



**Food and nutrition sustainability knowledge and diet  
among students at the Durban University of Technology**

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Faculty of Applied Sciences

at the

**Durban University of Technology**

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03 April 2025

## **DECLARATION**

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I, Sanrika Sahadeo, hereby declare that the research work presented by this thesis is my original work and all the materials used are appropriately acknowledged and explicitly referenced. A reference list is attached to the thesis.

I also confirm that the thesis has not been submitted in any of its part or entirety for any degree in any other institution of higher learning internationally or locally.

I therefore give permission that my work be available for replication and/or for re-printing, for inter-library loan, and for the title and abstract of my thesis to be made available to other educational institutions and students that might need it.

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## DEDICATION

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I dedicate this thesis to my parents:

My parents (Shanitha and Dhanesh Sahadeo)

My siblings (Kavil and Neha)

For always being there for me and their unending support.

*“You have only scratched the surface of what you’re capable of, there are decades of victories ahead of you.” –*

Rupi Kaur

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*“Wisdom is like a baobab tree; no one individual can embrace it.” – African proverb.*

## ABSTRACT

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**Background:** The climate emergency is now widely acknowledged with an international rise in environmentalism to maintain planetary habitability. Most greenhouse gas emissions from food production are caused by energy and water consumption. Conscious and responsible consumer behaviour is a long-term process that heavily depends on social, political, and commercial considerations to achieve the sustainability paradigm. The current South African food system and emanating consumer food choices directly impact climate change. South Africans are consuming resource-intensive foods, a diet high in animal foods and processed foods. This is evident in the high prevalence of obesity, which currently co-exist with stagnant high levels of stunting. South Africa is regarded as food secure, but the divide in access to resources and high unemployment continues to render a significant proportion of citizens' food and nutrition insecure at the household level. In South Africa, subsistence agriculture has been eroded by apartheid land policies and overcrowding. Inadequate agricultural extension services have resulted in rural households increasingly relying on processed food from the formal retail system. Policy actions to promote sustainable diets have been superseded by other climate change agendas as more pressing in South Africa, and thus, little is known about the environmental consequences of diet and food choices. The 27th Conference of the Parties (COP 27) forefronted nutrition in the agenda, advocating the development of policies with co-benefits for nutrition and the environment, mitigating the impact of climate change on human health and well-being. In this study, sustainability will be explored from the young consumer perspective to advance transformative strategies for sustainability, climate change goals, and enhanced health.

**Aim:** This study aimed to investigate food and nutrition sustainability knowledge and practices among university students at the Durban University of Technology (DUT) and to appraise the diet quality and the impact of diet on the environment, culminating in an event to advance consciousness towards food and nutrition sustainability.

**Methodology:** In this cross-sectional study, awareness, knowledge and attitudes toward food and nutrition sustainability were investigated among 405 registered university students at the DUT using a validated questionnaire. Respondents were conveniently selected at key hub areas at the university and recruited through informed consent. Data was analysed using descriptive statistics, chi-square goodness-of-fit-test and one sample *t*-test. Dietary data of respondents was

captured through the 24-hour food recall using the multiple pass method for two non-consecutive days, including a weekend day by trained field workers. The repeated 24-hour food recall data was captured onto the FoodFinder 3 software program of the South African Medical Research Council (SAMRC), to analyse the diet; the data was run through Statistical Package for Social Sciences (SPSS). The prevalence of inadequacy (POI) was calculated using the cut-point method, highlighting specific nutrient deficits among the men and women. The dimensions of diet quality were further assessed for nutrient adequacy and non-communicable disease (NCD) risk using the Global Diet Quality Score (GDQS). The environmental impact of respondents' diet was calculated using the Plate Up for the Planet carbon footprint calculator, which estimated the amount of CO<sub>2</sub> produced per kilogram of specific foods. Lastly, the South African Food Boost University Challenge (SAFBUC) was developed using a student-led participatory approach and implemented to raise awareness about food and nutrition sustainability among students at DUT.

**Results:** Regarding knowledge and awareness of food and nutrition sustainability, a substantial 54.8% of students were unfamiliar with the Sustainable Development Goals (SDGs), and the remaining 45.2% heard of it but lacked knowledge. Significant proportions of students never heard of product environmental footprint (65.2%), life cycle assessment (66.2%), greenwashing (64.9%), and food miles (58.5%) ( $p < 0.001$ ). A significant 77% ( $n = 313$ ) of students relied on the internet as the primary source of information about foods that do not harm the environment ( $p < 0.001$ ). There was significant agreement that students knew what a healthy diet comprised of; they understood the impact of a diet on health, and they knew what a sustainable diet consisted of ( $p < 0.001$ ). One of the food choice drivers that contributed to students being unable to have a healthy diet is that they found it difficult to avoid unhealthy food options ( $n = 120$ ), and some claimed that the cost of healthy foods was too expensive ( $n = 103$ ). Food preferences and taste were significant, followed by cost and ease of purchase ( $p < 0.001$ ). Thirty-two-point-six per cent of respondents rarely looked for any eco-label on the packaging to evaluate a product, 30.9% rarely considered the environmental friendliness of the products they purchased, and 29.4% seldom paid attention to where the food was produced or grown. Regarding diet, this study revealed that while most male respondents met or exceeded their carbohydrate (310.8 g) and protein (88.06 g) needs, which were well above the Estimated Average Requirements (130 g and 56 g, respectively), they exhibited notable deficiencies in various essential micronutrients, such as calcium (74.3% showed a POI), magnesium (96.7% showed a POI), vitamin D (92.8% showed a POI), vitamin K (89.5% showed a POI), and folate

(94.1% showed a POI). The data highlighted several critical nutrient inadequacies among the women, particularly in dietary fibre, calcium (94.0% showed a POI), magnesium (93.1% showed a POI), vitamin D (93.1% showed a POI), vitamin K (83.1% showed a POI), and folate (92.3% showed a POI). The GDQS was used to assess diet quality, nutrient adequacy and NCD risk among respondents. This study showed that 99% of students were at high risk for developing nutrient inadequacy and associated NCD risk. In this study, the carbon footprint from the diet was higher for males (308060 CO<sub>2</sub>e) compared to females (23910 CO<sub>2</sub>e). To promote food and nutrition sustainability, the SAFBUC was implemented to promote fruit and vegetable consumption. This university-wide challenge allowed students to develop products using fruits and vegetables that they would like to consume. Seven products were developed among students from various faculties in the university. The products were showcased at a campus event, and students were invited to taste samples and obtain information about the sustainability of the products. Students and staff conducted sensory analyses of the developed products. The top three products were: fruit and yoghurt popsicles, sweet potato long chips, vegetable pasta, tangy delights (yoghurt with strawberries and chocolate popsicles), ultimate veggie burger, sweet potato, avocado and feta muffins and an okra smoothie.

**Conclusion:** This study highlights the lack of knowledge and awareness related to food and nutrition sustainability among young university adults. The study underscores the need for targeted educational interventions to bridge the knowledge gap and empower young adults to make informed and sustainable food choices. The study's objectives were achieved, and implementing the SAFBUC at the DUT shows tremendous promise for success at the higher education institution level. The food environment within university campuses has a significant impact on the diet of students. Therefore, policy interventions to change the university food environment and create a sustainable food system are imperative for the future of the youth in South Africa.

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## ABBREVIATIONS

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AI	Adequate intake
CO <sub>2</sub> e	Carbon dioxide equivalents
DRC	Departmental Research Committee
DUT	Durban University of Technology
EAR	Estimated Average Requirement
EER	Estimated Energy Requirement
FRC	Faculty Research Committee
GDQS	Global Diet Quality Score
GHG	Greenhouse gas
FAO	Food and Agriculture Organization of the United Nations
IREC	Institutional Research Ethics Committee
NCD	Non-communicable disease
POI	Prevalence of inadequacy
SAFBUC	South African Food Boost University Challenge
SDG	Sustainable Development Goal
SPSS	Statistical Package for Social Sciences”

# **CHAPTER 1**

## **INTRODUCTION AND IMPORTANCE OF THE STUDY**

---

### **1.1 Introduction**

Chapter 1 begins by contextualising the study within existing literature and identifying gaps in knowledge that the research aims to address. The chapter then presents the research problem, aim, and objectives, underscoring the importance of advancing understanding of the topic. Overall, this chapter provides the blueprint of the research project and paves the way for the subsequent chapters.

### **1.2 Context of the research**

The current unsustainable production and unhealthy consumption habits threaten the global food systems. Food systems cause a third of the world's anthropogenic greenhouse gas (GHG) emissions (Crippa et al. 2021). The current food supply chain emits 13.7 billion metric tonnes of carbon dioxide equivalents (CO<sub>2</sub>e), which is responsible for 26% of all human-related GHG emissions (Poore and Nemecek 2018). The adverse effects of climate change and increasing levels of food insecurity are the two key issues humanity is currently experiencing (Ranganathan et al. 2018; Horn, Ferreira and Kalantari 2022). Consequently, converting more land for agricultural use is no longer a viable option to feed the estimated population of approximately 9.6 billion people by 2050. Therefore, the world needs to consider more sustainable farming methods (Ranganathan et al. 2018).

Burlingame and Dernini (2012) define sustainable diets as low-impact diets that support food and nutrition security and a healthy lifestyle for both the present and future generations. The World Cancer Research Fund International (2014) states that food, diet, and nutritional status can influence the risk of non-communicable diseases (NCDs). Therefore, consumers need to consume plant-based diets to reduce the risk of developing obesity, diabetes, cardiovascular disease, and some forms of cancer. These diets have a lower environmental impact than those of meat and dairy products. For that reason, to create a climate that supports nutritious, healthy diets, policymakers must develop and implement well-targeted policy interventions (World Cancer Research Fund International 2014).

The young adults included in this study are typically between the ages of 18 years old and 34 years old, a group that is in a transitional phase from adolescence to adulthood. This juncture

is defined by significant cognitive, social, and emotional growth. It is often a stage of life where students are making independent decisions about their food choices, most likely away from home for the first time. Many students are balancing demanding schedules and financial constraints, which can influence their dietary choices. This cohort is capable of understanding factors that affect food choices, including their knowledge of nutrition, access to sustainable food options, and the influence of social and environmental factors on their diet. This study's goal is to highlight potential gaps in knowledge or barriers to implementing healthy sustainable eating practices. Future university-based initiatives and interventions can benefit from this information.

According to a study by Rejman et al. (2019), for consumers to adopt more environmentally friendly food choices to increase the effectiveness of public health and food policy activities, authorities need to disseminate information on sustainability issues and the environmental impact. However, limited studies have been conducted in South Africa (Erasmus et al. 2020; Samkange et al. 2021). There are limited published studies surrounding food and nutrition sustainability conducted in South Africa. Food consumption preferences in South Africa have evolved significantly during the last few decades, and projections point to a substantial change in the coming decades. This study will investigate food and nutrition sustainability knowledge and practices among university students at the DUT and appraise the diet quality and the impact of diet on the environment to advance consciousness towards food and nutrition sustainability. This study will concentrate on the following Sustainable Development Goals (SDGs): SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action). The study will contribute to the young adult consumers' (students) understanding of sustainability, climate change goals, and enhanced health to achieve the Sustainable Development Goal (SDG) 2030 targets at the consumer level.

The South African Food Boost University Challenge (SAFBUC) is significant to the study as it underscores the necessity for innovative solutions to tackle food security and nutrition sustainability, and assesses whether students are willing to consume foods that include fruits and vegetables only.

### **1.3 Importance of the study**

An increase in environmentalism across the globe has led to a growing awareness of the climate emergency and the need to preserve planetary habitability. Energy and water usage are the primary contributors to GHG emissions from agricultural production (Ntinyari and Gweyi-Onyango 2021). To reach the sustainability paradigm, conscious and responsible consumer behaviour is a long-term process that significantly depends on social, political, and commercial concerns (Lubowiecki-Vikuk, Dąbrowska and Machnik 2021).

The current South African food system and emanating consumer food choices directly influence climate change. South Africans consume meals that are resource-intensive and have a diet high in animal products and processed foods (Forouzanfar et al. 2016; Atun et al. 2017). This is evident in the high prevalence of obesity, which currently co-exist with stagnant high levels of stunting. South Africa is nationally food secure, but the divide in access to resources and high unemployment continues to render a significant proportion of citizens food and nutrition insecure at the household level (Statistics South Africa 2016; Misselhorn and Hendriks 2017). Apartheid land restrictions and overpopulation in South Africa have compromised subsistence agriculture (Hendriks 2014). Even rural households are becoming more dependent on processed foods from the established retail sector because of insufficient agricultural extension services (Aliber 2005; Lee, McNamara and Ho 2023).

The three main problems associated with unsustainable food and nutrition are waste management, GHG emissions, and food security (Nahman et al. 2012; Cronjé, Van der Merwe and Müller 2018). Food waste has an impact on the environment and the resources needed to produce food throughout the entire food supply chain (Oelofse 2019). Food loss and waste can occur at any stage of the food supply chain. Food loss during production influences farmers' ability to earn a good living. It affects the price of food during the subsequent stages, such as processing, transporting, and retail. Consumption, which is the final stage, has an influence on a household's spending and nutrition. Discarded food that was meant for human consumption annually wastes about 25% of all agricultural water and emits 8% of GHGs (Conceição 2019).

In South Africa, other more urgent climate change goals have taken precedence over policy initiatives to support sustainable diets. Therefore, little is known about the environmental effects of diet and food choices. The 27th Conference of the Parties (COP 27) prioritised nutrition in the agenda and advocated for the development of legislation that would help both

the environment and nutrition while also mitigating the adverse effects of climate change on people's health and well-being (United Nations Nutrition 2022). This study will explore sustainability from the young adult consumer perspective to advance transformative strategies for sustainability, climate change goals, and enhanced health toward nature-positive solutions.

#### **1.4 Problem statement**

Making sustainable food choices is a difficulty faced by consumers, which poses a threat to the habitability of the earth. Due to a lack of information about sustainable food and nutrition, consumers are unaware of the effects of their dietary choices on their health and the environment. Unsustainable and unhealthy consumption and production practices currently challenge food systems. The food production and manufacturing sector utilises a significant amount of raw materials, energy, and water, and produces a substantial amount of waste in the environment (Ahmad, Wong and Ahmad 2019). Transitioning to sustainability has been a prolonged challenge, especially among consumers. Consumers' increasing demand for meat and dairy products is the prime cause of anthropogenic methane emissions. Methane has a high global warming potential and is 25 times more dangerous than CO<sub>2</sub> (Morganti et al. 2022). Recently, several international studies have investigated consumers' awareness, knowledge, and attitudes toward food sustainability (Petrescu, Vermeir and Petrescu-Mag 2020). According to Yüksel and Yılmaz Önal (2021), there is a significant knowledge gap regarding the attributes of sustainable food and nutrition. Therefore, it is crucial to educate consumers about how food production influences the environment.

There have been limited research studies in South Africa about food and nutrition sustainability knowledge, practices, and diet. The in-depth information gathered from the sustainable food and nutrition survey questionnaire will help improve the understanding of the Durban University of Technology (DUT) students' knowledge, consumer perceptions, attitudes, and experience of food and nutrition sustainability and food choice drivers in South Africa. This will facilitate the formulation of a strategy to advance consciousness towards food and nutrition sustainability.

## **1.5 Aim of the study**

This study aimed to investigate food and nutrition sustainability knowledge and practices among university students at the DUT and appraise the diet quality and the impact of diet on the environment to advance consciousness towards food and nutrition sustainability.

## **1.6 Specific objectives**

- To determine the awareness, knowledge and attitudes of food and nutrition sustainability, and food choice drivers among students at the DUT through a survey.
- To determine the dimensions of diet quality for nutrient adequacy and NCD risk among students at the DUT through the Global Diet Quality Score (GDQS).
- To investigate the environmental impact of diet among university students at the DUT using online carbon footprint calculators.
- To promote sustainable dietary practices by implementation of the South African Food Boost University Challenge (SAFBUC).

## **1.7 Assumptions**

- It is assumed that only registered undergraduate and postgraduate students of the DUT based at the Steve Biko, Ritson, and ML Sultan campuses will participate in this study.
- It is assumed that through convenience sampling, respondents will be readily available to participate in the study.
- It is assumed that the responses and data collected from the respondents for the sustainable food and nutrition survey questionnaire are unbiased and honest.
- It is assumed that all respondents involved in the sustainable food and nutrition survey questionnaire and 24-hour food recall comprehends English, which is the language used to communicate.

## **1.8 Study parameters**

- The study was limited to the DUT, namely the Steve Biko, Ritson, and ML Sultan campuses in KwaZulu-Natal, South Africa.

- Four hundred and five respondents were recruited for this study.

## 1.9 Outline of the project

The researcher created the outline of the research, as illustrated in Figure 1.1, in collaboration with the research supervisors.

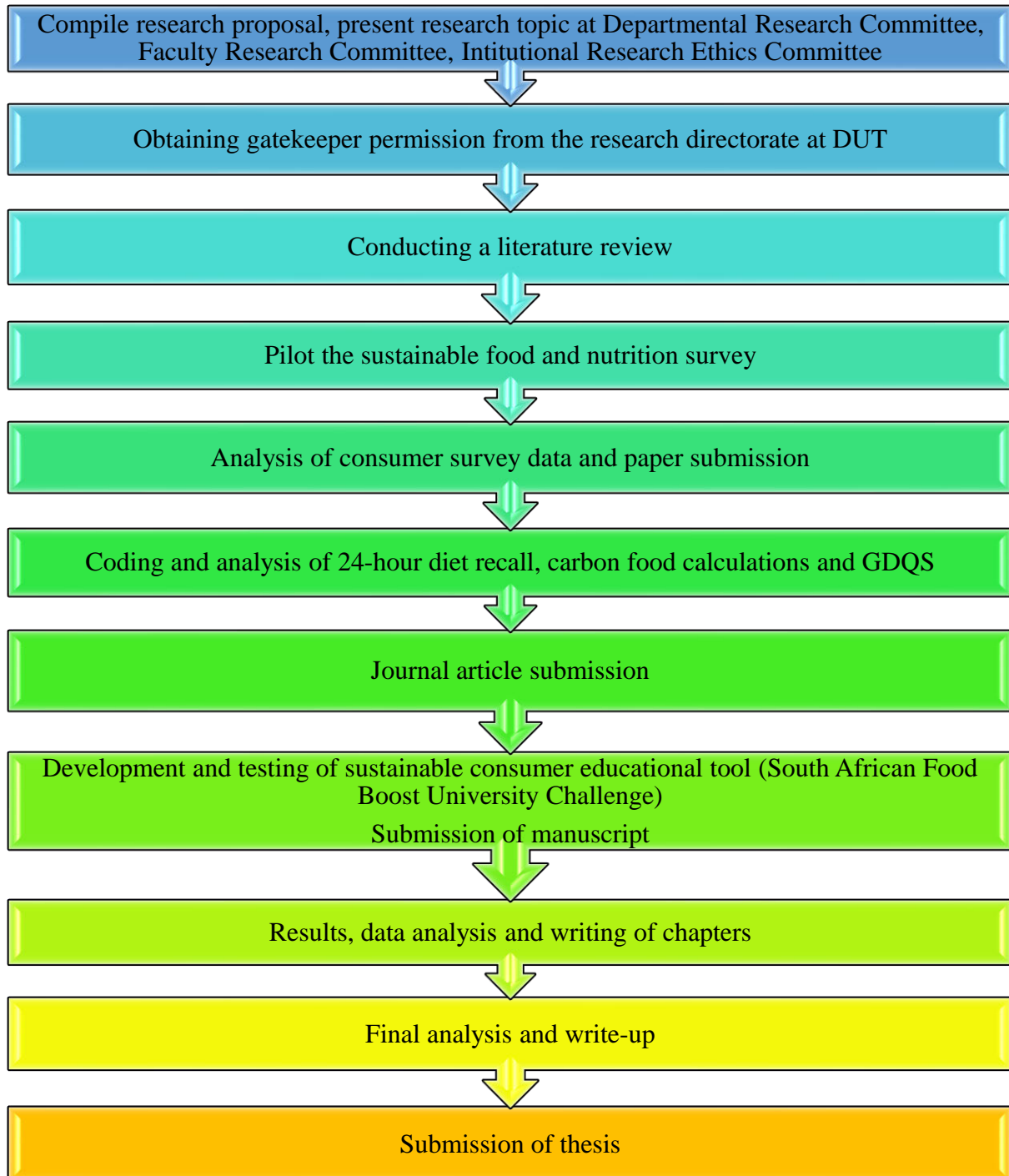


Figure 1.1: Framework of the research

## 1.10 Definition of terms

**Anthropocene:** Refers to the current era as the time when human activity has had the greatest impact on climate and the environment (Hamilton 2016).

**Carbon dioxide equivalent (CO<sub>2</sub>e):** CO<sub>2</sub>e is used to group various greenhouse gases into a single quantity. The amount of CO<sub>2</sub> that would have the equivalent effect on global warming for every quantity and type of greenhouse gas is denoted by the symbol CO<sub>2</sub> (Brander 2012).

**Carbon footprint:** Carbon footprint is defined as the total amount of greenhouse gases generated by human actions (Huang, Chen and Zhang 2018).

**COVID-19:** The SARS-CoV-2 virus is the infectious disease known as coronavirus disease (World Health Organization n.d.).

**Food insecurity:** Food insecurity is defined as a lack of enough access to nutritious, healthful, and culturally appropriate food, for example a household that has admitted to having food shortages at least once since the pandemic occurred (Porter et al. 2022).

**Food loss:** Food loss occurs before the consumption of food as a result of problems during the manufacturing, storage, processing, and distribution stages (Cheung 2019).

**Food miles:** The distance between where food is produced or prepared and where it is consumed (Sirieix, Grolleau and Schaer 2008).

**Indigenous foods:** Indigenous foods are defined as plant and animal-based foods that are naturally existing, produced in specific locations, and consumed as part of traditional diets (Akinola et al. 2020).

**Food security:** Food security is the condition in which everyone, at all times, has physical and financial access to an adequate supply of safe, nourishing foods that satisfy their dietary needs and food choices for an active and healthy life (Food and Agriculture Organization of the United Nations (FAO 2024a).

**Food sovereignty:** Refers to people's right to nutritious, culturally acceptable food produced using sustainable, environmentally friendly practices, in addition to their right to define and manage their own food and agricultural systems (Schreer and Padmanabhan 2020).

**Food waste:** Food waste refers to edible food that is intentionally wasted during the retail or consumption phases (Cheung 2019).

**Global warming:** The Intergovernmental Panel on Climate Change has defined global warming as the increase in the combined land surface, air, and sea surface temperatures, averaged over a 30-year period (Masson-Delmotte et al. 2019).

**Greenhouse gas emissions:** The term greenhouse gas refers to gases that trap heat in the atmosphere, creating an environment that is warmer than it should be, resulting in global warming. The most prevalent GHGs in the earth's atmosphere is ozone, carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and water vapour (Brander 2012).

**Greenwashing:** A term that combines the words *greenwash* and *whitewash* that environmentalists use to characterise the process of giving environmentally harmful practices a favourable public perception (for instance, by corporate organisations) (Ruiz-Blanco, Romero and Fernandez-Feijoo 2022).

**Non-communicable diseases:** Chronic diseases, sometimes referred to as non-communicable diseases (NCDs), are conditions that develop over an extended period as a result of a combination of genetic, physiological, environmental, and behavioural variables (World Health Organization 2023b).

**Sustainability:** The ability to continue for a prolonged period, for example the long-term sustainability of food systems (Doyle 2022).

**Sustainable Development Goals:** The sustainable development goals are the blueprints to achieve a better and more sustainable future for all generations (United Nations Development Programme 2022).

**Sustainable diets:** According to the British Dietetic Association (2022), sustainable diets are defined as diets with low environmental impacts that contribute to food and nutrition security and healthy life for present and future generations.

**Sustainable food systems:** A sustainable food system “assures food security and nutrition for all while maintaining the economic, social, and environmental foundations necessary to generate food security and nutrition for future generations” (High Level Panel of Experts on Food Security and Nutrition 2017).

## **1.11 Conceptual framework**

Figure 1.2 illustrates the conceptual framework of the study.

The conceptual framework was designed by the researcher and supervisor based on the aim and the objectives of the study. The food and nutrition sustainability integrates knowledge, awareness, attitudes, diet quality and practices. These in turn influence pillars such as awareness, behavioural change, accessibility and cultural reasons. These pillars influence the development interventions such as the SAFBUC to educate the target population for example young adult university students in this study, develop policy interventions, and promote the advocacy of food and nutrition sustainability. All these are interconnected with health and well-being, food environment, food and nutrition security and the SDG 2030 targets: SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action). Ultimately it aims to create a resilient food environment that promotes health for all individuals while preserving natural resources for future generations.

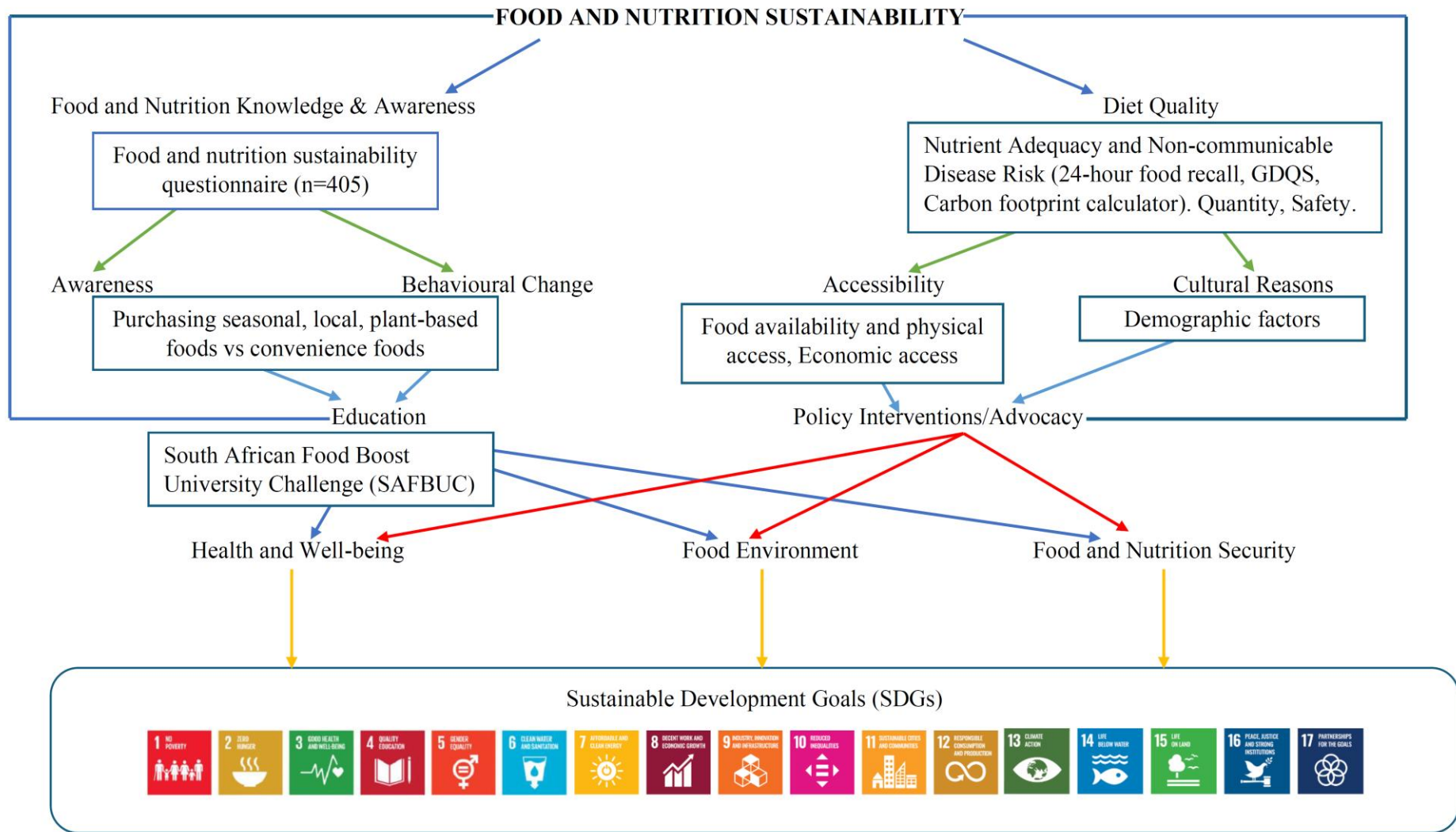


Figure 1.2: Conceptual framework of the study

## **1.12 Structure of thesis**

The thesis is structured as follows:

### *Chapter 1: Introduction and importance of the study*

This chapter provides the background to the study, the research problem and the justification of the research. The aim and objectives of the research are presented, as well as the significance of the study from a global perspective.

### *Chapter 2: Literature review*

A comprehensive analysis and summary of the studies conducted by other researchers based on food and nutrition sustainability internationally and in South Africa will be presented.

