A small percentage of 5.8% got R15, while 9.6% got R20 and 3.8% got R30. The sample group bought snacks on a regular base from these tuck shops, especially on Fridays, when 66.8% treated themselves and on Mondays, when 43.9% did so, in other words, before and after the weekend. They also got more snacks over weekends at home and were given more snack food items for school on Monday as well. During the rest of the week, 38.4% bought snacks on Tuesdays, 39.1% on Wednesday and 33.6% on Thursdays.

Table 17

Pocket money (n=290), for both schools

Do you get pocket money from parents?	
Yes	66
No	33.6
How much?	
R10	48.5
R20	9.7
R30	5.8
R40	5.8
R50	11.7
More than R50	18.4
How often?	
Daily	34.8
Weekly	21.1
Monthly	25
Seldom	14.5
Never	4.7
For what are you using pocket money?	
Snack food items	45.4
Movies	10
Games	19.6
Other – specify	86.3
Save	12.9
Soccer	0.4

More than half of the sample group (66%) received pocket money, while 33.6% did not received any. Most of the sample group (48.5%) received R10, 9.7% received R20, 5.8% received R30 and R40 each, while 11.7% received R50 and 18.4% received more that R50 from their parents. Most (34.8%) received pocket money on a daily basis, while 24.1% received money weekly and another 25% received pocket money monthly. A small percentage of the sample group (14.5%) seldom received

pocket money and 4.7% never received pocket money from their parents. They mostly (45.4%) spent the money on snack food items, and only 10% used the money to go to the movies, while another 19.6% used it for games. Only 12.9% saved money for something and 0.4% indicated that they used the money for soccer, either to watch a game at school or pay their own entrance fee, or to place bets on the game.

To determine the snacking habits of children, a combined question was asked to find out how often the sample group ate their normal meals together with snacks and how often they drank cold drinks, whether on a daily, weekly or monthly basis.

Table 18

Indicate when you do eat the following items (n=290), for both schools

Food item	Daily	Weekly	Monthly	Seldom	Never
Bread/Porridge	75.4	12.3	3.5	6.2	2.7
Meat	44.2	34.9	7	12.8	1.2
Dairy	30.5	28	7.9	21.3	12.1
Eggs	22	38.2	7.9	24	7.9
Cheese	29.3	23.6	10.2	25.2	11.8
Vegetables	47.3	25.9	3.1	9.8	3.9
Fruits	49.6	27.7	6.3	11.7	4.7
Dessert	14.9	28.9	16.6	22.6	17
Snacks	50.6	25.5	6.5	15.4	2
Cold Drinks	46.9	29	6.1	14.3	3.7

The type of food most frequently eaten food by the sample group in this question was carbohydrate, 75.4% consuming it on a daily basis, indicating a high intake. Another category showing high intake was snacks, and although the type of snack was not specified, 50.6% ate snacks on a daily basis and 46.9% drank cold drinks daily. The sample group indicated that they did eat vegetables (47.3%) and fruits (49.6%) as well, which is very good sign, as is the 30.5% dairy intake and the 22% intake of eggs.

Parents must set an example so that children inherent good eating habits and eat healthy food items. In the next question the opinions of the children were tested to find out when most snacks were consumed by both children and parents and then to find out when they usually snacked and on what type of food they snacked.

Table 19

Snacking patterns of children and parents (n=290), for both schools

When do you and parents snack?	
Daily	16.9
Weekly	28.5
Monthly	33
Seldom	16.9
Never	4.9
When do you usually snack?	
Breakfast	9.6
Midmorning	3.7
Lunch	67.2
Teatime	7.7
Dinner	12.9
After dinner	10
Snack while watching TV & play games	
Yes	80.2
No	19.8
What do you snack on?	
Bread	41.7
Simba Chips	56.1
Peanuts	14.4
Chocolates	40.6
Sweets	35.1
Toffees	14.4
Fruit	46.1
Yoghurt	36.9
Cookies	28.4
Salt Biscuits with dips	9.6
Ice Cream	34.3
Popcorn	25.1
Cold Drinks	43.2
Juice	46.9
Milo/Nesquick/Amazi	14
*Others – specify (Amazi, Carrots, Water)	97.8
Take a snack or drink before going to bed	
Yes	52.3
No	47.7
What do you snack on?	
Bread	27.3
Simba Chips	38.7
Peanuts	11.4
Chocolates	22.9
Sweets	19.9
Toffees	7.7
Fruit	22.9
Yoghurt	17.7
Cookies	15.9
Salt Biscuits with dips	7.4
Ice Cream	18.1
Popcorn	11.1
Cold Drinks	30.6
Juice	35.1

Table 19 continue

Milo /Nesquick/Amazi	8.9
**Others – specify (Milk, Water)	97.8
Do parents also snack a lot?	
Yes	38.5
No	61.5
When do you snack the most?	
Hungry	24.7
Bored	29.5
Stressed	5.2
Watching TV	36.9
Playing games	17.3
Avoid snacking 1 hour before meals	
Yes	58.1
No	41.9

* Others specified in this question by the sample group such as Amazi, carrots, water and milk, which are all very good and healthy choices. Some respondents indicated "others" on the questionnaire, but did not specify the type of snack.

**Others specified in this question by the sample group were water and milk, which is a very healthy choice. Some respondents indicated "others" on the questionnaire, but did not specify the type of snack.

On a daily basis 16.9% of the sample group snacked on something and 28.5% snacked on a weekly basis, while 33% snacked monthly and a very low percentage of 4.9% never snacked.

At lunchtime, 67.2% of the sample group snacked, which could be an indication that the snack food item was brought from home, or bought from the school tuck shop. Another 80.2% snacked while watching TV or playing PC games. The worst aspect of this is that they were inactive while watching TV and eating all these unhealthy snacks. The favourite snack food item of the sample group was Simba Chips (45.1%), followed by juice (46.9%), cold drink (43.2%) and bread (41.7%). Chocolates (40.6%) and sweets 35.1% are also high on their snacking list. The good news about the results in this question is that 46.1% ate fruit as a snack and 36.9% ate yoghurt. The sample group also specified that they had Amazi, carrots and water as well. Another 52.3% indicated that they had a snack or drink before going to bed. Simba chips were high on their list again (38.7%), as well as fruit juice, (35.1%), cold drinks, (30.6%) and chocolates (22.9%). On the other hand, 22.9% also ate fruit

before, although snacking before going to bed is not something to be encouraged. Another thing to take into consideration in this specific question is that some respondents indicated that they snacked on milk and water before going to bed. At least they did not eat something very fatty or drink something unhealthy, although a very low percentage of the sample group did that. Looking at the parents of the sample group, only 38.5% indicated that their parents also snacked a lot. The sample group snacked most while watching TV, (36.9%), and when they were bored (29.5%). A good sign is that 58.1% of the sample group avoid snacking one hour before meals, making it more likely that they eat the healthy food on their plates during the family meal.

An essential part of investigating snacking patterns is to find out if there are differences in meals at the beginning of a month and the end of the month. Assuming that there is less money available at the end of the month, the next question was asked to find out if there are differences – in food and in snacks. A percentage of 76.2% of the children answered that there was a difference and 23.8% answered that there was no difference in the meals.

Table 20

Differences in meals (n=290), for both schools

Food available	Month begin	Month end
	Yes	Yes
More Food	64.6	75.9
Less Food	46.8	47.5
More Snacks	57.1	60.7
Less Snacks	52.5	56.6
More Cold Drink	60.4	64.4
Less Cold Drink	50.7	51
More Sweets	44.8	50.3
Less Sweets	63.5	57.3
*Others – specify (Biscuits, Cake, Meat)	92.6	92.3

***** Other items eaten by the sample group were specified as biscuits, cake and meat.

It seems that there are more meals and snack food items available at the end of the month when there is more money to buy these items. Looking at the high percentages overall, there is never a shortage of any of the above items.

Table 21

General questions about other daily intakes (n=290), for both schools

Do you drink water each day?	
Yes	92.9
No	7.1
How many glasses p/day?	
1-3	47
4-6	25.4
More than 6	27.6
Drink a lot sweetened drink p/day?	
Yes	41.2
No	58.4
How many glasses p/day?	
1-3	73.9
4-6	18.3
More than 6	7.8
Parents force you to eat all food on plate	
Yes	34.3
No	65.7
Parents reward you with snacks for any reason	
Yes	52.7
No	47.3
With what do they reward you?	
Food	35.4
Sweet Snacks	19.6
Salty Snacks	10.3
Drinks	26.2
Other – specify – MONEY	8.5
Do parents buy tempting snacks advertised on TV?	
Yes	55.8
No	44.2

The majority of the sample group knew that they must drink water during the day and 92.9% indicated that they did. A high percentage of 27.6% drank more than six glasses per day, although a higher percentage of 41.2% drank a lot of sweetened drinks per day, 73.9% of which drank between one and three glasses per day. Although some parents forced children to eat all the food on their plates (34.3%) answered yes the other 65.7% were not forced to eat all their food. A percentage of 52.7% of the parents rewarded their children with snacks for some or other reason; 35.4% of them were rewarded with food by their parents, 26.2% with drinks, 19.6% with sweet snacks and 10.3% with salty snacks. A small percentage of 8.5% was rewarded with money, which they could use for anything they wanted. Another 55.8% of parents bought tempting snacks that they saw advertised on TV.

5.4.1.4 Section D: Activity results

Children had to tick all the options that best described their activities and specify where applicable.

Table 22

Activities of the sample group and their parents (n=290), for both schools

Physically active each day	
Yes	71.4
No	28.6
What do you participate in?	
Sport	55
Swim	14.8
Cycling	18.1
Dance	28
Traditional Games	15.5
Other – specify: Cleaning	0.4
Running	0.4
Singing	7
How often do you participate?	
Monday	43.5
Tuesday	35.4
Wednesday	26.9
Thursday	33.2
Friday	52.4
Saturday	52
Sunday	26.6
Do you walk to school each day?	
Yes	64.4
No	35.6
Pace of walking	
Slow	9.7
Normal	48
Fast	42.2
Are parents also active?	
Yes	74.3
No	25.7
Specify their activities	
Jogging	14
Gym	27.3
Gardening	23.6
Walking	48.3

In Table 22, the sample group indicated that 71.4% were active and that 55% of them participated in sport, 28% took part in dancing and also indicated that they cleaned, ran and sang. Although most activities took place on Fridays (52.4%), they were active throughout the whole week as well on Sundays. On Saturdays, 52% were

active probably because there are sports days at schools on Saturdays. Another 64.4% of the sample group walked to school every day, which is a good activity for them, especially since in the next question, 48% indicated that their pace of walking was normal and 42.2% indicated that they walked fast. Only 9.7% walked slowly. A high percentage of the sample group's parents (74.3%) were also active. Parents participated in jogging (14%), gym (27.3%), gardening (23.6%) and walking (48.3%).

5.4.1.5 Section E: Snack food item results

In these questions the respondents had to indicate which item they ate daily or weekly or as weekend treats, or if they seldom or never ate them.

Table 23

Snack food item list – savoury snacks (n=290), for both schools

Snack food item	Daily	Weekly	Weekend Treats	Seldom	Never
Simba Chips	40	29.8	9.1	17.4	3.8
Nik Naks	32.2	23.9	15.3	20.4	8.2
Cheesecurls	16.5	21.3	14.9	20.5	26.9
Popcorn	21.7	20.9	15.8	27.7	13.8
Peanuts	13.8	26.3	13.4	26.7	19.8
Nuts	14.2	16.6	10.9	21.5	36.8
Raisins	16.9	19.3	16.9	20.9	26.1

Daily:

The sample group ate a lot of Simba chips, (40%), as well as Nik Naks, (32.2%). Other snacks that were also high on their snack food item list were Cheesecurls (16.5%), popcorn, (21.7%), peanuts, (13.8%), nuts, 14.2% and raisins (16.9%).

Weekly:

A high percentage of savoury snack food items were also eaten weekly by the sample group, from Simba Chips eaten by 29.8%, the highest, to nuts, consumed by 16.6%, the lowest.

Weekend Treat:

The highest weekend treat indicated in this question was popcorn, consumed by 15.8%, but Simba Chips were the lowest, at 9.1% in this question.

Seldom:

Some respondents in the sample group seldom ate high percentages of snack food items. Popcorn and Simba Chips were consumed only seldom by 27.7%, and 17.4% of respondents respectively.

Never:

A very small percentage of 3.8% never ate Simba Chips versus 40% who ate Simba Chips daily.

Table 24

Snack food item list – sweets (n=290), for both schools

Snack food item	Daily	Weekly	Weekend Treat	Seldom	Never
Hard Sweets	20.6	17.4	10.1	27.1	24.7
Toffees	28.6	18.5	7.7	23	22.2
Jelly Sweets	21.6	23.2	14.4	26	14.8
Marshmallows	10.2	21.1	12.6	29.3	26.8
Nougat	10.2	14.9	10.2	21.7	43
Snack Bars	23.3	21.6	13.9	23.7	17.6
Chocolate Bars	27.4	24.6	17.5	21	9.5
Chocolate Slab	20.2	20.2	16.2	22.3	21.1

Daily:

Toffees were eaten by the sample group on a daily basis (28.6%), while 27.4% ate chocolate bars daily. The lowest percentages of sweet snack food items in this question eaten by the sample group were marshmallows and nougat, both at 10.2% daily.

Weekly:

Chocolate bars were eaten by 24.6% weekly followed by jelly sweets (23.2%). The snack eaten least by the sample group weekly is nougat, at 14.9%.

Weekend Treat:

Again the most often eaten sweet snack food item for a weekend treat was chocolate with a percentage of 17.5% and the lowest, toffees at 7.7%.

Seldom:

A percentage of 29.3% seldom ate marshmallows and 21% seldom ate chocolate bars.

Never:

Nougat was never eaten by 43% of the sample group, whereas 9.5% of them never ate chocolate bars.

Table 25

Snack food item list – cookies and biscuits (n=290), for both schools

Snack food item	Daily	Weekly	Weekend Treats	Seldom	Never
Rusk	15	14.2	9.8	25.2	35.8
Cookies	29.1	21.5	15	24.7	9.7
Cakes	13.9	21.1	19.5	36.3	9.2
Tarts	8.4	10.5	16	29	36.1
Scones/Muffins	9.4	16.7	11.8	31.8	30.2

Daily:

The sample group indicated that 29.1% ate cookies out of the above list, which is the highest on a daily basis and the lowest is 8.4% for tarts.

Weekly:

Also on weekly basis 21.5% ate cookies and 21.1% ate cakes, while the lowest is 10.5% for tarts.

Weekend Treats:

Cakes (19.5%) are the weekend treat for most of the sample group and only 9.8% ate rusk**,** which had the lowest percentage in this question.

Seldom:

A percentage of 36.3% seldom ate cake and 24.7% seldom ate cookies.

