

**DEVELOPMENT OF A HEALTHY SNACK FOR CHILDREN WITH HIV/AIDS  
OR COMPROMISED IMMUNITY**

**By**

**Valerie Erasmus**

**Bacalaureas Technologiae (Food Service Management)**



Dissertation submitted in fulfilment of the requirements for the degree of Magister Technologiae (Food Service Management) in the Department of Hospitality and Tourism and PR Management, Faculty of Human Sciences, Vaal University of Technology.

Supervisor: Prof. W.H. Oldewage-Theron

Co-Supervisor: Dr J.E. Kearney

May 2009

The financial assistance of NRF towards the research is hereby acknowledged.

## **DECLARATION**

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed .....

Date .....

## **STATEMENT 1**

This dissertation is being submitted in partial fulfilment of the requirements for the degree of Magister Technologiae in Food Service Management.

Signed .....

Date .....

## **STATEMENT 2**

The dissertation is the result of my own independent work, except where otherwise stated. Other sources are acknowledged by giving explicit references. A bibliography is appended. I also declare that I did not plagiarise any author's work.

Signed .....

Date .....

## **STATEMENT 3**

I hereby give consent for my dissertation, if accepted, to be available for photocopying and for interlibrary loan, and for the title and summary to be made available to outside organisations.

Signed .....

Date .....

## ACKNOWLEDGEMENTS

I hereby wish to express my gratitude to the following individuals, who enabled this dissertation to be completed successfully and timeously:

- Professor Wilna Oldewage-Theron my supervisor, for her guidance, assistance and support during the study.
- Dr. Jeanette Kearney, my co-supervisor, for her guidance help, support and motivation throughout this study.
- BTech students at the Vaal University of Technology who acted as fieldworkers, providing valuable assistance that enabled this study to be completed.
- Dr Egal for the support and help with the training of the students for the fieldwork as well as the measuring and recording of the results.
- Dr. Djoulde Darman Roger for the shelf life and chemical analysis that he did in the ISL food laboratory.
- Mary Hoffman for conducting the language editing.
- My husband Steyn and my children for their support and encouragement during the countless hours devoted to this project.
- My colleagues and friends for their support and encouragement.
- My mother who supports me with all her prayers.
- Above all, I wish to thank my Heavenly Father, without Whom I could not achieve anything.

## **ABSTRACT**

**Background** – Human Immunodeficiency Virus (HIV) is the virus that causes the disease Acquired Immunodeficiency Syndrome (AIDS). The HIV/AIDS epidemic in Sub Saharan Africa (SSA) has already orphaned a generation of children, and it is projected that by 2010, 18 million African children under the age of 18 years are likely to be orphans (Andrews, Skinner & Zuma 2006: 269-276). In 2005 approximately 4.1 million people became newly infected with HIV while approximately 2.8 million people died of AIDS-related illnesses. A common consequence of HIV/AIDS infection is malnutrition and weight loss, which is used as a diagnostic criterion for HIV/AIDS. The relationship between HIV/AIDS and malnutrition and wasting is well described, with nutritional status compromised by reduced food intake, malabsorption caused by gastrointestinal involvement, increased nutritional needs as a result of fever and infection and increased nutritional losses. Malnutrition contributes to the frequency and severity of the opportunistic infections seen in HIV/AIDS and nutritional status is a major factor in survival. Failure to maintain body cell mass leads to death at 54 percent of ideal body weight. The effectiveness of nutrition intervention has been documented and counselling in dietary nutrition is considered critical in the treatment of HIV/AIDS

**Objective** – The main objective of this study was to determine the nutritional status of the HIV/AIDS-affected or immunity compromised children attending a care centre in Boipatong in order to develop an energy bar to address malnutrition in these children.