### *Chapter 3: Research design and methodology*

This chapter presents the research strategy, procedures, and tools used to carry out the study, including ethical considerations, participant selection standards, and statistical analysis.

### *Chapter 4: Results and discussion*

In this chapter, the data is compiled, correlations are made, and the results are discussed in relation to the studied literature.

### *Chapter 5: Conclusion and recommendations*

This is the conclusion of the research and limitations to the study, with suggestions for future research.

## **1.13 Referencing style**

The referencing is done according to the Harvard method following the standards set by the DUT.

## **1.14 Conclusion**

Chapter 1 has outlined the purpose and importance of the study. This chapter also includes a framework and structure to serve as a roadmap for the research progress (Figure 1.1). Chapter 2 will cover the literature of the study in greater detail.

## **CHAPTER 2**

### **LITERATURE REVIEW**

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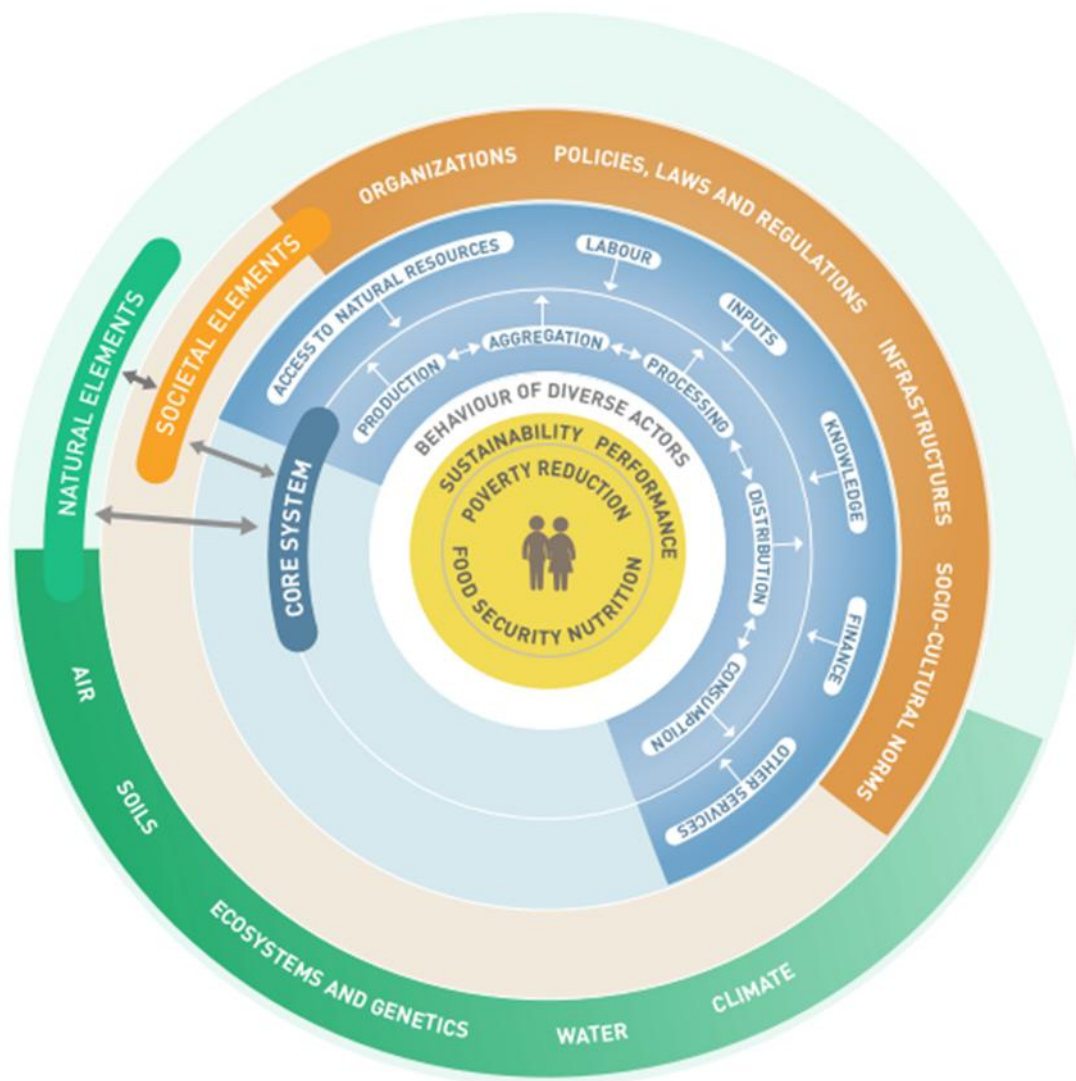
#### **2.1 Introduction**

This chapter provides a comprehensive analysis and summary of the studies conducted on food and nutrition sustainability both globally and within South Africa. This study aims to create transformative ideas for sustainability, climate change goals, and enhanced health that address the SDG 2030 goals. Sustainability will be examined from the consumers' perspectives, as food and nutrition sustainability has become increasingly significant in the last few years. As the world's population grows, there is an increasing demand for safe, nutritious food. However, numerous conventional practices from farm to fork are unsustainable and pose a threat to the environment. This literature review will examine consumer perceptions, attitudes, and knowledge of food and nutrition sustainability, food choice drivers and potential challenges that South Africa must overcome to meet the SDG 2030 agenda.

#### **2.2 Overview of sustainable food systems**

To achieve revolutionary food systems and improve quality of life, sustainability is a paradigm for thinking about future generations in which environmental, social, and economic concerns are balanced to ensure the estimated 10 billion people in the world still have access to safe, healthy, and nutritious food in 2050 (World Wildlife Fund 2021). According to the High Level Panel of Experts on Food Security and Nutrition (2014) and Nguyen (2018), a food system includes all the components (environment, people, inputs, processes, infrastructures, institutions, and so forth) and activities involved in the production, processing, distribution, preparation, and consumption of food as well as the results of these processes, such as socio-economic and environmental outcomes. The food system includes all the people and activities involved in growing, transporting, supplying, and, eventually, consumption of food. These processes also include variables that are frequently overlooked, such as food preferences and resource investments (Nguyen 2018; El Bilali et al. 2019). Sustainable food systems ensure food security and nutrition for future generations, which guarantees that the food produced is profitable, has nutritional benefits for society, and has a positive impact on the natural environment (Nguyen 2018). One of the objectives of global public health is to promote healthy diets and the development of sustainable food systems (Drewnowski et al. 2020). By offering a structured framework, the Food System Wheel facilitates a holistic approach to designing

and implementing strategies that promote sustainable food systems while addressing global challenges like hunger, malnutrition, and environmental degradation.



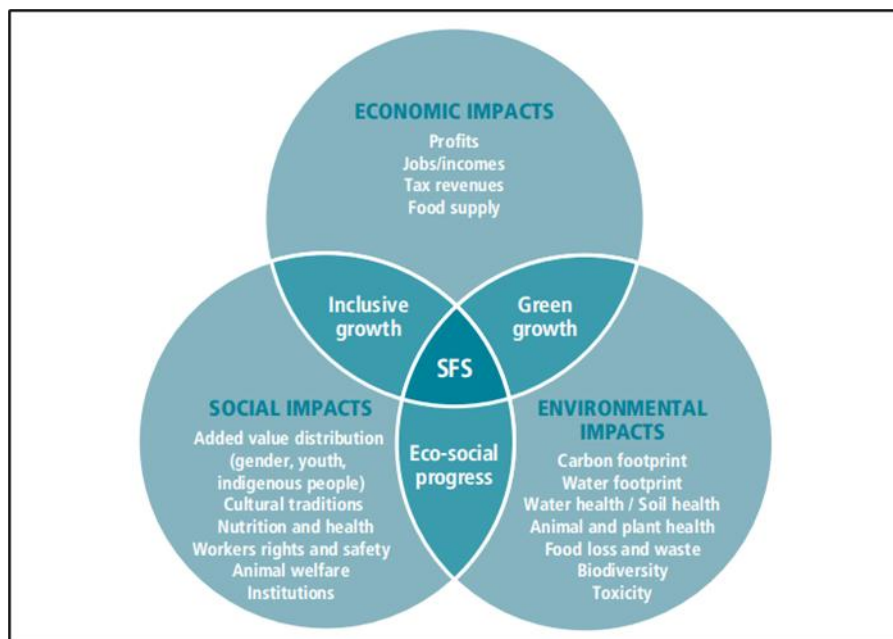
Source: Nguyen (2018)

Figure 2.1: The Food System Wheel

As illustrated in Figure 2.1, the FAO’s primary objectives are poverty reduction, food security, and nutrition at the centre of the Food System Wheel. These are part of the system’s overall performance and allude to the economic, social, and environmental aspects of sustainability, which the literature study will discuss further in the next section. The performance of stakeholders and policymakers influences sustainability performance, and the system’s structure then reflects their behaviour, which comprises a core system, societal components, and natural components. The core system consists of a series of activities (production, aggregation, processing, distribution, and consumption, including waste disposal) through

which food commodities flow and a layer of services that support the flow. Both the socio-cultural setting and the natural environment are part of these activities. The first category contains all relevant laws, policies, norms of socio-culture, organisations, and infrastructure. The last category comprises ecosystems, genetics, air, water, and soil. This conceptual tool provides a comprehensive view of the food system and its interconnections, especially in the context of sustainable food and nutrition.

The three pillars or dimensions that make up sustainable food systems are economic, social, and environmental impacts (Van Bussel et al. 2022).



Source: Neven (2014)

Figure 2.2: The three dimensions of sustainable food systems

In terms of the economic dimension, a food system is sustainable if each actor in the food system participates in activities that are economically and commercially lucrative. All stakeholders should reap the rewards of the actors, such as, profits for business ventures, remuneration for employees, taxes for governments, food supply improvements for customers and minimising food waste (Nguyen 2018).

Sustainability in the social dimension refers to socially and culturally acceptable foods that contribute to advancing health and nutrition, indigenous foods, labour conditions and animal welfare (Nguyen 2018). This dimension also focuses on food security and sustainability. It

promotes food sovereignty and empowers local communities to make informed decisions about their food choices.

In the environmental dimension, food systems are at the centre of international challenges such as climate change, reducing the carbon footprint, conserving natural resources, reducing agricultural degradation, decreasing food loss and waste, reducing GHG emissions and maintaining the earth's biodiversity by promoting sustainable agricultural practices such as agroecology (El Bilali 2018; El Bilali et al. 2019). Therefore, Figure 2.2, indicates that each dimension is integrated, and each actor's effectiveness directly affects the other (Nguyen 2018; El Bilali, Strassner and Ben Hassen 2021).

### **2.2.1 The importance of sustainable diets**

Sustainable diets are “diets that have minimal adverse effects on the environment that support food and nutrition security and healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair, affordable; nutritionally adequate, safe, and healthy while optimising natural and human resources” (Burlingame and Dernini 2012; British Dietetic Association 2022).

Sustainable diets play a vital role in food supply chains to combat environmental concerns connected to increased GHG emissions, social issues related to malnutrition, and low-quality diets, as well as developing sustainable, nutritious food that is available and accessible to all (Schäfer 2023). A sustainable diet is also considered healthy since it has the lowest impact on the environment and food supply chain. Adopting a sustainable diet can assist individuals in maintaining their health and well-being while also ensuring that there are enough natural resources on the planet to support food system sustainability and feed future generations (Berry et al. 2015; FAO 2019). The World Wildlife Fund (2016) states that a dietary shift to more sustainable diets by consuming less meat and managing food waste in high-income countries can significantly reduce the global carbon footprint along the food chain and produce sufficient food for the earth.

Sustainable diets lower the risk of diet-related diseases and NCDs (Aleksandrowicz et al. 2016). A diet rich in fruits, vegetables, whole grains and legumes is nutrient-dense and can positively influence health outcomes and the environment, especially compared to a diet high in meat, animal products and processed foods (Chai et al. 2019; Whittall et al. 2023). According to the FAO (2024b), food production must rise by 60% by the year 2050 to meet the demands

of an expanding worldwide population. However, the food industry is responsible for more than one-third of global GHG emissions that contribute to climate change (Ishangulyyev, Kim and Lee 2019). Strengthening the resilience of landscapes, natural environment, biodiversity, and the livelihoods of those who depend on them requires optimising agricultural land productivity. Transitioning to sustainable dietary patterns would sustain future production as it would alleviate climate change and the exhaustion of natural resources, such as energy, water, land use, and biodiversity.

### **2.3 Importance of food and nutrition sustainability**

Food and nutrition sustainability has gained significant attention in recent years, especially as worldwide issues such as climate change, malnutrition, and food insecurity become more pronounced. The interconnection of sustainable food systems is crucial for ensuring sufficient nutrition and promoting environmental well-being and economic resilience. Sustainable food systems encompass methods that foster the production, distribution, and consumption of food in processes that are environmentally sustainable, socially just and economically feasible. According to the 2024 Global Food Policy Report, the transformation of food systems is essential for achieving sustainable and healthy diets that are accessible to the entire population. This report underscores that inadequate dietary quality constitutes a primary contributor to global morbidity, with projections indicating that approximately one in five lives could be saved by adopting improved dietary practices (International Food Policy Research Institute 2024). Supporting this assertion, a comprehensive investigation examining global data from 1990 to 2020 revealed that in the year 2020 alone, sugar-sweetened beverages were associated with 2.2 million incidences of type 2 diabetes, 1.2 million occurrences of cardiovascular disease, and 340,000 fatalities on a global scale (Miller 2025). Improving dietary quality has the potential to prevent more than 11 million premature deaths, accounting for approximately 24% of all global fatalities (Wang et al. 2019).

#### **2.3.1 Definition and significance of food and nutrition sustainability**

Food and nutrition sustainability refers to the practices and policies that ensure food systems can provide healthy diets for current and future generations while minimising environmental impact. This concept includes a range of issues, including agricultural practices, food production, distribution, consumption, and waste management (Willett et al. 2019). Sustainable food systems strive to balance the economic, social, and environmental aspects of food

production. They promote biodiversity, reduce GHG emissions, and efficiently utilise resources, all while ensuring that communities can access nutritious food (Ben Hassen and El Bilali 2022). As global populations rise and climate change poses increasing challenges, food sustainability has become an important concern for governments and communities worldwide (Ben Hassen and El Bilali 2022).

Its potential to address several critical global challenges, including hunger, malnutrition, and environmental degradation, underscores the importance of food and nutrition sustainability. One multidisciplinary strategy for tackling these issues is the Mediterranean diet, which is an example of food and nutrition sustainability. The Mediterranean dietary pattern is congruent with the sustainability framework by emphasising the consumption of plant-based foods, including fruits, vegetables, and whole grains, which exhibit a reduced environmental footprint compared to animal-based products. This diet underscores the importance of locally sourced and seasonal produce, reducing food miles and food waste. By encouraging more nutritious dietary habits, it simultaneously facilitates sustainable public health benefits and positive environmental effects (Serra-Majem and Ortiz-Andrellucchi 2018). Sustainable practices can increase food security by making food systems more resilient to economic shocks and climate change (Headey and Ruel 2022). Additionally, prioritising local and seasonal foods can strengthen local economies and improve community well-being (Vargas et al. 2021). Global food supply chains had vulnerabilities during the recent COVID-19 pandemic, highlighting the need for more robust and sustainable systems (Jagtap et al. 2022). Food and nutrition policies must incorporate sustainability to promote health, equity, and environmental conservation as countries work to achieve the United Nations' SDGs, particularly Goal 2 (zero hunger) and Goal 12 (responsible consumption and production) (Willett et al. 2019; Ali et al. 2023).

Additionally, the necessity of dietary shifts toward more plant-based meals is emphasised by food and nutrition sustainability, which can significantly lower the carbon footprint of our food systems (Nolden and Forde 2023). The current global food system relies heavily on animal agriculture, contributing to GHG emissions, land degradation, and biodiversity loss (Eisen and Brown 2022). Adopting diets abundant in fruits, vegetables, legumes, and whole grains enhances individual health by mitigating the risk of chronic diseases. Also, it plays a pivotal role in promoting a more sustainable food system (Alcorta et al. 2021). Efforts such as the EAT-Lancet Commission encourage dietary frameworks that simultaneously enhance health and sustainability, providing recommendations for food consumption that align with

environmental standards while fostering human health (Willett et al. 2019). By contributing to awareness and education regarding sustainable dietary practices, communities can develop habits that strengthen their well-being and planetary health.

Frameworks for policies play a key role in advancing food and nutrition sustainability. Various stakeholders, including governmental entities, non-governmental organisations, and international bodies, progressively acknowledge the need for holistic policies that facilitate sustainable agricultural methodologies, improve food security, and mitigate food waste (El Benni, Grovermann and Finger 2023). Approaches such as encouraging local food production, allocating resources towards regenerative agricultural practices, and executing programmes aimed at reducing food waste are fundamental for establishing sustainable food systems. Furthermore, initiatives designed to raise public awareness can assist consumers in making discerning decisions regarding their food acquisitions while motivating them to endorse sustainable practices (Haley et al. 2023). Incorporating sustainability into food policies augments resilience in the face of climate change and promotes social equity by guaranteeing that underserved populations have access to nutritious food options (Serra-Majem and Ortiz-Andrellucchi 2018). As the global community confronts persistent challenges associated with food security and environmental degradation, a unified commitment to food and nutrition sustainability becomes essential for cultivating a healthier and more equitable future.

## **2.4 Sustainable Development Goals**

The Sustainable Development Goals (SDGs) have been formulated with the intention of enhancing the quality of human existence, preserving ecological integrity, augmenting economic wealth, and facilitating economic advancement (Lemaire and Limbourg 2019; Fleetwood 2020). The SDGs play a pivotal role in the eradication of poverty and hunger, the reduction of carbon emissions, and the assurance of a sustainable ecological framework for future generations. The overarching objective is to realise these goals by the year 2030, encompassing a total of 17 distinct SDGs (Lemaire and Limbourg 2019; De Iorio, Zampone and Piccolo 2022; Olabi et al. 2022). For an extended duration, the SDGs have been instrumental in raising awareness regarding sustainability and mitigating food waste, particularly in the context of achieving SDG 12, which pertains to sustainable consumption and production. The urgency to achieve the SDGs by 2030 is paramount for tackling a diverse array of challenges linked to climate change (Lemaire and Limbourg 2019).

### 2.4.1 Sustainable food and nutrition paradigms

The four paradigms that concentrate on sustainable food and nutrition are health and nutrition, economic, environmental, and socio-cultural. Sustainable Developmental Goal 1 (no poverty), SDG 2 (zero hunger), and SDG 3 (good health and well-being) all pertain to health and nutrition. Economical refers to the accessibility and affordability of sustainable food products to all demographic groups. The environmental component of sustainability relates to consumer knowledge, behaviours, and dietary choices that increase climate change-related carbon emissions. Sustainable Development Goal 13 (climate action), SDG 11 (sustainable cities and communities), and SDG 12 (responsible consumption and production) are all closely tied to this paradigm. An all-inclusive, culturally appropriate food is part of the socio-cultural paradigm that prioritises the right of people and communities to define their own food systems, ensuring access to culturally appropriate and sustainably produced food. This paradigm aligns with SDG 10 (reduced inequalities) and SDG 16 (peace, justice, and strong institutions), as it emphasises inclusivity, equity, and the preservation of cultural traditions in food systems (Ruben et al. 2021; United Nations Environment Programme 2023).



Source: Kerry Health and Nutrition Institute (2020)

Figure 2.3: Dimensions of food and nutrition sustainability

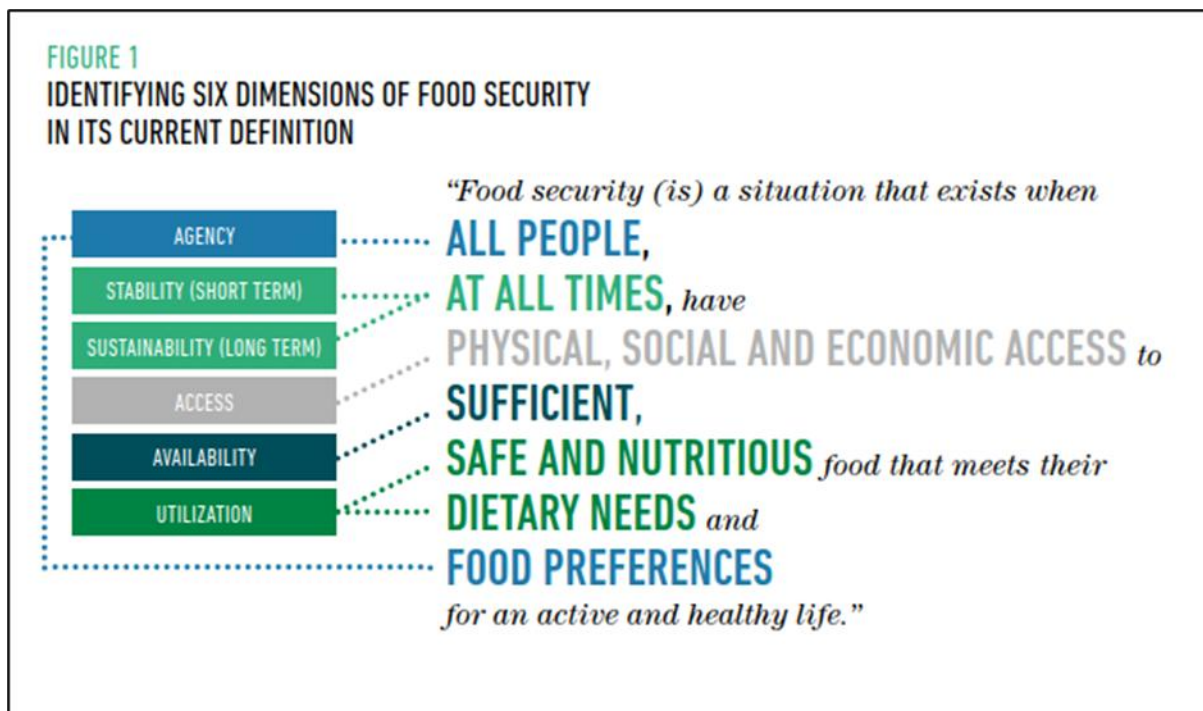
## **2.5 Food security and sustainability**

Food security and food sustainability are the two primary concepts at the centre of the food system debate. The current priorities are food security, GHG emissions and waste management to alleviate environmental degradation and attain the 2030 SDG agenda (Gustavsson et al. 2011; Masson-Delmotte et al. 2019; FAO 2024b). Although they are often discussed separately in scientific literature, this needs to evolve to expedite the essential transition to a sustainable food system (El Bilali et al. 2019). Food security is the condition in which everyone, at all times, has physical and financial access to an adequate supply of safe, nourishing foods that satisfy their dietary needs and food choices for an active and healthy life (FAO 1996; Gibson 2012; El Bilali et al. 2019; FAO 2024b).

Food security comprises more than just putting food on the table; it also concentrates on aspects such as malnutrition, obesity, hunger seasons, and a lack of nutritional diversity (Oxford 2018). Furthermore, 35% of women are unable to buy food for five days or longer at a time. It is a typical habit for consumers to skip meals to survive. Given that not everyone can participate in urban agricultural activities (such as vegetable gardens), young adult consumers in urban areas must buy food (Eastham 2017). The elevated unemployment rate exacerbates this challenge, especially for young consumers.

### **2.5.1 Dimensions of food security**

Up until recently, food security has typically been understood by the four key dimensions, also commonly known as pillars of food security: availability, access, utilisation, and stability. Two additional dimensions, agency and sustainability have been increasingly recognised as integral to food security. The study will thus discuss the six dimensions of food security in greater detail.



Source: High Level Panel of Experts on Food Security and Nutrition (2020)

Figure 2.4: Dimensions of food security

### 2.5.2 Availability

Food availability pertains to the presence of sufficient quantities of food across various scales, including national, international, and regional levels. Food supply systems and agricultural productivity are strongly related to this component. Climate change is having a growing influence on the availability of food due to its effects on agricultural crop yields and methods of food production (High Level Panel of Experts on Food Security and Nutrition 2020; FAO, International Fund for Agricultural Development, UNICEF, World Food Programme and World Health Organization 2021).

### 2.5.3 Access

Access to nourishment is fundamentally connected to sustainability, as equitable distribution of food resources and sustainable agricultural practices are imperative for the prolonged health of the environment and societal stability (Viroli, Kalmpourtzidou and Cena 2023). Research findings demonstrate that the enhancement of food accessibility has the potential to substantially decrease food waste and mitigate the carbon emissions related to food production (Bhatia et al. 2023). Sustainable agricultural practices, which encompass techniques such as the diversification of crops and the minimised application of synthetic fertilisers, not only

preserve natural resources but also enhance food security by sustaining soil fertility and water availability (Nadarajah and Abdul Rahman 2023). In addition, policies that support equitable trade and improve local food systems can give rise to more resilient food systems that show decreased vulnerability to interruptions in global supply chains. Therefore, incorporating sustainability into food access frameworks is critical for cultivating a more resilient and equitable international food system (Orengo Serra and Sánchez-Jauregui 2023).

#### **2.5.4 Utilisation**

Sustainable engagement with food involves improving production and consumption practices to reduce environmental consequences and support resource sustainability. The prevention of food waste through improved management techniques and the use of modern technology is an efficient strategy that will preserve resources and significantly decrease GHG emissions (Gustavsson et al. 2011; Riahi et al. 2017). Sustainable farming practices, such as organic farming and crop variety, can increase soil vitality and reduce reliance on artificial pesticides and fertilisers (Holka, Kowalska and Jakubowska 2022; Jaworski et al. 2023). The advocacy for plant-based dietary patterns represents another vital aspect, as the transition from animal-based to plant-based nutritional sources can reduce the carbon footprint and alleviate pressure on water resources (Viroli, Kalmpourtzidou and Cena 2023). Collectively, these approaches contribute to establishing a more resilient food system that promotes long-term environmental sustainability (Rikkonen et al. 2023).

#### **2.5.5 Stability**

The stability of food systems is closely linked to sustainability, as resilient food systems are better equipped to handle environmental changes and economic shocks (Ali et al. 2023). Research has highlighted that sustainable agricultural practices, such as soil conservation and agroecology, enhance the stability of food production by maintaining ecosystem functions and reducing vulnerability to climate change (Akanmu et al. 2023). Additionally, diversifying crop varieties and improving resource management can mitigate risks associated with pest outbreaks and extreme weather events, ensuring a more consistent food supply (Derbile, Dongzagla and Dakyaga 2019). Integrating local and sustainable practices into food supply chains can bolster food system stability by reducing dependence on global markets and fostering community-based resilience. Consequently, prioritising sustainability in food systems is essential for

achieving long-term stability and security in food availability (Avendano-Uribe, Lukosch and Milke 2022; Joshi et al. 2023).

### **2.5.6 Sustainability**

The sustainability of food systems is paramount for ensuring long-term environmental health, economic stability, and social justice. Recent studies emphasised that sustainable food practices, such as adopting agroecological methods and reducing food waste, are essential for mitigating environmental impacts and preserving natural resources (Cho, Devendorf and Voids 2021; Bhatia et al. 2023). For example, integrating practices like crop rotation and organic farming helps sustain soil health and biodiversity, contributing to more resilient agricultural systems (Yu et al. 2022; Gamage et al. 2023). Additionally, sustainable food systems aim to diminish GHG emissions through improved food production and distribution efficiency, aligning with global climate goals (Gao and Cabrera Serrenho 2023). Furthermore, promoting sustainable diets, which include more plant-based foods and less resource-intensive animal products, can significantly decrease the environmental footprint associated with food consumption (Tachie, Nwachukwu and Aryee 2023). Consequently, the advancement of sustainability within the food systems is crucial for tackling urgent environmental challenges to ensure a secure food future (Beal et al. 2023; Ivanovich et al. 2023).

### **2.5.7 Agency**

The notion of agency within food systems, denoting the ability of individuals and communities to exercise independent decision-making concerning food production, distribution, and consumption, is crucial for promoting sustainability (Wood et al. 2023). Strengthening local communities to manage their food systems can result in adopting more sustainable practices such as organic farming and local sourcing of foods, which reduce environmental impacts and promote biodiversity (Holka, Kowalska and Jakubowska 2022). Communities are more likely to embrace methods that support sustainable development objectives and address local environmental concerns when they have control over their food resources (Imoro et al. 2021). Furthermore, enhancing food sovereignty through the support of small-scale farmers and local producers can reduce reliance on industrial agriculture and cultivate more resilient food systems. Consequently, fostering agency within food systems is imperative for driving sustainability and ensuring that food practices are both environmentally and socially responsible (Byaruhanga and Isgren 2023).

The six dimensions of food security provide a comprehensive framework for understanding and addressing food security and insecurity in all its forms, from immediate hunger to long-term sustainability and nutrition.