Never:

The sample group indicated that 36.1% never ate tarts, but only 9.7% never ate cookies and 9.2% never ate cakes.

Table 26

Snack food item list – dessert items (n=290), for both schools

Snack food item	Daily	Weekly	Weekend Treats	Seldom	Never
Baked Pudding	17.5	15.5	15.9	27.5	23.5
Instant Pudding	13.5	12.7	18	23.8	32
Jelly	22.1	17.7	17.3	32.1	10.8
Custard	21.3	19.7	22.2	28	8.8
Canned Fruit	25.2	23.6	15.9	26	9.3
Ice Cream	32.3	20.7	21.9	19.1	60
Condensed Milk	24	18.4	13.6	20	24

Daily:

In the above table, 32.3% of the sample group ate ice cream daily, another 25.2% ate canned fruit and 24% ate condensed milk, which are all very high in sugars and fats. Only 13.5%, the lowest percentage ate instant pudding.

Weekly:

Canned fruit was eaten weekly by 23.6%, the highest percentage and only 12.7% ate instant pudding, the lowest percentage in this question.

Weekend Treats:

The weekend treat most frequently consumed was custard (22.2%) and the least was condensed milk (13.6%).

Seldom:

Jelly was eaten seldom by 32.1% of the sample group.

Never:

Ice cream was never eaten by 60% of the sample group, neither was baked pudding by 23.5% in this question.

Table 27

Snack food item list – convenience foods (Take-aways) (n=290), for both schools

Snack food item	Daily	Weekly	Weekend Treat	Seldom	Never
Pizza	15.6	17.6	20.4	28.8	17.6
Hamburger	14.3	13.9	20.9	33.2	17.6
Pies	14.9	20.2	18.5	30.2	16.1
Russians	17.9	21.1	17.5	30.9	12.6
Chips	35.7	20.8	16.1	22	5.5
Hotdog	19.5	15.9	18.7	31.5	14.3
Chicken	38.5	36.8	10.1	12.6	2
Toasted Sandwiches	24.1	29.4	10.6	19.2	16.7
Vetkoek	18.3	15.4	11.2	25.7	29.5
Doughnuts	11.5	14.5	12.4	23.5	38

Daily:

Of the sample group in this question 38.5% ate chicken and 35.7% ate chips, daily. Another high percentage of convenience food that they ate on a daily basis was toasted sandwiches, (24.1%). They also consumed a lot of hotdogs, (19.5%), vetkoek, (18.3%), Russians, (17.9%), pizza, (15.6%), pies (14.9%) and hamburgers (14.3%).

Weekly:

Chicken was high again at 36.8%, the most frequently consumed convenience food weekly, and hamburgers the least at 13.9%.

Weekend Treat:

Hamburgers were the most often consumed convenience food over weekends (20.9%) and chicken at 10.1% the least.

Seldom:

The sample group indicated that 31.5% seldom consumed hotdogs, which is the highest percentage, while chicken is the lowest percentage at 12.6%.

Never:

Thirty eight percent of the sample group indicated that doughnuts were the convenience food that they never consumed, while only 2% never bought chicken.

Table 28

Snack food item list – drinks (n=290), for both schools

Snack food items	Daily	Weekly	Weekend Treat	Seldom	Never
Carbonated Drinks	30	15.2	12.8	18.1	23.9
Milkshake	19	20.2	16.1	26.4	18.2
Fruit Juice	42.2	26.6	7.8	17.6	5.7
Oros	28.8	24.5	12	21.5	13.3
Amazi / Milk	30.3	19	7.8	24.2	18.6
Water	81.4	8.3	3.7	5	1.7
Yoghurt	29.9	33.8	13.4	17.1	6.8
Coffee	55.3	19	4.2	13.9	7.6
Tea	52.3	18	4.6	13	12.1
Sugar	55.1	14.1	5.6	16.2	9
Milo	17.7	15.5	11.2	28.4	27.2
Nesquick	11.3	13.4	14.3	20.3	40.7
Lucozade	9.5	12.5	7.8	15.9	54.3
Red Bull / Powerade / Energade	11.5	14.8	14.8	19.3	39.5
Other energy drinks – specify: they don't specify	21.1	18.1	6.3	18.1	36.3

Daily:

The drink mostly consumed by the sample group in this question is water (81.4%), followed by fruit juice (42.2%). This could be an indication that the sample group knew what a healthy drinks was. A high percentage of the group also chose coffee (55.3%) and tea (52.3%), probably to keep themselves warm, which could explain why the percentages were so high, especially considering that the fieldwork for this study was done during winter.

Weekly:

On a weekly basis the sample group chose yoghurt (33.8%) as their favourite drink and fruit juice (26.6%), Oros (24.5%) and then milkshake (20.2%). A lower percentage of the sample (12.5%) chose Lucozade.

Weekend Treat:

The favourite drink over weekends was milkshake and 16.1% chose this as their favourite drink. Over weekends there was also a high percentage of Red Bull / Powerade / Energade that were drunk by the sample group, with a percentage of 14.8%. It is possible that they participated more in sports over weekends and felt that they needed the extra energy.

Seldom:

A total of 28.4% seldom drank Milo and another 26.4% seldom drank milkshake. Also 24.2% seldom drank Amazi / Milk which they need for strong bones and teeth. Only 5% of the sample group indicated that they seldom drank water.

Never:

A percentage of 54.3% of the sample group never drank Lucozade and 40.7% never drank Nesquick. Another 1.7% never drank water, which is fortunately a very low percentage.

Table 29

Snack food item list – sugar-free, low-fat and high-protein snacks (n=290), for both schools

Snack food item	Daily	Weekly	Weekend Treat	Seldom	Never
Bio-Plus sweets	13.5	13.1	10.2	18.9	44.3
Canderel Chocolates	16.5	14.4	9.9	19.3	39.9
Sugar-Free Sweets	18.2	15.7	8.3	19.4	38.4
Low-Fat Products	20.6	16	9.7	20.6	33.2
High-Protein Snacks	29.8	16.6	8.9	17	27.7

Daily:

On a daily basis the sample group ate high-protein snacks (29.8%). They also indicated that they took low-fat products (20.6%). Then they also ate sugar-free sweets (18.2%) as well as Canderel Chocolates (16.5%) and 13.5% ate Bio-Plus sweets every day.

Weekly:

High-protein snacks (16.6%) were still the favourite of the sample group eaten per week, as well as low-fat products (16%). Sugar-free sweets (15.7%) were eaten by the sample group, 14.4% ate Canderel chocolates and 13.1% Bio-Plus sweets weekly.

Weekend Treat:

For weekend treats they chose Bio-Plus sweets (10.2%), then Canderel chocolates (9.9%). Lower percentages liked low-fat products (9.7%), then high-protein snacks (8.9%) and 8.3% of the sample group chose sugar-free sweets.

Seldom:

A percentage of 20.6% seldom ate low-fat products and 19.4 % seldom chose sugar-free sweets while another 19.3% chose Canderel chocolates, with only 175 seldom eating high-protein snacks.

Never:

A percentage of 44.3% never ate Bio-plus sweets, 39.9% never ate Canderel chocolates and another 38.4% never ate sugar-free sweets. Also 33.2% never ate low-fat products and 27.7% never ate high-protein snacks.

Section F: Portion sizes results

In this question the respondents must gave an indication of the portion sizes that they consumed. Portion sizes were not giving to them in grams and millilitres as children would not understand this. Therefore the indications of slices, halve or full portions, small or big packets and half or full cups were used for them to understand.

Table 30

Portion eaten of certain snack food item at a time per meal (n=290), for both schools

Product	Portion A	%	Portion B	%	Portion C	%
Bread	2 Slices (60g)	23.6	3 Slices (90g)	34.5	>3 slices (90g)	41.9
Hotdog	½ (50g)	18.9	1 (100g)	66.4	> 1 (100g)	14.8
Hamburger	½ (±100g)	21.7	1 (±200g)	62.2	>1 (±200g)	16.1
Pizza	2 Slices (300g)	54.9	3 Slices (450g)	25.1	>3 slices (450g)	20
Scone/Muffin	½ (40g)	34.4	1-2 (80-160g)	50	> 1-2 (80-160g)	15.6
Sweets/Chocolates	1 (50g)	45.5	2 (100g)	28	> 2 (100g)	26
Simba Chips	Small pkt (30g)	56.3	Large pkt (150g)	32.7	>l large pkt (150g)	11
Jelly/Pudding	½ cup (125ml)	38.9	1 Cup (250ml)	50	> 1 cup (250ml)	11.1
Cold drinks	½ cup (125ml)	13	1 Cup (250ml)	64.4	>1 cup (250ml)	22.5
Yoghurt	½ cup (125ml)	15.9	1 Cup (250ml)	62.2	>1 cup (250ml)	21.9
Pies	½ (70-80g)	16.5	1 (140-160g)	67.4	> 1 (140-160g)	16.1
Amazi	½ cup (125ml)	30.9	1 Cup (250ml)	53.6	>1 cup (250ml)	15.5

Portion A

A high percentage of 56.3% ate a small packet of Simba Chips at a time. A percentage of 54.9% ate two slices of pizza per meal. Another 45.5% ate one sweet or chocolate at a time. Also, 23.6% ate two slices of bread per meal. A higher percentage of 30.9% drank half a cup of Amazi, while only 13% drank half a cup of cold drink at a time.

Portion B

In this question 67.4% indicated that they ate one pie, 66.4% ate one hotdog and 62.2% ate one hamburger at a time or per meal. A high percentage of one cup of cold drink (64.4%) was consumed at a time and one cup of yoghurt by another 62.2%. Another 50% ate one to two scones or muffins and also 50% ate one cup of jelly or pudding per meal.

Portion C

In this section the sample group indicated that 41.9% ate more than three slices of bread per meal. More than two sweets or chocolates were eaten by 26%, while more

than one cup of cold drink was taken by 22.5%. More than one cup of yoghurt was eaten by 21.9% and 20% indicated that they ate more than three slices of pizza per meal.

5.5 Money results

Sixty six percent of the respondents received monthly pocket money and 45.4% of these bought snacks with their monthly pocket money whereas 86.3% indicated that they saved the money (Table 17). Parents must control money given to children to spend at school tuck shops. Because if parents give more money to children, they consumed more snack food items and their snacking habits increased. This study indicated that they used the money that they got from their parents for snacking. They snacked mostly on Fridays (66.8%) and on Mondays (43.9%). During the week, only 39.1% snacked on Wednesdays, 38.4% on Tuesdays and 33.6% on Thursdays (Table 16). They snacked most while watching TV (36,9%) or when bored (29.5%), while 24.7% snacked when they were hungry and 17.3% while playing games (Table 16).

5.6 Tuck shop results

Money was given to 89.9% of the respondents received money to buy snack food items from school tuck shops, and 50% bought daily from these shops (Table 16).

Crisps 100%	Doughnuts 100%	Peanuts 100%	Soup 100%	Sweets 100%	Toffees 100%
Cold drinks 54.6%	Schambane 100%	Pies 54.6%	Chocolates 54%	Toasted Sandwiches 100%	

Figure 8 Snack food items available at school tuck shops

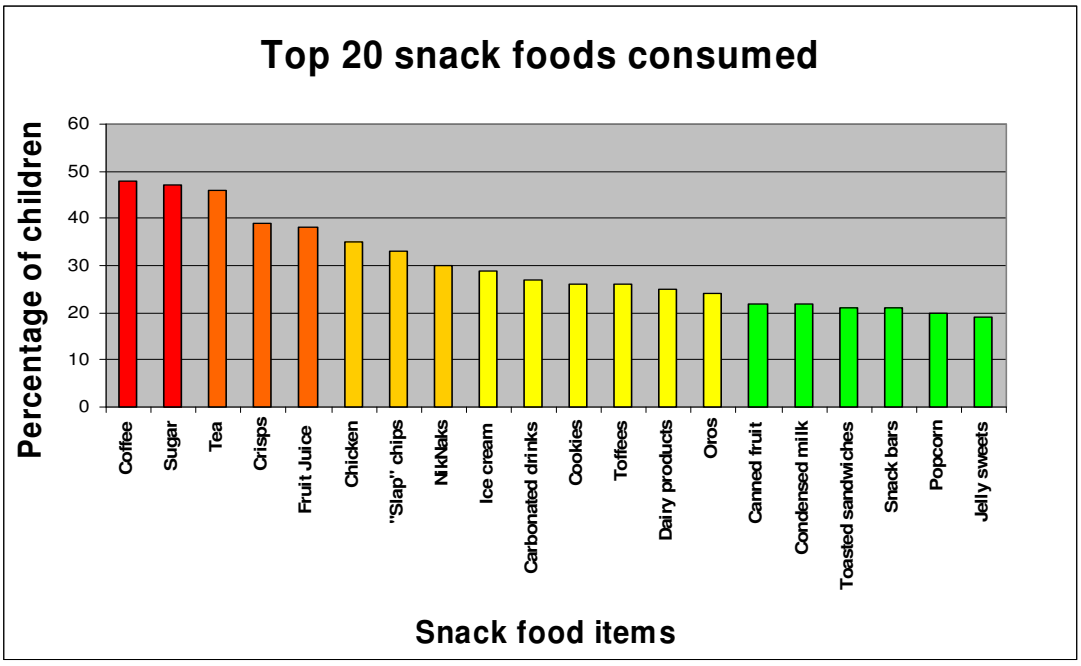

Figure 9 Top 20 snack food items consumed by children

The researcher tested only the perceptions of children and reported what they saw as a snack food item. This was not a 24-hour recall. Too much sugar was used in tea and coffee. The questionnaires were completed during the winter season and the children drank a lot of coffee and tea to stay warm, since it is a cheaper way to keep warm, especially at night. The most nutritious foods chosen were chicken, fruit juice and dairy.

5.7 Activity results

Activity results were not measured, but reported from the questionnaires filled in by the respondents. A percentage of 71.4% of the respondents indicated regular physical activity. The three activities most practised were sport (55%), dancing (28%) and cycling (18.1%). Activities took place mostly on the following days: Monday - Thursday 33.2% – 43.5% and during weekends 26.6% – 52%. Sport and games over weekends keep the children active. The children indicated that 74.3% of parents

were also active (Table 22). Activities for children are very important. A suggestion for keeping them active is to go with them to a gymnasium, or alternatively to buy skipping ropes and exercise with them at home, because parents must set an example for their children. Watching TV as a leisure activity can be associated with energy balance problems such as weight gain in excess of growth in height during early, middle and late childhood, and being less physically active can lead to increased weight in both pre-school and school-aged children and adolescents. The more hours spent watching TV the more overweight and obese children get in early childhood, middle-childhood and / or adolescence (Raynor *et al.* 2009:20). Watching television frequently is linked with obesity, especially in women and children. Three proposed mechanisms explain the link between obesity and watching television: (1) watching television displaces exercise and other physical activities, (2) watching television leads to consumption of more foods, and (3) it introduces the viewer to more advertisements, which leads to the consumption of more unhealthy foods that are advertised. Although there is so much television advertising of less healthful foods, there is a minority of nutritional claims made for food advertised on television and in magazines (Henderson *et al.* 2005:192).