**Methodology** – This was an experimental study carried out in four phases. The planning of the study constituted the first phase. In the second phase a baseline survey was conducted, in which a socio-demographic questionnaire (n=45) was administered amongst children aged six to 13, with the assistance of trained fieldworkers. Dietary intake was measured by a 24-hour recall and Food Frequency Questionnaire (FFQ) and anthropometric measurements included height and weight. The data from the socio-demographic questionnaires and FFQ were captured on an Excel spreadsheet. The

Statistical Package for Social Sciences (SPSS) for Windows version 15.0 program was used to analyse the data. Descriptive statistics were used (frequencies, means and SD). The 24-hour recall was analysed for means and Standard Deviations (SD) of nutrient intakes on the FoodFinder® program version 3.0 and compared to Dietary Reference Intakes (DRI). The anthropometric measurements were analysed using the WHO growth standards (2007). Phase 3 incorporated the development of the snack bar, sensory evaluation, microbiological tests for shelf life determination and chemical analyses to determine nutrient content. Phase 4 entailed the writing of the report.

**Results** – In the baseline survey the results indicated that this was a low-income community with compromised nutrition, mainly under-nutrition owing to poor dietary intake despite a good variety of foods in the diet. All the households included in this study were resident in Boipatong and the majority (86.5 percent) have lived in Boipatong for longer than five years. Although the majority of respondents resided in brick houses (69 percent), only 30 percent had access to water inside and outside their houses, 23.1 percent had access to water, 78.4 percent had access to electricity and 75 percent had regular waste removal. The percentage of unemployed among the children’s caregivers was high (60.9 percent) and the majority of households (40 percent) had an income of R500-1000 per month, with two contributors of household income in 57 percent of the households. Although the average household consisted of five people, the houses were relatively small with 75 percent of all the households having four or more rooms. All of the households experienced problems such as rodent and insect infestation. The household food security was also a dilemma in this community as 70.6 percent of the respondents indicated that they bought food only once a month and the majority of households spent less than R150 (5.4 percent of household income) on food per month i.e., less than R37.50 per week. The anthropometric results indicated 29 percent stunting, and 23 percent underweight among the boys in the target group, compared to 30 percent and 0 percent for the girls respectively.

The criteria applied in developing the snack food were to achieve at least 25 percent of vitamin A, vitamin C, vitamin E, certain B-group vitamins and minerals such as selenium, zinc and iron to meet the recommended dietary allowances (RDA).

Since the results showed that 67 percent of households had an electrical stove, an easily prepared recipe was formulated which could be taught to the caregivers. Moreover, at R1.50 per person per day, the product was cost-effective and proved safe as well as acceptable to the children, thus ensuring compliance when the feeding intervention is implemented. The sensory evaluation of the snack item showed that it was acceptable to the majority of the children as it received a high score for taste, general appearance and overall acceptability. The snack food item was tested for shelf life and the results showed a shelf life of 168 days in a refrigerator and a recommended shelf life of 21 days at room temperature (30°C).

**Conclusions and recommendations** – The results indicated that poverty, household food insecurity and malnutrition were prevalent in this community. Furthermore, the study proved that a product could be developed to meet specific criteria. It is recommended that this product be tested in a clinical intervention study to determine the impact on the nutritional status of children with compromised immunity.

## **TABLE OF CONTENTS**

<b>CONTENTS</b>	<b>Page</b>
Abstract	iv
List of figures	xiv
List of tables	xv
List of annexures	xvii
Glossary of terms and symbols	xviii

## **CHAPTER 1 THE PROBLEM, ITS SETTING AND OVERVIEW**

<b>OF THE STUDY</b>	<b>1</b>
1.1 INTRODUCTION	1
1.2 PREVALENCE OF HIV/AIDS GLOBALLY	1
1.3 DEFINITION OF HIV/AIDS	2
1.3.1 Stages of HIV/AIDS	3
1.4 ROUTES OF TRANSMISSION OF HIV/AIDS	4
1.4.1 Adults	4
1.4.2 Children	5
1.4.3 Compromised immunity	7
1.5 PREVALENCE OF HIV/AIDS IN SOUTH AFRICA	7

