

**A STUDY OF THE QUALITY AND FEASIBILITY OF *SIBUSISO*,
A READY-TO-USE FOOD**

BY

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ABSTRACT

Introduction: A ready-to-use food (RUF), *Sibusiso*, has the potential to alleviate protein-energy malnutrition. However, its nutritional composition, physical properties, consumer acceptability, and economic feasibility for use are unknown.

Objectives: This study aimed to determine the nutritional composition and physical properties of a RUF, *Sibusiso*. As well as to assess the consumer acceptability of *Sibusiso* to healthy and HIV infected children on antiretroviral (ARV) medication, and the caregiver's attitudes towards *Sibusiso*. The feasibility of using *Sibusiso* for nutrition rehabilitation was also determined.

Methodology: Four samples of *Sibusiso* and a peanut butter (control) were analysed for their nutritional composition and physical properties. The consumer acceptability of *Sibusiso* to healthy children and HIV infected children on ARVs (ART group) was determined using a five-point facial hedonic rating scale. Focus group discussions were conducted to assess the attitudes and perceptions of caregivers surrounding *Sibusiso*. These caregivers had children who were either malnourished or at risk of malnutrition. The financial feasibility of using *Sibusiso* for nutrition rehabilitation was determined using published data.

Results: The results revealed that *Sibusiso* was a good source of energy (2624 kJ/100 g) and quality protein (15.7 g/100 g). The nutritional composition of *Sibusiso* met the WHO/WFP/SCN/UNICEF recommendations for RUF. Instrumental colour analysis indicated that both *Sibusiso* and the peanut butter had a brown colour, although *Sibusiso* was slightly lighter. *Sibusiso* had the same spreadability or hardness as the peanut butter, but it was stickier than the peanut butter. Based on the sensory evaluation, *Sibusiso* was found acceptable to both healthy (n=121) and HIV infected children (n=51). Over 65% of the children in both the healthy and ART group liked the taste, smell and mouthfeel of *Sibusiso*. The caregivers also found *Sibusiso* acceptable and were willing to buy it, but at half its current price (60 ZAR/ 500 g). The price of *Sibusiso* and perception of the caregivers that *Sibusiso* was a peanut butter were the main factors that affected their willingness to buy the product. Financial feasibility analysis showed that the estimated cost (5.99 ZAR/day) of rehabilitating a child using *Sibusiso* was higher than the KwaZulu-Natal Department of Health nutrition budget of 0.02 ZAR/day.

Conclusion: *Sibusiso* is a good source of energy and quality protein, and it is fairly acceptable to children with HIV and caregivers. This indicates that *Sibusiso* has a potential to alleviate protein-energy malnutrition in the targeted groups. Yet, *Sibusiso* is expensive. There would be a need to somehow reduce the cost of *Sibusiso* so that it would be financially feasible to use it in nutrition intervention programmes.

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CHAPTER 1: INTRODUCTION, THE PROBLEM AND ITS SETTING

1.1 Background to the importance of the study

During emergency situations that include social unrest, war, natural (tsunamis and earthquakes) and non-natural (radio-active outbreaks and explosions) disasters, there is a shortage of basic services such as water, sanitation, electricity, shelter, food and health care. This has led to the development of ready-to-use foods (RUF) as one of the tools for treating malnutrition specifically in emergency situations (Jarrett 2008). Yet, in the developing world where there is a high prevalence of malnutrition, the lack of basic services, infrastructure and resources in non-emergency situations requires almost similar interventions (De Pee & Bloem 2008). Furthermore the developing world, in particular Sub-Saharan Africa, is experiencing devastation through the Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) pandemic that is directly affecting more than 67% of the population (Joint United Nations Program on HIV/AIDS [UNAIDS] 2011). In this context, malnutrition becomes very important to treat, but due to its social and political complexities also very difficult to treat.

South Africa is characterized by the dual existence of both over and under nutrition. The National Food Consumption Survey-Fortification Baseline (NFCS-FB) (2005) indicated that 18% of children between the ages of 1 and 9 were stunted (Labadarios, Swart, Maunder, Kruger, Gericke, Kuzwayo, Ntsie, Steyn, Schloss, Dhansay, Jooste, Dannhauser, Nel, Molefe & Kotze 2008), while 13% of adolescents were stunted (De Villiers, Steyn, Coopoo, Kruger, Norris, Puoane, Draper, Forbes, Kolbe-Alexander, Lambert, Lambert, Micklesfield, Mungalsingh, Seedat, Siljeur, McQuaide-Little, Borresen, Josephs & Johnson 2010). Furthermore children below the age of 9 had a high prevalence of underweight at 9.3% (Labadarios *et al* 2008), while adolescents had a high prevalence of overweight/obesity at 20% (De Villiers *et al* 2010). These findings are in line with general trends that indicate that the prevalence of underweight decreases with age while that of overweight increases with age, particularly in females (Kimani-Murage, Kahn, Pettifor, Tollman, Dungen, Gómez-Olivé & Norris 2010). Furthermore common nutritional deficiencies observed in South African children are not limited to protein and energy deficiency but also micronutrient deficiencies: vitamin A, iron and zinc deficiency. In 2005 the NFCS-FB indicated that 2 out of 3 children were vitamin A deficient, 1 in 7 had poor iron status, and 45.3% were zinc deficient. Similar deficiencies are expected for adolescents as the available data indicated that only 58% of adolescents reported

eating vegetables and fruit and the average intake was 1-2 servings per day (De Villiers *et al* 2010).

The high prevalence of undernutrition in South Africa indicates that children consume a diet that is insufficient in both nutrient quality and quantity. This is ascribed mainly to poverty and the HIV/AIDS pandemic. In 2009, approximately 61% of South African children lived below the poverty line (with a per capita income less than R550 per month) and 16% lived in households that reported hunger (Roman & Hall 2011). Similar findings were reported by the NFCS-FB (2005) which showed that 51% of South African households were food insecure and a further 28% of the households were at risk of food insecurity. Poverty is a multidimensional phenomenon and not merely a lack of food or income, but encompasses the security of basic needs such as shelter, health and education. In 2009, less than 75% of South African children lived in formal housing (Hall 2011a), less than 65% had access to clean safe water and adequate sanitation (Hall 2011b), and 30% of children had to walk long distances to the nearest health facilities (Roman & Hall 2011). Poverty retards human development and contributes to the development of intergenerational malnutrition. Furthermore, the persistence and severity of poverty is aggravated by the HIV pandemic which in turn increases the risk of poverty (Theodore 2009; National Department of Health [NDOH] 2008). Poverty and HIV/AIDS have a complex bidirectional relationship that has been proven over the years (Theodore 2009). HIV results in malnutrition, raised morbidity, increased health care costs, loss of skills, in some cases death of breadwinners and adaptation of harmful coping strategies such as children dropping out of school, contributing to the development of poverty (Theodore 2009). Due to poverty, individuals with HIV have limited resources to prevent and treat the disease, and adopt risky behaviours such as sex work in order to generate income.

In 2009, 438 000 South African children under the age of 14 were infected with HIV, making South Africa a country with the highest number of children living with HIV in the world (Roman & Hall 2011). In 2008 it was observed that the HIV prevalence was the highest amongst children under the age of 4 (3.3 %), had decreased with age reaching 1.1% in children between 12 and 14 years then after and suddenly peaked (4.5%) in children between 15 and 18 years (Shisana, Simbayi, Rehle, Zungu, Zuma, Ngogo, Jooste, Pillay-Van Wyk, Parker, Pezi, Davids, Nwanyanwu, Dinh & SABSSM III Implementation Team 2010). The decline in the HIV prevalence in children between 12 to 14 years was speculated to be related to HIV/AIDS related mortality, as mortality data indicates that most infected children

die before the age of 5. In 2009 the deaths of the children under the age of 5 contributed to 81% of the under-18 mortality rate, and HIV/AIDS and malnutrition were identified as underlying factors to 50% and 60% of these deaths, respectively (Hall, Nannan & King 2010; McKerrow & Mulaudzi 2010). HIV in children under the age of 5 is transmitted from the mother during pregnancy, delivery and breast feeding and in the teenagers was a result of sexual intercourse (Shisana *et al* 2010). The HIV/AIDS pandemic and poverty cycle impedes success in alleviating malnutrition and contributes to deteriorating health conditions of children.

The use of RUF in non-emergency situations and in the context of HIV/AIDS and poverty has been found highly effective in alleviating malnutrition (Singh, Kang, Ramachandran, Sarkar, Peter & Bose 2010; Lagrone, Cole, Schondelmeyer, Maleta & Manary 2010; Matilsky, Maleta, Castleman & Manary 2009; Ndekha, Manary, Ashorn & Briend 2005). The high and consistent success of RUFs in alleviating malnutrition has been ascribed to a number of factors, including the high nutrient density of the product allowing treatment of Protein Energy Malnutrition (PEM) and some micronutrient deficiencies; simplicity in delivering RUF based nutrition rehabilitation programs; fast recovery; stability of the products at various temperatures and conditions; wide cultural acceptability; and adjustability to meet local nutritional needs and taste preferences (Kapil 2009; Collins, Dent, Binns, Bahwere, Sadler & Hallam 2006).

1.2 Statement of the problem anecdotal

A ready-to-use food (RUF), *Sibusiso* with the potential to alleviate malnutrition has been developed and use widely with success. Yet, very little scientific evidence is available to substantiate its use. In addition, its properties, consumer acceptability, and feasibility for use have not been previously investigated.

1.3 Objectives

- 1.3.1 To determine the nutritional composition and physical properties of a RUF, *Sibusiso*.
- 1.3.2 To determine the effect that health status, age and gender have on the acceptability of the RUF, *Sibusiso*.
- 1.3.3 To determine the attitudes and perceptions of the caregivers towards the RUF, *Sibusiso*.
- 1.3.4 To determine the financial feasibility of the RUF, *Sibusiso* compared to others.

1.4 Type of study

A cross sectional survey was carried out to determine the nutritional composition, properties and the consumer acceptability of the RUF, *Sibusiso*. The feasibility of using *Sibusiso* for malnutrition rehabilitation in children was also determined. The nutritional composition and physical properties of *Sibusiso* were analyzed using standardized laboratory procedures. In addition, the consumer acceptability of *Sibusiso* in children between the ages of 4 to 17 years was also determined in healthy and HIV infected children who were taking anti-retroviral (ARV) medications. All the children evaluated the taste, colour, smell, mouthfeel and overall liking of *Sibusiso* using a five-point facial hedonic rating scale. The attitudes and perceptions of the caregivers towards *Sibusiso* were determined using focus group discussions and a semi-structured questionnaire as a guide. The caregivers were selected on the basis of having a child at risk of or already experiencing malnutrition. Finally, the feasibility of using the product in South Africa was determined using published secondary data.

1.5 Study constraints

The major study constraint was cost. Due to their expensive nature, the micro-nutrient analysis in particular vitamin A, iron and zinc were not measured. Having access to this information could have been valuable, as these micronutrients represent the most common nutrient deficiencies in South African children.

1.6 Study parameters

Analysis of the nutritional composition of *Sibusiso* was limited to energy, fat, protein, percent moisture, amino acid and ash analyses, and the carbohydrate content was calculated. The physical properties measured were instrumental colour and texture. The texture was measured in terms of the spreadability properties of *Sibusiso*. The study participants included consenting individuals who did not have a nut allergy, and were from Pietermaritzburg (PMB) and surrounding areas. The children used in this study were of preschool to high school age groups, and of different gender and racial backgrounds.

1.7 Assumptions

For the purpose of this study the following was assumed to be valid:

- The RUF samples were safe for consumption and of the same quality;
- The instruments used for analysis of the nutritional composition and physical properties were accurate and properly standardized;
- The participants understood the questions and were honest with their replies; and

- Peanut butter consumers did not have a nut allergy.

1.8 Definition of terms

Age: The number of years lived since birth.

Consumer food acceptability: The degree of liking or disliking a food (Lawless & Heyman 1999: p628). In this study acceptability was defined as the degree of liking or disliking the RUF, *Sibusiso*. This was measured through the use of the 5-point facial hedonic rating scale with Peryam and Kroll (P & K) writing ranging from “super good” to “super bad”.

Feasibility study: For the purpose of the study, it was limited to financial analysis, the amount of money required to rehabilitate a malnourished child compared to the current amount of money spent on child health.

Healthy Person: A person, who had not been ill in the past seven days, was not on medication and did not suffer from any chronic disease such as diabetes, asthma and HIV/AIDS.

Nutritional composition: The amount and type of nutrients such as proteins, fats, carbohydrates, water, vitamins and minerals found in food products (FAO 2011).

Ready-to-use food: An energy dense, vitamin and mineral enriched oil based paste that is resistant towards bacterial growth and does not need any preparation or cold storage (Manary 2005).

Texture: The ease of spreading *Sibusiso* as determined by the spreadability parameters: hardness, stickiness, work of shear and work of adhesion. Hardness referred to the maximum peak force required to deform food, while the work of shear was the total amount of force required for the shearing process (Basu & Shivhare 2010). Stickiness was defined as the maximum force required to overcome the attractive forces between the surface of the food and the surface of the probe in contact with the food. Work of adhesion was the total amount of force required to separate the probe from the sample (Basu & Shivhare 2010).

1.9 Abbreviations

AIDS	Acquired immunodeficiency virus
ANOVA	Analysis of variance
AOAC	Association of Official Analytical Chemists International
ART	Antiretroviral therapy
CBS	Cereal Based Supplement
CSB	Corn-Soya Blend
DOE	Department of Education
FAO	Food and Agriculture Organization
GOG	Gift of the Givers
HIV	Human immunodeficiency virus
INP	Integrated Nutrition Program
KZH-DOE	KwaZulu-Natal Department of Education
KZN-DOH	KwaZulu-Natal Department of Health
MIYCN	Maternal, Infant and Young Child Nutrition working group
NDF	Neutral Detergent Fibre
NDOH	National Department of Health
NFCS-FB	National Food Consumption Survey Fortification Baseline
NSP	Nutrition Supplementation Programme
PEM	Protein energy malnutrition
P&K	Peryam & Kroll scale
PMB	Pietermaritzburg
RDA	Recommended dietary allowance
RUCF	Ready-to-use complementary food
RUF	Ready-to-use food
SAGL	South African Grain Laboratory
SANAS	South African National Accreditation Services
SCN	The United Nations System Standing Committee on Nutrition
UKZN	University of KwaZulu-Natal

UNAIDS	Joint United Nations Program on HIV/AIDS
UNICEF	United Nations Children's Fund
USDA	United States Department of Agriculture
US\$	American dollars
WFP	World Food program
WHO	World Health Organization
ZAR	South African Rand

1.10 Summary

The NFCS-FB (2005) showed that the nutritional status of South African children has been deteriorating, despite the implementation of food fortification in 2003. The main cause of this decline in nutritional status is believed to be due to poverty and the HIV/AIDS pandemic. It is imperative that products such as *Sibusiso* are developed that can be used to alleviate the poor nutritional status of specific target groups. Scientific investigations are expensive and can take a very long time before results are available. Especially products such as *Sibusiso* stand the risk of not being used widely, mainly due to the lack of scientific evidence to support them, regardless of having significant anecdotal evidence at hand. This study was conducted to objectively and scientifically evaluate *Sibusiso* under controlled conditions. Therefore, the focus of this study was to determine the nutritional composition and physical characteristics of *Sibusiso*, as well as its consumer acceptability. The perceptions and attitudes of the caregivers toward *Sibusiso* and the financial feasibility of using *Sibusiso* for alleviating malnutrition were also determined.

1.11 Organization of dissertation

This dissertation contains six chapters. In this chapter (Chapter 1) the importance of the study, parameters and objectives of the study were given. In the next chapter (Chapter 2), a review of relevant literature is presented and it provides the current knowledge on the properties, acceptability and feasibility of RUFs. A review of the methodologies used to determine consumer acceptability was also provided. Chapter 3 was used to present the methodologies used in this study and their validation in research, while in Chapter 4 the results generated from this study are provided. In Chapter 5 a discussion of the results in association with the current knowledge (Chapter 2) is provided. Finally, in Chapter 6 the conclusions and recommendations based on the findings of this study are made.

1.12 Referencing style

The referencing style used in this dissertation is according to: The guidelines to academic writing, Dietetics and Human Nutrition, University of KwaZulu-Natal, Pietermaritzburg.

CHAPTER 2: REVIEW OF RELATED LITERATURE

This chapter provides a review of knowledge for establishing and understanding the research problem, as well as the methodologies that were used by previous researchers in solving similar research problems. The first section contains a brief background to the study and focuses on interventions used to address malnutrition, in particular food supplementation. This is followed by a review of the properties of RUFs and the factors that affect consumer food acceptability. The fourth section looks at the methods for analyzing consumer acceptability of foods products as well as an overview of consumer acceptability studies regarding RUFs. An outline of the cost of rehabilitating a child using RUFs and challenges that could affect the outcomes of rehabilitating a child using RUFs in South Africa follows on in the fifth section. Finally a section that concludes the review is provided.

2.1 Background to the study

Malnutrition refers to both the excessive energy intake (over nutrition), and the lack of macro and/or micro nutrients (under nutrition) (Faber & Wenhold 2007). In order to address malnutrition a balanced diet is essential however the primary cause needs to be addressed (Faber & Wenhold 2007). For example, malnutrition resulting from a disease requires both the management of the disease and dietary interventions. Interventions aimed at addressing malnutrition can be divided into direct nutrition interventions such as supplementation, fortification, biofortification, dietary diversification and nutrition education (Faber & Wenhold 2007), and indirect nutrition interventions such as immunisation, deworming and increased access to basic resources (KwaZulu- Natal Department of Health [KZN-DOH] 2010). In South Africa these interventions are part of a broader nutrition program, the Integrated Nutrition Program (INP), which is based on the United Nations Children's Fund (UNICEF) conceptual framework for the prevention of malnutrition and the triple A (Assess, analyse and Action) cycle (KZN-DOH 2010). As part of INP, supplementation programs are implemented in order to eliminate micronutrient deficiencies and promote weight gain in targeted populations (KZN-DOH 2010; NDOH 2008). The type of supplements and target populations for supplementation are provided in Table 2.1, and for the purpose of the study only food supplementation will be briefly reviewed.

Table 2.1 Supplements provided under the Integrated Nutrition Program
(KZN-DOH 2010; NDOH 2008)

Type of supplements	Target population
Iron-folate tables	All Pregnant women
Vitamin A capsules	Lactating women All children under 5 years
Multivitamin tables	All pregnant and lactating women Children with Severe malnutrition All Individuals with TB or HIV/AIDS
Food supplementation	At risk and malnourished: <ul style="list-style-type: none"> - Children - Pregnant and lactating women - TB,HIV/AIDS, elderly and chronically ill individuals

Food supplementation is a short term secondary intervention, implemented under the INP sub-program, the Nutrition Supplementation program (NSP) (Andresen, Wandel, Eide, Herselman & Iversen 2009; NDOH 2008). In addition to food supplements, NSP provides other food products such as breast milk substitutes and energy drinks (Iversen, Høisæther, Morseth and Herselman 2011). The commonly used food supplements are the fortified cereal based supplements (CBS) which can be made from maize meal, soya or rice depending on the local staple food, and in South Africa maize meal and soya based CBS are used. In general, food supplementation has been shown to be effective in alleviating malnutrition however it needs to be appropriately targeted (Allen & Gillespie 2001). For example, food supplementation can be used to increase the height of stunted children under the age of 36 months but not the height of preschool and school going children (Bhutta, Ahmed, Black, Cousens, Dewey, Giugliani, Haider, Kirkwood, Morris, Sachdev, Shekar & the Martnal and Child Undernutrition Study Group 2008). In preschool and school aged children food supplementation only contributes to increased weight (Bhutta *et al* 2008). The other benefits of food supplementation include increased maternal weight and birth weight, and reduced infant mortality (Allen & Gillespie 2001), and increased weight gain in underweight HIV infected people (Lategan, Steenkamp, Joubert & Le Roux 2010).

However newly developed foods for treating malnutrition, namely RUF, have been shown to result in better outcomes compared to using CBS. RUFs have been shown to result in reduced default rates (Lagrone *et al* 2010), better weight gain and recovery compared to CSB (Singh

et al 2010; Lagrone *et al* 2010). Other advantages of using RUF compared to CBS are that RUFs do not require any preparation or cold storage (Manary 2005). CSB are formulated to be prepared with the addition of a cold or hot liquid such as water or milk, and this largely influences the consistency, quantity and safety of the food consumed (De Pee & Bloem 2008). Also it has been shown that food supplements are likely to be shared within a household, decreasing the amount consumed by the malnourished child, hence their effectiveness (Novak 2006). This is further aggravated by the presence of high amounts of anti-nutrients which can interact with food, decreasing the availability of the nutrients (Michaelsen Hoppe, Roos, Kæstel, Stougaard, Lauritzen, Mølgaard, Girma & Friis 2008).

Previously CBS were mainly used to treat moderate malnutrition. Severe malnutrition with or without complications such as lack of appetite, ability to eat and oedema, was effectively treated using milk based therapeutic foods, F-75 and F-100 (WHO 1999). Similar to CBS, F-75 and F-100 need to be reconstituted and stored in a cold storage (Pruhdon, Prinzo, Briend, Daelmans & Mason 2006). This made it essential to have clean safe water, cold storage and a hygienic environment to prepare and store the formulas safely without any bacterial contamination (Pruhdon *et al* 2006). However RUFs are an anhydrous form of F-100 that can be used to treat both moderate and severe malnutrition without complications in the community (Linnenman, Matilsky, Ndekha, Manary, Maleta & Manary 2007). This has been shown to result in the early identification and treatment of malnutrition (Pruhdon *et al* 2006), and decreased hospital mortality rates and health care costs (Vaitla, Devereux & Swan 2009). The use of RUF for treating malnutrition in South Africa is a fairly new intervention that has not been studied thoroughly. It is for this reason that this study focused on RUF, and served as the first step towards implementing evidence based nutrition interventions.