5.8 General information results

Children knew what healthy food items were, but they did not always choose healthy options. When asking them to pick out only the healthy items, 77.5% chose fruit and 51.3% chose yoghurt. A small percentage of 7% chose Cheesecurls. When they had to choose a healthy drink the majority chose water (74.2%), while 54.2% chose milk and a small percentage chose milkshake (6.6%). A percentage of 39.8% indicated that they ate three to four portions of fruit and vegetables per day, but 4.5% indicated that they did not eat any fruit and vegetables. However, 6.7% indicated that they ate more than six portions of fruit and vegetables per day. In general, 34.3% of the respondents indicated that they had an excellent appetite (Table 6).

5.9 Anthropometric results

The anthropometric indices of the respondents are reported in Tables 31-36, which reflect the BMI-for-age of respondents in the whole group of both schools, which shows a strong correlation to the results from the NFCS where sunting and wasting, especially on national level, remain by far the most common nutritional disorders, affecting approximately one out of five and approximately one out of ten children respectively. On the other hand, 10% of children nationally were classified as overweight and 4% as obese (Labadarios *et al.* 2007:255), thus reflecting a double burden of malnutrition.

5.10 BMI for age

In young children (0-5 years), underweight is low W/A – however, W/A is inadequate for measuring growth beyond childhood due to its inadequate to distinguish between relative height and body mass. Hence, in school age children and adolescent, underweight (also called thinness) is measured using BMI for age:

Low BMI for age = underweight
High BMI for age = overweight and obesity
Low height for age = stunting.

Table 31

BMI for age of the whole sample group

BMI for age	Frequency	Percentage
Valid: Underweight (<3)	34	11.7
Risk of underweight (≥3 to <15)	58	20.0
Normal (≥15 to <85)	148	51.0
Risk of overweight (≥85 to <97)	28	9.7
Obese (≥97)	22	7.6
Total	290	100

The majority of the children in the sample were not normal (51%). However, 20% were at risk of underweight and 11.7% were thin or underweight. This indicates an

acute shortage of food in the diet. A percentage of 9.7% is at a risk of overweight and 7.6% are obese.

5.11 Risk of overweight

Overweight and obesity should be addressed amongst women and children. In recent findings by Labadarios *et al.* (2007:255) it is suggested that obesity in children is best addressed at clinics, crèches, schools and in the home environment. The panel also recommend that community-based programmes must target obesity in both cases. Dietary interventions should be based on a lifestyle approach and there must also be an increase in physical activities. There needs to be more regulation at school tuck-shops and more control of school activities, together with a reduced intake of sweetened cold drinks and high-energy, nutrient-poor snacks (Labadarios *et al.* 2007:256). A double burden of malnutrition is caused when childhood under nutrition and overweight co-exist in many countries (UNICEF – Progress for Children 2007:2).

Table 32

BMI for age cross tabulation according gender

BMI for age	Girls (n=172)	Boys (n=118)
Underweight (<3)	9.9	14.4
Risk of underweight (≥3 to <15)	17.4	23.7
Normal (≥15 to <85)	52.9	48.3
Risk of overweight (≥85 to <97)	11.1	7.7
Obese (≥97)	8.7	5.9
Total	100	100

The results in Table 32 indicate that a greater percentage of girls (52.9%) than boys (48.3%) were of normal body mass index. However, more girls (8.7%) were obese compared with the boys (5.9%), while more boys were underweight (14.4%) when compared with the girls (9.9%).

5.12 Height for age (stunting)

The major cause of stunting, or low height-for-age is long-term insufficient nutrient intake and frequent infections. The effects of stunting are largely irreversible, because it generally occurs before the age of two. Almost one third of children under five in the developing world are stunted and display symptoms that include impaired cognitive function and poor school performance (UNICEF – Progress for Children 2007:1).

Table 33

Height for age (stunting) of the whole sample group

Height for age	Frequency	Percentage
Valid: Stunting (<3)	35	12.1
Risk of stunting (≥3 to <15)	68	23.4
Normal (≥15 to <85)	119	41.0
Risk of tallness (≥85 to <97)	55	19.0
Very tall for age (≥97)	13	4.5
Total	290	100

Stunting is height-for-age and <3 percentile is an indication of chronic malnutrition. A total of 41% of the whole sample group were at normal height for age, while 23.4% were at risk of stunting and 12.1% were stunted. This could indicate that there is chronic hunger and food insecurity in some households. In comparison, 19% that are at risk of tallness and 4.5% are very tall for their age.

According to Labadarios *et al,* stunting should continue to be addressed and nutrition must be provided with the necessary additional resources to promote child growth (Labadarios *et al.* 2007:256).

Table 34

Height for age (stunting) cross-tabulation according to gender

Height for age	Girls (n=172) *	Boys (n=118) *
Stunting (<3)	16.8	5.00
Risk of stunting (≥3 to <15)	29.6	14.4
Normal (≥15 to <85)	34.3	50.8
Risk of tallness (≥85 to <97)	14.5	25.6
Very tall for age (≥97)	4.8	4.20
Total	100	100

* There is a statistical significance between gender and Height-for-Age as measured by Chi-Square at $p \leq 0.05$.

There is a significant difference between girls and boys in terms of height for age (Chi-Square = $p \leq 0.05$). A percentage of 50.8% of boys and 34.3% of girls are at normal height for age. More girls (29.6%) are at a risk of stunting in comparison with the boys (14.4%). Also more girls (16.8%) are stunted compared with the 5% of boys.

5.13 Phase 3: Results of the development of a snack food item, sensory and data analyses

5.13.1 Introduction

The results of the baseline survey indicated that the children in these two purposively selected schools snacked a lot on unhealthy snack items both at home and at school. The study also demonstrated that overweight and obesity is present among children nine to 13 years old in the Vaal Region. Simba Chips was the most frequently eaten snack food item by the children in both schools. The results of this survey indicate that there is a need for a healthy snack food item, that is definitely low in fat and that will attend to the obesity problem in SA. Therefore a low-fat, high-density snack food item was planned and according to these specifications a savoury snack recipe was chosen for children nine to 13 years old. The savoury snack recipe was chosen because the ingredients are not expensive and the recipe is easy to prepare and to bake.

5.13.2 Criteria for the snack food item

The criteria formulated for the snack food item were that it should be:

- Cost effective: < R1.00 per portion of 30g (Similar products cost R4.00/30g in the supermarket);
- Low in fat: no more than 5% of the total E intake;
- Nutritious: at least 20% of DRI for Fe and Zn;
- Safe for human consumption;
- Assured of a shelf life of at least one month; and
- Culturally acceptable to children.

5.13.3 Identification of basic food ingredients and theoretical dietary content

The original recipe chosen by the researcher for the snack food item was as follows:

Pro-Vita Biscuits (40-50 portions)

175	g	Nutty Wheat
25	g	Digestive Bran
10	ml	Salt
5	ml	Baking Powder
100	g	Margarine
1		Egg
15	ml	Marmite
30	ml	Warm Water

Part of the Nutty Wheat (10%) was replaced by soy flour, because the high quality of proteins in soy contain potential health benefits and it may be a good alternative for people who are obese, when trying to lose weight. Soy products are also high in zinc, but contain phytate, a substance that inhibits iron absorption. The digestive bran was taken out completely, because there is enough fibre in the Nutty Wheat. The salt was replaced by a flavoured sprinkle that does not have a very high salty taste and also contains no MSG. The baking powder was used as is throughout the

whole process. The margarine was reduced by half so that the snack food item could meet the criterion of low fat content. Another egg was added to the recipe, to increase the protein and zinc content of the product. The Marmite was also removed completely, because of the high salt content. The water was replaced with milk, because milk is a good source of protein and calcium.

Table 35

Recipes for the snack food item

Original Recipe	**Adjustment 1**	**Adjustment 2**	**Adjustment 3**	**Adjustment 4**	**Adjustment 5**
Nutty Wheat	Nutty Wheat	Nutty Wheat	Nutty Wheat	Nutty Wheat	Nutty Wheat
Digestive Bran	-	Commercial Soy Flour	Commercial Soy Flour	Supro 313 (biscuit)	Supro Max 6010
Salt	Flavoured Sprinkle	Flavoured Sprinkle	Flavoured Sprinkle	Flavoured Sprinkle	Flavoured Sprinkle
Baking Powder	Baking Powder	Baking Powder	Baking Powder	Baking Powder	Baking Powder
Margarine	Margarine	Margarine	Margarine	Margarine	Margarine
Egg	Egg	Egg	Egg	Egg	Egg
Marmite	Marmite				
Water	Water	Commercial Soy Sauce	Milk (2% Fat)	Milk (2% Fat)	Fat Free Milk

5.14 Preparation methods and changes of recipe

5.14.1 Original Recipe

The original recipe was prepared, baked in finger sized shapes and then underwent sensory testing by ten Hospitality staff members. They reported the taste, aroma, texture, colour and overall acceptability of the snack food item. Most of the staff members reported a too salty taste.

5.14.1.1 Adjustment 1

The recipe was prepared and baked in finger sized shapes. Only Nutty Wheat was used, with no extra digestive bran. Instead of the normal salt, a flavoured sprinkle was used. This recipe again underwent sensory analysis by ten staff members. They liked it and although some of them still reported that the taste was a little bit too salty for them, the aroma, texture, colour was acceptable and the overall impression was good. The specific recipe was then tested on a FoodFinder Programme®. Based on the nutritional analyses, the Marmite was taken out of the recipe and it was decided to add soy products, such as soy flour and soy sauce to the remaining ingredients of the recipe.

5.14.1.2 Adjustment 2

The next recipe was baked with a commercial soy flour and soy sauce. Because of the salt content in the soy sauce, the quantity of the flavoured sprinkle was reduced to half to avoid a too salty taste again. Although again a little salty the taste was very nice with the added soy ingredients. At this stage the dough was sticky on the surface, which could be as a result of the soy flour that was used.

5.14.1.3 Adjustment 3

The recipe was analysed on the FoodFinder Programme® and because of the high sodium content, the commercial soy sauce were taken out of the recipe. The energy value was also high so the amount of margarine were reduced by half, and instead of the soy sauce and water, milk with only a 2% fat content was used to increase the calcium content but keep it low fat.

5.14.1.4 Adjustment 4

For the next recipe Supro 313 (Biscuit) was used, supplied by The Solae Company, which specialises in soy products. Supro 313 is an isolated soy protein that is manufactured from defatted soy flour. The protein is extracted, precipitated, washed,

neutralized, dried and packed under strict processes and quality control procedures. Furthermore the product is produced using The Solae Company's Quality Management System, which is based on sound quality principles intended to ensure the consistency, safety and performance of their product. Instead of the previous Soy Flour the Supro 313 was added. The snack food item rose higher in the oven and the texture was softer. It also tasted different from the previous recipe. Because it browned quickly (because of the added soy), the oven temperature was dropped to 160°C and the product was baked for only 10 minutes. When the overall product was accepted by colleagues, it was decided to work on the shape, so that children from nine to 13 years old would accept the snack food item as well. Cookie cutters with the letters of the alphabet were used to cut out interesting shapes for children. This baking session indicated that the snack food item was more stable, because there was no crumbly appearance during the baking process and the appearance of the alphabet-shapes was attractive.

5.14.1.5 Adjustment 5

The next step in the development process was to bake a batch of the snack food item specifically for analysis by the ARC. A request was put through to the Solae Company, to supply the Institution with fresh Supro 313. They sent Supro Max 6010, because Supro 313 had been discontinued. For the purpose of this session, all the ingredients (Supro 6010, margarine, egg and milk) were taken out of the refrigerator to reach room temperature before baking to see if there were visible effects on the snack food item itself. It baked brown evenly and rose a little bit more. Supro Max 6010 is produced from Identity Preserved Conventional Ingredients and meets Solae's Identity Preservation Product Commitments. The basis consists of a source of soybeans that are produced without biotechnology, with documented identity preservation at each stage of processing, independent third-party certification of conformance to defined identity preserved (IP) procedures and a maximum of 0.9% adventitious residual genetically modified (GM) deoxyribonucleic acid (DNA) as tested by the Solae's process testing protocols. The only visible difference was that there was no need to spray the surface before rolling out the dough, because it

was not sticky at all, but because the dough was a little dryer than the previous one, 5ml of 2% milk was added to the recipe. The only thing that changed in this specific recipe that was sent to ARC, was the milk. Instead of 2% milk, fat free milk was used. The snack food item was baked on three different days at more or less the same time of day (in the mornings). For the ARC to test the shelf life of 28 days, a separate batch of the snack food item was baked at another time and a portion size of 30g was sent to them for testing. After the results came back from the ARC, the analyses were done on the FoodFinder Programme®. This was done to find out if the criteria for the snack food item had been met. The results indicated that the kJ content was a little lower and that the protein content was higher. The total fat was very low, which was one of the criteria set. The carbohydrates were a little higher. The calcium content was lower, while the iron content was more or less double the amount needed. The zinc content was also a little higher, satisfactorily meeting the criteria.

After all the adjustments, the final theoretical nutrient calculations on the FoodFinder Programme® are reflected in Table 36.

Table 36

Theoretical calculation

Nutrient	Unit	Theoretical Value /100g	DRI
Fat (Mojonnier) ASM 004	g	21.4	N/D
* ** Protein	g	18.2	34
Energy ASM 076 Boys Girls	kJ	1840	 9572 8698
Carbohydrates ASM 075	g	48.6	130
* **Vit A ASM 172	µg	0.7	600
**Calcium	mg	160.0	1300 AI
**Iron	mg	3.5	8
**Zinc	mg	2.7	8

* For the conversion of nitrogen content to protein content the factor 6.25 was used.

**Analyses done by subcontracted laboratory.

5.15 Experimental results

The results of the three samples sent to the ARC for nutritional analysis are reflected in Table 37.

Table 37

Experimental results

Analyses	**Accreditation number**	**Unit**	**# Sample 1 28/10/2008**	**# Sample 2 29/10/2008**	**# Sample 3 03/11/08**
Ash	ASM 048	%	5.39	5.83	5.98
Dry matter	ASM 013	%	88.02	89.06	89.51
Moisture	ASM 013	%	11.98	10.94	10.49
Fat (Mojonnier)	ASM 004	%	16.22	16.18	16.18
**Protein	Not SANAS accredited	%	24.94	24.70	24.80
Energy (calculated)	ASM 076	kJ/100g	1729	1739	1744
Carbohydrates (calculated)	ASM 075	%	41.47	42.35	42.55
Vit A	ASM 072	mg/100g	0.10	0.11	0.09
**Calcium	Not SANAS accredited	mg/100g	91.00	96.00	111.00
**Iron	Not SANAS accredited	mg/kg	75.06	63.59	83.73
** Zinc	Not SANAS accredited	mg/kg	27.50	26.44	28.94

* For the conversion of nitrogen content to protein content the factor 6.25 was used.