### **2.5.8 Food insecurity and food waste linked to the food supply chain**

Food insecurity is the state in which an individual does not have frequent access to enough safe and nourishing food for healthy growth and development. This might be brought about by a scarcity of food or the inability to access food (FAO 2024a). According to Bravi et al. (2020), food waste has increased the incidence of food insecurity in South Africa, leaving thousands malnourished and hungry. According to data from South Africa, over 23.6% of the country's population experienced moderate to severe food insecurity in 2020, with approximately 14.9% suffering from severe food insecurity because of the COVID-19 pandemic (Dordley 2022). Most of the food waste in South Africa comes from vegetables and fruits (44%), cereals (26%), meat and dairy products (15%), and roots and tubers (13%). This considerably exacerbates household food insecurity (Grosso and Falasconi 2018; Santeramo and Lamonaca 2021).

In South Africa, approximately 25% of households either endure or are vulnerable to hunger, whilst over 50% of the populace experiences food insecurity or is at risk thereof. Furthermore, as the costs of food escalate, it becomes increasingly unaffordable for economically disadvantaged individuals (Parlinska and Pagare 2018). As indicated by Koyanagi et al. (2019), 23% of South Africans confront moderate to severe food insecurity, with 14% experiencing severe food insecurity. The demographic of South Africa is confronting significant food security issues that have been aggravated by the COVID-19 pandemic, giving rise to elevated food costs and migration from rural to urban areas. The intensifying trend of urbanization exerts pressure on the urban supply chain and precipitates shortages in rural regions (Oxford 2018; Hall et al. 2020). Food scarcity is a serious problem and a reality in both developed and developing countries worldwide; the world loses or squanders one-third of the total food production due to food waste. Subsequently, it is imperative to reduce food loss and waste as this promotes food security and environmental sustainability (Marx-Pienaar et al. 2019).

### **2.5.9 Economic repercussions stemming from the phenomenon of food wastage**

In South Africa, it is estimated that approximately 10.3 million tonnes of consumable food are discarded annually prior to reaching the diets of individuals (Mmereki et al. 2024). As reported by Oelofse, Muswema, and Ramukhwatho (2018), the magnitude of food loss and waste

constitutes 45% of the total food supply within the nation, despite South Africa being a net food exporter. The proportion of food waste in South Africa corresponds to 34% of domestic food production. Furthermore, this phenomenon exerts significant repercussions on the economy, environment, and climate. According to Richards and Hamilton (2018), two primary issues adversely affecting both economic and environmental sustainability are food surplus and food waste. The economic repercussions stemming from food loss and waste in the country persist consistently (Bega 2021). Projections indicate that food waste is anticipated to more than double by the year 2050. In addition, it is foreseen that the global demand for food will increase annually, thereby intensifying agricultural production (Hiç et al. 2016). The issue of food waste necessitates the exploitation of land to satisfy the growing demands of the population. This situation has far-reaching implications for land utilised in agricultural activities and can only be effectively managed if 70% of the land is allocated for agricultural production. Moreover, this predicament compels farmers to expand agricultural land or to employ genetic modification strategies to enhance yield per unit area. Such policies not only pose a threat to the environment but also risk the extinction of biodiversity-rich areas (Bravi et al. 2020; Huang, Chen and Zhang 2018).

## **2.6 Environmental impact of food production**

Food production significantly contributes to environmental degradation, affecting land, water and air quality. Agriculture utilises approximately 40% of the earth's land, resulting in deforestation, ecosystem deterioration and decreased land (Kamau, Roman and Biber-Freudenberger 2023). Agricultural land expansion driven by the demand for food and biofuels transforms natural habitats such as forests and grasslands into croplands and pastures. According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2019) report, this change contributes to GHG emissions by emitting stored carbon into the atmosphere and reducing wildlife habitats.

According to Cheng, McCarl and Fei (2022), cattle production is a major contributor to environmental decline, through methane emissions from cows and nitrous oxide emissions from manure management and fertiliser use. According to the FAO (2023), these powerful GHGs exacerbate global warming by contributing to climate change. Furthermore, raising livestock has a notable water footprint because it requires much water for animal husbandry and feed production, sometimes in areas with scarce water supplies (Mekonnen and Hoekstra 2020). In various regions, excessive water extraction for irrigation intensifies water stress,

compromising freshwater sources for consumption, sanitation, and aquatic ecosystems (United Nations Water 2022). Sustainable agricultural approaches such as agroecology and pest control to alleviate these environmental effects by maintaining soil health, reducing pesticides, and improving water efficiency are becoming more widely acknowledged (FAO 2023).

Furthermore, climate change brings on issues with food security and nutrition, which puts additional strain on the world food system. Extreme weather phenomena, including floods and droughts, which also interfere with agricultural productivity, exacerbates food insecurity (Intergovernmental Panel on Climate Change 2022). Small-scale farmers are particularly prone to these climate effects because they mostly rely on agriculture reliant on rainfall. Reducing environmental footprints and responding to climate change requires sustainable agricultural techniques that build resilience, such as diverse cropping systems and improved water management (FAO 2023).

## **2.7 Environmental impact of diet: a carbon footprint perspective**

In recent years, the SDGs have placed considerable focus on evaluating the carbon emissions associated with different foods and food-related products. Changing eating behaviours across various countries presents significant challenges, particularly given the growing awareness about carbon footprints and the phenomenon of global warming (Afrouzi et al. 2023). The carbon footprint associated with dietary patterns plays a critical role in influencing global GHG emissions, with food production responsible for an estimated one-quarter of total emissions (Riahi et al. 2017). Animal-derived food products, particularly beef and dairy, represent some of the most significant sources of methane emissions stemming from livestock and manure management practices (Xu et al. 2021). For example, 1 kg of beef produces approximately 22 kg of CO<sub>2</sub>e emissions, whereas pork generates roughly 6 kg, and chicken emits only about 1.5 kg (Xu et al. 2021). Conversely, plant-based foods, which include grains, legumes, and vegetables, typically exhibit a significantly lower carbon footprint, making them preferable sustainable alternatives (Tachie, Nwachukwu and Aryee 2023).

### **2.7.1 Methods for calculating the environmental impact of diet**

Various methods describe how to assess the environmental impact of diets. It is vital to understand these methods to contribute to sustainable dietary practices. The study will thus discuss a brief overview of a few key methods:

### ***2.7.1.1 Life cycle assessment***

Life cycle assessment represents one of the most comprehensive approaches for assessing the environmental consequences of food systems. It analyses the entire life cycle of food products, from raw material extraction through production, distribution, consumption, and disposal. It evaluates various environmental indicators, including GHG emissions, water consumption, land utilisation, and energy consumption (Saade et al. 2022; Gao and Cabrera Serrenho 2023). According to a study by Poore and Nemecek (2018), life cycle assessment is essential for understanding the impacts of diverse dietary patterns, allowing researchers to effectively compare the environmental effects of meat- and plant-based diets. The flexibility of life cycle assessment renders it appropriate for evaluating either individual food items or complete diets (Kamari, Kotula and Schultz 2022).

### ***2.7.1.2 Carbon footprint analysis***

A carbon footprint analysis measures the total GHG emissions associated with a person, group, activity, or product over a given period. They are expressed as CO<sub>2</sub>e (Mostafaei et al. 2023). It includes all direct and indirect emissions from activities such as manufacturing, transportation, energy consumption, and waste disposal. Understanding carbon footprints is paramount for alleviating climate change, as GHGs play a significant role in global warming and environmental degradation (Gao and Cabrera Serrenho 2023; Mostafaei et al. 2023). For example, recent studies emphasised the substantial emissions linked to the food system, estimating that agriculture, including livestock production, is responsible for approximately 25% of global GHG emissions (Karunathilake et al. 2023; Raihan and Himu 2023). Consequently, carbon footprint analysis serves as a vital instrument for understanding and mitigating GHG emissions across diverse sectors.

### ***2.7.1.3 Ecological footprint analysis***

Ecological footprint analysis assesses the biological capacity required for producing consumed resources and managing waste generated through anthropogenic activities, particularly concerning dietary habits. This method indicates the environmental impact in terms of global hectares. The ecological footprint can show how dietary decisions and the planet's ability to regenerate itself differentiate (Ferreira et al. 2023). According to Jie et al. (2023), global food production contributes to nearly one-third of all GHG emissions. Ecological footprints have been used to advocate for lifestyle modifications and to draw attention to the underlying factors

that support unsustainable consumption patterns. Researchers have integrated human development indicators with footprint analysis to assess a country's progress toward sustainable development. The ecological footprint of sustainable development is insignificant regarding the number of biological resources per person (Jie et al. 2023).

#### ***2.7.1.4 Dietary modelling***

Dietary modelling predicts how nutritional changes will affect sustainability by combining information on food consumption trends with estimates of environmental repercussions. This strategy usually uses statistical techniques and simulations to analyse possible changes in consumption, such as consuming less meat or more plant-based foods (Probst et al. 2016). According to a study by Clark et al. (2019), dietary change modelling might be used to successfully depict how adopting plant-rich diets could reduce resource use and GHG emissions. This approach works well for guiding policy recommendations and public health interventions.

## **2.8 Consumer behaviour, attitudes, perceptions and emotions concerning food and nutrition sustainability**

Matharu, Jain and Kamboj (2020) have analysed the determinants that shape sustainable consumption, indicating that a health-oriented and sustainable lifestyle encourages consumer behaviour that support the adoption of eco-sustainable products. Furthermore, other researchers have observed that the intention to acquire eco-sustainable products depends on the type of product and is, in any case, correlated to the utilitarian value perceived by the consumer (Park and Lin 2020). Recent studies interested in exploring the cognitive variables related to sustainable behaviour have underscored, on the one hand, that social factors and technological knowledge enhance sustainable consumption by forming the basis of the sharing economy (Dabbous and Tarhini 2019; Goyal, Garg and Luthra 2022). Conversely, factors such as social influence and price improve the sustainable performance of consumers and suppliers (Wang et al. 2019). Consumers are becoming more aware of their dietary choices and their contribution to environmental well-being (Culiberg et al. 2022).

Young adults are increasingly aware of food and nutrition sustainability, shaping their consumption patterns. This demographic group often prioritises health, ethical sourcing, and the environmental impact of their dietary choices (Kennedy, Raiten and Finley 2020). Research indicates that younger consumers are more likely to seek out organic, locally sourced, and

plant-based options, motivated by concerns over climate change and animal welfare (Kennedy, Raiten and Finley 2020). The impact of social media plays a substantial role in influencing young adult behaviour, as platforms such as Instagram and TikTok promote sustainable diets and food trends (Muca et al. 2023). A desire to align their purchasing decisions with their ethical values drives many young consumers, often engaging in activities such as meal preparation to mitigate waste and choosing brands that prioritise sustainability (Wang 2023).

Considering the theory of planned behaviour, some students have acknowledged how the consumer's attitude towards sustainable products is influenced by many factors that act as barriers, such as the elevated costs, the perceived adverse effects linked to the purchase or consumption of certain products, but also as incentives for sustainable consumption, referring to the brand image or the use of that product by acquaintances or relatives (Sheoran and Kumar 2022). Overall, it is apparent that young adults can drive substantial shifts in the food sector through their sustainable consumption habits.

### **2.8.1 Consumer behaviour**

Environmental degradation is an urgent global challenge. According to the World Health Organization (2023a), research indicates that approximately 3.6 billion individuals reside in regions that are highly susceptible to the impacts of climate change. It is anticipated that between the years 2030 and 2050, climate change will result in an estimated 250 000 additional fatalities annually, attributable to undernutrition, malaria, diarrhoea, and heat stress alone (World Health Organization 2023a). Authorities project that the direct financial repercussions on health (excluding expenditures related to health-determining sectors such as agriculture, water and sanitation) to range from US\$ 2 to 4 billion per year by the year 2030 (World Health Organization 2023a). Consequently, there is an increasing awareness that anthropogenic activities primarily drive the numerous environmental issues and their detrimental effects (Nguyen and Johnson 2020). Essentially, consumer behaviour imposes a dual environmental burden on the ecosystem through pollution and the depletion of non-renewable natural resources (Abeliotis, Koniari and Sardionou 2010). Therefore, encouraging more pro-environmental behaviour is imperative for achieving environmental sustainability. This represents a challenge that governments, businesses, and socio-environmental organisations have persistently endeavoured to confront.

Nguyen and Johnson (2020) highlighted that the special issue of the *Journal of Consumer Behaviour on consumer behaviour and environmental sustainability* has several implications. Initially, a multitude of motives and determinants, which encompass internal, social, situational, and demographic factors, shaped environmentally sustainable behaviour. Subsequently, the influence of such factors appears to differ across various national and consumer contexts. Furthermore, integrative and comprehensive models that incorporate mediators and/or moderators may be employed to enhance the understanding of the mechanisms through which various factors influence pro-environmental behaviour (Nguyen and Johnson 2020). Additionally, green marketing initiatives (for example, sustainable products, and eco-friendly advertising) could be leveraged to foster consumer pro-environmental beliefs and behaviours. Furthermore, marketers ought to tailor interventions designed to influence habits and promote environmentally sustainable behaviour for distinct target groups, including individuals with different personality traits, environmental concerns, and degrees of engagement in domestic environmental practices (Nguyen and Johnson 2020).

The change in nutritional patterns through the evolution of consumer food choices and preferences toward more sustainable and health-oriented alternatives has gained considerable momentum. This phenomenon signifies a decline in the intake of animal-based foods coupled with an escalation in the consumption of plant-based food products. The behaviour of food consumers constitutes an essential element of the sustainability framework and, correspondingly, plays a crucial role in finding support for the protein transition (Onwezen and Dagevos 2024). Even though the topic of sustainable food consumption has gained attention within academic and policy discourses, this attention has yet to materialise into definitive ambitions and specific policies concerning the protein transition throughout Europe. It is noteworthy that the European Commission has articulated in its Farm to Fork Strategy in 2020 that transitioning towards a diet with a higher proportion of plant-based foods and a reduced intake of meat is key to enhancing the sustainability of food consumption patterns from both health and environmental perspectives. However, this acknowledgement does not mitigate the fact that policy initiatives frequently prioritise the production of plant-based proteins, while consumption and demand-side strategies receive merely secondary attention (European Commission 2020).

The Netherlands, however, has embarked on an initial endeavour to rectify this imbalance: “in 2022, the Dutch Ministry of Agriculture stated the policy target of adjusting the ratio of plant-

based to animal-based protein consumption from the current 43/57 to 50/50 by the year 2030.” This policy objective is significant for at least two reasons. First, public policymaking here tentatively challenges the political taboo surrounding the discussion of meat moderation. With the notable exception of Flanders (Belgium), we are not cognisant of other contemporary examples at the national level wherein authorities have established a direct policy objective to rebalance protein consumption away from meat. Most national policies do not reference the protein transition, let alone address the reduction of meat consumption, and the countries that do focus on the protein transition predominantly focus on shifts in the supply side, such as food production and provision (for example, Austria, Denmark, and the United Kingdom). Second, because behavioural change is pivotal to this Dutch policy objective, consumers are considered important agents of change. This perspective on consumer behaviour is innovative within the realm of food policymaking (Onwezen and Dagevos 2024). Food consumers are attached on a personal, social, and cultural level to their meat-centric dietary patterns that are deeply ingrained in various aspects of their lives, such as grocery shopping and social events. Consequently, bending the meat curve by reducing meat consumption or substituting meat products for alternative plant-protein foods is anything but self-evident. Therefore, to promote the consumption of alternative plant proteins among consumers, adequate support is needed. A deeper understanding of the drivers motivating consumer behaviour in the areas of meat reduction and substitution with alternative protein products could support policymaking and the execution of policies that facilitate the protein transition (Onwezen and Dagevos 2024).

### **2.8.2 Consumer attitudes**

In comparison to other factors such as consumer behaviour, consumer perceptions and consumer emotions, researchers have investigated the impact of consumer attitudes frequently (Onwezen et al. 2021; Nguyen et al. 2022). In a consumer behaviour context, attitudes are explained as a learned preference to behave in a consistently favourable or adverse way toward a specific object (Schanes, Dobernig and Gözet 2018). Researchers evaluate attitudes by asking questions or making assumptions from observed behaviour (Russell et al. 2017). For instance, questioning a consumer who habitually purchases a product and even recommends it to acquaintances and relatives. This illustrates that the consumer has a positive attitude towards the brand or product (Rathore et al. 2023). Attitudes are relevant to purchasing behaviours. Furthermore, marketers cultivate through direct engagement with the product, as well as through verbal information, advertising broadcasts, internet platforms, social media, and

various other marketing modalities (Wansink 2018). Their beliefs concerning sustainability and the evolution of their dietary preferences influences the perspectives of consumers regarding the substitution of meat and the reduction of meat consumption. Consumers can cultivate both affirmative and adverse attitudes concurrently; for example, they may relish the flavour of the meat while simultaneously expressing affection for animals, a phenomenon commonly referred to as the “meat paradox”. The term “ambivalence” characterises this notion (Kouarfaté and Durif 2023). Research indicates that consistent exposure to meat alternatives is essential for the formation of a positive attitude (Weinrich 2019).

### **2.8.3 Consumer perceptions**

Perceptions are defined as “cognitive constructs, convictions, or images that consumers possess stemming from their comprehension or interpretation of food-related sustainability” (Oxford learner’s dictionaries 2024). The classification “food choice” encapsulated perceptions regarding sustainable, local, and organic dietary selections. In quantitative studies, when consumers articulated their motivations for or barriers to sustainable food choices, they predominantly referenced food safety, elevated costs, enhanced flavour, and superior quality food items. Homogenous to sustainable food, locally sourced products were similarly characterised by attributes of food safety, better taste, and superior quality food items. In addition, consumers regarded local and organic food options as healthy (Van Bussel et al. 2022). In qualitative studies, motivations for preferring sustainable, locally sourced, and organic food options exhibited greater diversity. Consumers believed that sustainable food items were challenging to procure, inconvenient to utilise, more expensive, and more reliable. However, the consideration of sustainable foods remained relatively minimal. Consumers favoured organic food selections due to their taste and superior quality; however, they perceived the elevated price as a significant barrier. Perceptions of price in locally produced foods were inconclusive, consumers mentioned both cheaper and more expensive prices (Van Bussel et al. 2022).

According to Van Bussel et al. (2022), qualitative research methodologies (for example, focus groups or interviews) can clarify the essential perceptions held by consumers. One of the challenges in both quantitative and qualitative research approaches is obtaining the “true” perceptions of consumers. Certain perceptions are susceptible to social desirability biases; for instance, respondents may exaggerate their engagement in sustainable behaviours and assign higher levels of importance to ethical considerations (for example, child labour, labour

conditions, and animal welfare). Emotions such as guilt may influence these ethical dilemmas. Despite consumers' assertions regarding the importance of ethical production and sustainable consumption, the market share of sustainable food products remains comparatively low. Consequently, social desirability may lead to the disproportionate representation of specific subcategories, thereby introducing biases within those subcategories (Van Bussel et al. 2022).

A study by Van Bussel et al. (2022) stated that it would be pertinent to explore consumers' perceptions of food sustainability in low-income nations, given that their food systems are predominantly rural-based. This could provide new insights on how consumers can transition to a more sustainable food system, with equal access to food. As previously indicated, there exists a paucity of knowledge regarding the perceptions of food sustainability among children and adolescents (Van Bussel et al. 2022). A few studies introduced educational programmes pertaining to sustainable consumption, intending to raise awareness regarding ethical consumption practices (Schmid 2012) or facilitating improved decision-making related to sustainable consumption (Hadjichambis et al. 2015). Only Francis and Davis (2015) undertook an investigation that addresses sustainability issues and the underlying reasons for the absence of sustainable consumption among adolescents, although this study did not specifically focus on food-related sustainability. Therefore, it is of paramount importance to observe younger demographic groups and monitor their perceptions regarding environmental matters. This is particularly crucial given that climate change will have a profound impact on future generations. One challenge is that some customers are apprehensive about reducing their meat intake. Consumers mentioned that meat constitutes an important component of a meal, and is integral to a balanced diet, and consumers appreciate the sensory attributes of meat (for example, its satiating properties and taste) (Van Bussel et al. 2022). Consequently, these perceptions warrant acknowledgement, and it is advisable to advocate for the incorporation of healthy meat alternatives.

#### **2.8.4 Consumer emotions**

Emotions are defined as affective cognitive states or, more precisely, as distinct emotional experiences (Onwezen et al. 2021). An extensive array of scholarly reviews referenced emotions as a potentially significant determinant, exhibiting noteworthy impactful outcomes (Bryant and Barnett 2020; Onwezen et al. 2021; Fonseca and Sanchez-Sabate 2022), although scholars have documented mixed effects, and it is generally acknowledged that this domain remains inadequately explored (Taufik et al. 2019; Onwezen et al. 2021). Nevertheless, it is

frequently observed that negative emotions are predominantly emphasised. Consequently, there is a need to compare and evaluate multiple emotions because there is a gap in knowledge regarding this issue. Researchers deduced that the acceptance to consume more plant-based foods as compared to meat products was increased by activating positive emotions and creating environmental messages that evoke emotions in the consumers, which tended to promote healthier food choices (Bryant and Barnett 2020; Onwezen et al. 2021). For instance, depictions of emotional messages are associated with the subjects of animal slaughter, the anguish of animals, or the presence of unrefined meat, all intended to increase the sense of disgust among consumers; messages about the attributes of animals or the dynamics of human-animal bonds aim to elevate feelings of remorse; visual portrayals of cute and young animals encourage empathy and caregiving motivations (Kwasny, Dobernig and Riefler 2022). Ultimately, the researchers noted discernible distinctions among specific categories of products, especially about cultured meat and insects, where they recognised feelings of revulsion as a considerable barrier to understanding consumer acceptance (Florença et al. 2022; Kröger et al. 2022).

## **2.9 Global and South African consumers' knowledge, attitudes, and behaviours towards food and nutrition sustainability**

The global debate on food and nutrition sustainability has gained momentum in recent years, driven by increased awareness of environmental challenges, health concerns, and food security issues associated with food systems (Crippa et al. 2021). Consumers' knowledge, perspectives, and behaviours concerning sustainable food practices are crucial in shaping the transition towards a more sustainable future (Nguyen 2018). Public awareness about sustainable food practices has grown substantially. However, geographic disparities influence the level of understanding and willingness to change behaviours. In South Africa, challenges such as food insecurity, restricted access to nutritional information, and economic factors influence consumer behaviours, with some individuals showing strong support for sustainable food choices, while others face barriers (Dasgupta and Robinson 2022; Pais, Marques and Fuinhas 2023). Understanding these behavioural patterns is vital for the development of effective policy frameworks and educational initiatives aimed at promoting sustainability within food systems.

### **2.9.1 Global perspectives**

Globally, there is an expanding body of research indicating that consumers are increasingly aware of the repercussions of their food choices. A comprehensive survey executed by the FAO

in 2023 disclosed that 74% of respondents articulated concern regarding climate change and its ramifications on food production (Intergovernmental Panel on Climate Change 2023; FAO 2023). This increased awareness is commonly correlated with a more positive attitude towards sustainable food practices, which involve local sourcing, organic agriculture, and reduced meat consumption. Research indicates that consumers are open to spending more for eco-products as a sign of changing purchasing habits (Camilleri et al. 2023).

Despite this positive advancement, the existence of knowledge gaps is still apparent. A significant segment of consumers exhibits a lack of understanding regarding the components that define sustainable food systems. Empirical studies suggest that numerous individuals predominantly equate sustainability with organic agricultural products while failing to acknowledge more extensive concerns such as food waste, carbon emissions, and ethical labour practices. Consequently, the implementation of robust educational and outreach programmes is imperative in cultivating consumer choices that are informed and aligned with sustainability goals (Çakmakçı, Salık and Çakmakçı 2023).

## **2.9.2 South African consumer perspectives**

In South Africa, the domain of food sustainability presents a multifaceted landscape, intricately influenced by socio-economic inequalities and cultural determinants. According to a study by Sumardjo, Firmansyah and Dharmawan (2023), awareness of food sustainability is increasing, particularly among the urban demographic group. However, this awareness is not consistent across various demographics. While consumers belonging to the middle and upper socio-economic strata frequently emphasise sustainability in their dietary selections, communities with lower income levels may encounter limitations in resources or access to sustainable alternatives, resulting in divergent attitudes and behaviours. Research conducted in South African cities revealed that consumers exhibit a positive attitude towards sustainable practices, particularly about the mitigation of food waste and the importance of locally sourced food (Ben Hassen and El Bilali 2022). However, practical barriers such as elevated costs, limited availability of sustainable products, and insufficient information hinder the adoption of these practices. The findings underscore the necessity for tailored educational initiatives aimed at addressing these barriers and promoting sustainable food systems across all consumer demographics.

Furthermore, cultural beliefs and practices significantly influence food choices in South Africa. Traditional dietary patterns and indigenous cuisines frequently conflict with modern interpretations of sustainability, particularly concerning meat consumption. Advocating for a transition towards plant-based diets requires not only an increase in awareness but also an acknowledgement and respect for cultural identities and traditions (Font-i-Furnols 2023). Although there is an expanding global consciousness regarding food and nutrition sustainability, substantial knowledge gaps and behavioural barriers persist (Kennedy, Raiten and Finley 2020). In South Africa, socio-economic inequalities and cultural dynamics further exacerbates the challenge. Effectively addressing these challenges requires comprehensive educational strategies, policy advocacy, and community involvement to cultivate a more inclusive framework for sustainable food systems (Çakmakçı, Salık and Çakmakçı 2023). Future research should concentrate on developing strategies that resonate with diverse consumer groups and effectively convey the importance of sustainable practices in improving health outcomes and environmental resilience.

## **2.10 Transformative food systems**

Galt et al. (2013) define transformative food systems as “a complex, interconnected network of food production, distribution, consumption, and waste management that aims to create a more sustainable, equitable, and resilient food system”. Transforming food systems that bring about change is crucial, to ensure food and nutrition programmes tackle urgent worldwide issues such as climate change and the lack of food security and malnutrition (Kennedy, Raiten and Finley 2020). Transformative food systems strive to establish sustainable, equitable, and resilient food environments by tackling systemic problems such as poverty, inequality, and environmental degradation (Duncan et al. 2022). Consequently, the shift towards more inclusive and resilient food systems requires fundamental alterations across all components of the food system: production, consumption, trade, and governance (Ruben et al. 2021). Nonetheless, there is a growing consensus that achieving long-term food security cannot be reached without improving the resilience of food systems (Lipper et al. 2021). In addressing the intertwined challenges of malnutrition, hunger, micronutrient deficiencies, and obesity, it is imperative to formulate comprehensive strategies that bolster the availability, accessibility, safety, affordability, and desirability of food (Ruben et al. 2021). The primary reason for promoting the evolution of food systems over prioritising interventions lies in the objective of

simultaneously enhancing nutrition inclusivity and environmental sustainability (Van Berkum and Ruben 2021).

A fundamental component of transformative food systems is the promotion of sustainable agricultural practices, including agroecology and regenerative farming. These practices improve soil health, foster biodiversity, and increase resilience against climate impacts, ultimately leading to more nutritious food production (Akanmu et al. 2023). Research suggests that agroecological practices can significantly reduce the environmental footprint of food systems while increasing the availability of diverse, nutrient-rich foods (Vogel et al. 2023). Furthermore, transformative food systems underscore local food networks' importance, reinforcing community resilience and promoting sustainable economic practices. Initiatives like urban agriculture and community-supported agriculture supply fresh produce and improve food accessibility in marginalised areas, contributing to improved dietary diversity (Abdillah et al. 2023).

Comprehensive strategies to foster more inclusive and nutrient-sensitive investments are essential for enhancing food quality, ensuring food safety, and promoting the sustainability of food systems across diverse stakeholder groups. The pressing need for expediting the transformation of food systems, driven by the escalating prevalence of malnutrition in various regions globally, and the increasing environmental and social repercussions associated with unhealthy and unsafe dietary practices, renders it crucial to mitigate these challenges holistically (Ruben et al. 2021).

## **2.11 Drivers and barriers to food and nutrition sustainability**

Current global food systems are a focal point of international discourse, primarily because of their impact on the environment, through climate change, biodiversity loss, the depletion of natural resources and the rise of NCDs, all underpinned by the nutrition transition (Bodirsky et al. 2020; Crippa et al. 2021; Intergovernmental Panel on Climate Change 2023; United Nations Nutrition 2023). The fluctuations in food prices in recent years, exacerbated by geopolitical instability and detrimental effects stemming from climate change, have compromised the economic accessibility of healthy diets for approximately 42% of the global population in 2021 (FAO 2023). Initiatives aimed at mitigating these adverse effects across the various facets of food systems, from production through consumption, are of paramount global importance, including a transition towards more sustainable dietary patterns (Fanzo et al. 2021;

Zheng et al. 2022; Caleffi, Hawkes and Walton 2023). Food choices are predominantly determined by price, convenience, taste and health (Allès et al. 2017). Consequently, there has been a notable increase in research focused on the barriers and facilitators influencing consumers' adoption of sustainable and healthy diets in recent years. Environmental and animal welfare characteristics of specific foods may motivate individuals following a sustainable and healthy diet, while other demographic groups may be influenced more by price, taste, or nutritional value (Muñoz-Martínez, Cussó-Parcerisas and Carrillo-Álvarez 2024). Consumers' food choices play a pivotal role in the transition to sustainable diets. Therefore, it is imperative to understand how they interpret the concept of "sustainability" in alignment with their eating patterns and the food supply chain (Van Bussel et al. 2022). In qualitative studies, the motivations for the consumption of sustainable, locally sourced, and organic foods exhibited a greater degree of diversity (Van Bussel et al. 2022). Consumers believed that sustainable foods were challenging to locate, inconvenient to utilise, costly, and more reliable. However, sustainable foods were not prioritised in consumer choices. Consumers chose organic foods for their taste and superior quality, but they perceived the elevated price as a barrier (Van Bussel et al. 2022).

