

**Indigenising instant noodles: An interface of traditional *Amaranthus* leaves and wheat for improved food and nutrition security**



**Name of Student: Nothando Delight Qumbisa**

Student number: 218011656

**Submitted in fulfilment of the requirements for the degree of Master of  
Agriculture (Food Security)**

School of Agricultural, Earth and Environmental Sciences (SAEES)

College of Agriculture, Engineering and Science

University of KwaZulu-Natal

Pietermaritzburg

NOVEMBER 2019

## **ABSTRACT**

### **Introduction**

Instant noodles are becoming the new global staple and breakfast food due to their versatility and convenience. For centuries, instant noodles were a staple food only in East Asian countries; however, their consumption has increasingly grown globally. According to research findings, instant noodles are preferred because of their taste, extended shelf-life, affordability as well as convenience, which suits the busy lifestyle of the student and working population. There is a concern though, of the adequacy of nutrients obtained from instant noodles especially when consumed as a single food item. Researchers are therefore exploring the potential supplementation of noodles to make them a composite food to improve their nutritional value. Food supplementation using vegetable-based nutrients is steadily gaining momentum. It is a growing modern trend in response to consumer demands and health concerns. However, the use of traditional green leafy vegetables, which have high nutritional value, such as *Amaranthus* has been limited in South Africa. The aim of this study therefore was to investigate the nutritional quality, consumer acceptability and physical quality of *Amaranthus*-supplemented noodles among students at the University of Zululand (UniZulu), KwaDlangezwa Campus in South Africa. This was done to indigenize the product in an effort to mitigate food and nutrition insecurity challenges.

### **Methodology**

A quantitative research approach was followed in conducting the study. Descriptive and experimental designs were applied. A survey was conducted with 100 students to investigate the consumption of noodles and utilisation of *Amaranthus* among students using a self-administered questionnaire. Stratified purposive quota sampling was used to recruit participants for the survey investigating the utilisation of noodles. *Amaranthus*-supplemented noodles were developed by substituting wheat flour at 1, 2 and 3% (w/w) with *Amaranthus* leaf powder in a standard noodle recipe. The noodle samples were analysed for nutritional composition using AOAC methods. The physical quality of cooked noodle samples was assessed in terms of colour (CIELAB system) and texture (using texture analyser), and consumer acceptability was assessed by 60 untrained panellists.

## Results

The survey results indicated that the majority (93%) of the university students consumed instant noodles. The students consumed an average of two packets per week, as well as eight packets (per person) per month. About 58% of the students ate noodles as their main subsistence food without other food items to improve nutrient intake. About 14% of the students ate noodles with other food items such as mayonnaise, sauces, cheese, bread, with 5% of them combining noodles with pieces of chicken (2%), fish (1%) and boerewors/sausage (2%). Approximately 65% of the students mentioned two dominant attributes that influenced them to consume noodles: convenience (shelf-stable food) and time-saving (quick to prepare). The majority of the students (76%) knew of *Amaranthus* as a vegetable. Amongst the 76% that had knowledge of *Amaranthus*, 71% were consumers or had at least consumed *Amaranthus* once in their lifetime. The majority (92%) of the students consumed *Amaranthus* in the form of a leafy vegetable. Results of nutritional analysis showed that the protein content of *Amaranthus* leaf powder (ALP)-supplemented noodles was similar to that of the control (conventional instant noodles) and remained above the recommended percentage content (8%) for all the samples. Instant noodles supplemented with ALP had an improved fibre content, as well as ash content, suggesting that *Amaranthus* can be used to improve nutritional value. With regard to mineral composition, significant increases were observed for manganese, calcium and copper upon incorporation of ALP in the noodles. The antioxidant activity increased. Texture analyses results showed that ALP-supplemented noodles were softer (240 g cutting force) than the control, i.e. noodles without ALP (600 g force). The increase in ALP concentration had a significant effect on colour as shown by diminishing of yellowness of noodles while progressively shifting towards greenness. Sensory evaluation results revealed that the addition of ALP up to 3% was acceptable to the panellist. The green colour and soft texture of the noodles did not have a negative effect on the overall acceptability of the noodles. The texture of the 2% ALP-supplemented noodles was the most acceptable, although all other samples were similarly as acceptable. The sample with 3% got the lowest score for taste; however, overall it was more acceptable than other samples.

## Conclusion and recommendations

This study confirmed that instant noodle consumption amongst university students is high. This consumption trend increases the risk of malnutrition as noodles were mostly consumed as a

single meal (i.e. without vegetables or other accompanying foods). *Amaranthus* was an underutilized vegetable amongst the sampled population. Although others may have vast knowledge of the vegetable and its benefits, its consumption is still low. *Amaranthus*-supplemented noodles show a great potential for acceptability as an innovation. It is recommended that more products with this vegetable are developed so as to re-introduce it to the food system and reduce its stigmatization.

**Key words:** Noodles, *Amaranthus*, indigenisation, nutritional composition, consumer acceptability, traditional leafy vegetables, supplementation

## Table of Contents

ABSTRACT.....	i
PREFACE.....	xi
DECLARATION.....	xii
ACKNOWLEDGEMENTS.....	xiii
RESEARCH OUTPUTS.....	xiv
Chapter 1 : General Introduction .....	1
1.1 Background of the study .....	1
1.2 Problem Statement .....	2
1.3. Rationale.....	3
1.4 Aim of the study.....	3
1.5 Specific objectives of the study.....	3
1.6 Thesis structure .....	4
1.7 References .....	5
Chapter 2 : Literature review .....	7
Part A: Towards the Zero Hunger 2030 Agenda and development of future food systems: <i>a review on consumer behaviour effects towards the eradication of hunger</i> .....	7
2.1 Introduction .....	7
2.2 Global food and nutrition status .....	9
2.2.1 Food security status .....	9
2.2.2 Nutrition security status.....	10
2.2.3 Food and nutrition security gaps in Sub-Saharan Africa.....	11
2.3 Consumer behaviour and future food systems .....	12
2.4 Factors driving global food consumption trends and consumer preferences .....	13
2.4.1 Sociodemographic factors .....	13
2.4.2 Urbanization .....	13
2.4.3 Lifestyle changes and nutrition transition .....	14

2.4.4 Income influence on food selection vs food preferences .....	15
2.4.5 Trade liberalization.....	15
2.5 Factors that drive the food systems .....	16
2.5.1 Environmental drivers .....	17
2.5.2 Socioeconomic drivers of the food system.....	17
2.6 Impact of consumer behaviour and food systems on food and nutrition security .....	18
2.7 Consumption trends and preferences likely to shape the food system.....	19
2.7.1 Low Cost food .....	19
2.7.2 Naturalness and technology.....	19
2.7.3 Convenience and healthiness.....	20
2.7.4 Local and regional food and Globalization of flavour .....	21
2.7.5 Past and future orientation.....	22
2.7.6 Luxury foods and the millennial consumers.....	22
2.7.7 Individualism.....	22
2.7.8 Sustainability .....	23
2.8 Food system challenges and proposed interventions in order to meet zero hunger goal .....	23
2.8.1. Increasing the supply .....	23
2.8.2 Making available healthy food and influencing consumer behaviour.....	24
2.8.3 Ensuring sustainability .....	24
Part B: Quality attributes and consumer acceptability of enriched pasta-based products .....	25
2.9 Introduction .....	25
2.10 Instant noodle supplementation.....	26
2.11 Nutritional quality of enriched instant noodles .....	27
2.12 Physicochemical qualities .....	28
2.12.1 Colour .....	28
2.12.2 Texture.....	29

2.12.3 Cooking qualities .....	29
2.13 Consumer acceptability .....	30
2.14 Microbial quality and safety of low water content (LWC) foods .....	31
2.15 Future consumption trends- towards pasta-based products .....	32
2.16 Conclusion.....	32
2.17 References .....	34
Chapter 3 : Research Methodology.....	46
3.1 Conceptual framework .....	46
3.2 Research approach.....	47
3.3 Research design.....	47
3.4 Research population and study area .....	47
3.5 Sampling method and size.....	48
3.6 Product development, quality analysis and consumer acceptability .....	49
3.7 Management and Analysis of data .....	49
3.8 Ethical considerations .....	49
3.9 References .....	53
Chapter 4 : Incorporation of <i>Amaranthus</i> leaf powder into noodles as a strategy to increase healthier food choices in the market. ....	54
4.1 Introduction .....	55
4.2 Materials and methods .....	56
4.2.1 Participants demographics .....	56
4.2.2 Ethical considerations.....	56
4.3 Results and discussion.....	56
4.3.1 Instant noodles consumption trend and frequency .....	58
4.3.3 Noodle accompanying foods .....	59
4.3.4 Reasons for consuming instant noodles.....	60
4.3.5 Utilisation of <i>Amaranthus</i> .....	61

4.4 Product innovation .....	62
4.4.1 Recipe development and standardization .....	63
4.4.2 Processing of <i>Amaranthus</i> leaf powder .....	64
4.4.3 Preparation of instant noodles .....	64
4.5 Conclusion.....	69
4.6 References .....	70
Chapter 5 : Effect of <i>Amaranthus</i> leaf powder on the nutritional composition and physical quality of noodles.....	73
5.1 Introduction .....	74
5.2 Materials and methods .....	75
5.2.1 Processing of <i>Amaranthus</i> leaf powder .....	75
5.2.2 Processing of instant noodles .....	76
5.2.3 Proximate analysis.....	77
5.2.4 Physical quality assessments .....	78
5.2.5 Antioxidant activity assessments.....	78
5.2.6 Sensory evaluation.....	79
5.2.7 Data analysis.....	80
5.3 Results and discussion.....	80
5.3.1 Nutritional composition.....	80
5.3.2 Physical quality.....	83
5.3.3 Antioxidant activity .....	84
5.3.3 Consumer Acceptability .....	85
5.4 Conclusion.....	86
5.5 References .....	87
Chapter 6 : General conclusion and recommendations.....	91
6.1 Conclusion.....	91
6.2 Recommendations .....	92

6.2.1 Further Research.....	92
6.2.2 Government & policy makers.....	92
6.3 References .....	94
Appendix 1: Survey Questionnaire.....	110
Appendix: 2 Sensory Evaluation Questionnaire .....	114
Appendix 3: Consent form.....	116
Appendix 4: Request to conduct study letter .....	117
Appendix 4: Gatekeepers Letter (Department of Consumer science) .....	119
Appendix 5: Gatekeepers letter (University of Zululand) .....	120
Appendix 7: Ethical Clearance Letter.....	121

## List of figures

<b>Figure 3.1:</b> Study Conceptual Framework.....	46
<b>Figure 3.2:</b> Map of the study area (University of Zululand).....	48
<b>Figure 4.1:</b> Consumption frequency of instant noodles.....	58
<b>Figure 4.2:</b> Instant noodles food accompaniment.....	59
<b>Figure 4.3:</b> various reasons the consumption of instant noodles.....	60
<b>Figure 4.4:</b> Utilisation of <i>Amaranthus</i> .....	62
<b>Figure 4.5:</b> Raw dough control (0% ALP).....	66
<b>Figure 4.6:</b> 1% ALP raw dough.....	66
<b>Figure 4.7:</b> 2 % ALP raw dough.....	66
<b>Figure 4.8:</b> 3% ALP raw dough.....	66
<b>Figure 4.9:</b> Dried instant noodles control.....	67
<b>Figure 4.10:</b> Dried instant noodles with 1% ALP.....	67
<b>Figure 4.11:</b> Dried instant noodles with 2% ALP.....	67
<b>Figure 4.12:</b> Dried instant noodles with 3% ALP.....	67

## List of Tables

<b>Table 3.1:</b> Summary of Methodologies .....	51
<b>Table 4.1:</b> Participants demographics .....	57
<b>Table 4.2:</b> Standardized recipe .....	64
<b>Table 5.1:</b> Ingredients used for noodles production.....	76
<b>Table 5.2:</b> Nutritional Content of instant noodles.....	81
<b>Table 5.3:</b> Macronutrients in noodle samples .....	82
<b>Table 5.4:</b> Mineral composition of developed instant noodles .....	82
<b>Table 5.5:</b> Colour and texture of cooked noodles .....	83
<b>Table 5.6:</b> 1, 1-Diphenyl-2-picrylhydrazyl (DPPH) radical-scavenging activity (EC50) evaluated in noodles with different contents of <i>Amaranthus</i> leaf powder (ALP). .....	85
<b>Table 5.7:</b> Sensory analysis of developed noodles .....	86

## PREFACE

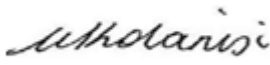
The work described in this dissertation was carried out at the School of Agricultural, Earth and Environmental Sciences at the University of KwaZulu-Natal from February 2019 to November 2019 under the supervision of Prof Unathi Kolanisi, Dr Nomali Ngobese and Prof Muthulisi Siwela.

Signed:  \_\_\_\_\_

Date: 29 November 2019

Nothando Qumbisa (Candidate)

As supervisors of the candidate we agree to the submission of this dissertation:

Signed:  \_\_\_\_\_


Date: 29 November 2019

Prof Unathi Kolanisi (Supervisor)

Signed: \_\_\_\_\_

Date: 29 November 2019

Prof Muthulisi Siwela (Co-supervisor)

Signed:  \_\_\_\_\_

Date: 29 November 2019

Dr Nomali Ngobese (Co-supervisor)

## DECLARATION

I, Nothando Delight Qumbisa, declare that:

1. The research reported in this dissertation, except where otherwise indicated is my original work.
2. This dissertation, or any part of it, has not been submitted for any degree or examination at any other university.
3. Where other sources have been used, they have not been copied and have been acknowledged properly.
4. This dissertation does not contain text, graphics or tables copied and pasted from the internet, unless specifically acknowledged, and the source being detailed in the dissertation and in the relevant reference section.

Signed: 

Date: 29 November 2019

Nothando Delight Qumbisa (Candidate)

## ACKNOWLEDGEMENTS

For I know the plans I have for you,” declares the Lord, “plans to prosper you and not to harm you, plans to give you hope and a future” **Jeremiah 29:11 New International Version (NIV)**. The utmost praise and gratitude goes to the lord who is my father and personal saviour. His grace and mercy has been following me throughout.

**I would also like to acknowledge the following persons who have supported the study up to the end:**

- My Mentor “Umama” Prof U Kolanisi, for your physical, emotional, spiritual and academic support, Thank You. Day in and day out you have never left me once, you have been more than a supervisor to me and without you this wouldn’t have been possible. Indeed, you have contributed immensely to the development of an African young black child.
- My Co-Supervisors Prof Muthulisi Siwela and Dr Nomali Ngobese, for academic support. I have learned a lot from you.
- The School of Agricultural, Earth & Environmental Sciences and the National Research Fund (NRF) for financial support
- The Department of Dietetics and Human Nutrition (University of KwaZulu Natal, Pietermaritzburg campus) for granting permission to utilize foods laboratory during texture and colour analysis of the developed products.
- The University of Zululand for approval to conduct the study at the KwaDlangezwa Campus and the Department of Consumer Science for allowing me to use their facilities to develop noodle samples. University of Zululand students who participated in the study.
- Dr Fikisiwe Gebashe for assisting with analysis of antioxidant activity.
- Mr N. Dlamini for his enormous support and assistance with analysis of data, you have been a blessing from God, my right hand and definitely my guardian angel.
- Andile Mthembu, Njabulo Dlamini, Sthembiso Mhlongo, Snegugu Nguse, Nqobile Miya, Thembeke Radebe, Nqobile Makhaye, Nonkululeko Madiya and Minenhle Mlambo for their assistance with data collection during the survey and sensory evaluation.
- My family, particularly my mother’s; Ms. A.L Qumbisa and Ms H.D Khowa, thank you for your prayers, love, care and support.

## **RESEARCH OUTPUTS**

The work presented in this document has been shared as follows:

Submitted for consideration and in DHET- accredited journals:

1. Qumbisa, ND, Ngobese NZ and Kolanisi U. Consumption of noodles and utilisation of *Amaranthus* at the University of Zululand, South Africa. Journal of Consumer Sciences, Manuscript number: 2019/JCS/006
2. Qumbisa ND, Ngobese NZ, Gebashe FC, Kolanisi U and Siwela M. Nutritional composition, physical quality and consumer acceptability of *Amaranthus*-supplemented noodles. Journal of Food Science and Technology, Manuscript number: JFST-S-19-03894.

### **Presented at conferences**

1. Qumbisa, N, Ngobese, N, Kolanisi, U and Siwela, M (2019). Consumption of instant noodles, utilisation of *Amaranthus*, consumer acceptability and physical quality of *Amaranthus*-supplemented noodles among students at the University of Zululand. 23<sup>rd</sup> Biennial Congress and Exhibition of the South African Association for Food Science and Technology: Food Science and Technology for the 21<sup>st</sup> Century. Johannesburg, South Africa, 1–4 September – Poster presentation

## **Chapter 1 : Problem statement and its setting**

### **1.1 Background of the study**

The World Instant Noodles Association (WINA) estimated that the demand for instant noodles reached 97 460 billion servings per capita consumption globally. China leads the statistics by 38 520 million servings, whilst South Africa held the number 29 position out of 54 countries with 200 million servings (WINA, 2017). Instant noodles are becoming the new global staple and breakfast food due to their versatility and convenience. For centuries instant noodles were a staple food only in East Asian countries, however, their consumption has increasingly grown globally (Adegunwa et al., 2012; Phakare et al., 2018). The consumption of instant noodles is notably dominant amongst the youth population (Sikander et al., 2017; Zahrul-lail, 2017). A study by Nelson et al. (2009) showed that students at colleges consumed instant noodles more than adults in other age group. According to research findings, instant noodles are preferred because of their taste, extended shelf-life, cheap price as well as convenience, which suits the busy lifestyle of the student population (Cotti and Tefft, 2013; Habibat et al., 2015; Sikander et al., 2017; Phakare et al., 2018). However, there are concerns as reliance on them could lead to malnutrition.

Noodles are long thin pieces of food made from a mixture of wheat flour, water and eggs; they are usually cooked in soup or boiling water. They originated from China where they were invented by Momofuku Ando of Nissin foods back in 1957 (Zahrul-lail, 2017). There is a concern in terms of the adequacy of nutrients obtained from instant noodles especially when consumed as a single food item. According to literature instant noodles generally contain about 250 kcal, 51 g of carbohydrates, 8 g of protein, 2 g of fat, 2 g of dietary fibre & 192 mg of sodium per 100g serving (Sikander et al., 2017). The high calorie content of the instant noodles, poor protein quality and lack in vitamins, as well as mineral availability, compromises the nutritional value of this product. Further, instant noodles contain high levels of salt, which if consumed in high percentages may be detrimental to the health of young women (Huh et al., 2017; Annigan, 2018). In addition, the poor quality of protein and other essential nutrients found in these instant noodles can lead to malnutrition (Annigan, 2018). Researchers are therefore exploring supplementation of noodles with healthy, nutrient-dense food materials to produce composite foods and improve their nutritional value (Phakare et al., 2018).

There are quality effects that need to be considered when supplementing noodles with other food materials, they include effects on flavour and texture, colour, the development of a rancid taste after long-term storage as well as cooking quality (Gulia et al., 2014). Normally, durum wheat flour is used to produce instant noodles, however, wheat flour has low protein and dietary fibre content. To increase the protein content of noodles, supplementation can be done with materials of animal or plant origin, however, animal protein sources are costly as opposed to plant protein sources (Adegunwa et al., 2012). The purpose of the current study was to improve the contribution of instant noodles to food and nutrition security by inclusion of *Amaranthus* leaf powder.

*Amaranthus* is an ancient vegetable that has been consumed in different regions and countries for over 8 000 years (DAFF, 2010). It is high in vitamins including  $\beta$ -carotene, vitamin B6, Vitamin C, riboflavin, folate as well as essential amino acids (Beswa et al., 2016). *Amaranthus* grain and leaves are a good source of protein and minerals, such as magnesium, calcium, potassium and phosphorus, iron and sodium (Alegbejo, 2013). *Amaranthus* grains are used as source of lipids and *Amaranthus* grain powder is used as a base of noodles, pancakes and other *Amaranthus*-based products (DAFF, 2010; Sanz-Pennella et al., 2013; Ogrodowska et al., 2014). Although there are no reports of use in instant noodles, *Amaranthus* leaves can be used with wheat flour to produce nutritionally enhanced food products (Ogrodowska et al., 2014).

Consumer acceptability of *Amaranthus*-supplemented food products has been investigated with the youth and a low preference and acceptability was reported (Beswa et al., 2016). With an increased addition of *Amaranthus* leaf powder to bio fortified maize snacks, acceptability decreased (Beswa et al., 2016). The supplementation of noodles with *Amaranthus* leaf powder and the evaluation of consumer acceptability had not been done in South Africa although *Amaranthus* use has been gaining popularity in supplementing nutrient deficient products (Cárdenas-Hernández et al., 2016). The objectives of the current study therefore include the effect of inclusion of *Amaranthus* leaf powder on consumer acceptability of instant noodles.

## **1.2 Problem Statement**

Researchers are investigating how to improve the nutritional value of noodles (Barcelon et al., 2015). Food supplementation using vegetable-based nutrients is steadily gaining momentum, it is a growing modern trend in response to consumer demands for nutritious healthy foods

(Barcelon et al., 2015). Although, certain vegetables have been introduced as nutrient enhancers, there are limited studies that report the use of indigenous and/or traditional leafy vegetables as nutrient enhancers of noodles. *Amaranthus* is one of the abundant indigenous and traditional vegetables, a good source of nutrients such as protein, vitamins and minerals (DAFF, 2010). However, the literature shows its underutilisation emanating from consumer negative perceptions (...“*food for old people, poverty food, and backwards food...*”) (Alegbejo, 2013; Ramdwar et al., 2017). Students form a large proportion of the population that consumes instant noodles the most. This study therefore investigates the acceptability of *Amaranthus*-based noodles to students at the University of Zululand, South Africa.

### **1.3. Rationale**

Changes in the lifestyles of people to being busy means less time spent in the kitchen for meal preparations. This justifies the growing trends in convenience foods consumption especially amongst youth and children. There is however a concern in terms of the healthiness of these convenience foods (Right Choice, 2014). This study looked at three problems that South Africa is facing: 1) limited transfer of indigenous knowledge especially on indigenous foods to the youth, 2) indigenous foods are not part of the local food system that increases the likelihood of loss of South African (SA) identity due to its underutilisation, 3) the posing malnutrition risks, especially among students, due to increasing consumption of instant noodles as the sole subsistence food item (Shin et al., 2014). *Amaranthus*, being an ancient traditional vegetable (DAFF, 2010) and having high nutritional value (Beswa et al., 2016), serves as a good food source for improving the nutritional value of noodles.

### **1.4 Aim of the study**

The aim of the study was to investigate consumer acceptability and quality attributes (nutritional value and physical quality) of *Amaranthus*-supplemented noodles among students at the University of Zululand.

### **1.5 Specific objectives of the study**

The objectives of the study were as follows:

- To assess the patterns of consumption of noodles and utilisation of *Amaranthus* among students

- To develop *Amaranthus* supplemented instant noodles
- To determine the physical quality (colour & texture) of *Amaranthus* leaf powder-supplemented noodles
- To assess the nutritional composition and antioxidant activity of the samples of noodles developed.
- To investigate the consumer acceptability of the *Amaranthus* leaf powder-supplemented noodles.

## **1.6 Dissertation structure**

The chapters of this dissertation have been formatted as manuscripts that have been submitted to peer-reviewed journals, except for the problem statement and its setting, General Methodology, and the General Conclusions and Recommendations chapters. Chapter 1 provides the background, problem statement, purpose and objectives of the study. Chapter 2 is a review of the relevant literature which is divided into two sections. Section A reviews literature on hunger and food systems in relation to the consumer behaviour and Section B discusses the quality attributes and consumer acceptability of enriched pasta-based products. Both the sections are to be submitted in DHET accredited journals for publications. Chapter 3 describes the methodology of the study. Chapter 4 presents the results and discussion of the survey of the patterns of consumption of noodles and utilisation of *Amaranthus*. Chapter 5 is a report of the investigation on “Effect of *Amaranthus* leaf powder on the nutritional composition and physical quality of noodles provide and provides results on the physical, nutritional effects and consumer acceptability of *Amaranthus* on noodles.” Chapter 6 is the General Conclusion, Limitations and Recommendations of the study.

## 1.7 References

- ADEGUNWA, M. O., BAKARE, H. A. & AKINOLA, O. F. 2012. Enrichment of noodles with soy flour and carrot powder. *Nigerian Food Journal*, 30.
- ALEGBEJO, J. O. 2013. Nutritional value and utilisation of amaranth (*Amaranthus* spp.) A review. *Bayero Journal of Pure & Applied Science*, 6 (1): 136-143. ISSN:2006-6996 <http://dx.doi.org/10.4314/bajopas.v6i1.27>.
- ANNIGAN, J. 2018. The effects of low protein intake” Healthy eating. SF Gate. written by Carly Schuna accessed online at <https://healthyeating.sfgate.com/effects-low-protein-intake-7123.html>
- BARCELON, E. G., MCHUA, J. N., MONTEMAYOR, J. E., NAGALINGAM, M. G., OCAMPO, A. E. & ONG, R. M. 2015. Vegetable added pasta noodles: Physio-chemical composition and consumer acceptability. *International Journal of agriculture innovation and research*, 3 (6) ISSN (Online) 2319-1473
- BESWA, D., DLAMINI, N. R., SIWELA, M., AMARISOU, E. O. & KOLANISI, U. 2016. Effect of amaranth addition on the nutritional composition and consumer acceptability of extruded provitamin A-biofortified maize snacks. *Food Science and Technology*. vol.36 no.1 <https://doi.org/10.1590/1678-457X.6813>.
- CÁRDENAS-HERNÁNDEZ, A., BETA, T., LOARCA-PIÑA, G., CASTAÑO-TOSTADO, E., NIETO-BARRERA, J. O. & MENDOZA, S. 2016. Improved functional properties of pasta: Enrichment with amaranth seed flour and dried amaranth leaves. *Journal of Cereal Science*, 72, 84-90.
- COTTI, C. & TEFFT, N. 2013. Fast food prices, obesity, and the minimum wage. *Economics and Human Biology*, 11, 134-147.
- DAFF 2010. *Amaranthus* production guideline. In: DEPARTMENT OF AGRICULTURE, F. A. F. (ed.). ISBN 978-0-621-40126-4.
- GULIA, N., DHAKA, V. & KHATKAR, B. S. 2014. Instant Noodles: Processing, Quality, and Nutritional Aspects. *Critical Reviews in Food Science and Nutrition*, 54, 1386-1399.
- HABIBAT, A., ABDUL-RASAQ, A., IBIYEMI, O., TAOFIK, S. & LATEEF, S. 2015. Production and Quality Evaluation of Noodles From Sweet Potato Starch. *Journal of Culinary Science & Technology*, 13, 79-93.
- HUH, I. S., KIM, H., JO, H. K., LIM, C. S., KIM, J. S., KIM, S. J., KWON, O., B. OH & CHANG, N. 2017. Instant noodle consumption associated with cardio metabolic risk

- factors among college students in Seol. *Nutrition Research and Practice* 11(3):232-239. doi: 10.4162/nrp.2017.11.3.232. Epub
- NELSON, M. C., KOCOS, R., LYTLE, L. A. & PERRY, C. L. 2009. Understanding the perceived determinants of weight-related behaviors in late adolescence: a qualitative analysis among college youth. *Journal of Nutrition Education and Behavior*, 41, 287-292.
- OGRODOWSKA, D., ZADERNOWSKI, R., CZAPLICKI, S., DEREWIAKA, D. & WRONOWSKA, B. 2014. Amaranth seeds and products—the source of bioactive compounds. *Polish Journal of Food and Nutrition Sciences*, 64, 165-170.
- PHAKARE, K. N., DAGADKHAIR, A. C. & UDACHAN, I. S. 2018. Enhancement of Nutritional and functional characteristics of noodles by fortification with protein and fibre: A review. *Journal of Pharmacognosy and Photochemistry*.
- RAMDWAR, M. N., CHADEE, S. T. & STOUTE, V. A. 2017. Estimating the potential consumption level of amaranth for food security initiatives in Trinidad, West Indies. *Cogent Food & Agriculture*, 3, 1321475.
- RIGHTCHOICE 2014. Instant noodles: Not a nutritious choice. Accessed online [http://cercervis.nic.in/PDF/Instant\\_Noodles.pdf](http://cercervis.nic.in/PDF/Instant_Noodles.pdf) 23 March 2019.
- SANZ-PENNELLA, J. M., WRONKOWSKA, M., SORAL-SMITENA, M. & HEROS, M. 2013. Effect of whole amaranth flour on bread properties and nutritional value. *LWT-Food Science and Technology*.
- SHIN, H. J., CHO, E., LEE, H. J., FUNG, T. T., RIMM, E., ROSNER, B., MANSON, J. E., WHEELAN, K. & HU, F. B. 2014. Instant noodle intake and dietary patterns are associated with distinct cardio metabolic risk factors in Korea. *J Nutr*
- SIKANDER, M., MALIK, A., KHAN, M. S. G. & KHAN, R. G. Q. 2017. Instant noodles: Are they really good for health? A review. *Electronic Journal of Biology*, 13, 222-227.
- WINA 2017. National trends in instant noodles demands. *World Instant Noodles Association*.
- ZAHRUL-LAIL, N. S. 2017. Influence of instant food among students. *Research Hub*, 3 (2) ISSN: 2180-0065.

## Chapter 2 : Literature review

The chapter herewith is divided into two sections. Section A mostly looks at relationships between food and nutrition security, food systems and consumer behaviour in the eradication of hunger. This forms basis for strategies and interventions that aim to reduce the prevalence of hunger and malnutrition especially in food product development. Understanding the food systems and how they are affected by the consumer behaviour assists the researcher to be able to match the new products with the current trends. However, there are other factors that affect the acceptability of new products which is why Section B looks at the quality attributes and consumer acceptability of enriched pasta-based products in order to determine whether supplementation of noodles with *Amaranthus* can be possible for both food and nutrition security of students.

### **Part A: Towards the Zero Hunger 2030 Agenda and development of future food systems: a review on consumer behaviour effects towards the eradication of hunger**

#### **2.1 Introduction**

Eradication of poverty, hunger and malnutrition in the world is one of the targets set out for the 2030 Agenda for Sustainable Development Goals (SDGs) (Rimas and Fraser, 2010; Colglazier, 2015). Efforts have been made in reducing food and nutrition insecurity and include the inclusion of eradication of poverty and hunger as goal number 1 in the millennial development goals that were set for 2015 despite the progress made, the prevalence of food insecurity still persist (FAO, 2015; Prosekov and Ivanova, 2018). This was reported in the MDGs report (2015) that although the target at a global scale was met, the poorest populations have yet to benefit from the MDGs (Way, 2015). It is for that reason that the goal towards zero hunger (Goal 2) has been solely included in the sustainable development goals (SDGs) with an understanding that it is broad on its own and requires its own targets and strategies.

Kearny (2010) remarks: “The world’s capacity and ability to feed its population has increased over the past 50 years”. This was due to increased food production, improved food diversity and reduced dependency on seasonal production which has been brought about the new development of technology (Crush and Frayne, 2011). Despite this, available data shows that the number of people who are hungry is steadily growing (FAO, 2015). About 821 million people in the world were still affected by undernourishment or chronic food deprivation in

2017, an increase from 801 million in 2016 with significant numbers being observed in South America and Sub-Saharan African regions (Kearney, 2010; Malik et al., 2013; FSIN, 2018; World Health Organization, 2018). The way food is produced, consumed and distributed is said to be contributing an integral part on poverty, hunger, contributions to land degradation, climatic change, malnutrition and other several factors (Foresight, 2011; FAO., 2014).

Currently, food systems are not sustainable as they generate negative outcomes on the environment, yet they are still failing to address the food insecurity and eradicate poverty for rural populations especially in the sub-Saharan Africa (Godfray et al., 2010; Foresight, 2011; McGuire, 2015). With no argument, the existing food systems form part of the topical challenges that the world is facing concerning social, economic and other challenges in food security (Freibauer et al., 2011; Garnett, 2014; Food, 2015; Gladek et al., 2016). Food systems are defined as *“all processes and infrastructure involved in satisfying the population’s food security, that is, the gathering/catching, growing, harvesting (production aspects), storing, processing, packaging, transporting, marketing, and consuming of food, and disposing of food waste (non-production aspects)*. It includes food security outcomes of the activities related to availability and utilisation of, and access to, food as well as other socioeconomic and environmental factors” (Ericksen, 2008; van Berkum et al., 2018).

More so, over the years the food systems have paid much attention on production of food without considering its quality. The aim was to address food insecurity that was highly escalating. In addition, during that period, food security and causes of food insecurity were also not understood properly by many as its definition was focused more on food production ( Defra and Plan, 2006; Gundersen and Ziliak, 2014). The issue of access, stability as well as the utilisation of food was later realised to be a challenge even though food was readily available, the number of people who were hungry continued to grow. As a result of health consequences, there was a need for a complex definition of food security and a need for modified food systems in order to meet future food needs (Fresco, 2009; Falguera et al., 2012). The World summit of 1996 then defined food security as being met when “all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (Godfray et al., 2010).