1.6	MALNUTRITION AMONGST HIV/AIDS-INFECTED PEOPLE	10
1.7	NUTRITION AND HIV/AIDS	12
1.8	NUTRIENTS IMPORTANT IN COMPROMISED IMMUNITY	15
1.8.1	Energy requirements	16
1.8.2	Macronutrients	16
1.8.2.1	Protein	16
1.8.2.2	Fat	17
1.8.2.3	Carbohydrates	18
1.8.3	Micronutrients	18
1.8.3.1	Vitamin A	18
1.8.3.2	Vitamin C	19
1.8.3.3	Vitamin E	19
1.8.3.4	Vitamin B-group	20
1.8.3.5	Iron	20
1.8.3.6	Selenium	21
1.8.3.7	Zinc	21
1.9	MOTIVATION FOR THIS STUDY	21
1.10	OBJECTIVES OF THIS STUDY	23
1.11	STUDY POPULATION AND SCOPE	24



1.12	STRUCTURE OF THE DISSERTATION	24
1.13	CONCEPTUAL FRAMEWORK	25
<b>CHAPTER 2 LITERATURE SYNTHESIS ON PRODUCT</b>		
	<b>DEVELOPMENT</b>	<b>26</b>
2.1	INTRODUCTION	26
2.2	PRODUCT DEVELOPMENT	26
2.3	INGREDIENTS	30
2.4	QUALITY CONTROL	32
2.4.1	Hazard analysis critical control points	33
2.4.2	Food safety concerns for people living with HIV/AIDS	34
2.4.3	Facts to keep in mind in quality control specifically for people living with HIV/AIDS	34
2.4.4	Food safety in South Africa	35
2.5	SENSORY EVALUATION	37
2.5.1	Introduction to sensory evaluation	37
2.5.2	Selection of panel members	40
2.5.3	Hedonic Scale	41
2.6	CHEMICAL ANALYSES OF FOOD ITEMS	43
2.6.1	Proximate analyses	44

2.6.1.1 Energy determination	45
2.6.1.2 Protein digestion and Kjeldahl protein analyses	45
2.6.1.3 Nitrogen determination	45
2.6.1.4 Fat determination	45
2.6.1.5 Ash determination	45
2.6.1.6 Moisture determination	46
2.6.1.7 Carbohydrate determination	46
2.6.1.8 Micronutrient analyses	46
<b>2.7 SHELF LIFE MEASUREMENTS</b>	<b>46</b>
2.7.1 Selecting criteria to assess shelf life	47
2.7.2 Guidelines to determine shelf life	49
<b>2.8 RECIPE WRITING</b>	<b>50</b>
2.8.1 Standard recipe format	50
2.8.2 Narrative recipe format	50
2.8.3 Action recipe format	51
<b>2.9 CONCLUSION</b>	<b>51</b>
<b>CHAPTER 3 METHODOLOGY</b>	<b>52</b>
3.1 INTRODUCTION	52
3.2 ETHICAL CONSIDERATIONS	52

3.3	STUDY DESIGN	52
3.3.1	Phase 1: Planning of the study	53
3.3.2	Phase 2: Pilot study / Baseline survey	55
3.3.2.1	Sampling strategy	55
3.3.2.2	Fieldworkers	56
3.3.2.3	The measuring instruments	56
3.3.2.4	Statistical analyses	59
3.3.3	Phase 3: Product development of the snack food item	60
3.3.3.1	Step A – Identification of nutritional needs	61
3.3.3.2	Step B – Estimation of food compositions	62
3.3.3.3	Step C- The formulation of the energy bar	62
3.3.3.4	Step D – Experimental analyses	63
3.3.3.5	Steps E & F – Optimisation process and nutrient development	65
3.3.3.6	Step G – Sensory analysis and shelf life testing	65
3.4	CONCLUSION	68
	<b>CHAPTER 4 RESULTS AND FINDINGS</b>	<b>69</b>
4.1	INTRODUCTION	69
4.2	PHASE 1: RESULTS OF THE PLANNING PHASE	69
4.3	PHASE 2: RESULTS OF THE BASELINE SURVEY	69

4.3.1	Socio-demographic results	69
4.3.1.1	Characteristics of the respondents	70
4.3.1.2	Living conditions	71
4.3.1.3	Socio-economic indicators	72
4.3.1.4	Education and language	73
4.3.2	Dietary intake and food consumption patterns: 24-hour recall	77
4.3.3	Dietary diversity	80
4.3.4	Health results	83
4.3.5	Anthropometric results	83
4.4	PHASE 3: DEVELOPMENT OF THE ENERGY BAR	84
4.4.1	Step A – Identification of the basic food ingredients	84
4.4.2	Step B – Estimation of food composition	87
4.4.3	Step C- The formulation of the energy bar	88
4.4.4	Step D – Results and discussion of the chemical analyses	90
4.4.5	Steps E & F – Optimisation process (reconstitution and refinement of product)	92
4.4.5.1	Costing of the product	93
4.4.6	Step G – Results of sensory analysis and shelf life testing	95
4.4.6.1	Results of sensory analysis	95