**Analyses done by subcontracted laboratory.

The same recipe was used to prepare samples 1, 2 and 3 in the above table.

For ease of calculation, an average for each of the nutrients was calculated by adding the three samples together and dividing by three for example, the zinc content for the final product would be presented as (2.75 + 2.64 + 2.89) ÷ 3 = 2.76

5.15.1 Optimisation

The results of the chemical analysis showed that ash, dry matter, moisture, fat, protein, E, carbohydrates, vitamin A, iron and zinc were present in the sample.

However, the theoretical content of the snack food item showed that there was enough iron and zinc in the baked product, but the experimental value showed there was too little of both of these for the formulation criteria of DRI per 30g portion. The kJ was a little high, as was the fat. For this reasons the recipe was slightly revised to meet the specific criteria.

These values were compared with the theoretical calculations on the FoodFinder Programme®, as well as the DRI values for children nine to 13 years old (NICUS 2003) and are shown in Table 38.

Table 38

Theoretical analyses

Nutrient	**Unit**	**Theo-retical value /100g**	**Chem-ical value /100g**	**Variance**	**DRI**	**Chem-ical value / portion**	**DRI % of contribu-tion by a 30g of the product**
Fat (Mojonnier) ASM 004	g	21.4	9	-12.4	N/D	-	-
* ** Protein	g	18.2	30.8	12.6	34	90%	27%
Energy ASM 076 Boys Girls	kJ	1840	1737	-102.6	9572 8698	18% 20%	5.4% 6%
Carbohydrates ASM 075	g	48.6	52.4	-6.4	130	40%	12%
* **Vit A ASM 072	µg	0.7	0.1	-0.6	600	17%	5.1%
**Calcium	mg	160.0	99.3	-60.6	1300 AI	7.6%	2.3%
**Iron	mg	3.5	7.4	70.6	8	92.5%	27.8%
**Zinc	mg	2.7	2.8	44.8	8	34.5%	10.4%

* Foe the conversion of nitrogen content to protein content the factor 6.25 was used.

** Analysis done by subcontracted laboratory

Vit A, retinal equivalent 1RE = 3.314

AI = Adequate Intake (No DRI's available)

As a result of the lower zinc and iron values, it was decided to adjust the recipe again. Food ingredients were studied to include zinc and iron content.

Pumpkinseeds met the criteria and were thus included in the recipe. Once the recipe was adjusted, it was prepared and baked again and tested by the ten Hospitality Management staff members for sensory acceptability. The theoretical values were calculated again on the FoodFinder Programme® and are reflected in Table 39.

Table 39

Theoretical values for new improved recipe

Nutrient	Unit	Portion / 100g	Portion / 30g	Retail Product / 30g	DRI % of 30g portion	DRI of 30g *Pro-Vita
Fat	g	23	7	3	-	3%
Protein	g	20	6	3.4	18%	10%
Energy Boys Girls	kJ	1827	548	525	 5.7% 6.3%	 5.5% 6%
Carbohydrates	g	43	13	21	10%	16%
Vit A	µg	198	59	-	10%	-
Calcium	mg	137	41	-	3.2%	-
Iron	mg	4	1	-	12.5%	-
Zinc	mg	4	1.1	-	13.4%	-

*The Retail Product (Pro-Vita) is used as an alternative to bread, and in Latin, means "for life". Pro-Vita is also one of South Africa's iconic brands and has a heritage of 135 years. The trademark for Pro-Vita was first registered in 1926. (http://www.provita.co.za/history.aspx).

According to the chemical analyses, the experimental value of the iron was 2.1 times more that the theoretical value (Table 38). According to this value the assumption was made that if the product were sent to the ARC for analysis again, the value would be double than the previous one, and therefore the iron content would be 12.5% in the new improved recipe (Table 39).

12.5% x 2.1 = 26%

A total of 13.4% for zinc was analysed in the new improved recipe the value staying more or less the same as the previous value. According to this finding an assumption was made that if the product were sent to the ARC for analysis again, the value would also stay more or less the same as the previous one, that is, 13.4% of the DRI (Annexure F).

Neither of these nutrients was reported on the ingredients list of the retail product (Pro-Vita). There were no preservatives or additives present in the Snack Food Item, so that could be an indication that this product will not cause allergies in human consumption. The fats that were used in this snack food item were good fats, comparing to those of the retail product (Pro-Vita). The added protein that was used in the Snack Food Item is necessary for children that are at risk of overweight and obesity.

The product was always baked in a Thermo-fan oven with one exception when it was baked in an oven without a Thermo-fan. This influenced the appearance of the snack food item and it also baked longer than the previous time and had a very dry taste. An assumption can be made that if a product like this is baked in a Thermo-fan oven, the appearance will be better and because the fan helped to dry out the biscuit, it was also crispier. The final recipe was thus adjusted as follows:

The final recipe was baked in 2008 and was sent to the ARC for chemical analysis and a costing was done. To meet the criteria of the zinc and iron content, another egg was added to the recipe as well as raw, unsalted pumpkinseeds. The next step was to bake enough of the snack food item to take it for sensory evaluation to the two purposively selected schools in the Vaal Region. The alphabet cookie cutters were used to cut out interesting shapes for the children.

Table 40

Final recipe of snack food item and costing

Final Recipe	**Costing of Recipe**
130g Wheat Flour	R0.82
100g Soy Flour (Supro Max 6010)	R0.50
10ml Flavoured Sprinkle	R0.72
5ml Baking Powder	R0.20
50g Margarine	R0.90
2 Eggs	R2.00
120ml Milk (Skimmed)	R1.00
40g Pumpkinseed (raw, unsalted)	R0.30
Yield: Raw weight = 522.90g	**R6.44**
Baked weight = 374.98g	
Portion size: 30g	**R0.52 per 30g**

If the baked weight of 374.98g is taken, divided by 30g, it equals a total of 12. Therefore 12 are the factor number that will be used to calculate the cost per 30g as well. For this calculation 12 divided by R6.44, equals the total of R0.55 for a 30g portion.

Figure 10 & 11 Final ingredients used and final snack food item

5.16 Sensory evaluation

5.16.1 Sensory evaluation of the snack food item

The final recipe was prepared and taken to the two primary schools where the randomly chosen respondents gave their views of the product. Each one of the respondents received a questionnaire to complete. The ratings were presented by the hedonic faces to describe the acceptability of the product. The results of sensory evaluation were as follows:

In the experimental sensory evaluation (snack food item) they were asked if they liked the item a lot. A percentage of 58.3% liked the taste a lot, 57% liked the texture a lot, 54.3% liked the colour a lot, while 59.5% liked the smell a lot and 48.9% liked the portion size a lot. Only a very small percentage of the respondents indicated that they disliked the product (Figure 12).

The following descriptions indicated the means in Figures 12 & 13.

DL lot = dislike a lot

DL little = dislike a little

N like = not like

L little = like a little

L lot = like a lot

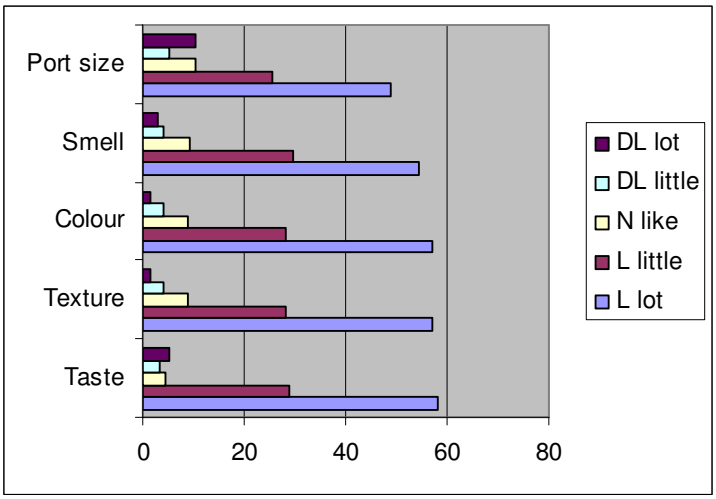

Figure 12 Sensory evaluation results of the developed snack food item

5.16.2 Sensory evaluation of the retail product

The respondents also had to taste the retail product under the same circumstances as the developed snack food item. The results of sensory evaluation are as follows:

In the control sensory evaluation (retail product) they were asked if they liked the item a lot. A percentage of 88.1% liked the taste a lot, 80.8% liked the texture a lot, 69.5% liked the colour a lot, while 84.8% liked the smell a lot and 67.5 liked the portion size a lot. Only a very small percentage of the respondents indicated that they disliked the product (Figure 13).

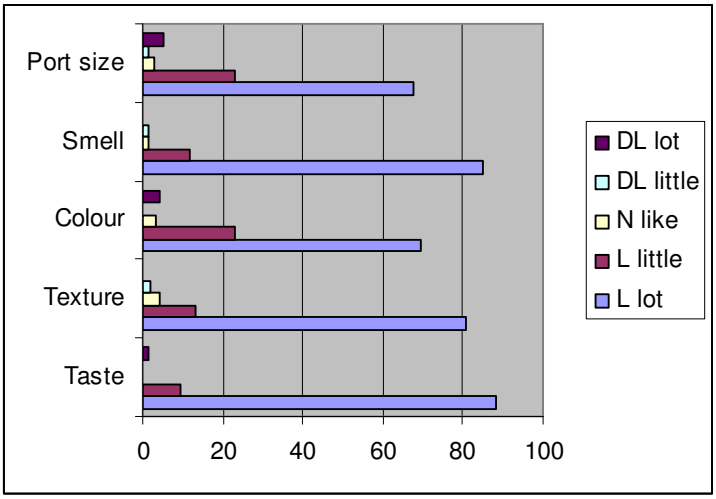

Figure 13 Sensory evaluation results of the retailed snack food item

Sensory characteristics on appearance, flavour, taste and smell of retail product

5.17 Shelf life analyses

Shelf life testing of edible products is a routine process in food product manufacture. This often involves storage under different temperatures and humidity conditions and testing for microbes commonly associated with particular ingredients and/or products. This is a measure of microbiological safety of the product and is conducted to provide information about a product's spoilage under real-life conditions. In this study, monitoring the shelf life of the snack food item was part of the quality control process to ensure it was safe for human consumption over time.

5.17.1 Shelf life results for the snack food item

The snack food item was analysed for a period of 28 days and the results presenting a total aerobic organism count remained below log 2/g throughout the entire trial.

5.18 Methods

The product was prepared on 28/10/2008, 29/10/2008 and again on 03/11/2008. It was vacuum sealed and stored at 24° C for 24 hours, before it was couriered to the laboratory. The ARC, a SANAS accredited testing laboratory, tested the shelf life of the product according standardized methods, each with an ASM number. An aliquot of 10mg was removed aseptically from the tube of Snack Food Item each time it was analysed. The samples were homogenized in Stomacher 400 (DHK Pty Ltd) with 90ml of diluents (Buffered peptone water). The samples were analysed for Total aerobic plate count (ASM 018) on Trypone soy agar and incubated at 25°C for 72, plus minus 3 hours and for Coliform (ASM 019) *E.coli* (ASM 019) count on Violet red bile MUG agar and incubated at 37°C for 24, plus minus 2 hours. Because no instructions were included with the sample, *E.coli* and Coliform analysis were left out on day 0. After consultation with the responsible person, these analyses were included in the rest of the trial. The yeast and moulds (ASM 020) were analysed on Rose Bengal agar with Chloramphenicol and incubated at 25°C for five days.

Enumeration of Salmonella SPP

- The snack food item sample was placed in an enriched medium for two hours. The sample was then streaked on a plate containing *Salmonella* Agar and then incubated at 37°C for 24 hours.
- The colonies of *Salmonella* were identified and transferred to three test tubes containing Triple Sugat iron Agar, Kligler Iron Agar and Lysine Iron Agar using the stab culture method.
- The test tubes were incubated again at 37°C for 24 hours.
- Growth was measured with the *Salmonella* present being identified (M009).

Enumeration of *Staphylococcus Aureus*

- The snack food item sample was sub-sampled and plated on Baird parker medium base.
- After inoculation the plate was incubated at 37°C for 24 hours.
- The colonies that grew were sub-streaked on Mannitol Salt Agar to isolate the *Staphylococcus aureus (S. aureus).*
- Observations were taken with the Staphylococcal strains being identified.

Enumeration of *Bacillus cerus*

- The respective snack food item was sub-sampled and placed in an enrichment medium for 2 hours.
- The sample was streaked on a plate containing *Bacillus cerus (B. cerus)* Agar and then incubated at 37°C for 24 hours.
- The colonies of *B. cerus* were then identified.

5.19 Results of shelf life analyses of the snack food item

The *Escherichia coli (E.coli)* and coliform counts remained beneath 10cfu/g throughout the entire trial. No *B.cereus, S.aureus* or *Salmonella* were detected throughout the 28-day testing period.

As a result of all the counts being very low throughout the trial and the presence of organisms read at <10 implying their absence, it can be concluded that the snack food item has a shelf life of at least 28 days.

5.20 Results of packaging materials

The literature indicated that children like bright colours and that they will buy snack food items in interesting and eye-catching packaging, therefore the MTech (Graphic

Design) student decided on the yellow and blue colours to make it more attractive to children.

The "Nutri-Max" was used as a fictitious name for the product to see how it would look on the packaging. Seven packaging material options were provided as follows:

5.20.1 Packaging material - Example 1

Figure 14 Paper canister

Paper canister liner sealed with surlyn used by Oreos is a good sealant moderate price. Composite canisters for packaging new Oreo Crunchies ™'99 are lined with 19µ'b5m (11.5lb/ream) of Surlyn®'ae extrusion coated on aluminium foil. The closure is a heat sealed membrane lid with a peelable seat layer of Surlyn®'ae on foil laminated to PET film. A resealable lid allows tight fit and does not compromise package integrity.

5.20.2 Packaging material – Example 2

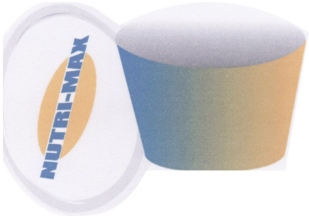

Figure 15 Dairy container

The conical lidded dairy container used for cream cheese is expensive. Lidding stock is widely used for cheese, dairy, produce, processed meats and in the dry goods

industry. The lidding stock, whether as a monolayer or laminated structure, can offer either a peelable or lock seal characteristic to the types of trays/cups on the market today.