Consumer behaviour along with the dietary preferences also contribute to the prevalence of food and nutrition security as they contribute to the underestimated pillars of food security and

somewhat affect the food system (Haddad et al., 2016). Responsible consumption and production is also stipulated as the 12<sup>th</sup> goal in the SDG's as it has been realised that activities that take place in the food system has an impact not only on food security but also has socioeconomic and environmental impacts (van Berkum et al., 2018). Consumer behaviour, consumer trends, food and nutrition security and food systems are interrelated and affect each other (Haddad et al., 2016). However, in development of policies and when exploring the impacts of these concepts most often this is done in isolation (El Bilali et al., 2019). It is important to study the drivers of the food systems and determine their impact instead of only focusing on impact of food on food security (Porter et al., 2014), although it also remains important as projections towards 2050 indicate an increased need for more food to be produced (Alexandratos and Bruinsma, 2012). There is a need to intensively look into the consumption patterns as major drivers of the change in the global food system in order to understand the instability of the current food systems and plan for the future (Moomaw et al., 2012). The aim of this part of the review therefore is to evaluate the consumer behaviour, understand the consumer demands and preferences as they relate to the change in the production system and also understand how the current trends in food consumption will affect the food systems and food and nutrition insecurity in the coming years.

## **2.2 Global food and nutrition status**

### **2.2.1 Food security status**

“Food insecurity exists when people lack sustainable physical or economic access to enough safe, nutritious, and socially acceptable food for a healthy and productive life” (Fawole et al., 2015). Food insecurity is one of the major contributors to malnutrition forms (Overweight, obesity and under nutrition) and in most countries these usually coexist together (Malik et al., 2013). The estimates made by the Food and Agricultural Organization (FAO) indicate that about 10% of the world's population is exposed to severe food insecurity (FAO et al., 2017). That is about 1.2 billion people live in extreme poverty and about 870 million are undernourished (Way, 2015). According to May (2017) the food security pillars which are availability, accessibility, utilisation and stability are hierarchical in nature where food availability is a necessity but not sufficient for food accessibility, similarly food accessibility and stability are also a requirement however they are not sufficient for utilisation. This suggests that in order to meet food and nutrition security all these pillars must be addressed and attained at the same time (FAO and FAOSTAT, 2008). Previously, studies and interventions have only

been addressing one pillar which relates to food availability and have been ignoring the other three (Crush and Frayne, 2011; Napoli et al., 2011). This has seen most countries like South Africa deploying the tasks to address food insecurity to the department of agriculture with expectations that more food must be produced, (Prosekov and Ivanova, 2018) also concluded that people were not hungry because food was not available, but the issue of access was a problem. It is therefore necessary to not only provide the population with food, however also consider providing healthy foods to maintain healthy diets and reduce the prevalence of malnutrition (Black et al., 2013; Ng et al., 2014). The quality of food can also be traced back to the type of food system being used. According to Haddad et al. (2016) the longer the production system or the food chain becomes, the more likely that the quality will be compromised. Policies that will not only be sensitive to the food access issue but be able to address the utilisation and stability of food supply are then required.

Although the world is sufficient in its production (Porter et al., 2014, Sinha, 2014) it seems that food is not able to reach all people. The most marginalised are those in the developing countries especially those in the sub-Saharan Africa (Alexandratos and Bruinsma, 2012; Porter et al., 2014). Food insecurity is mainly driven by poverty, natural cataclysms such as droughts, floods and cyclones as a result of climate change, as well as conflicts and population growth ( Fawole et al., 2015; Prosekov and Ivanova, 2018). All these have an impact on the food and nutrition status and natural cataclysms do this through the destruction of livelihood assets. Increased prices of nutritious food (Brinkman and Hendrix, 2011), the burden of living with food insecurity, and physiological adaptation also lead to increased risks of food insecurity and may result in malnutrition (Porter et al., 2014). Poor access to food leads to increased risk for stunting and low birth weight in children which may be detrimental to their lives at a later stage (Gundersen and Ziliak, 2014). Strategies to improve the livelihoods and income of the poorest communities are essential to achieve food security for all. Nutrition sensitive agricultural production and food systems are a major requirement if food and nutrition security of children, adolescents and women is to be addressed (May, 2017).

### **2.2.2 Nutrition security status**

The Global Nutrition Report (2018) states that there is high prevalence of malnutrition in the world. Malnutrition is a global problem that has raised so much concern in all countries all over the world. About a third of women of child bearing age are anaemic, 39% of the world's adults

are obese/overweight whilst over 20 million children born yearly are stunted ( FSIN, 2018; World Health Organization, 2018). According Muhammad et al. (2017) changes in the eating habits have contributed to the rise in global malnutrition and chronic non-communicable diseases (NCDs) such as diabetes and others (Malik et al., 2013; FAO et al., 2017). High consumption of animal fat and protein, refined grains and sugar was thought to be responsible for the nutritional transition in low and middle-income countries (Kearney, 2010; Monteiro et al., 2010; Khoury et al., 2014). Over the last three decades, the average consumption per person has increased from 2370 kcal/person/day to 2770 kcal/person/day and diets changed to more livestock products and vegetable based products such as oils (Khoury et al., 2014).

The rise in the rate of malnutrition as well as chronic diseases has drawn the attention of governments as well as the policy makers to make efforts to address the issue, paying attention to education and assisting consumers in making healthy food choices ( Department of Health, 2009; Malik et al., 2013; Anderson and O'Connor, 2019). Despite the efforts made around, the world progress has been very slow. Stunting was standing at 22.2% in 2017 (32.6% in 2000) and underweight women have decreased from 11.6% in 2000 to 9.7% in 2016 (World Health Organization, 2018). The stunting numbers are close to the projections made by De Onis et al. (2012) that by the year 2020 stunting amongst children will be around 21.8 %. The percentage of adults who are overweight and obese is expected to further increase in the low/middle income countries over the next two decades (Kelly et al., 2008; Alexandratos and Bruinsma, 2012; De Onis et al., 2012). This calls for another series of interventions that relate to lifestyle changes. These should focus on individual or community-based strategies, environmental change, food labelling, school-based initiatives, food marketing to children, promotion of physical activity and regulations on urban planning, and food and nutrition education campaigns (Kelly et al., 2008; Malik et al., 2013; Beckline and Kato, 2014; World Health Organization, 2018).

### **2.2.3 Food and nutrition security gaps in sub-Saharan Africa**

The issue of global food security crisis as it stands now, puts at risks the lives of many millions of people which are in vulnerable communities such as those in Africa where poverty and hunger are more prevalent (Ilaboya et al., 2012). Food insecurity in developing regions, sub-Saharan Africa in particular, is said to be attributed to several factors: the high levels of poverty, war and political instability, urbanization, population growth, insufficient food production due

to poor agricultural sector development as a result of poor leadership and policy development, lack of adequate storage facilities, inadequate food processing, climate change and natural disasters (Fanzo, 2012; Ilaboya et al., 2012; Fawole et al., 2015). While the rest of the world has made significant progress towards poverty alleviation, Africa, in particular sub-Saharan Africa continues to lag behind (Fanzo, 2012). Projections show that there will be an increase in this tendency unless preventive measures are taken (Alexandratos and Bruinsma, 2012). It is also suggested that the factors that facilitate food insecurity in South Africa may also prevail against the attainment of the SDGs. Food insecurity on the continent has worsened and the proportion of the malnourished population has remained within above 30% in sub-Saharan Africa (Fawole et al., 2015). South Africa is one of the food insecure countries because it still perceived food insecurity as a problem that only affects rural people and can only be addressed by farmers through increased food production (Aliber and Hart, 2009; Matshe, 2009). However, more people are urbanising and food purchasing is more practised than using agriculture as a primary source of food which leaves this group vulnerable to food insecurity as food prices are constantly rising (Crush and Frayne, 2010; Brinkman and Hendrix, 2011).

### **2.3 Consumer behaviour and future food systems**

Consumer behaviour is defined as “the mental and physical activities undertaken by households, businesses, or individual consumers that result in decisions and actions to pay for and use products and services” (Jisana, 2014). People’s lifestyles are constantly changing globally and so are their eating patterns, which in turn affects the food system as well as the food and nutritional status (Muhammad et al., 2017). Food systems consists of activities in relation to the food chain, the business aspects as well as the enabling environments that all aim to increase food security as per the sustainable development goal towards zero hunger (van Berkum et al., 2018). Recently the food systems have experienced a shift as supply of food now is relative to the demand by consumers and production has become more sensitive and responsive towards the consumers and the markets (Falguera et al., 2012). The Global Panel (2016) also made an emphasis that consumers now are the ones who determine what and how the food system produces. Food culture, i.e. values and social norms, plays an important role in what people consume (Scott, 2017). Moreover, income as well as other socioeconomic factors have an impact on the food choices in a similar way that the relationship between having nutritional knowledge and the health status does (The global panel on agriculture and food systems for nutrition, 2016). In addition to sufficient quantities of food, food systems are

expected to produce healthy food ('healthy diets') in order to meet the nutritional status of individuals. This calls for various interventions if the targets are to be met (van Berkum et al., 2018). It is said that there are many factors that drive or shape the food systems and these enable the world to be able to identify future threats as well as factors that will be shaping the food system in years to come (Fresco, 2009). The section below will explore the drivers of food consumption as well as food systems. In addition, we establish a relationship between consumer behaviour, food systems as well as food and nutrition insecurity.

## **2.4 Factors driving global food consumption trends and consumer preferences**

### **2.4.1 Socio-demographic factors**

Rapid demographic, social and economic changes in many low- and middle-income countries have led to increased urbanization and changes in food systems, lifestyles and eating habits. This means that consumers now do not only buy or consume food for satiety but also for physical and psychological developments. According to Kearny (2010), the per capita consumption (Kcal per person per day) was around 2950 in 2015 and is expected to increase to 3040 in 2030 and 3130 to 2050 all over the world (Khoury et al., 2014). In general, socio-economic factors such as culture, price, preferences, availability, convenience and health are some of the major factors that impact the diet composition of individuals (Godfray et al., 2010). As a consequence, dietary patterns have shifted toward increased consumption of processed foods that are often energy-dense, high in saturated fats, sugars and salt, and low in fibre (World Health Organization, 2018). Below is a summary of the drivers of consumer behaviour towards food consumption. According to projections made from, the population growth rates may decrease in high income countries however in low and middle income countries especially in the sub-Saharan Africa, whose food and nutrition security status is already a challenge, growth is still expected to accelerate (Alexandratos and Bruinsma, 2012; Fawole et al., 2015). According to Fawole et al., (2015) Nigeria forms part of these countries, projected to overtake America and become the third in the world's most populous countries by 2050.

### **2.4.2 Urbanization**

The movement of people from the rural areas towards cities or more developed areas, known as urbanization, has been thought to be a great contributor towards the change in the consumer diets and preferences (Fawole et al., 2015). Projections record that malnutrition in a form of

obesity and overweight people is high in cities. This happens through a shift from their traditional systems of attaining food towards a new and improved marketing system, that opens room for new distribution system, improved access to various producers as well as transporting systems. The supply of food is improved and the chance for importation is enhanced. This leads to an increased calorie intake that is partnered with minimal energy requirements for day-to-day activities. Without any supplementation with physical activity, the prevalence of malnutrition increases. In addition to that, as people move towards urban areas, there is high exposure to fast food outlets which contributes to a change in consumer dietary behaviour (Kearney, 2010, Havas and Salman, 2011). Increased availability of fast, easy to prepare and cheap foods that are high in salt, sugar and fats always meets the urban consumer demand however contributes so much in the nutritional concerns around the areas.

### **2.4.3 Lifestyle changes and nutrition transition**

The future food consumption patterns can be projected and assumed using drivers of food choices, which include population growth (Godfray et al., 2010) as well as income and food prices (Afshin et al., 2014). Consumption of cereals, milk, vegetable and meat is expected to increase all over the world with significant increases in developed countries. Changes in the way the diets are structured is also expected to change having a 1.1 percent increase in the demand for agricultural products (Alexandratos and Bruinsma, 2012; Kraemer et al., 2016). This will be because of the diet transition towards satiety and nutrition. Nutrition transition is defined as a series of adverse changes in the diet, physical activity and health of the country or the individual. It seems that currently the world is shifting from what was thought to be a concern (undernourishment) towards another concern (Obesity and increased risks of nutrition related non-communicable diseases) (Kearney, 2010). This is driven by high consumption of unhealthy foods, especially in developing countries, which can be attributed to the low prices, and increased supply of highly un-nutritious foods.

The ability to access food because of urbanization has led to an increased consumption of animal foods and fatty foods. Importation of food from highly industrialized companies also leads to the nutrition transition being observed as more countries tend to divert from the traditional and indigenous healthy diets, which include grains and vegetables to meals that are higher in sugar and fat content. Rapid increase in the economic growth has also contributed to how people live their lifestyles resulting in rise in the number of overweight individuals

(Kearney et al., 2010). It is difficult however to completely vouch for the removal of such foods from the diet as although these are deemed highly unhealthy, people still demand and prefer these foods in terms of taste. It is important therefore to come up with a variety of foods, which are as tasteful however with reduced effects on the overall health of the communities.

#### **2.4.4 Income influence on food selection vs food preferences**

Income is another factor that can be used to predict the consumption behaviour of individual's, households and the country at large (Alexandratos and Bruinsma, 2012). Poor dietary intake is often associated with low income. This was after it was established that individuals with low income purchased and consumed less fruits and vegetables and have a high intake of sugars and sugary beverages than individuals with a higher income (US Department of Agriculture, 2008; French et al., 2019). Research also confirms that changes in income along with food prices has a strong effect on food intakes, the differences being mostly realised in developing countries than in higher income countries (Muhammad et al., 2017). From this it can be predicted that the consumption of unhealthy meals will continue amongst the poor countries unless the productions systems are modified to produce functional foods as part of the current trends that will be of health benefits to the population (Baker and Friel, 2016). Over the years the food system has been encouraging consumers to buy and consume ready to eat meals which have led to an increase in the number of obese adults (Mendonça et al., 2016). As a result of changing lifestyles, convenient food consumption has become a trend and has given rise to a food system that is a conundrum of ultra-processed foods and indigenized foods (Monteiro et al., 2010, Finucane et al., 2011). The purchase of ultra-processed food is constantly increasing due to its low prices whilst purchasing of food with minimal or no processing is low (Monteiro et al., 2010, Baker and Friel, 2016, Marrón-Ponce et al., 2018). This calls for strategies that will help promote the consumption of unprocessed foods whilst discouraging the availability and accessibility of highly processed foods as this food system will lead to a diet change and affect the health of consumers (Baker and Friel, 2016).

#### **2.4.5 Trade liberalization**

Another important factor that affects the food intake is trade liberalization (Alexandratos and Bruinsma, 2012). This factor has led to an alteration in the food environment as well as the consumer food choices. Unhealthy products especially those that are rich in calories, have little

or no nutrients and are saturated with high levels of fats and sugars. They are ridiculously cheaper than the healthy options as well. Due to the economic crisis people are faced with, this has led to an increased desire and availability of these unhealthy choices. Urbanization and unstable relationships between consumers and suppliers as well as changes in lifestyle are some examples of how trade liberalization can affect the consumption of food, in particular for poor people (Thow and Hawkes, 2009; Kearney, 2010,). The issue of trade liberalization can significantly remove foreign trade investments barriers in food distributions and this can affect the availability of certain foods. Similarly, it can also enable other foreign investment in other types of food for example there has been a significant investment in fast food outlets in middle-income countries. Highly processed foods have been on the rise in developing countries because of these investments. These have been thought to have a contribution in the overall health of these regions by facilitation nutrition transition thereby giving rise to obesity and chronic diseases (Thow and Hawkes, 2009).

## **2.5 Factors that drive the food systems**

Over the years, there has been an adequate supply of food and it has been readily available for consumers at the global scale (Godfray et al., 2010). This was as a result of a shift from the national based, supply oriented and state regulated & supported food systems (Lowe et al., 2008) towards a global food industry which adopted intense and unique methods of production in order to meet both the demands of consumers and shareholders (McGill, 2009). This system was based on production of food with good appearance as well as a longer shelf life without paying any attention to the health concerns of the consumers (Traill et al., 2008; Falguera et al., 2012). The system however could not be concluded to be functional as 1/7 people still had no access to food and the same number of people were found to be over fed (Godfray et al., 2010, Reisch et al., 2013). The shift toward a complex, technology-led, globalized and demand-oriented food system also received negative feedback from the consumers as they express that food being produced in this manner lacks traditional quality attributes, does not include their concerns in decision making with regards to social and environmental equity (Casey, 2009). The issue of food safety has also lead to the mistrust in the food system by consumers as a result of the food scandals that have emerged due to food contamination in the food chain. This has resulted in high doubts on the arising technology being used in the food farming as well as in the entire production system (Lowe et al., 2008; Falguera et al., 2012). The drivers of the

food system are many (Kearney, 2010; Kraemer et al., 2016; El Bilali et al., 2019) and (van Berkum et al., 2018) categorized them into two groups as follows:

### **2.5.1 Environmental drivers**

The availability of land for agriculture and livestock farming, the use of fossil fuels in agricultural machinery and equipment, refrigeration, storage, processing and transportation of food; the use of minerals/micro minerals to enrich soils and various metals such as for the manufacture of packaging, infrastructure and cookware; biodiversity as well as water are important key environmental drivers of the food system (Kraemer et al., 2016; van Berkum et al., 2018). This is because most activities in the food system happen in the agricultural production levels and partially in the processing, packaging, distribution, consumption and discarding of food (Kearney, 2010). All these factors individually operate and interact with each other and shortage in one or more of these can have significant impact on the entire food system. For example, the quality of soil required for production is not only dependent on the amount of water it feeds from however the presence of biodiversity is also significant in improving the mineral composition and improving the quality of soils. These then in turn all affect what, how and how much of it will be produced.

### **2.5.2 Socioeconomic drivers**

Markets such as prices, population growth income, labour etc. have great contributions in balancing the demand and the supply of food in the food system (Fresco, 2009; Alexandratos and Bruinsma, 2012). Policies for example on land rights, food security etc. can influence the food system as they seek to provide guidance to the activity outcomes food system although due to poor formulations, these are sometimes not aligned (Kraemer et al., 2016). Science and Technology in a form of research innovations and education on key areas in agricultural production or nutritional education significantly contributes to the growth of activities that take place in the food system and further outcomes of such can help improve the quality as well as the value of the overall production (Fresco, 2009; El Bilali et al., 2019). Social organisations such as households, media, education sectors etc. all have an effect on the overall functioning of the food system for example knowledge on consumer demands as well as their needs can help producers align their production properly and can results in productions with very little losses (van Berkum et al., 2018). Lastly the individual factors such as lifestyle, nutrition transition, norms, culture and attitude are affected by the food system (Power, 2010;

Alexandratos and Bruinsma, 2012). As much as it may drive the food system to produce in a certain way as a result of consumer food choices, actions taken by the system such as the choice of readymade meals may influence their intention to buy considering the type of lifestyle being lived now.

## **2.6 Impact of consumer behaviour and food systems on food and nutrition security**

Traditional, mixed and formal food systems exist. According to Haddad (2017) each type of food system being used has an impact on the food and nutritional status of the population. For example, with the use of more traditional food systems, mortality, wasting, vitamin A deficiency and anaemia for children under the age of 5 is more prevalent. Formal systems however were associated with high levels of obesity. According to Grunert (2011) consumers have a significant role to play in the food system, and food chains in particular. Through their food choices, an impact is realised in the sustainability of the production as they determine what and how will be produced (Fresco, 2009). Also as global diets are shifting toward nutrient dense and highly processed foods, this results in changes in the food system but also it may be the results of the changes in the food system (Kraemer et al., 2016). Both the behaviour and the food system need to be sustainable. A sustainable food system (SFS) must address issues of food and nutrition security for all and the SDGs are highly dependent on the improvement in these so as to be able to predict the feasibility of the targets. This is because traditional food security programs tend to adopt a production-focused approach, which seeks to directly influence food security through increasing the supply of food. However, this leads to the neglect of other areas in which the root causes of the food system underperformance, as well as the leverage points to bring about the biggest impacts can often be found. Also it is important to note that in order for food systems to be sustainable, they must sustain the long term food and nutrition security with regards to availability, access, utilisation, and stability (El Bilali et al., 2019). This can be through sustainable, resilient and efficient components of the food system and a shift from an agricultural centred framework into a research framework (Grunert, 2011; El Bilali et al., 2019,).

## **2.7 Consumption trends and preferences likely to shape the food system**

### **2.7.1 Low Cost food**

The consumers demand or preference for food product directly responds to the change in the price of the product. Consumers are currently looking for cheap and/affordable good quality products that will be off good benefits to their health. According to Muhammad et al. (2017) and (Verain et al., 2015), affordability is one of the critical factors that drive the consumers demand for food or food products. This factor is however dependant on the income levels of the consumer as the response to price changes always vary according to the income group each consumer is at or the country is at (Muhammad et al., 2017). It is therefore of utmost importance for policy developers and intervention personnel to understand that the price of the product does not only affect the consumer demand, but also will shape the preference to buy the product in relation to health benefits (Verain et al., 2015). Other preferences, such as those rooted in cultural and religious practices, may lead to weaker price responsiveness than otherwise expected. Additionally, consumers tend to have lower price responsiveness (measured own-price elasticity) for necessities, such as staple foods, than for higher value foods such as meats (Schnepf, 2011).

### **2.7.2 Naturalness and technology**

Historically, the food production technologies were created in order to be able to convert different raw materials from different plant and animal sources into new products (Pérez-Escamilla, 2017). Over time, these have been modified and developed in order to increase the quality production and products, extend the shelf life, and improve flavour and appearance. In this way, there is a transfer of traditional knowledge to the newly scientific knowledge as these build upon what has already been the norm. This trend indicates that consumers demand food that is more natural (free of any additional chemicals and fertilizers) and with minimal use of technology & handling (McGill, 2009; Jensen et al., 2019), the trend is strongly supported by (Willer et al., 2019) who indicated that the demand for organic products was increasing and more investments were being made towards the sector with Australia and China having the largest portions of land designated for this purpose (Jensen et al., 2019). Ingredients that have not been processed or with minimal processing, food that is readily available, safe and affordable according to the local food standards are constantly being demanded (McGill, 2009). It is because of the growing attention to the health and wellbeing of individuals that the

development of new technologies has diverted to the development of functional foods which are defined as food that improves health or wellbeing, or reduces disease risk, through beneficially targeting the body's functions (Action, 1999).

Most consumers are still not sure of the nutritional benefits of these products as a result of poor knowledge management and dissemination (Falguera et al., 2012). Functional foods as well as organic foods although have been in great demand, their affordability still leaves consumers not willing to change their behaviours (Traill et al., 2008). The development of new technology does however have its own negative implications, for example, emerging technologies that aim to attempt to speed up the processes of purchasing and food preparation may lead to the excessive contamination of such foods as it pays much attention on the naturalness of the final product over the simple cooking practices.

### **2.7.3 Convenience and healthiness**

Changes in the lifestyles of people from being easy to being complicated and busy means less time spent in the kitchen for meal preparations. This justifies the growing trends in convenience foods consumption (Kearney, 2010). There is however a concern in terms of the healthiness of these convenience foods (Right Choice, 2014). Although, consumers demand convenience similarly they want healthy and nutritious foods to maintain a healthy and active lifestyle (Verain et al., 2015). According to a 2017 IBIS World industry report, as consumers have more health concerns and adopt healthier eating behaviours, they are increasingly seeking a greater variety of premium products (Grunert, 2011; Azzurra et al., 2019). Various interventions are then being put in place to bring convenience and health in one product meaning that more composite foods are desired. For example, studies have been done using composite flours from sweet potato, soy and other vegetables trying to improve the value of instant noodles (Ginting and Yulifianti, 2015). The development of food products using composite flour has increased and is attracting much attention from researchers, especially in the production of bakery products and pastries (Noorfarahzilah et al., 2014).

Composite flours are defined as mixture of flours from tubers rich in starch (e.g. cassava, yam, sweet potato) and/or protein rich flours (e.g. soy, peanut) and /or cereals (e.g. maize, rice, millet, buckwheat), with or without wheat flour (Chandra et al., 2015). These have been encouraged to be used in developing countries not only for the purpose of nutritional benefits

but also for economic purposes as it promotes the use of local raw materials including indigenous crops (Aziah and Komathi, 2009; Noorfarahzilah et al., 2014; Hasmadi et al., 2014). Other interventions such as reduction of salt in food have been implemented in various countries such as South Africa and through food reformulations and traffic light systems. Although consumer awareness of health risks associated with sodium intake (high blood pressure in particular) is steadily growing, people generally entertain a preference for salted foods, and are apt to experience low-sodium foods as bland or tasteless (Stein et al., 2012). Reducing sodium (commonly referred to as salt) intake is generally considered as one of the most pressing health challenges when it comes to food and beverage consumption (Kloss et al., 2015).

#### **2.7.4 Local and regional food and globalization of flavour**

This trend describes the relationship consumers have with food and the place of production, which also facilitates the consumption behaviours. Consumers are now in demand for food that is locally produced and can reach them with minimal transportation (Jensen et al., 2019). For them it also relates the product and its production to local cultures, traditions and entails environmental sustainability and economic growth for that specific area. The ability to have contact with the producer, build a relationship is deemed as an additional guarantee of authenticity (Kraemer et al., 2016). Local food is sometimes used to tell a story, which does not only relate to the preparation methods of the specific food but also to the culture and tradition of the original place of production and local people are familiar with. This trend however is in contrary with the trend that speak to the globalization of flavours and distributing exotic food across the world at any time as it limits the production into one area and may be seasonally constrained (Kraemer et al., 2016). This trend is characterized by the exchange of food cultures which opposes the uniqueness and specificity of exclusively local and regional food (Court and Narasimhan, 2010; Douglas and Craig, 2011). Globalization encourages the desire and curiosity for other countries food and lifestyle customs and therefore, the food production system must the fore make provision to accommodate all these demands around the world.

### **2.7.5 Past and future orientation**

Food is another way of recalling memories, this factor therefore relates to being able to identify, recall, and preserve the culinary tradition of different socio-geographic areas (Kraemer et al., 2016). It entails that the demand for a particular food product or group is affected by the consumers past experience with it. For example, consumers will prefer food that they can be able to relate its flavours and techniques back to previous experiences that makes them feel good. These type of food are usually called comfort foods, and are identified as food that provide comfort and bring about a certain memory or feeling every time they are consumed. Comfort food is of an intrinsically local nature, as it is linked to specific cultural differences and to people's diverse culinary habits and origins (Buchner et al., 2012). Food preferences are also linked to the negative memories that consumers may have which may inhibit the consumption, therefore producers must take note that this may negatively affect their profits. With regards to future orientation, the current trends suggest the production of food and food products that may be seen as having an ability to address the current issues such as that price, population growth and environmental sustainability (Buchner et al., 2012). This is responded to by constant research and creation of new products that meet the above mentioned factors.

### **2.7.6 Luxury foods and the millennial consumers**

It is a fact that the socioeconomic status of individuals contributes towards what they eat as well. Due to this, some consumers are willing to pay more than the expected price for products that perceive as natural which are produced within a very costly manner. The exclusivity of expensive foods is justified by their higher quality and the difficulty of finding them. Such products are only accessible to a limited number of people which economically, socially, and culturally discriminates against individuals that are less privileged, a case which cannot be realised for low cost foods (Buchner et al., 2012). Consumers also consider the relationship between price and quality especially when it comes to food products. This is mostly driven by perceptions as consumers only get satisfied with the products prices if it really matches their expectations in terms of quality (Nguyen and Gizaw, 2014).

### **2.7.7 Individualism**

Recently most meals are eaten quickly and alone. Most people are no longer preparing meals for the purpose of sharing, socializing as well as interacting with other people. There is a

decline in the historical styles of home cooked meals that also show that family bonds are slowly being destroyed. It can therefore be assumed that this trend towards eating meals alone is as due to the rapid change in the family dynamics and life in general. It is also important to note that most who people live alone find it less interesting to prepare and eat meals which make them have a high preference for ready to eat and snack foods (Buchner et al., 2012).

### **2.7.8 Sustainability**

The sustainability of food production and consumption is an issue of growing importance. Many conventional methods of food production and consumption are contributing to the environmental, ethical, and social problems seen around the world (Garnett et al., 2013, Reisch et al., 2013, Verain et al., 2015). Consumers are not only looking for products that will benefit them but are also looking for high quality products whose production is sensible to the environment. This means that the impact that the products production has on the environment shapes the consumer's intention to buy or consume that specific product. The sustainability of the environment is applicable to all stages of production with specific interests in production that preserves the resources, recycles materials and has less emissions to the atmosphere (Buchner et al., 2012; Kraemer et al., 2016).

## **2.8 Food system challenges and proposed interventions in order to meet zero hunger goal**

### **2.8.1. Increasing the supply**

The world's population is said to increase up to 9 billion people by the year 2050 and this trend will be realised in developing countries which are already faced with food insecurities. The number of hungry people is also constantly increasing reaching 1% of the whole population (FAO et al., 2017). This means that in order to be able to meet the SDG 2 targets which van Berkum et al., (2018) "view as an ambitious goal" there will be a need to increase the food production rate by 50% (Prosekov and Ivanova, 2018). The challenge however is the inadequate land available for agricultural production with some of it being used for biofuel production as well as the scarcity of water which is already prevailing. Another challenge is the food losses in the production chain either during processing or by the final consumer which reduce the food available for consumption (FAO., 2013). Proposed solutions include capacitating the farmers and consumers with adequate information and skills required in order to increase their supplies such as access to inputs, production with reduced losses and less food

waste as well as to improve the food storage management systems (Ilaboya et al., 2012; Pérez-Escamilla, 2017). In addition, consumer preferences may be swayed towards consumption of plant origin food crops and less can be spent of meat production as it contributes to the emission of gases. A policy which enforces and makes provision for education about reducing food losses, recycling and promotion of healthy eating, especially plant foods can also help in attainment of SDG12 (responsible consumption) and SDG 13 (biodiversity) (Pérez-Escamilla, 2017).

### **2.8.2 Making available healthy food and influencing consumer behaviour**

This suggests that even when adequate supplies are met, the utilisation component of food security in particular, ensuring diet diversity will remain a challenge. As it stands about 2 billion of people worldwide are suffering from micronutrient deficiencies (UNEP-WCMC, 2016), 19% children in particular in the sub Saharan Africa are still undernourished (Unicef, 2018). Similarly, significant numbers of people are obese and overweight and exposed to the risks of getting diseases. Production and consumption of healthy and diverse food which is currently a challenge in the food system, is then a necessary requirement in order to effectively contribute to the achievement of SDG 3 which talks on the good health and wellbeing. This can be archived through influencing external factors of malnutrition such as the policies, encouraging the inclusion of nutrition education and women empowerment which has been proven to be able to assist in this regard (Badiane et al., 2014) and also promote the consumption of plant based products instead on animal sources.

### **2.8.3 Ensuring sustainability**

Current systems contribute to 19-29% of anthropogenic greenhouse gas (GHG) emissions with agricultural production making the most contribution along with other activities such as processing which affect the environment (Whitmee et al., 2015). Sustainable use of all natural gases especially soil and water which are the major resources for agricultural production is required in order for the system to be sustainable and function properly (UNEP-WCMC, 2016). Climate change as an environmental outcome is going to affect the production as well as food prices, significantly having an impact on the farmers' incomes (Vermeulen et al., 2012; Brian, 2015). Mitigation is therefore important to adopt as a strategy to reduce the emissions of GHGs

so as to make sure that another contribution to SDGs 13 and 15 are met through agricultural production and processing (FAO et al., 2017).

As part of the strategies and methods that can be used to address the issue of food and nutrition security but also try to merge with the future trends and fit within the current food systems, food product development through supplementation, using composite flours from indigenous crops within consumer preferences and demands is recommended. It is important however to note that when developing new products there are quality attributes that will immensely contribute to its acceptance and/rejection. For the purpose of this study, in the next section, quality attributes and acceptability of enriched pasta products is reviewed so as to evaluate the potential of supplementing noodles with *Amaranthus* leaf powder for more improved nutrition, food and nutrition security status of students.

## **Part B: Quality attributes and consumer acceptability of enriched pasta-based products**

### **2.9 Introduction**

Pasta and pasta products are among the most popular carbohydrate-rich staple foods that are currently being consumed (Wood, 2009; WINA, 2017). In 2013, pasta was declared as the second after bread in the world food consumption (Kaur et al., 2013). Its convenience and cost effective price attributes are major contributors towards its wide acceptance (Adegunwa et al., 2012; Sikander et al., 2017). Instant noodles form part of the pasta family, and is manufactured by mixing wheat flour or any other type with water and other different types of ingredients. In other countries noodles have been classified as an alternative replacement of staple foods (Wahyono and Bakri, 2018).