2.2 Properties of ready-to-use foods

Ready-to-use foods (RUF) are energy dense foods manufactured to provide all the nutrients required by a person at almost 100% of the Required Dietary Allowance (RDA) (World Health Organization [WHO] & Unites States Food and Agricultural Organization [FAO] 2006). These are classified as ready-to-use therapeutic foods (RUTF) and read-to-use supplementary foods (RUSF), and are available in several forms of oil based pastes or biscuits (Manary 2005). The RUF investigated in this study was an oil based paste made mainly from peanuts.

2.2.1 Nutritional composition of ready-to-use foods

Nutritional composition refers to the amount and type of nutrients such as proteins, fats, carbohydrates, water, vitamins and minerals found in food products (FAO 2011). The information on the nutritional composition of food is used in food labelling, food regulation, nutrition education and most importantly in meal planning in order to ensure that human daily nutritional requirements are met (FAO 2011). RUFs are nutrient dense pastes made from ingredients that are high in energy and/or nutrients such as peanuts, milk powder or soya protein, vegetable oil, sugar and a premix of vitamins and minerals (Manary 2005). Peanuts, milk and soya beans are good sources of fats rich in unsaturated fatty acids, linoleic and oleic acids (Mazaheri-Tehrani, Yeganehzad, Razmkhah-Sharabiani & Amjadi 2009). However soya beans and milk contain a low fat content compared to peanuts. Moreover, peanuts, milk and soya nuts are good sources of protein high in the essential amino acids required for growth with the exception of lysine which is low in peanuts (Mazaheri-Tehrani *et al* 2009; Yeh, Ressurreccion, Phillips & Hung 2002).

In RUFs, milk and soya beans are used to fortify the protein content without reducing the amount of the other nutrients in the spreads (Yeh *et al* 2002). Mazaheri-Tehrani *et al* (2009) conducted a study to investigate the effect of substituting a peanut spread with soya nut and bean flour at 5%, 15%, 20% and 30% substitution level, as presented in Table 2.2. Irrespective of the level of substitution, it was found that the all peanut paste had the highest fat content, while the soy-peanut pastes had the highest protein content. An increase in the amount of soya flour that was substituted resulted in a decrease in the fat and energy content, while increasing the protein, carbohydrate and ash content. Furthermore the use of soya bean flour decreased the moisture content of the spreads while soya nut flour resulted in the opposite effect.

Table 2.2 Proximate composition of peanut pastes at different levels of soya flour substitution per 100g sample (adapted from Mazaheri-Tehrani *et al* 2009)

Sample	Energy (kJ)	Fat (g)	Protein (g)	Carbohydrates (g)	Ash (g)	Moisture (%)
All peanut paste	2545	46.3	25.4	23.6	3.3	1.5
Psw5	2503	45.0	26.1	23.2	3.7	2.0
Psw15	2444	42.5	27.2	24.1	4.1	2.2
Psw20	2415	41.3	27.8	24.4	4.3	2.2
Psw30	2358	38.8	29.0	25.4	4.5	2.4
Psn5	2505	44.8	25.9	24.0	3.8	1.5
Psn15	2441	41.8	26.9	25.8	4.5	1.5
Psn20	2414	40.3	27.4	27.0	4.3	1.1
Psn30	2357	37.4	28.4	29.0	4.4	1.0

Psw= soya bean paste

Psn= soya nut flour

The nutrient density of RUFs is further increased by the use of vegetable oil, sugar and a premix of vitamins and minerals. Vegetable oil and sugar mainly contribute towards increasing the energy density of pastes (De Pee & Bloem 2009). The type of vegetable oil used, for example palm or Canola oil, affects fatty acid composition, hence the quality and health benefits the product might have (Maternal, Infant and Young Child Nutrition [MIYCN] working group 2009; Sizer & Whitney 2008, p150). Furthermore, a vitamins and minerals premix is used to ensure that RUFs have a micronutrient profile similar to that of the therapeutic food, F100. The difference between RUTF, F100 and RUSF is the manner in which they are used and the target populations. The F100 and RUTF are used for therapeutic feeding in severely malnourished children, while RUSF are consumed in small quantities in combination with a diet to treat moderate malnutrition (Isanaka, Roederer, Djibo, Luquero, Nombela, Guerin & Grais 2010).

Generally, RUF contains five times more energy than F100 (Table 2.3). Furthermore, RUF contains four times more of the protein and fat content compared to F100. Amongst the different RUF reviewed, the energy content ranged from 2142 kJ/ 100 g to 2373 kJ/ 100 g. The protein content was the highest in the *Plumpy'nut* at 14.5 g/ 100 g. The fat content was the highest in the barley-sesame based RUF at 39 g/100 g. The maize-sesame RUF contained more carbohydrate (50.2 g/ 100 g) and ash (4.9 g/100 g).

Table 2.3 The nutritional composition of F100 and available ready-to-use foods per 100 g (adapted from De Pee & Bloem, 2008; Emergency Nutrition Network 2004; Diop, Dossou, Ndour, Briend & Wade 2003)

	Energy (kJ)	Protein (g)	Fats (g)	Carbohydrates (g)	Ash (g)
F100	414	2.5	5.0	-	-
<i>Plumpy'nut</i>	2218	14.5	33.5	43.0	4.0
Rice-sesame RUF	2307	13.8	36.0	43.0	4.3
Barley-sesame RUF	2373	14.1	39.0	39.9	3.9
Maize-sesame RUF	2142	13.2	50.2	28.6	4.9
<i>Nutributter</i>	2259	12.8	35.4	-	-
<i>Plumpy Doz</i>	2247	12.8	34.8	-	-
RUCF India	2176	10.0	31.0	-	-
<i>Supplementary Plumpy</i>	2274	13.6	35.8	-	-

RUCF= Ready-to-use complementary food

Michaelsen *et al* (2008) suggest that a problem that may be encountered with RUF is the availability of nutrients as the product contains antinutrients such as phytates, tannins and fibre. These antinutrients can result in a decreased nutrient availability by decreasing the digestibility of nutrients. Despite this limiting factor, the high nutritional composition of RUF contributes to both the healthiness and acceptability of the food. Evidence shows that the healthiness of food is one of the quality attributes that consumers use to select or buy food (Tourila & Cardello 2002). However the sensory attributes of that food need to be acceptable, as characteristics such as “off”/rotten flavours have been identified by consumers as a barrier towards healthy eating (Tourila & Cardello 2002).

2.2.2 Physical properties of ready-to-foods

The physical property of a food refers to the colour, texture or shape of that particular food. The chemical properties such as moisture, fat or ash content of that food contribute to the formation of the physical properties (Khumalo 2007). The colour of food contributes to the appearance of that food and this affects the food's acceptability to the consumers. This is one of the reasons that food colourants are widely used in the food industry in order to make food more appealing to the consumers. Colour not only contributes to the consumer's ability to identify a food product, but also to the intensity rating of the consumers other sensory attributes (Lawless & Heymann 1998, p106). For example, one study showed that an orange

flavoured drink was correctly identified by 66.1%, 24.4% and 5.4% of the subjects when coloured orange, colourless and purple, respectively (Garber, Hyatt & Starr 2000). This indicates that food colour affects consumer perception of the other food attributes.

Colour is determined when light strikes an object, and is visible to the eye or colorimeter (Loughrey 2002; Harold 2001). Instrumental measurement of colour can be done using Munsell, Hunter, Lovibond or Commission International l'Eclairage (CIE) systems. The Hunter system, which is the commonly used, measures the three dimensions of colour: lightness/darkness (L), red/green (a) and yellow/blue (b) values (Loughrey 2002). These values describe and identify the location of colour in the three dimensions of space and allow comparison with the sensory evaluation of colour (Loughrey 2002).

Yeh *et al* (2002), evaluated the colour of different peanut paste formulations: all peanut; 14% non-fat dry milk with 40% total fat content (PSM); 19% roasted soya beans at 40.5% total fat content (PSSA); and 19% roasted soya beans at 44.5% total fat content (PSSB). The results, as indicated in Table 2.4, show that the addition of milk and fat, or soya bean and fat resulted in higher L* values compared to the all peanut spread. The colour lightness value indicated that PSM was the lightest paste followed by PSSB, then PSSA and finally the control. The red/green values were low in all samples compared to the control, and PSM had the lowest value followed by PSSB and PSSA. The yellow/blue values indicated that milk had a low mean value, while soya increased the mean b* value compared to the control. The chroma indicated that the soy-peanut pastes have an intense colour which is in the red yellow (Hue angle) region however it was predominantly yellow compared to the control.

Table 2.4 Hunter L*, a* and b* values of soy-peanut spreads (Yeh *et al* 2002)

Sample	L*	a*	b*	Chroma	Hue angle
All peanut	55.8	12.2	40.7	42.5	73.3
PSM	64.2	7.9	36.1	37.0	77.6
PSSA	58.9	11.0	41.6	43.1	75.1
PSSB	59.8	10.1	42.9	44.1	76.8

The next physical property to be discussed is texture, a multi-parameter parameter used in product quality and product identification (Mazaheri-Tehrani *et al* 2009; Lawless & Heymann 1998, p379). Texture refers to characteristics such as hardness, chewiness,

grittiness, oiliness and stickiness (Lawless & Heymann 1998, p393). The measurement of texture can be done using both sensory and analytical tests.

Sensory tests can measure all the properties of texture and this is achieved by measuring texture from a bite, chewing or mastication as well as any residual in the mouth (Turnick 2010; Dubost 2001; Lawless & Heymann 1998, p393). Additionally, sensory tests allow textural properties to be measured as perceived by sight, hearing and the tactile properties of the consumers (Lawless & Heymann 1998, p379). For example, smooth or crunchy peanut butter can be evaluated by looking at the product. Contrary to sensory evaluation, the analytical measurement of texture is limited to the measurement of the tactile properties of food such as hardness or firmness, and this is achieved by applying force to food (Mazaheri-Tehrani *et al* 2009). Results generated from the instrumental measurement of texture have a poor correlation to those generated from sensory evaluation studies (Lee & Resurreccion 2001). Probable causes of this variation could be due to: use of a lower temperature to that found in the mouth; lack of saliva which acts as a lubricant and initiates digestion of food (Lee & Resurrection 2001); and individual variation in oral processing (Lawless & Heymann 1998, p399).

Peanut pastes have a semi-solid, homogeneous and smooth texture (United States Department of Agriculture [USDA] 2011), despite containing a low moisture content. This is due to the fact that peanut pastes are peanut particles in oil emulsion, making the oil content one of the important determinants of peanut paste texture (Citerne, Carreau & Moan 2001). Moreover the low moisture content of the peanut pastes results in a product with low microbial activity as few yeasts and molds can grow at a water activity score of 0.6 that is permitted in RUF (Briend & Collins 2010; DeMan 1999, p23). Other common textural attributes of peanut butter are that it is spreadable, sticky, and thick however the addition of the vegetable oil, milk and/or soya protein alters the texture and spreadability of RUF compared to the peanut butter. A high fat content in soy-peanut spreads has been shown to increase the softness of spreads (Dubost 2001), whilst high amounts of soya protein have been associated with the increasing hardness and graininess of spreads (Mazaheri-Tehrani *et al* 2009).

Mazaheri-Tehrani *et al* (2009) investigated the textural properties of soy-peanut spreads that were substituted with 5, 10, 15 and 30% (weight/weight) soya bean and soya nut flour. It was observed that as the amount of flour increased, the soy-peanut spreads experienced significant increases on the instrumental adhesiveness ($p < 0.05$), and hardness ($r = 0.87$)

compared to all peanut spread. The adhesiveness and hardness was 6.16 and 3.8 for the peanut paste, while it was 267.3 and 64.5 for the 30% soya bean flour, and 257.1 and 38.2 for the 30% soya nut flour, respectively. In another study conducted by Dubost (2001), it was observed that the addition of oil (6%) and low amounts (0.5%) of a stabilizer produced soy-peanut spreads which were less adhesive and hard compared to an all peanut paste. The adhesiveness and hardness of the peanut paste was -2.04 and 0.984 respectively, while it was -0.403 and 0.303 respectively in the 20% soya protein substituted peanut soya spread.

Spreadable RUFs are a derivative of peanut butter or paste with better nutritional composition, altered colour and texture to that of a peanut butter. The Physical properties of a RUF will influence the consumer's perception and thus its acceptance or rejection, making the measurement of its acceptability to the targeted population a necessity.

2.3 Factors affecting food acceptability amongst consumers

Consumer food acceptability is the degree of liking or disliking a food product by the end users (Lawless & Heyman 1999, p628). Food acceptability not only satisfies physiological and nutritional needs but also several other needs such as the age, gender, knowledge (Pohjanheimo 2010), and lifestyle (King, Meiselman, Hottenstein, Work & Cronk 2007). These are factors related to the food, individual and environment in which food choices are made (Costell, Tarega & Bayari 2010; Pohjanheimo 2010).

2.3.1 Food properties contributing to food acceptability amongst consumers

Food attributes used to determine food acceptability are taste, smell, texture and appearance of food in particular colour (Wilkinson, Dijksterhuis & Minekus 2000). These are generally perceived through the stimulation of the sensory organs that send messages to the brain for interpretation. For example, at the sight of food the appearance can be evaluated and a stimulus is sent to the brain resulting in the initiation of cephalic reflexes, creating expectations from the consumer's sensory organs (Visser 2007; Loughrey 2002). Unappealing food can result in distortions of the cephalic reflex decreasing the likelihood of that food being chosen. Nut based RUFs have a light brown colour (USDA 2011; Yeh *et al* 2002), which is primarily from melanin and it varies depending on the degree of roasting (Pattee, Giesbrecht & Young 1991). For example highly roasted nuts are used to make dark brown pastes. Another factor affecting the colour intensity of the peanut pastes is the amount of milk powder, fat and soya used (Yeh *et al* 2002). High quantities of soya and milk powder have been shown to result in light brown pastes.

The next attribute to be perceived by the human body is the odour of food. This occurs through the stimulation of olfactory receptor cells in the nasal cavity (Lawless & Heymann 1998, p50). Odour is perceived from the external environment as well as orally contributing to a wide identification of flavours in food. Flavour identification is perceived by a combination of odour and taste perception (Lawless & Heymann 1998, pp51-52). Taste is a sense perceived at any area of the tongue upon stimulation by organoleptic substances from a mixture of food and saliva during drinking or chewing food (Lawless & Heymann 1998, p41). It is not known if saliva is responsible for the taste response, or if it is only limited to transporting organoleptic molecules to the taste buds (Lawless & Heymann 1998, p41). There are four basic tastes: sweet, sour, salty and bitter. Astringent, metallic and umami are the newly discovered tastes (Lawless & Heymann 1998, p42).

In consumer studies, taste has been identified as one of the most important determinants of food acceptability (Visser 2007), selection (Pohjanheimo 2010) and consumption (Nu *et al* 1996). Previous studies have found that peanut based RUFs were very sweet in taste (Parker, Bentley, Chasela, Adair, Piwoz, Jamieson, Ellington, Kayira Soko, Mkhomawanthu, Tembo, Martinson & Van der Horst 2011). This might be due to the high amounts of sugar used to increase the energy content of RUFs and to mask the taste of the added vitamin and minerals.

The final sensory characteristic important in determining food acceptability is texture which is classified as visual, oral and auditory texture (Wilkinson *et al* 2000; Lawless & Heymann 1998, p379-391). Visual texture is assessed using the sense of sight and creates a perceived texture that is satisfied by the tactile texture (Wilkinson *et al* 2000; Lawless & Heymann 1998, p386). Tactile texture refers to the size, shape, mouthfeel and the phase changes of food, and it is evaluated using the sense of touch experienced in the mouth. Finally, auditory texture is measured using the sense of hearing (Lawless & Heymann 1998, p383). In some foods either one or a combination of the sense of visual, oral and/or auditory texture are used to determine the texture (Lawless & Heymann 1998, p379). Food texture can be used in product identification and contributes to food quality (Wilkinson *et al* 2000; Lawless & Heymann 1998, p380).

Texture and taste are the most commonly stated sensory attributes that influence food acceptability. However a balance between taste, texture, smell and appearance needs to be maintained as rarely does a food that is not visually appealing or has an “off” smell get

chosen. Perception of these food properties varies from person to person and some of the factors affecting perception are discussed in the following section.

2.3.2 Human factors affecting sensory perception of food

2.3.2.1 Genetic factors

Studies indicate a genetic variation in taste sensitivity, particularly those regarding the bitter taste (Mennella, Pepino & Reed 2005). Studies were conducted using a bitter compound 6-*n*-propylthiouracil (PROP) (Mennella *et al* 2005; Golding, Steer, Emmett, Bartoshuk, Horwood & Smith 2009), and it was found that consumers can be classified as supertasters, tasters or non-tasters of bitterness (Golding *et al* 2009). Supertasters in particular, were found to have a low consumption of bitter vegetables such as cucumber and broccoli (Bell & Tepper 2006). Genetics may also play a role in the predisposition to prefer sweet and salty taste, while rejecting bitter and sour tastes (Guinard 2001; Nu, Macleod & Barthelemy 1996). These findings were based on studies conducted observing the swallowing patterns and facial expression of newborn babies when exposed to solutions containing basic tastes (Zhang & Li 2007; Guinard 2001).

2.3.2.2 Age

Contrary to adults, young children's food preferences can be used to predict their food consumption patterns (Popper & Kroll 2005). Children have been found to prefer foods that are high in sugar, fats and energy, and have smooth textures and give a pleasant feeling of fullness (Pavon 2003; Nu *et al* 1996). It is thought that children's food intake is mainly influenced by the innate liking of sweet foods and familiarity with the food and the environment. A study by Nu *et al* (1996) showed that sweet foods such as chocolate, ice cream and sweets were mainly liked by adolescents compared to bitter foods such as offal, coffee and spinach. Preference of other tastes, such as bitter, is learned through modeling and repetitive exposure in an environment influenced by cultural, societal, economic, health and educational factors (Cooke & Wardle 2005; Nu *et al* 1996). This has been seen through observations of adult diets that have experienced an increased consumption of other tastes and flavours and a decreased consumption of sweet foods compared to children.

2.3.2.3 Gender

The general effect of gender on food choices is that females have been found to prefer healthy foods compared to males (Pohjanheimo 2010; Caine-Bish & Scheule 2009; Nu *et al* 1996). Studies conducted in children indicate that males have a higher preference of fatty and

sugary foods, meat and processed “meat” while girls have a higher preference for vegetables and fruits (Caine-Bish & Scheule 2009; Cooke & Wardle 2005). According to Cooke and Wardle (2005) the preference of energy dense foods in males may be for adaptive purposes so as to meet the high nutritional needs of males compared to females. Whereas female’s preferences are largely influenced by body composition or weight control. In a study by Pohjanheimo (2010) it was found that females as young as 13 were concerned about body composition and healthy eating. Another effect of gender on food choices is linked to age and it is observed that in childhood, boys disliked more foods than girls did however this was reversed in adolescence (Cooke & Wardle 2005).

2.3.2.4 Health status

The presence of some diseases such as cancer and HIV/AIDS, and the treatment thereof has been linked to alterations in sensory perceptions. Commonly the most affected senses are those of the sense of taste and smell, and this may be due to the shorter life span of the receptor cells of these sensory organs. It has been found that taste receptor cells have a life span of a week (Lawless & Heymann 1998, p39), while the nose receptors cells have a life span of a month (Lawless & Heymann 1998, p52). Generally people with chronic diseases have decreased sensory threshold levels resulting in a preference for highly concentrated foods along with decreased food intake (Heald, Pieper & Schiffman 1998).

Human immunodeficiency virus

The disease, HIV/AIDS, and the drugs used to manage it have been found to affect the chemosensory (Naik, Shetty & Maben 2010; Heald *et al* 1998), taste (NDOH 2007; Heald *et al* 1998), and smell perceptions (Mueller, Temmel, Quint, Rieger & Hummel 2002; Hornung, Kurtz, Bradshaw, Seipel, Kent, Blair & Emko 1998). In a study by Heald *et al* (1998), it was found that 70% of the sample (n=207) had chemosensory complaints, 44% had both smell and taste complains, 3% had smell complains and 23% had taste complains. The most common taste complaint was unusual taste, while the most common smell complaint was a decreased ability to identify smells.

Little is known on the exact mechanism in which HIV causes sensory alteration but manifestations of the disease have been linked to alterations in sensory perception. The development of conditions such as oral candidiasis, gingivitis, xerostomia, liver failure and neurological manifestations has been linked to an altered taste and smell perception (Heald *et al* 1998). Also HIV has been shown to alter the sensory perception of food through the

development of malnutrition and thus giving rise to the HIV malnutrition cycle. Undernutrition hastens HIV progression through a weakened immune system while HIV increases the severity of malnutrition through the increased nutrient requirements, decreased food intake and nutrient malabsorption (Koethe & Heimbürger 2010; NDOH 2007). During periods of malnutrition there is a decreased availability of nutrients and energy available for the development, repair and maintenance of receptor cells (Ehizele, Ojehanon & Akhionbare 2009). Common nutrient deficiencies including zinc and Protein Energy Malnutrition have been directly linked to sensory alterations. Zinc deficiency has been linked to taste misinterpretation and decreased taste sensitivity (NDOH 2007). Studies surrounding PEM have shown reductions in the size of salivary glands, secretions of saliva and salivary proteins which contribute to altered taste perception (Ehizele *et al* 2009; Moynihan & Lingström 2005; Ohara, Tabuchi, Kimura & Itokawa 1994).