### **2.11.1 Consumer awareness, knowledge and skills**

*Awareness* pertains to the extent to which an individual integrates sustainability into their actions or possesses knowledge of the environmental ramifications associated with selecting a particular item, such as when purchasing meat or meat alternatives (Kröger et al. 2022). According to Muñoz-Martínez, Cussó-Parcerisas and Carrillo-Álvarez (2024), an understanding of sustainable diets is essential for influencing consumer behaviour. Barriers to the adoption of diverse livestock options, such as rabbits or the consumption of upcycled products, have been linked to a lack of awareness regarding their nutritional benefits (Jiang et al. 2020) and the environmental impact of food waste (Aschemann-Witzel and Stangherlin 2021) respectively. Studies have indicated that an awareness of food costs is negatively associated with adherence to a sustainable healthy diet. Those more conscious were less inclined to choose food labelled with ethical, social, or health-related certifications (Tobi et al. 2019) or to consume recycled food products (Aschemann-Witzel and Stangherlin 2021). Jiang et al. (2020) stated that the ability to identify plant-based meat alternatives as substitutes for meat or knowledge regarding their preparation is of utmost importance. Furthermore, culinary proficiency significantly influences the selection of plant-based meat substitutes. Eckl et al.

(2021), found that individuals possessing higher culinary skills are more inclined to select legumes or tofu. In comparison, those with lesser skills tend to opt for processed plant-based meat alternatives that require minimal preparation at home. They identified limited culinary skills as a barrier to reducing meat consumption, particularly among those who habitually consume meat, as they exhibit confidence in their dietary choices and perceive a shift as misaligned with their abilities (Sanchez-Sabate, Badilla-Briones and Sabaté 2019). Aguirre Sánchez et al. (2021) also emphasise that possessing the skills to cultivate food is regarded as a positive attribute that encourages the purchase of organic products.

Nguyen et al. (2022), indicate that consumers are unaware of animal welfare issues and the environmental effects associated with meat consumption. The research study by Harguess, Crespo and Hong (2020), suggest that preconceived notions about food (nutrition, health, and taste), meat, and personal behaviour hindered (or facilitated) consumer awareness. Furthermore, researchers have reported alternative strategies; for instance, certain demographic groups have articulated that they perceived issues such as deforestation, food waste, and food packaging as more critical and detrimental to the environment than meat consumption. Additionally, consumers were sceptical of the credibility of sources and arguments reported by the media about the impact of meat consumption (Valli et al. 2022). Ultimately, an increased awareness of animal welfare and environmental concerns associated with meat consumption has the potential to foster more sustainable dietary choices. However, these strategies hold relevance exclusively when consumers demonstrate the willingness and capability to assimilate the information rather than resist or disregard it (Onwezen and Dagevos 2024).

*Skills* are the abilities to perform a specific behaviour; specific examples include competence training or providing courses aimed to assist in the preparation of plant-based food (Kwasny, Dobernig and Riefler 2022; Nguyen et al. 2022). Consumers state that one of the principal factors contributing to their reluctance to modify their meat intake is their self-acknowledged lack of nutritional and culinary knowledge, which inhibits their ability to reduce meat consumption (Fonseca and Sanchez-Sabate 2022; Kwasny, Dobernig and Riefler 2022; Nguyen et al. 2022). The assertion by consumers that nutritional and culinary education serves as a significant barrier underscores a pertinent opportunity for intervention. While potential biases may exist, this sentiment may also indicate that factors beyond mere resistance are influential, including fundamental knowledge and practical skills necessary for adopting an appealing low-meat or meat-free dietary regimen. This observation suggests a crucial avenue

for investigating the significance of imparting food-related skills, such as cooking, purchasing, and tasting, to encourage consumers to reduce their meat consumption (Harguess, Crespo and Hong 2020). Additional research has demonstrated that interventions focused on skill development yield mixed results (Taufik et al. 2019). This underscores that this remains an inadequately explored area, highlighting the necessity for further research within this domain (Sanchez-Sabate and Sabaté 2019; Taufik et al. 2019; Kwasny, Dobernig and Riefler 2022).

### **2.11.2 Culture and convenience**

Culture can be elucidated as the fundamental concepts of values, beliefs, and norms. People may transmit values, beliefs, and norms socially within and across generations, encompassing understandings of the functioning of the world as well as the delineation of good and evil, right and wrong, or valuable and invaluable (Gershman 2016). Culture is a constantly changing concept that is shaped and reshaped by social, political, economic, and ecological contexts. Cultures are perceived as an amalgamation of diverse cultural models that may unite or conflict with one another (Briones Alonso, Cockx and Swinnen 2018). Meat serves as a profoundly ingrained cultural and social symbol, so much so that people often regard meat as synonymous with a meal, and these meaty cultures and traditions create resistance to transformation (Sanchez-Sabate and Sabaté 2019; Florença et al. 2022; Fonseca and Sanchez-Sabate 2022; Nguyen et al. 2022). It is imperative to investigate the external factors that may prompt individuals to modify their perceptions of meat and regard alternative proteins as a significant substitute (Nguyen et al. 2022), given that prevailing cultural influences often supersede motives or attitudes favouring meat consumption (Sanchez-Sabate, Badilla-Briones and Sabaté 2019). Nevertheless, there exists a paucity of research concerning the cultural influences on food and nutrition sustainability, as the cultural dimensions are inadequately explored.

Research has recognised the orientation towards convenience as a barrier to the selection of organic food or adherence to a diverse and seasonally appropriate diet, as articulated by consumers from different socioeconomic strata, who asserted that in the presence of readily available and economically accessible meals or easily preparable food items, they would opt for such choices irrespective of their existing knowledge on the topic. The emergent barriers of time scarcity and lethargy are closely associated with individuals' entrenched habits and their challenges in dedicating time to acquire knowledge regarding more sustainable eating practices, a phenomenon observed even among individuals possessing an acute awareness of environmental and health issues. Muñoz-Martínez, Cussó-Parcerisas and Carrillo-Álvarez

(2024), agreed that there is insufficient information on the environmental impact of food systems (for example, water usage, and sustainability of fish) and the techniques required to prepare a nutritionally balanced meal devoid of meat, which was influenced by the interests of the food industry.

## **2.12 Critical reflection**

The challenges to achieving food and nutrition sustainability are alarming. The COP29 Climate Summit convened in Baku, Azerbaijan, focused on advancing global climate action, particularly within food systems, renewable energy, and climate finance. One of the key highlights included *Food Systems and Climate*, where discussions underscored the significance of regenerative agriculture and sustainable food systems as essential mechanisms for mitigating emissions and enhancing resilience. Delegates directed efforts at adopting practices that are congruent with climate goals while protecting food security in vulnerable regions (United Nations Climate Change 2024). The 17 United Nations SDGs provide a framework for fostering sustainable goal development for both present and future generations. Sustainable Development Goal 2 is centred on the issues of food security and nutrition, explicitly aiming for the eradication of hunger, the attainment of food security, the elimination of malnutrition in all its manifestations, and the advancement of sustainable agricultural practices. Sustainable Development Goal 12, which is closely aligned with this goal, advocates for the principles of responsible production and consumption (United Nations Development Programme 2022). The realisation of these objectives needs critical introspection of current and prospective food production systems, global nutrition, and health outcomes (Kennedy, Raiten and Finley 2020). Advances in agriculture, including biotechnology, have resulted in major gains in food security, nutrition, poverty alleviation, employment, and overall development (Pingali 2012). Since 1945, global food production has experienced a threefold increase, while the average caloric availability has escalated by 40% (FAO 2017). These advancements, commonly referred to as the Green Revolution, have resulted in enhanced food accessibility and notable public health improvements, including a marked reduction in protein or calorie malnutrition. Nonetheless, these achievements have incurred substantial costs to agricultural resources and the surrounding environment. They have adversely affected water and land resources and have significantly contributed to the escalation of GHG emissions. Numerous public health challenges have intensified, as evidenced by notable surges in obesity and associated comorbidities; furthermore, micronutrient malnutrition continues to afflict a considerable

segment of the global population (Demaio 2018; FAO 2019). The forthcoming challenge lies in initiating a “greener green revolution” that enhances agricultural productivity and public health while safeguarding natural resources. The interconnections between agriculture, public health, and the environment are profound, and achieving progress in these domains will require a novel paradigm that encourages open, candid, yet collegial, cross-disciplinary dialogue and collaboration that transcends mere prescriptiveness (Finley et al. 2017). This will entail the establishment of definitive boundaries and metrics designed to evaluate success or failure. Discussions surrounding responsible production and consumption must not be analysed in isolation; they particularly necessitate an evaluation of the trade-offs between sustainable production practices and healthy dietary patterns (Kennedy, Raiten and Finley 2020). Authorities must examine the viability of modifications in agricultural production within the framework of existing national agricultural systems, and the potential adaptability of these strategies to meet stipulated agricultural production objectives. For instance, adherence to the planetary reference diet would necessitate an increase of over 150% in nut production (Willett et al. 2019). It is important to emphasise that the development of planetary health diets is fundamentally rooted in nutritional considerations rather than environmental factors. Agriculture is anticipated to persist in its efforts to alleviate malnutrition by expanding food availability while concurrently enhancing food access to accommodate population growth. Effective and sustainable agricultural strategies must focus on increasing incomes, particularly among impoverished rural populations, serving as a significant mechanism for employment generation, enhancing agricultural output, safeguarding natural resources, and contributing meaningfully to food security and dietary quality (Kennedy, Raiten and Finley 2020).

As an omnivorous species, animal-source foods have constituted a pivotal element of the human dietary framework throughout evolutionary history. Beyond their provision of high-quality protein, animal-source foods serve as an abundant reservoir of micronutrients, and the deficiency of these micronutrients remains a persistent issue across diverse cultural contexts. Within Western societies, iron deficiency is prevalent among certain demographic subgroups (Gupta et al. 2016). At the same time, in regions of the global south, suboptimal dietary quality, predominantly characterised by carbohydrate-rich foods, has led to pronounced micronutrient deficiencies (iron, zinc, vitamin A, or vitamin B12) (International Food Policy Research Institute 2019). The development of context-specific strategies aimed at enhancing micronutrient status and overall dietary quality must incorporate the contributions of animal-source foods (Raiten et al. 2020). Our capacity to address these critical inquiries will

profoundly influence policy decisions regarding the role of animal-source foods in fulfilling nutritional requirements on both domestic and global scales and the sustainability of agricultural systems in an evolving environmental landscape (Kennedy, Raiten and Finley 2020).

The United Nations has specified that establishing sustainable food systems is paramount for advancing healthy diets (Nguyen 2018). Food systems encompass a comprehensive array of components (environment, human actors, inputs, operational processes, infrastructural frameworks, and institutional structures) and activities integral to the production, processing, distribution, preparation, and consumption of food; a sustainable food system expands this conceptual framework to encompass those systems that guarantee food security and nutritional adequacy for all, while not undermining the socioeconomic, environmental, and social foundations necessary for both current and future generations (High Level Panel of Experts on Food Security and Nutrition 2017). The challenge for international organisations and governments is to change the trajectories of food systems to maximise the impact of food security and nutrition. This endeavour presents a formidable challenge, considering the prevalent levels of malnutrition. Furthermore, by the year 2050, food systems need to sustain a population exceeding 9 billion individuals, with a projected increase in demand for livestock by 70%, predominantly in developing countries (Global Panel on Agriculture and Food Systems for Nutrition 2016). A comprehensive and integrative approach is imperative to effectively tackle the multifaceted challenges associated with sustainability, environmental degradation, persistent poverty, vulnerability, hunger, and malnutrition. Enhancements in food systems must prioritise efficiency and inclusivity, and the associated policies and legal frameworks must confront income inequality, support livelihoods, and guarantee resilience while also ensuring coherent and effective governance at both national and international levels (Fanzo et al. 2021). The challenge of promoting sustainable diets lies in the necessity to reconcile nutrient requirements, economic considerations, and cultural acceptance within the confines of environmental and societal norms (Kennedy, Raiten and Finley 2020).

### **2.13 Conclusion**

The United Nations have raised the challenges for achieving the SDG targets and authorities cannot address it in isolation because the challenges of the food system are interconnected. Authorities will need policies addressing the most significant priorities, but the prevailing model of governance assigns malnutrition to the health sector and food insecurity to

agriculture, resulting in a disjointed and uncoordinated framework, which may work at cross-purposes. Decisions must be made by consumers, producers, and policymakers alike. To overcome these obstacles, inform effective policy, and construct a system that fosters optimal health, environmental and economic sustainability, while also catering to consumer preferences, an integrated framework is imperative. The world has progressed over the past 50 years in improving food security, nutrition, and health outcomes. Continued progress will require concerted efforts to ensure that food security, nutrition and food and nutrition sustainability continue to be a priority in the 2030 development agenda. The next chapter presents and discusses the research design, methods, data collection methods, and ethical considerations.

## **CHAPTER 3**

### **RESEARCH DESIGN AND METHODOLOGY**

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#### **3.1 Introduction**

This chapter outlines the research design and methodology, detailing the data collection process employed. The sample selection, recruitment, validity of the measurement tool, and ethical considerations will be addressed in detail. This study aimed to investigate food and nutrition sustainability knowledge and practices among university students at the DUT and appraise the diet quality and the impact of diet on the environment to advance consciousness towards food and nutrition sustainability.

#### **3.2 Research design**

This cross-sectional study conducted a sustainable food and nutrition survey and dietary recalls to determine the situational analysis of food and nutrition sustainability among young consumers. This study has chosen university students to represent the young consumer demographic profile. A cross-sectional study observes and surveys a population to describe specific characteristics of that population (Heale and Twycross 2015).

The advantages of a cross-sectional study include:

- The various methods that can be used to validate or reject a hypothesis of an investigation.
- It is both affordable and time-efficient to complete.
- It focuses on a specific point in time, for example “How often do you purchase sustainable foods in a month?”
- The data can be used for a variety of studies.
- It enables the examination of various data and results to provide innovative theories, studies, or in-depth research. (Spector 2019).

The disadvantages of a cross-sectional study include:

- It cannot be used to study the behaviour of individuals over time.
- It does not assist in establishing the cause and consequences of a study.
- The process of selecting the sample group can be challenging, depending on the characteristics of the population under investigation.

Given the nature of the study, where the objective was to establish current food and nutrition sustainability practices among young consumers, the researcher deemed the cross-sectional study design as the most appropriate, enabling the collection of data at a single point in time, providing a clear snapshot of existing behaviours and practices within the target population (Cataldo et al. 2019).

### **3.3 Study population**

Respondents in this study were recruited from the DUT in KwaZulu-Natal, South Africa. The university, which is one of seven technical universities in the country, serves as a good proxy for young adults as consumers in South Africa. To restructure South Africa's higher education system and create all-inclusive universities, the former Natal Technikon and the ML Sultan Technikon merged to form the Durban Institute of Technology in 2002, and was renamed the Durban University of Technology in 2006. The DUT has a population of 33 000 registered undergraduate and postgraduate students (Mthembu 2023). The student population at DUT embodies a profound diversity, with roughly 90% of DUT students being African, 7% being Indian, and the remainder comprising white and coloured students, respectively (DUT 2021). This illustrates the institution's dedication to inclusivity and equitable representation among various racial and ethnic communities. The DUT Envision 2030 aims to develop students who are creative, innovative, entrepreneurial, and adaptive to changes in the world to enhance their skills and contribute towards a sustainable future.

The study area consists of three locations at the DUT: Steve Biko, Ritson, and ML Sultan campuses. All three campuses are based in the eThekweni municipality area in KwaZulu-Natal, South Africa (Figure 3.1).

### **3.4 Sample size**

There are approximately 33 000 registered students at the DUT (Mthembu 2023). The total sample size for a population size of +1 000 000 with a 95% confidence level and a 5% margin of error is 385 (Taherdoost 2017). Given that South Africa has almost 17 840 000 youth (18–34 years) (Statistics South Africa 2019), the study used a sample size of 405.



Source: Google Earth 10.65.1.2 (2023)

Figure 3.1: Map of the three DUT campuses represents the building locations for the study, outlined in green

### **3.5 Eligibility criteria**

Registered undergraduate and postgraduate students at the DUT were eligible to partake in the study, which included abled and disabled respondents. The respondents had to be between the ages of 18 and 34 years.

#### **3.5.1 Inclusion criteria**

- Respondents had to be between the ages of 18 and 34 years.
- Respondents had to be registered undergraduate and postgraduate students.
- The key hub areas comprised the Steve Biko Campus, Ritson Campus, and ML Sultan Campus.
- The study included both male and female students.
- The study included all ethnic groups among the respondents.
- The study included people who were abled and disabled.

#### **3.5.2 Exclusion criteria**

- Respondents younger than 18 years or older than 34 years of age.
- All DUT staff, outsourced general workers, maintenance workers, and security guards.
- All DUT students from other campuses not specified in Figure 3.1.

### **3.6 Recruitment of respondents**

After receiving gatekeeper permission from the research directorate at DUT, data collection commenced (Appendix A). For this study, three areas at the DUT were purposively selected: Steve Biko, Ritson, and ML Sultan campuses. Four hundred and five students were approached and recruited through informed consent whereafter they received a letter of information outlining the specifics of the study (Appendix B). The researcher informed potential respondents about the research and presented a consent letter requesting their consent (Appendix C). The information letter was in English, which is the official language at the DUT. After acquiring informed consent to partake in the study, a survey (Appendix D) that included general questions regarding respondents' sustainability knowledge and behaviour was administered. The researcher recruited respondents from key hub areas on all three campuses (Steve Biko, Ritson, and ML Sultan campuses). A key hub area is a place where students congregate to have their lunch, socialise and play social games. A stand was set up with a portable table and chair for the survey and the first 24-hour food recall administration

(Appendix E). Thereafter, the researcher conducted the weekend day 24-hour food recall by contacting students through their student email addresses and cell phone numbers to complete the second 24-hour food recall.

### 3.7 Measurement instruments

#### 3.7.1 Awareness, knowledge, and attitudes toward food sustainability survey

The researcher designed the survey to determine awareness, knowledge, attitudes toward food sustainability, and food choice motives among students. The research team examined, modified, and adapted the questionnaire using validated questionnaires for this study (García-González et al. 2020; Stratton 2021; Verain et al. 2021). The knowledge questionnaire aimed to assess respondents' knowledge of sustainable food choices, while the attitudes and awareness components measured their beliefs, values, and awareness regarding environmental sustainability. Drivers and barriers explored factors influencing sustainable food decisions, such as convenience, price, or environmental concern. Specific scales for measuring these constructs included the likert-type scales, multiple-choice choice and open-ended questions. The survey questionnaire consisted of the following sections: socio-demographic information, knowledge, awareness and attitudes, barriers and drivers of sustainable food choices and concern about environmental issues. Before the administration of the survey, a pilot study evaluated the questionnaire's reliability. Using convenience sampling, ten students were randomly selected for the pilot study but excluded from the main study. Convenience sampling is a practice used by researchers to acquire market research data from a readily available sample of respondents (Stratton 2021). It is the most frequently used sample technique since it is extremely quick, simple, and inexpensive (Stratton 2021). Consideration of the findings from the pilot survey, took place before the restructuring of the final questionnaire (Table 3.1).

**Table 3.1: Changes made from the pilot questionnaire**

Pilot questionnaire recommendations	Questionnaire adaptation based on recommendations
For each question <u>tick</u> the response option that best applies to you.	"Select" changed to "tick"
1. What is your dut4life email address? (Note this information is only required to contact you to complete the second food recall).	1. What is your dut4life email address and cell phone number? (Note this information is only required to contact you to complete the second food recall).
5. Added question.	5. "Which campus are you based at?"

11.5 Additional option.	11.5 “All of the above.”
Question 17.	17. Recommended to be removed from the questionnaire.
21. Additional option.	21. “I find it difficult to eat healthy because I have no say on what type of foods are bought at home.”

All suggestions and observations derived from the pilot questionnaire were acknowledged and modified to improve the coherence and fluency of the questionnaire while preserving the objectives of the study. The feedback obtained from the pilot study facilitated the completion of the questionnaire; respondents were recruited through convenience sampling at key hub locations across all three campuses (Steve Biko, Ritson, and ML Sultan campuses). An information letter (Appendix B) was provided, and informed consent was attained (Appendix C). Afterwards, the food and nutrition sustainability survey was administered (Appendix D).



Source: Sahadeo (2023)

Figure 3.2: Key hub area set up with a portable table and chair situated outside the Steve Biko library



Source: Sahadeo (2023)

Figure 3.3: Key hub area situated on the Ritson Campus



Source: Sahadeo (2023)

Figure 3.4: Key hub area situated on the ML Sultan Campus

### 3.7.2 24-hour food recall repeated method

This study used a multiple-pass method to collect the 24-hour food recall data. Trained field workers obtained information about the types of foods consumed by individuals over the age of 19 years over a 24-hour food recall for two non-consecutive days. The field workers collected the data randomly on all days of the week, including weekends. There was no specific day allocated for the principal researcher and field workers to collect data. Data was collected on any two weekdays, ensuring they were not consecutive. Two 24-hour recalls were completed: one on a weekday and one on a weekend day using the multiple pass method (The

multiple pass method in 24-hour food recall is a structured approach used to improve the accuracy of dietary assessment because it involves multiple interviews to obtain all the food and beverage items consumed by a respondent over a 24-hour period). Survey respondents completed one 24-hour diet recall at the point of time of the survey administration and one on a Monday to capture variability in diet across weekdays and weekend days. The information obtained from the 24-hour food recall included portion sizes, preparation methods and ingredients used. Portion sizes were determined using measuring cups, measuring bowls, plates of different sizes, cups, mugs, glasses, measuring spoons, dishing spoons and food aid props as seen in Figure 3.5. The total of 400 repeated 24-hour food recalls was obtained from this study. The first step of the 24-hour food recall was to determine the time of day when the respondents consumed the food. The respondents were then asked to list the foods that they consumed at specific times. Thereafter, respondents had to describe the preparation methods used to cook the meals. A dietary toolkit guided respondents in estimating portion sizes. Respondents had to indicate if this was their usual diet that they followed (Govender et al. 2021: 5). The 24-hour food recall was conducted using consistent methods, similar to previous studies (Fagúndez et al. 2015). A time commitment of 20–30 minutes was required per 24-hour recall.



Source: Sahadeo (2023)

Figure 3.5: Portion size tools used for the 24-hour food recall

Additional samples were added to the dietary toolkit to make it easier for students to identify the types and amount of food they consume, for example, a matchbox was used to determine the amount of cheese consumed by a student (Figure 3.6).



Source: Sahadeo (2023)

Figure 3.6: Additional samples added to the dietary toolkit

### 3.7.3 Dietary intake data

The repeated 24-hour food recall data was captured onto the FoodFinder version 3 software program of the South African Medical Research Council, to determine the nutrients consumed over the two non-consecutive days. The foods that each respondent consumed each day were recorded, and a report containing an average daily nutrient intake of the two days was generated. Data from the FoodFinder was exported to Microsoft Excel, and the mean daily nutrient intakes and standard deviations were calculated. Of the four Dietary Reference Intakes, the Estimated Average Requirement (EAR) and Adequate Intake (AI) were used to assess the nutrient intake (Govender et al. 2021). The EAR was selected as the recommended Dietary Reference Intake for assessing the nutritional status of population groups, defined by demographic profiles, including age, gender and lifecycle stage (Ross 2011). The EAR is the quantity of a nutrient that is thought to be sufficient for 50% of the population of a certain demographic group. The proportion of EAR was calculated using the mean intake value of each nutrient with its corresponding EAR. Subsequently, the incidence of inadequate intake was ascertained through the application of the EAR cut-point method. This method applies to most nutrients, except for energy (Institute of Medicine 2002; Murphy, Guenther and Kretsch 2006). The AI values were utilised for nutrients that lack a defined EAR. The AI is predicted on either observed or experimentally derived estimates of the average nutrient consumption of a healthy demographic group. It is postulated that exceeding the AI for nutrient intake indicates a reduced risk of inadequate intake.

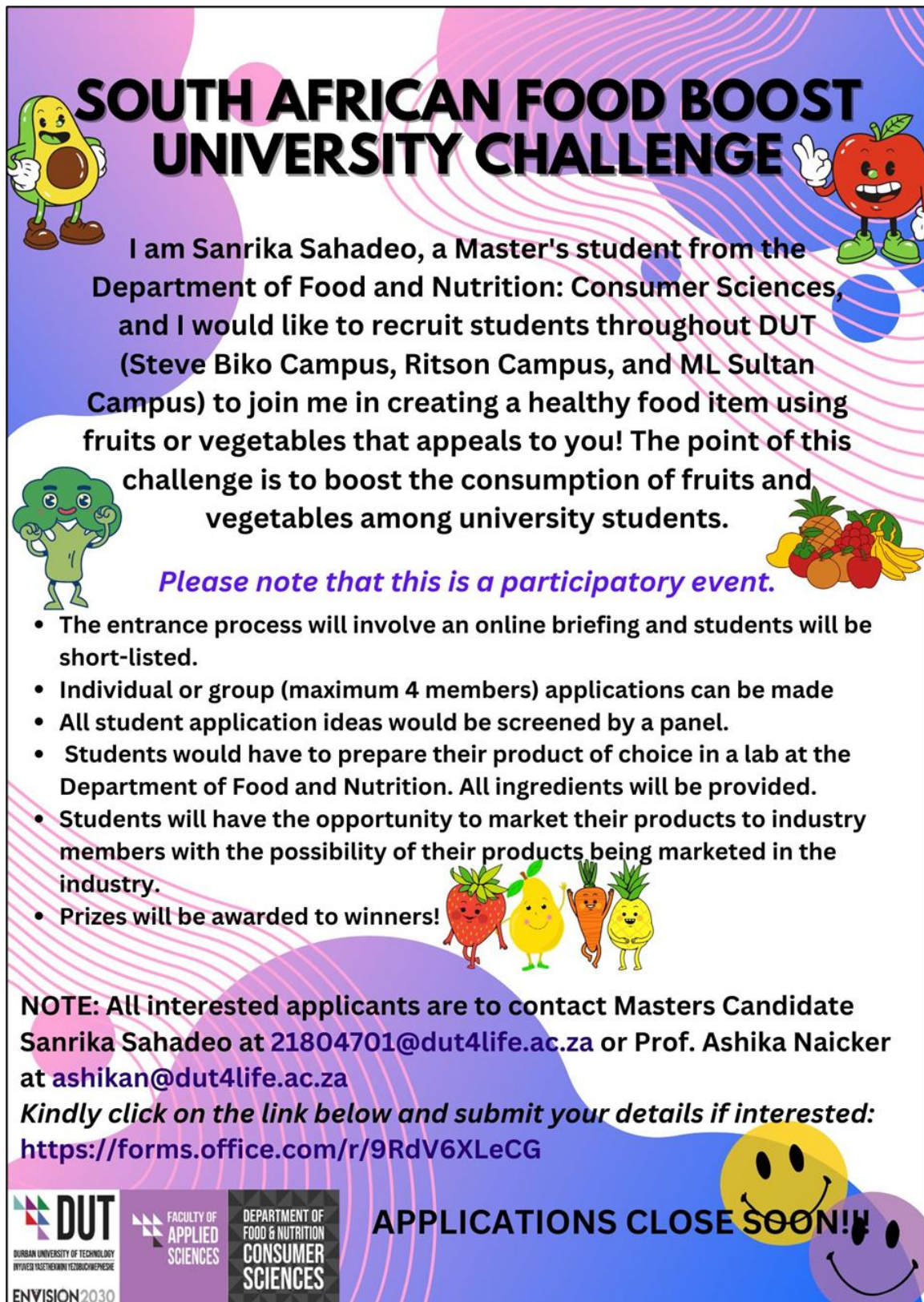
### **3.8 Analysis of diet and environmental impact**

To determine the dimensions of diet quality for nutrient adequacy and NCD risk, the South African Medical Research Council FoodFinder 3 software was used to capture and analyse dietary data. Through the GDQS, dimensions of diet quality were further assessed for nutrient adequacy and NCD risk (Bromage et al. 2021). The diet's environmental impact was calculated using the Plate Up for the Planet carbon footprint calculator, which estimated the amount of CO<sub>2</sub> produced per kilogram of specific foods, including composite meals (Plate Up for the Planet 2022). One calculator was used to determine the accuracy of food items. The Plate Up for the Planet carbon calculator assists individuals by evaluating the environmental consequences of their dietary selections, with particular emphasis on carbon emissions. It offers valuable insights into the extent to which various food items contribute to an individual's carbon footprint and promotes the adoption of more sustainable dietary practices. The Plate Up for the Planet carbon calculator has numerous advantages, including raising awareness regarding the carbon footprint associated with dietary selections, the provision of an accessible, user-friendly interface for engagement, and the facilitation of data collection pertinent to research on food-related emissions. However, disadvantages such as potential inaccuracies stemming from underlying assumptions within the model, a restricted emphasis on dietary selections without accounting for broader environmental considerations, and a dependence on self-reported data may exhibit inconsistencies. Future research should investigate the impact of using a carbon footprint calculator in conjunction with a structured carbon footprint reduction strategy or policy for procurement. Emphasis should be placed on understanding the feedback cycles and the ripple effects of this approach (Guðmundsdóttir 2022).