Although noodles are widely consumed, there is a concern in terms of the adequacy of nutrients obtained from instant noodles especially when consumed as a single food item (Huh et al., 2017; Sikander et al., 2017; Annigan, 2018). According to literature instant noodles generally contain about 250 kcal, 51 g of carbohydrates, 8 g of protein, 2 g of fat, 2 g of dietary fibre & 192 mg of sodium per 100g serving (Huh et al., 2017; Sikander et al., 2017). Consumers are getting more educated and aware of their health hence there has been a growing awareness on the connection between diet and diseases, causing consumers to re-examine their diets and seek healthier alternatives (Right Choice, 2014; Jayasena et al., 2010). Nevertheless, fast-paced

lifestyles continue to drive the demand for high-quality convenience foods. Thus, modern trends in the pasta production coincided with the growing interest on healthier options the production of vegetable-added pasta noodles (WINA, 2017).

Currently, there is a growing trend in using different flour blends to produce healthier noodles prepared from wheat flour (Barcelon et al., 2015; Ginting and Yulifianti, 2015; Huh et al., 2017). The major aim of this trend is to improve the nutritional value of instant noodles especially the protein and fibre content. Additionally, Gulia et al., (2014) emphasized that the quality factors on instant noodles which include acceptability in terms flavour, texture, colour, development of rancid flavours after long storage as well as the cooking quality as valuable factors affecting consumer acceptability. The present study aims to review various articles and investigate the consumer acceptability as well as the quality of noodles prepared from various flour blends to improve its nutritional value.

## **2.10 Instant noodle supplementation**

Due to the growing trends of hidden hunger as a result of micronutrient deficiencies, the World Health Organization (WHO, 2014) and Food and agriculture organization (FAO) came up with strategies to reduce the impact of these deficiencies (Mannar, 2006). Amongst the proposed strategies is consumption of a balanced diet, food supplementation, diet diversification and bio fortification strategy. Supplementation is a process whereby micronutrients are added to the products that are identified to be having a shortage (World Health Organization, 2014). Wheat flour supplementation is amongst the programs with an aim of reducing the prevalence of anaemia (Barkley et al., 2015). Supplementation is regarded as the sustainable health strategy because it is cost effective and does not require the target population to change its consumption patterns or diet as the process is done in industries to foods that are already present.

As an attempt to respond to the increased interests for healthier options for consumers, there is a growing trend in using different flour blends to produce healthier noodles prepared from wheat flour (Barcelon et al., 2015, Ginting and Yulifianti, 2015; Huh et al., 2017). The major concern with wheat flour blending is to improve the protein and fibre content of the noodles hence cereals, vegetables, root crops and legumes rich in these have been widely used (Phakare et al., 2018). The pasta family including instant noodles have been identified as the potential foods that require protein and mineral supplementation. These foods currently are very rich in

carbohydrates however the protein content and amino acid balance is not as much (Ebru and Mehmet, 2009). The pasta family including instant noodles have been identified as the potential foods that require protein and mineral supplementation. These foods currently are very rich in carbohydrates however the protein content and amino acid balance is not as much (Ebru and Mehmet, 2009). More so, the consumption of protein enriched foods from plant sources has increased among the health-conscious consumers and vegetarians (Phakare et al., 2018). Therefore, the use of plant protein has already penetrated the consumer market, thus the introduction of plant-based food supplementation is a familiar concept. Blends from sweet potato flour, cassava flour, and cowpea and soybean flour are some examples of composite flours that have been tried in noodles production. This blending helps improve the flavour, colour and adds nutrients to the instant noodles (Adegunwa et al., 2012; Barcelon et al., 2015). Instant noodles can be supplemented by substituting the flour used to make the noodles or by supplementing the seasoning consumed along with the noodles (Van Hung et al., 2007; Shao et al., 2009; Gulia et al., 2014).

### **2.11 Nutritional quality of enriched instant noodles**

The nutritional value along with energy content of all types of pasta is dependent on the type of raw materials used in the production (Duda et al., 2019). In a study conducted by Chen, it was revealed that addition of bran flour in the preparation of instant noodles improved the fibre content of the final product as well as its overall acceptability (Chen et al., 2011). Similarly, substitution of instant noodles with high quantity of oats flour lead to improved protein, fat, ash, and minerals content however this negatively affected the cooking quality and sensory properties of the final product (Aydin and Gocmen, 2011). Sudha et al. (2011) in their investigation found that the inclusion of defatted soy flour and whey protein concentrate in instant vermicelli not only enhanced their protein content and in vitro protein digestibility but also reduced the fat uptake in noodles (Sudha et al., 2011; Gulia et al., 2014). The results from various studies reflect a positive effect of addition of various ingredients such as pea flour (Kumar and Prabhasankar, 2015), oyster mushroom powder (Wahyono and Bakri, 2018), cricket powder (Duda et al., 2019), black bean and red pepper powders (Barcelon et al., 2015), sweet potato flour (Ginting and Yulifianti, 2015), cassava and carrot blends (Adegunwa et al., 2012) and other ingredients in the improvement of the protein and the overall nutritional value of noodles. Literature, recommends that even though some improvements in terms of the protein content may not be significant from the readily available noodles but it is important

that the final product at least meets the protein quality national standard which is 8% (Ginting and Yulifianti, 2015). In addition, other nutritional benefits that come with the vegetables or other sources being used to supplement come into play. For example, supplementation of various foods with *Amaranthus* leaf powder showed great potential to prevent post menopause complications in women as a result of improved nutritional value and antioxidant activity found in *Amaranthus* (Kushwaha et al., 2014). In addition, the use of gothan flour to supplement noodles contributed to the lowering of blood glucose levels against the control (Purwandari et al., 2014).

## **2.12 Physicochemical qualities**

The consumer's assessment of food is not only focused on the nutritional benefits or the health impacts but also sensory attributes have a direct impact on the desire to buy or preference of the product (Martins et al., 2016). Texture and colour are some of the important factors that must be considered when developing pasta or pasta product which influence the consumer acceptance (Susanna and Prabhasankar, 2013). Ash content may affect the colour of the product. The higher the ash content, the darker the noodle colour (Miskelly, 1984). The ash level may be regarded as a measure of the quality or grade of the flour and often a useful criterion in identifying the authenticity of the food.

### **2.12.1 Colour**

A bright and light yellow colour is the overall desirable colour for the instant noodles (Kim, 1996). Gulia et al. (2014) however also added that the processing factors such as steaming, frying, drying and the ability to absorb oil have a significant factor on the colour of the instant noodles. Variations in colour can also be observed during the production process, from the raw dough, to the sheet, and between the dried noodles and cooked noodles. The supplementation of noodles with various ingredients leads to the noodles adopting the colour of the supplement depending on the proportion of the ingredient. Addition of sweet potato flour and carrot powder lead to orange coloured noodles which were attributed to by the strong colour of the sweet potato and carrots (Ginting and Yulifianti, 2015), the pea flour produced pale green noodles (Kumar and Prabhasankar, 2015), red bell pepper addition lead to slightly reddish colour (Barcelon et al., 2015) whilst addition of soybean flour lead to a desirable white colour (Adegunwa et al., 2012). This is to show that the supplementation of instant noodles will vary

according to each sources and its acceptability (will be discussed later in the section) varies according to the preferences of consumers and colorants may be used to mask out the undesirable colours if they contribute to unacceptability of the new product.

### **2.12.2 Texture**

Textural preferences for noodles vary according to regions and its properties are affected by the quality of ingredients used, the processing parameters such as steaming, sheeting or the drying method used, as well as the water absorption capacity of the final product (Gulia et al., 2014). Through an analysis of firmness and total workforce required to cut the strands, the texture of the noodles is measured. Dziki et al. (2015) also noted that the textural measurements were dependant on the production process and cooking conditions (Dziki et al., 2012). Protein and fibre content of the developed instant noodles or pasta have an effect on the texture of the strands. In an investigation aimed at determining the effect of particle size and addition of wheat bran on the quality of dry white Chinese noodles, hardness, gumminess and chewiness were found to decrease with an increase in wheat bran addition (Chen et al., 2011). An addition of pea flour and cricket powder respectively, which are high in protein content lead to an increased firmness of the noodles strands (Kumar and Prabhasankar, 2015, Duda et al., 2019). This was mostly associated with an increased protein content which is said to result in stronger pasta texture (Duda et al., 2019). On the contrary, the addition or enrichment of pasta, noodles in particular with high fibre content results to weaker noodles strands, that is, the more fibre the product has the less firm it becomes. Addition of pea flour which is rich in fibre (Tudorica et al., 2002), addition of oyster mushroom powder (Wahyono and Bakri, 2018), addition of orange fleshed sweet potato flour (Ginting and Yulifianti, 2015) which are all rich in fibre resulted in decreased firmness and reduced force required to cut across noodles. In addition, low gluten and high ash content are also reported to contribute to the deterioration of the textural properties of the noodles strands (Kang et al., 2017) High absorption rate of water during cooking was also found to contribute to weaker texture leading to soft noodle strands (Park and Cho, 2004).

### **2.12.3 Cooking qualities**

Cooking time of instant noodles is usually determined by the point at which the white core disappears when cooked noodle strands are squeezed between a pair of glass plates (Oh et al.,

1983). The cooking properties of pasta are very significant indicators for good quality pasta. This means that alterations in the original recipe of pasta, particularly, the addition of high protein or high fibre source can have significant impacts on the overall cooking properties (Khan et al., 2013). Low cooking loss is an indicator for high quality pasta (Larrosa et al., 2016) and the use of protein additives especially of plant origin increases the cooking loss (Kaur et al., 2013). For example, the addition of Oyster mushroom powder (OMP) resulted in increased cooking loss, whilst the addition of cricket powder resulted in increased cooking time and less cooking loss (Kumar and Prabhasankar, 2015). Adegunwa et al., (2012) found that with an increased addition of different flour blends, the cooking time tends to increase, the water absorption capacity also increases and the final product tends to be softer in terms of texture in relation to the commercial products. The standard cooking time for commercially produced noodles is between 4-5 minutes however the protein content of instant noodles also may affect the cooking time (Park and Baik, 2004).

### **2.13 Consumer acceptability**

The consumer acceptability of supplemented noodles varies according to each type of additives being added. Through sensory analysis, various results have been obtained by different researchers in this regard. The documents reviewed in this paper all indicate an acceptance of the supplemented noodles up to a certain extent. Colour has presented itself as a major attribute that contributes to the acceptability of the products (Barcelon et al., 2015; Wahyono and Bakri, 2018; Duda et al., 2019). Noodles supplemented with red bell pepper (Barcelon et al., 2015), pea flour (Kumar and Prabhasankar, 2015) and orange fleshed sweet potatoes (Ginting and Yulifianti, 2015) although were accepted by the panel, the colour of the strands had a major impact on the overall liking of the product. Similar results were obtained for instant noodles supplemented with soybean flour where panellists indicated the dislike for the products colour as it was seen as less white than the control with 100% wheat flour (Omeire et al., 2014). For other, addition of vegetables in the instant noodle production does add an appealing and attractive colour. With regards to texture, the addition of various powder and additives leads to the weakening or strengthen of the noodle strands. For example, addition of pea flour improved the strand quality and texture. This was said to be attributed to by the high fibre content present in the sample (Kumar and Prabhasankar, 2015).

## **2.14 Microbial quality and safety of low water content (LWC) foods**

Globally, the issues of food safety have become a major concern however developing countries have recently over the years' experienced a series of outbreaks that are associated with food borne illnesses (Beuchat et al., 2013). These are as a result of the presence of food borne pathogens in low water content foods such as spices, dry nuts, chocolates, infant and adult cereals as well as milk powder (Beuchat et al., 2013). "Low foods are derived from high moisture foods which are often subjected to dehydration or desiccation processes to achieve this, or they could be naturally low in moisture"(Vaclavik and Christian, 2014) p1. Furthermore, the water content of such foods could also be achieved by adding solutes (salt or sugar) or freezing to control the quality of the final product" (Beuchat et al., 2013; Syamaladevi et al., 2016). The outbreaks have been traced down to poor households as the main areas where they have taken place. This did not only capture the eyes of the food industry but has also raised concerns to consumers of these foods (Syamaladevi et al., 2016). The spoilage of noodles can also be due to the presence of bacteria and microbes which may emerge during preparation, it is to be noted however that according to Okafor & Sunday (2014), there were no reports on the spoilage of ready to eat noodles. It is amongst those reasons that research has emanated around the outbreaks with attention to investigate the presence of pathogens in dry or low water content foods (Okafor and Sunday, 2014).

The amount of water present in a dried food product is important in predicting and determining the stability as well as the safety of the product (Vaclavik and Christian, 2014). This helps in defining the rate at which the product deteriorates and spoils. Lowering the water content of foods leads to an extended shelf life, perceptions however arising around the shelf life of these products show that people believe that low water content foods are not safe for consumption (Byrd-Bredbenner et al., 2013). This was also perpetrated by research findings which indicated that although, microorganisms were thought to be not able to survive in dry conditions and dry foods, some actually were found to be able to withstand and have an ability to survive in such foods (Beuchat et al., 2011; Beuchat et al., 2013; Finn et al., 2013). The outbreaks that have been reported were evident of the outcomes of research that some microorganisms could survive in LWC foods (Scott et al., 2009; Beuchat et al., 2013; Finn et al., 2013).

## **2.15 Future consumption trends- towards pasta-based products**

Instant noodle has increasingly become an important food item globally, with annual production of 101,420 million packs in 2012, and a steady increase of 3% annually since 2010 (Purwandari et al., 2014; Aghaei and Naeini, 2018). Compared to rice, affordability, convenience and recently nutritional values makes the demand for the pasta and pasta based products such as noodles to continuously increase. In Iran for example, dried pasta is ranked as the best-selling product in the market (Aghaei and Naeini, 2018). This trend in high pasta consumption and production has led to an addition of new health and wellness products within the same food group. Among others is supplementation of pasta with high antioxidant content products and other innovative products. Consumers do not generally accept novel product, however their familiarity to pasta as well as the value (benefits) attached to these new supplemented noodles will help facilitate the wide acceptance of the novel pasta and pasta products (Barrena and Sánchez, 2013).

## **2.16 Conclusion**

The review of the literature established that although food production is sufficient in the world to feed everyone, there is still hunger. It seems that production on its own cannot end hunger as there are other factors that contribute to inability to access food (Prosekov and Ivanova, 2018). Trade liberalization, economic growth and rapid urbanization were identified as major contributors to increase rate of overweight and obesity in developed countries (Kearney, 2010; Malik et al., 2013; Khoury et al., 2014). Ever changing demands and preferences of consumers continue to affect and shape the food systems in ways that tend to make it unstable. Growing population, industrialisation and urbanisation, busy lifestyles and occupations, economic disparities and consumption trends, especially the heavy dependency on animal protein and typically western diets that are dominated by processed foods are major factors that will contribute to the unsustainability of food systems (Reisch et al., 2013).

To achieve sustainable food consumption, the problems of both over- and under-consumption must be addressed. Food supplementation is increasingly gaining momentum in improving the nutritional value of food. The supplementation of noodles has been done in different countries and regions and has significantly improved the nutritional value of the noodles. However, the quality of the innovative noodles, especially with regard to texture and colour, is still a challenge. Consumer acceptability studies, however, indicate that the supplemented noodles

would be acceptable to consumers if the food materials being used for supplementation are familiar and contribute to improved flavour and nutritional value of the innovative products. However, there is limited use, however, of traditional and green leafy vegetables, which presents a gap that can still be filled as some of the leafy vegetables are good sources of nutrients.

## 2.17 References

- ACTION, E. 1999. Scientific concepts of functional foods in Europe: consensus document. *British Journal of Nutrition*, 81, 1-27.
- ADEGUNWA, M. O., BAKARE, H. A. & AKINOLA, O. F. 2012. Enrichment of noodles with soy flour and carrot powder. *Nigerian food journal*, 30.
- AFSHIN, A., MICHA, R., KHATIBZADEH, S. & MOZAFFARIAN, D. 2014. Consumption of nuts and legumes and risk of incident ischemic heart disease, stroke, and diabetes: a systematic review and meta-analysis. *The American Journal of Clinical Nutrition*, 100, 278-288.
- AGHAEI, S. & NAEINI, A. 2018. Consumer attitudes toward new pasta products in Iran market: A qualitative and quantitative study. *Management Science Letters*, 8, 109-120.
- ALEXANDRATOS, N. & BRUINSMA, J. 2012. World agriculture towards 2030/2050: the 2012 revision. ESA Working paper FAO, Rome.
- ALIBER, M. & HART, T. G. 2009. Should subsistence agriculture be supported as a strategy to address rural food insecurity? *Agrekon*, 48, 434-458.
- ANDERSON, C. L. & O'CONNOR, E. L. 2019. The effect of the health star rating on consumer decision-making. *Food Quality and Preference*, 73, 215-225.
- ANNIGAN, J. 2018. The effects of low protein intake” Healthy eating. SF Gate.
- AYDIN, E. & GOCMEN, D. 2011. Cooking quality and sensorial properties of noodle supplemented with oat flour. *Food Science and Biotechnology*, 20, 507-511.
- AZIAH, N. & KOMATHI, C. 2009. Acceptability attributes of crackers made from different types of composite flour. *International Food Research Journal*, 16, 479-482.
- AZZURRA, A., MASSIMILIANO, A. & ANGELA, M. 2019. Measuring sustainable food consumption: A case study on organic food. *Sustainable Production and Consumption*, 17, 95-107.
- BADIANE, O., MAKOMBE, T. & BAHIGWA, G. 2014. Promoting agricultural trade to enhance resilience in Africa: ReSAKSS annual trends and outlook report 2013. *Promoting Agricultural trade to enhance resilience in Africa: ReSAKSS annual trends and outlook report 2013*.
- BAKER, P. & FRIEL, S. 2016. Food systems transformations, ultra-processed food markets and the nutrition transition in Asia. *Globalization and health*, 12, 80.
- BARCELON, E. G., MCHUA, J. N., MONTEMAYOR, J. E., NAGALINGAM, M. G., OCAMPO, A. E. & ONG, R. M. 2015. Vegetable added pasta noodles: Physio-

- chemical composition and consumer acceptability. *International Journal of Agriculture Innovation and Research*, 3.
- BARKLEY, J. S., WHEELER, K. S. & PACHON, H. 2015. Anaemia prevalence may be reduced among countries that fortify flour. *British Journal of Nutrition*.
- BARRENA, R. & SÁNCHEZ, M. 2013. Neophobia, personal consumer values and novel food acceptance. *Food Quality and Preference*, 27, 72-84.
- BECKLINE, M. & KATO, M. S. 2014. Assessing the impact of consumer behaviour on food security in south west Cameroon. *Journal of Food Security*, 2, 87-91.
- BEUCHAT, L., KOMITOPOULOU, E., BETTS, R., BECKERS, H., BOURDICHON, F., JOOSTEN, H., FANNING, S. & TER KUILE, B. 2011. Persistence and survival of pathogens in dry foods and dry food processing environments. *ILSI Europe report series*.
- BEUCHAT, L. R., KOMITOPOULOU, E., BECKERS, H., BETTS, R. P., BOURDICHON, F., FANNING, S., JOOSTEN, H. M. & TER KUILE, B. H. 2013. Low–water activity foods: increased concern as vehicles of foodborne pathogens. *Journal of Food Protection*, 76, 150-172.
- BLACK, R. E., VICTORA, C. G., WALKER, S. P., BHUTTA, Z. A., CHRISTIAN, P., DE ONIS, M., EZZATI, M., GRANTHAM-MCGREGOR, S., KATZ, J. & MARTORELL, R. 2013. Maternal and child undernutrition and overweight in low-income and middle-income countries. *The lancet*, 382, 427-451.
- BRIAN, K. 2015. *OECD Insights Income Inequality The Gap between Rich and Poor: The Gap between Rich and Poor*, oecd Publishing.
- BRINKMAN, H.-J. & HENDRIX, C. S. 2011. Food Insecurity and Violent Conflict: Causes. *Consequences, and Addressing the Challenges*, World Food Programme.
- BUCHNER, B., FISCHLER, C., GUSTAFSON, E., REILLY, J., RICCARDI, G., RICORDI, C. & VERONESI, U. 2012. Eating in 2030: Trends and perspectives. In: NUTRITION, B. C. F. F. A. (ed.) *People, Environment, Science, Economy*.
- BYRD-BREDBENNER, C., BERNING, J., MARTIN-BIGGERS, J. & QUICK, V. 2013. Food safety in home kitchens: a synthesis of the literature. *International Journal of Environmental Research and Public Health*, 10, 4060-4085.
- CASEY, D. K. 2009. Three puzzles of private governance: GlobalGAP and the regulation of food safety and quality.

- CHANDRA, S., SINGH, S. & KUMARI, D. 2015. Evaluation of functional properties of composite flours and sensorial attributes of composite flour biscuits. *Journal of Food Science and Technology*, 52, 3681-3688.
- CHEN, J., FEI, M., SHI, C., TIAN, J., SUN, C., ZHANG, H., MA, Z. & DONG, H. 2011. Effect of particle size and addition level of wheat bran on quality of dry white Chinese noodles. *Journal of Cereal Science*, 53, 217-224.
- COLGLAZIER, W. 2015. Sustainable development agenda: 2030. *Science*, 349, 1048-1050.
- COURT, D. & NARASIMHAN, L. 2010. Capturing the world's emerging middle class. *McKinsey Quarterly*, 3, 12-17.
- CRUSH, J. & FRAYNE, B. 2010. The invisible crisis: Urban food security in Southern Africa.
- CRUSH, J. S. & FRAYNE, G. B. 2011. Urban food insecurity and the new international food security agenda. *Development Southern Africa*, 28, 527-544.
- DE ONIS, M., BLÖSSNER, M. & BORGHI, E. 2012. Prevalence and trends of stunting among pre-school children, 1990–2020. *Public health nutrition*, 15, 142-148.
- DEFRA, F. S. P. & PLAN, E. E. 2006. Department for Environment. *Food and Rural Affairs (DEFRA)*.
- DEPARTMENT OF HEALTH 2009. Promoting healthy weight. *In: HEALTH (ed.)*.
- DOUGLAS, S. P. & CRAIG, C. S. 2011. Convergence and divergence: Developing a semiglobal marketing strategy. *Journal of International Marketing*, 19, 82-101.
- DUDA, A., ADAMCZAK, J., CHEŁMIŃSKA, P., JUSZKIEWICZ, J. & KOWALCZEWSKI, P. 2019. Quality and Nutritional/Textural Properties of Durum Wheat Pasta Enriched with Cricket Powder. *Foods*, 8, 46.
- DZIKI, D., BIERNACKA, B. & LASKOWSKI, J. 2012. Influence of cooking time and common wheat flour addition to semolina on spaghetti mechanical properties. *Acta Agrophysica*, 19, 277-287.
- EBRU, E. & MEHMET, H. 2009. The effect of apricot kernel flour incorporation on the physicochemical and sensory properties of noodles. *African Journal of Biotechnology*, 8, 85-90.
- EL BILALI, H., CALLENIUS, C., STRASSNER, C. & PROBST, L. 2019. Food and nutrition security and sustainability transitions in food systems. *Food and Energy Security*, 8, e00154.
- ERICKSEN, P. J. 2008. Conceptualizing food systems for global environmental change research. *Global environmental change*, 18, 234-245.

- FALGUERA, V., ALIGUER, N. & FALGUERA, M. 2012. An integrated approach to current trends in food consumption: Moving toward functional and organic products? *Food Control*, 26, 274-281.
- FANZO, J. 2012. The nutrition challenge in sub-Saharan Africa. United Nations Development Programme, Regional Bureau for Africa.
- FAO 2015. Regional overview of food insecurity: African food security prospects brighter than ever. Author Accra.
- FAO & FAOSTAT 2008. Food and agriculture organisation of the United Nations. *Retrieved on*, 15.
- FAO, IFAD, UNICEF, WFP & WHO 2017. The state of food security and nutrition in the world 2017. *Building Resilience for Peace and Food Security (Food and Agriculture Organization, Rome)*.
- FAO 2013. *FAO Statistical Yearbook: World Food and Agriculture*, FAO.
- FAO 2014. *State of Food Insecurity in the World 2013: The Multiple Dimensions of Food Security*, FAO.
- FAWOLE, W., ILBASMIS, E. & OZKAN, B. Food insecurity in Africa in terms of causes, effects and solutions: a case study of Nigeria. 2nd ICSAE 2015, International Conference on Sustainable Agriculture and Environment, September 30-October 03, 2015, Konya, Turkey. Proceedings book, 2015. 6-11.
- FINN, S., CONDELL, O., MCCLURE, P., AMÉZQUITA, A. & FANNING, S. 2013. Mechanisms of survival, responses and sources of Salmonella in low-moisture environments. *Frontiers in microbiology*, 4, 331.
- FINUCANE, M. M., STEVENS, G. A., COWAN, M. J., DANAEI, G., LIN, J. K., PACIOREK, C. J., SINGH, G. M., GUTIERREZ, H. R., LU, Y. & BAHALIM, A. N. 2011. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9· 1 million participants. *The Lancet*, 377, 557-567.
- FOOD, I. 2015. The new science of sustainable food systems: overcoming barriers to food systems reform. *First Report of the International Panel of Experts on Sustainable Food Systems*.
- FORESIGHT, U. 2011. The future of food and farming. *Final Project Report, London, The Government Office for Science*.
- FREIBAUER, A., MATHIJS, E., BRUNORI, G., DAMIANOVA, Z., FAROULT, E., GIRONA, I. G. J., O'BRIEN, L. & TREYER, S. 2011. Sustainable Food Consumption

- and Production in a Resource-Constrained World; the 3rd SCAR Foresight Exercise. *European Commission: Brussels, Belgium.*
- FRENCH, S. A., TANGNEY, C. C., CRANE, M. M., WANG, Y. & APPELHANS, B. M. 2019. Nutrition quality of food purchases varies by household income: the SHoPPER study. *BMC public health*, 19, 231.
- FRESCO, L. O. 2009. Challenges for food system adaptation today and tomorrow. *Environmental science & Policy*, 12, 378-385.
- FSIN 2018. Global report on food crisis.
- GARNETT, T. 2014. Three perspectives on sustainable food security: efficiency, demand restraint, food system transformation. What role for life cycle assessment? *Journal of Cleaner Production*, 73, 10-18.
- GARNETT, T., APPLEBY, M. C., BALMFORD, A., BATEMAN, I. J., BENTON, T. G., BLOOMER, P., BURLINGAME, B., DAWKINS, M., DOLAN, L. & FRASER, D. 2013. Sustainable intensification in agriculture: premises and policies. *Science*, 341, 33-34.
- GINTING, E. & YULIFIANTI, R. 2015. Characteristics of noodles prepared from orange fleshed sweet potato and domestic wheat flour. *Procedia Food Science*.
- GLADEK, E., FRASER, M., ROEMERS, G., MUNOZ, O. S., KENNEDY, E. & HIRSCH, P. 2016. The global food system: an analysis. *Metabolic, Amsterdam*.
- GODFRAY, H. C. J., CRUTE, I. R., HADDAD, L., LAWRENCE, D., MUIR, J. F., NISBETT, N., PRETTY, J., ROBINSON, S., TOULMIN, C. & WHITELEY, R. 2010. The future of the global food system. The Royal Society.
- GRUNERT, K. G. 2011. How changes in consumer behaviour and retailing affect competence requirements for food producers and processors. *Economía Agraria y Recursos Naturales-Agricultural and Resource Economics*, 6, 3-22.
- GULIA, N., DHAKA, V. & KHATKAR, B. S. 2014. Instant Noodles: Processing, Quality, and Nutritional Aspects. *Critical Reviews in Food Science and Nutrition*, 54, 1386-1399.
- GUNDERSEN, C. & ZILIAK, J. P. 2014. Childhood food insecurity in the US: Trends, causes, and policy options. *The Future of Children*, 1-19.
- HADDAD, L., HAWKES, C., WAAGE, J., WEBB, P., GODFRAY, C. & TOULMIN, C. 2016. Food systems and diets: Facing the challenges of the 21st century.
- HASMADI, M., MATANJUN, P., SALWA, I., SITI, F., MANSOOR, A. H. & AINNUR, S. R. 2014. The effect of seaweed composite flour on the textural properties of dough and bread. *Journal of Applied Phycology*, 26, 1057-1062.

- HAVAS, K. & SALMAN, M. 2011. Food security: its components and challenges. *International Journal of Food Safety, Nutrition and Public Health*, 4, 4-11.
- HUH, I. S., KIM, H., JO, H. K., LIM, C. S., KIM, J. S., KIM, S. J., KWON, O., B.OH & CHANG, N. 2017. Instant noodle consumption associated with cardio metabolic risk factors among college students in Seol. *Nutrition Research and Practice*.
- ILABOYA, I., ATIKPO, E., OMOFUMA, F., ASEKHAME, F. & UMUKORO, L. 2012. Causes, effects and way forward to food insecurity. *Iranica Journal of Energy and Environment*, 3.
- JAYASENA, V., LEUNG, P. P. & NASAR-ABBAS, S. M. 2010. Effect of lupin flour substitution on the quality and sensory acceptability of instant noodles. *Journal of Food Quality*, 33, 709-727.
- JENSEN, J. D., CHRISTENSEN, T., DENVER, S., DITLEVSEN, K., LASSEN, J. & TEUBER, R. 2019. Heterogeneity in consumers' perceptions and demand for local (organic) food products. *Food Quality and Preference*, 73, 255-265.
- JISANA, T. 2014. Consumer behaviour models: an overview. *Sai Om Journal of Commerce & Management*, 1, 34-43.
- KANG, J., LEE, J., CHOI, M., JIN, Y., CHANG, D., CHANG, Y. H., KIM, M., JEONG, Y. & LEE, Y. 2017. Physicochemical and Textural Properties of Noodles Prepared from Different Potato Varieties. *Preventive Nutrition and Food Science*, 22, 246.
- KAUR, G., SHARMA, S., NAGI, H. & RANOTE, P. 2013. Enrichment of pasta with different plant proteins. *Journal of food science and technology*, 50, 1000-1005.
- KEARNEY, J. 2010. Food consumption trends and drivers. *Philosophical transactions of the royal society B: Biological Sciences*, 365, 2793-2807.
- KELLY, T., YANG, W., CHEN, C.-S., REYNOLDS, K. & HE, J. 2008. Global burden of obesity in 2005 and projections to 2030. *International Journal of Obesity*, 32, 1431.
- KHAN, I., YOUSIF, A., JOHNSON, S. K. & GAMLATH, S. 2013. Effect of sorghum flour addition on resistant starch content, phenolic profile and antioxidant capacity of durum wheat pasta. *Food Research International*, 54, 578-586.
- KHOURY, C. K., BJORKMAN, A. D., DEMPEWOLF, H., RAMIREZ-VILLEGAS, J., GUARINO, L., JARVIS, A., RIESEBERG, L. H. & STRUIK, P. C. 2014. Increasing homogeneity in global food supplies and the implications for food security. *Proceedings of the National Academy of Sciences*, 111, 4001-4006.
- KIM, S. 1996. Instant noodles. *Pasta and noodle technology*, 195-225.

- KLOSS, L., MEYER, J. D., GRAEVE, L. & VETTER, W. 2015. Sodium intake and its reduction by food reformulation in the European Union—A review. *NFS Journal*, 1, 9-19.
- KRAEMER, K., CORDARO, J., FANZO, J., GIBNEY, M., KENNEDY, E., LABRIQUE, A., STEFFEN, J. & EGGERSDORFER, M. 2016. .1 Ten Forces Shaping the Global Food System. *Good nutrition: perspectives for the 21st century*. Karger Publishers.
- KUMAR, S. B. & PRABHASANKAR, P. 2015. A study on noodle dough rheology and product quality characteristics of fresh and dried noodles as influenced by low glycemic index ingredient. *Journal of Food Science and Technology*, 52, 1404-1413.
- KUSHWAHA, S., CHAWLA, P. & KOCHHAR, A. 2014. Effect of supplementation of drumstick (*Moringa oleifera*) and amaranth (*Amaranthus tricolor*) leaves powder on antioxidant profile and oxidative status among postmenopausal women. *Journal of Food Science and Technology*, 51, 3464-3469.
- LARROSA, V., LORENZO, G., ZARITZKY, N. & CALIFANO, A. 2016. Improvement of the texture and quality of cooked gluten-free pasta. *LWT-Food Science and Technology*, 70, 96-103.
- LOWE, P., PHILLIPSON, J. & LEE, R. P. 2008. Socio-technical innovation for sustainable food chains: roles for social science. *Trends in Food Science & Technology*, 19, 226-233.
- MALIK, V. S., WILLETT, W. C. & HU, F. B. 2013. Global obesity: trends, risk factors and policy implications. *Nature Reviews Endocrinology*, 9, 13.
- MANNAR, M. V. 2006. Successful food-based programmes, supplementation and fortification. LWW.
- MARRÓN-PONCE, J. A., SÁNCHEZ-PIMIENTA, T. G., DA COSTA LOUZADA, M. L. & BATIS, C. 2018. Energy contribution of NOVA food groups and sociodemographic determinants of ultra-processed food consumption in the Mexican population. *Public health nutrition*, 21, 87-93.
- MARTINS, N., RORIZ, C. L., MORALES, P., BARROS, L. & FERREIRA, I. C. 2016. Food colorants: Challenges, opportunities and current desires of agro-industries to ensure consumer expectations and regulatory practices. *Trends in Food Science & Technology*, 52, 1-15.
- MATSHE, I. 2009. Boosting smallholder production for food security: some approaches and evidence from studies in sub-Saharan Africa. *Agrekon*, 48, 483-511.