4.4.6.2 Results of the self life testing	98
4.5 CONCLUSION	103
<b>CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS</b>	<b>104</b>
5.1 INTRODUCTION	104
5.2 LIMITATIONS OF THIS STUDY	104
5.3 MAIN FINDINGS	105
5.3.1 Literature	105
5.3.2 Baseline survey	106
5.3.3 The development of the snack food	107
5.4 CONCLUSIONS	108
5.5 RECOMMENDATIONS	109
<b>RESEARCH OUTPUTS</b>	<b>110</b>
References	111
Annexures	121

## LIST OF FIGURES

	Pages	
Figure 1.1	The Cycle of Nutrition and HIV/AIDS	14
Figure 1.2	Conceptual framework	25
Figure 2.1	Development of Optimum Food Products	29
Figure 2.2	The role of sensory evaluation relative to activities in the manufacturing of a product	39
Figure 2.3	Example of facial expressions used in a Hedonic scale	42
Figure 3.1	Map indicating location of the Care Centre in Boipatong	54
Figure 3.2	Children queuing for food	54
Figure 3.3	A fieldworker completing a questionnaire	57
Figure 3.4	Stages and processes involved in the development of a novel food	61
Figure 4.1	Children queuing for food at Care Centre	76
Figure 4.2	Children queuing to receive food	77
Figure 4.3	The final energy bar	95
Figure 4.4	Results of the sensory evaluation of the experimental product	96
Figure 4.5	Children testing the energy bar assisted by a fieldworker	97
Figure 4.6	Results of the sensory evaluation of the control product	98
Figure 4.7	The extent of oxidation of energy bars stored at 40°C, 50°C and 60°C	100

## LIST OF TABLES

	Pages	
Table 1.1	Estimated HIV prevalence among South Africans aged two years and older, by sex, race and province	9
Table 1.2	AIDS prevalence in South Africa	10
Table 2.1	Symptoms and recommendations for HIV/AIDS	30-31
Table 2.2	Food standards available in South Africa	36
Table 2.3	Methods of chemical analyses of products to determine the nutrient content	44
Table 4.1	Summary of the characteristic of the respondents	70
Table 4.2	Socio-demographic summary of living conditions	71
Table 4.3	Socio-economic indicators	72
Table 4.4	Education and language	73
Table 4.5	Socio-demographic summary of food procurement and preparation patterns	74-75
Table 4.6	Top 20 food list of the children	78
Table 4.7	Comparison of actual nutrient intake measured by 24-hour recall	79
Table 4.8	Household food access	81
Table 4.9	Summary of the good variety within the food groups	82
Table 4.10	Summary of food group diversity	82
Table 4.11	Anthropometric indicators for boys in Boipatong	83

Table 4.12	Anthropometric indicators for girls in Boipatong	84
Table 4.13	Theoretical analyses of the developed product (100g)	87-88
Table 4.14	Theoretical and laboratory proximate composition of the developed energy bar.	91
Table 4.15	Micronutrient composition of vitamins of the developed energy bar	92
Table 4.16	Micronutrient composition of minerals of the developed energy bar	92
Table 4.17	Nutrient content of final recipe	93
Table 4.18	Costing of energy bar	94
Table 4.19	Results of the sensory evaluation of the experimental product	96
Table 4.20	Results of the sensory evaluation of the control product	97
Table 4.21	Results of shelf life testing	101
Table 4.22	Arrhenius shelf life equation, $R^2$ , and estimated shelf life	102