### **3.9 Promotion of sustainable dietary practices by the implementation of the South African Food Boost University Challenge**

The SAFBUC was adapted from a Food Boost Challenge (FBC) conducted in the Netherlands. It was a participatory action study to enhance the consumption of fruits and vegetables among adolescents. The results showed that the FBC resonated with all stakeholders, generating valuable insights to increase fruit and vegetable intake (Van Lieshout et al. 2023). Therefore, the SAFBUC was adapted and developed to promote the consumption of fruits, vegetables, and food and nutrition sustainability among university students. The promotion of the SAFBUC took place through an advertisement that was shared on WhatsApp and Instagram. Advertisements were also pinned on the DUT pinboard and distributed via email to all students

and staff to invite students from all faculties to participate in this challenge. A Microsoft Forms link was provided so that registered students could easily submit their details to participate in the challenge. A WhatsApp group was created with all students to communicate effectively; the students were then briefed on the product or recipe development for SAFBUC and given recipe templates to complete their recipes. Thereafter, students submitted their recipe ideas, whereafter the principal researcher and supervisor screened the recipes to ensure that they aligned with the product criteria and essence of the SAFBUC. An invitation to attend the SAFBUC was distributed on all social media networks to invite students to the event and to participate in the sample tasting. The SAFBUC took place on 4 September 2024, and seven products were made in quantities of over 100 sample portions of each product.



# SOUTH AFRICAN FOOD BOOST UNIVERSITY CHALLENGE

I am Sanrika Sahadeo, a Master's student from the Department of Food and Nutrition: Consumer Sciences, and I would like to recruit students throughout DUT (Steve Biko Campus, Ritson Campus, and ML Sultan Campus) to join me in creating a healthy food item using fruits or vegetables that appeals to you! The point of this challenge is to boost the consumption of fruits and vegetables among university students.

*Please note that this is a participatory event.*

- The entrance process will involve an online briefing and students will be short-listed.
- Individual or group (maximum 4 members) applications can be made
- All student application ideas would be screened by a panel.
- Students would have to prepare their product of choice in a lab at the Department of Food and Nutrition. All ingredients will be provided.
- Students will have the opportunity to market their products to industry members with the possibility of their products being marketed in the industry.
- Prizes will be awarded to winners!

**NOTE:** All interested applicants are to contact Masters Candidate Sanrika Sahadeo at 21804701@dut4life.ac.za or Prof. Ashika Naicker at ashikan@dut4life.ac.za  
*Kindly click on the link below and submit your details if interested:*  
<https://forms.office.com/r/9RdV6XLeCG>

**APPLICATIONS CLOSE SOON!!**

**DUT**  
 DURBAN UNIVERSITY OF TECHNOLOGY  
 INYENKHE TALENTENKHWI YEKHOKHOPHESE  
 ENVISION 2030

**FACULTY OF APPLIED SCIENCES**

**DEPARTMENT OF FOOD & NUTRITION CONSUMER SCIENCES**

Figure 3.7: SAFBUC invitation to participate in the challenge

The DUT’s Food and Nutrition staff and students conducted sensory analysis on the following products: fruit and yoghurt popsicles, sweet potato long chips, vegetable pasta, tangy delights

(yoghurt with fruit and chocolate popsicles), ultimate veggie burgers, sweet potato, avocado and feta muffins, and an okra smoothie. The Department of Food and Nutrition staff applied a sensory analysis using a 9-point hedonic scale to score students' products accurately. The first to fourth-year students from the Department of Food and Nutrition, who tasted the sensory samples, use a Microsoft Forms link to select the top three favourite items. Thirteen staff members and 74 students in total conducted sensory analysis. The data from the 9-point hedonic scale was then captured on Google Forms and the Microsoft Forms link that was used to capture the top three favourite items, which were in turn further analysed on an Excel spreadsheet by the university's statistician using the IBM SPSS Statistics software version 29. The top three winners were awarded prizes (images appear in Chapter 4).



Figure 3.8: Invitation for students to attend the SAFBUC

### **3.10 Statistical analysis**

Data analysis was conducted in consultation with the university's statistician using the IBM SPSS Statistics software version 29. The food and nutrition sustainability questionnaire was captured on Microsoft Forms, downloaded in an Excel format by the principal researcher and thereafter transferred to SPSS for analysis by the university statistician. The 24-hour food recalls were captured on FoodFinder 3 by a fieldworker, cross-checked by the principal researcher and exported to SPSS for analysis. The food carbon footprint data was calculated using Plate Up for the Planet and transferred to an Excel spreadsheet by the principal researcher. The university statistician thereafter analysed the data using a one-sample *t*-test. The SAFBUC data was captured on Google Forms (staff data using the 9-point hedonic scale) and Microsoft Forms survey (student data, ranking the top three favourite products) by the principal researcher; the data was then transferred to an Excel spreadsheet that was sent to the statistician for analysis.

Descriptive statistics, presented in the form of tables and graphs, were used to visually summarise the data. Inferential statistics were applied to identify significant trends, with a *p*-value of  $< 0.05$  considered indicative of statistical significance. The Chi-square goodness-of-fit test, a univariate test for categorical variables, was used to determine whether specific response options were selected significantly more or less frequently than others, under the null hypothesis that all responses were equally likely. The binomial test assessed whether a significant proportion of respondents chose one of two possible responses. The GDQS, food carbon footprint, and SAFBUC data were analysed using the one-sample *t*-test to calculate the mean, median, standard deviation, and confidence interval. Additionally, the Mann-Whitney U test was employed to compare the mean ranks of the carbon footprint across genders, as the data were not normally distributed.

### **3.11 Validity**

According to Heale and Twycross (2015), validity in research refers to the accuracy of the instruments used to measure the results. A validated survey was used to evaluate the sustainable food and nutrition survey questions. The university statistician made a few alterations to the survey before the administration to maintain the data quality. The survey followed standard fieldwork guidelines to ensure the reliability of the results.

### **3.11.1 Construct validity**

Construct validity refers to the process of validating a measurement approach in relation to the specific construct that is intended for evaluation (Heale and Twycross 2015). This was done by piloting the questionnaire prior to the commencement of data collection.

### **3.11.2 Face and content validity**

Face validity refers to a category of validity that is reflected in the transparency, pertinence, complexity, and responsiveness of a measurement to its intended demographic (Allen, Robson and Iliescu 2023). Face validity is subjective and evaluations have been criticised for not being generalisable because a variety of factors can influence opinions, including environment, culture, personal characteristics, and casualness, which increases the possibility of prejudice. To address these concerns in research, validated questionnaires and research articles were used to create the questionnaire and 24-hour food recall. As guided by Bolarinwa (2015), content validity was assured by ensuring that all questionnaires, including adapted questionnaires and information sheets used in this research, were reviewed by a statistician and piloted among students who did not participate in the main study to identify any potential flaws.

### **3.11.3 Predictive validity**

Predictive validity is a significant dimension of research in the domains of food and nutrition, as it facilitates the accuracy of predictive metrics in forecasting subsequent outcomes (Verbeij et al. 2022). This is essential for assessing the efficacy of interventions and policies designed to enhance dietary behaviours and nutritional well-being.

## **3.12 Reliability**

Reliability refers to whether an evaluation instrument produces the same outcomes each time when used in an identical set with the same type of respondents (Bornstein 2018; Surucu and Maslakci 2020). Enhanced reliability proves that the chosen measurement instruments are trustworthy and capable of yielding consistent results. Establishing reliable evidence is a crucial preliminary phase in ascertaining the effectiveness of a measurement tool. The process of retesting allows a researcher to recognise and mitigate potential sources of error, thus optimising the reliability of the findings (Bornstein 2018). For example, piloting the questionnaire to remove ambiguity before administration, ensuring that field workers were

trained before conducting the survey and 24-hour food recall, and making certain that the dietary toolkit was checked every day before data collection.

### **3.13 Quality assurance and reduction of bias**

The sustainable food and nutrition survey questionnaire was piloted by ten DUT students between the ages of 18 and 34 years, which is the same age as the sample group of the study, to ensure clarity, appropriateness, and understandability. However, these students did not partake in the survey. During the recruitment phase, consent and information letters were given to the respondents with a verbal explanation of the study. Respondents were also alerted that a second 24-hour food recall had to be administered on a Monday. Each survey and the first 24-hour food recall took 20 minutes, which was ensured for all respondents. To maintain sanitary protocols many respondents used alcohol-based sanitiser before and after the survey. The researcher collected data with the assistance of trained field workers and supervisors monitored the process for quality assurance.

### **3.14 Data quality management**

The researcher captured data from the sustainable food and nutrition survey questionnaires and the 24-hour food recall on Microsoft Forms. The data were cross-checked for accuracy by the supervisor and statistician. Data quality was preserved throughout the data collection, coding, and cleaning processes by ensuring that all data was meticulously collected, correctly coded, and thoroughly cleaned to remove any inconsistencies. Only the researcher, supervisors, and statistician had access to the password-protected electronic and hard copy data.

### **3.15 Ethics**

Ethics is associated with moral judgments concerning what is correct or incorrect (Nundy, Kakar and Bhutta 2022). The researcher should be transparent with all respondents regarding all study aspects. Only when it can compromise the reliability of the results, specific information can be omitted. Responding students cannot be coerced into participating; it must be voluntary. It is also vital to ensure that respondents consent to participate and provide as much information as possible to make an informed decision (Xiao et al. 2023).

To ensure ethical credibility, the following gatekeepers gave approval before commencement of the methodology procedures:

- Prior to the start of the study, the researcher submitted the proposal for evaluation and approval by the DUT's Departmental Research Committee (DRC). The research proposal received approval whereafter, it was submitted to the Faculty Research Committee (FRC).
- Furthermore, the research proposal was submitted to, and evaluated and approved by the DUT's Institutional Research Ethics Committee (IREC). The research proposal received full permission from the head of the department and DUT gatekeeper, as well as ethical clearance (IREC 102/23) (Appendix F).
- Gatekeeper permission was attained from the Research Directorate (Appendix A). The respondents received an information letter, and consent was sought for participation in the survey (Appendixes B and C).
- All prospective respondents were informed that their participation was voluntary and that they could opt out anytime.

The process of consent was as follows:

- potential respondents were given a hard copy of the consent form given time to read it, allowing opportunities for questions;
- signatures of respondents were obtained;
- respondents were given a copy of the information letter to keep; and
- the signed consent forms were kept for record-keeping.

No individual names or identifying information was used to capture data. All respondents' details were de-identified and listed as codes in the data set to maintain their anonymity. Only the researcher and supervisor have access to the de-identified data, which was password protected. Data will be stored for five years in sealed boxes in a secure room at the Department of Consumer Sciences: Food and Nutrition and will be disposed of by shredding. All electronic datasets were password protected and will be disposed of permanently in any storage devices or applications after five years.

### **3.16 Conclusion**

This chapter highlighted the research design and delved into a detailed description of the methodology used. The researcher made every effort to preserve the accuracy and

dependability of research results and to eliminate any bias that might have been present in this study. Chapter 4 will critically analyse and discuss the findings, interpretations, correlations, and outcomes, considering previous research on food and nutrition sustainability on a global and national level.

## CHAPTER 4

### RESULTS AND DISCUSSION

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#### 4.1 Introduction

This chapter elucidates the information about the collected data that has been systematically processed, rigorously verified, thoroughly analysed, and subsequently translated into comprehensible results, which are represented through tables and graphs, by the specific objectives delineated in this study utilising both descriptive and inferential statistical methods.

*Objective 1: To determine awareness, knowledge and attitudes of food and nutrition sustainability, and food choice drivers among students at the DUT through a survey.*

#### 4.2 Demographic profile of respondents

Four hundred and five respondents completed the survey, of which 62% ( $n = 251$ ) were females and 38% ( $n = 154$ ) were males. More than half the respondents were Black (84.7%,  $n = 343$ ), 12.3 % were Indian ( $n = 50$ ), 2.5 % were coloured ( $n = 10$ ) and 0.5% were white ( $n = 2$ ). Respondents were young adults between 18 and 26 years (98.3%,  $n = 398$ ), and 1.7% ( $n = 7$ ) were between 27 and 34 years. Most respondents were from the Ritson campus (39%,  $n = 158$ ) and the Steve Biko campus (38%,  $n = 154$ ). The lowest number of respondents were from the ML Sultan campus (23%,  $n = 93$ ). The Faculty of Accounting and Informatics had the highest representation (42%,  $n = 170$ ), followed by Applied Sciences (23.7%,  $n = 96$ ), Engineering and the Built Environment (15.1%,  $n = 61$ ), Management Sciences (14.6%,  $n = 59$ ), Health Sciences (3.0%,  $n = 12$ ) and Arts and Design (1.7%,  $n = 7$ ). Regarding academic year, most of the respondents were first-year students (42%,  $n = 170$ ), followed by second-year students (31.1%,  $n = 126$ ), and third-year students (20.7%,  $n = 84$ ); the remaining were fourth-year students (4.0%,  $n = 16$ ) and postgraduate students (2.2%,  $n = 9$ ).

Table 4.1 represents the demographic profile of respondents for the sustainable food and nutrition survey ( $n = 405$ ).

**Table 4.1: Demographic profile of respondents (*n* = 405)**

<b>Demographics</b>	<b><i>n</i></b>	<b>%</b>
<b>Gender</b>		
Male	154	38
Female	251	62
<b>Race</b>		
Black	343	84.7
White	2	0.5
Indian	50	12.3
Coloured	10	2.5
Other	0	0
<b>Age (years)</b>		
18–26	398	98.3
27–34	7	1.7
<b>Campus</b>		
Steve Biko	154	38
Ritson	158	39
ML Sultan	93	23
<b>Faculty</b>		
Accounting and Informatics	170	42
Applied Sciences	96	23.7
Management Sciences	59	14.6
Engineering and the Built Environment	61	15.1
Health Sciences	12	3
Arts and Design	7	1.7
<b>Level of study</b>		
First year	170	42
Second year	126	31.1
Third year	84	20.7
Fourth year	16	4
Postgraduate	9	2.2

### 4.3 Knowledge and awareness

Table 4.2 represents the participant’s awareness and knowledge of sustainable food and nutrition terms.

**Table 4.2: Participant’s awareness and knowledge of sustainable terms ( $n = 405$ )**

Awareness and knowledge	Responses as frequency (%)				X <sup>2</sup>	df	p-value
	Never heard of	Heard of- but know nothing about	Heard of – know a little about	Heard of –know a lot about			
The Sustainable Developmental Goals (SDGs)	222 (54.8)	107 (26.4)	57 (14.1)	19 (4.7)	230.486	3	< .001*
Sustainable nutrition	88 (21.7)	153 (37.8)	134 (33.1)	30 (7.4)	88.916	3	< .001*
Sustainable/green products	96 (23.7)	113 (27.9)	154 (38.0)	42 (10.4)	63.790	3	< .001*
Product lifecycle	150 (37.0)	112 (27.7)	105 (25.9)	38 (9.4)	64.264	3	< .001*
Carbon footprint	115 (28.4)	88 (21.7)	123 (30.4)	79 (19.5)	13.163	3	.004*
Product Environmental Footprint (PEF)	264 (65.2)	91 (22.5)	35 (8.6)	15 (3.7)	379.464	3	< .001*
Life cycle assessment (LCA)	268 (66.2)	85 (21.0)	38 (9.4)	14 (3.5)	391.928	3	< .001*
Green washing	263 (64.9)	91 (22.5)	30 (7.4)	21 (5.2)	373.183	3	< .001*
The term “recycled”	25 (6.2)	27 (6.7)	126 (31.1)	227 (56.0)	274.101	3	< .001*
The term “energy efficient”	62 (15.3)	79 (19.5)	146 (36.0)	118 (29.1)	42.654	3	< .001*
The term “eco-friendly”	52 (12.8)	64 (15.8)	129 (31.9)	160 (39.5)	79.356	3	< .001*
The term “Food miles”	237 (58.5)	98 (24.2)	57 (14.1)	13 (3.2)	278.368	3	< .001*
The term “eco-label”	219 (54.1)	106 (26.2)	61 (15.1)	19 (4.7)	219.978	3	< .001*

The results presented in Table 4.2 showed that a significant 54.8% ( $n = 222$ ) of respondents had never heard of the SDGs, ( $p < 0.001$ ). In comparison, 45.2% ( $n = 183$ ) had heard of them but were unfamiliar with them. A significant percentage of students demonstrated no knowledge of product environmental footprint (65.2%,  $n = 264$ ), life cycle assessment (66.2%,  $n = 268$ ), greenwashing (64.9%,  $n = 263$ ), food miles (58.5%,  $n = 237$ ) and eco-label (54.1%,

$n = 219$ ), ( $p < 0.001$ ). A substantial number of respondents have heard of the phrases recycled (56.0%,  $n = 227$ ), energy-efficient (29.1%,  $n = 118$ ), eco-friendly (39.5%,  $n = 160$ ), and carbon footprint (19.5%,  $n = 79$ ). Thirty-seven point eight per cent of students ( $n = 153$ ) heard of sustainable nutrition, sustainable or green products (27.9%,  $n = 113$ ), and product lifecycle (27.7%,  $n = 112$ ) but knew nothing about it.

Table 4.3 displays the findings concerning awareness of the term sustainability.

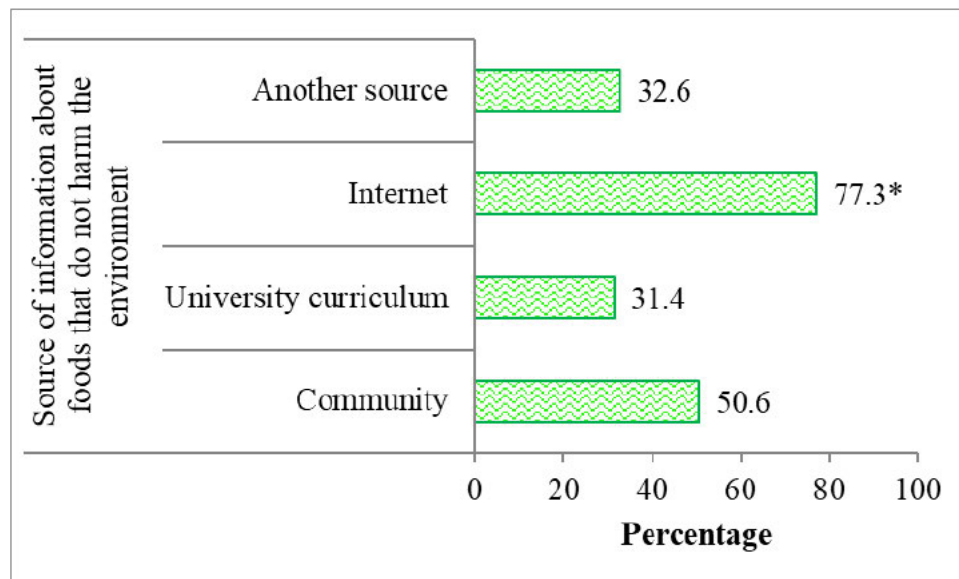
**Table 4.3: Knowledge of the term sustainability ( $n = 405$ )**

Knowledge on sustainability	Frequency (%)		<i>n</i>	<i>p</i> -value
	Correct	Incorrect		
Sustainability	251 (62)	154 (38)	405	< .001*

A significant 62% ( $n = 251$ ) knew what the term sustainability meant, and the remaining 38% ( $n = 154$ ) did not ( $p < 0.001$ ).

#### 4.4 Information source used to identify environmentally friendly foods

Figure 4.1 represents the information source used to identify environmentally friendly foods.



\* $p < 0.001$

Figure 4.1: Resources for information about environmentally friendly food choices

A binomial test was used to determine significant proportions between the four sources. A significant 77.3% ( $n = 313$ ) of students relied on the internet as the primary source of information about foods, followed by the community (50.6%,  $n = 205$ ), another source (32.6%,  $n = 132$ ) and university curriculum (31.4%,  $n = 127$ ). A significant 69% ( $n = 278$ ) of respondents stated that they do not obtain information on foods beneficial to the environment from the university curriculum and various other sources (67.4%,  $n = 273$ ).

#### 4.5 Respondents' level of agreement or disagreement with statements

Table 4.4: One-sample  $t$ -test showing respondents' agreement over what constitutes a healthy diet

Construct	$n$	Mean (SD)	$t$	$df$	$p$ -value
I know what a healthy diet consists of	405	3.63 (.879)	14.471	404	< .001*
I understand the impact that my diet has on my health	405	3.88 (.939)	18.889	404	< .001*
I know what a sustainable/environmentally friendly diet consists of	405	3.12 (.901)	2.646	404	.008*
I understand the impact that my diet has on the environment	405	3.07 (1.018)	1.415	404	.158

Mean scores were recorded on a scale from 1 to 5. As shown in Table 4.4, an average of 3.63  $\bar{x}$  of respondents recognised what constitutes a healthy diet, 3.88  $\bar{x}$  understood the effect of their diet on health, 3.12  $\bar{x}$  understood the components of sustainable diets, and 3.07  $\bar{x}$  understood the impact of their diet on the environment. There was significant agreement that students knew what a healthy diet comprised of; they understood the impact of a diet on health, and they knew what a sustainable diet consisted of ( $p < 0.001$ ).

#### 4.6 Knowledge questions

Figure 4.2 displays the foods that respondents considered most harmful to the environment.

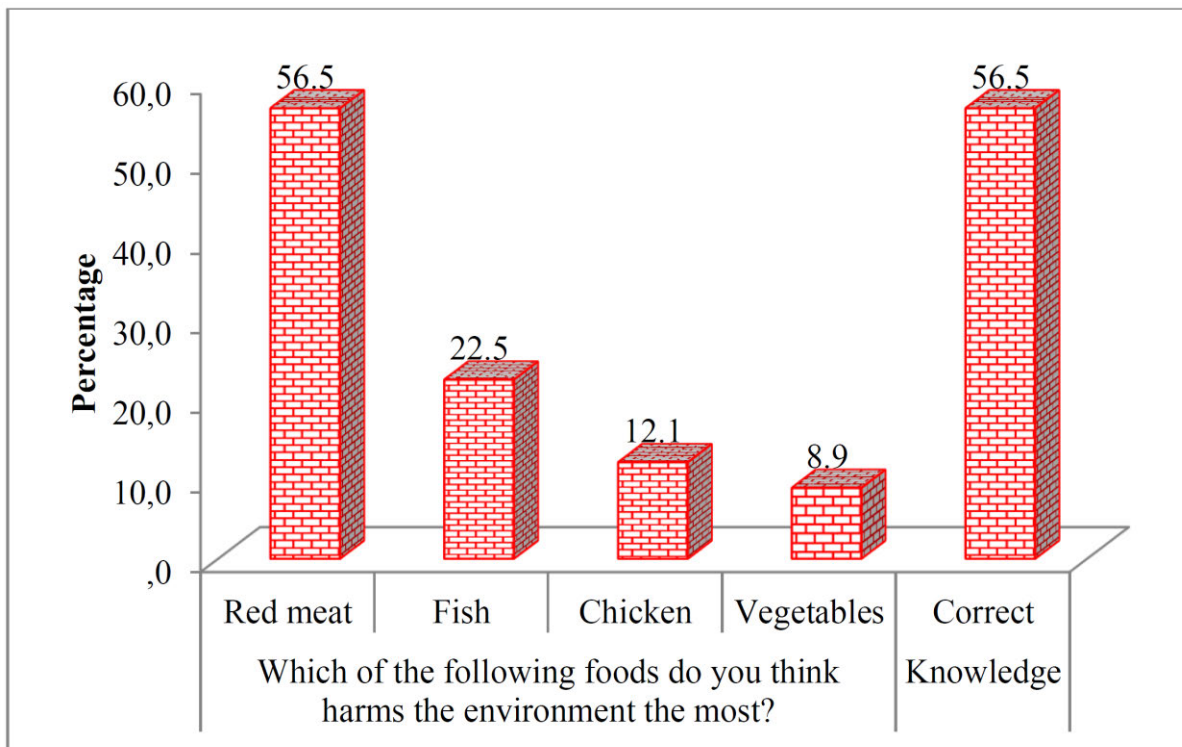


Figure 4.2: Foods deemed to be most harmful to the environment

As seen in Figure 4.2, a notable 56.5% ( $n = 229$ ) of respondents were aware that red meat is thought to be the most environmentally harmful food. Red meat is known to have the most detrimental effect on the environment compared to fish, chicken and vegetables. Therefore, the correct knowledge score bar is included. Twenty-two per cent ( $n = 91$ ) of the respondents selected fish, followed by 12.1% ( $n = 49$ ) who selected chicken, and 8.9% ( $n = 36$ ) who selected vegetables.

Figure 4.3 presents which diet has the least negative environmental impact.

Most students (65.9%,  $n = 267$ ) knew that a diet based on vegetables and fruit, chicken protein, fish and legumes, reduced fat and less sugar' had the least environmental impact, which was correct. The remaining 34.1% ( $n = 138$ ) made non-environmentally friendly dietary choices.

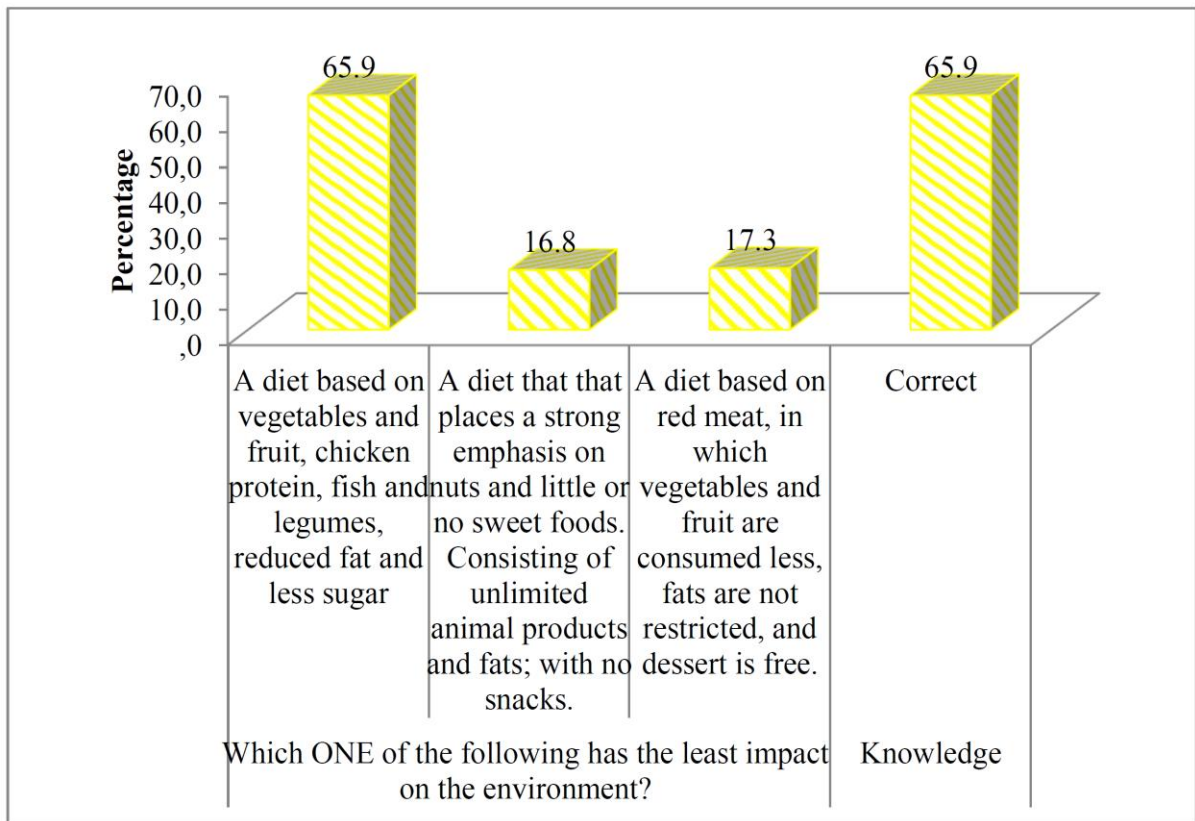


Figure 4.3: Diet that has the least impact on the environment

Figure 4.4 shows the food group that produces more CO<sub>2</sub> emissions per kilogram.