- MAY, J. 2017. Food security and nutrition: Impure, complex and wicked. Food Security SA Working Paper Series.
- MCGILL, A. E. 2009. The potential effects of demands for natural and safe foods on global food security. *Trends in Food Science & Technology*, 20, 402-406.
- MCGUIRE, S. 2015. FAO, IFAD, and WFP. The state of food insecurity in the world 2015: meeting the 2015 international hunger targets: taking stock of uneven progress. Rome: FAO, 2015. Oxford University Press.
- MENDONÇA, R. D. D., PIMENTA, A. M., GEA, A., DE LA FUENTE-ARRILLAGA, C., MARTINEZ-GONZALEZ, M. A., LOPES, A. C. S. & BES-RASTROLLO, M. 2016. Ultraprocessed food consumption and risk of overweight and obesity: the University of Navarra Follow-Up (SUN) cohort study. *The American Journal of Clinical Nutrition*, 104, 1433-1440.
- MISKELLY, D. M. 1984. Flour components affecting paste and noodle colour. *Journal of the Science of Food and Agriculture*, 35, 463-471.
- MONTEIRO, C. A., LEVY, R. B., CLARO, R. M., DE CASTRO, I. R. R. & CANNON, G. 2010. Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. *Public Health Nutrition*, 14, 5-13.
- MOOMAW, W., GRIFFIN, T., KURCZAK, K. & LOMAX, J. 2012. The critical role of global food consumption patterns in achieving sustainable food systems and food for all. *United Nations Environment Programme, Tech. Rep.*
- MUHAMMAD, A., D'SOUZA, A., MEADE, B., MICHA, R. & MOZAFFARIAN, D. 2017. The influence of income and prices on global dietary patterns by country, age, and gender.
- NAPOLI, M., DE MURO, P. & MAZZIOTTA, M. 2011. Towards a food insecurity Multidimensional Index (FIMI). *Master in Human Development and Food Security*.
- NG, M., FLEMING, T., ROBINSON, M., THOMSON, B., GRAETZ, N., MARGONO, C., MULLANY, E. C., BIRYUKOV, S., ABBAFATI, C. & ABERA, S. F. 2014. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The lancet*, 384, 766-781.
- NGUYEN, T. H. & GIZAW, A. 2014. Factors that influence consumer purchasing decision of Private Label Food Product: A case study of ICA Basic.

- NOORFARAHZILAH, M., LEE, J., SHARIFUDIN, M., FADZELLY, M. A. & HASMADI, M. 2014. Applications of composite flour in development of food products. *International Food Research Journal*, 21, 2061.
- OH, N., SEIB, P., DEYOE, C. & WARD, A. 1983. Noodles. I. Measuring the textural characteristics of cooked noodles. *Cereal Chem*, 60, 433-438.
- OKAFOR, A. & SUNDAY, T. 2014. Detection of Bacteria Associated with the Spoilage of Ready-To-Eat Instant Noodles.
- OMEIRE, G., UMEJI, O. & OBASI, N. 2014. Acceptability of Noodles Produced from Blends of Wheat, Acha and Soybean Composite Flours. *Nigerian Food Journal*, 32, 31-37.
- PARK, C. S. & BAIK, B. K. 2004. Relationship between protein characteristics and instant noodle making quality of wheat flour. *Cereal Chemistry*, 81, 159-164.
- PARK, S. & CHO, E.-J. 2004. Quality characteristics of noodle added with chlorella extract. *Korean J Food Nutr*, 17, 120-127.
- PÉREZ-ESCAMILLA, R. 2017. Food security and the 2015–2030 sustainable development goals: From human to planetary health: Perspectives and opinions. *Current developments in nutrition*, 1, e000513.
- PHAKARE, K. N., DAGADKHAIR, A. C. & UDACHAN, I. S. 2018. Enhancement of Nutritional and functional characteristics of noodles by fortification with protein and fibre: A review. *Journal of Pharmacognosy and Photochemistry*.
- PORTER, J. R., XIE, L., CHALLINOR, A. J., COCHRANE, K., HOWDEN, S. M., IQBAL, M. M., LOBELL, D. B. & TRAVASSO, M. I. 2014. Food security and food production systems.
- POWER, K. 2010. Introducing behaviour changes towards sustainable food consumption. *Corpus*, 3.
- PROSEKOV, A. Y. & IVANOVA, S. A. 2018. Food security: The challenge of the present. *Geoforum*, 91, 73-77.
- PURWANDARI, U., TRISTIANA, G. & HIDAYATI, D. 2014. Gluten-free noodle made from gathotan flour: antioxidant activity and effect of consumption on blood glucose level. *International Food Research Journal*, 21.
- REISCH, L., EBERLE, U. & LOREK, S. 2013. Sustainable food consumption: an overview of contemporary issues and policies. *Sustainability: Science, Practice and Policy*, 9, 7-25.
- RIGHTCHOICE 2014. Instant noodles: Not a nutritious choice.
- RIMAS, A. & FRASER, E. 2010. *Empires of food: feast, famine, and the rise and fall of civilizations*, Simon and Schuster.

- SCHNEPF, R. 2011. *Consumers and Food Price Inflation*, DIANE Publishing.
- SCOTT, P. 2017. Global panel on agriculture and food systems for nutrition: food systems and diets: facing the challenges of the 21st century. Springer.
- SCOTT, V. N., CHEN, Y., FREIER, T. A., KUEHM, J., MOORMAN, M., MEYER, J., MORILLE-HINDS, T., POST, L., SMOOT, L. & HOOD, S. 2009. Control of Salmonella in low-moisture foods I: Minimizing entry of Salmonella into a processing facility. *Food Protection Trends*, 29, 342-353.
- SHAO, S., DUNCAN, A. M., YANG, R., MARCONE, M. F., RAJCAN, I. & TSAO, R. 2009. Tracking isoflavones: from soybean flour, soy protein isolates to functional soy bread. *Journal of Functional Foods*, 119-127.
- SIKANDER, M., MALIK, A., KHAN, M. S. G. & KHAN, R. G. Q. 2017. Instant noodles: Are they really good for health? A review. *Electronic Journal of Biology*, 13, 222-227.
- SINHA, G. 2014. LINKAGES BETWEEN FOOD CONSUMPTION PATTERNS FOOD SECURITY AND SUSTAINABLE FOOD SYSTEMS.
- STEIN, L. J., COWART, B. J. & BEAUCHAMP, G. K. 2012. The development of salty taste acceptance is related to dietary experience in human infants: a prospective study. *The American journal of clinical nutrition*, 95, 123-129.
- SUDHA, M., RAJESWARI, G. & RAO, G. V. 2011. Influence of defatted soy flour and whey protein concentrate on dough rheological characteristics and quality of instant vermicelli. *Journal of texture studies*, 42, 72-80.
- SUSANNA, S. & PRABHASANKAR, P. 2013. A study on development of Gluten free pasta and its biochemical and immunological validation. *LWT-Food Science and Technology*, 50, 613-621.
- SYAMALADEVI, R. M., TANG, J., VILLA-ROJAS, R., SABLANI, S., CARTER, B. & CAMPBELL, G. 2016. Influence of water activity on thermal resistance of microorganisms in low-moisture foods: a review. *Comprehensive Reviews in Food Science and Food Safety*, 15, 353-370.
- THE GLOBAL PANEL ON AGRICULTURE AND FOOD SYSTEMS FOR NUTRITION 2016. Food systems and diets: Facing the challenges of the 21st century. London, UK.
- THOW, A. M. & HAWKES, C. 2009. The implications of trade liberalization for diet and health: a case study from Central America. *Globalization and health*, 5, 5.
- TRAILL, W., ARNOULT, M. H., CHAMBERS, S., DEAVILLE, E., GORDON, M., JOHN, P., JONES, P., KLIEM, K., MORTIMER, S. & TIFFIN, J. 2008. The potential for

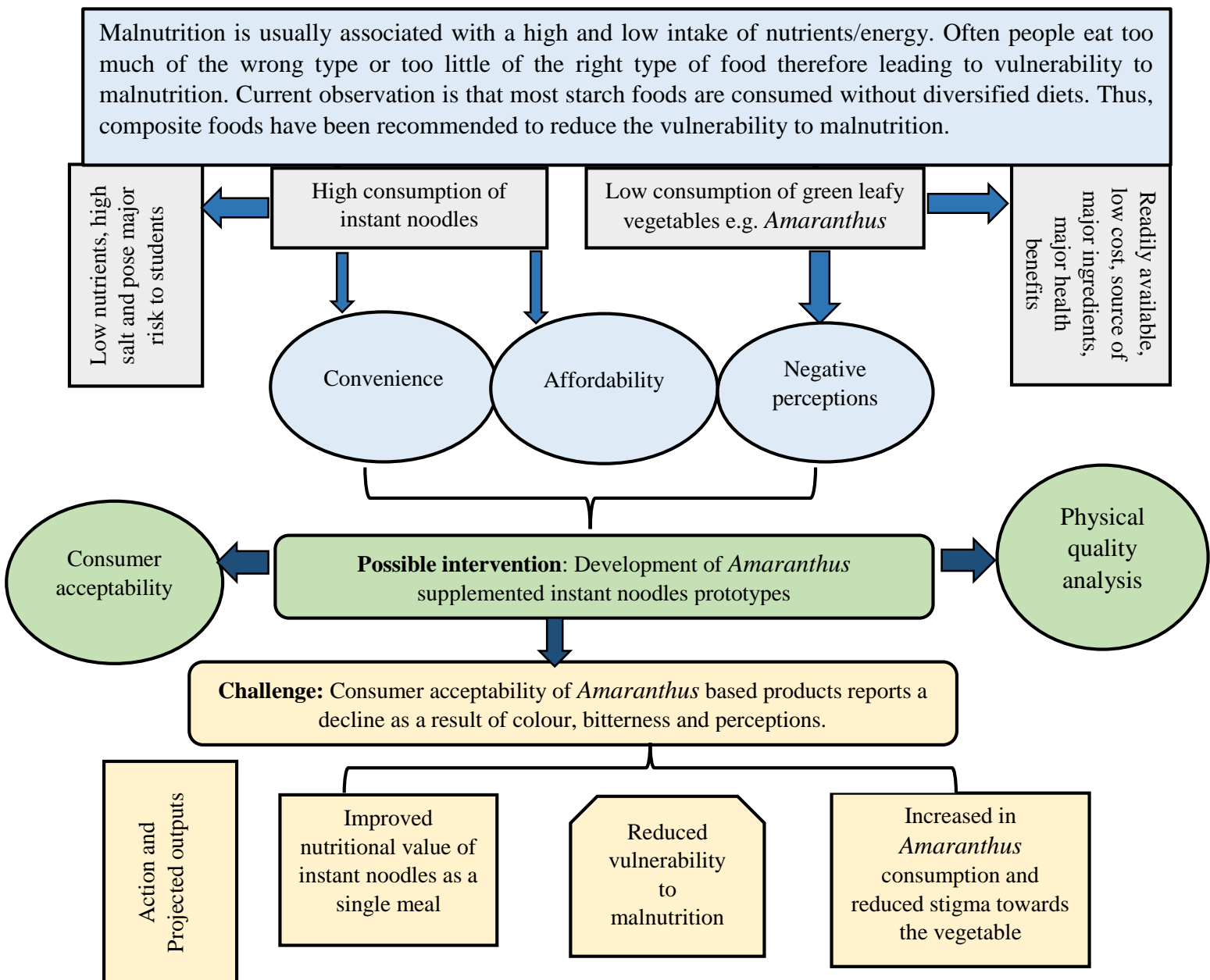
- competitive and healthy food chains of benefit to the countryside. *Trends in food science & technology*, 19, 248-254.
- UNEP-WCMC, I. 2016. Protected planet report 2016. *UNEP-WCMC and IUCN: Cambridge UK and Gland, Switzerland*, 78-95.
- UNICEF 2018. Levels and trends in child malnutrition. eSocialSciences.
- US DEPARTMENT OF AGRICULTURE 2008. Diet Quality of Americans by Food Stamp Participation Status: Data from the National Health and Nutrition Examination Survey, 1999–2004. *In: AGRICULTURE* (ed.). Alexandria, VA.
- VACLAVIK, V. A. & CHRISTIAN, E. W. 2014. Food preservation. *Essentials of food science*. Springer.
- VAN BERKUM, S., DENGERINK, J. & RUBEN, R. 2018. The food systems approach: sustainable solutions for a sufficient supply of healthy food. Wageningen Economic Research.
- VAN HUNG, P., MAEDA, T. & MORITA, N. 2007. Dough and bread qualities of flours with whole waxy wheat flour substitution. *Food Research International*, 40, 273-279.
- VERAIN, M. C., DAGEVOS, H. & ANTONIDES, G. 2015. Sustainable food consumption. Product choice or curtailment? *Appetite*, 91, 375-384.
- VERMEULEN, S. J., CAMPBELL, B. M. & INGRAM, J. S. 2012. Climate change and food systems. *Annual review of environment and resources*, 37.
- WAHYONO, A. & BAKRI, A. Physicochemical and sensorial characteristics of noodle enriched with oyster mushroom (*Pleurotus ostreatus*) powder. *Journal of Physics: Conference Series*, 2018. IOP Publishing, 012120.
- WAY, C. 2015. *The millennium development goals report 2015*, UN.
- WHITMEE, S., HAINES, A., BEYRER, C., BOLTZ, F., CAPON, A. G., DE SOUZA DIAS, B. F., EZEH, A., FRUMKIN, H., GONG, P. & HEAD, P. 2015. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health. *The Lancet*, 386, 1973-2028.
- WILLER, H., SCHAACK, D. & LERNOUD, J. 2019. Organic farming and market development in Europe and the European Union. *The World of Organic Agriculture. Statistics and Emerging Trends 2019*. Research Institute of Organic Agriculture FiBL and IFOAM-Organics International.
- WINA 2017. National trends in instant noodles demands. *World Instant Noodles Association*.

- WOOD, J. A. 2009. Texture, processing and organoleptic properties of chickpea-fortified spaghetti with insights to the underlying mechanisms of traditional durum pasta quality. *Journal of Cereal Science*, 49, 128-133.
- WORLD HEALTH ORGANIZATION, E. F. 2014. Global Action plan for prevention and control of non-communicable diseases.
- WORLD HEALTH ORGANIZATION, W. 2018. *The state of food security and nutrition in the world 2018: building climate resilience for food security and nutrition*, Food & Agriculture Org.

## Chapter 3 : Research Methodology

### 3.1 Conceptual framework

The conceptual framework of the current investigation is adopted from the United Nations Children Fund (UNICEF) conceptual framework of malnutrition as well as the food security conceptual framework (Khoza, 2014; World Health Organization, 2015). It demonstrates the factors that lead to malnutrition amongst the youth and how *Amaranthus*-supplemented foods could possibly contribute to the reduction of this prevalence.



**Figure 3.1:** Study Conceptual Framework

### **3.2 Research approach**

A quantitative research approach was followed in conducting the study. This is a type of research approach that involves large representative samples and well-structured data collection methods (Struwig and Stead, 2010). It was the main approach chosen for this study because it enabled the researcher to test the proposed hypotheses through experiments during product development and sensory evaluation and be able to conduct a survey on utilisation of *Amaranthus*. Because the approach involves large samples, the findings maybe generalized for at least the whole student population of the University of Zululand.

### **3.3 Research design**

Descriptive and experimental designs were used in the study. Descriptive design “is designed to provide a clear idea of a situation as it naturally happens (Welman et al., 2005). For the purpose of this study, descriptive research was used to obtain a picture of student’s perceptions and opinions on instant noodles consumption and *Amaranthus* consumption. Experimental research is a type of research that requires some form of an intervention to the participants or testing materials (samples) under controlled conditions, usually, with inclusion of control/s (Welman et al., 2005). In this study, the instant noodles were supplemented with *Amaranthus* leaf powder as a form of intervention for improving the nutritional quality of the final product. The developed samples were measured against a control sample measuring the same attributes.

### **3.4 Research population and study area**

With regard to the survey and sensory evaluation conducted, the population of the study was the students of the University of Zululand, KwaDlangezwa Campus that is situated between Mthunzini and Richards’s bay, KwaZulu-Natal, South Africa. This institution is located at KwaDlangezwa under the tribal authority of KwaMkhwanazi and has another campus at Richards’s bay. The sample was drawn from students who reside on and off campus residents of the main campus (KwaDlangezwa).



**Figure 3.2:** Map of the study area (University of Zululand)

### **3.5 Sampling method and size**

A stratified purposive quota sampling method was used in order to recruit participants for the survey on the utilisation of noodles. Stratified sampling methods “draw pre-existing, heterogenous groups then all members in each stratum or group can be randomly selected for the eventual sample” (Welman et al., 2005). Purposive sampling method is described as “the deliberate choice of a participant due to the qualities the participant possesses, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience (Etikan et al., 2016). Quota sampling then involves the selection of participants who meet a number of requirements that are defined by the researcher (Welman et al., 2005). These methods were going to bring about benefits in terms of costs and time efficiency. Students were categorized according to where they stay and the final sample of 108 students was randomly selected from those living in on the campus residences and those from off the campus university residences. For the sensory evaluation test, 60 untrained panellists were recruited during the survey. Invitations were also sent out to the identified participants as a reminder to attend the sensory evaluation session.

### **3.6 Product development, quality analysis and consumer acceptability**

*Amaranthus* leaf powder-supplemented noodles were developed by substituting wheat flour at 1, 2 and 3% (w/w) with *Amaranthus* leaf powder using a standard noodle recipe. The processing of both *Amaranthus* into leaf powder and the development of the supplemented noodles is fully described in Chapter 4 (p60-62). Proximate analysis (nutritional analysis) AOAC Official Methods were used and are described in Chapter 5 (p73-74) and antioxidant assessments were done for 5 dry sample of noodles ie. 0% (without ALP), 1%, 2% and 3% ALP. An additional commercial noodle sample was also assessed. The samples were ground into powder, extracted and evaluated using methods described in chapter 5 (p75-76). Furthermore, the physical quality of the noodle samples developed was assessed by analysing colour using a chromometer; texture with a TA-XT2 texture analyser (Stable Micro Systems, UK) which are all described in chapter 5 (p74-75). Consumer acceptability tests were done with 60 untrained panellists whom each tested 4 samples of noodles. A 9-point hedonic scale was used to rate the likeness of the product (Appendix 2). Chapter 5 (p 76) describes the process followed for sensory evaluation.

### **3.7 Management and analysis of data**

Once the data for the survey and sensory evaluation had been collected it was coded. Coding means that the variables that the researcher wants to analyse were identified and given different attributes and code numbers which represents those variable attributes (Welman *et al*, 2005). The codes were entered on MS Excel then on SPS and statistical analysis was carried out. The data obtained from nutritional analysis and anti-oxidant activity were analyzed by analysis of variance (ANOVA) using SPSS version 25. Significant F tests at levels of probability ( $p < 0.05$ ) are reported. Descriptive, frequency, correlations and chi square statistics was used to analyse the data collected.

### **3.8 Ethical considerations**

Ethical clearance for the study was attained from the Biomedical Research Ethics Committee BREC Ref no: BE453/19, see appendix 7. Additionally, gatekeeper's letters were attained from the University of Zululand, Deputy Vice Chancellor: Research and Innovation (see appendix 6) as well as from the Department of Consumer Sciences (see appendix 5) for both the survey

and laboratory activities. Consent forms (Appendix 3) were used in both cases of the survey and the sensory evaluation in students who had agreed to partake in the study.

**Table 3.1:** Summary of Methodologies

Objectives	Data collected	Data collection tool/s	Sampling technique	Data analysis
To assess the utilisation of noodles by students	Demographics, frequency of consumption, reasons for consumption, perceptions on the nutritional content	Self-administered survey questionnaires	Stratified purposive quota sampling 100 respondents	Descriptive statistics
To develop <i>Amaranthus</i> Supplemented instant noodles	Preparation of <i>Amaranthus</i> leaf powder, recipe development and standardization Cooking quality	Direct observations Trials Timer	Four samples were developed with 1, 2 and 3% ALP supplementation after 3 trials.	Descriptive statistics
To determine the physical quality (Colour and texture) of <i>Amaranthus</i> noodles	Texture- firmness (Cooked noodles) Colour- L*a*b*value For Dry & Wet sheets Cooked noodles and broth	TA. XT PLUS Texture analyser CIELAB color space	Samples with Ratios of 1:2:3 % of ALP were measured against the control	Statistical analyses for mean values and standard deviations
To investigate the consumer acceptability of the <i>Amaranthus</i> based noodles.	Acceptability of colour, texture, aroma, taste and overall acceptability	9-point hedonic scale questionnaire	Purposive and convenience sampling	Descriptive statistics

			60 panellists between 17-35 years were involved in sensory evaluation	
To determine the nutritional composition and antioxidant activity of the developed products	Protein, vitamin A, B, C $\beta$ carotene, folate, minerals such calcium, iron, zinc, copper and magnesium and antioxidants	Samples with ALP were ground into fine powder using a mortar and pestle and were stored in sterile Eppendorf tubes.	Samples with 0, 1, 2, 3% ALP were sent to the Department of Agriculture and Rural Development (CEDARA) for analysis	AOAC methods

### 3.9 References

- ETIKAN, I., MUSA, S. A. & ALKASSIM, R. S. 2016. Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5, 1-4.
- KHOZA, S. 2014. *Modelling with commercial egg powder to assess the potential of indigenous knowledge-processed egg powder to improve household food and nutrition security*.
- MA, D., ZHANG, J., LOU, X., WANG, X., WANG, C. & GUO, T. 2014. Color, cooking properties and texture of yellow alkaline noodles enriched with millet and corn flour. *International Food Research Journal*, 21, 1151.
- STRUWIG, F. W. & STEAD, G. B. 2010. *Planning, designing and reporting research*. Pearson Education of South Africa, South Africa.
- WELMAN, C., KRUGER, F. & MITCHELL, B. 2005. *Research methodology*, Oxford University Press Cape Town.
- WORLD HEALTH ORGANIZATION 2015. *World report on ageing and health*, World Health Organization.

## **Chapter 4 : Incorporation of *Amaranthus* leaf powder into noodles as a strategy to increase healthier food choices in the market.**

### **Abstract**

Over the years, there have been significant increases in the consumption of instant noodles in the world. This trend has been notably prevalent amongst the youth in colleges and was due to the convenience attributes associated with the product. Over dependence of instant noodles was, however, noted to compromise the health of the consumers, especially when consumed as the sole main meal. *Amaranthus* is one of the most abundant traditional vegetables in South Africa and a good source of nutrients. However, the vegetable is underutilized and is often overlooked compared to exotic vegetables. The main objective of this investigation was to assess the patterns of instant noodles consumption and utilisation of *Amaranthus* among students at the University of Zululand. A quantitative research approach was followed by using self-administered questionnaires. One hundred students were sampled using a quota sampling method. Results showed that the majority of the students (96%) were active consumers of instant noodles. Convenience and cost-effectiveness remain the major driver of high instant noodles consumption among students. About 76% students had knowledge on *Amaranthus*, however only 71% were consumers or have at least consumed *Amaranthus* in the past. The majority (92%) of participants used *Amaranthus* fresh leaves when cooking the plant while 4% used it in a powdered form. *Amaranthus* was therefore a familiar traditional leafy vegetable; however, its regular consumption as a vegetable was low due to stigmatization. Indigenisation of noodles using *Amaranthus* as a supplement can be used as an intervention to optimise the consumption of the vegetable.

**Keywords:** Instant noodles, consumption, *Amaranthus*, traditional vegetables, utilisation

## 4.1 Introduction

About 96 billion portions per capita of instant noodles are eaten worldwide (Sikander et al., 2017). China lead the statistics by 38 520 million servings whilst South Africa held the number 29 position out of 54 countries with 200 million servings (WINA, 2017). A significant increase in consumption is notably dominant amongst the youth population especially students (Sikander et al., 2017; Zahrul-lail, 2017). According to research, instant noodles are preferred because of their taste, extended shelf-life, cheap price as well as convenience, which suits the busy lifestyle of the student population (Cotti and Tefft, 2013; Sikander et al., 2017; Phakare et al., 2018). However, it was highlighted that instant noodles were not always a healthy food choice (Cotti and Tefft, 2013). There was a concern in terms of the adequacy of nutrients obtained from instant noodles especially when consumed as a single food item meal, which can lead to malnutrition if consumed frequently and may be detrimental to the health of young women (Huh et al., 2017; Sikander et al., 2017; Annigan, 2018).

*Amaranthus* is one of the abundant traditional vegetables, which is a good source of nutrients such as proteins, vitamins and minerals in South Africa (Biel et al., 2017; Samota, 2017; Alegbejo, 2013; DAFF, 2010; Akubugwo et al., 2007). However, its underutilisation persists due to consumer negative perceptions (food for old people, poverty food, and backwards food) (Alegbejo, 2013; Ramdwar et al., 2017). The negative perceptions affect the preference of this vegetable, especially amongst the youth. This study therefore was aimed at determining the patterns of instant noodles consumption and utilisation of *Amaranthus* among university students. This was done to gauge the potential of using *Amaranthus* leaf powder to improve the nutritional profile of instant noodles. Supplementation of food products with ingredients such as flours/powders from root tubers, legumes and other unconventional sources is gaining popularity in the food industry. This can have a positive impact on the functional, physicochemical and nutritional properties of developed products (Noorfarahzilah et al., 2014). In the current case, this would contribute towards indigenizing instant noodles, which are originally from Asia (Zahrul-lail, 2017). Such an investigation is necessary as previous investigations on improving instant noodles established that when replacing or introducing ingredients, the consumers should be familiar with it (Mnkeni et al., 2007; Barcelon et al., 2015; Phakare, 2018).

## **4.2 Materials and methods**

Students at the University of Zululand were surveyed to determine noodle consumption patterns and check if they were in line with the popularity claims on instant noodles consumption. This rural based University enrolls students mostly from the surrounding rural areas who have access to *Amaranthus* vegetables at the same time form part of the student population that consumes nutrient deficient convenience foods. A quantitative research approach was followed when conducting the study. A total of 100 students were sampled and filled in the questionnaire using the quota sampling method as defined in Welman et al. (2005). The students came from four faculty divisions and were categorized according to where they reside, i.e. selected from those living in on-campus residences and off-campus private or university residences. A self-administered questionnaire (see appendix 1) was designed and piloted with 10 students who were then excluded as the progressing study sample to avoid bias. After careful revision it was used to collect data on utilisation of instant noodles and *Amaranthus*. The questionnaire was divided into 3 sections: demographics, consumption of noodles and utilisation of *Amaranthus*.

## **4.3 Management and data analysis**

The Statistical Package for Social Sciences (IBM SPSS), version 21, was used to generate descriptive statistics.

## **4.4 Ethical considerations**

An informed consent form with all the details of the research explaining the purpose of the research was administered (see appendix, 3). It was explained to the respondents and they signed as an indication of agreeing to participate in the study. Respondents were assured of privacy and anonymity when data are reported.

## **4.5 Results and discussion**

### **4.5.1 Participants demographics**

The study comprised individuals of ages between 19 and 30 years, which are considered the target market population for the product. Of the sampled population, there were more females (61%) than males (39%) participating in the study (**Table 4.1**). This ratio is a reflection of the

gender distribution found in student profile of the University of Zululand, where there was a clear demonstration of women (57, 29%) being populous than men (42, 71%) (Unizulu Facts and Figures, 2018/19). Forty-one percent of the students sampled were final-year undergraduate students, while 26% were postgraduate students. This represents a population group that has been at the university for quite some time and has the busiest academic schedule. Moreover, this particular group gives an insight into the food culture at the university. In terms of residence conditions, a bigger portion of the participants lived in off-campus residences. Students living both on-campus and off-campus had the primary responsibility to purchase their own groceries, as the University did not have any working system to provide students with meals for example, dining halls. A large portion of the participants (63%) depended on the National Student Financial Aid Scheme (NSFAS) allowance (R1500 per month) as a source of income in the year 2018. Only 3% received more than one income e.g. from parents as well as through part-time jobs. The rest of the participants, especially postgraduate students, were dependent on bursaries for both accommodation and subsistence.

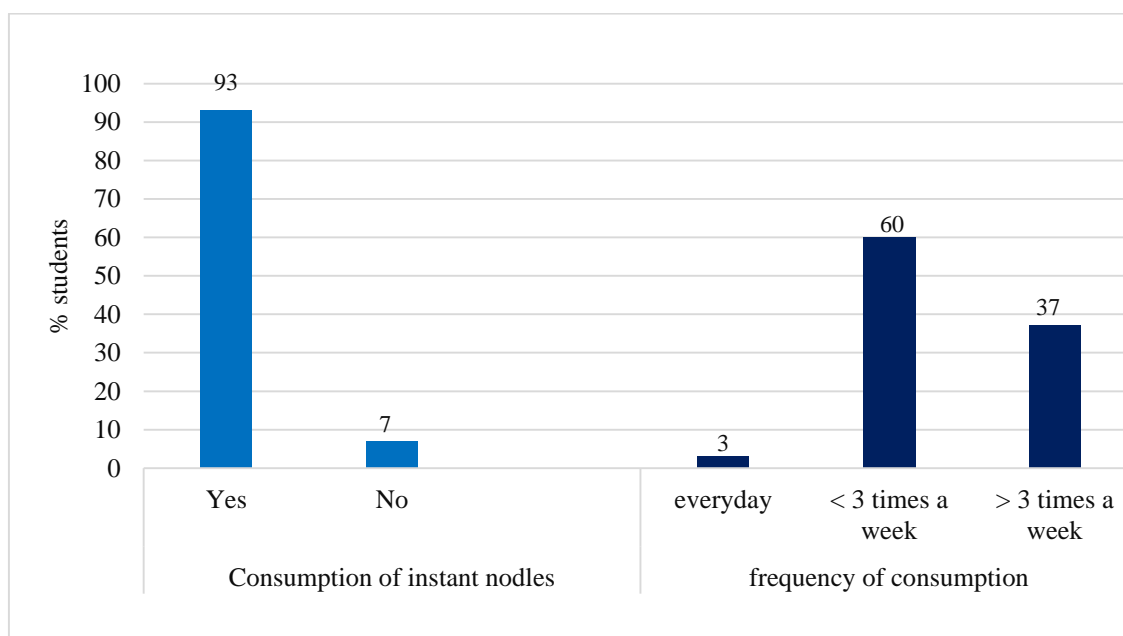
**Table 4.1:** Participants demographics. n=100

<b>Variable</b>	<b>Attributes</b>	<b>Total of participants (n)</b>	<b>Percentage (%)</b>
Gender	Male	39	39
	Female	61	61
Age	19-25 years	83	83
	26-30 years	10	10
	Above 30 years	7	7
	Education		
Faculty	Arts	20	20
	CAL	8	8
	Education	30	30
	Science & Agriculture	42	42
Level of study	First year	9	9
	Second year	9	9
	Third year	15	15
	Final year	41	41
	Postgraduate	26	26
Residence	On campus	39	39

	Off-campus	61	61
Income	NSFAS	63	63
	Parents allowance	10	10
	Other	24	24
	Mixed	3	3

#### 4.5.2 Instant noodles consumption trend and frequency

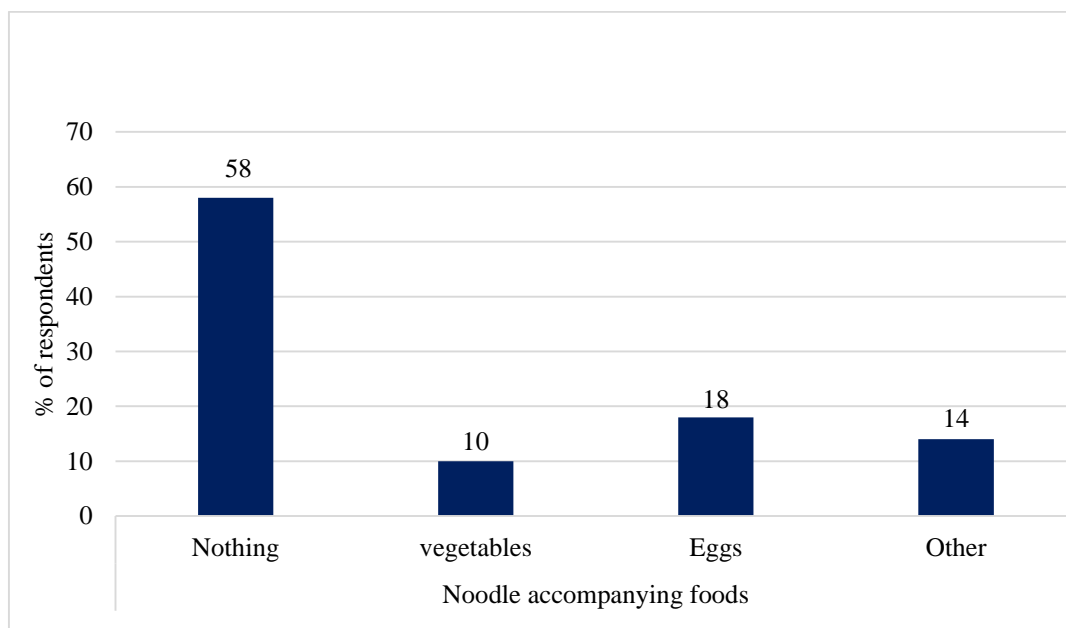
A majority (93%) of the participants in this study consumed instant noodles (**Figure 4.1**). About 37% of the students were consuming instant noodles more than three (3) times a week, only 3% ate noodles every day and the remainder consumed noodles less than three times a week. An average of 8 packets (per person) per month, was being consumed by the participants. By gender, females consumed less noodles than males, with an average of 3 packets per month. This is similar to the findings of (Chung et al., 2010). Students who resided in off campus private residents consumed instant noodles more often than those residing on campus. This may be due to limited time in hand to prepare meals as students have to walk distances to attend classes. The noodles consumption trend observed in this study confirms the findings reported by Nelson et al. (2009); Sikander et al. (2017) and Zahrul-lail (2017) who noted a similar trend among students at higher learning institutions.