Medication side effects

Drug induced taste disorders are common and their management is essential for the survival of people affected by chronic diseases. For example, taste disorders contribute to reduced food intake and weight loss which is a significant indicator of disease progression and risk of mortality in HIV infected people (Ndekha, van Oosterhout, Saloojee, Pettifor & Manary 2009). The list of the individual drugs given to children and their side effects thought to affect sensory perception are listed in Table 2.5. Oral manifestations of the disease commonly affect taste perceptions. There are multiple ways in which drugs can induce alterations in taste and smell perception. It is thought that drugs can: modify transduction mechanisms; interfere with the chemosensory neurological pathway; interfere with production of receptor cells; inhibit release of transmitters of taste by blocking calcium inflow; affect liver, kidney and salivary gland function; or cause malnutrition (Naik *et al* 2010).

Table 2.5 Antiretroviral medication and side effects affecting sensory perception
(National Department of Health [NDOH] 2007; World Bank 2007)

Name of drug	Side effects
Nevarapine (NVP)	Stomatitis
Abacavir (ABC)	Dyspnoea, pancreatitis, fever
Didanosine(ddi)	Dry mouth, loss of taste, stomatitis, pancreatitis, fever
Lamivudine (3TC)	Nasal symptoms, pancreatitis, anaemia
Zidovudine (AZT)	Dyspnoea, taste changes, peripheral neuropathy, anaemia
Ritonavir (RTV)	Hepatitis, taste changes
Stavudine (D4T)	Peripheral neuropathy, stomatitis, anaemia, pancreatitis
Indinavir (IDV)	Taste changes
Saquinavir (SQV)	Mouth ulcerations, taste changes

In a study by Heald *et al* (1998) it was found that 21% and 5% of HIV infected people reported that their medication affected their sense of taste and smell, respectively. It was also reported that medication tasted (38%) and smelled (21%) bad. Medications commonly reported as problematic were Indinavir, Ritonavir, Zidovudine, Didanosine, Lamivudine, and Bactrim (Heald *et al* 1998), and most of these medications are protease inhibitors (Heald *et al* 1998).

2.3.2.5 Parental influences

In early childhood parents are identified as the major influencers of a child's food choices as they determine foods that become familiar to their children and shape the environment in which food is consumed (Savage, Fisher & Birch 2007). However in many instances mothers or females are the main influencers particularly in the first year of life as they are responsible for feeding children, whether this is in the form of breast or bottle feeding and the introduction of solids (NDOH 2008; Al-Shoshan 2007). Shaping of children's food choices is a process that begins in pregnancy and continues through breast feeding, the introduction of solids stage as well as the establishment of feeding practices within a certain family environment (Scaglioni, Salvioni & Galimberti 2008; Savage *et al* 2007). During pregnancy the flavour of the amniotic fluid is thought to change according to the mother's dietary flavours exposing the fetus to those particular flavours (Mennella, Johnson & Beauchamp 1995). Similarly the flavour of breast milk changes according to the diet of the mother

exposing babies to those particular flavours resulting in the development of a higher preference of those flavours (Mennella & Beauchamp 1991).

The next opportunity to influence a child's food choice is during the introduction of solids and during this time parents decide on the foods to introduce, make conclusions about their child's acceptability of foods after a few exposures (Al-Shoshan 2007). They also facilitate the development of culturally acceptable eating patterns and habits (Savage *et al* 2007). The development of food preferences is done in an environment shaped by the parents eating behavior, foods available and served, atmosphere in which the food is consumed, the regulation of media- in particular television as well as feeding strategies (Scaglioni *et al* 2008; Savage *et al* 2007). For example, the availability of vegetables liked by children at home has been linked to an increased consumption of those vegetables at school (Brug, Tak, te Velde, Bere & Bourdeaudhuij 2008), whilst strategies such as excessive restriction of sweet foods has been linked to a high preference of sweet foods (Liem, Mars & de Graaf 2004).

2.4 Measurement of food acceptability amongst consumers

2.4.1 Methods for measuring food acceptability amongst consumers

Food acceptability can be measured using affective sensory evaluation methods to deliver cost efficient products acceptable to consumers. Commonly the bi-polar hedonic rating scale is used to measure the degree of liking, and has different lengths: 9, 7, 5 and 3 point hedonic rating scale, and formats: verbal descriptors and/or smiley faces (Lawless & Heymann 1998, pp450-455). The ideal scale is the 9-point hedonic rating scale with verbal cues ranging from "like extremely" to "dislike extremely" (Stone & Sidel 2004, p255; Lawless & Heymann 1998, pp222, 450), and is usually used in people above the age of eight and are literate (Guirnard 2001; Stone & Sidel 1993, p88). Over the years it was established that the results generated from hedonic rating scales were valid, reliable and reproducible (Stone & Sidel 2004, p90, 255; Lawless & Heymann 1998, p455). Additionally the presentation of the scale: either vertical or horizontal; or starting with the like or dislike side, did not affect the results generated (Lawless & Heymann 1998, p450). The test can be carried in a laboratory, central location and at home, however is commonly conducted in a central location (Stone & Sidel 2004, pp262-269).

The other scales: 7, 5 and 3 point hedonic rating scales were developed for use in illiterate people and children for reasons later explained (Stone & Sidel 2004, p257; Lawless &

Heymann 1998, pp455-456). The scales can be further modified by using face scales and/or Peryam & Kroll (P &K) verbal descriptors ranging from “super good” to “super bad”. From these the commonly used scale is the 5 point hedonic rating scale (Khumalo 2007; Visser 2007; Guinard 2001), and it has been used in children as young as 4 years (Guinard 2001). Another method used to measure food acceptability is the focus group discussion, a method not frequently used compared to other methods. This method is not commonly used as the qualitative data obtained cannot be analyzed statistically (Lawless & Heymann 1998, p519), and it is not very significant (Visser 2007; Lawless & Heymann 1998, p536). Focus group discussions are used mainly for validating and understanding data from other sensory evaluation methods (Visser 2007). It is a method which is easy to plan, implement, is cheap, uses tools such as a semi structured questionnaires and tape recorders to collect data (Stone & Sidel 2004, p303).

2.4.2 Children as subjects of consumer acceptability studies

One of the main challenges with using children in sensory evaluation studies is their limited developmental skills. During childhood, sensory organs are developing and only reach threshold levels during adulthood (Zandstra & de Graaf 1998). It has been shown that part of the front and back areas of the tongue only reach the adult level of functioning around the ages of 8-10 and 15-16 years, respectively (Temple, Hutchinson, Laing & Jinks 2002). Another concern with children is that their cognitive function is still developing (Lawless & Heymann 1998, p455). Research shows that children under the age of seven have limited thinking, concentration, memory, verbal and literacy skills (Popper & Kroll 2005). The cognitive limitations posed by children require them to be treated as special subjects. Extra assistance needs to be provided to ensure that children are comfortable, and can understand and perform the task at hand (Guinard 2001). Liem and Zandstra (2010) showed that the type of instructions given to children can affect the outcome of sensory evaluations. For example, competitive instructions were associated with a decreased ability to perform a similarity test compared to cooperative instructions. Around 44% and 64.7% of the children given competitive and cooperative instructions could correctly identify the reference sample. Others state that foods should be evaluated during the time the food is usually consumed. For example, it has been found that breakfast foods such as cereals are more acceptable when evaluated in the morning than in the evening (Birch, Billman & Richards 1984). Despite these limitations, sensory evaluations studies are conducted in children. This is done to

ensure that their needs are met as the literature indicates that children have an increased financial autonomy and are more informed than previously thought (Pavon 2003).

2.4.3 Analysis of sensory evaluation data

Both quantitative and qualitative data can be generated from food acceptability studies depending on type of methodology used. Hedonic rating scales are categorical scales (Lim & Fujimaru 2010; Lawless & Heymann 1998, p220) that generate quantitative data (Bower 1995), while focus group discussions generate qualitative data (Lawless & Heymann 1998, p519). The quantitative data from the hedonic rating scales is analyzed in a three step process (Smith 1988, p335). First, data is collated then summarized using statistical tests such as means, modes, medians, frequency distribution, standard deviation and coefficient of variation. This is followed by second step of further statistical analysis using appropriate statistical procedures with either parametric tests, such as analysis of variance (ANOVA) and t-test, or non-parametric test, such as CHI square and Kramer test. Decisions on whether to use parametric or non-parametric tests follows after data has been assessed for normality, and this can be achieved using graphical techniques or statistical tests such as dot plots and coefficient of skewness, respectively (Bower 1995; Smith 1988, p340). The coefficient of skewness is first calculated to determine symmetry of the data and if data is symmetrical this is followed by calculation of kurtosis to determine if the data is normally distributed (Bower 1995; Smith 1988, pp340-341). In the final step of data analysis, conclusions or inferences about the results can be made.

As previously mentioned, focus group discussions generate qualitative data that cannot be analyzed using statistical tests. However it can be analyzed using a method such as content analysis. The main aim of the method is to capture important or main ideas without quantifying the results (Lawless & Heymann 1998, p541). Content analysis involves transcription of the discussion into text followed by the measurement of the frequency at which an idea is voiced and the assessment of the attitude towards an idea (Lawless & Heymann 1998, p537).

2.4.4 Studies investigating the acceptability of ready-to-use foods

Studies investigating acceptability of ready-to-use foods are presented in Table 2.6, and show that RUFs are generally acceptable. This was achieved using different formulations of RUFs as well as different methodologies to obtain this information. Matias *et al* (2011) tested both the regular and cinnamon flavoured RUF, while Hess *et al* (2010) tested RUF with high zinc

concentrations and Adu-Afarwuah, Lartey, Zeilani and Dewey (2010) tested RUF with 50% low sugar content and a high nutrient content of some nutrients such as zinc, calcium, phosphorus, selenium, magnesium and manganese. In all the studies the RUFs were found to be acceptable. Different formulations of RUF are a necessity as RUFs need to be developed to meet country specific nutritional problems and tastes (MIYCN working group 2009). For example, it is recommended that in countries where malaria is a problem, RUFs should contain low amounts of iron as high levels of iron in the body can increase the severity of malaria (MIYCN working group 2009). In some of the studies reviewed, physical characteristics such as taste, colour and odour were also found acceptable to the consumers. In the study by Mana Foods (2011) the taste, smell and texture had a mean rating of 5 (“very good”), and in the study by Adu-Afarwuah *et al* (2010) the colour, taste and odour had a median of 5 (“like a lot”). The acceptability of RUF in these studies might have been increased by the fact that most of these studies were conducted over certain period of time allowing children to become familiar with the food. Another factor that might have contributed to the high acceptability was that some of the studies tested acceptability of RUF with a familiar or locally consumed product. In a study by Parker *et al* (2011) it was found that nearly half of the children did not like eating RUF on its own. Methodologies commonly used to determine the acceptability of RUF were observations, interviews, and a five-point facial hedonic rating scale. Also the studies were conducted in children under the age of 5 years and their caregivers.

Table 2.6 Studies investigating the acceptability of lipid based ready-to-use foods to children and caregivers

Author (s) and date	Place	Type of supplement	Sample characteristics	Methodology and duration of study	Results
Mana foods (2011)	Rwanda	Peanut based Mana RUF	n= 14 pairs of children and mothers children: 50% males & 50% females; & 6-36 months old with Severe Acute Malnutrition (SAM) without complications	Interviews Semi- structured questionnaire 2 months 6 point rating scale	Both mother and child liked the product. The mothers scored the taste, smell and texture of the product average of 5 (“very good”).
Matias, Chaparro, Perez-Exposito, Peerson, Dewey (2011)	Guatemala	Peanut based regular & cinnamon flavoured RUF	42 pairs of mother and child between the ages of 6 to 18 months 49% males & 51% females	Cross sectional study Observations Focus group discussions 5 point hedonic rating scale	Amount of regular RUF consumed was 74. 6% and 67. 6% that of cinnamon RUF. 79% of the mothers liked regular RUF and 74% liked cinnamon flavoured RUF. 96% of the mothers thought child liked regular RUF while 90% of the mothers thought child liked cinnamon flavoured RUF. Properties of RUF liked were colour (100% regular, 79% cinnamon flavoured), texture (87% regular, 95% cinnamon flavoured), smell (92% regular, 83% cinnamon flavoured) and taste (92% regular, 84% cinnamon flavoured). 93% mixed supplements with food such as soups and stews.
Parker <i>et al</i> (2011)	Malawi	Locally made peanut based RUF eaten with other food or on its own	45 HIV infected mothers (+28 years old) with children between the ages of 15-16 months	Semi structured interviews 9months	Mothers had positive perception of supplement: 75% of the mothers thought the supplement was sweet and child liked it. It was further associated with improved health (84%), appetite (38%), weight gain (53%) and energy (29%). Almost half of the children did not eat RUF on its own. 18% of mothers associated supplement with development of diarrhoea.

Table 2.6 Studies investigating the acceptability of lipid based ready-to-use foods to children and caregivers (*Continued*)

Author (s) and date	Place	Type of supplement	Sample characteristics	Methodology and duration of study	Results
Adu-Afarwuah, <i>et al</i> (2010)	Ghana	<i>Nutributter</i> & modified <i>Nutributter</i> : 50% sugar reduced, with altered nutrient content mixed with Koko	n= 22 child and mother pair 6-12 months children with 59% Males and 41% females	Questionnaire Observations 5 point hedonic rating scale ± 1 month	Amounts of both <i>Nutributter</i> & modified <i>Nutributter</i> consumed were above 50% of confidence interval, indicating that they were acceptability. The mothers rated the colour, odour, taste, overall liking and infant liking of the children's modified RUF median 5 ("like a lot"). 81% mothers rated child's liking 5 or like a lot, 1 mother rated it dislike a lot and 3 mothers associated product with development of diarrhoea.
Hess, Bado, Aaron, Ouédraogo, Zeilani & Brown (2010)	Burkina Faso	RUF with and without zinc mixed with porridge	36 pairs of mothers and children between the age of 9-15 months	5 point hedonic rating scale Focus group discussions 3 days	Consumption of RUF with or without Zinc did not differ (P = 0. 97). 93.3% of the mothers ranked children's liking of both products as 'like a lot' & 85. 7% of the mothers rated the products as "like a lot". Product liked and viewed as medicine. Mothers associated product with improved appetite, energy and perceived happiness. Few associated product with development of diarrhoea and decreased appetite.
Flax, Thakwalakwa, Phuka, Ashorn, Cheung, Maleta & Ashorn (2009)	Malawi	Peanut based RUF and corn-soya blend (CSB) porridge	n =504 6- 14 months of age with moderate malnutrition, 50. 5% males and 49. 5% females	Semi structured questionnaire 2 studies that took 5-6months	95% of the mothers said Corn-soya blend porridge was acceptable and to 93% of the mothers found RUF acceptable. Reason for liking of supplement were: sweetness (CSB 32%, RUF 34%), improved child's health or growth (CSB17%, RUF19%), or child liked eating the supplement (CSB 16%, RUF 15%). The supplement was associated with improved health, weight gain, and risk of illness and the development of diarrhoea. The sweet taste and smell of oil were not liked.

Table 2.6 Studies investigating the acceptability of lipid based ready-to-use foods to children and caregivers (*end*)

Author (s) and date	Place	Type of supplement	Sample characteristics	Methodology and duration of study	Results
Dube, Rongsen, Mazumder, Taneja, Rafiqui, Bhandari & Bhan (2009)	India	RUF and local meal khichri Served individually	N=31 6-36 months old with malnutrition, and 51.6% male and 48.4% females	Observations Interviews + 2 days	Khichri had better acceptability compared to RUF. 18 of the children liked RUF while 24 children liked khichri. Average of 56 g of RUF consumed against 242 g of Khichri. Mothers thought consistency (n=28) and appearance (n= 10) were good. The supplement was associated with improved energy, appetite.
Flax, Maleta, Ashorn, Manary, Briend & Ashorn (2008)	Malawi	Peanut based RUF served on its own	n =16 6-17 months old with moderate malnutrition	Semi structured questionnaire 12 weeks	Mean consumption of RUF on not ill days was 50.6 g and 43.4 g on ill days. Based on this it was concluded that RUF acceptable during illness and recovery.

2.5 Use of ready-to-use foods in the Nutrition Supplementation Program

Modification of NSP needs to be undertaken after careful planning and evaluation of the best measures to incorporate provision of RUF, impact on other programs, monitoring and evaluation of the program. Also financial, operational and human factors along with politics, social preferences, ethics and system barriers need to be reviewed to ensure a better distribution of scarce resources as well as the attainment of the best outcomes at minimum costs (Hutubessy, Chisolm, Edejer & WHO-CHOICE 2003). A major concern with the use of RUFs is the high cost of the products (Latham, Jonsson, Sterken & Kent 2011; Matilsky *et al* 2009; De Pee & Bloem 2008). It has been found that RUFs are one of the major cost contributors in the management of malnutrition, contributing to around 30% of the total costs (Wilford, Golden & Walker 2011; Bachman 2009). Commonly around 11Kg of RUF is required to rehabilitate a malnourished child (Manary, Ndekha, Ashorn, Maleta & Briend 2004), and the amount is doubled to 22kg for rehabilitation of a HIV infected malnourished child (Ndekha, Manary, Ashorn & Briend 2005). In December 2011 the average international cost of buying RUF was 401 South African Rands (ZAR) per 13.8 kg (UNICEF 2011). This translates into 320 ZAR (40.26 US\$) for providing RUF to a malnourished child and 639 ZAR (80.52 US\$) to a HIV infected malnourished child. The cost of providing RUF to a malnourished and HIV infected malnourished child account for more than 25% and 50% of the South African primary health care per capita expenditure (R 1100 or 138.6 US\$) for 2010/2011 respectively.¹

The cost of rehabilitating a malnourished child can however be reduced by using locally produced RUF. The literature has shown that the local production of RUF is favoured as it can be tailored to meet local nutritional needs using local skills and foods leading to greater acceptability (Gera 2010; Lagrone *et al* 2010; MIYCN working group 2009). Use of locally produced RUF has been shown to halve the cost of rehabilitating a malnourished child (Ashorn 2006), however products need to be manufactured in a safe manner as peanut pastes are susceptible to salmonella contamination (Manary 2005).

The NSP was never fully implemented and there is a wide gap between policy and program implementation. In a study by Hendriks, le Roux, Fernandes & Irlam (2003) it was found that former NSP, PEM scheme, had a poor coverage of the targeted population. The program

¹ The South African Rand was converted to the American Dollar using the average exchange rate from January 2012 to June 2012, 1 ZAR = 0.126 US Dollar (x-rate.com, 08/07/2012).

reached 50% of children and 60% of pregnant and lactating women in Northern Cape. There was also low level of nutrition education: 46% of the interviewed mothers had some knowledge about the program and a further 22% knew about the program when shown food supplements issued. Similar results were found in a study conducted in the Western Cape by Iversen *et al* (2011). It was found that half of the children eligible for food supplementation were not in the supplementation program and there were discrepancies in program implementation. For example, it was found that not all children receiving supplements were recorded. Also the personnel responsible for issuing of supplements had little training yet thought the program was well managed and had no specific problem. From the studies it can be seen that the program had little improvements from 2003 to 2009, and introducing RUF to the current program may result in minimum attainment of benefits from RUF.

Researchers have proposed two methods of introducing RUF into a community nutrition rehabilitation program. The first option is to provide supplementation with RUF to all individuals belonging to the groups at risk of developing malnutrition, and the second option is to provide RUF to targeted individuals already experiencing under nutrition. The first option offers better coverage and has been shown to lead to a long term reduction of malnutrition (De Pee & Bloem 2008) but it is costly. It is suggested that supplementation of all pregnant and lactating women, and children below the age of 2 is a better option to decrease the intergenerational cycle of malnutrition (Hendriks *et al* 2003). This might seem like a better option for South Africa, as better coverage of the targeted population might be reached. However the training of health care providers along with nutrition education needs to be continued and improved to support primary nutrition interventions such as breastfeeding, hygiene and healthy eating habits. For example, RUF contains a low water content making it essential to drink water along with it, however this might be a problem in areas with no clean safe water, increasing the risk of developing dehydration or water borne diseases (Manary 2005).

2.6 Conclusion

Evidence shows that the characteristics of a food (Nutritional composition, colour and texture); personal characteristics (age, gender and health); and the environment in which food is introduced (parental influences), greatly affect the sensory perception and acceptability of food. The minimal research that is available shows that peanut based RUF are nutrient dense

and have modified physical properties compared to that of an all peanut paste and prove to be generally acceptable. The studies reviewed indicated that both quantitative and qualitative research methods should be used, obtaining data through the five-point facial hedonic rating scale and focus group discussions in caregivers. In children the acceptability of RUFs was measured by observing of the amount of RUF consumed. The limitation of this method is that using this method the food/RUF properties liked or disliked by the children could not be identified. This type of knowledge can contribute to improvements of products to better suit children's preferences. Furthermore RUFs are expensive making assessment of financial feasibility a necessity.

CHAPTER 3: RESEARCH METHODOLOGY

Methodology is a systematic way to solve a problem, and its accuracy and relevancy in solving the research problem is essential. In this chapter, the different methods used in solving the research problem are explained in detail. The study design, materials and methods used in collecting and analysing the data are provided.

3.1 Study design

A cross-section study was carried out to collect both the quantitative and qualitative data. Quantitative data was collected using laboratory-based experimental designs. The quantitative data collected included the properties of the RUF, *Sibusiso*, and its acceptability to subjects of different health status, as well as the feasibility of using RUF for nutrition rehabilitation. Qualitative methods, namely focus group discussions, were used to collect data on the perceptions and attitudes of the caregivers towards *Sibusiso*. The study was conducted in three phases:

- Phase 1: To determine the nutritional composition, colour and texture of the RUF, *Sibusiso*;
- Phase 2: Sensory evaluation of *Sibusiso* divided into two parts. In the first part the consumer acceptability of *Sibusiso* to children of different health status was measured using quantitative methods. The second part involved the assessment of the attitudes and perception of *Sibusiso* by the caregivers with children at risk of or already experiencing malnutrition using qualitative methods; and
- Phase 3: A review of studies determining the cost of rehabilitating a malnourished child using a peanut based RUF.