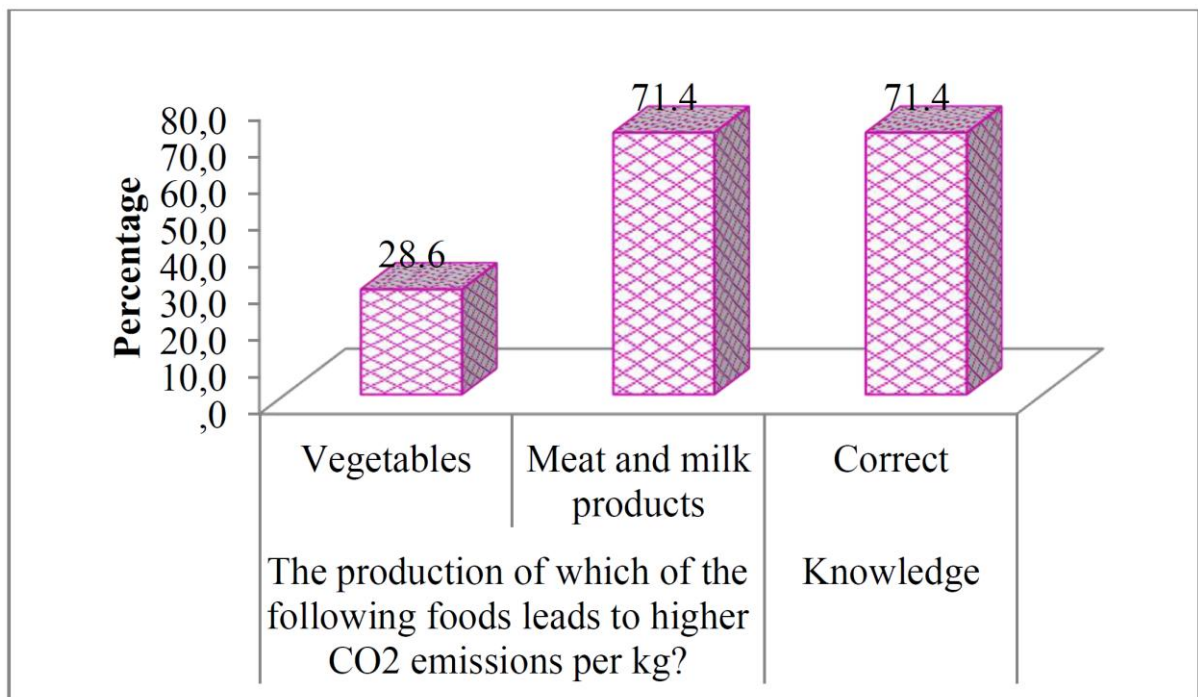


Figure 4.4: The food category that emits the most CO<sub>2</sub> per kilogram

According to the graph in Figure 4.4, 71.4% of respondents ( $n = 289$ ) knew that meat and milk products produce more CO<sub>2</sub> emissions than vegetables (28.6%,  $n = 116$ ). The knowledge bar indicates that this was correct.

Figure 4.5 illustrates the stage in which the food sector has the largest environmental impact.

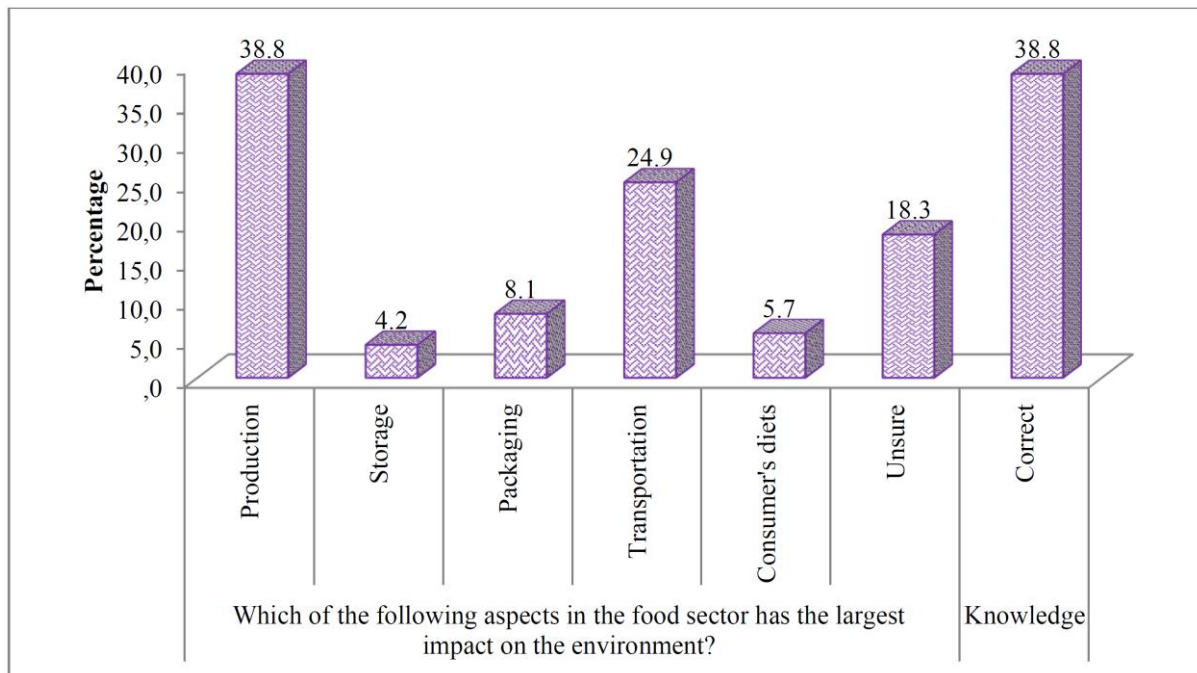


Figure 4.5: The phase where the food sector has the greatest influence on the environment

The illustration in Figure 4.5 shows that the respondents knew that the production stage in the food supply chain (38.8%,  $n = 157$ ) had the biggest environmental impact. Twenty-four per cent ( $n = 101$ ) of the respondents believed that transportation exerted the most significant environmental impact followed by the cohort of uncertain respondents (18.3%,  $n = 74$ ), those concerned with packaging (8.1%,  $n = 33$ ), respondents focused on dietary consumption (5.7%,  $n = 23$ ), and respondents selecting storage (4.2%,  $n = 17$ ).

Table 4.5 illustrates the responses of respondents ( $n = 405$ ) regarding their accurate and inaccurate answers in the realm of knowledge and awareness about the alimentary items that are most harmful to the environment, the alimentary items that have minimal environmental impact, the alimentary items that result in heightened CO<sub>2</sub> emissions per kilogram, and the factors within the food sector that exert the most significant influence on the environment.

**Table 4.5: Responses on knowledge and awareness of the environmental impact of various foods and the food sector ( $n = 405$ )**

Questions answered correctly and incorrectly	Frequency (%)		<i>n</i>	<i>p</i> -value
	Correct	Incorrect		
Q11. Which of the following foods do you think harms the environment the most?	229 (57)	176 (43)	405	.010
Q14. Which ONE of the following has the least impact on the environment?	276 (66)	138 (34)	405	< .001*
Q15. The production of which of the following foods leads to higher CO <sub>2</sub> emissions per kg?	289 (71)	116 (29)	405	< .001*
Q16. Which of the following aspects in the food sector has the largest impact on the environment?	157 (39)	248 (61)	405	< .001*

A significant 57% ( $n = 229$ ) of respondents answered question eleven correctly, which indicated that red meat harmed the environment the most, and 66% ( $n = 276$ ) of respondents answered question fourteen correctly. Respondents chose that “a diet based on vegetables and fruit, chicken, protein, fish and legumes, reduced fat and less sugar had the least impact on the environment”. Seventy-one per cent of ( $n = 289$ ) respondents answered question fifteen correctly, which stipulated that meat and milk products lead to higher CO<sub>2</sub> emissions per kilogram. Only 39% ( $n = 157$ ) answered question sixteen correctly, which indicated that the production phase in the food sector had the highest environmental impact, followed by 61% ( $n = 248$ ) that answered it incorrectly,  $p < 0.001$ .

Figure 4.6 represents a meal that is most environmentally friendly in each category. According to Category 1 of the graph, 75.1% of respondents selected the correct answer, while the remaining 24.9% selected the option that was least environmentally friendly. In contrast to the 18.3% of respondents who chose the incorrect options (chicken burger) and the 15.1% who chose the beef burger, Category 2 demonstrates that respondents were aware that plant-based burgers (66.4%) were more environmentally friendly. Respondents in Category 3 selected chakalaka and pap (60.7%) above chicken shawarma (21.7%) and boerewors (15.6%) as the most sustainable food products. In Category 4, only 36.5% of the respondents selected an appropriate food item. Notably, 76.3% of respondents were aware that the most environmentally conscious meal option in Category 5 was 100 g of spinach. In Category 6, tap water was deemed the most beneficial to the environment.

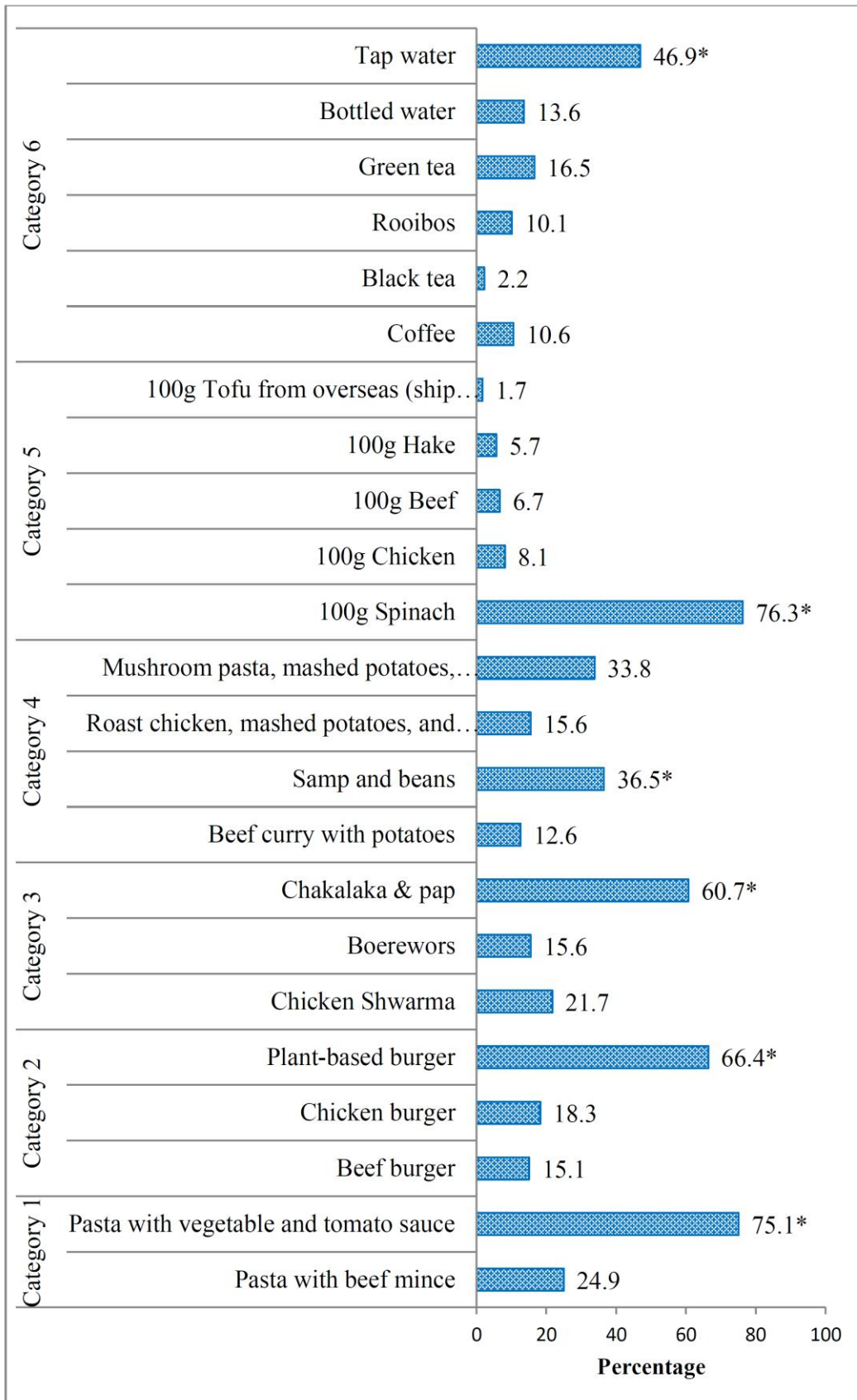


Figure 4.6: A meal that is most environmentally friendly in each category (\* $p < 0.001$ )

Table 4.6 presents correct and incorrect responses from respondents regarding the six categories of foods.

**Table 4.6: The food item in each category that is the most sustainable ( $n = 405$ )**

Category	Frequency (%)		<i>n</i>	<i>p</i> -value
	Correct	Incorrect		
Category 1 (pasta with beef and vegetable pasta)	304 (75)	101 (25)	405	< .001*
Category 2 (beef, chicken and plant-based burger)	270 (67)	134 (33)	405	< .001*
Category 3 (chicken shawarma, boerewors, chakalaka and pap)	246 (61)	159 (39)	405	< .001*
Category 4 (beef curry with potatoes, samp and beans, roast chicken, mashed potatoes and beans, mushroom pasta, mashed potatoes and beans)	148 (37)	257 (63)	405	< .001*
Category 5 (100g: spinach, chicken, beef, hake, tofu from overseas)	309 (76)	96 (24)	405	< .001*
Category 6 (coffee, black tea, rooibos, green tea, bottled water, tap water)	190 (47)	215 (53)	405	.233

This binomial table represents the number of respondents who selected the correct or incorrect food item from each of the six categories. In Category 1 ( $n = 304$ ), Category 2 ( $n = 270$ ), Category 3 ( $n = 246$ ), and Category 5 ( $n = 309$ ), a significant number of respondents selected the correct food item ( $p < 0.001$ ). Of the respondents, 63% ( $n = 257$ ) ( $p < 0.001$ ) made the incorrect choice for Category 4, and 53% ( $n = 215$ ) made the incorrect choice for Category 6.

The subsequent graph in Figure 4.7 displays various knowledge scores according to the questions that have a correct or incorrect response by respondents.

The average knowledge across the sample based on the questions that could be correct or incorrect = 51.9%.

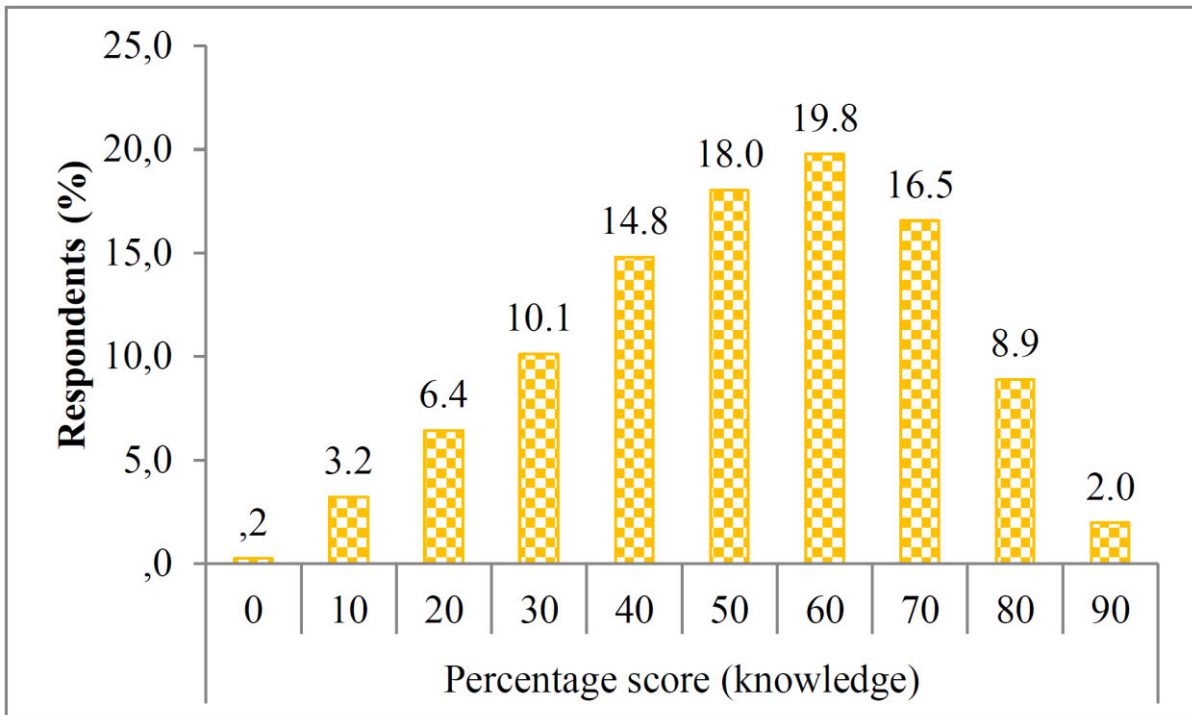


Figure 4.7: Overall knowledge score

#### 4.7 Barriers and drivers of food choices

In Table 4.7, the respondents ranked statements in order of importance. This table provides the results of a one-sample test conducted for variables that were deemed significant. Here, respondents in the study ranked the statements related to the barriers and drivers of food choice according to importance ( $n = 405$ ).

Table 4.7 indicates that when it comes to food purchases, respondents gave the greatest importance to price ( $5.04 \bar{x}$ ), which is followed by packaging that is biodegradable or compostable ( $4.38 \bar{x}$ ), produces the least amount of food waste during processing ( $4.27 \bar{x}$ ), is made in companies that respect the social rights of their employees ( $4.18 \bar{x}$ ) and the biodiversity of the ecosystem, and has a minimal environmental impact ( $4.14 \bar{x}$ ). The remaining individuals ( $23.2 \bar{x}$ ) thought that plant-based, organic, locally grown, seasonal, and culturally appropriate foods were the best options. When respondents made their food purchases, all the aspects displayed in Table 4.7 were significantly important to them ( $p < 0.001$ ).

**Table 4.7: Ranking of barriers and drivers of food choice (n = 405)**

Aspects deemed important	<i>n</i>	Mean (SD)	<i>t</i>	<i>df</i>	<i>p</i> -value
Affordable	405	5.04 (1.640)	18.862	404	< .001*
Culturally acceptable	405	3.92 (1.600)	5.325	404	< .001*
Plant-based (flexitarian, vegetarian or vegan)	405	3.72 (1.628)	2.671	404	.008*
Locally produced	405	3.90 (1.533)	5.266	404	< .001*
Seasonal	405	3.80 (1.459)	4.207	404	< .001*
Organic	405	3.93 (1.488)	5.793	404	< .001*
Simple, with no additives and based on foods with few ingredients that are not very processed	405	3.93 (1.618)	5.391	404	< .001*
Respectful of ecosystem biodiversity and with a low environmental impact	404	4.14 (1.608)	8.046	403	< .001*
Produced in companies that respect workers' social rights	405	4.18 (1.673)	8.213	404	< .001*
Result in the minimum amount of food waste during processing	405	4.27 (1.573)	9.869	404	< .001*
Packaged in biodegradable, compostable packaging	405	4.38 (1.504)	11.781	404	< .001*

Table 4.8 represents the average importance of respondents' responses to barriers and facilitators.

**Table 4.8: Average importance of respondents' responses to barriers and facilitators (from most to least important)**

	Average importance (1 = very unimportant to 6 = very important)
Affordable	5.04
Packaged in biodegradable, compostable packaging	4.38
Result in the minimum amount of food waste during processing	4.27
Produced in companies that respect workers' social rights	4.18
Respectful of ecosystem biodiversity and with a low environmental impact	4.14
Simple, with no additives and based on foods with few ingredients that are not very processed	3.93
Organic	3.93
Culturally acceptable	3.92
Locally produced	3.90
Seasonal	3.80
Plant-based (flexitarian, vegetarian or vegan)	3.72

Table 4.8 represents the average importance of respondents' responses from most to least important. The most significant factor is food affordability (5.04  $\bar{x}$ ), while plant-based diets (3.72  $\bar{x}$ ) rank lowest (3.72  $\bar{x}$ ).

Table 4.9 presents factors that inhibit purchasing plant-based foods.

**Table 4.9: Factors that inhibit purchasing plant-based foods ( $n = 405$ )**

Aspects preventing the purchase of plant-based foods	$n$	Mean (SD)	$t$	$df$	$p$ -value
Cost	405	3.44 (1.348)	6.527	404	< .001*
Lack of information	405	3.11 (1.229)	1.820	404	.070
Lack of culinary knowledge	405	3.09 (1.249)	1.393	404	.164
Food preferences and taste	405	3.65 (1.276)	10.321	404	< .001*
Food customs and traditions	405	2.95 (1.285)	-.851	404	.395
Ease of purchase (accessibility)	405	3.29 (1.329)	4.376	404	< .001*

Table 4.9 outlines which aspects prevented respondents from purchasing plant-based foods. The results indicate that lack of information (3.11  $\bar{x}$ ), lack of culinary knowledge (3.09  $\bar{x}$ ), food customs, and traditions (2.95  $\bar{x}$ ) prevented respondents to buy plant-based foods to a moderate extent. However, cost (3.44  $\bar{x}$ ), food preferences and taste (3.65  $\bar{x}$ ), and ease of purchase (accessibility) (3.29  $\bar{x}$ ) are to an above-average extent. The average score for these is more than three indicating that these are on the side of a large extent and significantly more than moderate ( $p < 0.001$ ).

Figure 4.8 depicts the reason for not purchasing plant-based foods. It explains the reasons why respondents refrain from purchasing plant-based foods. Food preferences and taste are significant, followed by cost and ease of purchase ( $p < 0.001$ ). The lack of information, lack of culinary knowledge, food customs, and traditions hindered respondents to buy plant-based foods to a moderate extent.

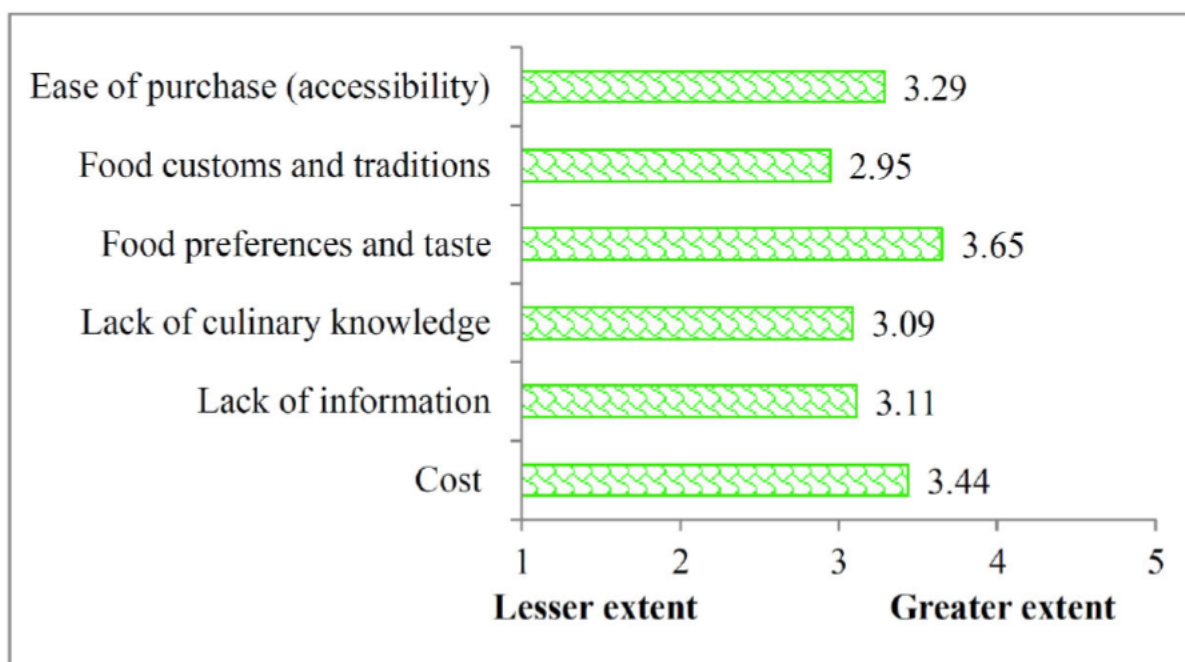


Figure 4.8: Reasons that prevent respondents from purchasing plant-based foods

Table 4.10 displays the challenges and motivators for eating healthy.

**Table 4.10: Barriers faced by respondents when trying to eat healthy**

Drivers and barriers	Responses as Frequency (%)	X <sup>2</sup>	df	p-value
	Response selected more than others			
I do not need to eat a healthier diet/my diet is already healthy	36 (8.9)	101.415	5	< .001*
I find it difficult to avoid unhealthy options	120 (29.6)	101.415	5	< .001*
I find it difficult to form new, healthier habits	59 (14.6)	101.415	5	< .001*
My mood makes it difficult to eat a healthier diet e.g., unhealthy foods help me to relax, or cope with stress	61 (15.1)	101.415	5	< .001*
The cost of healthier foods makes it unaffordable for me	103 (25.4)	101.415	5	< .001*
I find it difficult to eat healthy because I have no say on what type of foods are bought at home	26 (6.4)	101.415	5	< .001*

A notable 29.6% ( $n = 120$ ) of respondents indicated that they found it difficult to avoid unhealthy options and 25.4% ( $n = 103$ ) respondents noted that the cost of healthier foods makes it unaffordable for them to maintain a healthy diet. The remaining 45% ( $n = 177$ ) of respondents indicated that they face obstacles when adhering to a healthy diet. These include the following: “They do not need to eat healthy/my diet is already healthy”, “I find it difficult to avoid unhealthy options”, “my mood makes it difficult to eat a healthier diet”, or “I find it difficult to eat healthy because I have no say on what type of foods are bought at home”. The results presented in Table 4.10 showed that a significant 29.6% ( $n = 120$ ) of respondents found it difficult to avoid unhealthy food options, while 25.4% ( $n = 103$ ) of respondents stated that the cost of healthy foods makes it unaffordable for them to sustain a healthy diet ( $p < 0.001$ ).

#### 4.8 Attitudes and practices towards sustainable nutrition and the environment

Table 4.11 describes the perceptions of the cost of plant-based foods in comparison to non-plant-based foods.

**Table 4.11: The comparison in price between plant-based and non-plant-based foods**

Attitudes and practices	Responses as Frequency (%)	X <sup>2</sup>	df	p-value
	Cost of plant-based foods vs non-plant-based foods			
Plant-based is much cheaper than non-plant-based	77 (19.0)	53.457	4	< .001*
Plant-based is cheaper than non-plant-based	79 (19.5)	53.457	4	< .001*
The cost is about the same	98 (24.2)	53.457	4	< .001*
Plant-based is more expensive than non-plant-based	120 (29.6)	53.457	4	< .001*
Plant-based is a lot more expensive than non-plant-based	31 (7.7)	53.457	4	< .001*

A significant 29.6% ( $n = 120$ ) of respondents perceived that a plant-based diet is more expensive than a non-plant-based diet, and 24.2% ( $n = 98$ ) thought that the cost is about the

same ( $p < 0.001$ ). According to the Chi-squared test, there was no substantial difference between plant-based being cheaper (19.5%,  $n = 79$ ) and plant-based being much cheaper than non-plant-based (19%,  $n = 77$ ) foods. Plant-based foods are not significantly more expensive than non-plant-based items, according to only 7.7% ( $n = 31$ ) of respondents.

Table 4.12 presents the degree of agreement that the food industry is crucial in encouraging consumers to adopt a zero-waste lifestyle.

**Table 4.12: Level of agreement that the food industry plays a role in motivating students to adopt a zero-waste lifestyle**

Level of agreement	<i>n</i>	Mean (SD)	<i>t</i>	<i>df</i>	<i>p</i> -value
Indicate your level of agreement that the food industry plays a vital role in influencing consumers to practice a zero-waste lifestyle	405	3.40 (.924)	8.708	404	< .001*

There is a significant level of agreement that the food industry plays a vital role in influencing consumers to practice a zero-waste lifestyle ( $3.40 \bar{x}$ ;  $p < 0.001$ ).

Table 4.13 outlines the factors that prevented the purchase of plant-based foods ( $n = 405$ ).