**Figure 4.1:** Consumption frequency of instant noodles n=100

### 4.5.3 Noodle accompanying foods

Fifty-eight percent of the participants mainly ate noodles without any other nutritious food items (Figure 4.2). About 14% of the participants consumed noodles with ingredients such as chicken, fish, boerewors/sausage, mayonnaise, sauces, cheese and even bread; while 18% combined them with eggs and 10% combined them with vegetables. According to the World Health Organization (WHO) (2014), most consumers do not combine instant noodles with any vegetables or protein sources to improve their nutritional value. This study suggests that protein source is more popular than vegetables in the South African context. A smaller portion of participants combined noodles with vegetables, as they found vegetables expensive.

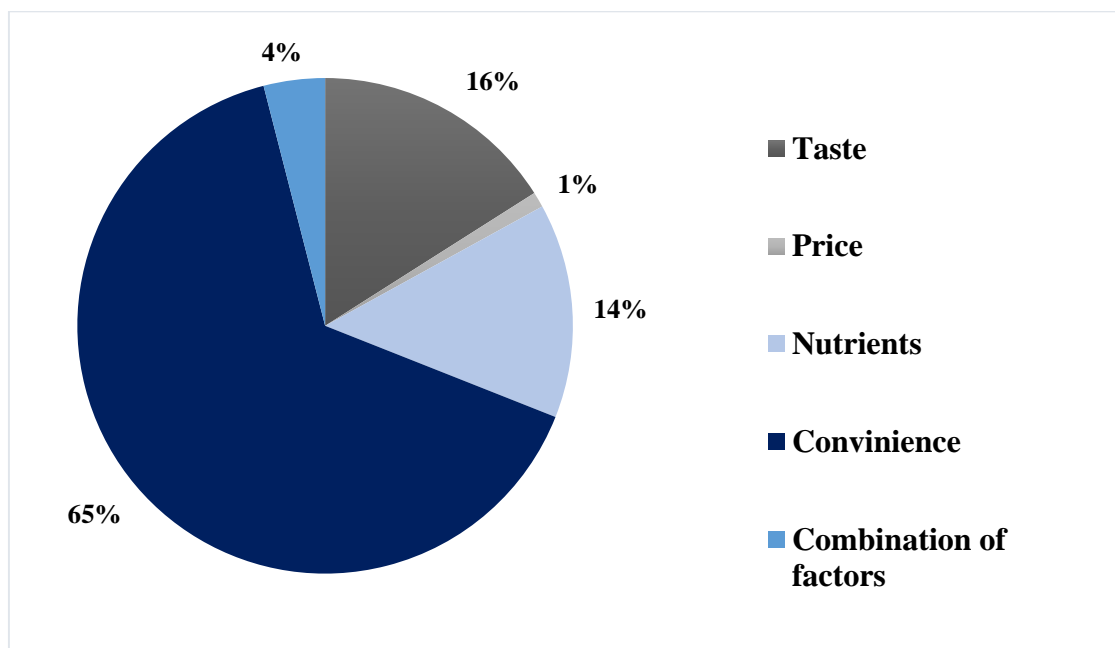


**Figure 4.2:** Instant noodles food accompaniment. n=100

The literature shows that several authors have raised concerns about the nutritional value of instant noodles, as they are regarded as a ‘hunger filling food’ containing few nutrients. Noodles are notorious for being low in fibre and protein, having high amounts of sodium, they thus expose the consumer to risks of metabolic diseases and malnutrition (Shin et al., 2014). Pekcan (2013) argued that consumption of monotonous starch-based diets is related to a high prevalence of malnutrition among the youth. There is a need to take a closer look at the ingredients used in the production of noodles, modify the formulation with appropriate food materials and thereby address the food and nutrition security issues associated with noodle consumption (Eddyono and Subroto, 2014).

#### 4.5.4 Reasons for consuming instant noodles

There were various reasons that influenced participants' consumption of instant noodles. Sixty-five percent of participants that were consuming instant noodles indicated that the main attribute that influenced their decision was the convenience of the food as noodles have a long shelf life and are quick to prepare (**Figure 4.3**). According to Tan et al. (2016), instant noodles saved students time to prepare foods due to their busy academic schedules. (Shin et al., 2014; Zahrul-lail, 2017) reported similar findings.



**Figure 4.3:** Various reasons the consumption of instant noodles. n=100

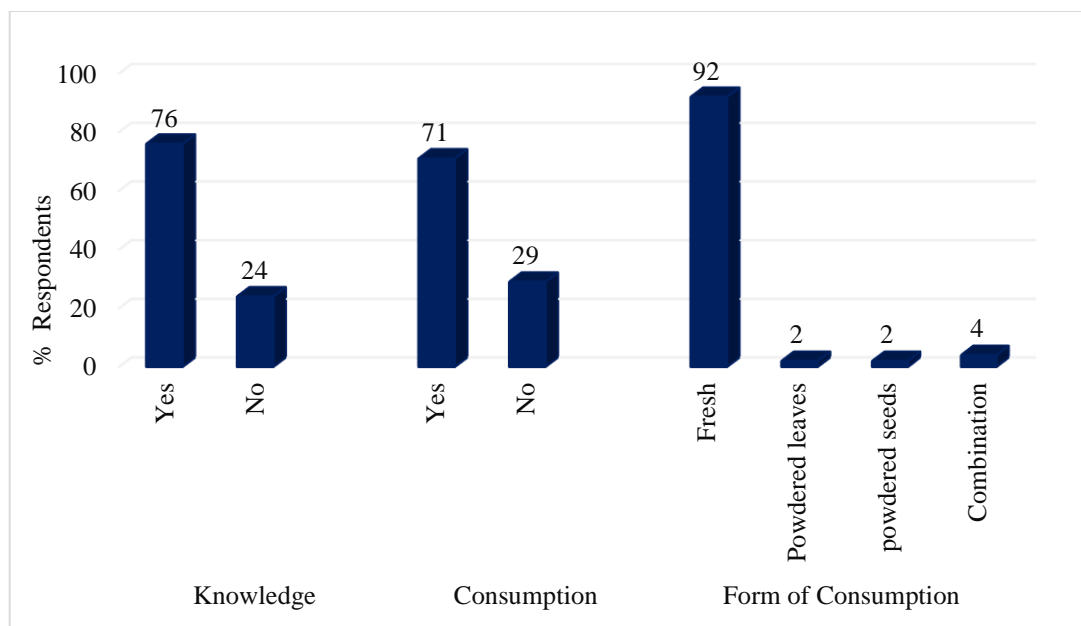
About 16% and 14% students reported taste and the nutritional value respectively, of noodles as part of the important factors influencing noodle consumption. Although nutrition was not a dominant factor, recent literature reports an increased demand for healthy instant foods among the health-conscious groups (Right Choice, 2014). In the survey by Right Choice (2014), flavour was identified as the major driver towards purchasing specific noodles. This is important to consumers as some have grown loyalty and preference of flavours in the noodles family. In this study, preferred flavours among students varied from beef to vegetable flavoured instant noodles such as spinach and mushrooms. According to literature, it must be noted that the consumers often confuse flavour with the actual presence of the flavouring as the major ingredient. This is because the production processes for flavouring differ with each brand, of which with others, artificial flavouring ingredients in conjunction with lots of salt and fat are used over natural ingredients (Bloom, 2017). Price and brand of instant noodles were some of

the least notable influential factors that were noted in this study. The price of noodles makes them a competitive carbohydrate food. Although the brand had a role in the preference for noodles, consumers really did not find much of a distinct difference among brands except in the fact some brands were considered as 'trusted brand'.

#### **4.5.5 Utilisation of *Amaranthus***

Due to the recent concerns of the increasing rise in noodle consumption, research has recommended supplementation of noodles (Phakare et al., 2018, Kalkumi et al., 2012). The study also encouraged interventions that explore ways to fortify instant noodles with essential micronutrients like vitamins and minerals, fibre and other flavours that enhance the nutritional value of noodles for improved nutrition of communities (Gulia et al., 2014). Wheat flour is the most prominent ingredients used in making instant noodles and they can be supplemented with a range of materials that can boost its nutritional content.

As a way forward, the current study introduced *Amaranthus* leaves as a supplement ingredient to provide the necessary missing nutrients. Studies done on improving instant noodles have cautioned that when replacing or introducing ingredients, at least they should be familiar to consumers. Thus, the awareness of *Amaranthus* leafy vegetable was investigated. As shown in **Figure 4.6**, the majority of the students (76%) had knowledge/knew the *Amaranthus* vegetable. *Amaranthus* leaves were described as: *an indigenous green leafy vegetable that grows in the wild; food that is usually cooked in rural homesteads; healthy herb; isishebo (relish) that is usually cooked by mothers.*



**Figure 4.4:** Utilisation of *Amaranthus*. n=100

Amongst the 76% that had knowledge on *Amaranthus*, 71% were consumers or have at least consumed *Amaranthus* once in their life (**Figure 4.6**). The majority (92%) of participants used *Amaranthus* fresh leaves when cooking the plant. There were a few (4 %) participants who mentioned using *Amaranthus* in the form of powdered dry leaves and grains. It was evident that although participants were familiar with *Amaranthus*, others going as far as acknowledging its nutritional benefits, very few were consuming the product as a staple food. As reported in the literature, in South Africa there is a decline in the consumption of traditional leafy vegetables especially among youth (Nyembe, 2015). This study confirmed that students had a similar behaviour to *Amaranthus* consumption. Most of the participants mentioned that they preferred exotic vegetables such as spinach and lettuce over traditional vegetables. Although, there is a reported decline of *Amaranthus*, secondary consumption of the vegetable as a wheat supplement to prepare noodle composite food could improve the utilisation of the vegetable and consequently improve the food and nutrition security for consumers.

#### **4.6 Product innovation**

As can be noted from the above results, majority of students consumed instant noodles as a single meal and do not pair it up with any vegetables or proteins. This puts them at risks as it was noted that consumption of noodles as a single meal could lead to malnutrition if consumed regularly (Huh et al., 2017; Sikander et al., 2017; Annigan, 2018). Noodles are amongst popular consumed starch food by youth and children in SA, it has now surpassed the preference of

maize in this particular population segment competing with bread that has been fortified (WINA, 2017). It is in the interest of this study to indigenise noodles by supplementing them with *Amaranthus* which is an available, highly nutritious & a traditional crop in South Africa. The researcher developed *Amaranthus* based noodles by using *Amaranthus* leaves to form a composite flour which was incorporated with the wheat flour to come up with a product that does not only have improved nutritional value but also will be used as a strategy to re-introduce the leafy vegetable to the youth whom have widely rejected the vegetable on various reasons noted earlier.

#### **4.6.1 Recipe development and standardization**

The ingredients were collected and modified according to Gulia et al. (2013) (**Table 4.3**) and were prepared according to the method adopted and modified from Peteya et al. (2014) and Adegunwa (2012). Artificial ingredients were excluded in this recipe in order to ensure that the product is in line with the health and naturalness requirements by the population. In general, noodles are developed using wheat flour (Ginting and Yulifianti, 2015). Wheat flour (WF) was used to produce a control then prototypes were developed by supplementing wheat flour with *Amaranthus* leaf powder (ALP) at ratios 1%, 2%, & 5% as suggested by Zungu (2016) in a study of fortifying bread through supplementation with moringa leafy powder. A descriptive sensory test was done with five trained panellists using a descriptive score card. The samples with 5% ALP was found to be bitter as a result of the bitter tastes from *Amaranthus*. Standardization was done and the proportions were reduced down to 1, 2 and 3% ALP, respectively, and other adjustments such as the reduction of the egg content were done before the samples were taken to pilot testing. According to the USDA a standardized recipe is the one that “has been tried, adapted, and retrieved several times for use by a given foodservice operation and has been found to produce same good results and yield every time when the exact procedures are used with same type of equipment and same quantity and quality of ingredients” (United States Department of Agriculture, 1995).

**Table 4.2:** Standardized recipe

<b>Name of dish:</b> Amaranth supplemented noodles				<b>Output</b>	100g dry noodles
<b>Preparation time:</b> 30 Minutes <b>Steaming:</b> 5 minutes <b>Drying:</b> 2 hours				<b>Cooking time</b>	4-5 minutes
<b>Amount</b>				<b>Ingredients</b>	<b>Procedures</b> Pre-heat the oven to 180°C  1. Add all the dry ingredients in a bowl. 2. Add the liquids then mix together. 3. Knead for ten minutes to form a dough ball. Roll into a thick sheet then extrude using the pasta machine to form 2 mm noodle sheets. 4. Cut the sheet into the strands using the pasta machine. 5. Steam for 5 minutes using a steamer. 6. Once done, dry for 2 hours using an oven with a fan at 70°C. Cool the strands well then package well for further use
<b>O</b>	<b>V1</b>	<b>V2</b>	<b>V2</b>		
100g	99g	98 g	97g	Wheat flour	
1g	1g	1g	1g	Onion Powder	
1g	1g	1g	1g	Sodium Bicarbonate	
1g	1g	1g	1g	Salt	
2g	2g	2g	2g	Starch	
5ml	5ml	5ml	5ml	Lemon Juice	
1g	1g	1g	1g	Garlic Powder	
1g	1g	1g	1g	Cumin Powder	
5ml	5ml	5ml	5ml	Oil	
5ml	5ml	5ml	5ml	Egg	
31ml	31ml	31ml	31ml	Warm Water	
-	1g	2 g	3g	<i>Amaranthus</i> LP	

#### 4.6.2 Processing of *Amaranthus* leaf powder

The *Amaranthus* (*Amaranthus cruentus*) leaves were sourced from local vendors at eSikhawini location. The naturally growing species of *Amaranthus* is more abundant in this area and is usually sold by local vendors. These leaves were sorted, graded and thoroughly washed under running tap water to remove dirt. The cleaned leaves were then spread over a paper towel to get rid of excess water. They were then dried in a hot air oven at 70°C for 2 hours as suggested by (Singh et al., 2009). This method is also the most effective preservation method used by indigenous communities to extend the shelf life of *Amaranthus* leaves. The dried leaves were then milled into a fine powder using a blender. The powder was kept in airtight zipped labelled plastic bags for 24 hours for further use (Singh et al., 2009).

#### 4.6.3 Preparation of instant noodles

The *Amaranthus* leaf powder-supplemented instant noodles were developed at the University of Zululand's Department of Consumer Science domestic food laboratory. Dry ingredients were mixed and liquids were added. The combination was mixed and kneaded for ten minutes to form a dough ball, (**Figure 4.5-4.8**) below which each weighed 150 g. The dough was rolled

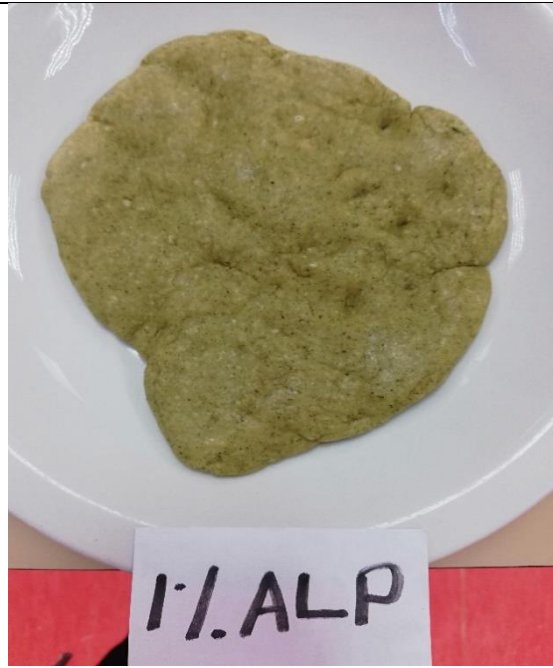
into a thick sheet then was extruded using the pasta machine to form noodle sheets. The sheets were cut into noodle strands using the pasta machine and was steamed for 5 minutes (Figure 4.9-4.12) for steamed noodles. Once done, they were dried for 2 hours using an oven with a fan at 70°C. The dried samples were cooled, weighed and packaged and labelled in clear plastic bags further use. Each dried sample weighed 100 g which is equivalent to the per serving packets sold in supermarkets.

#### **4.6.4 Product Information**

The outcome of product development is shown in Figures 4.5-4.12. The instant noodles were green in colour as attributed to *Amaranthus* colour. Each sample weighed 100 g which is “the per serving” of the noodles in the commercial stores. The samples were subjected to physicochemical analysis as well as nutritional analysis, which will be reported in Chapter 5 and 6.



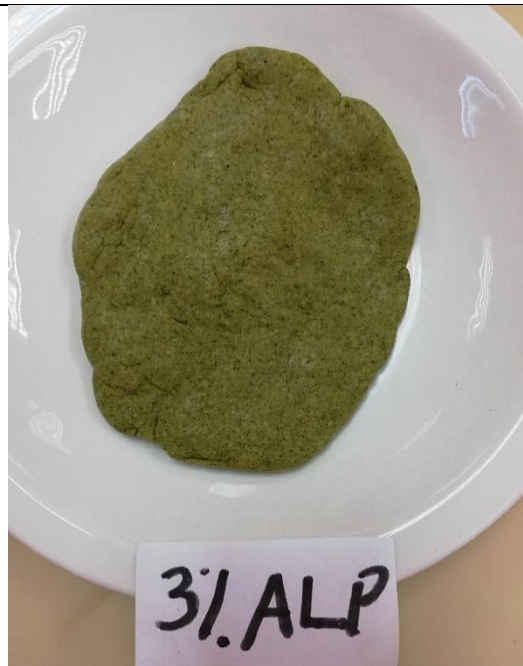
**Figure 4.5:** Raw dough control (0% ALP)



**Figure 4.6:** 1% ALP raw dough



**Figure 4.7:** 2 % ALP raw dough



**Figure 4.8:** 3% ALP raw dough



**Figure 4.9:** Dried instant noodles control



**Figure 4.10:** Dried instant noodles with 1% ALP



**Figure 4.11:** Dried instant noodles with 2% ALP



**Figure 4.12:** Dried instant noodles with 3% ALP

#### 4.6.4.1 Indigenisation of instant noodles

Food offers an opportunity for self-knowledge, which is grounded in immediate experience and usually embodies knowledge and personal and collective memory (Winter, 2003). South African cuisines were also originally indigenous based on various tribes in the country, however due to immigration and colonialization, other styles and types of dishes are being cooked and consumed in the country. Instant noodles form part of this cultural ingestion which comes about as a result of current trends in the food system including, globalization, convenience, trade liberalization etc. (Pérez-Escamilla, 2017). This has led to the wide

acceptance and consumption of this foreign Asian food in South Africa. Other trends like the increased demand for localization, health, cultural experiences and sustainability to be considered in production however cannot be reported for this product. The addition of *Amaranthus* leaf powder to the instant noodles helps to adopt the product, which is of Asian origin and gives it a sense of African identity as this is a traditional plant. This is called “indigenisation” formally defined as the fact of making more native, transformation of some service, idea etc. to suit a local culture, especially through the use of more indigenous people in administration, employment etc. (Dictionary, 1989; Godfray et al., 2010). The developed noodles adopted, integrated and modified the traditional processing and preservation methods currently being used by communities and the Asian communities.

*Amaranthus* was dried using the oven method, which is quick when compared to the sun drying method used by communities. This demonstrate the past and future orientation trends as well as adjusting the production methods to suit the new technology currently entering the food system through the fourth industrial revolution. The leaves in this study were milled into a fine powder. The product therefore is in line with the current and future trends where it was reported that there will be a need for products that will be locally produced using local ingredients, be past and future oriented, demonstrate a sense of globalization of flavours, be healthy and convenient (Schnepf, 2011; Verain et al., 2015; Muhammad et al., 2017 ; Pérez-Escamilla, 2017; Willer et al., 2019).

#### **4.6.4.2 Cooking quality**

The noodles were assessed for cooking quality by soaking in boiling water. This is a method commonly used by students and it involves enclosing the noodles and boiling water in a container until the noodles become soft. This is followed by draining water and addition of flavouring. The developed noodles took 8-10 minutes to cook which is in contrary to the documented cooking time (2 minutes) for noodles. In contrary, it took 4-5 minutes to cook the noodles when a microwave is used. This is in line with the standard cooking time for noodles as suggested by Park & Baik (2004). Adegunwa et al. (2012) also made note that the protein content may increase the cooking time in noodles and therefore the longer cooking time present in these samples as opposed to the commercial “two minutes’ noodles” is attributed to by the anticipated increased protein content because of *Amaranthus* leaf powder addition. The study

therefore recommends that a microwave method or cooking/on top of stove cooking for 4-5 minutes in this regard.

#### **4.7 Conclusion**

The first and second objective of the study was to determine the consumption of instant noodles and utilisation of *Amaranthus* and to develop an *Amaranthus* based instant noodle prototype. It is concluded that about 93% of students at the University of Zululand are active consumers of instant noodles. The consumption ranged from two packets per week to eight packets per month. Majority of students did not eat noodles with vegetable or sources of proteins and considered convenience as the major driver towards the purchasing and consumption of noodles. Most students had knowledge of what *Amaranthus* was, however of those the majority consumed the vegetable when they are at home but not when they are at school. This showed that the consumption of *Amaranthus* amongst the youth remains low. There is a need to re-introduce the vegetables to the youth and encourage its consumption. In this regard, incorporation of *Amaranthus* leaf powder in instant noodles during production was deemed as a strategy to address the nutritional content of noodles as well as to encourage consumption of the vegetable among the youth. Sensory evaluation and physicochemical tests were however necessary in order to determine the acceptability of the product and will be reported in chapter 5.

## 4.8 References

- ALEGBEJO, J. O. 2013. Nutritional value and utilisation of amaranth (*Amaranthus* spp.) A review. *Bayero Journal of Pure & Applied Science*, 6 (1): 136-143. ISSN:2006-6996 <http://dx.doi.org/10.4314/bajopas.v6i1.27>.
- AKUBUGWO, I., OBASI, N., CHINYERE, G. & UGBOGU, A. (2007). Nutritional and chemical value of *Amaranthus Hybridus* L. leaves from Afikpo. Nigeria, *African Journal Biotechnology* 6(24): 2833-28-39.
- ANNIGAN, J. 2018. The effects of low protein intake” Healthy eating. SF Gate. written by Carly Schuna accessed online at <https://healthyeating.sfgate.com/effects-low-protein-intake-7123.html>
- BIEL, W., JENDRZICZAK, E., JARZEWSKA, A., WITKOWICZ-ROBERTY, P.E. & TELESINSKI, A. (2017). Nutritional content and antioxidant properties of selected species of *Amaranthus l.* *Italian Journal of Food Science*. 29.728-740
- COTTI, C. & TEFFT, N. 2013. Fast food prices, obesity, and the minimum wage. *Economics and Human Biology*, 11, 134-147.
- DAFF 2010. *Amaranthus* production guideline. In: . DEPARTMENT OF AGRICULTURE, Forestry and Fisheries. accessed online <https://www.daff.gov.za/Daffweb3/Portals/0/Brochures%20and%20Production%20guidelines/AMARANTH%20PRODUCTION%20GUIDELINES%202014.pdf>
- DICTIONARY, O. E. 1989. Oxford english dictionary. *Simpson, JA & Weiner, ESC.*
- EDDYONO, F. & SUBROTO, B. 2014. Purchase Behavior of Noodles: A Case Study of Effort Primary Food Diversification in Indonesia. *International Journal of Science and Technology*, 3.
- GINTING, E. & YULIFIANTI, R. 2015. Characteristics of noodles prepared from orange fleshed sweet potato and domestic wheat flour. *Procedia Food Science*: 3. 289-302 <https://doi.org/10.1016/j.profoo.2015.01.032>
- GODFRAY, H. C. J., CRUTE, I. R., HADDAD, L., LAWRENCE, D., MUIR, J. F., NISBETT, N., PRETTY, J., ROBINSON, S., TOULMIN, C. & WHITELEY, R. 2010. The future of the global food system. The Royal Society.
- GULIA, N., DHAKA, V. & KHATKAR, B. S. 2014. Instant Noodles: Processing, Quality, and Nutritional Aspects. *Critical Reviews in Food Science and Nutrition*, 54, 1386-1399.
- HUH, I. S., KIM, H., JO, H. K., LIM, C. S., KIM, J. S., KIM, S. J., KWON, O., B.OH & CHANG, N. 2017. Instant noodle consumption associated with cardio metabolic risk

- factors among college students in Seol. *Nutrition Research and Practice* 11(3):232-239. doi: 10.4162/nrp.2017.11.3.232. Epub
- KULKAMI, S.S., DESAI, A.D., RANVEER, R.C. & SAHOO, A.K. 2012. Development of nutrient rich noodles by supplementation with malted ragi flour. *International Food Research Journal* 19(1): 309-313
- MUHAMMAD, A., D'SOUZA, A., MEADE, B., MICHA, R. & MOZAFFARIAN, D. 2017. The influence of income and prices on global dietary patterns by country, age, and gender. United States Development Agency: Economic Research Report Number 225.
- NOORFARAHZILAH, M., LEE, J., SHARIFUDIN, M., FADZELLY, M. A. & HASMADI, M. 2014. Applications of composite flour in development of food products. *International Food Research Journal*, 21, 2061.
- NYEMBE, S. N. 2015. *Preserving traditional leafy vegetables using indigenous knowledge-based drying technologies to improve household food security in Limpopo Province, South Africa*. Masters Dissertation, University of KwaZulu Natal. School of Agriculture, Earth and Environmental Science-Food Security
- PEKCAN, J. 2013. *Pasta and Health Nutrition: "Pasta: The Sustainable, Healthy and Delicious Food"* World Pasta day 2013. Hacettepe University.
- PÉREZ-ESCAMILLA, R. 2017. Food security and the 2015–2030 sustainable development goals: From human to planetary health: Perspectives and opinions. *Current developments in nutrition*, 1, e000513.
- PHAKARE, K. N., DAGADKHAIR, A. C. & UDACHAN, I. S. 2018. Enhancement of Nutritional and functional characteristics of noodles by fortification with protein and fibre: A review. *Journal of Pharmacognosy and Photochemistry*. E-ISSN: 2278-4136 P-ISSN: 2349-8234 JPP 2018; 7(1): 351-357
- RAMDWAR, M. N., CHADEE, S. T. & STOUTE, V. A. 2017. Estimating the potential consumption level of amaranth for food security initiatives in Trinidad, West Indies. *Cogent Food & Agriculture*, 3, 1321475.
- RIGHTCHOICE 2014. Instant noodles: Not a nutritious choice. Accessed online [http://cercervis.nic.in/PDF/Instant\\_Noodles.pdf](http://cercervis.nic.in/PDF/Instant_Noodles.pdf) 23 March 2019.
- SAMOTA, M.K. (2017). Nutritional value of Amaranthus. *Biotech Articles*. <https://www.biotecharticles.com/Agriculture-Article/Nutritional-Value-of-Amaranthus-3958.html>
- SCHNEPF, R. 2013. *Consumers and Food Price Inflation*, Congressional Research Services DIANE Publishing 7-5700 www.crs.gov R40545.

- SHIN, H. J., CHO, E., LEE, H. J., FUNG, T. T., RIMM, E., ROSNER, B., MANSON, J. E., WHEELAN, K. & HU, F. B. 2014. Instant noodle intake and dietary patterns are associated with distinct cardio metabolic risk factors in Korea. *Journal of Nutrition* 144(8):1247-55. doi: 10.3945/jn.113.188441. Epub.
- SIKANDER, M., MALIK, A., KHAN, M. S. G. & KHAN, R. G. Q. 2017. Instant noodles: Are they really good for health? A review. *Electronic Journal of Biology*, 13, 222-227.
- SINGH, S., PUNIA, D. & KHETARPAUL, N. 2009. Nutrient composition of products prepared by incorporating amaranth (*Amaranthus tricolour*) leaf powder. *Nutrition & Food Science*, 39, 218-226.
- STATISTICS, S. 2011. Gender statistics in South Africa, 2011. Pretoria: Statistics South Africa.
- TAN, P. L., HANIF, M. & AMALINA, F. 2016. An exploration of the factors influencing the intention of University students towards the consumption of instant noodles. *Journal of Advanced Research Design*, 20, 1-77.
- UNITED STATES DEPARTMENT OF AGRICULTURE, U. 1995. A Tool Kit for Healthy School Meals: Recipes and Training Materials. USDA's New School Lunch and Breakfast Recipes. In: AGRICULTURE (ed.). Washington, DC. Accessed online: <https://eric.ed.gov/?id=ED423950> 25 April 2019.
- VERAIN, M. C., DAGEVOS, H. & ANTONIDES, G. 2015. Sustainable food consumption. Product choice or curtailment? *Appetite*, 91, 375-384.
- WELMAN, C., KRUGER, F. & MITCHELL, B. 2005. *Research methodology*, Oxford University Press Cape Town.
- WILLER, H., SCHAACK, D. & LERNOUD, J. 2019. Organic farming and market development in Europe and the European Union. *The World of Organic Agriculture. Statistics and Emerging Trends 2019*. Research Institute of Organic Agriculture FiBL and IFOAM-Organics International. Online at: <http://www.organic-world.net/yearbook/yearbook-2017.html>
- WINA 2017. National trends in instant noodles demands. *World Instant Noodles Association*. Accessed at <https://instantnoodles.org/en/noodles/market.html> 25 April 2019.
- WORLD HEALTH ORGANIZATION, E. F. 2014. Global Action plan for prevention and control of non-communicable diseases. Accessed online at [https://www.who.int/nmh/events/ncd\\_action\\_plan/en/](https://www.who.int/nmh/events/ncd_action_plan/en/) 25 April 2019.
- ZAHRUL-LAIL, N. S. 2017. Influence of instant food among students. *Research Hub*, 3 (2) ISSN: 2180-0065.

## Chapter 5 : Effect of *Amaranthus* leaf powder on the nutritional composition and physical quality of noodles

### Abstract

Noodles are amongst popularly consumed starch food by youth and children. However, they do not have sufficient nutrients to be consumed as a single meal. This has led to various food development endeavours. The aim of the study was to determine the effect of *Amaranthus* leaf powder (ALP) supplementation on the nutritional composition, physical quality and consumer acceptability of instant noodles. Instant noodle prototypes were developed by substituting the wheat flour used in a common noodle recipe with 1%, 2% and 3% (w/w) substitution level of ALP. The samples were analysed for nutritional composition using AOAC methods. Physical quality of cooked noodles was determined by assessing the colour (CIELAB colour space) and texture (texture analyser). The protein content of ALP-supplemented noodles was similar to the control (conventional instant noodles) and remained above the recommended percentage content (8%) for all the samples. Instant noodles with ALP had insignificantly higher fibre content (13.8%) as well as ash content (3.8%) suggesting that *Amaranthus* can be used to improve the nutritional value of instant noodles. The fat content in fortified samples increased up to (5.1%), which led to a higher energy value albeit the decrease in total carbohydrates. With regard to the mineral composition, significant increases were observed for Manganese, Calcium and Copper. The antioxidant activity (DPPH radical-scavenging activity) in samples increased with the increase in the content of *Amaranthus* leaf powder in the noodles. However, the increases were not significant ( $p>0.05$ ). The texture analysis showed that cooked *Amaranthus* noodles (ALP-supplemented) were softer (240 g cutting force) than those without ALP (600 g force) and the degree of softness negligibly increased with the increase in ALP content. The lightness of noodles significantly decreased with the increase in ALP content. This innovation could be complemented with product promotional campaigns on leafy vegetable consumption to encourage consumption of ALP-supplemented noodles.