The study design is shown in Figure 3.1.

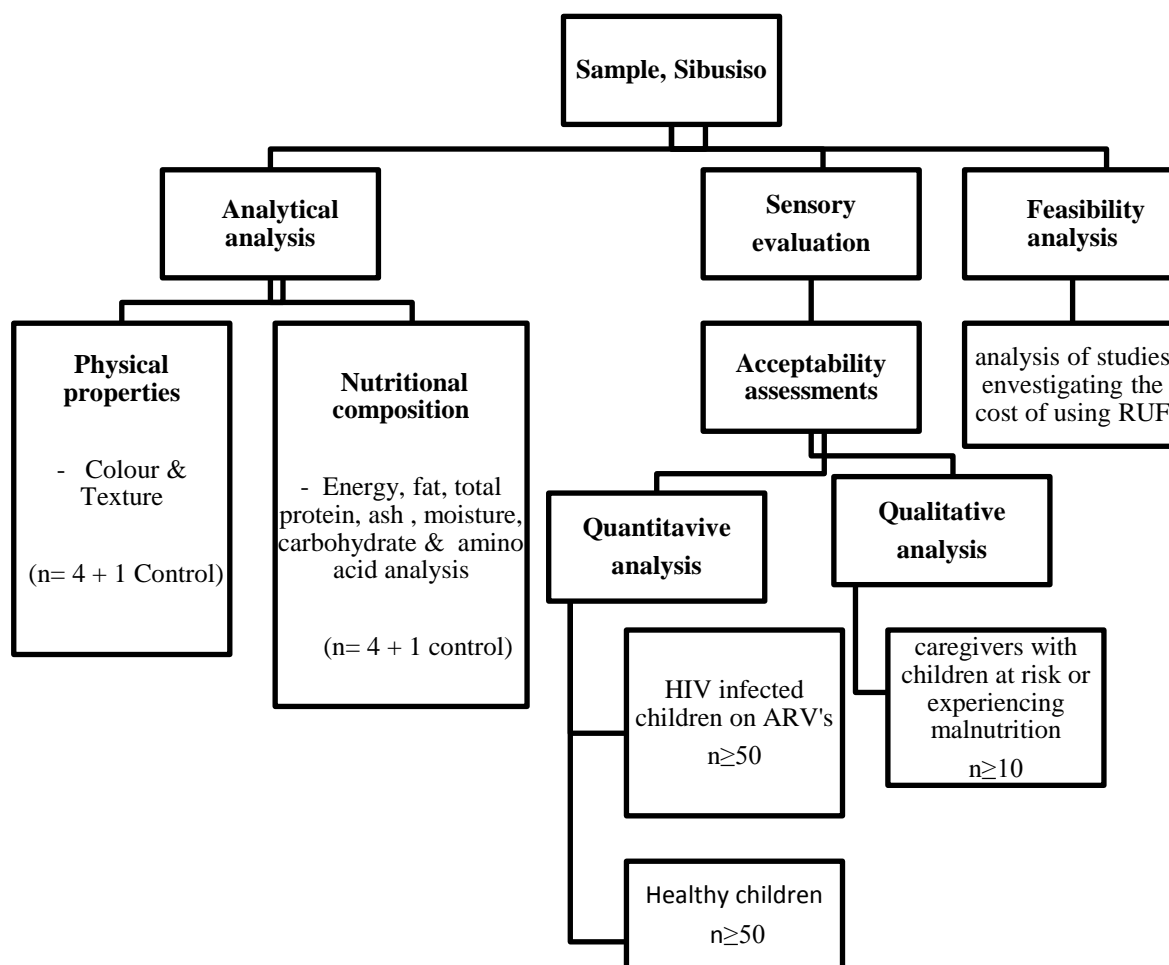


Figure 3.1 Study design

3.2 Materials and methods

3.2.1 Phase 1: Properties of *Sibusiso*

The RUF, *Sibusiso*, was supplied by a South African Non-Governmental Organisation, Gift of the Givers (GOG). The GOG obtained *Sibusiso* from a firm it has contracted to produce it. The label on the packaging of *Sibusiso* indicated that it was made using the following ingredients: a peanut paste, soya milk powder, soya oil, soya protein, sugar, vitamin and mineral premix as well as a vanilla flavouring. It was packaged in 500 g plastic containers and once opened, had a shelf life of three weeks when stored at room temperature.

A smooth commercial peanut butter was used as a control as both the peanut butter and *Sibusiso* (soy-peanut paste) are peanut pastes. The peanut butter was composed of peanuts, sugar, palm fruit vegetable oil, hydrogenated vegetable (canola and soya) oil, cotton seed, salt

and a preservative, Tertiary Butyl hydroquinone (TBHQ). The peanut butter used as a control in this study was selected on the basis that, visually, its physical properties were similar to those of *Sibusiso*.

Samples of *Sibusiso* were selected from four different batches of *Sibusiso* manufactured in the year 2010 and 2011. From each batch two samples were selected. Two samples of a peanut butter were randomly selected from a local supermarket. Before any measurement was done, all samples were thoroughly mixed, clearly labelled and stored at room temperature. Mixing was done to ensure that the samples had a uniform consistency as it was observed that *Sibusiso* had a tendency to separate. This was probably due to the fact that it had no stabilizers (Lee & Ressureccion 2001).

3.2.1.1 Nutritional composition analysis

An overview of the nutritional analyses done as well as the methods and instruments used are provided in Table 3.1.

Table 3.1 Methods and instrumentation used for the nutritional composition analysis

Analysis	Method	Instrument
Gross energy	Bomb calorimetry	LECO AC500 automatic bomb calorimeter
Crude protein	Dumas Combustion method, AOAC official method 990.03	LECO Truspec Nitrogen analyser
Crude fat	Soxhlett procedure, AOAC Official method 920.39	Buchi 810 Soxhlett fat extractor
Fibre	AOAC official method 2002.04	Dosi-Fibre system
Ash	AOAC official method 942.05	Furnace
Moisture percentage	AOAC Official method 934.0.	Air circulated hot oven
Amino acid analysis	HPLC method.	HPLC

AOAC = Association of Analytical Chemists, HPLC = High Performance Liquid Chromatography

Four samples of the RUF, *Sibusiso*, and the peanut butter (control) were analysed in duplicates for their nutritional composition following standard and referenced methods, which are briefly described below.

Gross energy

The gross energy of the samples was determined by using a LECO AC500 automatic calorimeter (LECO Corporation, 3000 Lakeview Avenue, St Joseph MI 49085-2396, USA), following the instrument manual.

Crude fat

The crude fat content of the samples was measured by the Soxhlett procedure following the Association of Analytical Chemists (AOAC) official method 920.39 (AOAC 2002). The fat of the samples (5 g) was extracted with petroleum ether in a Buchi 810 Soxhlett Fat extractor.

Neutral detergent fibre

The fibre content of the samples was determined as the neutral detergent fibre (NDF). NDF refers to the indigestible nitrogenous matter and cell wall constituents (cellulose, lignin, silica and hemicelluloses). The NDF was analysed using a Dosi-fibre machine according to the AOAC official method 2002.04 (AOAC 2002). This method involved the extraction of the easily digestible lipids, proteins, starches and pectins, leaving the fibrous residue/NDF. After the extraction process, the residue was dried, ashed and weighed. NDF was calculated using a given formula with an adjustment for fat and moisture loss.

Ash

The total mineral content of the samples was measured as ash. The samples were heated in a furnace for four hours at 550°C following the AOAC official method 942.05 (AOAC 2002). In this method, the organic matter of the sample is volatilized and the remaining residue is the ash.

Moisture

The moisture content of the samples was determined according to the AOAC Official method 934.01 (AOAC 2002). The samples were dried in an air circulated hot oven at 95°C for 72 hours. The moisture was calculated by subtracting the weight of the dried sample from the weight of the sample prior to drying it.

Total carbohydrate

The percentage total carbohydrate was calculated by subtracting the moisture, protein, fat and ash from 100% (Greenfield & Southgate 2003, p168).

Crude protein and amino acids

The crude protein content of the samples was analysed by the Dumas Combustion method in a LECO Truspec Nitrogen Analyser according to the AOAC official method 990.03 (AOAC 2002).

The Pico-Tag method was used to analyse the amino acid content of the samples (Millipore Corporation 1986, 1987). The samples were first hydrolysed using 6 N HCl for a period of 24 hours. The samples were then derivatized using phenylisothiocyanate (PITC), to produce phenylthiocarbamyl (PTC) amino acid. Analysis was done in the reverse phase using a Waters Breeze High-Performance Liquid Chromatography (HPLC) with Empower software (Waters, Millipore Corp., Milliford, MA).

Amino acid scores

The amino acid score of the essential amino acids in *Sibusiso* was calculated using the amino acid composition data and equation 1.

$$\text{Equation 1: Amino acid score} = \frac{\text{mg of the most limiting amino acid in 1g of test protein}}{\text{mg of amino acid in 1g of reference population}}$$

3.2.1.2 Analysis of the physical properties of *Sibusiso*

Colour

The colour of *Sibusiso* and the peanut butter were measured in terms of the Hunter Lab colour system. In the Hunter Lab colour system, L represents lightness/darkness, a red/green and b yellow/blue. The colour of samples obtained from each of the four batches of *Sibusiso* and one sample of the peanut butter was measured. The analysis was carried out at room temperature (approx. 25°C) using a Colourflex colorimeter (model 45/0, Hunter lab, Reston, Virginia, United states of America). The colorimeter was standardised using two tiles, one black and the other white tile. A portion of the sample was transferred to the sample cup of the Colourflex colorimeter. The portion of the sample transferred was evenly spread at the bottom of the sample cup, and filled the cup to a depth of 2 cm. The peanut butter reading was taken first, followed by the *Sibusiso* samples. A total of three readings were taken per sample and used to calculate the mean Hunter Lab colour value. The Hunter a and b values of the samples were used to calculate the chroma (equation 2) and the hue angle values (equation 3).

$$\text{Equation 2: Chroma} = [(a)^2 + (b)^2]^{1/2}$$

$$\text{Equation 3: Hue} = \tan^{-1} (b/a)$$

Texture

The texture of the study samples was measured using a texture analyser (TA·XTplus, Stable Micro Systems, Godalming, United Kingdom) connected to a computer with Texture exponent analysis software 2007. A standard method for measuring the spreadability/firmness of smooth peanut butter was used (Exponent 32 reference SPRD4/SR 2007). A 10 kg load cell was attached to the texture analyser. To this, a TTC spreadability rig was attached, which had a male 90 degree cone-shaped probe attached to it. Female cone-shaped sample holders were used. The sample holders were filled with the samples and then anchored to the texture analyser platform. The probe penetrated the sample to a depth of 2 mm, at a test speed of 3 mm per second. This forced the sample to flow outward at an angle of 45 degrees between the male and the female cone surfaces. The force exerted on the sample over time was measured and used to determine the hardness, stickiness, work of shear and work of adhesion. A total of three readings were taken per sample and used to calculate the mean values.

3.2.2 Phase 2: Sensory evaluation of *Sibusiso*

3.2.2.1 Sensory evaluation subjects (panellists)

The target population for this study was children at a risk of and/ or already experiencing malnutrition. Consequently HIV infected children on anti-retroviral drugs (ARVs) were identified as a group of children more likely to develop malnutrition and use the product. However in order to determine the effect of the health status on the acceptability of *Sibusiso*, the HIV infected children on ARVs had to be compared to a group of healthy children. In the literature it is noted that the children's acceptance of food and eating habits are largely influenced by their caregivers (Savage *et al* 2007). Therefore, the caregiver's perceptions and attitudes towards *Sibusiso* could influence its acceptance and use in children. For this reason caregivers were selected to participate in the focus group discussions.

The study participants were recruited from six schools, a day care and a hospital (Appendix A, p91), in Pietermaritzburg and surrounding areas, South Africa. The healthy participants were selected from six schools and the day care. For the purpose of the study, healthy children were defined as children who had not been ill in the past seven days, taking any

medication or suffering from any chronic diseases. This criterion was included in a check list for school children (Appendix B, p92) attached to the parental consent form.

The schools and day care used were located in the urban areas and from well off families. In South Africa, children living in urban areas have been shown to be less prone to undernutrition (NFCS-FB-1 2005). Furthermore, selecting children from schools in Quintile 4 and 5 minimized the chances of recruiting undernourished children. According to the National Department of education (2008), the socio economic status of the schools can be grouped into 5 Quintiles, with Quintile 1 schools being the poorest and Quintile 5 being the least poor schools. The HIV infected children on ARVs and the caregivers were selected from a government's district hospital. Selecting a district hospital was convenient as this allowed access to more people. Prior to carrying out the study, approval was obtained from the KZN- DOE and DOH.

The recruitment of study participants at the schools and day care was done by the teachers. At the day care, all children above the age of four were invited to participate in the study. While at the schools three children from each grade were invited to participate in the study. This allowed a spread of the sample for children aged between 4 and 18 years. At the hospital, all children present in the ARV department on the days of the study were invited to participate through the issuing of flyers and word of mouth. The caregivers were selected on the basis of having a child at risk of or already experiencing malnutrition on the day of the study. The recruitment was done at the ARV and Tuberculosis (TB) pharmacy queue by the word of mouth. All those who were willing to participate were included in the study. All the study participants were selected on the basis of being peanut butter consumers, and were therefore assumed not to have a peanut allergy and could consume *Sibusiso*. In the literature, it is recommended that people who consume a product similar to the product being evaluated, are used for the sensory evaluation panels (Lawless & Heymann 1998, p493).

3.2.2.2 Sensory analysis

The consumer acceptability of *Sibusiso* was determined using a standard consumer acceptance test and a five-point facial hedonic rating scale, as described by Lawless and Heyman (1998, pp83-97). The 5-point facial hedonic rating scale was used to measure the degree of acceptability of the taste, smell, colour, mouth feel and overall liking of *Sibusiso*. The five-point facial hedonic rating scale used consisted of "smiley" faces ranging from

“super bad” to “super good” (Figure 3.2). A facial scale was selected as children have been shown to perform better with facial scales (Stone & Sidel 2001, p257; Lawless & Heymann 1998, pp455-456). Furthermore, the understanding of the scale was improved through use of the P & K scale with the wording ranging from “super good” to “super bad”. Studies indicate that children perform better with P & K scale compared to the standard hedonic rating scale with the wording ranging from “dislike extremely” to “like extremely” (Popper & Kroll 2004). Additional information on the age, race, and gender along with attributes most liked and least liked by the participants was collected (Appendix C, p93).

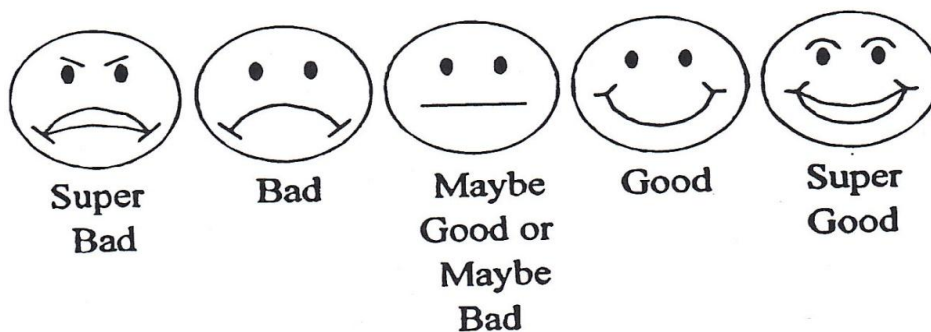


Figure 3.2 Five-point facial hedonic rating scale

The sensory evaluation sessions were conducted at central locations between the year 2011 and 2012, in an area with good lighting and ventilation. Before the children could participate in the study, they were required to present a signed parental consent form. Children recruited at the schools and day care were issued with the parental consent forms three days before the day of the study. The children recruited who were at the hospital were given the parental consent form on the day of the study. The form was signed by the parents on the same day. The study participants were made aware that participation in the study was voluntary. Additionally, the information gathered would be confidential and dealt with according to the University of KwaZulu-Natal (UKZN) ethics regulations.

At the schools and day care, the evaluation of *Sibusiso* was done in 15-20 minute sessions of 10 panellists participating. At the hospitals it was done as the participants walked in. At the beginning of each session, the researcher would introduce the team conducting the study and explain the purpose of the study. That was followed by a detailed explanation of the

questionnaire and the instructions on how to perform the test. Each participant was allocated a booth containing *Sibusiso*, water, a plastic spoon, serviette, participant number and questionnaire (Figure 3.3). One heaped teaspoon of *Sibusiso* and 125 ml of water were served in disposable cups at room temperature. Peanut spreads are commonly consumed at room temperature. In most of the sites, there was no room in which to conduct the sensory evaluation and the back of the room was used as a serving area. The younger children were assisted with filling in the questionnaire, and all the participants were encouraged to raise a hand and ask for help whenever they did not understand anything.

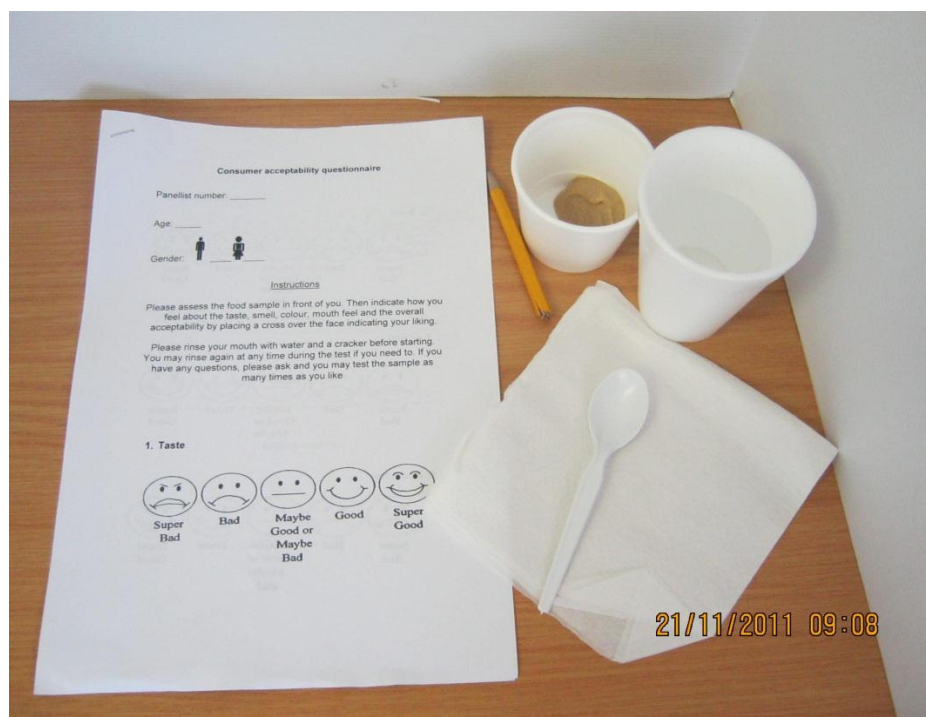


Figure 3.3 A sensory evaluation booth

3.2.2.3 Focus group discussions

The focus group discussions were held following the guidelines described by Lawless & Heymann (1998, pp528-533). Two sessions with five female participants in each session were held. The minimum recommended number of participants in a focus group discussion is 8 (Lawless & Heymann 1998, p528). However this number was not reached as caregivers were reluctant to participate in the study. Furthermore, only the female caregivers participated in the study as they were more willing to participate compared to male caregivers. The female caregivers formed the majority of the caregivers present at the hospital. This is in line with current knowledge that indicated that females are the main

primary caregivers, especially in the first year of life (NDOH 2008; Al-Shoshan 2007). The caregivers participated in the study in order to identify their attitudes towards *Sibusiso*, as this would affect the procurement and feeding *Sibusiso* to children (Savage *et al* 2007). Also, the information generated from the focus group discussions would help understand and explain the children's acceptance or rejection of *Sibusiso*.

The focus group discussions were conducted in an isolated room with the participants, facilitator and scribe seated in a circle (Figure 3.4). At the beginning of each focus group discussion session, introductions were done by the facilitator followed by a brief description of the purpose of the study. The importance of freely expressing views with honesty and setting of ground rules such as speaking one at a time and respecting each other were stated. This was followed by completion of a demographic questionnaire (Appendix D, p96) in IsiZulu which was the language spoken and understood by the participants. During the sessions, the caregivers were provided with a cup containing one heaped spoon of *Sibusiso* and a cup of water. This was followed by the discussion of the perception and acceptability of the attributes of *Sibusiso* using a questionnaire (Appendix E, p99) as a guide. The questionnaire was designed with the guidance of two experienced consumer scientists and an economist. The exact order of the questions on the questionnaire was not followed, but all the questions were covered during a session. The discussions were conducted in isiZulu and recorded with a digital voice recorder. Each session lasted about 35 minutes. The audio data was transcribed into text and together with the hand written notes, were used to divide the data into main findings.



Figure 3.4 Setting of the focus group discussion area

3.2.3 Phase 3: Feasibility/practicality of using *Sibusiso*

A review of the studies investigating the cost of using RUFs in a community setting was done. The search engines: Google scholar, PubMed, Ebcoghost and Medline were used to search for articles using key words such as ‘cost effective analysis’ or ‘cost’ or ‘cost benefit analysis’ and ‘ready-to-use foods’. The titles and abstracts of the articles were read to determine their relevancy. The reference list of the relevant articles was read to find more articles. The selection criteria used for selecting studies for review was: studies using RUF; conducted in malnourished children; published in English; used primary data; and described the costs included when estimating the cost of rehabilitating a child using RUF. A total of 5 studies that met the selection criteria were found and compared to an estimated cost of providing *Sibusiso* to a child per day. The costs in the year of the individual studies were reported in American dollars (US\$). Then converted to US\$ per child per day in the year 2012 using the United States of America annual inflation rate (Appendix F, p101). These costs were then converted to South African Rands (ZAR). The cost of rehabilitating a child using *Sibusiso* was compared to that of the other studies and the amount spent on nutrition per person in KwaZulu-Natal province.