**Table 4.13: Factors that prevented the purchase of plant-based foods**

Factors preventing the purchase of plant-based foods	<i>n</i>	Mean (SD)	<i>t</i>	<i>df</i>	<i>p</i> -value
The growing environmental issues (e.g., global warming) are a serious threat	405	4.18 (1.036)	22.921	404	< .001*
The environment is currently the most pressing issue the world needs to deal with	405	4.01 (.916)	22.243	404	< .001*
I am concerned about the current environmental situation and what it entails for future generations	405	4.00 (.920)	21.873	404	< .001*
We are not doing enough in our country to protect the environment	405	4.12 (1.071)	21.101	404	< .001*

A one-sample *t*-test was used to determine the significant agreement of respondents regarding the aspects that prevented the purchase of plant-based foods. From Table 4.13, it can be deduced that there was a significant agreement ( $p < 0.001$ ).

Table 4.14 presents the attitudes and practices of food and nutrition sustainability among respondents.

**Table 4.14: Attitudes and practices of food and nutrition sustainability**

Attitudes and practices	Responses as frequency (%)					X <sup>2</sup>	df	p-value
	Never	Rarely	Sometimes	Often	Always			
I check whether the packaging of a product I purchase is recyclable or reusable	114 (28.1)	106 (26.2)	112 (27.7)	50 (12.3)	23 (5.7)	86.420	4	< .001*
I use my own shopping bag when shopping	88 (21.7)	72 (17.8)	109 (26.9)	63 (15.6)	73 (18.0)	16.074	4	.003
I read the information on the product label	55 (13.6)	89 (22.0)	119 (29.4)	78 (19.3)	64 (15.8)	30.642	4	< .001*
I buy local products	12 (3.0)	62 (15.3)	181 (44.7)	110 (27.2)	40 (9.9)	217.827	4	< .001*
I pay attention to where the food is produced or grown	97 (24.0)	119 (29.4)	96 (23.7)	55 (13.6)	38 (9.4)	54.938	4	< .001*
I buy food that is in season	53 (13.1)	110 (27.2)	128 (31.6)	83 (20.5)	31 (7.7)	78.247	4	< .001*
I buy food in portions that are convenient for me to avoid food waste	43 (10.6)	74 (18.3)	84 (20.7)	94 (23.2)	110 (27.2)	31.012	4	< .001*
I take care that the products I buy are environmentally friendly	65 (16.0)	125 (30.9)	134 (33.1)	54 (13.3)	27 (6.7)	106.741	4	< .001*
I check nutritional information when making food purchases	89 (22.0)	99 (24.4)	111 (27.4)	55 (13.6)	51 (12.6)	35.358	4	< .001*
I substitute meat with more sustainable vegetarian products	149 (36.8)	97 (24.0)	83 (20.5)	45 (11.1)	31 (7.7)	107.160	4	< .001*
I search for more information about the manufacturing process of products (e.g., country of origin, ingredients, environmental footprint)	195 (48.1)	97 (24.0)	69 (17.0)	28 (6.9)	16 (4.0)	252.222	4	< .001*
I carefully examine all the information about the manufacturing process of products provided on the packaging (e.g., eco-labels, certifications, ingredient details)	157 (38.8)	136 (33.6)	63 (15.6)	35 (8.6)	14 (3.5)	194.198	4	< .001*
I seek information about the manufacturing process of products from additional sources (e.g., websites, discussion groups, friends)	196 (48.4)	100 (24.7)	66 (16.3)	26 (6.4)	17 (4.2)	258.420	4	< .001*
I separate my waste or garbage into plastic, paper, glass, food waste etc.	137 (33.8)	88 (21.7)	74 (18.3)	58 (14.3)	48 (11.9)	59.901	4	< .001*
I use leftover food to make new dishes	82 (20.2)	51 (12.6)	112 (27.7)	91 (22.5)	69 (17.0)	26.000	4	< .001*

I look for any eco-logo or eco-label on the packaging to evaluate a product	133 (32.8)	132 (32.6)	88 (21.7)	34 (8.4)	18 (4.4)	142.370	4	< .001*
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A notable 48.4% ( $n = 196$ ) of respondents never sought information about the manufacturing process of products from additional sources, 48.1% ( $n = 195$ ) of respondents never searched for more information about the manufacturing process of products, and 38.8% ( $n = 157$ ) never carefully examined all the information about the manufacturing process of products provided on the packaging. Approximately 36.8% ( $n = 149$ ) of the respondents noted that they never substitute meat with more sustainable vegetarian options. Thirty-two-point-six per cent of respondents rarely looked for any eco-label on the packaging to evaluate a product, 30.9% ( $n = 125$ ) seldomly took care that the products they buy are environmentally friendly, and 29.4% ( $n = 119$ ) seldom paid attention to where the food was produced or grown. A significant 44.7% ( $n = 181$ ) of respondents occasionally bought local products, 29.4% ( $n = 119$ ) frequently read information on the product label, and 27.4% ( $n = 111$ ) sometimes checked nutritional information when making food purchases. Merely 27.2% of students reported they regularly purchase local goods, compared to 9.9% ( $n = 40$ ) who indicated they always did. The proportions of those who “used leftover food to make new dishes” frequently (22.5%,  $n = 91$ ) and always (17.0%,  $n = 69$ ) did not differ significantly. According to the results, there was no significant difference between the groups who “buy food in portions that are convenient for them to avoid food waste” frequently (23.2%,  $n = 94$ ) and always (27.2%,  $n = 110$ ).

Table 4.15 presents the one-sample test of the level of agreement that young adults can support South Africa’s transition to a sustainable food system.

**Table 4.15: One-sample test assessing the degree of consensus on young adults’ potential to support South Africa in its transition to a sustainable food system ( $n = 405$ )**

Level of agreement	$n$	Mean (SD)	$t$	$df$	$p$ -value
Increasing the consumption of plant-based	405	3.58 (.978)	11.990	404	< .001*
Reducing the consumption of meat products	405	3.28 (1.021)	5.497	404	< .001*
Conserving water	405	4.19 (.946)	25.259	404	< .001*
Reducing food waste	405	4.24 (.970)	25.728	404	< .001*

Table 4.15 shows the significant agreement that young adult consumers can contribute towards a sustainable food system in South Africa by implementing the following: reducing food waste (4.24  $\bar{x}$ ), conserving water (4.19  $\bar{x}$ ), increasing the consumption of plant-based foods (3.58  $\bar{x}$ ), and reducing the consumption of meat products (3.28  $\bar{x}$ ). There is significant agreement ( $p < 0.001$ ), as indicated by the results in Table 4.15, that young adults can help South Africa transition to a sustainable food system.

#### **4.9 24-hour food recall dietary data**

Table 4.16 notes the key observations for energy and macronutrient intake for men. The prevalence of inadequate intake was calculated using the cut-point method, highlighting specific nutrient deficits among the group. The cut-point method is used to assess the prevalence of nutrient inadequacy by comparing an individual's intake of a particular nutrient against a predetermined cut-off point. If their intake is below the cut-off point, it is classified as inadequate, and if the intake is above the cut-off point, it is classified as adequate. While the mean energy intake (9691 kJ) exceeded the EAR (9205 kJ), nearly 59.9% of respondents failed to meet the energy requirement, suggesting an uneven energy distribution among men in this study. Total fat intake (mean: 775 g) was slightly below the EAR (86 g), and 75.7% of respondents consumed inadequate amounts. The mean intake for dietary fibre (26.69 g) was substantially below the AI of 38 g, with 94.7% of respondents having inadequate fibre intake. The following key observations were made for micronutrient deficiencies:

Although the mean calcium intake was 681.98 mg, 74.3% of respondents failed to meet the AI of 800 mg. The mean intake of magnesium (252.79 mg) is well below the EAR of 420 mg, and 96.7% of respondents exhibit inadequate magnesium intake. The mean intake of vitamin D is 6.89  $\mu\text{g}$  against an AI of 15  $\mu\text{g}$ , with 92.8% of respondents having inadequate vitamin D intake. The mean intake of vitamin K (61.21  $\mu\text{g}$ ) is well below the AI (120  $\mu\text{g}$ ), with 89.5% of respondents having insufficient intake. The mean intake of folate (117.01  $\mu\text{g}$ ) is substantially below the EAR (400  $\mu\text{g}$ ), with 94.1% of respondents not meeting the requirement. The notable exceptions were for carbohydrates and protein, in which the average intakes for carbohydrates (310.8 g) and protein (88.06 g) are well above the EARs (130 g and 56 g, respectively).

Table 4.16 represents the results of the first and second 24-hour food recall for men, and Table 4.17 represents the results of the first and second 24-hour food recall for women.

**Table 4.16: Recommended nutrient intake, mean, percentiles and prevalence of inadequate intake of male respondents (n = 152)**

Nutrient/Calorie	EAR/AI* cut-off points	Mean (SE)	Percentiles					Prevalence of inadequate intake (%)
			10%	25%	50%	75%	90%	
Energy (kJ)	9205	9691.25 (701.63)	5842.00	7076.75	8676.25	<b>9909.38</b>	12106.00	59.9
Total protein (g)	56	88.06 (6.82)	48.12	<b>59.75</b>	75.48	93.04	129.14	19.1
Carbohydrate (g)	130	3108161 (29.19)	<b>167.07</b>	215.34	265.78	343.54	401.35	3.3
Total fat (g)	86	77.5(6.88)	38.17	47.73	65.35	84.90	<b>105.69</b>	75.7
Dietary fibre (g)	38*	26.69 (5.55)	10.72	14.60	18.23	26.08	32.73	94.7
Ca (mg)	800*	681.98 (52.52)	275.50	412.50	605.00	<b>812.88</b>	1072.90	74.3
Fe (mg)	8	17.98 (1.709)	<b>8.43</b>	11.01	14.33	19.00	28.36	7.9
Se (µg)	55	74.72 (7.83)	22.97	36.71	<b>59.08</b>	86.50	128.68	47.4
Zn (mg)	11	15.42 (3.03)	6.60	8.33	<b>11.09</b>	15.09	1960	48.7
Mg (mg)	420	252.79 (38.18)	101.40	137.13	188.25	254.88	331.45	96.7
P (mg)	700	978.90 (103.42)	491.65	623.25	<b>817.00</b>	1021.13	1358.95	34.2
Vitamin A (µg)	900	967.06 (121.16)	207.65	338.63	619.75	<b>916.75</b>	1925.50	74.0
Vitamin C (mg)	90	117.96 (7.96)	20.10	46.13	88.75	153.75	268.05	50.7
Vitamin D (µg)	15*	6.89 (.51)	.75	2.54	5.78	9.64	13.78	92.8
Vitamin E(µg)	15	17.85 (1.46)	5.31	8.78	13.81	22.79	34.88	55.9
Vitamin K (µg)	120*	61.21 (5.42)	17.11	29.02	39.98	67.04	<b>129.41</b>	89.5
Riboflavin	1.3	1.60 (.11)	.69	.94	1.25	1.75	2.78	53.9
Folate (µg)	400	117.01 (20.50)	1.59	14.38	46.13	117.86	302.37	94.1
Niacin	16	26.37 (1.34)	12.03	<b>17.85</b>	22.65	30.18	44.62	17.1
Vitamin B6 (µg)	1.1	2.29 (.29)	.79	<b>1.14</b>	1.71	2.25	3.25	22.7
Vitamin B12 (µg)	2.4	3.81 (.37)	.90	1.55	<b>2.75</b>	4.25	7.02	41.4
Thiamine (mg)	1.2	1.68 (.14)	.78	.98	<b>1.39</b>	1.84	2.69	37.7
Total sugar (g)	166	65.96 (10.79)	20.72	37.93	49.90	69.89	95.17	99.3
Added sugar (g)	36	10.06 (.98)	0.00	0.00	5.48	16.80	29.76	94.7
Saturated fat (g)	29	23.11 (2.83)	9.39	13.35	18.66	24.39	<b>33.35</b>	82.9
Monounsaturated fat (g)	31	24.94 (2.63)	11.01	14.59	21.24	27.49	<b>33.9</b>	84.9
Polyunsaturated fat (g)	23	23.04 (1.56)	8.64	12.39	18.10	<b>29.08</b>	40.02	66.4
Trans fat (g)	2	1.09 (.13)	.09	.19	.62	1.21	<b>2.743</b>	86.8
Cholesterol (mg)	300	240.49 (16.68)	61.80	101.50	180.00	<b>317.38</b>	522.25	73.7

\*AI = Adequate intake (National Institutes of Health n.d.; National Academies of Sciences, Engineering and Medicine 2023); EAR- Estimated Adequacy Requirement, SE- Standard error. Figures in bold type refer to the level where the EAR/AI is met.

**Table 4.17: Recommended nutrient intake, mean, percentiles and prevalence of inadequate intake of female respondents (n = 248)**

Nutrient/Calorie	EAR/AI cut-off points	Mean (SE)	Percentiles					Prevalence of inadequate intake
			10%	25%	50%	75%	90%	
Energy (KJ)	7531	7766.78 (159.97)	5182.55	6188.03	7253.50	<b>9201.38</b>	10784.80	53.6
Total protein (g)	46	67.15 (1.66)	39.68	<b>50.18</b>	64.30	78.84	101.43	19.8
Carbohydrate (g)	130	241.35 (5.46)	<b>149.53</b>	181.30	229.43	282.30	340.57	4.4
Total fat (g)	69	32.59 (1.20)	13.25	19.50	28.50	40.86	56.89	95.2
Dietary fibre (g)	25*	17.744 (0.56)	9.79	12.45	16.08	21.16	<b>26.37</b>	86.7
Ca (mg)	900*	517.71 (14.59)	257.90	355.38	479.00	624.75	833.25	94.0
Fe (mg)	18	14.91 (0.53)	7.69	9.74	12.85	16.66	<b>23.68</b>	79.0
Se (µg)	55	62.26 (2.69)	22.71	37.69	54.78	<b>74.10</b>	107.70	50.4
Zn (mg)	8	11.02 (0.37)	5.56	7.519	<b>9.69</b>	12.84	17.85	29.8
Mg (mg)	320	181.77 (5.89)	82.45	118.50	168.75	220.88	294.15	93.1
P (mg)	700	757.65 (20.16)	413.75	541.63	<b>716.25</b>	894.50	1210.75	48.4
Vitamin A (µg)	700	1308.86 (232.87)	245.60	363.63	571.00	<b>1042.50</b>	2405.10	63.3
Vitamin C (mg)	75	121.37 (5.75)	26.50	42.75	<b>106.25</b>	177.00	240.90	39.9
Vitamin D (µg)	15*	5.98 (0.35)	1.37	2.46	4.42	7.25	12.67	93.1
Vitamin E(µg)	15	14.34 (0.55)	5.52	8.09	12.44	<b>18.21</b>	26.32	64.1
Vitamin K (µg)	90*	71.43 (6.80)	12.62	22.13	39.39	66.00	<b>148.99</b>	83.1
Riboflavin	1.1	1.40 (0.06)	0.69	0.86	<b>1.13</b>	1.57	2.42	46.0
Folate (µg)	400	121.92 (12.99)	3.15	15.17	50.19	124.19	328.64	92.3
Niacin (mg)	11	21.96 (0.70)	10.29	<b>14.41</b>	19.95	26.24	35.87	12.5
Vitamin B6 (µg)	1.1	1.89 (0.06)	0.89	<b>1.18</b>	1.67	2.32	3.14	20.6
Vitamin B12 (µg)	2.4	5.78 (0.85)	.90	1.60	<b>2.73</b>	4.33	10.07	42.3
Thiamine (mg)	1.1	1.35 (0.05)	0.71	0.88	<b>1.18</b>	1.55	2.14	44.8
Total sugar (g)	132	44.96 (1.67)	16.27	24.49	39.75	61.93	80.44	99.2
Added sugar (g)	24	11.14 (1.05)	0.00	.20	4.78	14.95	<b>29.96</b>	85.1
Saturated fat (g)	23	20.30 (0.59)	10.05	14.06	18.39	<b>24.93</b>	34.69	67.3
Monounsaturated fat	26	22.33 (0.69)	9.87	14.89	20.69	<b>27.98</b>	36.82	69.4
Polyunsaturated fat	18	20.82 (0.84)	7.67	11.53	17.57	<b>27.51</b>	37.26	51.2
Trans fat	2	1.14 (0.09)	0.11	0.28	0.62	1.34	<b>2.76</b>	85.1
Cholesterol (mg)	300	230.54 (12.32)	55.90	107.63	173.25	288.50	<b>505.40</b>	77.0

\*AI = Adequate intake (National Institutes of Health n.d.; National Academies of Sciences, Engineering and Medicine 2023); EAR- Estimated Adequacy Requirement, SE- Standard error figures in bold type refer to the level where the EAR is met.

Table 4.17 provides data on the nutrient intake of 248 female respondents compared to the EAR or AI guidelines. The prevalence of inadequate intake was calculated using the cut-point method, highlighting specific nutrient deficits among the group. The mean energy intake (7766 kJ) closely aligns with the EAR (7531 kJ). However, 53.6% of respondents consumed inadequate amounts, indicating variability in energy intake within the group. Protein intake exceeded the EAR (46 g), with a mean intake of 67.15 g. Only 19.8% of respondents consumed inadequate protein levels, suggesting most women met their protein requirements. The mean carbohydrate intake (241.35 g) significantly exceeded the EAR (130 g), with only 4.4% of respondents showing inadequacy. In contrast, dietary fibre intake (mean: 17.74 g) was significantly below the AI (25 g), with 86.7% of respondents failing to meet the requirement. Calcium intake was critically low, with a mean intake of 517.71 mg compared to the AI of 900 mg. A striking 94% of respondents consumed insufficient calcium. For iron, while the 90th percentile intake (23.68 mg) exceeded the EAR (18 mg), 79% of respondents had inadequate iron intake, likely reflecting poor dietary diversity. Magnesium intake was also notably low, with a mean of 181.77 mg compared to the EAR of 320 mg, leaving 93.1% of respondents with inadequate intake. Vitamin D intake (mean: 5.98 µg) fell far short of the AI (15 µg), with 93.1% of respondents showing inadequacy. Similarly, vitamin K intake (mean: 71.43 µg) was below the AI of 90 µg, with 83.1% of respondents consuming inadequate levels. Finally, folate intake was alarmingly low, with a mean intake of 121.92 µg compared to the EAR of 400 µg. As a result, 92.3% of respondents consumed inadequate levels of folate.

*Objective 2: To determine the dimensions of diet quality for nutrient adequacy and NCD risk among students at the DUT through the GDQS.*

Table 4.18 represents the GDQS for each category.

**Table 4.18: GDQS score for the three categories (n = 400)**

GDQS category	n	%
Low risk	0	0
Moderate risk	1	0.3
High risk	399	99.8

Table 4.18 indicates that no respondents fall under the low risk category for nutrient inadequacy and NCDs. Only one respondent was classified as moderate risk, representing 0.3% of the total

number of respondents. This suggests that a very minimal percentage of respondents are at a moderate level of risk. A significant majority, 99.8% ( $n = 399$ ), of respondents, are deemed high risk. The data indicates a prevalence of high nutrient inadequacy risk and associated NCD outcomes among respondents.

Table 4.19 displays the GDQS score.

**Table 4.19: GDQS score**

GDQS score	
Mean	5.5069
Median	5.2500
Standard deviation	2.74412
95 % confidence interval (CI)	(0.128; 5.759)

Table 4.19 shows the mean, median, standard deviation and confidence interval for the GDQS.

**Objective 3:** *To investigate the environmental impact of diet among university students at the DUT using online carbon footprint calculators.*

Table 4.20 displays the carbon footprint data for the entire sample ( $n = 400$ ).

**Table 4.20: Carbon footprint for the first 24-hour food recall ( $n = 400$ )**

Carbon footprint for the full sample	Value
Number of valid entries (N)	400
Number of missing entries	0
Mean	6137.33
Standard deviation	15992.265
Minimum	450
Maximum	308060
25 <sup>th</sup> percentile	2532.50
50 <sup>th</sup> percentile (median)	4130.00
75 <sup>th</sup> percentile	7232.50

Table 4.21 shows the gender-specific carbon footprints.

**Table 4.21: Gender-specific carbon footprints**

Carbon footprint for both genders	Female	Male
Number of valid entries (N)	248	152
Number of missing entries	0	0
Mean	5020.36	7959.74
Standard deviation	3790.467	25434.271
Minimum	450	880
Maximum	23910	308060
25th percentile	2352.50	3077.50
50th percentile (median)	3795.00	4490.00
75th percentile	6752.50	7905.00

Table 4.22 presents the Mann-Whitney test used to compare mean ranks across genders.

**Table 4.22: Comparison of the mean rank across gender**

Gender	<i>n</i>	Mean (SD)	Median (IQR)	Mean rank	Z	<i>p</i> -value
Female	248	5020.4 (3790.47)	3795 (2352.5–6752.5)	190.08	-2.302	.021
Male	152	7959.7 (25434.27)	4490 (3077.5–7905)	217.51		

A Mann-Whitney test indicated that male carbon footprints are significantly higher than those of females ( $Z = -2.302, p = .021$ ).

**Objective 4:** *To promote sustainable dietary practices by implementation of the South African Food Boost University Challenge.*

Table 4.23 shows the sensory analysis for each item and the most liked product among students.

**Table 4.23: The number of evaluations each food item received from students during the sensory analysis of the South African Food Boost University Challenge**

Food	Frequency
1. Fruit and yoghurt popsicles	32
2. Sweet potato long chips	31
3. Vegetable pasta	40
4. Tangy delights (yoghurt with fruit and chocolate popsicles)	25
5. Ultimate veggie burger	40
6. Tropical paradise smoothie	4
7. Sweet potato, avocado and feta muffins	38
8. Okra smoothie	9

The vegetable pasta and ultimate veggie burger were the most frequently evaluated ( $n = 40$ ), indicating a high level of interest. The sweet potato, avocado and feta muffins also received a notable number of evaluations (38). The fruit and yoghurt popsicles and sweet potato long chips were slightly less frequently evaluated, with 32 and 31 evaluations respectively. The tangy delights (yoghurt with fruit and chocolate popsicles), received 25 evaluations, showing moderate interest. In contrast, the okra smoothie and tropical paradise smoothie had the fewest evaluations, with 9 and 4 respectively, suggesting less frequent assessment or lower interest in these items. Therefore, we can deduce that the top three favourites were: vegetable pasta; ultimate veggie burger and sweet potato, avocado and feta muffins.

Table 4.24 presents sensory evaluations for various foods across four attributes: appearance/colour, taste/flavour, texture/mouthfeel, and smell/aroma. The students noted significant differences for the fruit and yoghurt popsicles, in appearance/colour and texture/mouthfeel, indicating robust positive perceptions ( $p < 0.001$ ). Simultaneously, they positively rated ( $p < 0.025$ ) taste/flavour, suggesting moderate significance. The sweet potato long chips exhibited superior ratings in taste and appearance ( $p < 0.001$ ). The vegetable pasta demonstrated high acceptance across attributes, ( $p < 0.001$ ). The tangy delights (yoghurt with fruit and chocolate popsicles), received the highest ratings across all attributes, consistently showing significance ( $p < 0.001$ ), indicating exceptional sensory appeal. The ultimate veggie burger received favourable evaluations across all sensory attributes, each with  $p$ -values  $< .001$ . The students positively rated the sweet potato, avocado and feta muffins in most sensory aspects, ( $p < 0.001$ ), except for smell/aroma, which had a moderately higher significance ( $p < 0.001$ ). Lastly, the okra smoothie exhibited varied outcomes, demonstrating significant  $p$ -values for appearance ( $p < 0.013$ ), taste ( $p < 0.017$ ), and texture ( $p < 0.017$ ), while showing a comparatively elevated ( $p < 0.005$ ) for aroma, suggesting inconsistent sensory attractiveness.

Table 4.24 represents a one-sample  $t$ -test to determine if there is a significant difference between the sensory attributes.

**Table 4.24: One-sample *t*-test showing the average score for each food across each sensory attribute for staff data**

Food	Sense	<i>n</i>	Mean	Standard deviation	<i>t</i>	<i>df</i>	<i>p</i> -value
Fruit and yoghurt popsicles	Appearance/Colour	10	8.40	1.075	10.002	9	< .001
	Taste/Flavour	10	6.90	2.234	2.690	9	.025
	Texture/Mouthfeel	10	7.60	1.506	5.461	9	< .001
	Smell/Aroma	10	6.40	2.319	1.909	9	.089
Sweet potato long chips	Appearance/Colour	10	7.70	1.252	6.821	9	< .001
	Taste/Flavour	10	7.50	1.434	5.514	9	< .001
	Texture/Mouthfeel	10	6.70	2.058	2.613	9	.028
	Smell/Aroma	10	7.00	1.826	3.464	9	.007
Vegetable pasta	Appearance/Colour	8	8.13	.835	10.591	7	< .001
	Taste/Flavour	8	7.88	.991	8.205	7	< .001
	Texture/Mouthfeel	8	8.25	.707	13.000	7	< .001
	Smell/Aroma	8	7.38	1.506	4.461	7	.003
Tangy delights (yoghurt with fruit and chocolate popsicles)	Appearance/Colour	11	8.45	.820	13.969	10	< .001
	Taste/Flavour	11	8.36	.674	16.547	10	< .001
	Texture/Mouthfeel	11	7.82	1.662	5.622	10	< .001
	Smell/Aroma	11	7.64	1.433	6.100	10	< .001
Ultimate veggie burger	Appearance/Colour	8	7.88	1.246	6.524	7	< .001
	Taste/Flavour	8	8.25	.707	13.000	7	< .001
	Texture/Mouthfeel	8	8.25	.707	13.000	7	< .001
	Smell/Aroma	8	8.25	.707	13.000	7	< .001
Sweet potato, avocado and feta muffins	Appearance/Colour	9	8.33	.866	11.547	8	< .001
	Taste/Flavour	9	8.11	1.167	8.000	8	< .001
	Texture/Mouthfeel	9	8.33	.866	11.547	8	< .001
	Smell/Aroma	9	7.67	1.323	6.047	8	< .001
Okra smoothie	Appearance/Colour	8	7.13	1.808	3.325	7	.013
	Taste/Flavour	8	7.25	2.053	3.100	7	.017
	Texture/Mouthfeel	8	7.25	2.053	3.100	7	.017
	Smell/Aroma	8	7.38	1.685	3.987	7	.005

Figure 4.9 illustrates the 9-point hedonic scale used by staff to conduct the sensory analysis based on the appearance, taste, texture and smell of all seven products prepared for the South African Food Boost University Challenge.