**Keywords:** Instant noodles, *Amaranthus*, leafy vegetables, nutrition security

## 5.1 Introduction

Instant noodles have gained popularity to become one of the most commonly consumed starchy foods around the world (Birt et al., 2013). In the case of South Africa, a food consumption survey conducted in 1999 showed that carbohydrate-rich foods like maize, brown bread and sugars are the most popular foods (Steyn et al., 2005). The issues around the dominance of such foods is that they are often consumed in undiversified and unbalanced diets, which exposes consumers to malnutrition and diet-related health problems. This concern is perpetuated in the increasing popularity of instant noodles. A single serving of instant noodles is usually high in carbohydrates but low in fibre, vitamins, and minerals (Annigan, 2018; Sikander et al., 2017). Evidence has shown that many of the chronic health conditions could be prevented or managed through dietary changes: for example, type 2 diabetes can be addressed through nutrition transition (Hu, 2011). Strategies adopted by South Africa towards this cause include the supplementation of the top consumed foods as well as the establishment of South African Food-Based Dietary Guidelines (SAFBDGs) to promote nutrition security (Trentmann et al., 2012; World Health Organization, 2014). Food supplementation is regarded as a sustainable strategy for alleviation of malnutrition. It is cost effective and convenient. The success of this intervention is rooted in the fact that it does not require the target population to change its consumption patterns or diet (Barkley et al., 2015). The SAFBDGs suggest that people make starchy food the basis of their meals. This allows for a sufficient intake of dietary carbohydrates to meet an individual's caloric needs (Vorster et al., 2013). The rest of the SAFBDG guidelines encourage diversification to acquire a balanced diet. However, susceptibility to malnutrition persists as starch-based foods remain the staple for most households and a substantial proportion of the population consumes undiversified meals.

Instant noodles are considered an unbalanced meal. This has led to various developments to improve their nutritional quality. Most research done in this area has sort to achieve this by substituting the basal wheat flour used to prepare the product with flours from buckwheat (Choy et al., 2013), gathotan (Purwandari et al., 2014), brown rice (Wu et al., 2017), rice bran (Yılmaz Tuncel et al., 2017), mung bean (Liu et al., 2018), banana (Adebayo et al., 2018), cassava (Sanni et al., 2007) and pomegranate (Koca et al., 2018) among others. Supplementation studies have explored the inclusion of poultry-based food ingredients (Pal et al., 2017) and powders from vegetables such as beetroot (Koca et al., 2018) and carrot (Singh

et al., 2018). This is in contrary with many countries including the Philippines who have opted to fortify the noodle seasoning rather than the flour (Gulia et al., 2014).

Considering that *Amaranthus* is an easily accessible traditional leafy vegetable in South Africa, which has been praised for its nutritional value, it would be beneficial to explore its use as an inexpensive supplement for instant noodles. *Amaranthus* is an ancient vegetable that has been consumed in different regions globally for over eight thousand years (DAFF, 2010). It is high in vitamins including  $\beta$ -carotene, vitamin B6, vitamin C, riboflavin, folate as well as amino acids (Kushwaha et al., 2014; Beswa et al., 2016). *Amaranthus* grain and leaves are a good source of protein (32.51 g/100 g) and minerals such as magnesium (248mg/100g), calcium (159mg/100g), potassium (508 mg/100g), phosphorus (557mg/100g), iron (68.77 mg/kg), zinc 31.33 mg/kg and sodium (2.87 mg/100g) with grains being significantly richer than other grains such as maize (Soriano-García et al., 2018; Beswa et al., 2017; Samota, 2017; Mampholo et al., 2015; Alegbejo, 2013). The powder from the leaves blends well with wheat flour to produce nutritious products (Odunlade et al., 2017). The use of this ingredient is also steadily gaining popularity in supplementing products low in nutrients, especially protein (Cardenas-Hernandez et al., 2016). The use of leafy vegetables for value addition in staple foods is gaining popularity within the food industry. *Amaranthus* is one of the abundant but underutilised traditional vegetables in South Africa. Its underutilisation is associated with negative consumer perceptions about the vegetable (considered to be food for old people, poverty food and backward food) (Alegbejo, 2013; Ramdwar et al., 2017). Therefore, the aim of this study was to investigate the effect of *Amaranthus* leaf powder supplementation on the nutritional content, antioxidant activity, physical quality and consumer acceptability of instant noodles.

## **5.2 Materials and methods**

### **5.2.1 Processing of *Amaranthus* leaf powder**

*Amaranthus* (*Amaranthus cruentus*) leaves were sourced from local vendors at eSikhawini (28.8677° S, 31.9160° E) KwaZulu-Natal, South Africa. These leaves were sorted, graded and thoroughly washed under running tap water to remove dirt. 1 litre of water with 1 teaspoon of salt was further used to wash and kill any other microorganisms in the leaves. The cleaned leaves were spread over paper towel to get rid of excess water and dried in a hot air oven at 70°C for 2 hours as suggested by (Singh et al., 2009). The dried leaves were milled into a fine

powder using a blender (Wz-Q10S, Multifunctional Blender). The powder was kept in airtight labelled plastic bags for 24 hours for further use.

### 5.2.2 Processing of instant noodles

*Amaranthus*-supplemented instant noodles were developed in a domestic food laboratory. The samples and ingredients were collected according to Gulia et al. (2013) and were prepared according to a method modified from Peteya et al. (2014) and Adegunwa (2012). The ingredients that were used were sourced from Indlovu multi-sales company in Richards'bay and are given in Table 5.1. Dry ingredients were mixed and liquids were added. The combination was mixed and kneaded for 10 min to form a dough ball. The dough was rolled into a thick sheet and extruded using the pasta machine (Imperia Italian SP150 Double Cutter, Yuppie Chef) to form noodle sheets. The sheets were cut into noodle strands using the pasta machine and the strands were lined in a gastronome pan and put in the steaming machine (Hobart, HC24EA Series Steamers) at 100° C for 5 min. Once done, the strands were dried for 2 hours in an oven at 70°C. The dried samples were allowed to cool to room temperature ( $\pm 25^{\circ}\text{C}$ ) and packaged in clear plastic bags for further use. Standardization was done over a series of trials before the final product was taken for pilot testing. Wheat flour (WF) was used to produce control samples and the recipe was adjusted by substituting some of the wheat flour with *Amaranthus* leaf powder (ALP) at ratios 1, 2 and 3% to prepare *Amaranthus*-supplemented noodle prototypes.

**Table 5.1:** Ingredients used for noodles production

<b>Ingredient</b>	<b>Amount</b>
Wheat flour	750 g
Onion Powder	3.8 g
Sodium Bicarbonate	7.5 g
Salt	7.5 g
Starch	15 g
Lemon Juice	37.5 mL
Garlic Powder	3.8 g
Cumin Powder	3.8 g
Oil	37.5 mL
Egg	37.5 mL
Warm Water	232.5 mL
ALP	7.5 g, 15 g, 22.5 g (1, 2 and 3%, respectively)

### 5.2.3 Proximate analysis

Büchi 810 Soxhlet Fat extractor (Büchi, Flawil, Switzerland) was used to determine the fat content of the freeze-dried samples according to the AOAC Official Method 920.39 (Thiex et al., 2003). For extraction, petroleum ether (60 °C) was used. The following equation was used to calculate crude fat:

$$\% \text{ crude fat} = \frac{\text{beaker} + \text{fat} - \text{beaker}}{\text{samplemass}} \times 100$$

LECO Tsuspec Nitrogen Analyzer was used to measure protein content (LECO Corporation, Michigan, USA) using the AOAC official method 990.03109 (Thiex et al., 2003). A combustion chamber with autoloader was used to place the samples briefly at 950°C. To convert nitrogen content obtained to percentage the following equation was used:

$$\% \text{ crude protein} = \% \text{ N} \times 6.25$$

All samples mineral content was determined as ash according to the AOAC official method 942.05 (Thiex et al., 2003). Furnace was used to place the samples at 550°C after were weighed. After volatilization of the organic matter from the samples the minerals remained as residues of ash in the crucibles. The percentage of ash, which was found in the samples, was determined using the following equation:

$$\% \text{ ash} = \frac{(\text{Mass of sample} + \text{crucible after ashing}) - (\text{mass of pre} - \text{dried crucible})}{(\text{mass of sample} + \text{crucible}) - (\text{mass of pre} - \text{dried crucible})} \times 100.$$

Fibre was determined as neutral detergent fiber (NDF). Dosi-Fibre machine (JP Selecta, Abrera, and Barcelona, Spain) was used to analyse NFD of the samples, according to the AOAC Official Method 2002.04 (Mertens, 2002). Method 6.5.1 of Agricultural Laboratory Association of Southern African was used to analyse individual minerals magnesium (Mg), calcium (Ca), manganese (Mn), copper (Cu), zinc (Zn), iron (Fe), phosphorus (P), and sodium (Na). Shortly, HCl was used to dissolved freeze-dried which were ashed overnight at 550 °C in a furnace and then HNO<sub>3</sub> was added. After which, inductively coupled plasma optical emission spectrophotometer (Vista-MPX 2004, Mulgrave, Varian, Australia) was used to analyze samples. Analytic Jena Spekol 1300 spectrophotometer (Analytic 110 Jena AG, Achtung, Germany) was used to determine calcium and P. Varian Specter AA atomic absorption spectrophotometer (Mulgrave, Victoria, Australia) was used to determine iron and GBC 905AA spectrophotometer (GBC Scientific Equipment Pty. Ltd., Dandenong, Victoria, Australia) was used to determine Zn in the samples.

## 5.2.4 Physical quality assessments

### 5.2.4.1 Texture

Cooked noodle texture was evaluated using a TA-XT2 texture analyser (Stable Micro Systems, UK) within 5 min after cooking. Fifty grams (50 g) of noodles were cooked by soaking them in boiled tap water (150 mL) and soaked for 8 min. The broth was drained and kept for colour assessments. A set of three cooked noodle strands were placed parallel to a flat metal plate and measured using the HDP/PFS metal blade (Ma et al., 2014). Five replicates per sample were analysed.

### 5.2.4.2 Colour

Noodle colour was measured using a pre-calibrated Hunter Lab colorimeter (Hunter Associates Laboratory, Inc., Reston, VA). The prototypes were placed on the centre of a dry and clean glass sample cup, placed in a sample port, then covered and readings taken (Rao *et al.*, 2011) and recorded on a CIELAB colour space where  $L^*$ ,  $a^*$ , and  $b^*$  values were recorded ( $L^*$ = lightness and ranges from 0 [black] to 100 [white],  $a^*$ = redness and ranges from green [-] up to red [+],  $b^*$ = yellowness and ranges from blue [-] to yellow [+]). Three colour readings were taken from wet and dry noodle sheets, bundles of cooked noodle strands and the broth drained after cooking (Ma et al., 2014). All measurements were taken at room temperature.

## 5.2.5 Antioxidant activity assessments

Five dry samples of noodles, i.e. those with 1, 2 and 3% *Amaranthus* leaf powder, those without and a commercial noodle sample (Maggie noodles), were ground into fine powder using a mortar and pestle. The finely ground noodle samples (1.0 g) were extracted with 10 mL 80% methanol in an ice-cold sonication (Branson Model 5210, Branson Ultrasonics B.V., Soest, Netherlands) bath for 1 h. The extracts were then filtered through Whatman No. 1 filter paper and concentrated *in vacuo*, using a rotary evaporator (Büchi, Germany) at 30°C. The concentrates were transferred to pre-weighed glass vials and completely dried under a stream of cold air at room temperature. Once a constant weight of each extract was obtained, the extracts were stored in the dark at 10°C until used for analysis. The 1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical-scavenging capacity of the noodle sample extracts was evaluated using a DPPH assay described by Moyo et al. (2010) with modifications. In triplicate, 15 µL of methanolic extracts at different concentrations (10, 25 and 50 mg/mL) were diluted

with 80% methanol to a final volume of 750  $\mu$ L. The diluted extracts were then added to an equal volume of DPPH (100  $\mu$ M in methanol). The mixtures were incubated at room temperature in the dark for 30 min. A solution consisting of methanol in place of the extract was used as a negative control, while ascorbic acid was used as a positive control. The absorbance was read at 517 nm using a Cary 50 UV–visible spectrophotometer (Varian, Australia) Background correction of the extract absorbance was done by adding methanol in place of the DPPH solution, this was done for each extract to correct any absorbance due to extract colour. The radical scavenging activity (RSA) was calculated using the following equation:

$$\% \text{ RSA} = [1 - (A_{\text{extract}} - A_{\text{background}} / A_{\text{control}})] \times 100$$

where  $A_{\text{extract}}$ , is the absorbance of the reaction mixture containing the sample extract or standard antioxidant,  $A_{\text{background}}$  is the absorbance of the background solution and  $A_{\text{control}}$  is the negative control. The  $EC_{50}$ , which is the concentration of the extract required to scavenge 50% of DPPH radical, was determined for each extract using Graph Pad Prism software.

### 5.2.6 Sensory evaluation

Dried noodle strand samples were used for sensory evaluation. Two hundred gram (200g) samples were cooked by adding 500 mL of boiling water for 5 min before draining. Drained noodles were served using small plastic dishes to a panel. Untrained panelists (60 students recruited at the University of Zululand) were used in this study. The panelists were consumers of noodles and had at least tasted *Amaranthus* before. Ethical clearance was obtained from the Biomedical Research Ethics Committee (BREC), University of KwaZulu-Natal (BREC REF NO: BE453/19.) and consent was obtained from participants before they evaluated the samples. A nine-point hedonic scale, where 9 = extremely like and 1= extremely disliked, was used to assess the products. The cooked noodles were evaluated for sensory attributes: color, texture, aroma, taste and overall acceptability and each panelist evaluated four samples. To prevent bias, panelists were sat apart from each other and each panelist received samples in a randomized order, which was done using a table of permutation. Water was used to rinse the mouth before and in-between the testing of samples to get rid of previous tastes.

### 5.2.7 Data analysis

The results represent the average of replicate determinations, expressed as mean  $\pm$  standard deviation (S.D). The data obtained were analyzed by analysis of variance (ANOVA) using SPSS version 25. Significant F tests at levels of probability ( $p < 0.05$ ) are reported.

## 5.3 Results and discussion

### 5.3.1 Nutritional composition

The nutritional analysis and mineral composition is represented in **Table 5.3 and 5.4**. This is done in comparison with data on Table 5.2 according to Sikander et al. (2017). The protein content of ALP supplemented noodles was similar to the control (conventional instant noodles) and remained above the recommended percentage content (8%) for all the prototypes (Ginting and Yulifianti, 2015). Although the addition of ALP slightly increased the protein content in terms of the percentage change, these changes were not significant. This may be linked to the smaller substitution ratios of *Amaranthus* leaf powder. The nutritional value of noodles is dependent on the type of ingredients used (Duda et al., 2019). According to Olusanya et al. (2019) longer cooking time of *Moringa oleifera* leaf powder which is derived from a green leafy vegetable, might lead to loss of nutrients. An assessment of the nutritional composition of leaves used is then recommended in order to fully establish the factor behind not having an improved protein content against the control as expected. Instant noodles with ALP had an improved protein (12.38%), fibre (13.85%), ash (3.82%) as well as fat content (5%) (**Table 5.3**) against wheat noodles tested by Sikander et al. (2017) (**Table 5.2**) suggesting that *Amaranthus* can potentially be used to produce nutritious instant noodles. Although there is an increasing trend in reporting on the addition of *Amaranthus* on food, this study is the first to report on ALP supplemented noodles. *Amaranthus* addition has been reported to increase nutrition value of bio fortified maize snacks (Beswa et al., 2016). Concerning the mineral composition, significant increases were observed for Manganese, Calcium and Copper, which confirms that *Amaranthus* is rich in these mineral (**Table 5.4**). This suggests that this product can be consumed to contribute to these elements in the diet of individuals. Other mineral elements were not significantly different from each other with Iron decreasing with each addition.

**Table 5.2:** Nutritional Content of instant noodles according to Sikander et al. (2017)

<b>Type of instant noodle</b>	<b>Calories (Kcal)</b>	<b>Total fat (mg)</b>	<b>Sodium (mg)</b>	<b>Potassium (mg)</b>	<b>Total carbs (g)</b>	<b>Dietary fibre (g)</b>	<b>Sugars (g)</b>	<b>Protein (g)</b>
<b>Ramen</b>	420	20	0	0	60	0	0	10
<b>Rice</b>	160	0	25	0	37	0	0	3
<b>Soba/buckwheat</b>	226.7	1.3	600	0	46.7	2.7	1.3	6.7
<b>Bean thread</b>	260	0	6	0	65	2	0	0
<b>Wheat flour</b>	250	2	192	0	51	2	1	8
<b>Shirataki</b>	10	0	0	0	0	5	0	0
<b>Egg</b>	334	2	7	0	75	1	0	11

**Table 5.3:** Macronutrients in noodle samples

	<b>Total Energy (kcal)</b>	<b>Total carbohydrates (%)</b>	<b>Available Carbohydrates (%)</b>	<b>Fat (%)</b>	<b>Protein (%)</b>	<b>Total Fibre (%)</b>	<b>Ash (%)</b>
C	396.05±0.66 <sup>c</sup>	83.38±0.44 <sup>a</sup>	71.61±3.48 <sup>ab</sup>	1.55±0,13 <sup>c</sup>	12,15±0.52 <sup>a</sup>	11.77±3.11 <sup>a</sup>	2.92±0 <sup>a</sup>
V1	409.51±1.23 <sup>ab</sup>	81.20±0.42 <sup>a</sup>	73.12±3.51 <sup>a</sup>	4.09±0,25 <sup>b</sup>	11,98±0.53 <sup>a</sup>	8.08±3.14 <sup>a</sup>	2.73±0 <sup>a</sup>
V2	411±0.87 <sup>ab</sup>	79.54±0.69 <sup>b</sup>	65.68±1.43 <sup>b</sup>	5±0.17 <sup>a</sup>	11,96±0.53 <sup>a</sup>	13.85±1.53 <sup>a</sup>	3.5 ±0 <sup>a</sup>
V3	407.55±1.32 <sup>b</sup>	79.23±0.70 <sup>b</sup>	66.87±0.90 <sup>ab</sup>	4.57±0.26 <sup>ab</sup>	12,38±0.55 <sup>a</sup>	12.36±0.72 <sup>a</sup>	3,82±0 <sup>a</sup>

C-Control, V1-1%ALP, V2- 2% ALP, V3- 3% ALP \*data reported as mean ± standard deviation \* values with the same letter in a column are not statistically different, letter was assigned in a descending order in reference to the mean

**Table 5.4:** Mineral composition of developed instant noodles

	<b>Zn (mg/kg)</b>	<b>Fe (mg/kg)</b>	<b>Mn (mg/kg)</b>	<b>Ca (mg/kg)</b>	<b>Mg (mg/kg)</b>	<b>K (mg/kg)</b>	<b>Na (mg/kg)</b>	<b>P (mg/kg)</b>	<b>Cu (mg/kg)</b>
C	10.3±0.6 <sup>a</sup>	43.67±2.52 <sup>a</sup>	9±0 <sup>a</sup>	0.05±0.01 <sup>b</sup>	0,04±0.01 <sup>a</sup>	0,26±0,04 <sup>a</sup>	0,82±0,05 <sup>a</sup>	0,1±0,1 <sup>a</sup>	4,33±1,53 <sup>a</sup>
V1	12±1 <sup>a</sup>	39.67±5.51 <sup>a</sup>	11±2.65 <sup>a</sup>	0.08±0.03 <sup>ab</sup>	0,05±0,02 <sup>a</sup>	0,26±0.04 <sup>a</sup>	0,82±0,04 <sup>a</sup>	0,11±0,11 <sup>a</sup>	2,67±0,6 <sup>ab</sup>
V2	11±0 <sup>a</sup>	40.33±4.51 <sup>a</sup>	9.3±2.3 <sup>a</sup>	0.06±0.02 <sup>ab</sup>	0,04±0,01 <sup>a</sup>	0,27±0,01 <sup>a</sup>	0,82±0,02 <sup>a</sup>	0,11±0,11 <sup>a</sup>	2±1 <sup>b</sup>
V3	12±2 <sup>a</sup>	36.33±3.06 <sup>a</sup>	12±0 <sup>a</sup>	0.10±0.02 <sup>a</sup>	0,06±0,02 <sup>a</sup>	0,28±0,06 <sup>a</sup>	0,80±0,03 <sup>a</sup>	0,12±0,12 <sup>a</sup>	2,33±0,58 <sup>b</sup>

C-Control, V1-1%ALP, V2- 2% ALP, V3- 3% ALP \*data reported as mean ± standard deviation \* values with the same letter in a column are not statistically different, letter were assigned in a descending order in reference to the mean

### 5.3.2 Physical quality

#### 5.3.2.1 Texture

On texture, it was revealed that instant noodles supplemented with *Amaranthus* leaf powder (ALP) were softer than the control. The force required to break the noodles decreased from 609.08 g for the control to 271.39 g for the 3% ALP prototype (**Table 5.5**). In a study conducted by Alemayehu et al. (2016) similar results were found where an addition of nettle leaves powder to wheat flour led to a decrease in noodle texture (Alemayehu et al., 2016). This was associated with an addition of a non-gluten flour as well to improve the fibre content. This attribute can, however, be considered as a desirable attribute for the instant noodles as consumers have various preference in terms of texture and highly vary according to the cooking times and other factors (Gulia et al., 2014). This means that this can be food for age groups that demand softer foods such as those having difficulties in swallowing, the old aged as well as toddlers.

**Table 5.5:** Colour and texture of cooked noodles

	Colour readings			Texture
	L*	a*	b*	Firmness (g)
<b>Cooked strands</b>				
C	71.77±0.04 <sup>a</sup>	1.74±0.04 <sup>d</sup>	28.67±0.07 <sup>c</sup>	609.08±8.71 <sup>a</sup>
V1	52.22±0.02 <sup>b</sup>	1.85±0.01 <sup>c</sup>	30.52±0.02 <sup>a</sup>	285.99±3.14 <sup>b</sup>
V2	48.56±0.04 <sup>c</sup>	2.93±0.04 <sup>a</sup>	29.49±0.05 <sup>b</sup>	306.42±49.84 <sup>b</sup>
V3	45.39±0.02 <sup>d</sup>	2.41±0.03 <sup>b</sup>	29.45±0.10 <sup>b</sup>	271.39±64.11 <sup>b</sup>
<b>Broth</b>				
C	27.83±0.10 <sup>a</sup>	-3.15±0.08 <sup>c</sup>	7.91±0.09 <sup>b</sup>	
V1	17.64±0.16 <sup>b</sup>	-2.19±0.19 <sup>b</sup>	12.47±0.93 <sup>a</sup>	
V2	15.29±0.05 <sup>c</sup>	-2.42±0.17 <sup>b</sup>	8.02±0.06 <sup>b</sup>	
V3	13.23±0.01 <sup>d</sup>	-1.55±0.19 <sup>a</sup>	12.91±0.54 <sup>a</sup>	
<b>Wet sheets</b>				
C	54.54±0.08 <sup>a</sup>	4.30±0.00 <sup>a</sup>	25.49±0.09 <sup>a</sup>	
V1	44.74±0.01 <sup>b</sup>	3.26±0.03 <sup>b</sup>	25.08±0.01 <sup>b</sup>	
V2	43.18±0.02 <sup>c</sup>	2.03±0.05 <sup>c</sup>	25.04±0.12 <sup>b</sup>	
V3	38.26±0.03 <sup>d</sup>	3.26±0.04 <sup>b</sup>	20.83±0.07 <sup>c</sup>	
<b>Dry Sheets</b>				
C	52.45±0.01 <sup>a</sup>	2.84±0.03 <sup>b</sup>	22.46±0.02 <sup>b</sup>	
V1	49.66±0.02 <sup>b</sup>	2.21±0.01 <sup>c</sup>	24.69±0.03 <sup>a</sup>	
V2	38.67±0.02 <sup>d</sup>	2.17±0.02 <sup>c</sup>	21.71±0.09 <sup>c</sup>	
V3	45.45±0.01 <sup>c</sup>	3.08±0.03 <sup>a</sup>	24.67±0.08 <sup>a</sup>	

C-Control, V1-1%ALP, V2- 2% ALP, V3- 3% ALP \*data reported as mean ± standard deviation \* values with the same letter in a column are not statistically different, letter was assigned in a descending order in reference to the mean

### 5.3.2.2 Colour

A bright light and yellow colour is desirable for instant noodles (Kim, 1996) however an addition of a different coloured ingredient to the noodles may alter this colour. The CIELAB colour space readings (**Table 5.5**) indicated that as more ALP is added, the noodles became greener, decreasing the lightness of the instant noodles. With an addition of ALP, the samples for the raw and dried noodle sheets, cooked noodles as well as the broth were greener compared to the control. This indicates that the addition of green ALP significantly leads to the change in colour from cream white to dark green which can also be directly observed during production. Similar results were attained where addition of green pea flour produced pale green coloured noodles (Kumar and Prabhasankar, 2015) and addition of *Suma* spp. wheat flour also produced green colours (Adebayo et al., 2018). The green colours are attributed to by chlorophyll pigments present in *Amaranthus* leaves. The broth readings indicated that during the cooking process there may be some colour attributes of the noodle strands that are lost into the broth as suggested by Gulia et al. (2014). Differences in the processing method of instant noodles may result in different effects on the colour of the final product. A study on the effect of different processing method on colour on noodles may be investigated further.

### 5.3.3 Antioxidant activity

**Table 5.6** shows that the antioxidant activity in samples increased with the increase in the content of *Amaranthus* leaf powder in the noodles. Noodle samples without ALP as well as from 1 to 2% *Amaranth* substitution exhibited the lowest antioxidant activity, while noodles with a 3% content of ALP exhibited the highest antioxidant activity. The differences in the DPPH radical-scavenging activity among the samples tested were not significant ( $p>0.05$ ). The similarities in the DPPH radical-scavenging activity among these samples is attributed to the narrow range of ALP contents tested. Antioxidants are known to scavenge free radicals, offers cellular protection. Antioxidants scavenge free radicals, provide cellular protection and fight against human diseases. *Amaranthus* leaves have medicinal and functional properties, which helps in fighting against diseases (Andrews and Andrews, 2009). The presence of antioxidants in the instant noodles developed in this study therefore suggests that this product has a potential to contribute to the improvement of consumer health. Supplementation with *Amaranth* was found to contribute to an increased antioxidant activity and positively contribute to reduction of stress and other postmenopausal women (Kushwaha et al., 2014). An investigation of the

possible effect of *Amaranthus* supplemented noodles on the overall health status is proposed and larger substitution increments are suggested.

**Table 5.6:** 1, 1-Diphenyl-2-picrylhydrazyl (DPPH) radical-scavenging activity (EC<sub>50</sub>) evaluated in noodles with different contents of *Amaranthus* leaf powder (ALP).

Sample	RSA % (50 mg/mL)	EC <sub>50</sub> (mg/mL)
Control (Commercial)	50±0.89 <sup>c</sup>	25.66 ± 0.20 <sup>c</sup>
C	53±0.24 <sup>b</sup>	22.66 ± 0.20 <sup>b</sup>
V1	53±0.31 <sup>b</sup>	25.00 ± 0.54 <sup>bc</sup>
V2	52±0.45 <sup>b</sup>	13.85 ± 0.72 <sup>a</sup>
V3	57±0.41 <sup>a</sup>	12.57 ± 0.25 <sup>a</sup>

C-Control, V1-1%ALP, V2- 2% ALP, V3- 3% ALP \*Values indicate mean ± STD (n = 3). Different letters associated with EC<sub>50</sub> indicate significant differences at the 5% level of significance

### 5.3.3 Consumer Acceptability

Results are represented in Table 5.7 In terms of overall acceptability, the 3% ALP noodle samples were liked the most by the panelists. This suggests that the addition of ALP to the instant noodles did not compromise the overall acceptability of noodles among students although the acceptability of color of this sample was lower than the other samples. This observation is noteworthy as the color of starchy foods is known to play a huge role in their acceptability (Beswa et al., 2016). Acceptance, in this case, may be attributed to the familiarity of green foods arising from spinach consumption, which some consumers indicated that they were already consuming. The 2% ALP-supplemented noodles were the most acceptable in terms of texture, although all other samples were similarly acceptable. This may be due to a lower cutting force required to break the strands that was observed during textural analysis (Table 5.7) as the ALP content increased. The aroma for samples with ALP was as acceptable as that of the control. Samples with 3% ALP got the lowest score for taste. This means tastes and flavor need to be further developed as the addition of *Amaranthus* powder may contribute a bitter taste towards the final product. This observation is contrary to sentiments expressed by the panelists as some reported a leafy “Imfino” flavor bursting out from the samples, which was quite acceptable to them during testing. The study also proposes that an instant noodle sachet made from *Amaranthus* leaves is developed to complement the ALP-supplemented noodles and improve color, flavor, and aroma.

**Table 5.7:** Sensory analysis of developed noodles

	Colour	Uniform color	Aroma	Texture	Taste	Overall
	Ave/STDV	Ave/STDV	Ave/STDV	Ave/STDV	Ave/STDV	Ave/STDV
C	6.67±2.12 <sup>a</sup>	6.85±1.88 <sup>a</sup>	5.6±2.29 <sup>a</sup>	6.4±2.03 <sup>a</sup>	5.33±2.34 <sup>a</sup>	5.68±2.27 <sup>a</sup>
V1	6.38±1.91 <sup>ab</sup>	6.08±1.99 <sup>a</sup>	5.1±2.27 <sup>a</sup>	6.73±2.02 <sup>a</sup>	5.55±2.9 <sup>a</sup>	5.63±1.97 <sup>a</sup>
V2	6.32±2.21 <sup>ab</sup>	6.41±2.03 <sup>a</sup>	5.63±2.15 <sup>a</sup>	7±1.87 <sup>a</sup>	5.15±2.46 <sup>a</sup>	5.37±2.07 <sup>a</sup>
V3	5.47±2.22 <sup>b</sup>	3.75±2.17 <sup>b</sup>	5.2±2.45 <sup>a</sup>	6.88±1.78 <sup>a</sup>	4.93±2.61 <sup>a</sup>	6.67±2.14 <sup>a</sup>

C-Control (0%ALP), V1-1%ALP, V2- 2% ALP, V3- 3% ALP \*data reported as mean ± standard deviation \* values with the same letter in a column are not statistically different, letters were assigned in descending order in reference to the mean.

## 5.4 Conclusion

The objective of the study was to determine the nutritional composition, antioxidant activity and physical qualities of the instant noodle prototypes of *Amaranthus* supplemented noodles. The texture of the instant noodles showed that with an addition of ALP the noodle strands become softer. Similarly, in terms of colour the addition of ALP lead to the darkening of the noodles as they become greener with each addition. This, however, did not compromise the overall acceptability of the instant noodles as the sample with 3% ALP was the most overall liked. The product however still requires improvement in terms of taste and flavours and there is a potential for the product to be widely accepted by the population. The nutritional content of all the samples had fairly acceptable levels of proteins however noodles that were supplemented with *Amaranthus* showed significant increases in terms of fibre, ash as well as minerals such as Manganese and Calcium. This study suggests that *Amaranthus* leaf powder-supplemented noodles could be as acceptable as the control. The innovation could be complemented with product promotional campaigns on indigenous food consumption and further product development is recommended to improve the overall quality of the ALP supplemented noodles.