3.3 Data quality

3.3.1 Reliability

Reliability refers to the reproducibility of the findings when different researchers use similar procedures (Kothari 2004, p74). In this study, reliability was assured by ensuring that the samples used were clearly labelled and stored. The sample preparation and serving methods were also standardised. The nutritional composition was determined using standard or validated methods. Furthermore the researchers first received training on operating the machines for colour and texture analysis before doing the actual measurements. The measurements were done in replicates using standard methods provided in the manufactures manuals. The researchers also attended sensory evaluation studies conducted by fellow students who were guided by lecturers with sensory evaluation expertise to observe and learn.

3.3.2 Validity

Validity refers to the effectiveness of the measuring tool to measure what it is intended to measure (Kothari 2004, p73). In the literature review and definition of terms, a clear meaning or understanding of the concepts measured was provided. Other methods were used to ensure the validity of the results include the use of standardised questionnaires, clear definitions of the target population, and use of an experienced statistician for data analysis and the interpretation of the results.

3.4 Data analysis

The data were analysed using the Predictive Analytic Software (PASW) Statistics version 18 (IBM Corporations, New York). The energy, fat, protein, ash, NDF, carbohydrate, hunter L, a, b, chroma, hue angle, hardness, work of shear, stickiness and work of adhesion means and standard deviations for *Sibusiso* per batch and the peanut butter were calculated from the replicate values. The means of *Sibusiso* per batch were used to calculate the grand mean of *Sibusiso* which was used to calculate the coefficient of variation percentage (CV %). This was done in order to determine the batch effect on the nutritional composition, colour and texture of *Sibusiso*. The energy, fat, protein and ash of *Sibusiso* were compared to the WHO/World Food Program (WFP)/, the United Nations System Standing Committee on Nutrition (SCN)/ the United Nations Children's Fund (UNICEF) recommendations for RUF. The estimated percentage contribution of *Sibusiso* to the diet of children between the ages of 1 to 18 years was calculated. The amino acid composition of *Sibusiso* was compared to the

FAO/WHO pattern of amino acid requirements for children. The estimated essential amino acids contributions to the diet were also calculated

For the sensory evaluation data, descriptive statistics were used to summarize the demographic data of evaluation panellist. The sensory evaluation data was aggregated into the “good”, “neutral” and “bad” categories, and the Chi-square test was performed to determine whether there were associations between the health status, age, gender and the acceptability of *Sibusiso* to children. The data pertaining to the attributes most and least liked by the panel was used to generate the verbal descriptors for *Sibusiso*. The tape recordings from the focus group discussion were put into text format and information from the two groups was drawn together. The transcripts together with tapes, notes and memory were used to analyse the data using content analysis (Lawless & Heymann 1998, p541).

3.5 Ethical considerations

The study was approved by the Humanities and Social Sciences Research Ethics Committee of the University of KwaZulu-Natal (Appendix G, p102), reference HS/0375/011M. Approval was also obtained from the KZN- DOH reference HRKM 15/12 (Appendix H, p103), and DOE reference 2/4/8/68 (Appendix I, p104). Written parental consent (Appendix J, p107) was obtained from the parents and caregivers of the children participating in sensory evaluation and consent (Appendix K, p109) was also obtained from the adult participant for the focus group discussions.

3.6 Summary

The study was carried out in 3 phases and both the qualitative and quantitative data were collected. In phase 1 the nutritional composition, colour and texture of *Sibusiso* and a peanut butter (control) were measured using quantitative laboratory based experimental methods. In phase 2 quantitative data was collected on the acceptability of *Sibusiso* to healthy and HIV infected children on ARVs. This was done at centralised location using a five-point facial hedonic scale with each participant assigned to a booth. This was followed by the measurement of the caregiver’s perceptions and attitudes towards *Sibusiso* using qualitative methods namely the focus group discussions. In phase 3 the feasibility of using *Sibusiso* was determined using published data. The results of these 3 phases will be presented in the following chapter.

CHAPTER 4: RESULTS

In this chapter the results generated from this study together with the demographics of the study population are provided. The results are provided and described in the order of the 3 phases of the study. These include the information on the nutritional composition, colour, and texture of *Sibusiso*, as well its acceptability to healthy and HIV infected children. The information on the caregiver's attitude towards *Sibusiso* and the cost of rehabilitating a child using *Sibusiso* is also provided.

4.1 Phase 1: Properties of *Sibusiso*

4.1.1 Nutritional composition of *Sibusiso*

The nutritional composition of *Sibusiso* did not vary with the different batches of *Sibusiso* evaluated except for the fibre contents (Table 4.1). There were slight (15.5%) variations in the fibre content of the different batches of *Sibusiso* analysed. The grand mean of *Sibusiso* was used to compare with the commercial peanut butter (control). *Sibusiso* contained more ash and carbohydrate compared to the peanut butter. However it was low in energy, protein, fat and fibre compared to the commercial peanut butter. The ash and carbohydrate content of *Sibusiso* was approximately 30% and 42% more than that of the control, respectively. The energy content of *Sibusiso* (2624 kJ/ 100 g) was slightly lower than that of the peanut butter (2852 kJ/ 100 g) by 8 %. The fat content of *Sibusiso* (40.1 g) was also slightly lower than that of the peanut butter of 43.2 g by 7%. *Sibusiso* had almost half the protein content of the peanut butter of 25.4 g/ 100 g and a fibre content 5.6 times lower than that of the peanut butter.

The nutritional composition of *Sibusiso* was also similar to the WHO/WFP/SCN/UNICEF (2007) recommendations for RUF, Table 4.2. However *Sibusiso* contained the higher energy content. The energy content of *Sibusiso* was 12.3% more than the energy content stipulated in the WHO/WFP/SCN/UNICEF recommendations for RUF.

The consumption of 50 g of *Sibusiso* was estimated to provide less than 40% of the estimated energy requirements of the individuals between the ages of 1 to 18 years (Table 4.3). The estimated protein contribution to the diet of children decreased with an increase in age. The estimated protein contribution was the highest among children between the ages of 1 and 3

years at 60%. The lowest protein contributions were 17% and 15% in males and females between the ages of 14 and 18 years, respectively.

Table 4.1 Nutritional composition of *Sibusiso* per 100 g sample ^{1,2}

Sample	Batches	Gross energy (kJ)	Protein (g)	Fat (g)	Fibre ³ (g)	Ash (g)	Carbohydrates ⁴ (g)
<i>Sibusiso</i>	1	2640 (2)	15.7 (0.2)	42.0 (0.8)	1.3 (0.0)	3.6 (0.0)	36.9 (0.5)
<i>Sibusiso</i>	2	2604 (5)	16.0 (0.3)	39.4 (0.3)	1.6 (0.1)	3.7 (0.1)	36.9 (1.3)
<i>Sibusiso</i>	3	2630 (3)	14.7 (0.3)	39.8 (0.4)	1.2 (0.1)	3.6 (0.1)	39.2 (0.9)
<i>Sibusiso</i>	4	2621 (15)	16.2 (0.2)	38.9 (1.1)	1.5 (0.1)	3.4 (0.0)	39.4 (0.7)
Grand Mean		2624 (15)	15.7 (0.6)	40.1 (1.4)	1.1 (0.2)	3.6 (0.2)	38.1 (1.4)
CV%		1	4.0	3.5	15.5	4.1	3.8
Peanut butter		2852 (12)	25.4 (0.1)	43.2 (0.4)	6.2 (0.6)	2.6 (0.0)	22.2 (0.1)

¹ Mean values (n=2) and standard deviation in brackets

² As is weight basis

³ NDF = Neutral Detergent Fibre

⁴ Non-fibre carbohydrates calculated by difference

Table 4.2 Nutritional composition of *Sibusiso* compared to the WHO/WFP/SCN/UNICEF recommendations for RUF (100 g serving of sample)

Nutrient	WHO/WFP/SCN/UNICEF ¹ recommendations	<i>Sibusiso</i> ²
Moisture (%)	<2.5	0.6
Energy (kJ)	2176-2301	2624
Protein (% total energy)	10-12	10
Fat (% total energy)	45-60	58
Ash (g)	4	3.6

¹WHO/WFP/SCN/UNICEF 2007

²Calculated using grand mean of *Sibusiso*, Table 4.1

Table 4.3 Percentage nutrient supplied by 50 g of *Sibusiso* to an individual between the age of 1 and 18 years

Age in years	Energy EER (kJ/day) ¹	% of EER met	Protein RDA (g/day) ¹	% of RDA met	Carbohydrate RDA (g/day) ¹	% of RDA met	Fat AMDR (g/day) ¹	% of AMDR met	Fibre AI (g/day) ^{1,2}	% of AI met
Males										
1-3	4377	30	13	60	130	15	30-40	50-67	19	3
4-8	7289	18	19	41	130	15	25-35	57-80	25	2
9-13	9535	14	34	23	130	15	25-35	57-80	31	2
14-18	13188	10	52	15	130	15	25-35	57-80	38	1
Females										
1-3	4151	32	13	60	130	15	30-40	50-67	19	3
4-8	6870	19	19	41	130	15	25-35	57-80	25	2
9-13	8665	15	34	23	130	15	25-35	57-80	26	2
14-18	9908	13	46	17	130	15	25-35	57-80	26	1

¹Sizer & Whitney (2008)²Neutral Detergent Fibre

EER = Estimated Energy Requirement, RDA = Required Dietary allowance, AMDR = Acceptable Macronutrient Distribution range, AI = Adequate intake

In general *Sibusiso* contained a higher amino acid content compared to the peanut butter and the FAO/WHO recommended patterns of children between the ages of 1 to 2 years (Table 4.4). *Sibusiso* contained approximately 41%, 37%, 33% and 31% more lysine, histidine, isoleucine and valine compared to the peanut butter, respectively. The leucine, threonine, proline, serine and the sulphur containing amino acids methionine and cysteine content of *Sibusiso* was 20% more than that of the peanut butter. *Sibusiso* also contained 10% more alanine, aspartic acid, and the aromatic amino acids phenylalanine and tyrosine compared to the peanut butter.

When *Sibusiso* was compared to the FAO/WHO pattern of amino acid requirements, *Sibusiso* contained twice the amount of histidine and the aromatic amino acids, phenylalanine and tyrosine. Also, the amount of isoleucine, threonine and valine in *Sibusiso* was approximately 1.5 times that of the FAO/WHO pattern of amino acid requirements. Consuming 50g of *Sibusiso* is estimated to provide more than 55% of the FAO/WHO recommended amino acid patterns for children between the ages of 1 to 2 years.

The most limiting amino acids in *Sibusiso* were lysine and sulphur containing amino acids: methionine and cysteine with amino acid scores of 1.1. Lysine was also the most limiting amino acid in the peanut butter with an amino acid score of 0.7.

Table 4.4 Amino acid composition of *Sibusiso*

Amino Acid	Peanut pastes ¹		FAO/WHO/UNU recommended amino acid pattern ^{1,3}	% amino acid requirement met ⁴	Amino acid score ⁵	
	<i>Sibusiso</i> ²	Peanut butter ²			<i>Sibusiso</i>	Peanut butter
Essential						
His	3.5	2.2	1.8	97.2	1.9	1.2
Lys	5.8	3.4	5.2	55.8	1.1	0.7
Leu	8.5	6.5	6.3	67.5	1.4	1.0
Isole	4.9	3.3	3.1	79.0	1.6	1.1
Thr	4.1	3.2	2.7	75.9	1.6	1.2
Try	1.0	0.8	0.7	71.4	1.4	1.1
Val	6.1	4.2	4.2	72.6	1.5	1.0
Phe + Tyr	10.5	8.5	4.6	114.1	2.3	1.9
Met + Cys	2.9	2.1	2.6	57.8	1.1	0.8
Non-essential						
Ala	5.0	4.1				
Arg	11.0	11.9				
Asp	13.5	11.1				
Glu	22.5	20.6				
Gly	6.5	6.4				
Pro	6.3	4.6				
Ser	6.6	5.1				

¹ g per 100g protein, wet weight² Mean (n=2) values³ Pattern of amino acid requirements for children between the ages of 1-2 years (FAO 2007)⁴ Percentage of FAO/WHO recommended amino acid pattern met when 50g of *Sibusiso* is consumed⁵ Amino acid score = mg of amino acid in 1g of test protein/mg of amino acid in 1g of reference population

4.1.2 Colour of *Sibusiso*

The Hunter L, a and b values, and the chroma and hue angle of *Sibusiso* did not vary with the different batches of *Sibusiso* analyzed, Table 4.5. The hue angle, a and b values indicated that *Sibusiso* and the peanut butter were in the red-yellow region, and they were more towards the yellow. The L values of both *Sibusiso* and the peanut butter were around the center of the axis, indicating that they were in the grey area of the scale. This indicates that both *Sibusiso* and the peanut butter have a light brown colour. However *Sibusiso* was slightly lighter than the peanut butter as indicated by the Hunter L value and hue angle, and may be seen in Figure 4.1a and 4.1b. The hunter L and hue angle of *Sibusiso* were slightly higher than the hunter L and hue angle of the control by 4.4% and 7.5%, respectively. The chroma or saturation of the colour was the same for both *Sibusiso* and the peanut butter.

Table 4.5 Colour of *Sibusiso* ¹

Sample	Batches	L	a	b	Chroma	Hue
<i>Sibusiso</i>	1	56.1 (0.0)	6.1 (0.2)	20.3 (0.3)	8.6 (0.0)	73.4 (0.0)
<i>Sibusiso</i>	2	56.7 (0.0)	6.3 (0.0)	21.3 (0.0)	8.6 (0.0)	73.6 (0.0)
<i>Sibusiso</i>	3	54.9 (0.1)	6.3 (0.0)	20.3 (0.1)	8.5 (0.0)	72.7 (0.0)
<i>Sibusiso</i>	4	58.6 (0.1)	6.1 (0.0)	20.9 (0.0)	8.6 (0.0)	73.7 (0.1)
Grand mean		56.7 (0.1)	6.2 (0.2)	20.7 (0.4)	8.6 (0.0)	73.3 (0.0)
CV%		2.2	3.1	1.7		
Peanut butter		54.2 (1.0)	9.0 (0.2)	22.2 (0.6)	8.2 (0.1)	67.8 (0.8)

¹ Mean values (n=3) and standard deviation in brackets

L = Measure of lightness (0= black to 100 = white)

a = Measure of redness (+a = redness; -a greenness)

b = Measure of yellowness (+b = yellowness; -b = blueness)

Chroma = $[(a)^2 + (b)^2]^{1/2}$

Hue = $\tan^{-1} (b/a)$



Figure 4.1a *Sibusiso*



Figure 4.1b Peanut butter

4.1.3 Texture of *Sibusiso*

The hardness, work of shear and work of adhesion did not vary with the different batches of *Sibusiso* analyzed (Table 4.6). The stickiness of *Sibusiso* slightly (12%) varied with the different batches, and *Sibusiso* had higher stickiness and work of adhesion compared to the peanut butter. The stickiness and work of adhesion of *Sibusiso* was 17% and 28% more than that of the peanut butter, respectively. Less (8%) force (work of shear) was required to penetrate *Sibusiso* compared to the peanut butter. However the hardness was the same for both *Sibusiso* and the peanut butter.

Table 4.6 Textural properties of *Sibusiso*¹

Sample	Batches	Hardness (N)	Work of shear	Stickiness (N)	Work of adhesion
<i>Sibusiso</i>	1	10.2 (0.3)	7.3 (0.2)	12.8 (0.3)	3.7 (1.0)
<i>Sibusiso</i>	2	10.4 (0.2)	7.6 (0.2)	16.1 (0.4)	4.1 (0.3)
<i>Sibusiso</i>	3	10.2 (0.3)	7.1 (0.2)	13.1 (0.1)	4.1 (0.2)
<i>Sibusiso</i>	4	10.3 (0.4)	7.4 (0.6)	15.5 (0.3)	4.0 (0.3)
Grand mean		10.3 (0.1)	7.4 (0.2)	14.8 (1.7)	4.0 (0.2)
CV %		1	3	12	5
Peanut butter		10.3 (0.2)	8.0 (0.2)	13 (0.1)	2.9 (0.3)

¹ Mean values (n=2) and standard deviation in brackets

4.2 Phase 2: Sensory evaluation of *Sibusiso*

4.2.1 Consumer demographics

The sensory evaluation panel consisted of children between the ages of 4 and 17 years living in Pietermaritzburg, as presented in Table 4.7. The children were grouped into the healthy and ART (HIV infected on ARV's) group depending on their health status. In the healthy category the age range was 4-17 years with the mean age of 11.5 years (data not shown). In the ART group the age range was 4-14 years and the mean age was 8.8 years (data not shown). The healthy group had more children in the 12-18 age range. While in the ART group more children were between the ages of 4-11 years. Similar numbers of males and females were obtained in both health categories.

Table 4.7 Demographics of the sensory evaluation panel

	Health status	
	Healthy % (n=123)	ART % (n=65)
Age		
4-11	43.7 (54)	73.8 (48)
12-18	56.1 (69)	26.2(17)
Gender		
Males	50.4 (62)	49.2(32)
Females	49.6(61)	50.8(33)
Race		
Black	39.8(49)	100 (65)
White	17.1(21)	0(0)
Coloured	17.1(21)	0(0)
Indian	26(32)	0(0)

4.2.2 The relationship between health status, gender and the consumer acceptability of *Sibusiso*

The health status of the children was associated with the number of children rating *Sibusiso* per rating (“good”, “neutral” and “bad”) category (Table 4.8). Conversely, gender had no effect ($p > 0.05$) on the acceptability of *Sibusiso*. Generally over 75% of the participants in both the healthy and unhealthy group rated the overall product as “good”. Furthermore more than 65% of the children from both the healthy and ART group rated the taste, smell and mouthfeel of *Sibusiso* as “good”. The colour of *Sibusiso* was rated as “good” by 72.3% and 44.7% of the children from the ART and healthy group, respectively.

More children in the ART group liked the sensory attributes of *Sibusiso* compared to the healthy group. However more healthy children liked the overall product compared to the ART group. Slightly (5%) more children in the ART group rated the taste as “good”. Also more (10.6%) children in the ART group rated the taste as “bad”. Around 16.4% children in the healthy group rated the taste of *Sibusiso* as “neutral” compared to the ART group. The rating of the mouthfeel of *Sibusiso* also followed a similar trend. Slightly 5% and 6% more children in the ART group rated the mouthfeel of *Sibusiso* as “good” and “bad” compared to the healthy group, respectively. While 11.7% more children from the healthy group rated the mouthfeel of *Sibusiso* as “neutral” compared to the ART group. Around 31% more children from the ART group rated the colour of *Sibusiso* as “good” compared to the healthy group. More children in the healthy group rated the colour of *Sibusiso* as “bad” and “neutral” at 8.2% and 25.5%, respectively. No significant differences were observed in the rating of the smell of *Sibusiso* between the healthy and ART group. Slightly (4%) more children in the healthy group rated the overall product as “good” and “neutral” compared to the ART group. Around 7.4% more children in the ART group rated the overall product as “bad”.

In the healthy group, the colour and taste of *Sibusiso* had the largest (23.6%) and least (3.3%) percentage of children who did not like it, respectively. While in the ART group the mouthfeel and smell of *Sibusiso* had the largest (21.5%) and least (13.8%) number of children who did not like it, respectively. The healthy group liked the smell the most, followed by the taste, mouth feel then the colour of *Sibusiso*. In the ART group the taste was liked by most of the children followed by the smell, mouthfeel and lastly the colour of *Sibusiso*.

Table 4.8 The relationship between health status, gender and the sensory attributes of *Sibusiso*

	Health status			p-values ²	Gender		p-values ²
	Healthy % (n=123)	ART % (n=65)	Total % (n=188)		Male % (n=94)	Female % (n=94)	
Taste							
Bad	3.3	13.9	6.9	<0.01	9.6	4.2	0.45
Neutral	17.9	1.5	12.2				
Good	78.9	84.6	80.9				
Smell							
Bad	5.7	13.8	8.5	0.15	5.3	11.7	0.06
Neutral	13.8	6.2	11.2				
Good	80.5	80	80.3				
Colour							
Bad	23.6	15.4	20.7	0.00	22.3	19.1	0.56
Neutral	31.7	6.2	22.9				
Good	44.7	78.5	56.4				
Mouthfeel							
Bad	15.5	21.5	17.6	0.03	17.1	18.1	0.80
Neutral	17.9	6.2	13.8				
Good	66.7	72.3	68.6				
Overall liking							
Bad	6.5	13.9	9	0.02	8.5	9.6	0.62
Neutral	11.4	7.7	10.1				
Good	82.1	78.5	80.9				

² The p-values were determined using the Chi-Square test

4.2.3 The relationship between health status, age and the consumer acceptability of *Sibusiso*

The age of the children was associated with the acceptability of *Sibusiso* in the healthy group compared to the ART group, Table 4.9. Generally more healthy children between the ages of 4 and 11 years rated the attributes of *Sibusiso* and the overall product as “good”. While more healthy children between the ages of 4 and 12 years rated the taste and smell of *Sibusiso*, and the overall product as “neutral”. Approximately 8% and 4% more healthy children between the ages of 4 and 11 years rated the taste of *Sibusiso* as “good” and “bad”, respectively. While a higher percentage (12.1%) of the healthy children between the ages of 12 and 18 years rated the taste of *Sibusiso* as “neutral”. The rating of the smell and overall liking of *Sibusiso* followed a similar trend. The colour of *Sibusiso* was rated as “good” by 6.8% more healthy children between the ages of 4 and 11 years. While 6.9% more healthy children between the ages of 12 and 18 years rated the colour of *Sibusiso* as “bad”. Similar numbers of the healthy children between the ages of 4-11 and 12-18 years rated the colour of *Sibusiso* as “neutral”. The rating of the mouthfeel of *Sibusiso* followed a trend similar to that of the rating of the colour of *Sibusiso*. However the number of children rating the mouthfeel as “good” and “bad” was larger than that of the number of children rating the colour as “good” or “bad”. The mouthfeel of *Sibusiso* was rated as “good” by 16.5% more healthy children between the ages of 4 and 11 years. While 17.6% more healthy children between the ages of 12 and 18 years rated the mouthfeel of *Sibusiso* as “bad”.