5.20.3 Packaging material – Example 3

Figure 16 Acetate box

This clear acetate box used in toys packaging is a poor sealant. It is printed on with offset lithography, expressive and moderate in price. However, it has a labour intensive, folding process.

5.20.4 Packaging material - Example 4

Figure 17 Acetate deli box

This clear acetate deli box is low in price. It is used for salads and sandwiches. Mouldings properties of the acetate box would allow for customized and inexpensive shapes.

5.20.5 Packaging material – Example 5

Figure 18 Zippered pouch

This is a cell pack zippered stand-up pouch used in Whiskas packaging. It is elegant, hygienic and moderate in price. It is used in packaging products, similar to the product developed by the researcher. This can be an indication that this packaging can be suitable for packaging the snack food item.

5.20.6 Packaging material – Example 6

Figure 19 Multi-layer roll stock

Multi-layer roll stock is strong and elegant looking. It is used in Pringles packaging. The price per unit is moderate. Traipak is able to customize structures according to customer's choices, product's features and packaging machine requirements, to meet different packaging needs. Traipak has experienced and knowledgeable sales representatives proposing the most suitable materials for the products for their customers. Traipak can also provide complimentary sample rolls for customers to test with their packing machines. Traipak asserts that only quality assured products will be delivered to customers.

5.20.7 Packaging material – Example 7

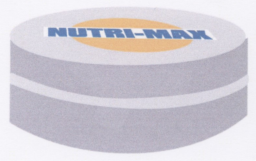

Figure 20 Silver metal tin

These silver metal tins, custom-sized, are strong and elegant but expensive. For larger quantities the price drops. They are used for Cavendish and Harvey Sour Drops.

5.21 Discussions

This study provided an opportunity to determine the nutritional status and consumption patterns of primary school children, aged nine to 13 years old in the Vaal Region, SA, in terms of addressing obesity in these communities. The outcomes of this research led to the development of a snack food item that is affordable, acceptable, safe for consumption, nutritious and easy to prepare from the ingredients that are readily available in the households and shops in the community. At present there are few affordable snack food items available on the market.

In a study that was done in Iran and published in 2009, researchers looked at in-school snacking, breakfast consumption, and sleeping patterns of normal and overweight Iranian High School girls in urban and rural areas in Guilan. Data were collected by self-administered questionnaires and body weight and height were measured. The sample group were represented by 2303 schoolgirls (1106 in Rasht City and 1196 in rural areas). The main outcomes of the study measure breakfast-skipping, snacking habits at school, sleep habits, body weight and height. It analysed the differences in the frequencies between the urban and rural girls and overweight and normal weight girls were tested. The results showed that prevalence of obesity was significantly ($P<.05$) lower in urban areas (4.1%) than in rural areas (5.2%). But the prevalence of overweight was significantly higher in those who usually skipped

breakfast (P <.001). The consumption of food items of low nutrient density as snacks during the school day was common in this population, especially in rural areas. They conclude that the school environment may contribute to the high prevalence of overweight / obesity observed among these Iranian schoolgirls. They further emphasise the importance of eating breakfast and choosing nutritious snacks during the school day. There was a limited consumption of fruit as a snack in both groups, as well as iron, zinc, vitamin A and vitamin D deficiencies, especially in Iran. Although schools were instructed not to sell junk food (high-calorie, low-nutrient-density foods) – namely potato chips, corn puffs, and chocolate candy – they still provide these foods to children. Another problem is that there are no school nurses in most Iranian high schools and health education is limited. Already in the 1970s the Iranian Government distributed milk, nuts and fruit as "charge-free snacks" to children during the school day to improve their nutritional status, but they must now pay for all food obtained at school. More research addressing these problems is strongly recommended (Maddah, Rashidi, Mohammadpour, Vafa & Karandish 2009: 30).

In this study of consumption patterns in children nine to 13 years old in the Vaal Region, the researcher also investigated the snacking, breakfast consumption, and sleeping patterns of normal and overweight school children in two schools. Data were also collected through questionnaires and body weight and height were measured. A percentage of 89.2% indicated that they ate breakfast, but no findings were made to link this to obesity. When looking at the snacking habits of the respondents (n=290), 95.2% indicated that they were given a snack (Simba Chips) in their lunch boxes. In addition 52.4% ate a snack (Simba Chips) in the afternoon and 33.6% ate chocolates, while a high percentage of 43.2% had a cold drink or fruit juice as a snack. With regard to their sleep habits, 24.3% indicated that they got to bed between 9- and 10 o'clock from Monday to Thursday and 13.9% got to bed after 11 o'clock during Friday to Sunday (on weekends). An assumption can be made that those respondents going to bed so late ate more snacks because they were awake later than the rest of the group. With reference to the school environment, many of the respondents bought extra snack food items from the tuck shops at schools, which

also contributed to the alarming levels in obesity. Only 11.5% indicated that they ate the recommended daily amount of fruit and vegetables per day, which was far less than what they should eat.

In another study published in 2009, the researchers investigated children from two to 12 years. The sample group consisted of 174 children, 49% preschool-aged, 54% female, 28% Hispanic and 34% overweight and at risk of overweight. Variable measurements were collected from parents who reported eating/leisure time behaviours and also provided height / weight measurements from medical records. The results of this study showed that according to the parents' report, preschool-aged children consumed more servings per day of low fat dairy (2.1 ± 1.6 vs. 1.7 ± 1.5; $P < .01$), fewer servings per day of sweetened drinks (1.4 ± 1.9 vs. 2.2 ± 2.6; $P < .01$) and watched fewer hours of TV per day or weekend (2.3 ± 1.3 vs. 2.7 ± 1.3; $P < .05$) than school-aged children. Fewer preschool-aged children consumed salty (14.0% vs. 26.1%; $P < .05$) and sweet (16.3% vs. 29.5%; $P < .05$) snack food daily, and a greater percentage regularly consumed dinner with a parent (93.0% vs. 80.7%; $P < .05$), as assessed by parent report. For this specific study the researchers conclude that parent-reported children's eating and leisure time patterns may influence energy balance and were less healthful in the school-aged children. Taking all their findings together, they recommended that interventions should start with families with preschool-aged children and suggests that parent-reported of behaviours promoted childhood obesity that increased with older children. They also recommend further research that should focus on identifying factors that might be contributing to increased reporting of problematic food and leisure-time activity patterns in school-aged children (Raynor *et al.* 2009:19-26).

In the present study, the researcher also investigated self-reported eating and leisure time activities of the respondents. They reported a lot of snacking during school time and in the afternoons. Respondents also indicated that there were a lot of snacks available at home (49.4%) and 25.5% reported that they ate snacks on a daily basis. A high percentage of 89.9% indicated that they got money to buy snacks at tuck shops and 50% bought daily from these shops. They normally bought the most snack

food items on Friday (66.8%) and on Mondays (43.9%). The respondents who indicated that they did received pocket money from their parents used the money to buy snack food items as well (45.4%). A percentage of 52.7% reported that when their parents rewarded them with something, 35.4% of parents rewarded their children with food, while 19.6% were rewarded with sweet snacks and 10.3% were rewarded with salty snacks. They also reported that they snacked to most while they watched television or played games (80.2%), Simba Chips being the most usual snack (56.1%) during this time. In this study the children were asked to report back on their parents as well, and parents were very guilty in setting a poor example for their children.

In another study in SA the activity levels and fat mass were measured to assess the effect television viewing amongst children 12-18 years old. It was conducted in 14 schools in the WC and included boys (=2 026) and girls (=2 792). Levels of obesity were associated with inactivity due to watching television, low fitness levels and the low daily intake of fruits and vegetables. In persons of lower socio-economic status, the time spent watching television was greater and the opportunities for school-based or after-school sports and physical activities were also fewer (Goedecke, *et al.* 2006:72).

In the study of consumption patterns in children nine to 13 years old in the Vaal Region, the researcher also looked at the activity levels, and the television viewing of these children. A percentage of 71.4% of the respondents indicated that they were physically active and most of them (52.4%) participated in sports and games on Fridays. Moreover, 64.4% of them walked to school every day and 48% indicated that they have a normal walking pace. Of the sample, 74.3% indicated that their parents were also physically active and that the parents' favourite activity is walking (48.3%). The researcher did not specifically look at the hours of television viewing, but in general, investigated television as part of the snacking patterns of the respondent. The following findings were made: that 31% of the respondents had a television in their bedrooms, that 80.2% snacked while watching television or playing games; that 36.9% snacked most while watching television and that 55.8% of

parents buy tempting snacks advertised on television. Owing to these findings, television viewing can be linked to obesity, because a lot of snacking is part of the respondent's diet during this time.

5.22 Findings concerning the criteria in previous studies of products developed

In a previous study (Kearney 2006), the following criteria were reached. The developed product (vetkoek) contained a minimum of 25% of DRI's for energy, iron, zinc, calcium and vitamin A for children six to 13 years old. The developed vetkoek was easy for illiterate mothers to prepare and made with ingredients available in the household. The product was cost effective and acceptable to children. It was possible to develop the vetkoek for this particularly area. The 25% of EAR's of micronutrients were met in the criteria of zinc, iron and energy. From the sensory evaluation, the vetkoek was acceptable to the majority of the children with high scores for taste, appearance and acceptability. The recommended shelf life of two days at room temperature (24°C) and seven days when refrigerated was reached. The vetkoek that was developed for this study met all the criteria for the intended use in a school feeding programme for this specific community (Kearney 2006).

In another study done by Matiwane (2008), the following criteria were reached. Locally sourced and selected food items of the multimix complemented each other in terms of the zinc and iron content to achieve at least 30% of the RDA for energy, zinc and iron in a 100g of the dry food multimix. It was affordable and safe for human consumption. The study showed that it was possible to formulate the food multimix by meeting these criteria. Furthermore, it was important to use both theoretical and biochemical analysis methods as theoretical calculations cannot be relied on. The majority of the households could prepare the developed soup and muffins and the product was cost effective and accepted to the elderly. It was classified as convenience food, because it can be used in summer and winter. The muffin was used in summer and the soup in winter. From the sensory analysis, it was clear that both products were acceptable and received high scores for taste and appearance and was acceptable to the elderly. The results of the shelf life testing

indicate that the food multimix has a shelf life of longer than 28 days while the soup showed a recommended shelf life of two days at room temperature (24°C) if not reheated, and the muffin showed a recommended shelf life of three days at room temperature (24°C). These results showed that the food multimix and recipes were safe for human consumption, especially in households where no fridges were available. The required criteria of 30% of the RDA's for the iron and micronutrients were not met, however; only the 30% criterion for zinc was met, but no special equipment was required and ingredients available in the households were used for the preparation. The multimix, soup and muffin developed in this specific study, met all the criteria for the intended use as a feeding intervention for that community (Matiwane 2008).

The major objective of a study by Twenefor in 2008 was to develop a food multimix supplement that was affordable and where the nutritive value was required to meet 20% of the RDA for iron, folate and protein. The product had to be culturally acceptable and safe for human consumption. It was developed to address the state of maternal malnutrition in the Vaal Region. Objectives for this study were achieved through analysis of data gathered from previous studies conducted amongst pregnant women in the Vaal Region. This study concluded that a food multimix could be developed and optimised to meet certain criteria needed for pregnant women, but not all the criteria, specifically those related to the nutrient content, were met in this study. Further suggestions were that the nutrients should be prioritised and in the development of the food multimix (Twenefor 2008).

In a study by D Oosthuizen, a multimix was developed to address one-third of the nutritional requirements of selected nutrients for children six to 13 years old. It had to be culturally acceptable, commonly purchased and consumed by the community and affordable. The multimix formulation proved that the combination of the ingredients provide substantial nutritional value for the specific age group. This study can be beneficial as part of an intervention to reduce malnutrition. Although children enjoy snacking, they normally prefer a sweet product, but in this study they also responded positively to the savoury item that was given to them. This study

showed it was also possible to develop a multimix that met the criteria of nutrient density, local availability of ingredients, cultural acceptability, and which was affordable and palatable. The specific product met the criteria that it should supply one-third of the daily requirements of most nutrients. It could assist in reducing food insecurity by providing good quality food, but further research is recommended (Oosthuizen 2006).

5.23 Conclusion

The poor eating habits and high snacking patterns resulted in the 7.6% (BMI for age) and in the 4.5% (height for age) results of the respondents in the whole sample group.

This study was one of the first attempts to address obesity through a food-based approach by developing a snack food item to met the criteria of low fat, high density nutritional value, with at least 20% DRI of protein and iron.

Most recipes of snack foods are high in both fat and sugar and these two ingredients always contribute to unhealthy snacking (Boobier *et al.* 2006:1). A snack food item has been developed to reduce these two ingredients and provide a healthy snack choice for children that will teach them to make healthy food choices in the future. The content of the snack is what is most important!

This study proved that it is possible to formulate a snack food item according to a certain formulation, as the theoretically formulated product met the criteria of at least 20% DRI of protein and iron, although not for zinc. All the other criteria were met.

Chapter 6 Discussion, Conclusions and Recommendations

6.1 Introduction

There are huge obesity problems amongst young children in SA. The prevalence of obesity identified in children from a very young age in SA, as well as the large consumption of snack food items, motivated this study. There is a plea from many different organisations like the WHO, DoH and DoE to do something about this growing obesity problem in SA.

Through this study an opportunity was given to determine the nutritional status and consumption patterns of the children nine to 13 years of age in two purposively selected schools in the Vaal Region in order to develop a snack food item that addresses the obesity in children from a very young age.

6.2 Implications of this study

Snacking is an important way for people to get energy throughout the day. But mothers watching their children's weight should think about both the type of snacks they choose and how often they snack.

School-based healthy eating and physical activity programmes offer a great opportunity to improve the future health and well being of children because they can reach almost all children and may improve learning and offer social benefits, as well as improve health through critical periods of growth and maturation. Furthermore they can lower the risk of chronic diseases in adulthood, and be of assistance in instilling at an early age healthy behaviours that will lead to permanent healthy habits (Baranowski, Mendlein, Resnicow, Frank, Weber-Cullen & Baranowski 2000:S8).

6.3 Limitations of this study

The first limitation of this study is the fact that the final snack food item was not sent to the ARC for analysis again, because of time limits and because it is a very expensive method.

A second limitation is the fact that a 24-hour recall was not done in this study, which could probably help to determine the actual total energy intake of the children on a daily basis. If a 24-hour recall were done, the children's energy values could be analysed to find out if it is only snack food items that make children obese.

This study was carried out in only two primary schools in the Vaal Region and it would have been more beneficial if it had covered other primary schools in the same area, but the results can be used as a pilot study for further research to be undertaken in this field.

Although mainly household ingredients were used for the preparation of the snack food item, the soy flour, namely Supro Max 6010, is not available from supermarkets. A soy flour that is readily available can be used, however, the criteria of the snack food item in this study has not been met or tested.