## 5.5 References

- ADEBAYO, W., OGUNSINA, B. & TAIWO, K. 2018. SENSORY, TEXTURAL AND COOKING QUALITY OF INSTANT NOODLES PRODUCED FROM MUSA SPP-WHEAT COMPOSITE FLOURS. *Arid Zone Journal of Engineering, Technology and Environment*, 14, 74-85.
- ADEBIYI, J. A., OBADINA, A. O., ADEBO, O. A. & KAYITESI, E. 2017. Comparison of nutritional quality and sensory acceptability of biscuits obtained from native, fermented, and malted pearl millet (*Pennisetum glaucum*) flour. *Food chemistry*, 232, 210-217.
- ALEGBEJO, J. O. 2013. Nutritional value and utilisation of amaranth (*Amaranthus* spp.) A review. *Bayero Journal of Pure & Applied Science*, 6 (1): 136-143. ISSN:2006-6996 <http://dx.doi.org/10.4314/bajopas.v6i1.27>.
- ALEMAYEHU, D., DESSE, G., ABEGAZ, K., DESALEGN, B. B. & GETAHUN, D. 2016. Proximate, Mineral Composition and Sensory Acceptability of Home Made Noodles from Stinging Nettle (*Urtica simensis*) Leaves and Wheat Flour Blends. *International Journal of Food Science and Nutrition Engineering*, 6, 55-61.
- ANDREWS, D. A. & ANDREWS, K. 2009. Nutraceutical moringa composition. Google Patents. US 2009/0098230 A1.
- ANNIGAN, J. 2018. The effects of low protein intake” Healthy eating. SF Gate. written by Carly Schuna accessed online at <https://healthyeating.sfgate.com/effects-low-protein-intake-7123.html>.
- BARKLEY, J. S., WHEELER, K. S. & PACHON, H. 2015. Anaemia prevalence may be reduced among countries that fortify flour. *British Journal of Nutrition*. 114(2):265-73.
- BESWA, D., DLAMINI, N. R., SIWELA, M., AMARISOU, E. O. & KOLANISI, U. 2016. Effect of amaranth addition on the nutritional composition and consumer acceptability of extruded provitamin A-biofortified maize snacks. *Food Science and Technology*. vol.36 no.1 <https://doi.org/10.1590/1678-457X.6813>.
- BIRT, D. F., BOYLSTON, T., HENDRICH, S., JANE, J.-L., HOLLIS, J., LI, L., MCCLELLAND, J., MOORE, S., PHILLIPS, G. J. & ROWLING, M. 2013. Resistant starch: promise for improving human health. *Advances in Nutrition*, 4, 587-601.
- CARDENAS-HERNANDEZ, A. C., TRUST, B., LOARCA-PINA, G., CASTANOTOSTADO, E., NIETO-BARRERA, J. O. & MENDOZA, S. 2016. Improved functional properties of pasta: Enrichment with amaranth seed flour and dried

- amaranth leaves. *Journal of Cereal Science*, 72, 84-90  
<https://doi.org/10.1016/j.jcs.2016.09.014>.
- CHOY, A.-L., MORRISON, P. D., HUGHES, J. G., MARRIOTT, P. J. & SMALL, D. M. 2013. Quality and antioxidant properties of instant noodles enhanced with common buckwheat flour. *Journal of Cereal Science*, 57, 281-287.
- DAFF 2010. *Amaranthus* production guideline. In: . DEPARTMENT OF AGRICULTURE, Forestry and Fisheries. accessed online  
<https://www.daff.gov.za/Daffweb3/Portals/0/Brochures%20and%20Production%20guidelines/AMARANTH%20PRODUCTION%20GUIDELINES%202014.pdf>
- DUDA, A., ADAMCZAK, J., CHEŁMIŃSKA, P., JUSZKIEWICZ, J. & KOWALCZEWSKI, P. 2019. Quality and Nutritional/Textural Properties of Durum Wheat Pasta Enriched with Cricket Powder. *Foods*, 8, 46.
- GINTING, E. & YULIFIANTI, R. 2015. Characteristics of noodles prepared from orange fleshed sweet potato and domestic wheat flour. *Procedia Food Science*: 3. 289-302  
<https://doi.org/10.1016/j.profoo.2015.01.032>.
- GULIA, N., DHAKA, V. & KHATKAR, B. S. 2014. Instant Noodles: Processing, Quality, and Nutritional Aspects. *Critical Reviews in Food Science and Nutrition*, 54, 1386-1399.
- HU, F. B. 2011. Globalization of diabetes: the role of diet, lifestyle, and genes. *Diabetes care*, 34, 1249-1257.
- KIM, S. 1996. Instant noodles. *Pasta and noodle technology*, 195-225.
- KOCA, I., TEKGULER, B., YILMAZ, V. A., HASBAY, I. & KOCA, A. F. 2018. The use of grape, pomegranate and rosehip seed flours in Turkish noodle (erişte) production. *Journal of Food Processing and Preservation*, 42, e13343.
- KUMAR, S. B. & PRABHASANKAR, P. 2015. A study on noodle dough rheology and product quality characteristics of fresh and dried noodles as influenced by low glycemic index ingredient. *Journal of food science and technology*, 52, 1404-1413.
- KUSHWAHA, S., CHAWLA, P. & KOCHHAR, A. 2014. Effect of supplementation of drumstick (*Moringa oleifera*) and amaranth (*Amaranthus tricolor*) leaves powder on antioxidant profile and oxidative status among postmenopausal women. *Journal of food science and technology*, 51, 3464-3469.
- LIU, Y., XU, M., WU, H., JING, L., GONG, B., GOU, M., ZHAO, K. & LI, W. 2018. The compositional, physicochemical and functional properties of germinated mung bean flour and its addition on quality of wheat flour noodle. *Journal of food science and technology*, 55, 5142-5152.

- MA, D., ZHANG, J., LOU, X., WANG, X., WANG, C. & GUO, T. 2014. Color, cooking properties and texture of yellow alkaline noodles enriched with millet and corn flour. *International Food Research Journal*, 21, 1151.
- MERTENS, D. R. 2002. Gravimetric determination of amylase-treated neutral detergent fiber in feeds with refluxing in beakers or crucibles: collaborative study. *Journal of AOAC international*, 85, 1217-1240.
- MOYO, M., NDHLALA, A. R., FINNIE, J. F. & VAN STADEN, J. 2010. Phenolic composition, antioxidant and acetylcholinesterase inhibitory activities of *Sclerocarya birrea* and *Harpephyllum caffrum* (Anacardiaceae) extracts. *Food Chemistry*, 123, 69-76.
- ODUNLADE, T., FAMUWAGUN, A., TAIWO, K., GBADAMOSI, S., OYEDELE, D. & ADEBOOYE, O. 2017. Chemical Composition and Quality Characteristics of Wheat Bread Supplemented with Leafy Vegetable Powders. *Journal of Food Quality*. Volume 2017, 9536716 <https://doi.org/10.1155/2017/9536716>
- OLUSANYA, R. N., KOLANISI, U., VAN ONSELEN, A., NGOBESE, N. Z. & SIWELA, M. 2019. Nutritional composition and consumer acceptability of Moringa oleifera leaf powder (MOLP)-supplemented mahewu. *South African Journal of Botany*.
- PAL, G. K., KUMAR, S. B., PRABHASANKAR, P. & SURESH, P. 2017. Inclusion of poultry based food ingredients in the formulation of noodles and their effects on noodle quality characteristics. *Journal of Food Measurement and Characterization*, 11, 939-947.
- PURWANDARI, U., TRISTIANA, G. & HIDAYATI, D. 2014. Gluten-free noodle made from gathotan flour: antioxidant activity and effect of consumption on blood glucose level. *International Food Research Journal*, 21.
- RAMDWAR, M. N., CHADEE, S. T. & STOUTE, V. A. 2017. Estimating the potential consumption level of amaranth for food security initiatives in Trinidad, West Indies. *Cogent Food & Agriculture*, 3, 1321475.
- SANNI, L., BAMGBOSE, C., BABAJIDE, J. & SANNI, S. Production of instant cassava noodles. Proc ISTRC Symp, 2007. 466-472.
- SIKANDER, M., MALIK, A., KHAN, M. S. G. & KHAN, R. G. Q. 2017. Instant noodles: Are they really good for health? A review. *Electronic Journal of Biology*, 13, 222-227.
- SINGH, J., KAUR, S. & RASANE, P. 2018. Evaluation of the Nutritional and Quality Characteristics of Black Carrot Fortified Instant Noodles. *Current Nutrition & Food Science*, 14, 442-449.

- SINGH, S., PUNIA, D. & KHETARPAUL, N. 2009. Nutrient composition of products prepared by incorporating amaranth (*Amaranthus tricolour*) leaf powder. *Nutrition & Food Science*, 39, 218-226.
- STEYN, N., LABADARIOS, D., MAUNDER, E., NEL, J., LOMBARD, C. & SURVEY, D. O. T. N. F. C. 2005. Secondary anthropometric data analysis of the National Food Consumption Survey in South Africa: the double burden. *Nutrition*, 21, 4-13.
- SORIANO-GARCÍA, M., ARIAS-OLGUÍN, I.I., MONTES, J.P.C., et al. 2018 Nutritional functional value and therapeutic utilization of Amaranth. *J Anal Pharm Res.*7(5):596-600. DOI: [10.15406/japlr.2018.07.00288](https://doi.org/10.15406/japlr.2018.07.00288).
- THIEX, N. J., ANDERSON, S. & GILDEMEISTER, B. 2003. Crude fat, diethyl ether extraction, in feed, cereal grain, and forage (Randall/Soxtec/submersion method): collaborative study. *Journal of AOAC International*, 86, 888-898.
- TRENTMANN, C., REINHARD, I. & VIERCK, L. 2012. Supplementation, Food Fortification and Dietary Diversification: A Three-Pronged Approach to Reducing Hidden Hunger. *BMZ May*.
- VORSTER, H. H., BADHAM, J. & VENTER, C. 2013. An introduction to the revised food-based dietary guidelines for South Africa. *South African Journal of Clinical Nutrition*, 26, S5-S12.
- WORLD HEALTH ORGANIZATION, E. F. 2014. Global Action plan for prevention and control of non-communicable diseases.
- WU, N. N., TAN, B., LI, S. S., TIAN, X. H., LIU, M., LIU, Y. X., WANG, L. P. & ZHAI, X. T. 2017. Cooking quality, antioxidant properties, and starch digestibility of wheat noodles substituted with extruded brown rice flour. *Cereal Chemistry*, 94, 464-470.
- YILMAZ TUNCEL, N., KAYA, E. & KARAMAN, M. 2017. Rice bran substituted Turkish noodles (erişte): textural, sensorial, and nutritional properties. *Cereal chemistry*, 94, 903-908.

## Chapter 6 : General conclusion and recommendations

### 6.1 Conclusions

The study looked at the acceptability of *Amaranthus*-supplemented noodles among students. Specific objectives included to assess the utilisation of noodles among students, to develop *Amaranthus* supplemented noodles, to determine the quality (colour, texture) of *Amaranthus* noodles and to investigate the sensory acceptability of the *Amaranthus* based noodles. With regards to objective 1: To assess the patterns of consumption of noodles and utilisation of *Amaranthus* among students. This study has confirmed that indeed consumption of noodles amongst the students at the University of Zululand is high. This put them at risk of malnutrition as noodles were mostly consumed as a single meal without vegetables or protein. *Amaranthus* still remains an underutilized vegetable amongst the youth population. It was found that although others may have vast knowledge of the vegetable and its benefits, its consumption is still low.

This calls for the development of new products using this vegetable as an ingredient so as to re-introduce it back to the food system. This will help in sustaining the vegetable, reduce the negative perceptions associated with it and might lead to a wide acceptance of the vegetable in future. Using the well-known and well-accepted foods and making them composite foods will not only sustain the health of young ones but also sustain our foods within the food systems. The study aforementioned therefore based the development of *Amaranthus* supplemented noodles on the feedback from student during the survey. ALP supplemented were found to be green in colour which was attributed to by *Amaranthus* green coloured leaves.

Although the addition of ALP slightly increased the protein content in terms of the percentage change, these changes were not significant. Fibre and fat content slightly increased indicating that *Amaranthus* has a potential to improve the nutritional value of foods. Presence of antioxidants in the instant noodles developed in this study suggests that this product has a potential to contribute to the improvement of consumer health as in other studies it was found that the increased consumption of food rich in antioxidants leads to reduced stress.

The instant noodle prototypes with ALP up to 3% were found to be slightly acceptable to the target population (students) which is in contrary with the literature that reports the rejection of

the *Amaranthus* supplemented product as due to green colour. The textural results indicated lower firmness in the ALP supplemented noodles which indicated that a lower force is required to break the noodles. This was a significant observation as these noodles can then be recommended for children and population groups having difficulties in chewing and swallowing food. This innovation can greatly contribute to strategies that aim to reduce the prevalence of malnutrition and food insecurity which are inclusive of the indigenous/traditional food systems and also integrate indigenous foods which are rich in nutrients, however further development of the product is recommended.

## **6.2 Recommendations**

### **6.2.1 Further Research**

- Further development of the products still needs to be done to increase the acceptability.
- Textural improvement should be done so that the cooking time is shortened.
- An *Amaranthus* sachet can be developed in order to complement and improve the products taste attributes
- The developed prototypes with nutritional benefits should be adopted and offered to children with malnutrition in order to determine its effectiveness in combating the diseases. This can be done through pre and post blood tests.
- Consumer acceptability of the *Amaranthus* supplemented noodles should also be done with other institutions so that results can be generated for the whole student population.
- An investigation of the possible effect of *Amaranthus* supplemented noodles on the overall health status is proposed and larger substitution increments are suggested.
- The study also recommends that a HACCP model should be adopted, and investigated parallel to the identification of the microbe's present in the samples. This will help determine the microbial safety and stability of the product.

### **6.2.2 Government & policy makers**

Nutrition education on *Amaranthus* should be done especially with the youth so that the stigma attached to the vegetable is reduced and its acceptance and consumption are improved.

*Amaranthus* leaf powder-supplemented noodles could be as acceptable as the control if the innovation is complemented with product promotional campaigns on indigenous food consumption.

The Department of Consumer Science at the University of Zululand is investing tremendous efforts in promoting indigenous knowledge use in the mainstream food industry. This is just one example of interventions that can be made towards indigenizing commercial food products. Support from relevant stakeholders is required in order to commercialize the products developed.

### 6.3 References

- ACTION, E. 1999. Scientific concepts of functional foods in Europe: consensus document. *British Journal of Nutrition*, 81, 1-27.
- ADEBAYO, W., OGUNSINA, B. & TAIWO, K. 2018. SENSORY, TEXTURAL AND COOKING QUALITY OF INSTANT NOODLES PRODUCED FROM MUSA SPP-WHEAT COMPOSITE FLOURS. *Arid Zone Journal of Engineering, Technology and Environment*, 14, 74-85.
- ADEBIYI, J. A., OBADINA, A. O., ADEBO, O. A. & KAYITESI, E. 2017. Comparison of nutritional quality and sensory acceptability of biscuits obtained from native, fermented, and malted pearl millet (*Pennisetum glaucum*) flour. *Food Chemistry*, 232, 210-217.
- ADEGUNWA, M. O., BAKARE, H. A. & AKINOLA, O. F. 2012. Enrichment of noodles with soy flour and carrot powder. *Nigerian Food Journal*, 30 (1) 74-81 [https://doi.org/10.1016/S0189-7241\(15\)30016-3](https://doi.org/10.1016/S0189-7241(15)30016-3).
- AFSHIN, A., MICHA, R., KHATIBZADEH, S. & MOZAFFARIAN, D. 2014. Consumption of nuts and legumes and risk of incident ischemic heart disease, stroke, and diabetes: a systematic review and meta-analysis. *The American Journal of Clinical Nutrition*, 100, 278-288.
- AGHAEI, S. & NAEINI, A. 2018. Consumer attitudes toward new pasta products in Iran market: A qualitative and quantitative study. *Management Science Letters*, 8, 109-120.
- AKHIGBEMIDU, W., MUSA, A. & KUFORIJ, O. 2015. Assessment of the microbial qualities of noodles and the accompanying seasonings. *Nigerian Food Journal*, 33, 48-53.
- ALEGBEJO, J. O. 2013. Nutritional value and utilisation of amaranth (*Amaranthus* spp.) A review. *Bayero Journal of Pure & Applied Science*, 6 (1): 136-143. ISSN:2006-6996 <http://dx.doi.org/10.4314/bajopas.v6i1.27>.
- ALEMAYEHU, D., DESSE, G., ABEGAZ, K., DESALEGN, B. B. & GETAHUN, D. 2016. Proximate, Mineral Composition and Sensory Acceptability of Home Made Noodles from Stinging Nettle (*Urtica simensis*) Leaves and Wheat Flour Blends. *International Journal of Food Science and Nutrition Engineering*, 6, 55-61.
- ALEXANDRATOS, N. & BRUINSMA, J. 2012. World agriculture towards 2030/2050: the 2012 revision. ESA Working paper FAO, Rome.

- ALIBER, M. & HART, T. G. 2009. Should subsistence agriculture be supported as a strategy to address rural food insecurity? *Agrekon*, 48, 434-458.
- ANDERSON, C. L. & O'CONNOR, E. L. 2019. The effect of the health star rating on consumer decision-making. *Food Quality and Preference*, 73, 215-225.
- ANDREWS, D. A. & ANDREWS, K. 2009. Nutraceutical moringa composition. Google Patents. US 2009/0098230 A1.
- ANNIGAN, J. 2018. The effects of low protein intake” Healthy eating. SF Gate. written by Carly Schuna accessed online at <https://healthyeating.sfgate.com/effects-low-protein-intake-7123.html>
- AYDIN, E. & GOCMEN, D. 2011. Cooking quality and sensorial properties of noodle supplemented with oat flour. *Food Science and Biotechnology*, 20, 507-511.
- AZIAH, N. & KOMATHI, C. 2009. Acceptability attributes of crackers made from different types of composite flour. *International food research journal*, 16, 479-482.
- AZZURRA, A., MASSIMILIANO, A. & ANGELA, M. 2019. Measuring sustainable food consumption: A case study on organic food. *Sustainable Production and Consumption*, 17, 95-107.
- BADIANE, O., MAKOMBE, T. & BAHIGWA, G. 2014. Promoting agricultural trade to enhance resilience in Africa: ReSAKSS annual trends and outlook report 2013. *Promoting agricultural trade to enhance resilience in Africa: ReSAKSS annual trends and outlook report 2013*.
- BAKER, P. & FRIEL, S. 2016. Food systems transformations, ultra-processed food markets and the nutrition transition in Asia. *Globalization and health*, 12, 80.
- BARCELON, E. G., MCHUA, J. N., MONTEMAYOR, J. E., NAGALINGAM, M. G., OCAMPO, A. E. & ONG, R. M. 2015. Vegetable added pasta noodles: Physiochemical composition and consumer acceptability. *International Journal of agriculture innovation and research*, 3 (6) ISSN (Online) 2319-1473.
- BARKLEY, J. S., WHEELER, K. S. & PACHON, H. 2015. Anaemia prevalence may be reduced among countries that fortify flour. *British Journal of Nutrition*. 114(2):265-73.
- BARRENA, R. & SÁNCHEZ, M. 2013. Neophobia, personal consumer values and novel food acceptance. *Food quality and preference*, 27, 72-84.
- BECKLINE, M. & KATO, M. S. 2014. Assessing the impact of consumer behaviour on food security in south west Cameroon. *Journal of Food Security*, 2, 87-91.
- BESWA, D., DLAMINI, N. R., SIWELA, M., AMARISOU, E. O. & KOLANISI, U. 2016. Effect of amaranth addition on the nutritional composition and consumer acceptability

- of extruded provitamin A-biofortified maize snacks. *Food Science and Technology*. vol.36 no.1 <https://doi.org/10.1590/1678-457X.6813>
- BEUCHAT, L., KOMITOPOULOU, E., BETTS, R., BECKERS, H., BOURDICHON, F., JOOSTEN, H., FANNING, S. & TER KUILE, B. 2011. Persistence and survival of pathogens in dry foods and dry food processing environments. *ILSI Europe report series*.
- BEUCHAT, L. R., KOMITOPOULOU, E., BECKERS, H., BETTS, R. P., BOURDICHON, F., FANNING, S., JOOSTEN, H. M. & TER KUILE, B. H. 2013. Low–water activity foods: increased concern as vehicles of foodborne pathogens. *Journal of food protection*, 76, 150-172.
- BIRT, D. F., BOYLSTON, T., HENDRICH, S., JANE, J.-L., HOLLIS, J., LI, L., MCCLELLAND, J., MOORE, S., PHILLIPS, G. J. & ROWLING, M. 2013. Resistant starch: promise for improving human health. *Advances in Nutrition*, 4, 587-601.
- BLACK, R. E., VICTORA, C. G., WALKER, S. P., BHUTTA, Z. A., CHRISTIAN, P., DE ONIS, M., EZZATI, M., GRANTHAM-MCGREGOR, S., KATZ, J. & MARTORELL, R. 2013. Maternal and child undernutrition and overweight in low-income and middle-income countries. *The lancet*, 382, 427-451.
- BRIAN, K. 2015. *OECD Insights Income Inequality The Gap between Rich and Poor: The Gap between Rich and Poor*, oecd Publishing.
- BRINKMAN, H.-J. & HENDRIX, C. S. 2011. Food Insecurity and Violent Conflict: Causes, Consequences, and Addressing the Challenges, *World Food Programme*.
- BUCHNER, B., FISCHLER, C., GUSTAFSON, E., REILLY, J., RICCARDI, G., RICORDI, C. & VERONESI, U. 2012. Eating in 2030: Trends and perspectives. In: NUTRITION, B. C. F. F. A. (ed.) *People, Environment, Science, Economy*.
- BYRD-BREDBENNER, C., BERNING, J., MARTIN-BIGGERS, J. & QUICK, V. 2013. Food safety in home kitchens: a synthesis of the literature. *International journal of environmental research and public health*, 10, 4060-4085.
- CÁRDENAS-HERNÁNDEZ, A., BETA, T., LOARCA-PIÑA, G., CASTAÑO-TOSTADO, E., NIETO-BARRERA, J. O. & MENDOZA, S. 2016. Improved functional properties of pasta: Enrichment with amaranth seed flour and dried amaranth leaves. *Journal of Cereal Science*, 72, 84-90.
- CASEY, D. K. 2009. Three puzzles of private governance: GlobalGAP and the regulation of food safety and quality.

- CHEN, J., FEI, M., SHI, C., TIAN, J., SUN, C., ZHANG, H., MA, Z. & DONG, H. 2011. Effect of particle size and addition level of wheat bran on quality of dry white Chinese noodles. *Journal of Cereal Science*, 53, 217-224.
- CHOY, A.-L., MORRISON, P. D., HUGHES, J. G., MARRIOTT, P. J. & SMALL, D. M. 2013. Quality and antioxidant properties of instant noodles enhanced with common buckwheat flour. *Journal of Cereal Science*, 57, 281-287.
- COLGLAZIER, W. 2015. Sustainable development agenda: 2030. *Science*, 349, 1048-1050.
- COSTA, C., LUCERA, A., MASTROMATTEO, M., CONTE, A. & DEL NOBILE, M. A. 2010. Shelf life extension of durum semolina-based fresh pasta. *International Journal of Food science & Technology*, 45, 1545-1551.
- COTTI, C. & TEFFT, N. 2013. Fast food prices, obesity, and the minimum wage. *Economics and Human Biology*, 11, 134-147.
- COURT, D. & NARASIMHAN, L. 2010. Capturing the world's emerging middle class. *McKinsey Quarterly*, 3, 12-17.
- CRUSH, J. & FRAYNE, B. 2010. The invisible crisis: "Urban food security in Southern Africa." Urban Food Security Series No. 1. Queen's University and AFSUN: Kingston and Cape Town.
- CRUSH, J. S. & FRAYNE, G. B. 2011. Urban food insecurity and the new international food security agenda. *Development Southern Africa*, 28, 527-544.
- DAFF 2010. *Amaranthus* production guideline. In: DEPARTMENT OF AGRICULTURE, Forestry and Fisheries. accessed online <https://www.daff.gov.za/Daffweb3/Portals/0/Brochures%20and%20Production%20guidelines/AMARANTH%20PRODUCTION%20GUIDELINES%202014.pdf>
- DE ONIS, M., BLÖSSNER, M. & BORGHI, E. 2012. Prevalence and trends of stunting among pre-school children, 1990–2020. *Public health nutrition*, 15, 142-148.
- DEFRA, F. S. P. & PLAN, E. E. 2006. Department for Environment. *Food and Rural Affairs (DEFRA)*.
- DEPARTMENT OF HEALTH 2009. Promoting healthy weight. In: HEALTH (ed.).
- DICTIONARY, O. E. 1989. Oxford english dictionary. *Simpson, JA & Weiner, ESC*.
- DOUGLAS, S. P. & CRAIG, C. S. 2011. Convergence and divergence: Developing a semiglobal marketing strategy. *Journal of International Marketing*, 19, 82-101.
- DUDA, A., ADAMCZAK, J., CHEŁMIŃSKA, P., JUSZKIEWICZ, J. & KOWALCZEWSKI, P. 2019. Quality and Nutritional/Textural Properties of Durum Wheat Pasta Enriched with Cricket Powder. *Foods*, 8, 46.

- DZIKI, D., BIERNACKA, B. & LASKOWSKI, J. 2012. Influence of cooking time and common wheat flour addition to semolina on spaghetti mechanical properties. *Acta Agrophysica*, 19, 277-287.
- EBRU, E. & MEHMET, H. 2009. The effect of apricot kernel flour incorporation on the physicochemical and sensory properties of noodles. *African Journal of Biotechnology*, 8, 85-90.
- EL BILALI, H., CALLENIUS, C., STRASSNER, C. & PROBST, L. 2019. Food and nutrition security and sustainability transitions in food systems. *Food and Energy Security*, 8, e00154.
- ERICKSEN, P. J. 2008. Conceptualizing food systems for global environmental change research. *Global environmental change*, 18, 234-245.
- ETIKAN, I., MUSA, S. A. & ALKASSIM, R. S. 2016. Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5, 1-4.
- FALGUERA, V., ALIGUER, N. & FALGUERA, M. 2012. An integrated approach to current trends in food consumption: Moving toward functional and organic products? *Food Control*, 26, 274-281.
- FANZO, J. 2012. The nutrition challenge in sub-Saharan Africa. United Nations Development Programme, Regional Bureau for Africa.
- FAO 2015. Regional overview of food insecurity: African food security prospects brighter than ever. Author Accra.
- FAO & FAOSTAT 2008. Food and agriculture organisation of the United Nations. *Retrieved on*, 15.
- FAO, IFAD, UNICEF, WFP & WHO 2017. The state of food security and nutrition in the world 2017. *Building Resilience for Peace and Food Security (Food and Agriculture Organization, Rome)*.
- FAO. 2013. *FAO Statistical Yearbook: World Food and Agriculture*, FAO.
- FAO. 2014. *State of Food Insecurity in the World 2013: The Multiple Dimensions of Food Security*, FAO.
- FAWOLE, W., ILBASMIS, E. & OZKAN, B. Food insecurity in Africa in terms of causes, effects and solutions: a case study of Nigeria. 2nd ICSAE 2015, International Conference on Sustainable Agriculture and Environment, September 30-October 03, 2015, Konya, Turkey. Proceedings book, 2015. 6-11.

- FINN, S., CONDELL, O., MCCLURE, P., AMÉZQUITA, A. & FANNING, S. 2013. Mechanisms of survival, responses and sources of Salmonella in low-moisture environments. *Frontiers in microbiology*, 4, 331.
- FINUCANE, M. M., STEVENS, G. A., COWAN, M. J., DANAEI, G., LIN, J. K., PACIOREK, C. J., SINGH, G. M., GUTIERREZ, H. R., LU, Y. & BAHALIM, A. N. 2011. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9· 1 million participants. *The Lancet*, 377, 557-567.
- FOOD, I. 2015. The new science of sustainable food systems: overcoming barriers to food systems reform. *First Report of the International Panel of Experts on Sustainable Food Systems*.
- FORESIGHT, U. 2011. The future of food and farming. *Final Project Report, London, The Government Office for Science*.
- FREIBAUER, A., MATHIJS, E., BRUNORI, G., DAMIANOVA, Z., FAROULT, E., GIRONA, I. G. J., O'BRIEN, L. & TREYER, S. 2011. Sustainable Food Consumption and Production in a Resource-Constrained World; the 3rd SCAR Foresight Exercise. *European Commission: Brussels, Belgium*.
- FRENCH, S. A., TANGNEY, C. C., CRANE, M. M., WANG, Y. & APPELHANS, B. M. 2019. Nutrition quality of food purchases varies by household income: the SHoPPER study. *BMC public health*, 19, 231.
- FRESCO, L. O. 2009. Challenges for food system adaptation today and tomorrow. *Environmental science & policy*, 12, 378-385.
- GARNETT, T. 2014. Three perspectives on sustainable food security: efficiency, demand restraint, food system transformation. What role for life cycle assessment? *Journal of Cleaner Production*, 73, 10-18.
- GARNETT, T., APPLEBY, M. C., BALMFORD, A., BATEMAN, I. J., BENTON, T. G., BLOOMER, P., BURLINGAME, B., DAWKINS, M., DOLAN, L. & FRASER, D. 2013. Sustainable intensification in agriculture: premises and policies. *Science*, 341, 33-34.
- GINTING, E. & YULIFIANTI, R. 2015. Characteristics of noodles prepared from orange fleshed sweet potato and domestic wheat flour. *Procedia Food Science*: 3. 289-302 <https://doi.org/10.1016/j.profoo.2015.01.032>
- GLADEK, E., FRASER, M., ROEMERS, G., MUNOZ, O. S., KENNEDY, E. & HIRSCH, P. 2016. The global food system: an analysis. *Metabolic, Amsterdam*.

- GODFRAY, H. C. J., CRUTE, I. R., HADDAD, L., LAWRENCE, D., MUIR, J. F., NISBETT, N., PRETTY, J., ROBINSON, S., TOULMIN, C. & WHITELEY, R. 2010. The future of the global food system. The Royal Society.
- GRUNERT, K. G. 2011. How changes in consumer behaviour and retailing affect competence requirements for food producers and processors. *Economía Agraria y Recursos Naturales-Agricultural and Resource Economics*, 6, 3-22.
- GULIA, N., DHAKA, V. & KHATKAR, B. S. 2014. Instant Noodles: Processing, Quality, and Nutritional Aspects. *Critical Reviews in Food Science and Nutrition*, 54, 1386-1399.
- GUNDERSEN, C. & ZILIAK, J. P. 2014. Childhood food insecurity in the US: Trends, causes, and policy options. *The Future of Children*, 1-19.
- HABIBAT, A., ABDUL-RASAQ, A., IBIYEMI, O., TAOFIK, S. & LATEEF, S. 2015. Production and Quality Evaluation of Noodles From Sweet Potato Starch. *Journal of culinary science & technology*, 13, 79-93.
- HADDAD, L., HAWKES, C., WAAGE, J., WEBB, P., GODFRAY, C. & TOULMIN, C. 2016. Food systems and diets: Facing the challenges of the 21st century.
- HASMADI, M., MATANJUN, P., SALWA, I., SITI, F., MANSOOR, A. H. & AINNUR, S. R. 2014. The effect of seaweed composite flour on the textural properties of dough and bread. *Journal of Applied Phycology*, 26, 1057-1062.
- HAVAS, K. & SALMAN, M. 2011. Food security: its components and challenges. *International Journal of Food Safety, Nutrition and Public Health*, 4, 4-11.
- HU, F. B. 2011. Globalization of diabetes: the role of diet, lifestyle, and genes. *Diabetes care*, 34, 1249-1257.
- HUH, I. S., KIM, H., JO, H. K., LIM, C. S., KIM, J. S., KIM, S. J., KWON, O., B.OH & CHANG, N. 2017. Instant noodle consumption associated with cardio metabolic risk factors among college students in Seoul. *Nutrition Research and Practice* 11(3):232-239. doi: 10.4162/nrp.2017.11.3.232. Epub
- ILABOYA, I., ATIKPO, E., OMOFUMA, F., ASEKHAME, F. & UMUKORO, L. 2012. Causes, effects and way forward to food insecurity. *Iranica Journal of Energy and Environment*, 3.
- JAYASENA, V., LEUNG, P. P. & NASAR-ABBAS, S. M. 2010. Effect of lupin flour substitution on the quality and sensory acceptability of instant noodles. *Journal of food quality*, 33, 709-727.

- JENSEN, J. D., CHRISTENSEN, T., DENVER, S., DITLEVSEN, K., LASSEN, J. & TEUBER, R. 2019. Heterogeneity in consumers' perceptions and demand for local (organic) food products. *Food Quality and Preference*, 73, 255-265.
- JISANA, T. 2014. Consumer behaviour models: an overview. *Sai Om Journal of Commerce & Management*, 1, 34-43.
- KANG, J., LEE, J., CHOI, M., JIN, Y., CHANG, D., CHANG, Y. H., KIM, M., JEONG, Y. & LEE, Y. 2017. Physicochemical and Textural Properties of Noodles Prepared from Different Potato Varieties. *Preventive nutrition and food science*, 22, 246.
- KAUR, G., SHARMA, S., NAGI, H. & RANOTE, P. 2013. Enrichment of pasta with different plant proteins. *Journal of food science and technology*, 50, 1000-1005.
- KEARNEY, J. 2010. Food consumption trends and drivers. *Philosophical transactions of the royal society B: biological sciences*, 365, 2793-2807.
- KELLY, T., YANG, W., CHEN, C.-S., REYNOLDS, K. & HE, J. 2008. Global burden of obesity in 2005 and projections to 2030. *International journal of obesity*, 32, 1431.
- KHAN, I., YOUSIF, A., JOHNSON, S. K. & GAMLATH, S. 2013. Effect of sorghum flour addition on resistant starch content, phenolic profile and antioxidant capacity of durum wheat pasta. *Food Research International*, 54, 578-586.
- KHOURY, C. K., BJORKMAN, A. D., DEMPEWOLF, H., RAMIREZ-VILLEGAS, J., GUARINO, L., JARVIS, A., RIESEBERG, L. H. & STRUIK, P. C. 2014. Increasing homogeneity in global food supplies and the implications for food security. *Proceedings of the National Academy of Sciences*, 111, 4001-4006.
- KHOZA, S. 2014. *Modelling with commercial egg powder to assess the potential of indigenous knowledge-processed egg powder to improve household food and nutrition security*. Masters Dissertation, University of KwaZulu Natal.
- Kim, S.K.(1996) Instant Noodle, In: Kruger, J.E., Matsuo R.B. and Dick, J.W., EDS., Pasta and Noodle Technology. American Association of Cereal Chemists, Inc. Saint Paul, MN, USA, 195-225.
- KLOSS, L., MEYER, J. D., GRAEVE, L. & VETTER, W. 2015. Sodium intake and its reduction by food reformulation in the European Union—A review. *NFS Journal*, 1, 9-19.
- KOCA, I., TEKGULER, B., YILMAZ, V. A., HASBAY, I. & KOCA, A. F. 2018. The use of grape, pomegranate and rosehip seed flours in Turkish noodle (erişte) production. *Journal of Food Processing and Preservation*, 42, e13343.