Over 75% of all the children in the healthy group rated the overall product/*Sibusiso* and its taste and smell as “good”. The colour of *Sibusiso* was rated as “good” by 51.9% and 44.7% of the healthy children between 4-11 years and 12-18 years, respectively. The mouthfeel of *Sibusiso* was rated “good” by 75.9% and 59.4% of the healthy children between 4-11 years and 12-18 years, respectively.

Table 4.9 The relationship between health status, age and the sensory attributes of *Sibusiso*

	Health categories					
	Healthy			ART		
	4-11 yrs % (n=54)	12-18 yrs % (n=69)	p-value ³	4-11 yrs % (n=48)	12-18 yrs % (n=17)	p-value
Taste						
Bad	5.6	1.4	<0.01	14.6	11.8	0.91
Neutral	11.1	23.2		2.1	0	
Good	83.3	75.3		83.4	88.2	
Smell						
Bad	7.4	4.3	0.00	14.6	11.8	0.39
Neutral	7.4	18.8		4.2	11.8	
Good	85.2	76.8		81.3	76.5	
Colour						
Bad	16.7	23.6	0.17	18.8	5.9	0.35
Neutral	31.5	31.7		8.3	0	
Good	51.9	44.7		73	94.1	
Mouthfeel						
Bad	5.6	23.2	<0.02	22.9	17.7	0.71
Neutral	18.5	17.4		4.2	11.8	
Good	75.9	59.4		72.9	70.6	
Overall liking						
Bad	7.5	5.8	0.00	14.6	11.8	0.69
Neutral	3.7	17.4		10.4	0	
Good	88.9	76.8		75	88.2	

³ The p-values determined using the Chi-Square test

4.2.4 Consumer acceptability of *Sibusiso*

The taste, smell, mouthfeel and overall liking of *Sibusiso* were perceived as “good” (mean = 4) by both ($p > 0.05^4$) the healthy and ART groups, Table 4.10. The colour of *Sibusiso* was perceived differently ($p < 0.01$) by the healthy and ART group. The healthy group was “neutral” (mean= 3) about the colour of *Sibusiso* while the ART group thought it was “good” (mean= 4). The acceptability of *Sibusiso* was not ($p > 0.05$) affected by age or gender. However it was noted that healthy children between the ages of 12 -17 years rated the colour of *Sibusiso* as “neutral” (mean = 3). While the healthy children between 4-11 years and all the children in the ART group rated it as “good” (mean = 4). Also healthy females generally had low mean scores compared to healthy males. However in the ART group the females had higher mean ratings compared to the males in the ART group.

⁴ p-values determined using a t-test

Table 4.10 Consumer acceptability of *Sibusiso* as characterised by consumer demographics¹

	Taste		Smell		Colour		Mouthfeel		Overall liking	
	Healthy	ART	Healthy	ART	Healthy	ART	Healthy	ART	Healthy	ART
Overall mean	4.1	4.1	4.0	3.9	3.4	3.8	3.8	3.7	4.1	3.8
Age										
4- 11	4.3	4.0	4.2	3.9	3.6	3.7	4.2	3.6	4.4	3.8
12-18	4.0	4.2	3.8	3.9	3.2	4.2	3.5	3.8	3.9	3.9
Gender										
Male	4.2	3.8	4.0	3.7	3.4	3.6	3.9	3.4	4.3	3.7
Female	4.1	4.3	4.0	4.0	3.3	4.0	3.7	3.9	4.0	3.9

¹ Means are reported

1= super bad, 2 = bad, 3= neutral, 4= good, 5 = super good

4.2.5 Focus group discussions

The focus group panel consisted of African female caregivers (n = 10) with children on ARV's, and receiving health care from a public health hospital in Pietermaritzburg, (Appendix L, p110). The age of the panel ranged between 27 and 46 years (Mean age 36.2 years). The majorities of the participants (90%) were single, unemployed (60%) and had high school (60%) level education. Furthermore the caregivers were from households with 3 to 11 people sharing a home and 60.4% were children under the age of 18. Eight out of nine caregivers received child support grant (R280 per month) and only one received an old age pension (R1000 per month) grant. It was also found that all the caregivers used spreads, 8 used supplements and only 1 used an immune booster. The type of spreads and supplements used are indicated in Figure 4.1 and 4.2, respectively. On a monthly basis the amount of money spent on spreads ranged between R20 and R300 (mean = R158), and between R5 to R136 (mean = 66.25) was spent on supplements. Around R130 was spent on immune boosters. The main sources of the supplements were clinics and hospitals (6/8) and from these, 2 bought additional supplements from the pharmacy and doctor. A further 2 procured supplements from the doctor and the supermarket.

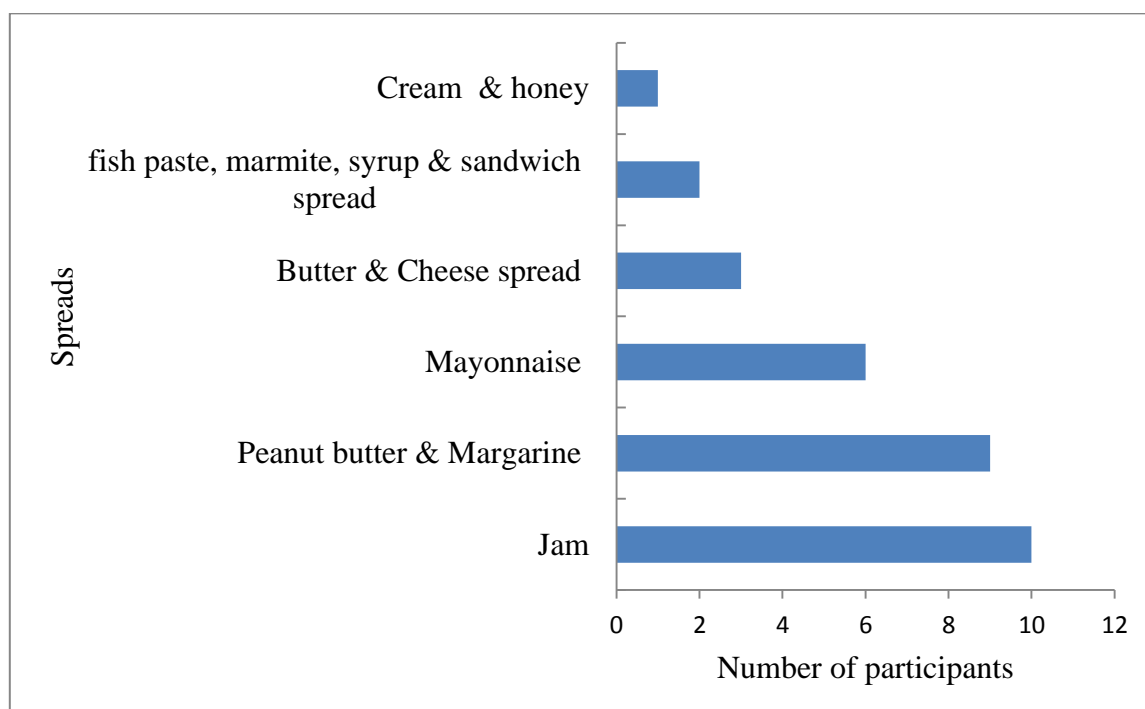


Figure 4.2 Spreads procured by caregivers

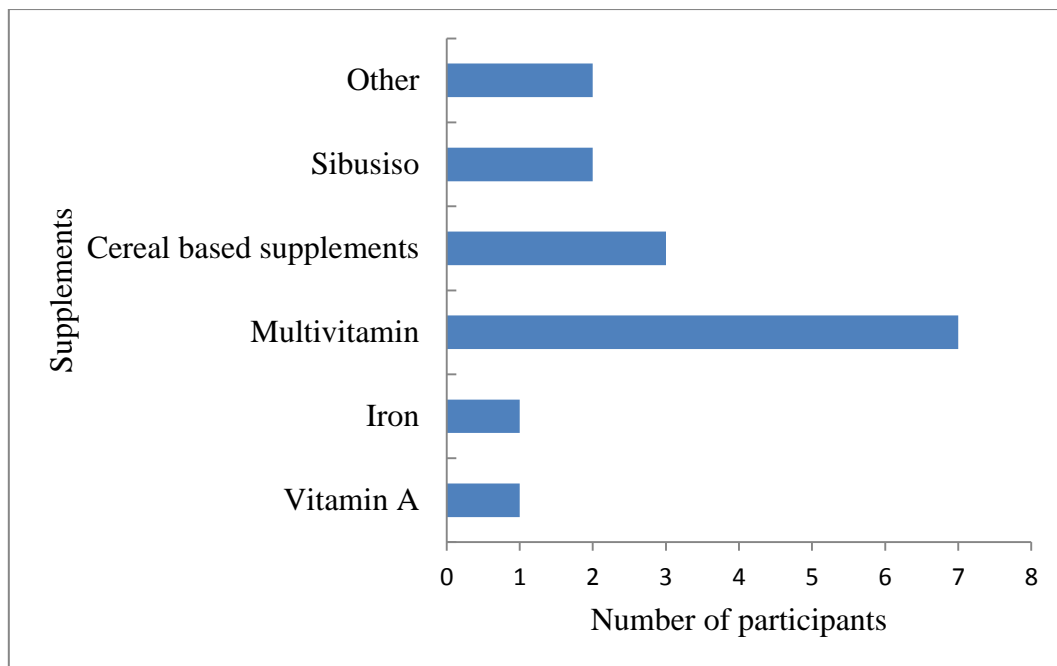


Figure 4.3 Supplements procured by caregivers

The focus group panel perceived the properties (taste, colour, smell and mouthfeel) of *Sibusiso* as acceptable. They also viewed *Sibusiso* as a peanut butter despite its sweet taste (3/10) and rough texture (6/10).

“.....like peanut butter but a bit sweet.....”

“It is rough but not that different from peanut butter”

Furthermore the verbal descriptors used by caregivers to describe *Sibusiso* were similar to those generated by the children, Table 4.11. This indicated that both groups had a similar perception of *Sibusiso*.

Factors affecting the use and procurement of *Sibusiso* are indicated in Table 4.12. The price of *Sibusiso* was a major limiting factor regardless of the knowledge about the health benefits of *Sibusiso*.

Table 4.11 Verbal product descriptors generated by the sensory evaluation and focus group panel

Food properties	Sensory evaluation panel	Focus group panel
Taste	Nutty, sweet Sweet sour	Sweet ,nutty Tasty
Smell	Sweet, nutty	Milky, Nutty
Colour	Light peanut butter, brown	
Texture	Grainy , rough Crunchy, sandy, not sticky	Rough , oily, melts Grainy

Table 4.12 Factors affecting procurement and willingness to use *Sibusiso*

Theme	Main findings	Summary of the discussions
Procurement and consumption of spreads, supplements and immune boosters by children	Commonly bought: <ul style="list-style-type: none"> • Spreads: peanut butter, jam and margarine • Supplements: multivitamin syrup & porridges (2/10) And only 1 person used immune boosters	The listed spreads were commonly bought as children liked consuming foods with these spreads, and this liking is thought to be the result of familiarity with the spreads and parental influence of food choices. The cost of supplements was identified as the main limiting factor towards purchasing supplements while nutrition knowledge had a positive effect on procurement. The multivitamin syrup was bought at 7 ZAR (1 per month) mainly to improve appetite while the porridges were bought at 10 ZAR (2 per month) each and 22 ZAR (4 per month) mainly as children showed preference of the porridges during periods of poor appetite and also to maintain normal weight. Immune boosters were not used as participants were educated about the dangers of mixing ARV's and immune boosters, and also from life's experiences.
	Factors affecting procurement of: <ul style="list-style-type: none"> • Spreads: child preferences (8/10) • Supplements : Cost (9/10), child preference (1/10) & nutritional status (1/10) • Immune boosters: Health awareness (9/10) 	
	The spreads in particular peanut butter was consumed on its own, with bread and porridge.	
Willingness to buy and use the paste	All of the participants were willing to buy <i>Sibusiso</i> & factors affecting willingness to buy were: <ul style="list-style-type: none"> • Price (7/10) • Perception of the product (8/10) • Nutrition knowledge (6/10) 	Affordability was identified as a major concern as the participants felt that <i>Sibusiso</i> should be affordable to the poor/unemployed. Without nutrition information, <i>Sibusiso</i> was viewed as a peanut butter affecting its pricing. Prices suggested by the participants ranged from 17.99 to 30 ZAR. The high prices were given as the 500 g tub of <i>Sibusiso</i> was larger the peanut butter tub (400 g) they buy. After the participants were given the nutritional information and benefits of <i>Sibusiso</i> they valued it at 25 ZAR and 30 ZAR. They were also willing to buy <i>Sibusiso</i> and leave the peanut butter. However they were not willing to buy at high prices (+ 70 ZAR) which other supplements are sold. Only 1 person was willing to replace the immune boosters with <i>Sibusiso</i> .
	<i>Sibusiso</i> will be used like peanut butter as a spread, with porridge or on its own, and factors that would improve its consumption in children are: <ul style="list-style-type: none"> • Modelling (7/10) • Motivation (8/10) 	All participants thought that their children would like <i>Sibusiso</i> and if the children did not like <i>Sibusiso</i> , the parents would show the children that they (caregivers) like eating <i>Sibusiso</i> , and tell them that <i>Sibusiso</i> is tasty and good for them.

4.3 Phase3: Feasibility/practicality of using *Sibusiso*

The cost of rehabilitating a malnourished child ranged between 1.03 ZAR to 33.69 ZAR per day, and an average of 12.75 ZAR per day, Table 4.13. The cost of a 50 g of *Sibusiso* was 5 times more than that of the other RUFs. While the cost of implementing a new intervention that uses RUF for nutrition rehabilitation was 25 times more than the cost of introducing a RUF in an operational setting. The cost of introducing a local produced RUF was slightly cheaper than using an imported RUF.

Table 4.13 Cost analysis of using ready-to-use foods

Source/ reference	Place	Study characteristics	Type of supplement	Results	Description of cost	Cost of intervention	Adjusted cost of interventions in SA 2012 per child per day
This study	South Africa	Hypothetical estimate	Imported RUF providing 1320kJ/ day or 50g	Not published	Cost of providing supplement at a facility		5.99 ZAR or 0.76 US\$/ child/day
KwaZulu- Natal Department of Health (2011)	South Africa	Calculated based on KZN- DOH budget	Corn based supplements & locally produced RUF	Not published	Cost of providing supplements	0.03 US\$ /child/day In 2010/11	0.02 ZAR or 0.01 US\$/child/day
Singh, Kang, Ramachandra n, Sarkar, Peter & Bose (2010)	India	N=118 Age between 18-60mnths with moderate malnutrition	Locally produced RUF providing 23 J per gram	Increase in weight gain Mean weight gain 0.54kg at end of study	Providing RUF	0.15 US\$ /child/day In 2008	1.22 ZAR or 0.15 US\$/child/day
Manary (2005)	Malawi	Hypothetical estimate	Locally produced providing 1151 kJ/day or 50g	Not indicated	Cost of producing RUF based on field experience	0.13 US\$ /child/day In 2002- 2005	1.03 ZAR or 0.13 US\$ /child/day
Isanaka, Roederer, Djibo, Luquero, Nombela, Guerin &Grais (2010)	Niger	N=1645 non malnourished children between 6-60 months	Imported RUF providing 1117 kJ/day or 50g	In villages with previous supplementation RUF associated with less (46%) incidence of wasting and severe wasting In villages with no pervious supplementation RUF, incidence of wasting was reduced by around 19%	Cost of providing food supplement	0.21 US\$ /child per/ day 2007	1.698 ZAR or 0.21 US\$/child/day

Table 4.13 Cost analysis of using ready-to-use foods (*end*)

Source/ reference	Place	Study characteristics	Type of supplement	Results	Description of cost	Cost of intervention	Adjusted cost of interventions in SA 2012 per child per day
Bachmann (2009)	Zambia	N=3358 Children under the age of 5 with severe acute malnutrition both with and without HIV	Imported & local RUF providing 837 kJ/kg/day or 271 g	Mortality was reduced by 11.5% and DALY's increased by a 3.8 compared to doing nothing	Implementing intervention Decision tree model used to calculate program cost	4.14 US\$ / child /day In 2008	33.65 ZAR or 4.24 US\$/ child/day
Wilford, Golden & Walker (2011)	Malawi	N=2750 children under 5 with acute malnutrition, both with and without HIV infection	Locally produced RUF	91.3% recovered 1% died 4.6% defaulted 3.1% admitted at hospital	Implementing intervention	4.03 US\$ /child/day 2007	32.56 ZAR or 4.10 US\$/ child/day

4.4 Summary

Sibusiso contained more ash and carbohydrate compared to the peanut butter. *Sibusiso* was also low in energy, protein, fat and fibre compared to the commercial peanut butter. However the nutritional composition of *Sibusiso* was in line with the WHO/WFP/SCN/UNICEF recommendation for RUF. *Sibusiso* contributed significant amount of macronutrients to the diet of children below the age of 8 years. Both *Sibusiso* and the peanut butter were light brown however *Sibusiso* was lighter. Furthermore the hardness of *Sibusiso* was similar to that of the peanut butter however *Sibusiso* was stickier. It was also found that *Sibusiso* was acceptable to both the healthy and HIV infected children on ARVs. The caregivers also had a positive attitude towards *Sibusiso* and were willing to buy it at half its current price. Using *Sibusiso* for nutrition rehabilitation was very costly. In the following chapter, these results will be discussed.

CHAPTER 5: DISCUSSION

5.1 Phase 1: Properties of *Sibusiso*

5.1.1 Nutritional composition of *Sibusiso*

The RUF, *Sibusiso*, had an energy content higher than that of the other available RUFs including *Plumpty'nut*, *Nutributter* and RUCF India (Pee & Bloem, 2008; Emergency Nutrition Network [ENN] 2004; Diop *et al* 2003). The high energy content of *Sibusiso* was largely due to its high fat content compared to that of *Plumpty'nut*, *Nutributter* and RUCF India (Pee & Bloem, 2008; ENN 2004; Diop *et al* 2003). Fats provide twice the amount of energy provided by proteins and carbohydrates. The fat content of *Sibusiso* is estimated to have contributed approximately 58% of the total energy per 100 g. The energy content of *Sibusiso* was also within the WHO/WFP/SCN/UNICEF recommendations for RUF. This indicated that *Sibusiso* could be used effectively to meet the high energy needs of malnourished children, similar to other available RUF such as *Plumpty'nut*.

The consumption of 50 g of *Sibusiso* was estimated to provide less than 32% of the EER for healthy children between the ages of 1 to 18 years. Additionally the energy contributions decreased with an increase in age. The energy contributions of any RUF including *Sibusiso* would have less energy contribution at the 30 g/ day intake recommended by the KZN-DOH under NSP (KZN-DOH 2010). This suggests that the amount of RUF consumed by children needs to be age specific in order for the RUF to have significant contributions to the diet of children. However there may be difficulties in the community to consume 50 g or more of *Sibusiso* per day. In this study, *Sibusiso* was described as a product similar to a peanut butter. This was reflected in the words used by the sensory evaluation and focus group discussion panel. Furthermore, the caregivers stated that they would use *Sibusiso* in the same way they use a peanut butter. In South Africa, the consumption of peanut butter was less than 30 g/ day amongst consumers between the year 1983 and 2000, and the amount was halved in children between the ages of 1 to 5 years (Nel & Steyn 2002). This highlights the importance of educating the public about the importance of viewing *Sibusiso* as more than a peanut butter and consuming the recommended amount of RUF in order for the RUF to be efficient in alleviating malnutrition.

The lower energy content of *Sibusiso* compared to the peanut butter may be due to the lower fat content of *Sibusiso* compared to that of the peanut butter. Similar results were reported by Mazaheri-Tehrani *et al* (2009), who showed that soy-peanut spreads have a low fat content

compared to that of a peanut butter. Soya beans generally contain a low fat content compared to peanuts (Michaelsen *et al* 2009; Mazaheri-Tehrani *et al* 2009). The fat content of soya beans is around 18 g/ 100 g while that of peanuts is 43 g/ 100 g sample (Michaelsen *et al* 2009).

In early childhood, fats are regarded as a key nutrient that can be used in the diet in order to meet the high energy needs of growing children without making the food bulky (FAO 2010). The other functions of fats in the body include the absorption of fat soluble vitamin A, D, E and K, and development of the brain and retina from pregnancy to the first two years of life (FAO 2010; Uauy & Dangour 2000).