6.4 Main findings

6.4.1 Literature

The prevalence of obesity affects children, worldwide, and obesity affects more than 22 million children younger than five years old. These numbers increase to 155 million for school-going children and is estimated that by the year 2020, half the girls and a third of all the boys in the world will be overweight (Kerr 2006:15). Recent data from SA show the prevalence of overweight, including obesity, amongst young people aged 13-19 years to be 17% overall, affecting more girls (25%) than boys

(7%) and prevalence was the highest (over 20% for boys and girls combined) in white and Indian population groups (SASSO 2004:2).

Increased snacking is one of the main cause of the obesity problem, because most children snack during the day on snacks that contain few vitamins, minerals or protein and little fibre. They also consume a lot of sweetened carbonised drinks, which not only contribute to overweight and obesity but also displace milk consumption, which contributes to calcium deficiency (SASSO 2004:3). If children eat regular, balanced meals and reduce snacks, they have less risk of developing preventable diseases, which are due to childhood obesity (Munro 2005:1).

In SA, the DoH implemented the PSNP to ensure that nutritious snacks are being provided and regulated by the DoH (Kloka 1999:4). The DoH also implemented the INP to prevent and manage malnutrition and to ensure optimum nutrition for all South Africans. In addition, it launched a campaign in May 2005 to promote physical activities and healthy behaviours in communities. It has been engaging QSR's to provide healthy meals since 2006, it has developed draft implementation strategies on obesity, and also addresses the marketing of foodstuffs to children, recommending that messages that encourage healthy dietary practices and physical activities be promoted. The FBDG were used as a basis for a healthy eating plan. The DoE needs to bring back physical education in all schools in SA.

Snack food items developed for obese children must be low in fat, low in salt, high density, but must also provide nutritional value to these children's diets. Parents must control snack food items, because as parents they must be role models to children.

6.4.2 Baseline survey

Based on the baseline survey, the results indicate that children snack a lot during the day and many of the children in this study indicate that they snacked mostly on the following items, make up the Top 20 snack food consumption list for this study. The

majority of food items consumed include coffee, sugar, tea, crisps, fruit juice, chicken, "slap" chips, Nik Naks, ice cream, carbonated drinks, chocolates, toffees, dairy products, Oros, canned fruit, condensed milk, toasted sandwiches, snack bars, popcorn and jelly sweets.

The dietary intake results confirmed that these primary school children consumed mainly unhealthy snack food items like crispy chips and they also eat a lot of bread and Polony. These findings indicated the rising of obesity prevalence amongst children in SA.

The anthropometric data in this study were measured using BMI for age (underweight) and Height for age (stunting).

The results of measurements for BMI for age (Table 31) show that 20% of the group as at risk of underweight and 11.7% were underweight, which indicates that there is an acute shortage of food in the children's diets. With regard to gender (Table 32), a large percentage of (48.3%) of boys had normal weight, while more girls (8.7%) were overweight in comparison with the boys (5.9%), and more boys (14.4%) were wasted. The results for stunting in the group (Table 33) show that (23.4%) was at risk of stunting and (12.1%) were stunted, which indicates that there is chronic hunger and food insecurity in some households. The majority of the boys (50.8%) were at normal height-for-age, while more girls (29.6%) were at risk of stunting and more girls (16.8%) than boys (5%) were stunted. Although a huge percentage of boys (25.6%) were at risk of tallness, more girls (4.8%) were actually very tall for their age in comparison with the boys (4.2%) in the stunting measurements. Underweight measurements in the group indicated that (23.4%) of the children were at risk of underweight, (7.3%) underweight, (13.4%) at risk of tallness and (6.6%) very tall for their age.

6.4.3 Product development

The criteria for the development of the snack food item included:

- Affordability, in that the portion should not cost more than R1.00 per 30g. The criteria were met as the snack food item developed in this study cost R0.52 per 30g.
- Nutritive value, meeting 20% of the DRI for protein and iron, as well as low energy and fat content. The chemical analyses of the three samples indicated that the 27% of protein and 27.8% of iron were met when compared to DRI. This proved that it is very difficult to meet the 20% criterion for both macronutrients and micronutrients. The energy criteria were also met as this product supply 5.4%-6% of DRI. However, only 10.4% of DRI was met for zinc.
- Cultural acceptability, using mostly ingredients that are readily available in the households in this community. The soy flour that was used (Supro Max 6010) was the only ingredient used in the formulation of the product that was not readily available from supermarkets in this community. The sensory analyses indicate that the snack food item was acceptable to the children for consumption as the majority of the children in the two purposively selected schools rated the snack food item very high. This criterion was thus met.
- Safe for human consumption. This criterion was met as proved by the chemical analyses and shelf life testing of the snack food item and recipes.

6.5 Conclusions

From the results the following conclusions are drawn:

1. Obesity is found in children from a very young age. Of the 290 respondents taking part in this study 7.6% (Table 31), were overweight. In (Table 33) a percentage of 4.5% were very tall for their age. Diets of obese children are characterised by the high consumption of high-fat foods, many carbonated drinks and dairy products and a low intake of homemade food, fresh fruits

and vegetables. Children eat less than the recommended amount of fresh fruits and vegetables, compiled by WHO.

2. Various strategies are required to address the prevalence of obesity, globally and in SA, snacking and the causes of the problem, as well as solutions to the snacking problem in SA and different kinds of snacking products available on the market.
3. Food diversification is a feasible solution to address obesity amongst children, as it is more sustainable than supplementation.
4. A novel food was developed to address the problem of obesity among primary school children in the Vaal Region, South Africa. An affordable, safe and acceptable food product, with a low-fat and high-density nutritional value, with at least 20% of RDI for protein and iron was successfully developed.
5. This solution is sustainable as household ingredients were used for the preparation of the snack food item and parents can be taught to prepare this product at home.

6.6 Recommendations

Children spend much of their younger years in school and recommendations are made that they are exposed to nutrition education in schools. It is a great place to learn about positive, healthy eating habits (Celebuski & Farris, 2000:4). Such education can help children understand why healthy eating will make them feel more energetic, look better, and work more efficiently. The diets of many school –age students can stand general improvement with regard to fruit, vegetable, whole grain and dairy choices (Hampl 1999:582).

6.6.1 Food Industry

PepsiCo aims to provide a snack that is more portion controlled, trans fatty acid free and lower in total fat and sodium. Furthermore they also strive to ensure that the snack is free from added MSG, artificial colourants, contains no tartrazine and is

high in fibre. But the range is still very limited in SA. There is thus a need for nutritious, palatable and affordable snack food items on the market, because a healthier snack will in all likelihood result in healthier children.

6.6.2 Department of Health and Education

Nutrition education is recommended from a very early age. The mothers and caregivers who are responsible for meals and packed lunch boxes of children must also be educated in the importance of ensuring that children eat a healthy breakfast, lunch and dinner so that they need only a small snack between meals. Public health measures should be aimed at limiting the amount of fast foods that children and teenagers eat.

The Nutrition Education Programme must form apart of the curriculum in all schools and even require schools to teach children healthy eating and exercise habits. Children's weight must be evaluated in schools to prevent obesity and must be combined with weight loss and exercise programmes. This could be done by sending health reports to parents of their children's weight on a regular basis. Schools must get rid of fast-food tuck shops on their premises or must allow them to sell only healthy foods and drinks to children, because they serve a lot of fatty foods and few or no healthy foods. These fast foods include huge portion sizes, high-energy values and high amounts of refined starch and added sugars. They are also high in fat and contain low levels of dietary fibre. Fast foods containing these ingredients seem to be the staple diet of millions of SA children and a suggestion is to increase the cost of unhealthy foods and drinks marketed to children so that they buy less of it. Regulate and control the fast food advertisements during television programmes, to avoid the temptation of buying it.

The health of children must be reconsidered – and schools need to be pro-active and offer them effective nutrition education, as well as healthy meals.

6.6.3 Parents of children

6.6.3.1 Physical activities

As a result of all the knowledge gained through this study, the following guidelines were compiled and these can form part of a nutrition education programme for school curriculum in future. But parents must not forget that they should be good role models for their children, and must also remember that snacking habits cannot change overnight. Parents should look for positive changes encourage the rest of the family to make healthy eating a lifetime habit.

Physical activities and healthy food choices begin from a very early age. The more energy we take in and the less exercise we have, the bigger we get, and the bigger we become the more susceptible we are to life-threatening conditions like hypertension, diabetes and certain cancers (Lowell 2004:238). When parents sit in front of the TV and snack on food that is loaded with sugar, oil and other unhealthy ingredients and take part in little or no activity, they encourage the same behaviour in their children (Kotiah 2004:6).

In developing obesity prevention programmes, physical activities must be also be reconsidered to fight the obesity epidemic in SA.

This study recommended that an activity pyramid be implemented by the DoH as part of the SAFBDG to make people aware of the importance of exercise. An example is shown in Figure 17. The activity pyramid is a good indication of what kind of activities are good for children (indicated at the bottom, in green) who must practise this kind of activity each day. The next colour (yellow-green) also indicates that they must practise these exercises three to five times a week. The next colour (orange) indicates that they must do this kind of exercises two to three times a week. But the red colour on top indicates activities that must be reduced, because children who take part in these are physically inactive.

Figure 21 Activity pyramid: adapted from
http://www.classbrain.com/cb pta/images/childact1.jpg

6.6.3.2 Tips for preparing lunch boxes

Snacks should be small and satisfying, not offered too often or too close to mealtimes (Kotiah 2004:4). Start by making small changes in the children's diets and keep their preferences in mind and be creative with foods to make these changes acceptable to them.

Children need healthy food and drinks to snack on or to take to school and if snack menus are planned beforehand these items will be available in the household to put in their lunchboxes. In this way parents can ensure that children have healthy food and drinks available when they need something to snack on. For this reason, weekly or monthly shopping lists must include healthy snack food items for lunch boxes as

well. Shopping lists for fresh fruits and vegetables can be compiled weekly or daily. Once parents get used to organising food purchases and planning ahead, the daily challenge of providing children with healthy snacks should no longer be a nightmare. The rest of the family can also benefit from this. It is a much healthier and cheaper option to pack lunches than to buy them.

When snacks are planned foods should be chosen from the bottom of the Food Guide Pyramid (fruits, vegetables, whole grain bread and cereals). Small amounts of lean meat and dairy products should be chosen. Foods from the top of the Pyramid (cake, candy, and cookies), which are high in fat and kJ must be selected only occasionally. Nuts in small amounts can also contribute to the nutritional value in children's diets. Children should be involved from a very young age to help with shopping, meal planning and cooking, so that they can learn what is healthy and what not. When purchasing food, labels should be read so that more nutritious choices can be made. It is important to try to buy 100% fruit juices instead of fruit drinks and carbonated cold drinks, which can cause tooth decay in children.

Avoid snacks high in fat and energy before mealtimes and before going to bed, otherwise the children will not eat the meal and will feel hungry later at night and snack on unhealthy food items again.

From this study it was found that the majority of children in all age groups snacked during the day. They get a snack in their lunchboxes, buy snacks from school tuck shops, they get a snack in the afternoon after school and then also snack in the late afternoons, so snacking occurred both at home and at school. Only a small percentage indicated that they ate five to six portions of fruit and vegetables during the day. In this sample, the fruit intake is very low and the intake of unhealthy snack food items very high.

In South African schools there is overweight and obesity on the one hand, while on the other hand, some families are struggling to supply basic nutrition.

The findings of this study can help schools, parents and tuck shop owners to focus on meal options that are healthy and affordable, to improve activities for children (sport and play outside) and help to prevent the obesity epidemic in South Africa. Parents and schools have a role to play in addressing the obesity problem in the Vaal Region.

Results of this study show that children need more healthy foods and drinks as snacks. Education in healthy food choices must start at home and if parents are not educated or informed about healthy snack food items, the children will follow in the footsteps of their role models (the parents) who must set an example. If parents purchase snacks like chocolates, crisps, cookies, cakes and toffees, children will eat those instead of fruits and vegetables. Also, when parents eat huge portions, children will do the same, so parents must also encourage children to eat smaller portions so that children can see it is an important component of a healthy meal. Other studies have found that educated parents placing restrictions on certain foods at home help their children not to consume too many forbidden foods outside the family environment. In this way the educated parents shape their children's eating behaviours.

A group working with Dr Amy Baughcum, a psychologist in the Paediatric Hospital and an Assistant Professor of clinical Paediatric at the Ohio State University College of Medicine, found that most of the low-income women in their study thought that an overweight (heavy) child was a healthier child and they fed the child accordingly.

Foods high in fats, sugars and salt such as confectionary, soft drinks, crisps and savoury snacks, fast food and pre-sugared breakfast cereals are part of the 'Big Five'. Families are also eating more pre-prepared/convenience foods, which are high in fats, salt and sugar, making a 'Big Six' of foods causing concerns to dieticians and health professionals. Some children do not know that fruit and vegetables are good for them and that they should avoid eating food that contains high levels of fat, sugars and salt (Story *et al.* 2002:49).

According to the MRC, South Africans are digging their graves with their teeth (MRC 2006:1).

All the above shocking information mentioned, should ring alarm bells in every community, but most South Africans are either unaware of the dangers associated with poor dietary habits, or are not interested in changing their food intake. If any of the above information concerning you or your family, you must start doing something positive such as making healthier food choices and avoiding unhealthy snacking patterns.

Primary school children in this study knew healthy snacks, but behaviour indicated a large consumption of unhealthy snack foods, because of the types of snack food items consumed the money available. There is NO supervision at tuck shops and children snack while watching TV and when they are bored.

6.7 Recommendations for further research

It is recommended that this snack food item be implemented in an intervention study for children nine to 13 years old in the Vaal Region to measure the impact of the snack food item on the nutritional status of these children over a long period.

Thereafter, decisions can be made about including this in a school feeding programme or teaching the parents to prepare this snack food item.

Furthermore, the possibility of marketing this product can also be explored. More research will be needed to determine the most suitable, affordable and acceptable packaging for this snack food item.

Future research is recommended to focus on a nutrition programme and to help children from a very early age to identify healthy foods and to help them make healthy choices.

Mothers and child caregivers should also be educated so that they can take the lead in the obesity prevention programme for a sustainable solution to the problem.

Tuck shops at schools should be targeted to provide healthier food choices for the benefit of children.

"Children are the major repository of South Africa's potential human capital for the future. The fact that children are the workers, scientists, parents, leaders and civil society participants of tomorrow means that their survival, health, nutrition and educational progress are key issues for reconstruction and development today." Nelson Mandela, May 1996

RESEARCH OUTPUTS

Abstract published as part of conference proceedings:

DU PLESSIS, R.M., KEARNEY, J.E., OLDEWAGE_THERON, W.H. 2008. Snack food consumption patterns of primary school children aged nine to thirteen years old in the Vaal Region. Nutrition Congress 28 September – 2 October 2008. Pretoria SA.