## LIST OF ANNEXURES

		Page
Annexure 1	Ethical clearance (R14/49, M080365)	121
Annexure 2	Consent form from parents	122
Annexure 3	Socio-demographic questionnaire	123
Annexure 4	Food frequency questionnaire	124
Annexure 5	24-hour recall questionnaire	125
Annexure 6	Signs of malnutrition	126
Annexure 7	Sensory questionnaires	127
Annexure 8	Proof of language editing	128

## **GLOSSARY OF TERMS AND SYMBOLS**

AACC	American Association of Clinical Chemistry
AAS	Atomic absorption spectrometry
AI	Adequate intake
AIDS	Acquired Immunodeficiency Syndrome
AMRD	Adequate Macronutrient Distribution Range
$\alpha_w$	water activity or water availability
AOAC	Association of Official Agricultural Chemists,
BMI	Body Mass Index
c	confidence interval, expressed as decimal
°C	degree Celsius
Ca	Calcium
CCP	Critical Control Points
CD4+ cells	Also known as T-cell
CFNI	Caribbean Food and Nutrition Institute
CHO	Carbohydrates
cm	centimetre
CODEX	Codex Alimentarius Commission (the Codex Alimentarius commission, created by FAO and WHO to develop food standards and codes of practice)

Cr	Chromium
Cu	Copper
DNA	Deoxyribonucleic acid
DoE	Department of Education
DoH	Department of Health
Dr	Doctor
DRI	Dietary Reference Intake
DTech	Doctor Technologiae
EAR	Estimated Average Requirements
EER	Estimated Energy Requirement
<i>et al.</i>	and others
FAO	Food and Agricultural Organisation
Fe	Iron
FFQ	Food Frequency Questionnaire
FNIC	Food and Nutrition Information Centre
FVS	Food Variety Score
g	gram
HAART	Highly Active Antiretroviral Therapy
HACCP	Hazard Analysis Critical Control Points
Hct	Haematocrit
HIV	Human Immunodeficiency Virus

HPLC	High Performance Liquid Chromatography
HSRC	Human Sciences Research Council
I	Iodine
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ISL	Institute of Sustainable Livelihoods
ISO	International Organisation of Standards
IOM	Institute of Medicine
kg	kilogram
kJ	kilojoules
mcg	microgram
Mg	Magnesium
mg	milligram
ml	millilitre
mm	Millimetre
Mn	Manganese
MRC	Medical Research Council
MUAC	Mid-upper arm circumference
MUFA	Monounsaturated Fatty Acid
M-Tech	Magister Technologiae
N	Nitrogen
n=	number equals

nm	nanometre
NFCS	National Food Consumption Survey
NGOs	Nongovernmental Organizations
NICUS	Nutrition Information Centre University of Stellenbosch
NIDCR	National Institute of Dental and Craniofacial Research
NO	Number
NPO	Non-Profit Organisation
n-3	omega 3 fatty acids
n-6	omega 6 fatty acids
p	percent picking a choice, expressed as decimal
PLWHA	Peoples Living With HIV/AIDS
PUFA	Polyunsaturated Fatty Acid
RBC	Red Blood Cell Count
PCR	Polymerase Chain Reaction
QFFQ	Quantitative Food Frequency Questionnaire
R	Rand (SA)
RD	Registered Dietician
RDI	Dietary Reference Intakes
RDP	Reconstruction and Development Programme
SA	South Africa
SABS	South African Bureau of Standards

SAG	South African Government
SAJCN	South African Journal of Clinical Nutrition
SD	Standard Deviation
Se	Selenium
SPSS	Statistical Package of Social Sciences
SSA	Sub-Saharan Africa
T-cells	White blood cells called the T lymphocyte (help defend the body against germs)
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNICEF	The United Nations Children's Fund
UOM	Units of Measurements
US	United States
USA	United States of America
USFDA	United States Food and Drug Administration
UV	Ultra violet
Vit	Vitamin
VUT	Vaal University of Technology
vs	versus
WHO	World Health Organization
Z	Z value (e.g. 1.96 for 95% confidence level)
Zn	Zinc

$<$	Less than
$\leq$	Less than or equal to
$\geq$	Greater than or equal to
$\%$	Percent
$\text{\textcircled{R}}$	Registered to a company
$\&$	and
$\text{\textcircled{M}}$	Symbol for male
$\text{\textcircled{F}}$	Symbol for female