The protein content of *Sibusiso* was slightly higher than the protein content of other available RUF such as *Plumpy'nut*, *Nutributter* and RUCF India (De Pee & Bloem, 2008; ENN 2004; Diop *et al* 2003). This may be attributed to the addition of higher amounts of protein-rich ingredients such as soya in *Sibusiso* compared to the other available RUF such as *Plumpy'nut*, *Nutributter* and RUCF India. The protein content of *Sibusiso* found in this study was similar to the protein content stated on the label and within the WHO/WFP/SCN/UNICEF recommendation for RUF. This indicated that *Sibusiso* has a potential to alleviate protein deficiency. However its efficacy will be affected by the quality of the protein. The protein content of *Sibusiso* was however lower than that of the peanut butter. This may be attributed to the low content of protein containing ingredients in *Sibusiso* compared to the peanut butter. A typical commercial peanut butter consists of at least 90% peanuts (FDA 2009). While the amount of the protein containing ingredients (soya, peanut and/or milk) used to make RUF is generally between 50 and 60% of the weight ingredients (Matilsky, Maleta, Castleman & Manary 2009; Singh *et al* 2010; Jarrett 2007; Manary 2005). In a study by Matilsky *et al* (2009), the soy-peanut RUF used contained 27% peanuts and 26% soya and the second RUF used was made from 26% peanuts and 25% milk. Whereas Singh *et al* (2010) used a RUF containing about 30% peanuts and 28% milk. This could further explain why *Sibusiso* and the other soy-peanut based RUF such as *Plumpy'nut* contain a lower protein content compared to the soy-peanut pastes.

The amino acid composition of *Sibusiso* was higher than that of the peanut butter. This is because, unlike the peanut butter, *Sibusiso* contains both soya and peanuts. From the plant proteins, soya has the highest protein quality and is comparable to animal proteins (Mazaheri-Tehrani *et al* 2009; Yeh *et al* 2002). The most limiting amino acids in *Sibusiso* were lysine

and the sulphur containing amino acids (methionine and cysteine). However these amino acids can be obtained from a balanced diet that contains animal products such as chicken, fish, eggs, milk and milk products and plant products such as potatoes, apples, soy products, lentils and pumpkin seeds. Peanuts have been reported to have a low lysine content (Michaelsen *et al* 2009; Yeh *et al* 2002), while soya bean have low amounts of the sulphur containing amino acids (Michaelsen *et al* 2009). The digestibility of the protein in the peanut butter and soya isolate is above 95% (Sarwar, Peace Botting & Brulé 1989). It can be assumed that the protein in *Sibusiso* is readily available to the body. The literature also reports that protein absorption and storage is high when the energy content of that food/meal is high (WHO/FAO/UNU 2007). But other factors such as physical activity and adequate zinc consumption play a vital role in the formation of lean tissue (Michaelsen *et al* 2009; WHO/FAO/UNU 2007).

In general, infections increase the body requirements for protein. However there is a lack of data that supports an increased protein requirement in HIV infected people (NDOH 2010; WHO/FAO/UNU 2007). This is despite of the association of HIV/AIDS with weight loss (60% lean tissue) and mortality. *Sibusiso* was a fairly good source of protein and the essential amino acids. This indicated that *Sibusiso* can be used to enhance the protein intake of malnourished children including those with HIV/AIDS.

The higher carbohydrate content of *Sibusiso* compared to that of the peanut butter could be due to the inclusion of sugar and soya. Sugar mainly contains simple carbohydrates and empty calories (De Pee & Bloem 2009, Michaelsen *et al* 2009). Soy-peanut pastes have been reported to have a higher carbohydrate content compared to a peanut butter (Mazaheri-Tehrani *et al* 2009). The carbohydrate content in soya beans and peanuts is estimated to be approximately 35% and 25%, respectively (Michaelsen *et al* 2009). The high carbohydrate content of *Sibusiso* compared to the protein content, would allow the body to use the carbohydrate for energy as it is the preferred source of energy. The carbohydrate content stated on the label was higher than the carbohydrate content found in this study by 9.7 g. This could be due to different analysing methods used.

Sibusiso contained a significantly low fibre content compared to the peanut butter. The advantage of the low fibre content of *Sibusiso* is that there will be reduced fibre and nutrient interaction. Fibre in food can decrease the digestibility and absorption of the nutrients (Michaelsen *et al* 2009; WHO/FAO/UNU 2007). For example, moderate fibre intake has

been associated with approximately 2-3% reduced energy absorption (WHO/FAO/UNU 2007).

The ash content of *Sibusiso* was higher than that of the peanut butter. The high micronutrient profile of *Sibusiso* may be attributed to the vitamin and mineral premix used in making the product. The ash content of *Sibusiso* was also similar to the WHO/WFP/SCN/UNICEF recommendations for RUF, and other RUF such as *Plumpy'nut* (Pee & Bloem, 2008; ENN 2004; Diop *et al* 2003). This indicated that *Sibusiso* has a potential to alleviate some of the common micronutrient deficiencies. However the exact micronutrients which can be alleviated are unknown as the micro nutrient analysis was not done due to cost restriction. Micronutrients are essential for the normal function of the human body.

5.1.2 Colour of *Sibusiso*

Sibusiso had a lighter (High Hunter L value and hue angle) shade of the brown colour compared to the peanut butter. *Sibusiso* was also described as light brown in colour by the sensory evaluation panel. Yeh *et al* (2003) indicated that soy-peanut pastes have a lighter brown colour compared to the peanut butter. The different processing procedures and/or ingredients used could explain the slight variation in the colour of *Sibusiso* and the peanut butter. As it was previously mentioned, RUF have a low peanut and soya content compared to the peanut content found in peanut butter. In peanut pastes these foods are the main source of the brown colour developed during roasting (USAID 2006; Patee *et al* 1991). The roasting temperature and time are the main factors that affect the colour of peanut pastes (USAID 2006; Pattee *et al* 1991). Roasting nuts for a short time and at low temperature has been shown to result in light paste, and vice versa (USAID 2006). Also the addition of sugar, soya milk and vegetable oil in *Sibusiso* could have diluted the colour of *Sibusiso*.

5.1.3 Texture of *Sibusiso*

Sibusiso has the same hardness as the peanut butter and this result was not anticipated. Mazaheri-Tehrani *et al* (2009) reported that not only are soy-peanut pastes harder than all peanut paste, but the level of hardness increased with the amount of soya flour used. However all peanut paste formulations contained 90.5% peanut or soya and peanut. Dubost (2001) also observed an increase in the hardness of soy-peanut paste as the level of the isolated soya protein used increased. This may be due to the low fat content of soy-peanut pastes compared to a peanut butter. In peanut pastes, the fat content is an important determinant of the texture as peanut pastes are peanut particles in oil emulsions (Citerne *et al*

2001). RUF contain less than 60% peanut and soya (Matilsky, Maleta, Castleman & Manary 2009; Singh *et al* 2010; Jarrett 2007; Manary 2005), while the peanut butter contained at least 90% peanut (FDA 2009). This may have contributed to the similar levels of hardness between the *Sibusiso* and the commercial peanut butter.

Dubost (2001) reported that soy-peanut pastes with high levels of stabilizer are harder than those with the lower levels of the stabilizer. *Sibusiso* contained no stabilizer while the peanut butter had TBHQ. This may have also contributed to the similar levels of hardness between *Sibusiso* and the peanut butter. The similarity in the hardness of *Sibusiso* and the peanut butter indicated that *Sibusiso* can be used or spread like a peanut butter. However *Sibusiso* was stickier than the peanut. This result was as expected as soy-peanut pastes have been shown to be stickier than peanut butters (Mazaheri-Tehrani *et al* 2009). This may be due to a lack of a stabilizer in *Sibusiso*. Aryana, Ressurreccion & Chinman (2000) reported that peanut protein form clumps in the absence of a stabilizer. The stickiness of *Sibusiso* may result in it being avoided during periods when people have oral sores, which are common in HIV infected people (NDOH 2007). The presence of oral sores makes eating food painful and generally hard, rough or sticky foods are avoided. However *Sibusiso* can be added to foods that can be eaten with a straw such as thin porridge and soup.

5.2 Phase 2: Sensory evaluation of *Sibusiso*

Sibusiso was acceptable to both the children and caregivers. Generally, RUFs have been reported to be acceptable to both the children and their mothers regardless of the type of RUF and methodology used (Adu-Afarwuah *et al* 2011; Mana foods 2011; Matias *et al* 2011; Parker *et al* 2011). As previously mentioned, both the children and the caregivers viewed *Sibusiso* as a form of a peanut butter. The background information collected on the caregivers who are peanut butter consumers indicated that peanut butter was one of the most commonly used spreads (9/10). The peanut butter was mainly bought as children liked it. The association of the supplement with peanut butter might have contributed to the high acceptability of the supplement. Another factor that may have increased the acceptability of *Sibusiso* may be its sweet taste. Parker *et al* (2011) and Flax *et al* (2009) reported that mothers thought that their children liked the RUFs due to their sweet taste. The high acceptability of sweet foods in children has been associated with a genetic predisposition to prefer sweet tastes (Zhang & Li 2007; Guinard 2001; Nu, Macleod & Barthelemy 1996). The high acceptability of *Sibusiso* indicated that *Sibusiso* can be used effectively for nutrition rehabilitation.

5.2.1 The relationship between health status and the acceptability of *Sibusiso*

The health status had an effect on the number of children rating *Sibusiso* (overall product) and its attributes, except for the smell, per rating category. However both groups had similar perceptions of *Sibusiso* and its attributes except for its colour. HIV infected people have been reported to suffer from altered taste perception (NDOH 2007; Heald *et al* 1998). One of the common tastes complaints is unusual taste (Heald *et al* 1998). However, in this study the taste of *Sibusiso* was highly acceptable to both the healthy and HIV infected children. This may be due to the fact that the effect of HIV and the ARV's on the taste perception is minimal.

The smell of *Sibusiso* was also acceptable to both the healthy and HIV infected children on ARV's. Smell complaints are common in HIV Infected people (Mueller *et al* 2002; Hornung *et al* 1998). Often HIV infected people have decreased smell sensitivity (Heald *et al* 1998). The high acceptability of the smell of *Sibusiso* may be due to the nutty aroma.

HIV infected children on ARV's "liked" the colour of *Sibusiso* while the healthy children were "neither liked nor disliked" it. Furthermore a larger proportion of the HIV infected children on ARV's compared to the healthy children thought the colour of *Sibusiso* was "Good". The instrumental colour analysis indicated that the colour of *Sibusiso* was lighter than that of the peanut butter. The sensory evaluation panel also described the colour of *Sibusiso* as a "light peanut butter". This may have caused the differences in the acceptability of the colour of *Sibusiso*.

The mouthfeel of *Sibusiso* was acceptable to both the healthy and HIV infected children on ARV's. This was despite the children and caregivers describing the mouthfeel as "grainy", "sandy" or "rough". Soya beans produce pastes with a grainy texture as they do not soften completely during processing (Yeh *et al* 2002). However the caregivers stated that the "grainy" texture of *Sibusiso* was not very different from that of the peanut butter. This may have contributed to the acceptability of the mouthfeel of *Sibusiso*. There is some substance to this as the instrumental texture analysis of *Sibusiso* indicated that *Sibusiso* has the same spreadability as the peanut butter however it was stickier.

5.2.2 The relationship between age and the acceptability of *Sibusiso*

The age of the children had no effect on the acceptability of *Sibusiso* and its attributes except for colour. In the healthy group, children between the ages of 12 to 18 years neither liked nor

disliked the colour of *Sibusiso* and those between the ages of 4 to 11 years thought it was “good”. The age of the children had no effect on the acceptability of the colour of *Sibusiso* in HIV infected children on ARV’s. Comparison of the acceptability of the colour of *Sibusiso* between the healthy and HIV infected children on ARV’s need to be interpreted with caution. The number of children within this age category was low in the HIV infected children on ARV’s group compared to the healthy group.

5.2.3 The relationship between gender and the acceptability of *Sibusiso*

Gender had no effect on the acceptability of *Sibusiso*. It has been reported that females food choices are largely influenced by the health status compared to males (Pohjanheimo 2005).

5.2.4 The attitudes and perceptions of the caregivers towards *Sibusiso*

The caregivers generally had a positive attitude towards *Sibusiso* and its properties. Similar results were obtained in a study by Flax *et al* (2009). In early childhood parents are the main influencers of children’s food choices (Al-Shoshan 2007; Savage *et al* 2007). The positive attitude of the caregivers towards *Sibusiso* indicated that the caregiver’s attitude would not be a barrier towards the use and consumption of *Sibusiso* by the children at home. Flax *et al* (2009) reported that mothers were willing to use the supplements if they were provided for free. However the caregivers were not willing to buy *Sibusiso* at its current price (60 ZAR per 500 g). This could be due to the fact that the majority of the caregivers were unemployed. They were receiving multivitamins for free at the clinics and hospitals which might have created dependency on the public health system for the supplements. Two caregivers bought supplements at 100 and 130 ZAR, and 1 person spent 130 ZAR on Immune boosters indicating that at least 3 people can afford to buy *Sibusiso*. However a significant influencer of the willingness to buy *Sibusiso* was perception of *Sibusiso*. The caregivers perceived *Sibusiso* as a peanut butter and were not willing to pay a price above 30 ZAR despite of being educated about the benefits of *Sibusiso*. However this attitude can be changed once the parents used and saw the benefits of using *Sibusiso*. Overtime caregivers using a RUF have been found more willing to pay a high price for the supplements compared to those using a CSB (Flax *et al* 2009). These results need to be interpreted with caution due to the small sample size and may not be applicable to all caregivers receiving health care at the public health facilities due to different cultural and socio-economic backgrounds.

5.3 Phase 3: Feasibility/practicality of using *Sibusiso*

The use of RUF was generally costly compared to the amount of money currently spent on nutrition in KwaZulu-Natal. The amount spent per day on nutrition rehabilitation was extremely low (0.01 ZAR). Although only half of the Nutrition budget was spent in 2010/2011, the amount spent on nutrition rehabilitation per day would still be low. The cost of *Sibusiso* was also high compared to the cost of RUF used in the studies by Singh *et al* (2010), Wilford *et al* (2010) and Isanaka *et al* (2010). This could be due to high transport cost of importing *Sibusiso* from Malawi to South Africa or the cost of the ingredients used. In general RUFs are costly (Latham *et al* 2011; Matilsky *et al* 2009; De Pee & Bloem 2008), and a major contributor of nutrition rehabilitation costs (Wilford *et al* 2011; Bachman 2009). Wilford *et al* (2011) estimated that the cost of providing RUF in a community based project account to 32% of the total program costs. The high cost of RUF has been identified as a major barrier towards a wide scale use of RUF in the community.

5.4 Summary

The nutritional composition of *Sibusiso* was comparable to the nutritional composition of other available RUF including *Plumpy'nut* and *Nutributter*. *Sibusiso* was lighter than the peanut butter. This was similar to the literature and was assumed to be due to various factors including different roasting procedures. The similarity in the hardness of *Sibusiso* and the peanut butter was not as expected mainly as soy-peanut pastes have been shown to be harder than peanut butter. The higher Stickiness of *Sibusiso* compared to the peanut butter was as expected. This was assumed to be the results of the absence of the stabilizer in *Sibusiso*. The acceptability of *Sibusiso* in children was thought to be due to its sweet taste and the perception of *Sibusiso* as a peanut butter. In the literature it was found that RUFs are generally acceptable to children. The caregiver's positive attitude towards *Sibusiso* was as expected. The caregivers were willing to buy *Sibusiso* at half its current price mainly as they perceived it as a peanut butter. However literature shows that the caregivers may be willing to spend more on *Sibusiso* once they see its benefits. The high cost of rehabilitating a child using *Sibusiso* was expected. Generally RUFs are costly and even more costly when imported. The following chapter will provide the conclusions on the study results.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

This aim of the study was to determine the nutritional composition, colour and texture of *Sibusiso*, a RUF with a potential of alleviating malnutrition. The consumer acceptability and financial feasibility of using *Sibusiso* for nutrition rehabilitation were also determined. In this chapter the conclusions on the main findings of the study are provided. This is followed by the discussion of the limitations of the study and the recommendations for future research.

6.1 Conclusions

The RUF, *Sibusiso*, is a sufficient source of energy and proteins for children between the ages 1 to 8 years. The amino acid profile of *Sibusiso* is good. However, *Sibusiso* does not contain sufficient energy and protein to meet the RDAs of the older children (age 9 to 18 years). If *Sibusiso* was the main food for the older children and adults, there would be a need to reformulate the product in order to increase its energy and protein contents. However *Sibusiso* is consumed as a supplement to a diet, in order to help individuals meet their nutrient requirements. Furthermore larger amounts of *Sibusiso* can be recommended for consumption for the older children and adults compared to the younger children. The total mineral content is also within the WHO/WFP/SCN/UNICEF recommendations for RUF, which suggests that *Sibusiso* can be used to alleviate mineral deficiencies in the targeted groups of people. However, it cannot be concluded from this study whether or not *Sibusiso* would significantly contribute to the alleviation of deficiencies in specific minerals, including zinc and iron, which are predominantly deficient in the developing regions including South Africa.

Sibusiso is lighter than the commercial peanut butter, which may not be acceptable to consumers. Consumers are likely to expect a product containing peanut butter, such as *Sibusiso*, to be dark. Indeed, in this study healthy children generally had a lower liking of the colour of *Sibusiso* relative to HIV infected children. The study results show that *Sibusiso* is of the same hardness as the peanut butter, but it is stickier than the peanut butter. The results suggest that *Sibusiso* can be used in foods as a spread in the same manner as a peanut butter. However, the stickiness of *Sibusiso* may not be acceptable to consumers, especially consumers with oral sores, which are common in HIV infected people.

The study findings indicate that *Sibusiso* is overall acceptable to both healthy and HIV infected children despite the low acceptability of its colour by the healthy children. This

finding was irrespective of the children's age and gender, highlighting the high potential of *Sibusiso* for use in alleviating PEM in children. The caregivers had a positive attitude towards *Sibusiso*. This indicates that *Sibusiso* is likely to be used by the caregivers. However, they stated that *Sibusiso* was expensive. This suggests that if *Sibusiso* was to be sold in the market, the caregivers would be less likely to buy *Sibusiso*.

The use of *Sibusiso* for nutrition rehabilitation in KZN may not be financially feasible. This suggests that there is a need to reduce the costs of *Sibusiso*.

6.2 Limitations of the study

Analysis of specific micronutrients was not done. These results are important as the NFCS-FB (2005) showed that the micronutrient status of South African children has been deteriorating, despite the implementation of food fortification in 2003. The nutritional composition, colour and texture of *Sibusiso* were determined using a small sample size. The consumer acceptability study was only conducted in KZN and did not represent the entire South African population. The focus group discussions were conducted using a small sample size. The data collected may not represent the attitudes and perceptions of all caregivers in KZN or South Africa. The financial feasibility was determined using published studies, which were all conducted outside South Africa.

6.3 Recommendations for future research

This study showed that the mineral content of *Sibusiso* was high, indicating that *Sibusiso* has a potential to alleviate certain micronutrient deficiencies. However, a profile of the specific micronutrients needs to be determined. This would help determine the role of *Sibusiso* in alleviating common micronutrient deficiencies such as vitamin A, zinc and iron deficiency.

More consumer acceptability studies need to be conducted in other provinces of South Africa in order to factor in the different cultures outside and within the different provinces. This would allow the attainment of the results that are a representation of the South African population.

Also, studies can be conducted to determine the efficacy of *Sibusiso* in alleviating PEM in the South African context. Factors such as cultural backgrounds, feeding practices and stigmatization can affect consumption and use of *Sibusiso* in the community. In both the children and adults indicators of malnutrition such as weight and mid upper arm circumference gain can be monitored. Other indicators of malnutrition that can be monitored

in children, particularly those below the age of 2 years include the length gain and the weight for height Z score.

There is also a need to develop a cheaper RUF. This can be done by using locally produced and acceptable foods such as maize, wheat and beans. The use of micronutrient sprinkles in combination with a peanut butter, or the modification of CBS by using dried milk and/ or adding phytase are some of the options that can be explored. However more detailed feasibility studies need to be conducted in order to determine the short and long term effects of using products such as *Sibusiso*.

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APPENDIX A: LIST OF PARTICIPATING SCHOOLS, DAY CARE AND HOSPITAL**Schools**

1. Bisley Park Primary School
2. Woodlands Primary School
3. Northlands Primary School
4. Maritzburg College
5. Eastwood High School
6. Kharina Secondary School

Day care centre

1. Lindiwe day care

Hospital

1. Northdale Hospital

APPENDIX B: CHECK LIST FOR SCHOOL CHILDREN

Indicate with a tick if your child has any of the following

My child has been ill in the past seven days

My child is taking medication



My child suffers from chronic disease such as asthma, diabetes and HIV/AIDS

-Thank you!!!!-

APPENDIX C: CONSUMER ACCEPTABILITY QUESTIONNAIRE

Panellist number: _____

Age: _____

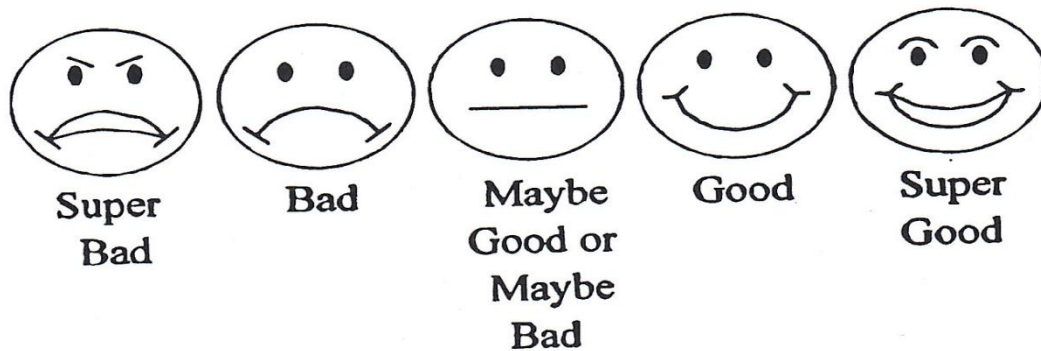
Gender:   _____

Instructions

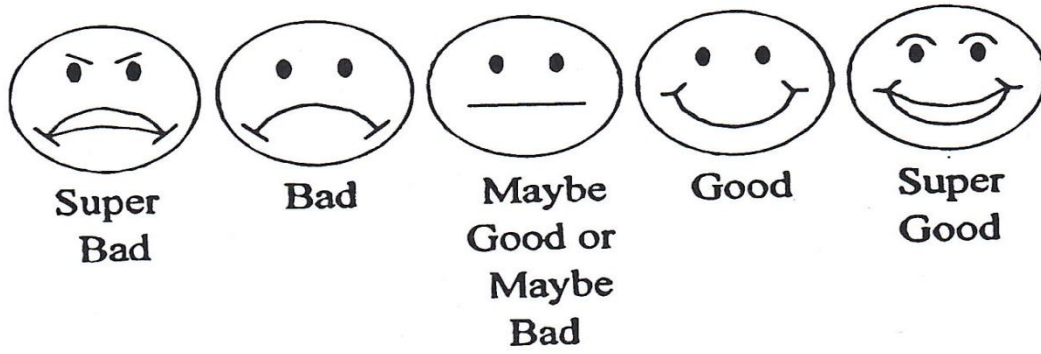
Please assess the food sample in front of you. Then indicate how you feel about the taste, smell, colour, mouth feel and the overall acceptability by placing a cross over the face indicating your liking.