Particulars of congress participation:

1. 2nd Annual Research Seminar of the Faculty of Human Sciences. Developing young researchers – The drive for new knowledge. Vanderbijlpark SA. 6 June 2008.
Title: Snack food consumption patterns of primary school children aged nine to thirteen years old in the Vaal Region: a pilot study.

2. Nutrition Congress 2008. Pretoria SA. 28 September – 2 October 2008.
Title: Snack food consumption patterns of primary school children aged nine to thirteen years old in the Vaal Region.

BIBLIOGRAPHY

ALLISON, D.B., GADBURY, G., SCHWARTZ, L.G., MURUGESAN, R., KRAKER, J.L. & HESHKA, S. 2003. A novel soy-based meal replacement formula for weight loss among obese individuals: A randomised controlled clinical trial. *European Journal of Clinical Nutrition,* 57(4):514-522.

AMUNA, P., ZOTOR, F & TEWFIK, I. 2004. Human and economic development in Africa: A public health dimension employing the food multimix concept. *World Review of Science, Technology and Sustainable Development,* 1(2):129-137.

ASTRUP, A. 2004. Association for the study of obesity – BBC NEWS.

ASTRUP, A. 2005. Human nutrition 11th edition. Obesity 379-399.

ASTM. AMERICAN SOCIETY FOR TESTING AND MATERIALS. 1968. Manual on sensory testing methods. *American Society For Testing And Materials, Philadelphia,* Nr 434.

AXTELL, A. 2009. Quality control in food processing. Technical information online. [Online]. Available at: <http://practicalaction.org/docs/technical_information_service/quality%20control.pdf>. Accessed: 04/14/2009.

BARANOWSKI, T., MENDLEIN, J., RESNICOW, K., FRANK,E., WEBER-CULLEN, K. & BARANOWSKI, J. 2000. Physical activity and nutrition in children and youth: An overview of obesity prevention. *American Journal of Preventive Medicine,* 31:S1-S10.

BARTLETT, M. Daily News. Are we making our children fat. 9 October 2003. [Online]. Available at: <http://www.iol/co.za/general/newsview.php?click_id=1664&art_id=vn20031014111857975>. Accessed: 06/15/2006.

BENER, A. 2006. Prevalence of obesity, overweight and underweight in Qatari adolescents. *Food and Nutrition Bulletin,* 27(1):43, March.

BENNER, M., LINNEMANN, A.R., JONGEN, W.M.F. & FOLSTAR, P. 2003. Quality function deployment (QFD)-Can it be used to develop food products? *Food Quality and Preference,* 14(4):327-339.

BLENFORD, D.E. 1990. Satisfying a growing appetite for snacks. *Food Technology International Europe,* 145-149.

BOOBIER, WJ., BAKER, JS. & DAVIES, B. 2006. Development of a healthy biscuit: An alternative approach to biscuit manufacture. *BioMedNutritional Journal,* 5:7.

BOYSE, K.R.N. Obesity and overweight. 2007. University of Michigan. [Online]. Available at:<http://www.med.umich.edu/1libr/yourchild/obesity.htm>.

BREWER, S.B. 2006. Preparing a HACCP plan: 1-25.

BROWNELL, K.D. & HORGER, K.B. 2004. *Food fight: The inside story of the food industry, America's obesity crisis, and what we can do about it.* New York: Contemporary books.

BURDON, T.A. 1989. Rancidity in snack foods. *Rancidity in foods,* 2nd Edn. (eds. Allen, J.C. & Hamilton, R.J.), 161-169.

CAELERS, D. 2005. There is a solution for overweight children. Pretoria News, 26 April 2005:10.

CALLE, M.L., HOUGH, G., CURIA, A. & GOMEZ, G. 2006. Bayesian survival analysis applied to sensory shelf life of foods. *Foods Quality and Preference,* 17:307-312.

CARPENTER, R.P., LYON, D.H. & HASDELL, T.A. 2002. *Guidelines for sensory analysis in food product development and quality control*. Second Edition. Aspen: Aspen Publishers, Incorporated.

CELEBUSKI, C. & FARRIS, E. Nutrition education in public elementary school classrooms, K-5 STATICAL REPORT (nces200-40). Us Department of Education. [Online]. Available at:<http://www.nces.ed.gov.surveys.frss.publications/>. Accessed on: 12/03/2007.

CONTENTO, I.R., WILLIAMS, S.S., MICHELA, J.L. & FRANKLIN, A.B. 2006. Understanding the food choice process of adolescents in the context of family and friends. *Journal of Adolescent Health,* 38:575-582.

CURIALE, M.S. 1998. Limiting growth: Microbial shelf life testing. *Food Product Design:* 1-8 [Online] Available at: <http://www.fodproductdesign.com/archive/1998/0298qa.html>. Accessed: 31/03/06.

DALMENY, K., HANNA, E. & LOBSTEIN, T. 2004. Broadcasting bad health: Why food marketing to children needs to be controlled. *Journal of the Home Economics Institute of Australia,*11(1):11.

DECKELBAUM, R.J. & WILLIAMS, C.L. 2001. Childhood obesity: The health issue. *Obesity Reviews,* 2001, 9:239S-243S.

DENOON, D.J. 2006. Ten causes of obesity other than over eating, inactivity. [Online]. Available at:<http://www.foxnews.com/story/0,2933,201397,00.html>. Accessed: 11/12/2007.

DIETZ, W.H. 1998. Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics Journal,* 101:518-525.

DE ONIS, M., ONYANGO, A.W., BORGHI, E., SIYAM,A., NISHIDA, C. & SIEKMANN, J. Development of a WHO growth reference for school-aged children and adolescents, 85(9):660-667.

DoH. DEPARTMENT of HEALTH. SOUTH AFRICA. 2008. The integrated nutrition programme.

EBBERLING, C.B., SINCLAIR, K.B. & PEREIRA, M.A. 2006. Compensation for energy intake from fast food among overweight and lean adolescents. *Journal of the American Medical Association,* 291:2828-2833. [Online]. Available at: <http://www.diabetes.org/diabetes_research/summareis/ebberling-fastfoodjsp>. Accessed: 05/24/2006.

FDC. FOOD DEVELOPMENT CENTRE. 2006. Shelf life studies. Optimising consumer safety and sanitation. [Online]. Available at: <http://www.gov.mb.ca/agriculture/fdc/services/fdc04s05.html>. Accessed: 25/04/05.

FIRST SOUTH AFRICAN NATIONAL YOUTH RISK BEHAVIOUR SURVEY 2003. [Online]. Available at: http://www.info.gov.za/otherdocs/2003/youth/part3.pdf. Accessed: 20/05/08.

FMI. FOOD MARKETING INSTITUTE. 2004. RESEARCH & PREVENTION-RODALE. Shopping for health 2004 – Making sense of nutrition news and health claims: Washington DC: Food Marketing Institute.

FOOD AND DRINK STATISTICS. 1998. A sector-by-sector guide to agriculture, fisheries, foods and drink statistics in the UK. European PA and Associates, Cambridge, England.

FOODBIZ. Quality and safety. [Online]. Available at: <http://www.safoodcentre.com>.

FORSLUND, H.B., TORGERSON, J.S. & SJOSTROM, L. 2005. Eating a lot of snacks linked to obesity. *International Journal of Obesity,* 29:711-719. [Online].Available at: <http://www.diabetes.org/diabetes-research/summaries/forslund-snack.jsp>. Accessed: 5/24/2006.

FRNFM. FOOD RESOURCE NUTRITION AND FOOD MANAGEMENT. 1998. [Online]. Available at:<http://food.oregonstate.edu/sensory/denahtml>. Accessed: 05/10/05.

FROM UNDER NUTRITION TO OVER NUTRITION IN SOTH AFRICA. 2006. S*outh African Journal of Clinical Health,* 19:1:50.

GOEDECKE, J.H., JENNINGS, C.L. & LAMBERT, E.V. 2006. Obesity in South Africa. *Chronic diseases of lifestyle in South Africa*: 1995-2005.

HAMPL, J.S. 1999. Intakes of Vitamin C, vegetables, and fruits: Which school children are at risk? *Journal of the American College of Nutrition* 81:582, 1999.

HEALTH 24.COM. Are South Africans gluttons? [Online]. Available at: <http://www.health24.com?dietnfood/Weight-cnetre/15-51-2954-2960,36121.asp>. Accessed: 06/14/2006.

HENDERSON, V.R. & KELLY, B. 2005. Food advertising in the age of obesity: Content analyses of food advertising on general market and African American television. *Journal of Nutrition Education and Behaviour,* 37:191-196.

HEN. HEALTH EVIDENCE NETWORK. 2006. Which are the known causes and consequences of obesity, and how can it be prevented? [Online]. Available at: <http://www.euro.who.int/HEN/Syntheses/short/20040908-1>. Accessed: 05/10/2006.

HOFFMAN, D.J., SAWAYA, A.L., VERRESCHI, I., TUCKER, K.L. & ROBERTS, S.B. 2000. Why are nutritionally stunted children at increased risk of obesity? Studies of metabolic rate and fat oxidation in Shantytown children from Sáo Paulo, Brazil. *American Journal of Clinical Nutrition,* 72(3):702-707, Sep. [Online]. Available at:<http://www.org/cgi/content/full/72/3/702. Accessed: 4/3/2006>.

HOFFMAN, D. 2007. Boost your wellness naturally. South African Herb Academy. [Online]. Available at: <http://www.masterherbremedies.com/herbalremedyhandbook/index.html>. Accessed: 7/26/2007.

HOOD, L.L., LUNDY, R.J. & JOHNSON, D.C. 1995. New product development: North America ingredients supplier's role. *British Food Journal,* 97(3):12-17.

HOUGH, G., LANGOHR, G., GO'MEZ, G., GORIA, S. 2003. *In:* CALLE, M.L. 2006. Bayesian survival analysis applied to sensory shelf life of foods. *Foods Quality and Preference,* 17:307-312.

HOUGH, G., GARITTA, L. & SA'NCHEZ, R. 2004. Determination of consumer acceptance limits to sensory defects using survival analysis. *Food Quality and Preference,* 15:729-734.

IRI. INFORMATION RESOURCES INC. [Online]. Available at: <http://www.inforces.com/public/uk/newsEvents/thoughtleadership/uk_new_081402.htm>.

JEBB, S.A., KOPELMAN, P. & BUTLAND, B. 2007. Tackling obesities: Future choices. *The International Association for the Study of Obesity.*

JOUBERT, J., NORMAN, R., BRADSHAW, D., GOEDECKE, J.H., STEYN, N.P. & PUOANE, T. 2007. Estimating the burden of disease attributable to excess body weight in South Africa in 2000. *South Africa Medical Journal* 2007; 97(8):683-690.

KEARNEY, J.E. 2006. Development of a novel breakfast food product for primary school children in an informal settlement. DTech. Theses. Vaal University of Technology. Vanderbijlpark.

KERR, I. 2006. Obesity: Complication in kids. Health 24.com [Online]. Available at:<http://www.health24.com/dietnfood/Eating_throughout_life/15-50-660,33092.asp>. Accessed: 06/21/2006.

KILCAST, D. & SUBRAMANIAM, P. 2000. Leatherhead food research association. *The stability and shelf life of food.* Cambridge England: Woodhead Publishing limited.

KINSELLA, K. 1997. Aging trends: South Africa. International Programs Centre, U.S. Bureau of Census. Issued August 1997.

KIRSCHENBAUM, D.S. 2007. Effect of obesity or being overweight on self-esteem.

KLOKA .1999. The role that snacking plays in a child's diet. *Health and Hygiene,* 13(4):4, April.

KOIVISTO, H. 1999. Factors influencing children's food choice. *Annals of Medicine Journal,* 31(1):26-32, April.

KRUGER, H.S., PUOANE, T., SENEKAL, M. & VAN DER MERWE, M.T. 2005. Obesity in South Africa: Challenges for government and health professionals. *Public Health Nutrition,* 8(5):491-500, May.

KRUGER, S. 2002. The role that snacking plays in a child's diet. *Health and hygiene,* 13(4):4, April.

LABADARIOS, D., STEYN, N.P., MAUNDER, E., MACINTYRE, U., GERICKE, G., SWART, R., HUSKISSON, J., DANNHAUSER, A. VORSTER, H.H., NESMVUNI, A.E. & NEL, J.H. 2005a. The National Food Consumption Survey (NFCS): South Africa 1999. *Public Health Nutrition,* 8(5):587-596.

LABADARIOS, D., STEYN, N.P., MAUNDER, E., MACINTYRE, U., GERICKE, G., SWART, R., HUSKISSON, J., DANNHAUSER, A. VORSTER, H.H. & NESMVUNI, A.E. 2001. The National Food Consumption Survey (NFCS) – Children aged 1-9 years, South Africa, 1999. 2001. *The South African Journal for Clinical Nutrition,* 14(2):62, May.

LABADARIOS, D. & STEYN, N.P. 2001. South African Food-Based Dietary Guidelines. *The South African Journal of Clinical Nutrition,* 14(2):42-43.

LABADARIOS, D., SWART, R., MAUNDER, E.M.W., KRUGER, H.S., GERICKE, G.J., KUZWAYO, P.M.N., NTSIE, P.R., STEYN, N.P., SCHLOSS, I., DHANSAY, M.A., JOOSTE, P.L. & DANNHAUSER, A. 2007. The National Food Consumption Survey-Fortification Baseline (NFCS-FB-I): South Africa, 2005. Directorate: Nutrition, Department of Health, Pretoria. 2007.

LANGNASE, K., ASBECK, I., MAST, M & MULLER, M.J. 2004. Influence of socioeconomic status on long-term effect of family-based obesity treatment intervention in prepubertal overweight children. Health Education 104:336-343.

LATREILLE, J., MAUGER, E., AMBROISINE, L., TENENHAUS, M., VINCENT, M., NAVARRO, S. & GUINOT, C. 2005. Measurements and the reliability of sensory panel performance. *Food Quality and Preference,* 17:369-375.

LAUREN, D., JACQUES, H. & MOORJANI, S. 1991. Effects of a soy-protein beverage on plasma proteins in children with familial hypercholesterolemia. *American Journal of Clinical Nutrition,* 54:98-103.

LAW, M., MORRIS, J. 1998. By how much does fruit and vegetable consumption reduce the risk of ischaemic heart disease? *European Journal of Clinical Nutrition,* 52:549-556.

LICHTAROWICZ, A. BBC NEWS. 2004.

LIST, D., THORPE, L.E. & MAY, L. 2003. Obesity begins early. New York City vital signs. 2:1-2.

LINO, M., GERRIOR, S.A., BASIOTOS, P.P. & ANAND, R.S. REPORT CARD ON THE DIET QUALITY OF CHILDREN. 1998. Nutrition insights, October, 1998:9. available at:<http://www.usda.gov/cnpp>.