- KRAEMER, K., CORDARO, J., FANZO, J., GIBNEY, M., KENNEDY, E., LABRIQUE, A., STEFFEN, J. & EGGERSDORFER, M. 2016. .1 Ten Forces Shaping the Global Food System. *Good nutrition: perspectives for the 21st century*. Karger Publishers.
- KUMAR, S. B. & PRABHASANKAR, P. 2015. A study on noodle dough rheology and product quality characteristics of fresh and dried noodles as influenced by low glycemic index ingredient. *Journal of Food Science and Technology*, 52, 1404-1413.
- KUSHWAHA, S., CHAWLA, P. & KOCHHAR, A. 2014. Effect of supplementation of drumstick (*Moringa oleifera*) and Amaranth (*Amaranthus tricolor*) leaves powder on antioxidant profile and oxidative status among postmenopausal women. *Journal of Food science and Technology*, 51, 3464-3469.
- LARROSA, V., LORENZO, G., ZARITZKY, N. & CALIFANO, A. 2016. Improvement of the texture and quality of cooked gluten-free pasta. *LWT-Food Science and Technology*, 70, 96-103.
- LI, M., ZHU, K. X., GUO, X. N., BRIJS, K. & ZHOU, H. M. 2014. Natural additives in wheat-based pasta and noodle products: opportunities for enhanced nutritional and functional properties. *Comprehensive Reviews in Food Science and Food Safety*, 13, 347-357.
- LIU, Y., XU, M., WU, H., JING, L., GONG, B., GOU, M., ZHAO, K. & LI, W. 2018. The compositional, physicochemical and functional properties of germinated mung bean flour and its addition on quality of wheat flour noodle. *Journal of Food Science and Technology*, 55, 5142-5152.
- LOWE, P., PHILLIPSON, J. & LEE, R. P. 2008. Socio-technical innovation for sustainable food chains: roles for social science. *Trends in Food Science & Technology*, 19, 226-233.
- MA, D., ZHANG, J., LOU, X., WANG, X., WANG, C. & GUO, T. 2014. Color, cooking properties and texture of yellow alkaline noodles enriched with millet and corn flour. *International Food Research Journal*, 21, 1151.
- MALIK, V. S., WILLETT, W. C. & HU, F. B. 2013. Global obesity: trends, risk factors and policy implications. *Nature Reviews Endocrinology*, 9, 13.
- MANNAR, M. V. 2006. Successful food-based programmes, supplementation and fortification. LWV. DOI:[10.1097/01.mpg.0000255850.30400.ae](https://doi.org/10.1097/01.mpg.0000255850.30400.ae)
- MARRÓN-PONCE, J. A., SÁNCHEZ-PIMIENITA, T. G., DA COSTA LOUZADA, M. L. & BATIS, C. 2018. Energy contribution of NOVA food groups and sociodemographic determinants of ultra-processed food consumption in the Mexican population. *Public Health Nutrition*, 21, 87-93.

- MARTINS, N., RORIZ, C. L., MORALES, P., BARROS, L. & FERREIRA, I. C. 2016. Food colorants: Challenges, opportunities and current desires of agro-industries to ensure consumer expectations and regulatory practices. *Trends in Food Science & Technology*, 52, 1-15.
- MATSHE, I. 2009. Boosting smallholder production for food security: some approaches and evidence from studies in sub-Saharan Africa. *Agrekon*, 48, 483-511.
- MAY, J. 2017. Food security and nutrition: Impure, complex and wicked. Food Security SA Working Paper Series.
- MCGILL, A. E. 2009. The potential effects of demands for natural and safe foods on global food security. *Trends in Food Science & Technology*, 20, 402-406.
- MCGUIRE, S. 2015. FAO, IFAD, and WFP. The state of food insecurity in the world 2015: meeting the 2015 international hunger targets: taking stock of uneven progress. Rome: FAO, 2015. Oxford University Press.
- MENDONÇA, R. D. D., PIMENTA, A. M., GEA, A., DE LA FUENTE-ARRILLAGA, C., MARTINEZ-GONZALEZ, M. A., LOPES, A. C. S. & BES-RASTROLLO, M. 2016. Ultraprocessed food consumption and risk of overweight and obesity: the University of Navarra Follow-Up (SUN) cohort study. *The American journal of clinical nutrition*, 104, 1433-1440.
- MERTENS, D. R. 2002. Gravimetric determination of amylase-treated neutral detergent fiber in feeds with refluxing in beakers or crucibles: collaborative study. *Journal of AOAC international*, 85, 1217-1240.
- MISKELLY, D. M. 1984. Flour components affecting paste and noodle colour. *Journal of the Science of Food and Agriculture*, 35, 463-471.
- MONTEIRO, C. A., LEVY, R. B., CLARO, R. M., DE CASTRO, I. R. R. & CANNON, G. 2010. Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. *Public health nutrition*, 14, 5-13.
- MOOMAW, W., GRIFFIN, T., KURCZAK, K. & LOMAX, J. 2012. The critical role of global food consumption patterns in achieving sustainable food systems and food for all. *United Nations Environment Programme, Tech. Rep.*
- MOYO, M., NDHLALA, A. R., FINNIE, J. F. & VAN STADEN, J. 2010. Phenolic composition, antioxidant and acetylcholinesterase inhibitory activities of *Sclerocarya birrea* and *Harpephyllum caffrum* (Anacardiaceae) extracts. *Food Chemistry*, 123, 69-76.

- MUHAMMAD, A., D'SOUZA, A., MEADE, B., MICHA, R. & MOZAFFARIAN, D. 2017. The influence of income and prices on global dietary patterns by country, age, and gender.
- NAPOLI, M., DE MURO, P. & MAZZIOTTA, M. 2011. Towards a food insecurity Multidimensional Index (FIMI). *Master in Human Development and Food Security*.
- NELSON, M. C., KOCOS, R., LYTLE, L. A. & PERRY, C. L. 2009. Understanding the perceived determinants of weight-related behaviors in late adolescence: a qualitative analysis among college youth. *Journal of nutrition education and behavior*, 41, 287-292.
- NG, M., FLEMING, T., ROBINSON, M., THOMSON, B., GRAETZ, N., MARGONO, C., MULLANY, E. C., BIRYUKOV, S., ABBAFATI, C. & ABERA, S. F. 2014. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The lancet*, 384, 766-781.
- NGUYEN, T. H. & GIZAW, A. 2014. Factors that influence consumer purchasing decision of Private Label Food Product: A case study of ICA Basic.
- NOORFARAHZILAH, M., LEE, J., SHARIFUDIN, M., FADZELLY, M. A. & HASMADI, M. 2014. Applications of composite flour in development of food products. *International Food Research Journal*, 21, 2061.
- NOURI, L., NAFCHI, A. M. & KARIM, A. 2015. Mechanical and sensory evaluation of noodles incorporated with betel leaf extract. *International journal of food engineering*, 11, 221-227.
- ODUNLADE, T., FAMUWAGUN, A., TAIWO, K., GBADAMOSI, S., OYEDELE, D. & ADEBOOYE, O. 2017. Chemical Composition and Quality Characteristics of Wheat Bread Supplemented with Leafy Vegetable Powders. *Journal of Food Quality*. 9536716 <https://doi.org/10.1155/2017/9536716>
- OGRODOWSKA, D., ZADERNOWSKI, R., CZAPLICKI, S., DEREWIKA, D. & WRONOWSKA, B. 2014. Amaranth seeds and products—the source of bioactive compounds. *Polish Journal of Food and Nutrition Sciences*, 64, 165-170.
- OH, N., SEIB, P., DEYOE, C. & WARD, A. 1983. Noodles. I. Measuring the textural characteristics of cooked noodles. *Cereal Chem*, 60, 433-438.
- OKAFOR, A. & SUNDAY, T. 2014. Detection of Bacteria Associated with the Spoilage of Ready-To-Eat Instant Noodles. *International Journal of Research* 1(8) 11(88) ISSN 2348-6848

- OLUSANYA, R. N., KOLANISI, U., VAN ONSELEN, A., NGOBESE, N. Z. & SIWELA, M. 2019. Nutritional composition and consumer acceptability of Moringa oleifera leaf powder (MOLP)-supplemented mahewu. *South African Journal of Botany*. DOI: [10.1016/j.sajb.2019.04.022](https://doi.org/10.1016/j.sajb.2019.04.022)
- OMEIRE, G., UMEJI, O. & OBASI, N. 2014. Acceptability of Noodles Produced from Blends of Wheat, Acha and Soybean Composite Flours. *Nigerian Food Journal*, 32, 31-37.
- PAL, G. K., KUMAR, S. B., PRABHASANKAR, P. & SURESH, P. 2017. Inclusion of poultry based food ingredients in the formulation of noodles and their effects on noodle quality characteristics. *Journal of Food Measurement and Characterization*, 11, 939-947.
- PARK, C. S. & BAIK, B. K. 2004. Relationship between protein characteristics and instant noodle making quality of wheat flour. *Cereal Chemistry*, 81, 159-164.
- PARK, S. & CHO, E.-J. 2004. Quality characteristics of noodle added with chlorella extract. *Korean J Food Nutr*, 17, 120-127.
- PÉREZ-ESCAMILLA, R. 2017. Food security and the 2015–2030 sustainable development goals: From human to planetary health: Perspectives and opinions. *Current developments in nutrition*, 1, e000513.
- PHAKARE, K. N., DAGADKHAIR, A. C. & UDACHAN, I. S. 2018. Enhancement of Nutritional and functional characteristics of noodles by fortification with protein and fibre: A review. *Journal of Pharmacognosy and Photochemistry*. E-ISSN: 2278-4136 P-ISSN: 2349-8234 JPP 2018; 7(1): 351-357
- PORTER, J. R., XIE, L., CHALLINOR, A. J., COCHRANE, K., HOWDEN, S. M., IQBAL, M. M., LOBELL, D. B. & TRAVASSO, M. I. 2014. Food security and food production systems.
- POWER, K. 2010. Introducing behaviour changes towards sustainable food consumption. *Corpus*, 3.
- PROSEKOV, A. Y. & IVANOVA, S. A. 2018. Food security: The challenge of the present. *Geoforum*, 91, 73-77.
- PURWANDARI, U., TRISTIANA, G. & HIDAYATI, D. 2014. Gluten-free noodle made from gathotan flour: antioxidant activity and effect of consumption on blood glucose level. *International Food Research Journal*, 21.
- RAMDWAR, M. N., CHADEE, S. T. & STOUTE, V. A. 2017. Estimating the potential consumption level of amaranth for food security initiatives in Trinidad, West Indies. *Cogent Food & Agriculture*, 3, 1321475.

- REISCH, L., EBERLE, U. & LOREK, S. 2013. Sustainable food consumption: an overview of contemporary issues and policies. *Sustainability: Science, Practice and Policy*, 9, 7-25.
- RIGHTCHOICE 2014. Instant noodles: Not a nutritious choice. Accessed online [http://cercervis.nic.in/PDF/Instant\\_Noodles.pdf](http://cercervis.nic.in/PDF/Instant_Noodles.pdf) 23 March 2019.
- RIMAS, A. & FRASER, E. 2010. *Empires of food: feast, famine, and the rise and fall of civilizations*, Simon and Schuster.
- SANNI, L., BAMGBOSE, C., BABAJIDE, J. & SANNI, S. Production of instant cassava noodles. Proc ISTRC Symp, 2007. 466-472.
- SANZ-PENNELLA, J. M., WRONKOWSKA, M., SORAL-SMITENA, M. & HEROS, M. 2013. Effect of whole amaranth flour on bread properties and nutritional value. *LWT-Food Science and Technology*. 50(2):679-685 DOI: [10.1016/j.lwt.2012.07.031](https://doi.org/10.1016/j.lwt.2012.07.031)
- SCHNEPF, R. 2013. *Consumers and Food Price Inflation*, Congressional Research Services DIANE Publishing 7-5700 www.crs.gov R40545
- SCOTT, P. 2017. Global panel on agriculture and food systems for nutrition: food systems and diets: facing the challenges of the 21st century. Springer.
- SCOTT, V. N., CHEN, Y., FREIER, T. A., KUEHM, J., MOORMAN, M., MEYER, J., MORILLE-HINDS, T., POST, L., SMOOT, L. & HOOD, S. 2009. Control of Salmonella in low-moisture foods I: Minimizing entry of Salmonella into a processing facility. *Food Protection Trends*, 29, 342-353.
- SHAO, S., DUNCAN, A. M., YANG, R., MARCONE, M. F., RAJCAN, I. & TSAO, R. 2009. Tracking isoflavones: from soybean flour, soy protein isolates to functional soy bread. *Journal of Functional Foods*, 119-127.
- SHIN, H. J., CHO, E., LEE, H. J., FUNG, T. T., RIMM, E., ROSNER, B., MANSON, J. E., WHEELAN, K. & HU, F. B. 2014. Instant noodle intake and dietary patterns are associated with distinct cardio metabolic risk factors in Korea. *J Nutr*
- SIKANDER, M., MALIK, A., KHAN, M. S. G. & KHAN, R. G. Q. 2017. Instant noodles: Are they really good for health? A review. *Electronic Journal of Biology*, 13, 222-227.
- SINGH, J., KAUR, S. & RASANE, P. 2018. Evaluation of the Nutritional and Quality Characteristics of Black Carrot Fortified Instant Noodles. *Current Nutrition & Food Science*, 14, 442-449.
- SINGH, S., PUNIA, D. & KHETARPAUL, N. 2009. Nutrient composition of products prepared by incorporating amaranth (*Amaranthus tricolour*) leaf powder. *Nutrition & Food Science*, 39, 218-226.

- SINHA, G. 2014. Linkages between food consumption patterns food security and sustainable food systems.
- STEIN, L. J., COWART, B. J. & BEAUCHAMP, G. K. 2012. The development of salty taste acceptance is related to dietary experience in human infants: a prospective study. *The American journal of clinical nutrition*, 95, 123-129.
- STEYN, N., LABADARIOS, D., MAUNDER, E., NEL, J., LOMBARD, C. & SURVEY, D. O. T. N. F. C. 2005. Secondary anthropometric data analysis of the National Food Consumption Survey in South Africa: the double burden. *Nutrition*, 21, 4-13.
- STRUWIG, F. W. & STEAD, G. B. 2010. *Planning, designing and reporting research*. Pearson Education of South Africa, South Africa.
- SUDHA, M., RAJESWARI, G. & RAO, G. V. 2011. Influence of defatted soy flour and whey protein concentrate on dough rheological characteristics and quality of instant vermicelli. *Journal of texture studies*, 42, 72-80.
- SUSANNA, S. & PRABHASANKAR, P. 2013. A study on development of Gluten free pasta and its biochemical and immunological validation. *LWT-Food Science and Technology*, 50, 613-621.
- SYAMALADEVI, R. M., TANG, J., VILLA-ROJAS, R., SABLANI, S., CARTER, B. & CAMPBELL, G. 2016. Influence of water activity on thermal resistance of microorganisms in low-moisture foods: a review. *Comprehensive Reviews in Food Science and Food Safety*, 15, 353-370.
- THIEX, N. J., ANDERSON, S. & GILDEMEISTER, B. 2003. Crude fat, diethyl ether extraction, in feed, cereal grain, and forage (Randall/Soxtec/submersion method): collaborative study. *Journal of AOAC International*, 86, 888-898.
- THE GLOBAL PANEL ON AGRICULTURE AND FOOD SYSTEMS FOR NUTRITION 2016. Food systems and diets: Facing the challenges of the 21st century. London, UK.
- THOW, A. M. & HAWKES, C. 2009. The implications of trade liberalization for diet and health: a case study from Central America. *Globalization and health*, 5, 5.
- TRAILL, W., ARNOULT, M. H., CHAMBERS, S., DEAVILLE, E., GORDON, M., JOHN, P., JONES, P., KLIEM, K., MORTIMER, S. & TIFFIN, J. 2008. The potential for competitive and healthy food chains of benefit to the countryside. *Trends in food science & technology*, 19, 248-254.
- TRENTMANN, C., REINHARD, I. & VIERCK, L. 2012. Supplementation, Food Fortification and Dietary Diversification: A Three-Pronged Approach to Reducing Hidden Hunger. *BMZ May*.

- UNEP-WCMC, I. 2016. Protected planet report 2016. *UNEP-WCMC and IUCN: Cambridge UK and Gland, Switzerland*, 78-95.
- UNICEF 2018. Levels and trends in child malnutrition. eSocialSciences.
- UNITED STATES DEPARTMENT OF AGRICULTURE, U. 1995. A Tool Kit for Healthy School Meals: Recipes and Training Materials. USDA's New School Lunch and Breakfast Recipes. In: AGRICULTURE (ed.). Washington, DC.
- US DEPARTMENT OF AGRICULTURE 2008. Diet Quality of Americans by Food Stamp Participation Status: Data from the National Health and Nutrition Examination Survey, 1999–2004. In: AGRICULTURE (ed.). Alexandria, VA.
- VACLAVIK, V. A. & CHRISTIAN, E. W. 2014. Food preservation. *Essentials of food science*. Springer.
- VAN BERKUM, S., DINGERINK, J. & RUBEN, R. 2018. The food systems approach: sustainable solutions for a sufficient supply of healthy food. Wageningen Economic Research.
- VAN HUNG, P., MAEDA, T. & MORITA, N. 2007. Dough and bread qualities of flours with whole waxy wheat flour substitution. *Food Research International*, 40, 273-279.
- VERAIN, M. C., DAGEVOS, H. & ANTONIDES, G. 2015. Sustainable food consumption. Product choice or curtailment? *Appetite*, 91, 375-384.
- VERMEULEN, S. J., CAMPBELL, B. M. & INGRAM, J. S. 2012. Climate change and food systems. *Annual review of environment and resources*, 37.
- VORSTER, H. H., BADHAM, J. & VENTER, C. 2013. An introduction to the revised food-based dietary guidelines for South Africa. *South African Journal of Clinical Nutrition*, 26, S5-S12.
- WAHYONO, A. & BAKRI, A. Physicochemical and sensorial characteristics of noodle enriched with oyster mushroom (*Pleurotus ostreatus*) powder. *Journal of Physics: Conference Series*, 2018. IOP Publishing, 012120.
- WAY, C. 2015. *The millennium development goals report 2015*, UN.
- WELMAN, C., KRUGER, F. & MITCHELL, B. 2005. *Research methodology*, Oxford University Press Cape Town.
- WHITMEE, S., HAINES, A., BEYRER, C., BOLTZ, F., CAPON, A. G., DE SOUZA DIAS, B. F., EZEH, A., FRUMKIN, H., GONG, P. & HEAD, P. 2015. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health. *The Lancet*, 386, 1973-2028.

- WILLER, H., SCHAACK, D. & LERNOUD, J. 2019. Organic farming and market development in Europe and the European Union. *The World of Organic Agriculture. Statistics and Emerging Trends 2019*. Research Institute of Organic Agriculture FiBL and IFOAM-Organics International.
- WINA 2017. National trends in instant noodles demands. *World Instant Noodles Association*. Accessed at <https://instantnoodles.org/en/noodles/market.html> 25 April 2019.
- WOOD, J. A. 2009. Texture, processing and organoleptic properties of chickpea-fortified spaghetti with insights to the underlying mechanisms of traditional durum pasta quality. *Journal of Cereal Science*, 49, 128-133.
- WORLD HEALTH ORGANIZATION 2015. *World report on ageing and health*, World Health Organization.
- WORLD HEALTH ORGANIZATION, E. F. 2014. Global Action plan for prevention and control of non-communicable diseases. Accessed online at [https://www.who.int/nmh/events/ncd\\_action\\_plan/en/](https://www.who.int/nmh/events/ncd_action_plan/en/) 25 April 2019.
- WORLD HEALTH ORGANIZATION, W. 2018. *The state of food security and nutrition in the world 2018: building climate resilience for food security and nutrition*, Food & Agriculture Org.
- WU, N. N., TAN, B., LI, S. S., TIAN, X. H., LIU, M., LIU, Y. X., WANG, L. P. & ZHAI, X. T. 2017. Cooking quality, antioxidant properties, and starch digestibility of wheat noodles substituted with extruded brown rice flour. *Cereal Chemistry*, 94, 464-470.
- YILMAZ TUNCEL, N., KAYA, E. & KARAMAN, M. 2017. Rice bran substituted Turkish noodles (erişte): textural, sensorial, and nutritional properties. *Cereal chemistry*, 94, 903-908.
- ZHRUL-LAIL, N. S. 2017. Influence of instant food among students. *Research Hub*, 3 (2) ISSN: 2180-0065.

## Appendix 1: Survey Questionnaire

### Instant noodles consumption survey 2019

#### Instructions to respondents

- Please answer all questions truthfully
- Please use a tick/cross where necessary

#### Section 1

#### Socio-Demographic information

##### 1.1 Gender

1	Male	
2	Female	

##### 1.2 Age

--	--	--

##### 1.3 Residence

1	On campus resident	
2	Off campus private resident	
3	Off campus school resident	

##### 1.4 Source of Income

1	NSFAS allowance	
2	Parents allowance	
3	Wages	
4	Other	

## Section 2

### *Amaranthus* Utilisation

#### 2.1 Are you familiar with *Amaranthus*/pigweed/Hanekam/Thepe/Imbuya/Vowa?

1	Yes	
2	No	

#### 2.2 If yes, how do you know it?

---

---

---

#### 2.3 Do/have you ever consumed *Amaranthus*?

1	Yes	
2	No	

#### 2.4 If yes, in what form have you consumed *Amaranthus*?

1	Fresh (leaves, roots, seeds)	
2	Powdered leaf form	
3	Powdered seeds	

#### 2.5 If no, when encouraged to use *Amaranthus* as food for nutritional benefits, would you? Please tick one

1	I would happily use it	
2	I would try it at least once	
3	I am not sure	
4	I would not use it	

### Section 3

#### Instant noodles consumption

**3.1 How often do you consume instant noodles?** Please tick/cross

1	Everyday	
2	< three times a week	
3	> three times a week	

**3.2 How many packets (per 100g) of instant noodles do you consume?** Indicate number

1	Per day	
2	Per week	
3	Per month	

**3.3 Why do you eat instant noodles?** Please tick/cross

1	Taste		
2	Price		
3	Nutrients		
4	Convenience		
5	Time		
6	Other	(please specify)	

**3.4 What brand of instant noodles do you prefer?**

Please specify:

---

**3.5 Why do you prefer the above mentioned brand of instant noodles?**

Please explain:

---

**3.6 What do you look for when buying instant noodles?**

1	Price	
2	Flavour	
3	Brand	
4	Packaging	
5	New Product	

**3.7 What do you eat instant noodles with?**

1	Nothing	
2	Vegetables	
3	Eggs	
4	Other please specify	

**3.8 What flavour of instant noodles do you prefer? Please specify**

---

**3.9 Would you try a different flavour?**

1	Yes	
2	No	

**3.10 Why or Why not?**

---

---

**3.11 Would you try instant noodles supplemented with *Amaranthus* leaf powder?**

1	Yes	
2	No	

**3.12 Why or Why not?**

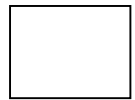
---

---

Would you like to be part of the panel for sensory evaluation of *Amaranthus*-supplemented instant noodles?

Yes		No	
-----	--	----	--

**Thank you for your participation**



## Appendix: 2 Sensory Evaluation Questionnaire

**Name of the product: Instant noodles**

Date: \_\_\_\_\_

Please Cross/ tick the relevant box below

### 1. Gender

1	Male	
2	Female	

### 2. Age (Please provide the exact age)

--	--	--

### 3. Residence

1	On campus resident	
2	Off campus private resident	
3	Off campus school resident	

### 5. Instructions to Panelists

1. Panelists are urged to ensure that they are not allergic or neophobic to eggs & *Amaranthus*
2. Panelists may not discuss or share any information during the session.
3. Please raise your hand quietly if seeking clarity or done with the tasting.
4. Please sip water before and in-between tasting products.

**Please taste and rate the products from left to right by making a cross against the word that describes your feelings on the product on the next pages.**

Sample no.:

Attribute	Like				Indifferent Neither like nor dislike	Dislike			
	Like extremely	Like very much	Like moderately	Like slightly		Dislike slightly	Dislike moderately	Dislike very much	Dislike extremely
	1	2	3	4		5	6	7	8
<b>Cooked Instant Noodles</b>									
Green colour									
Uniformity of colour									
Aroma/smell									
Stickiness/separation									
Chewiness									
Saltiness									
After taste									
<b>Overall Acceptability</b>									

### Appendix 3: Consent form

#### CONSENT

I \_\_\_\_\_ have been informed about the study entitled: **Indigenizing instant noodles: An interface of indigenous traditional *Amaranthus* leaves with wheat by Nothando Qumbisa (218011656).**

I understand the purpose and procedures of the study is to investigate the consumer acceptability of the developed Amaranth supplemented instant noodles.

I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at [qumbisanothando@gmail.com](mailto:qumbisanothando@gmail.com)/ call 065 648 9884. Supervisor details e: [kolanisi@ukzn.ac.za](mailto:kolanisi@ukzn.ac.za). If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

#### HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban

4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557 - Fax: 27 31 2604609

Email: [HSSREC@ukzn.ac.za](mailto:HSSREC@ukzn.ac.za)

Additional consent, where applicable

I hereby provide consent to:

Audio-record my interview / focus group discussion      YES / NO

Use of my photographs for research purposes      YES / NO

\_\_\_\_\_  
**Signature of Participant**

\_\_\_\_\_  
**Date**

\_\_\_\_\_  
**Signature of Translator**

\_\_\_\_\_  
**Date**

#### **Appendix 4: Request to conduct study letter**

P.O Box 315

Gamalakhe

4249

17 July 2019

University of Zululand Research Ethics Committee

Private Bag X1001

KwaDlangezwa

3886

Dear Sir/Medam

#### **Request to conduct research at the University of Zululand**

My name is Nothando Qumbisa (218011656), a master's student from University of KwaZulu Natal, Pietermaritzburg campus in the college of Agriculture, Earth and Environmental science.

I wish to conduct a study that involves production of instant noodles using *Amaranthus* titled: **Indigenising instant noodles: An interface of traditional *Amaranthus* leaves with wheat.**

The aim and purpose of this research is to investigate the consumption of instant noodles as well as the utilisation of *Amaranthus* (Imbuya/Imfino) among students. The study is expected to enrol 100 students, 40 residing on campus and 60 residing outside the institution. A self-administered questionnaire will be distributed among the sample and will be collected after three days. The total duration of data collection is expected to be one month It will involve answering a structured interview questionnaire which is self-administered. No risks are expected and privacy and anonymity will be ensured during reporting. Results yielded from this study will contribute towards developing a new product using *Amaranthus* which will be targeted to the students as an intervention and will also be shared through publications. The University will be well acknowledged in the case of both dissertation writing and publications.

This study is in the process of being ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (Approval number not yet available) and is funded by the National research fund and UKZN.

In the event of any problems or concerns/questions you may contact the researcher at 0656589884/0724737259 or email: [qumbisanothando@gmail.com](mailto:qumbisanothando@gmail.com). Alternatively, you may contact my supervisor at [kolanisi@ukzn.ac.za](mailto:kolanisi@ukzn.ac.za) or the UKZN Humanities & Social Sciences Research Ethics Committee, contact details as follows:

**HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION**

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban

4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: [HSSREC@ukzn.ac.za](mailto:HSSREC@ukzn.ac.za)

Yours Sincerely

Nothando Qumbisa (218011656)

Master of Agriculture, Food Security

## Appendix 4: Gatekeepers Letter (Department of Consumer science)



UNIVERSITY OF  
ZULULAND

University of Zululand, Private Bag X1001, KwaDlangezwa, 3886

W: [www.unizulu.ac.za](http://www.unizulu.ac.za)

**FACULTY OF SCIENCE AND AGRICULTURE  
CONSUMER SCIENCE DEPARTMENT  
12/04/2019**

Dear Miss Qumbisa,

**RE: PERMISSION TO CONDUCT LABORATORY EXPERIMENTS AT THE  
DEPARTMENT OF CONSUMER SCIENCE**

The University of Zululand is happy to grant you permission to give you permission to conduct your laboratory experiments, which include product development as part of your research titled: **Indigenizing Instant noodles: An Interface of traditional Amaranthus leaves with wheat**. This includes utilization of both the domestic kitchen laboratory and the use of the Steamer at the DOCSHERD laboratory. The time period for this will be from April 15 till June 14, 2019.

Please note that for the **SURVEY**, the University of Zululand requires an **ETHICAL CLEARANCE CERTIFICATE** from your respective university enrolled at (University of KwaZulu Natal) in order to issue out a letter permitting you to conduct a survey with our students.

We are looking forward to working with you, and wish you best for your studies.

Yours sincerely,

Dr NK Ndwandwe

Community Engagement Representative: Consumer Science department

RESTRUCTURED FOR RELEVANCE

## Appendix 5: Gatekeepers letter (University of Zululand)



University of Zululand, Private Bag X1001, KwaDlangezwa, 3886

W: [www.unizulu.ac.za](http://www.unizulu.ac.za)

T: +27 35 902 6731 E: [DlelanaM@unizulu.ac.za](mailto:DlelanaM@unizulu.ac.za)

*Deputy Vice-Chancellor: Research and Innovation*

Miss N.D Qumbisa  
P.O Box 315  
Gamalakhe  
4249  
18 July 2019

Dear Miss Qumbisa

**REQUESTING TO CONDUCT RESEARCH AT UNIZULU: "INDIGENIZING INSTANT NOODLES: AN INTERFACE OF TRADITIONAL AMARANTHUS LEAVES WITH WHEAT"**

Your letter to me, refers.

I hereby grant approval for you to conduct part of your research at UNIZULU, as per the methodologies stated in your research proposal and in terms of the data collection instruments that you have submitted. I note also that University of KwaZulu-Natal, has issued a provisional ethical clearance certificate and having read the documentation, I am happy to accept that certificate.

You may use this letter as authorization when you approach the relevant persons. Please note that permission is based on the documentation that you have submitted. Should you revise your research instruments, or use additional instruments, you must submit those to us as well.

I wish you well in your research.

Yours sincerely,

  
Professor Gideon De Wet  
Chairperson: University of Zululand Research Ethics Committee  
Deputy Vice-Chancellor: Research and Innovation

**CHAIRPERSON**  
UNIVERSITY OF ZULULAND RESEARCH  
ETHICS COMMITTEE (UZREC)  
REG NO: UZREC/17/1110-30

24-07-2019

RESEARCH & INNOVATION OFFICE

RESTRUCTURED FOR RELEVANCE

## Appendix 7: Ethical Clearance Letter



05 August 2019

Ms ND Qumbisa (218011656)  
School of Agricultural, Earth and Environmental Sciences  
College of Agriculture, Engineering and Science  
[qumbisanothando@gmail.com](mailto:qumbisanothando@gmail.com)

Dear Ms Qumbisa

Protocol: Indigenizing Instant noodles: An Interface of traditional Amaranthus leaves with wheat  
Degree: Master of Agriculture  
BREC Ref No: BE453/19

### EXPEDITED APPLICATION: APPROVAL LETTER

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application received on 18 June 2019.

The study was provisionally approved pending appropriate responses to queries raised. Your response dated 26 July 2019 to BREC letter dated 01 July 2019 has been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have been met and the study is given full ethics approval and may begin as from 05 August 2019. Please ensure that outstanding site permissions are obtained and forwarded to BREC for approval before commencing research at a site.

This approval is valid for one year from 05 August 2019. To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at <http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx>.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be noted by a full Committee at its next meeting taking place on 10 September 2019.

Yours sincerely

  
Prof V Rambiritch  
Chair: Biomedical Research Ethics Committee

cc: Postgrad Admin: [manjoom@ukzn.ac.za](mailto:manjoom@ukzn.ac.za)  
Supervisor: [kolanisi@ukzn.ac.za](mailto:kolanisi@ukzn.ac.za) [sjwelam@ukzn.ac.za](mailto:sjwelam@ukzn.ac.za)

Biomedical Research Ethics Committee  
Professor V Rambiritch (Chair)

Westville Campus, Govan Mbeki Building

Postal Address: Private Bag X54001, Durban 4000

Telephone: +27 (0) 31 260 2486 Facsimile: +27 (0) 31 260 4609 Email: [brec@ukzn.ac.za](mailto:brec@ukzn.ac.za)

Website: <http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx>

  
1910 - 2010  
100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses:  Edgewood  Howard College  Medical School  Pietermaritzburg  Westville