Please rinse your mouth with water and a cracker before starting. You may rinse again at any time during the test if you need to. If you have any questions, please ask and you may test the sample as many times as you like

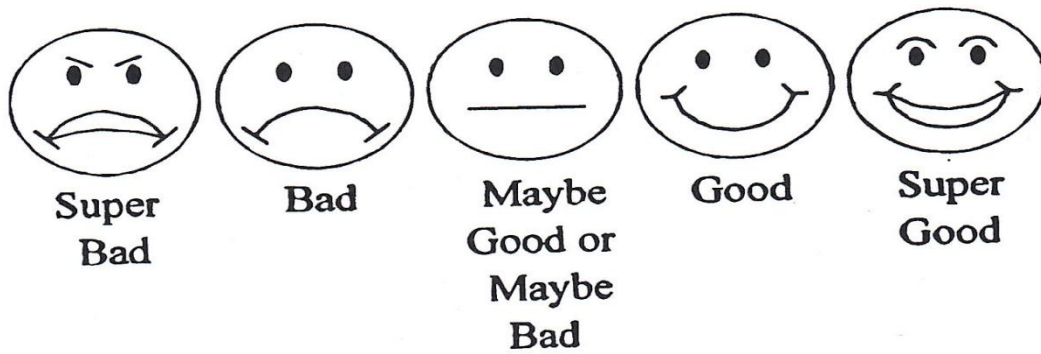
1. Taste



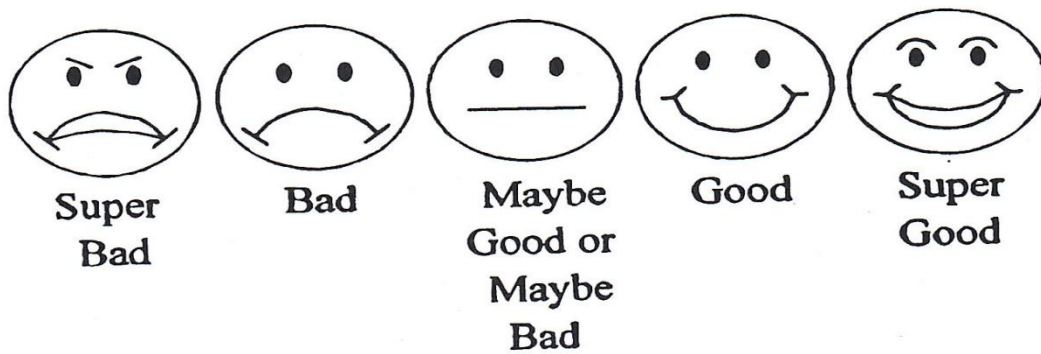
2. Smell

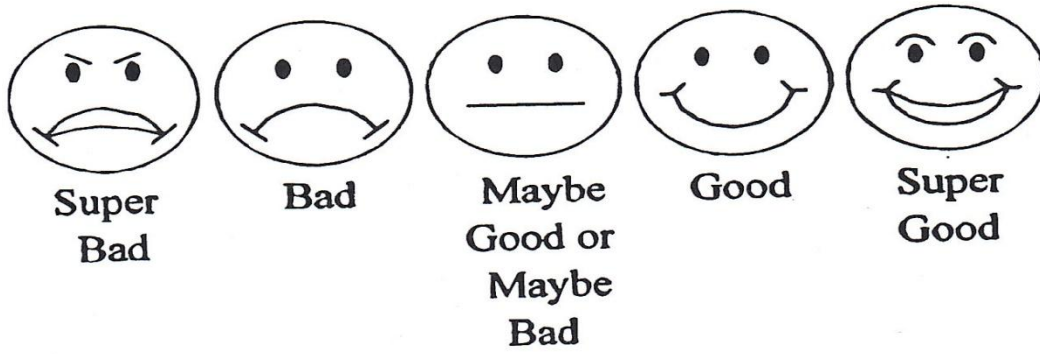


3. Colour



4. Mouth feel



5. Overall liking

6. What did you like about the sample?

7. What did you not like about the sample?

-Thank you!!!!-

APPENDIX D: FOCUS GROUP DEMOGRAPHIC QUESTIONNAIRE

1. Name _____

2. Age _____

3. Gender

Female Male

4. Race

Black Coloured Indian White Other _____

5. Marital Status

Married Single Divorced Separated Widow/widower

6. How many people (including you) live in your house? _____

Indicate the number of people per age category by writing a number in a box.

0-12 Months 1-5 years 5-17 years

17-25 years 25-45 years >45 years

7. What is your highest **level of education** you have achieved?

No schooling Primary school High school College diploma

Bachelor's degree Master's degree

8. What is your current **employment** standing?

Unemployed Employed self-employed

Pension/grants *Please specify*

Old age	Child support	Foster child	Disability	Care Dependency	War Veteran's

9. Which of the spreads do you buy and use? Indicate with a tick

Butter	
Cheese spread	
Cream	
Fish paste	
Honey	
Jam	
Liver paste	
Margarine	
Marmite	
Mayonnaise	
Meat paste	
Melrose	
Peanut butter	
Sandwich spread	
Syrup	
Vegemite	
Other (s), specify	

10. How much do you spend on the spreads per month?

11. Do you use any supplements? Yes No If **yes** please indicate below,

Vitamin A Iron Calcium Multivitamin

Porridge *Sibusiso* Other (s) _____

12. Where do you source or get your supplements from?

Clinics Hospitals Pharmacy

Doctor Supermarket Other (s) _____

13. If you buy supplement(s), how much do you spend on them? _____

14. How often do you buy or receive supplements? I buy or receive supplements:

Every week Every 2 weeks Monthly Other(s) _____

15. Please indicate the type or quantity you buy or are given.

Tablets/ 1 packet Sachets Tub (s) other(s) _____

16. Do you take any immune booster (s)? Yes or No

17. Which of the immune boosters do you buy and use? Indicate with a tick

Stameta	<input type="checkbox"/>
Aloe Vera	<input type="checkbox"/>
Cell food	<input type="checkbox"/>
Vukuhlale	<input type="checkbox"/>
Spirulina	<input type="checkbox"/>
	<input type="checkbox"/>
Other(s)	<input type="checkbox"/>

18. How much do you spend on these products per month? _____

APPENDIX E: FOCUS GROUP DISCUSSION QUESTIONNAIRE

Caregiver as the primary buyer and a key Influencer of peanut paste consumption

- What spreads, immune boosters and supplements do you usually buy for your household? (*Probe on which ones are mainly used for children and which ones are most liked by children and why*)
- *Nhloboni yezinto zokugcoba isikwa okanye izakhamzimba ozithengayo endlini? (Buzisisa ngezisetshenziselwa abantwana nalezo ezithandwa abantwana).*
- What influences you to buy the above mentioned spreads, immune boosters & supplements? *e.g. Price, nutritional value, taste*
- *Yini eyenza nithenge lezi zigcobo okanye izakhamzimba?e.g. inani, izithako, umsoco noma ukunambitheka*
- What type of foods do you make for children with the above mentioned spreads? / How do you use the above mentioned spreads, immune boosters and supplements?
- *Nizisebenzisa nanhloboni yokudla?*

Consumer perception towards the peanut paste: Sensory evaluation of peanut paste

- How would you describe the peanut paste presented to you? (*Physical component: colour, smell, taste & Mouthfeel*) Also explain your likability of the each of the physical components)
- *Ningakuchaza kanjani lokhu kudla esenikukuhlolile?(umbala, ukunuka, ukunambitheka kanye nokuzwakala kwakho emloyeni)*
- How does it compare to the peanut butter you know? (*Physical component*)
- *Ungayiqhathanisa kanjani nebhotela ojwayele ukuyisebenzisa?*
- How do you compare to other supplements you know?
- *Ungayiqhathanisa kanjani nezinye izakhamzimba ozaziyo?*

Peanut paste consumer acceptability

- If the peanut paste could be commercialized would you buy it for your household? *Discuss why you would buy it and how you would use it.*
- *Uma kungathiwa lelibhotela liyadayiswa ezitolo, ungalithengela indlu yakho na?Chaza ukuthi ungalithengelani futhi ungalisebenzisa kanjani.*

Caregiver's willingness to utilize the peanut paste

- What type of food would you make with the peanut paste?
- *Ungalisebenzise kunhloboni yokudla lelibhotela?*

- If children do not like it, how would you motivate them to eat it?
- **Uma izingane zingalithandi, ungenza kanjani ukuthi zilithande okanye zilidle?**
- Would you use the product for its nutritional value?
- **Ungakusebenzisa lokudl njengoba kunomsoco omningi?**

Caregiver's willingness to buy

- How much would you pay for the peanut paste? (*Take the average prices mentioned or the least to the highest*)
- ***Malini ongayikhokhela lelibhotela?***
- *Would you call it a spread, immune booster or supplement?*
- ***Ungayibiza ngokuthi iyini?***

APPENDIX F: USA INFLATION RATE SINCE 2005

Year	USA annual inflation rate %
2005	4
2006	2.1
2007	4.3
2008	0.03
2009	2.63
2010	1.63
2011	2.93

Source <http://www.forecast-chart.com/forecast-inflation-rate.html>

APPENDIX G: UKZN ETHICAL CLEARANCE



Research Office, Govan Mbeki Centre
Westville Campus
Private Bag x54001
DURBAN, 4000
Tel No: +27 31 260 3587
Fax No: +27 31 260 4609
mohunp@ukzn.ac.za

27 June 2011

Ms N Mahlangu (207512994)
School of Agricultural Sciences & Agribusiness (SASA)
Faculty of Science & Agriculture
Pietermaritzburg Campus

Dear Ms Mahlangu

PROTOCOL REFERENCE NUMBER: HSS/0375/011M
PROJECT TITLE: Sensory evaluation and feasibility study of a ready-to-use food supplement by adults and children in Pietermaritzburg, KwaZulu-Natal (KZN)

In response to your application dated 21 June 2011, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....
Professor Steven Collings (Chair)
HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE

cc. Supervisors: Prof F Veldman & Ms N Wiles
cc. Ms M Francis

 1910 - 2010 
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Founding Campuses: ■ Edgewood ■ Howard College ■ Medical School ■ Pietermaritzburg ■ Westville

**APPENDIX H: PERMISSION FROM THE KWAZULU NATAL
DEPARTMENT OF HEALTH**



health

Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management sub-component
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : HRKM15/12
Enquiries : Mrs G Khumalo
Telephone : 033 – 3953189

25 January 2012

Dear Ms Z N Mahlangu

Subject: Approval of a Research Proposal

1. The research proposal titled '**Sensory evaluation and feasibility study of a ready-to-use food supplements by adults and children in Pietermaritzburg**' was reviewed by the KwaZulu-Natal Department of Health.

The proposal is hereby **approved** for research to be undertaken at Northdale & Edendale Hospitals.

2. You are requested to take note of the following:
 - a. Make the necessary arrangement with the identified facility before commencing with your research project.
 - b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.
3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mrs G Khumalo on 033-3953189.

Yours Sincerely



Dr E Lutge

Chairperson, Health Research Committee

KwaZulu-Natal Department of Health

Date: 10/02/2012

uMnyango Wezempilo. Departement van Gesondheid

Fighting Disease, Fighting Poverty, Giving Hope

**APPENDIX I: PERMISSION FROM THE KWAZULU NATAL
DEPARTMENT OF EDUCATION**



kzn education

Department:
Education
KWAZULU-NATAL

Enquiries: Sibusiso Alwar

Tel: 033 341 8610

Ref.: 2/4/8/68

Ms. Zodwa Nita Mahlangu
29 Isabelle Beardmore Road
Pietermaritzburg
Scottsville
3209

Dear Ms. Mahlangu

PERMISSION TO CONDUCT RESEARCH IN THE KZNDoe INSTITUTIONS

Your application to conduct research entitled: **Assessment of the sensory attributes and acceptability of a ready-to-use food supplement by adults and children in Pietermaritzburg KwaZulu-Natal**, in the KwaZulu Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, educators, schools and institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Head of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period: From 01 July 2011 to 31 July 2012.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Superintendent General. Please note that Principals, Educators, Departmental Officials and Learners **are under no obligation to participate or assist you in your investigation.**
8. Should you wish to extend the period of your survey at the school(s), contact Mr. Alwar at the contact numbers below.

...dedicated to service and performance
beyond the call of duty.

KWAZULU-NATAL DEPARTMENT OF EDUCATION

POSTAL: Private Bag X9137, Pietermaritzburg, 3200, KwaZulu-Natal, Republic of South Africa

PHYSICAL: Office G 25, 188 Pietermaritz Street, Metropolitan Building, Pietermaritzburg, 3201

TEL: Tel: +27 33 341 8610/11 | Fax: +27 33 341 8612 | email:sibusiso.alwar@kzndoe.gov.za

9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Address to: The Director: Resource Planning; Private Bag X9137; Pietermaritzburg; 3200

The Department of Education in KwaZulu Natal fully supports your commitment toward research and wishes you well in your endeavours. It is hoped that you will find the above in order.



Nkosinathi SP Sishi, PhD
Head of Department: Education

2011-07-25

Date

...dedicated to service and performance
beyond the call of duty.

KWAZULU-NATAL DEPARTMENT OF EDUCATION

POSTAL: Private Bag X9137, Pietermaritzburg, 3200, KwaZulu-Natal, Republic of South Africa

PHYSICAL: Office G 25, 188 Pietermaritz Street, Metropolitan Building, Pietermaritzburg, 3201

TEL: Tel: +27 33 341 8610/11 | Fax: +27 33 341 8612 | email: sibusiso.alwar@kzndoe.gov.za



kzn education

Department:
Education
KWAZULU-NATAL

Enquiries: Sibusiso Alwar

Tel: 033 341 8610

Ref.: 2/4/8/68

Ms. Zodwa Nita Mahlangu
29 Isabelle Beardmore Road
Pietermaritzburg
Scottsville
3209

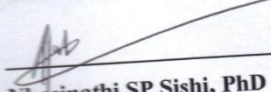
Dear Ms. Mahlangu

PERMISSION TO CONDUCT RESEARCH IN THE KZNDoe INSTITUTIONS

Your application to conduct research entitled: **Assessment of the sensory attributes and acceptability of a ready-to-use food supplement by adults and children in Pietermaritzburg KwaZulu-Natal**, in the KwaZulu Natal Department of Education Institutions has been approved. The research and interviews will be limited to the following Schools and Institutions:

1. Bisley Park Primary School
2. Ridge Primary School
3. Woodlands Primary School
4. Northlands Primary School
5. Maritzburg College
6. Girls High
7. Eastwood High
8. Kharina Secondary School
9. Alexandra High School

Regards,


Nkosinathi SP Sishi, PhD
Head of Department: Education

25 / 07 / 2011

Date

...dedicated to service and performance
beyond the call of duty.

KWAZULU-NATAL DEPARTMENT OF EDUCATION

POSTAL: Private Bag X9137, Pietermaritzburg, 3200, KwaZulu-Natal, Republic of South Africa

PHYSICAL: Office G 25, 188 Pietermaritz Street, Metropolitan Building, Pietermaritzburg, 3201

TEL: Tel: +27 33 341 8610/11 | Fax: +27 33 341 8612 | email: sibusiso.alwar@kzndoe.gov.za

APPENDIX J: LETTER REQUESTING PARENTAL CONSENT

Dear parents/guardian

We are requesting consent for your child to participate in the tasting of a fortified food supplement. The reason for this study is to gather information on the acceptance of the fortified food supplement. The food supplement is made from ground nuts, sugar, milk powder, vegetable oil and a premix of vitamin and minerals. It contains high amounts of energy, proteins and nutrients which are lacking in many of the children's diet. It is suitable for vegetarian, halaal and kosher people. Currently it is used in food aid program and treatment of malnutrition in places such as Malawi, Congo, and Afghanistan.

In South Africa, there is a high rate of malnutrition, in particular under-nutrition which results from not eating enough food to meet energy and micronutrient needs. This contributes to high rates of child illnesses, growth failure and deaths in the country. In order to help minimize the effect of malnutrition, the food supplement can be introduced to the diet of the malnourished child. However, the acceptability of this product in South African children is not known, and this is important as people usually eat food that is acceptable and liked by them.

This research will be conducted by Nita Mahlangu, a Master student in the Discipline of Dietetics and Human Nutrition at the University of KwaZulu-Natal, under the guidance of Professor Veldman. The research will be conducted with aid of the school and will not interfere with class activities. Your child's participation is requested for one session of 30-45 minutes. During this time the children will be provided with an unlabelled sample and be asked to evaluate it using a standard scale. The following principles will be followed in order to ensure that your child's rights are protected:

- Children are randomly selected to participate in the study;
- Participation is voluntary;
- Your child can withdraw at any time;
- Participation of your child is free;
- There are no risk to the child, unless they are allergic to nuts;
- All information will be kept confidentially and in line with the standard of the UKZN research ethics committee; and
- As a parent you are free to deny your child's participation and whether or not your child participates in this study will not affect your child's status with the school or the University of KwaZulu-Natal.

Should you have any questions about the research, please contact Professor Veldman at 033 206 5453 or at veldmanf@ukzn.ac.za. Thank you for your cooperation and hope you will allow your child to participate in the study. If you consent, please sign the attached consent form and return it to a teacher.

Sincerely,

Prof. F. Veldman

Nita Mahlangu

I hereby declare that I understand the above information and that I was given an opportunity to ask questions if there was anything that was not clear.

I understand the aim of the study and the benefits it holds, as well as the way in which the study will be conducted.

Furthermore, I understand that there will be no risk or discomforts for my child resulting from the study and that I may withdraw him/her, or he/she may withdraw himself/herself from the study at any time, without any consequences.

I (parent/guardian) _____ hereby give permission that my child _____ may participate in the study.

Signed: _____ (parent/guardian) Date: _____

APPENDIX K: LETTER REQUESTING PARTICIPATION

I, the undersigned, _____ (Full Name) participant,

Tel: _____,

Have been fully informed of:

- It is my responsibility to report prior to participation to the investigators any allergies I may have;
- The purpose of this study;
- That my participation is voluntary;
- That I can withdraw at any time;
- That a tape recorder will be used during the session;
- That participation will cost me nothing; and
- That all information given will be kept confidential.

I agree to:

Sensorial test the quality of the ready-to-use food supplement and participate in a focus group discussion.

This consent form was explained to me by _____ (Full Name), in _____ (language) and I confirm that I have understood.

I _____ (full name) agree to voluntarily take part in this research project.

(Participants signature or mark)

(Witness)

Signed at: _____ on ____/____/____ 2011.

APPENDIX L: DEMOGRAPHICS OF THE FOCUS GROUP PANEL

Variable s	N (total 10)	Variables	N (total 10)
Age (years)		Type of grant received	
• 18-25	0	• Old age	1
• 26-35	5	• Child support	8
• 36-45	4	• Foster child	0
• > 45	1	• Disability	0
Gender	10	• Care dependants	0
• Female	10	• War veterans	0
• Male	0	Use & buy spreads	
Race	10	• Yes	10
• African	10	• No	0
• White	0	Buy & use supplements	
• Coloured	0	• Yes	8
• Indian	0	• No	2
Marital status	10	Type of supplements	
• Married	1	• Vitamin A	1
• Single	9	• Iron	1
• Divorced	0	• Multivitamin	7
• Separated	0	• Supplementary porridge	3
• Widow	0	• <i>Sibusiso</i>	2
Household size (n)		• other	
• 2-4	4	Place procured	
• 5-7	4	• Clinic	1
• 8-10	1	• Hospital	6
• 11-15	1	• Pharmacy	2
Household age structure		• Doctor	2
• 0- 11 months	4	• Supermarket	1
• 1-5yrs	9	• Other	0
• 6- 17yrs	19	Frequency of procurement	
• 18-25yrs	4	• Weekly	0
• 26-45	13	• Every two weeks	0
• >45yrs	4	• Monthly	8
Level of education	10	Use & buy Immune booster	10
• None	2	• Yes	1
• Primary	2	• No	9
• High school	6	Amount spent on Spreads (ZAR)	
• College	0	• <100	3
• University	0	• 100-200	4
Employment	10	• >200	3
• Unemployed	6	Amount spent on supplements (ZAR)	
• Employed	4	• <50	2
• Self employed	0	• 50-100	1
Receive grants	10	• >100	1
• Yes	9	Amount spent on Immune boosters (ZAR)	
• No	1	• <100	0
		• 100-150	1