LOB-CORZILIUS, T. 2007. Overweight and obesity in childhood – A special challenge for public health. *International Journal of Hygienic and Environmental Health,* 210:585-589.

LOBSTEIN, T., BAUER, L. & UANY, R. 2004. Obesity in children and young people: A crisis in public health. Report to the WHO by the International Obesity Task Force. *Obesity Reviews,* 5(1):5-104.

LOVE, P., MAUNDER, E., GREEN, M., ROSS, F., SMALE-LOVELY, J. & CHARLTON, K. 2001. South African Food-Based Dietary Guidelines: Testing of the preliminary guidelines among women in KwaZulu-Natal and the Western Cape. *The South African Journal of Clinical Nutrition,* 14(1):9-19, February.

LOWELL, J. 2004. The food industry and its impact upon increasing global obesity. *British Food Journal,*106(3):238-248).

MADDAH, M., RASHIDI, A., MOHAMMADPOUR, B., VAFA, R. & KARANDISH, M. 2009. In-school snacking, breakfast consumption, and sleeping patterns of normal and overweight Iranian high school girls: A study in urban and rural areas in Guilan, Iran. *Journal of Nutrition Education and Behaviour,* 41(1):27-31.

MALHOTRA, R., HOYO, C., OSTBYE, T., HUGHES, G., SCHWARTZ, D., TSOLEKILE, L., ZULU, J. & PUOANE, T. 2008. Determinants of obesity in urban townships of South Africa. *The South African Journal of Clinical Nutrition,* 21(4):315-320.

MAN, C.M.D. 2000. Potato chips and savoury snacks. In: Man, CMD & Jones A (eds). *Shelf Life Evaluation Of Foods*. 2nd ed. Gaitersberg, Maryland: Aspen Publishers Inc.

MARX, S., VAN ROOYEN, D.C. & BOSCH, J.K. 2001. *Business Management*.2nd Ed. J L van Schaik.

MATIWANE, N.B. 2008. Development of a food multimix to address malnutrition amongst an elderly in Sharpeville. MTech. Dissertation. Vaal University of Techynology. Vanderbijlpark.

MATSHEGO. 2001. The role that snacking plays in a child's diet. *Health and Hygiene,* 13(4):4, April.

McILRATH,L. & SLABBERT, T. 2003. Sedibeng economic regeneration summit. Unpublished, pp. 1-24.

McSWANE, D. & RUE, N. LINTON, R. 2003. *Essentials of good safety and sanitation.* 3rd Ed. New Jersey: Prentice Hall.

MEILGAARD, D., CIVILLE, G.V. & CARR, B.T. 1991*: Sensory evaluation techniques.* Boca Raton CRC Press.

MRC. MEDICAL RESEARCH COUNCIL. 2006. Dietary changes & the health transition in South Africa; VORSTER. H.H. 2001. Development of Food Based Dietary Guidelines for South Africa. *The South African Journal of Clinical Nutrition,* 14(3):S3-S6).

MESSINA, M.J. Soy foods and soybean isoflavones and menopausal health. 2002. *Nutritional Clinical Care,* 5:272-282.

MOKDAD, A., MARKS, E., STROUP, E. & GERBERDING, J. 2004. Actual causes of death in the United States, 2000, *Journal of the American Medical Association,* 291(2004):1238-1245.

MOLARIUS, A., SEIDELL, J.C., SANS, S., TUOMILEHTO, J. & KUULASMAA, K. 2000. Educational Level. Relative body weight, and changes in their association over 10 years: An International perspective from the Word Health Organisation (WHO), MONICA Project. *American Journal of Public Health,* 90:1260-1268.

MUNRO, L. 2005. BC MEDICAL ASSOCIATION, March 22, 2005.

NGWENYA .2001. The role that snacking plays in a child's diet. *Health and Hygiene,* 13(4), April.

NICKLAS, T. & JOHNSON, R. 2004. Position of the American Dietetic Association: Dietary guidance for healthy children ages 2 to 11 Years. *Journal of the American Dietetic Association,* 104:660-677.

NCHS. NATIONAL CENTRE FOR HEALTH STATISTICS. 2003. *Health, United States*. US Department of Health and Human Services, Centres for Disease Control and Prevention, National Centre of Health Statistics, Washington DC (2003). [Online]. Available at: <http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VHT-4F472DI-4&-user=137861…>. Accessed: 08/13/2007.

NICUS. NUTRITION CENTRE UNIVERSITY OF STELLENBOSCH. 2003. The dietary reference intakes. The Nutrition Information at the University of Stellenbosch.

NIKNAKS. SIMBA BRAND. [Online]. Available at: <http://www.simba.co.za/new/?ref=4&refCorp=0>. Accessed: 01/25/2006.

NORRIS, S. 2004. Obesity. SANEP LIVE ON 3. Talk with Noleen Maholwane Sangqu. [Online]. Available at: <http://sanep.experthealth.co.za/live/pagebuilder/componenets/ensight/content_toolbox_print.p…>. Accessed: 6/14/2006.

OAKLEY .2000. The role that snacking plays in a child's diet. *Health and Hygiene,* 13(4), April.

OBESITY WORLDWIDE. 2002. *FoodReview,* 25(3):38-43. [Online]. Available at:<http://www.worldheartday.com/articulos/ObesityWorldwide>. Accessed: 6/14/2006.

OLDEWAGE-THERON, W.H. & AMUNA, P. 2002. Dietary diversification for the improvement of household food security and health in an informal settlement (part of Vaal Triangle Integrated Nutrition Research Project) proposal. Vaal University of Technology. Vanderbijlpark.

O'MAHONY, M. 1986. S*ensory Evaluation of Food.* New York: Marcel Dekker, Inc.

OOSTHUIZEN, D. 2006. A food multimix to address malnutrition amongst primary school children living in Eatonside. MTech. Dissertation. Vaal University of Technology. Vanderbijlpark.

PARIZKOVA, J., HILL, A. 2001. Childhood obesity: Prevention and treatment, CRC Press LLC, Boca Raton Florida.

PIANA, M.L., ODDO, L.P., BENTABOL, A., BRUNEAU, E., BOGDANOV, S. & GUYOT DECLERCK, C. 2004. Sensory analysis applied to honey; state of the art. *Apidologie* 35:S26-S37.

POPKIN, B.M. 2005. Using research on the obesity pandemic as a guide to a unified vision of nutrition. *Public Health Nutrition,* 8(6A):724-725, September.

POWELL, L.M., AULD, M.C., CHALOUPKA, F.J., O'MALLEY, P.P. & JOHNSTON, L.D. 2007. Associations between access to food stores and adolescent Body Mass Index. *American Journal of Preventative Medicine,* 33(S4):S301-S307).

PROVITA. The history. 2007. [Online]. Available at: <http://www.provita.co.za/history.aspx>. Accessed: 10/06/2008.

RAYNOR, H.A., JELALIAN, E., VIVIER, P.M., HART, C.N. & WING, R.R. 2009. Parent-reported eating and leisure-time activity selection patterns related to energy balance in preschool- and school-aged children. *Journal of Nutrition Education and Behaviour,* 41(1):19-26.

REED, D.B. & SCHUSTER, E. 2002. Recipe check list: A tool aid development of recipes for audience with limited resources. *Journal of Extension,* 40(6): 1-12.

ROBINSON, T.N. 2001. Obesity in childhood and adolescence. Nestle nutrition workshops series paediatric program, Volume 49. Obesity prevention.

RUXTON. 1996. The role that snacking plays in a child's diet. *Health and Hygiene Journal,* 13(4):4, April.

SAVAGE K. F. & BURGESS, A. 2000. Nutrition for developing countries.

SAVACG. SOUTH AFRICAN VITAMIN A CONSULTATIVE GROUP. 1995. Children aged 6 to 71 months in South Africa. 1994: Their anthropometric, vitamin A, iron and immunization coverage status. Isando:SAVACG.

SENEKAL, M., STEYN, N.P. & NEL, J.H. 2003. Factors associated with overweight/obesity in economically active South African population. *Ethnical Disorders,* 13(1):109-116.

SEWALD, M. & DEVRIES, J. 2003. Shelf life testing. *Biological Sciences and Medical Science,* 56(2):47-53.

SHABALALA-MSIMANG. 2004. Speech of the Minister of Health on World Diabetes Day in Makapanstad, North West. [Online]. Available at: <http://www.doh.gov.za/docs/sp/2004/sp1114html>. Accessed: 05/23/2006.

SHEPHERD, R. 2005. Influences on food choice and dietary behaviour. *Annals of Medicine Journal,* (57):36-43.

SIEGENBERG, D., BAYNES, R.D., BOTHWELL, T.H., MACFARLANE, B.J., LAMPARELLI, R.D., CAR, N.G., MACPHAIL, P., SCHMIDT, U., TAL, A. & MAYET, F. 1991. Ascorbic acid prevents the dose-dependent inhibitory effects of polyphenols and phytates on nonheme-iron absorption. *American Journal of Clinical Nutrition,* 53:537-541.

SIMBA (PROPIERTARY) LIMITED. Pepsico.

SINGH, R.P. 2000. Scientific principles of shelf life evaluation. *In*: Man, CMD & Jones A (eds). Shelf Life Evaluation Of Foods. 2nd ed. Gaitersberg, Maryland: Aspen Publishers Inc.

SASSO. SOUTH AFRICAN SOCIETY FOR THE STUDY OF OBESITY. 2004. [Online]. Available at:http://www.iaso.org/content/safrica.ht. Accessed: 05/15/2006.

SOUTH AFRICAN JOURNAL OF CLINICAL HEALTH (SAJCN). 2006. Vol 19, No.1. STILL LOOKING FOR REF

SMITH, J.P., DAIFAS, D.P., EL-KHOURY, W., KOUKOUTIS, J. & EL-KHOURY, A. 2004. Shelf life safety concerns of bakery products – A review. *Critical Review Foods Science Nutrition,* 44:19-55.

SPECIAL ASSIGNMENT. SABC 3. 2005. Heavy weight. [Online]. Available at:<http://www.sabcnews.com/specialassignment/20050802.html>. Accessed: 05/12/2006.

STATISTICS SOUTH AFRICA. 2007. Mid-year population estimates. 3 July 2007.

STEELE, R. 2004. Understand and measuring the shelf life of food. Cambridge: Woodhead Publishing LTD.

STEWART-KNOX, B. & MITCHELL, P. 2003. What separates the winners from the losers in the food product development? *Trends in Food Science & Technology,* 14(1-2): 58-64. [Online] Available at:<http://www.sciencedirect.com/science?-ob=ArticleURL&-udi=B6VHY-47RB37X-5&-COVERdATE=02%2F2>. Accessed: 20/03/06.

STEYN, N.P., ABERCROMBIE, R. & LABADARIOS, D. 2001. Food Security – An update for health professionals. *The South African Journal of Clinical Nutrition,* 40(3):98-102, September.

STEYN, N.P., BRADSHAW, D., NORMAN, R., JOUBERT, J., SCHNEIDER, M. & STEYN, K. 2006. Dietary changes and the health transition in South Africa: Implications for health policy, Cape Town: South African Medical Research Council (MRC).

STONE, H. 2006. Sensory evaluation and mythology. [Online]. Available at:<http://www.tragon.com/artivles/sens-eval.htm>. Accessed: 16/11/07.

STORY, M., NEUMARK-SZTAINER, D. & FRENCH, S. 2002. Individual and environmental influences on adolescent eating behaviours. *Journal of the American Dietetic Association,* 102(3), S40-S51.

THE SURVEY SYSTEM. [Online]. Available at: <http://www.surveysystem.com/sample-size-formula.htm>. Accessed: 4/17/2008.

THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES' NATIONAL DIABETES EDUCATION PROGRAM (NDEP). Eat healthy foods. 2005. NIH Publication No. 03-5295.

TWENEFOR, C. 2008. A food multimix for pregnant women in the Vaal Region. MTech. Dissertation. Vaal University of Technology. Vanderbijlpark.

UNICEF. 2007. Progress for children: A world fit for children statistical review, stunting, wasting and overweight. [Online]. Available at: <http://www.unicef.org/progressforchildren/2007n6/index_41505.htm?q=printme>. Accessed: 2/4/2009.

VAN DER LINDEN, N. 2004. Super size South Africa. [Online]. Available at: <http://lifestyle.iafrica.com/longlife/features/343924.htm>. Accessed: 05/12/2006.

WALTERS, P. 2004. Snacks under attack. [Online]. Available at: <http://www.election.cbsnews.com/stories/2004/03/23/health/main608182.shtml>. Accessed: 4/3/2006.

WANSINK, B. 2007. Helping consumers eat less. *Food Technology,* 34.

WHITAKER, R.C., WRIGHT, J.A., PEPE, M.S., SEIDAL, K.D. & DIETZ, W.H. 1997. Predicting obesity in young adulthood from childhood and parental obesity. *The Nutritional England Journal of Medicine,* 337:869-873.

WHITNEY, E.N. & ROLFES, S.R. 2005. *Understanding nutrition.* 10th Ed. USA: Thomson Wadsworth.

WHO. WORLD HEALTH ORGANISATION. 2002. Keep fit for life: Meeting the nutritional needs of older persons. Geneva.

WHO. WORLD HEALTH ORGANISATION. 2006. REF NOG HIER INSIT

WHO/NUT. WORLD HEALTH ORGANISATION. 1998. Complementary feeding of young children in developing countries. Geneva: WHO.

WILSON, B.J. 2007. Designing media messages about health and nutrition: What strategies are most effective? *Journal of Nutrition Education and Behaviour,* 39(25):S13-S19, March/April.

WISHH. Undated composition of soy. [Online]. Available at: <http://www.wishh.org/aboutsoy/composition.html>. Accessed: 04/12/208.

WOLMARANS, P. & OOSTHUIZEN, W. 2001. Eat fat sparingly – Implications for health and disease. *The South African Journal of Clinical Nutrition,* 14(3):S48-S54, September.

WOLMARANS, P. & DANSTER, N.A. 2008. Characteristics of the South African Food Composition Database, an essential tool for the nutrition fraternity in the country: Part I. *The South African Journal of Clinical Nutrition,* 21(4):308-313, December.

YOUNG, V.R. 1991. Soy protein in relation to human protein and amino acid nutrition. *Journal of the American Dietetic Association,* 91:828-835.

ZHANG, Q., WANG, Y. 2004. Trends in the association between obesity and socio-economic status in US adults: 1971 to 2000. *Obesity Research,* 12:1622-1632.

ANNEXURE A

Questionnaires tested for reliability

ANNEXURE B

Questionnaires

ANNEXURE C

Hedonic scale for developed snack food item

ANNEXURE D

Hedonic scale for commercial snack food item

ANNEXURE E

ARC results

ANNEXURE F

Nutritional analyses results – FoodFinder®

ANNEXURE G

Invoice from statistical consultation

ANNEXURE H

Certificate for language editing