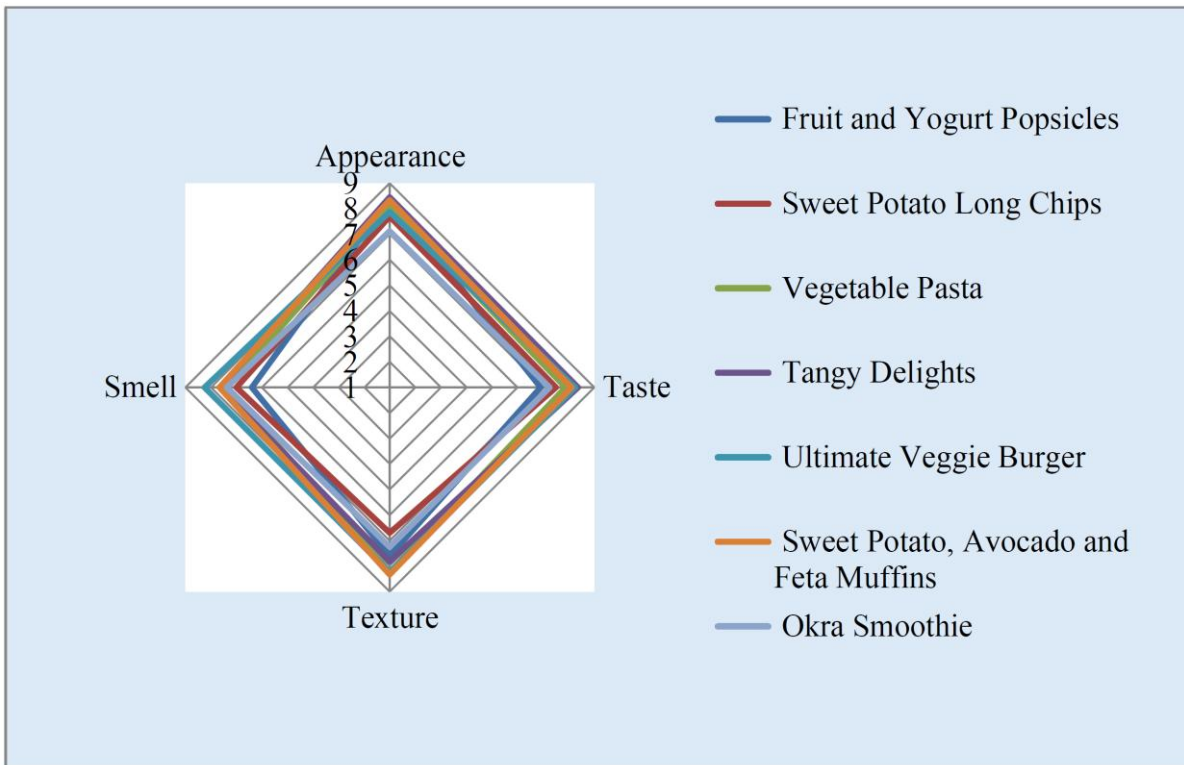


Figure 4.9: The sensory attributes of the seven products developed for the SAFBUC

#### 4.10 Pictures from the South African Food Boost University Challenge



Figure 4.10: Fruit and yoghurt popsicles



Figure 4.11: Students tasting session



Figure 4.12: Staff member 1, tasting session



Figure 4.16: Sweet potato long chips



Figure 4.13: Staff member 2, tasting session



Figure 4.17: Staff member 3, tasting session



Figure 4.14: Vegetable pasta



Figure 4.18: Students product displayed



Figure 4.15: Tangy delights



Figure 4.19: Sensory analysis in progress



Figure 4.20: Discussion of products



Figure 4.23: Ultimate veggie burger

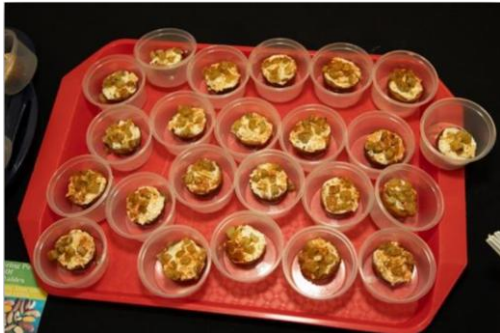


Figure 4.21: Sweet potato, avocado and feta muffins



Figure 4.24: Students tasting samples



Figure 4.22: Staff tasting session



Figure 4.25: Okra smoothie



Source: Kisten (2024)

Figure 4.26: Group photo of the top three respondents and principal researcher



Source: Kisten (2024)

Figure 4.27: First place for the South African Food Boost University Challenge (Kamva Nguqu)



Source: Kisten (2024)

Figure 4.28: Second place for the South African Food Boost University Challenge (Matilde Ebengo, Lethukuthula Zikalala (left to right) and Asanda Mashazi (right))



Source: Kisten (2024)

Figure 4.29: Third place for the South African Food Boost University Challenge (Sinegugu Ngidi)

## **4.11 Discussion**

### **4.11.1 Introduction**

This section will review the study's findings in relation to its objectives. To validate this study and establish whether the planned objectives were achieved, comparisons with other published studies with comparable backgrounds will be explored. This study aimed to create transformative ideas for sustainability, climate change goals, and enhanced health that address both the SDG 2030 and Agenda 2063 goals at a young adult student level. This cross-sectional developmental study examined sustainability from the perspective of the South African young adult consumer. The study investigated student consumer perceptions, attitudes, and understanding of food and nutrition sustainability and food choice drivers in South Africa through a survey. Thereafter, diet was recorded using the 24-hour food recall questionnaire, and diet quality was assessed using the GDQS. The environmental impact of the diet was assessed using an online environmental calculator to determine GHG emissions. Lastly, a South African Food Boost University Challenge was implemented to promote sustainable dietary practices among students. In this cross-sectional study, data was collected from students at a specific point in time to investigate the relationship between heterogeneous variables. Quantitative data was analysed and reported as frequencies and proportions for categorical variables.

## **4.12 Importance of food and nutrition sustainability**

### **4.12.1 Importance for university students**

Food and nutrition sustainability is particularly important for university students as they navigate a critical phase of life where dietary habits are formed and health outcomes are established (Li, Tang and Le 2023). Throughout this period, students frequently face unique challenges such as financial constraints, demanding schedules, and a dependence on convenience foods, which may result in poor nutritional decisions (Contini et al. 2020). Embracing sustainable food practices allows students to prioritise their health while also being mindful of the environmental impact of their dietary choices. For instance, opting for local and seasonal produce enhances their diet with fresher and more nutrient-dense foods, supports local farmers, and reduces carbon emissions associated with long-distance food transportation (Nakajima 2022).

Furthermore, university campuses are progressively incorporating sustainability programmes into their dining services, making accessible healthy and sustainable food options easier for students (Doherty 2022). Many institutions are adopting practices such as sourcing food from local farms, offering plant-based meal choices, and reducing food waste through composting and donation initiatives (Leal Filho et al. 2023). These efforts promote a culture of sustainability on campus and educate students about the significance of making informed food choices (Meijer, Grunert and Lähteenmäki 2023). By participating in these programmes, students can build habits that contribute to their long-term health, while advocating for environmental concerns within their communities (Ramzan et al. 2023).

Subsequently, the increasing awareness of food and nutrition sustainability can enable university students to act as advocates for change on campus and beyond (Fretes et al. 2021). Participating in sustainability efforts, such as campus gardens dedicated to food security, encourages students to develop leadership skills and build a community spirit (Mittal and Bansal 2024). As students understand the links between food systems, public health, and environmental concerns, they are better prepared to support policies and actions that encourage sustainability (Wood et al. 2023). This comprehensive awareness may motivate future leaders across different sectors to emphasise sustainability in both their personal and professional lives, ultimately aiding in a more sustainable future for all.

#### **4.13 Awareness, knowledge and attitudes toward food and nutrition sustainability**

##### **4.13.1 Survey methodology and participant demographics**

In this study, a face-to-face food and nutrition sustainability questionnaire was administered to determine awareness, knowledge and attitudes of food and nutrition sustainability, and food choice drivers among students at the DUT. All the respondents in this study were young adults, and more than half were predominantly female. According to a study by Nuzzo and Deaner (2023), there is insufficient data regarding determinants of survey participation by gender. However, it has been noted that females demonstrate a higher inclination than males to participate in surveys, although they show reluctance towards painful or unpleasant tasks. Additionally, young adults between 18 and 26 years old and 27 to 34 participated in the physical questionnaire (Nuzzo and Deaner 2023). This study is consistent with prior research titled *Evaluation of university students' knowledge of and practices for sustainable nutrition*,

conducted in Istanbul, Turkey's most urban and diverse city (Yüksel and Yılmaz Önal 2021). The racial demographic profile of this study is primarily Black South Africans (84.7%). This observation aligns with local demographics and highlights enduring diversity and inclusion issues in higher education by ensuring that universities make active and conscious efforts to increase the number of Black, mainly African students in the system (Pillay 2019). The minimal representation of white (0.5%), coloured (2.5%) and Indian (12.3%) students indicates socioeconomic challenges and historical disparities in the area (Pillay 2019).

#### **4.13.2 Findings on awareness and knowledge levels among students**

In tackling the global challenges imposed on the environment, sustainable nutrition takes on a vital relevance. It is paramount to assess the knowledge and perspectives of university students, who represent the young adult demographic group that will shape the future, regarding this matter (Yüksel and Yılmaz Önal 2021). According to the results of the questionnaire, multiple factors affect students' knowledge and awareness regarding food and nutrition sustainability. For instance, the findings from Table 4.2 reveal a concerning lack of awareness and understanding among respondents regarding key concepts related to sustainability. A significant 54.8% of survey respondents acknowledged that they had not been exposed to the SDGs before, while only 45.2% displayed minimal awareness, though lacking more profound understanding. This lack of awareness aligns with previous studies that reported a gap in knowledge surrounding sustainable nutrition issues among young adults (Rieckmann et al. 2017; García-González et al. 2020).

#### **4.13.3 Attitudinal trends and key food choice drivers**

Nutrition is a fundamental aspect of human life and plays a vital role in maintaining optimal health and well-being. However, the nutritional status of university students has become a major concern (Suárez-Reyes, Muñoz Serrano and Van den Broucke 2019). A student's university life is a pivotal period for establishing healthy eating habits and attitudes. However, university students are susceptible to the development of inadequate eating patterns because of various factors, including economic constraints, academic pressures, and the lack of knowledge regarding nutritional concepts. Poor diet quality often leads to malnutrition or overnutrition, increasing the risk of preventable diseases. Food environments present within university campuses play a crucial role in shaping the dietary habits of students, with the presence and accessibility of healthy food choices serving as essential variables that influence food

preferences and dietary standards. The prevalence of disordered eating habits and body dissatisfaction are prevalent among university students and result in the emergence of eating disorders. Furthermore, income and living arrangements also influence dietary habits, with low household income and solitary living arrangements being associated with unhealthy eating habits (Almoraie et al. 2024).

As young adults transition from adolescence to the stage of young adulthood, they encounter a multitude of challenges associated with making healthy dietary decisions (Stok et al. 2018). These challenges may stem from an inability to sustain a nutritious diet due to a variety of factors, including demanding schedules, heightened stress levels, restricted availability of healthy food alternatives on or near campus, and detrimental eating patterns such as excessive snacking (Escoto et al. 2012; Bremner et al. 2020; Almoraie et al. 2021). Inadequate dietary habits can lead to the emergence of mental health disorders, including anxiety, depression, and diminished academic performance (Solomou et al. 2023). For instance, numerous students consume diets that lack essential nutrients such as vitamins and minerals. Many students choose to consume foods that are high in kilojoules, sugar and fat, such as fast food, processed snacks and sugary beverages (Almoraie et al. 2021). These issues are further intensified by the limited availability of nutritious food options within the campus environment. Due to time constraints or resources, many students tend to frequently skip meals, which may result in energy deficits and nutritional shortages that adversely affect their academic performance (Merhy et al. 2023).

According to the results of this study, it has been noted that the campus food environment at DUT is not ideal for promoting a healthy food environment among young adults. The food environment consists of high-kilojoule foods that can cause weight gain, poor sleep quality, and NCDs. Furthermore, the prevalence of unhealthy food environments within universities is a major concern, particularly because most students, as young adults, are more susceptible to poor dietary habits due to limited income, restricted cooking skills, insufficient nutritional knowledge and limited access to kitchen facilities, particularly in shared housing and on-campus accommodation (Munt, Partridge and Allman-Farinelli 2017; Whatnall et al. 2021). The nutritional habits of students often exhibit significant deviations from the characteristics of a healthy, balanced diet due to a variety of factors, such as geographical separation from their family residences, prevailing economic circumstances, considerable academic pressures, time constraints, and insufficient knowledge of nutritional guidelines (Papadaki et al. 2007;

Sprake et al. 2018). However, nutritional habits, which reflect the behaviours displayed by individuals in terms of food selection and consumption, are determined by a sophisticated interplay of genetic, demographic, socioeconomic, and cultural variables. Consequently, in different countries, cultural traditions, disparities in food access, and social and economic considerations can all affect food intake. Similarly, the phenomenon of westernisation of diets has become a common prevalence globally. This transition involves the abandoning of traditional, culturally-specific eating practices in favour of increased consumption of sugars, sweetened beverages, fast foods, red meats, and processed food consumption (Wirtz and Madanat 2012; Thorpe et al. 2014; Suliga et al. 2020). The Western dietary pattern is correlated with an elevated risk of developing chronic health conditions and is most commonly observed during the transitional phase from adolescence to adulthood.

University students display a variety of prevalent dietary behaviours, which include the regular consumption of energy-dense snacks, the skipping of meals, particularly breakfast, the excessive intake of processed food while neglecting fruits and vegetables, and tending to opt for convenience foods that require minimal cooking time. These habits, in conjunction with insufficient physical activity and extended engagement with computers and television, may contribute to malnutrition or overnutrition, thereby increasing an individual's susceptibility to preventable diseases (Omage and Omuemu 2018). In a parallel study conducted in Turkey, it was found that 39.7% of university students indulge in fast food at least once every fifteen days, and this is regarded as their preferred culinary choice (Arslan, Aslan Ceylan and Hatipoğlu 2023). A cross-sectional investigation conducted in Saudi Arabia aimed to assess the dietary habits of university students and revealed that a majority of students frequently consumed fast food and a substantial quantity of soft drinks, with a minimal intake of fruits and vegetables, despite their awareness of the advantages associated with the consumption of fruits and vegetables as well as the adverse consequences of soft drink consumption (Shi, Grech and Allman-Farinelli 2022). While the investigations conducted in Turkey and Saudi Arabia yielded analogous results, a research endeavour carried out in Slovakia, Germany, and Poland, that examined disparities in dietary quality and nutritional knowledge among 394 students, revealed variations in dietary practices according to country (Suliga et al. 2020). A cross-sectional study of 1 055 students in Spain evaluated dietary quality employing the Spanish Healthy Eating Index, revealing that merely 184 students adhered to a healthy diet. Furthermore, a significant lack of compliance with the dietary recommendations was observed, especially regarding the intake of fruits, vegetables, processed meats, and confectionery

(Ramón-Arbués et al. 2021). Likewise, a study in Australia assessed diet and examined the state of food security and other factors that could influence diet quality among 141 university students. The results indicated that diet quality was generally poor, food insecurity was associated with lower nutritional quality, and culinary skills were linked to superior diet quality (Shi, Grech and Allman-Farinelli 2022). Consequently, based on these three studies, it can be concluded that Polish, Spanish, and Australian students consumed an inferior-quality diet, while German students consumed a superior-quality diet.

Healthy eating is one of the most constructive ways to improve overall health. A balanced diet should encompass natural and fresh foods, including fruits, vegetables, and foods abundant in vitamins and minerals (Nelson et al. 2008). Research conducted in Malaysia (Ganasegeran et al. 2012), Lebanon (Yahia et al. 2008) and China (Sakamaki et al. 2005) revealed that 57.4%, 61.4%, and 83.6% of university students, respectively, routinely consumed nutritious meals. The study conducted in Malaysia indicated that 60% of the students were consuming a balanced diet, 81.8% consumed vegetables and legumes often, and 48.5% consumed fruits at least three times a week. These are quite encouraging findings, especially when compared to those observed in many other countries (Ganasegeran et al. 2012). In contrast to numerous investigations, the research conducted in Malaysia revealed that 78.8% of the respondents infrequently engaged in the consumption of fast food. Furthermore, an additional study featuring a cohort of students from a university in the United Arab Emirates demonstrated that these students exhibited a preference for purchasing fresh fruits, dry-roasted nuts, and popcorn (Hasan et al. 2021). However, various obstacles impede the consumption of nutritious foods among university students.

Universities can play a vital role in promoting healthy eating habits by providing access to healthy food options on campuses and educating students about the importance of optimal nutrition (Abraham, Noriega and Shin 2018; Hafiz et al. 2023). The food environment on university campuses has a considerable impact on students' dietary choices. Observations at the regional level indicate a universal necessity for interventions that foster healthier food choices on campuses, underscoring the importance of creating environments aligned with national dietary guidelines (Dhillon et al. 2019; Mann et al. 2021). Also, dietary trends and eating behaviours play a fundamental role in academic performance and may compromise the health of students (Sogari et al. 2018).

## **4.14 Assessing diet quality among university students**

### **4.14.1 Nutritional adequacy regarding the 24-hour food recall**

In this study, the prevalence of inadequate nutrient intake was determined utilising the cut-point method, thus highlighting distinct nutrient deficiencies among male and female university student respondents. For the male respondents, the prevalence of nutrient inadequacies, especially in dietary fibre, calcium, magnesium, vitamin D, vitamin K, and folate, was noted. Calcium, magnesium, vitamin D, vitamin K, and folate are critical for bone health, immunity, and metabolic functions (Weaver 2008; Bailey, West Jr and Black 2015). These deficiencies suggest that respondents are at risk for long-term health complications like osteoporosis, cardiovascular issues, and compromised immunity (Weaver 2008; Bailey, West Jr and Black 2015).

The results for female university student respondents indicated that while energy and protein intakes were generally adequate, there were significant nutrient gaps, particularly in fats, dietary fibre, calcium, magnesium, vitamin D, vitamin K, and folate. These deficiencies typically reflect a diet pattern low in fruits, vegetables, dairy, nuts, seeds, and healthy fats, or a lack of dietary diversity (Van den Berg et al. 2013; Gresse, Steenkamp and Pietersen 2015). The high prevalence of inadequate iron intake (79%) and folate inadequacy (92.3%) is particularly concerning for women of reproductive age, as these nutrients are critical for preventing anaemia and supporting pregnancy health (World Health Organization 2001). The low intake of dietary fibre, coupled with excessive consumption of added sugar, suggests a preference for processed and refined foods over whole grains and plant-based sources (Popkin, Adair and Ng 2012). Additionally, inadequate vitamin D and calcium intake could increase the risk of osteoporosis and related conditions, particularly in later life (Weaver 2008; Bailey, West Jr and Black 2015). This high prevalence of inadequate nutrient intake underscores the need for targeted nutrition education, policy interventions, and programmes promoting diversified diets rich in micronutrient-dense foods among university students.

### **4.14.2 Overview of the Global Diet Quality Score**

The GDQS represents a comprehensive metric meticulously developed to evaluate dietary quality and compliance with nutritional guidelines across diverse populations globally (Miller et al. 2022). Developed by the World Health Organization in collaboration with researchers from various institutions, the GDQS encompasses a wide range of dietary elements, including

the consumption of fruits, vegetables, whole grains, legumes, nuts, and beneficial fats, while simultaneously restricting the intake of sugars, saturated fats, and ultra-processed foods (Intake 2021). This score is a valuable tool for policy-making and public health monitoring since it allows for assessing how dietary patterns influence health outcomes such as obesity and NCDs. Recent studies have shown that higher GDQS scores are associated with improved health, highlighting the need for initiatives to promote healthier eating habits globally (Bromage et al. 2021). Given the increased prevalence of diseases related to diets in many countries, the GDQS offers vital information to formulate nutrition policies and initiatives appropriate for national dietary customs and cultural backgrounds.

#### **4.14.3 Nutrient adequacy and dietary patterns**

Nutrient adequacy and dietary patterns among university students are critical areas of concern, particularly in relation to the GDQS. Recent research indicates that many university students struggle to meet nutrient adequacy due to lifestyle changes, increased stress, and academic demands, leading to poor dietary choices. Many students frequently consume excessive amounts of ultra-processed foods and sugary drinks, which lowers their GDQS scores and causes them to consume insufficient amounts of fibre, vitamins, and minerals (Nguyen et al. 2023).

The GDQS is a useful tool for assessing dietary quality by evaluating adherence to recommended food group consumption. Elevated GDQS scores correlate with dietary patterns abundant in fruits, vegetables, whole grains, and lean proteins, which are critical for achieving optimal health outcomes. Nevertheless, a significant number of students do not adhere to these dietary guidelines, with research indicating that merely a limited fraction attains the recommended levels of fruit and vegetable consumption. This dietary inadequacy heightens the risk of nutrient deficiencies and related health issues, such as obesity and metabolic syndrome (Shinozaki et al. 2023).

Interventions aimed at improving dietary patterns among university students are essential. Recent initiatives, such as campus-wide nutrition education programmes and improved availability of healthy food options, have shown promise in enhancing GDQS scores. These efforts can promote better nutrient adequacy and instil lifelong healthy eating habits. Continued research is crucial in clarifying the barriers to healthy dietary habits within this population and

formulating tailored strategies that encourage equitable nutrient consumption, thus ultimately reducing the risk of chronic diseases associated with inadequate nutritional quality.

#### **4.14.4 Diet quality in relation to non-communicable disease risk**

The risk of NCDs among university students is greatly influenced by diet quality. This group is more vulnerable to unhealthy eating patterns because of changing lifestyles and academic demands. According to recent studies, many campus students turn to convenience meals, which have a detrimental effect on diet quality since they are high in sugar and unhealthy fats, and lack adequate nutrients (Contini et al. 2020).

A systematic study found a strong correlation between students who skip breakfast and increased risk factors for being overweight and obese, in addition to poor nutrition quality. The prevalence of obesity has increased drastically over the years (Ricotti et al. 2021). Furthermore, a study highlighted that those who consumed a diet rich in processed foods and sugary beverages reported higher levels of stress and anxiety, further exacerbating unhealthy eating habits (Chen et al. 2023; Tristan Asensi et al. 2023).

According to a study by Goodman et al. (2021), there is potential for lowering the risk of NCDs through diet-quality improvement initiatives, including nutrition education and healthy eating campaigns on campus. These initiatives usually include raising awareness of the long-term health benefits of balanced meals, improving cooking abilities, and encouraging the consumption of whole foods (Jiwani et al. 2022). Promoting a culture of healthy eating can significantly decrease the risk of NCDs as university students deal with social and academic demands, highlighting the necessity of continued research and focused public health initiatives to support dietary improvement in this susceptible group (Shan et al. 2023).

### **4.15 Environmental impact of diet: a carbon footprint perspective**

#### **4.15.1 Analysis of students' dietary patterns and carbon footprint**

In recent years, the dietary behaviours of university students have gained significant attention due to their implications for public health and environmental sustainability. Research suggests that university students often adopt diets high in processed foods and low in fruits and vegetables, contributing to poor nutritional outcomes. This dietary phenomenon not only adversely affects individual health but also exacerbates environmental challenges, given that

food production is a major source of GHG emissions. A study by Poore and Nemecek (2018) underscores that livestock production is responsible for approximately 75% of the GHG emissions associated with the food sector. Furthermore, a study of university students found that their dietary choices substantially influenced their carbon footprint, with those who consumed more plant-based foods exhibiting fewer emissions. This difference might be fundamentally connected to the observation that males frequently exhibit a higher tendency to consume a larger portion of food compared to females. Mitigating climate change requires transitioning to more sustainable eating practices, such as consuming plant-based meals and minimising food waste. Educational initiatives that raise understanding of how dietary decisions affect the environment are key in changing students' eating habits toward more sustainable diets to promote healthier lifestyles and decrease environmental footprints.

#### **4.15.2 Key findings and implications for food choices**

Recent studies concerning the dietary habits of university students have disclosed significant patterns and consequences relevant to health and sustainability. Jakobsdottir et al. (2023) suggest that many students opt for convenience-driven diets, often prioritising fast foods and processed meals over healthier options, leading to inadequate nutritional intake. This pattern causes concern as it not only affects students' physical and emotional health but also their academic performance and mental well-being (Almoraie et al. 2024).

Furthermore, this study highlighted a growing need for awareness and knowledge among students regarding the environmental impact of their dietary choices. A survey conducted by Mollaei et al. (2023) found that students who are aware of sustainable eating are more likely to select plant-based options, substantially reducing their carbon footprint. For instance, individuals adhering to vegetarian or vegan diets can potentially decrease their food-related GHG emissions by up to 50% compared to those who consume meat (Lambrecht et al. 2023). These findings suggest that universities should undertake strategic initiatives to promote healthier and more sustainable dietary practices. By establishing educational initiatives highlighting the benefits of nutritional diets and environmental sustainability, universities can encourage students to make informed dietary choices. Ultimately, nurturing a culture of mindful eating among students can lead to enhanced health outcomes and contribute to broader sustainability efforts on campus and beyond.

## **4.16 Development of a consumer education tool on food and nutrition sustainability**

### **4.16.1 Conceptualising the educational tool**

The SAFBUC was conceptualised from a Food Boost Challenge (FBC) executed in the Netherlands. This initiative constituted a participatory action research project aimed at stimulating the consumption of fruits and vegetables within the adolescent demographic group. The findings indicated that the FBC resonated profoundly with all stakeholders involved, thereby yielding significant insights to enhance the intake of fruits and vegetables (Van Lieshout et al. 2023). The challenge aimed to promote the consumption of fruits and vegetables, and create awareness of sustainable eating practices among university students. The SAFBUC is an educational tool that was designed to engage students in understanding and addressing global food concerns such as climate change, food insecurity, and hunger. It challenged students to explore sustainable food practices, innovative product development, and how to make fruits and vegetables appealing. The SAFBUC allowed students to think critically about the campus food environment and raised awareness of food and nutrition sustainability.

### **4.16.2 Key messages and content focus**

The key messages and content focus of the SAFBUC focused on addressing the pervasive issue of global food insecurity while advocating for sustainable and innovative strategies to guarantee food accessibility for all demographics. The SAFBUC has yielded significant insights regarding the specific requirements of adolescents to enhance their consumption of vegetable and fruit products. The SAFBUC promotes sustainability and can be adopted in other countries. This approach could also be applied to promote other challenging healthy eating behaviours, such as the adoption of more sustainable dietary patterns or the increased consumption of water (Van Lieshout et al. 2023). This initiative aims to enhance collaboration among individuals, communities, and organisations, thus encouraging joint efforts focused on establishing a more resilient food system. Ultimately, it empowers respondents to make informed decisions regarding food choices and policies, providing them with the tools and knowledge to drive meaningful change within their local and global food systems.

### **4.16.3 Integration of sustainability in food and nutrition education**

The incorporation of sustainability principles in food and nutrition education through the FBC at the university level involves the integration of fundamental principles of sustainable food systems into academic curricula and experiential learning opportunities. Students are encouraged to explore the environmental, social, and economic facets of food production, consumption, and waste, promoting a holistic understanding of food sustainability. The challenge stimulates critical analysis of sustainable agricultural methodologies, the ramifications of climate change on food security, and the contributions of innovative technologies towards the establishment of resilient food systems. Additionally, it underscores the significance of nutrition and health, establishing a connection between sustainable food choices and enhanced public health outcomes. By actively engaging students in authentic problem-solving situations, the FBC cultivates the skills and knowledge essential for future leaders to advocate for and implement sustainable food practices within both local and global frameworks. This pedagogical approach empowers university students to drive positive transformations in food systems while simultaneously ensuring nutritional equity for all.

## **4.17 Testing and acceptance of the consumer education tool**

### **4.17.1 Testing methodology and student feedback**

The conceptual framework of the SAFBUC was based on participatory action research (Chevalier and Buckles 2019). The testing methodology for the SAFBUC incorporated pre-challenge assessments to understand students' knowledge, followed by practical tasks where they apply their skills in meal planning, budgeting, and sustainability. This process was overseen by the principal investigator and the supervising authority, who meticulously evaluated respondents' recipes to ensure their conformity with the established product guidelines. The students engaged in the challenge exhibited enthusiasm in presenting their products to their peers. Students from Consumer Sciences Food and Nutrition conducted a sensory analysis of the products and ranked them according to their three preferred selections. Feedback from the students was systematically gathered via a survey administered through Microsoft Forms. The insights derived from the student feedback are instrumental in pinpointing areas necessitating enhancement for the SAFBUC, including the reconfiguration of the challenge's complexity, the enhancement of available resources and refining facilitation methods. This process ensures the challenge evolves to better support students' educational

requirements and engagement for future iterations. Students who participated in the SAFBUC were awarded certificates, and the top three were given prizes.

#### **4.17.2 Levels of acceptance and potential improvements**

The SAFBUC was positively accepted by students and staff who conducted sensory analysis on the products made for the challenge. Numerous students expressed gratitude for the assistance, acknowledging the initiative's beneficial influence on enhancing access to vital food resources, alleviating stress, and fostering overall well-being among students. However, obstacles persist concerning awareness, distribution, and consistency of access, as certain students indicated challenges in obtaining these resources due to insufficient awareness, limited availability, or price as a barrier. To improve the challenge, it is recommended to enhance marketing efforts so that more students are informed, increase the number of student respondents for future challenges, engage with local markets and community organisations for sustainability, and establish more flexible delivery systems to cater to the diverse schedules of students. Furthermore, the incorporation of nutrition education in conjunction with food support could empower students to make more informed and healthier dietary choices. Consistent assessment and feedback mechanisms from the student population are essential to guarantee that the programme evolves in accordance with their evolving needs.

#### **4.17.3 Recommendations for effective deployment**

To successfully implement the SAFBUC, it is crucial to establish a clear and compelling objective that resonates with university students, encouraging innovation in the realm of food and nutritional sustainability. The challenge should be designed to be inclusive, ensuring it accommodates diverse teams from various academic disciplines and backgrounds. Providing respondents with access to mentorship, resources, and expert guidance will help facilitate the refinement of their concepts while offering funding or prizes can incentivise engagement. Strong communication through university networks and social media will raise awareness and drive participation. Furthermore, fostering collaboration with local food organisations, businesses, and policymakers can augment the practical relevance of the solutions developed and ensure that they yield a significant impact. Lastly, it is essential to provide post-challenge support to assist students in scaling their innovations and transforming theoretical concepts into viable, long-term contributions to the food system. It is advisable to engage industry stakeholders in advance to obtain extensive support. Ultimately, the SAFBUC is structured as

an intervention aimed at augmenting the consumption of vegetable and fruit products among adolescents. While we ascertain that the SAFBUC has generated considerable interest, the efficacy of intake and its broader implications have yet to be evaluated (Van Lieshout et al. 2023).

## **4.18 Conclusion and recommendations**

### **4.18.1 Summary of findings**

In conclusion of the findings, a substantial 54.8% of students were unfamiliar with the SDGs, and the remaining 45.2% had heard of it but lacked knowledge. Therefore, there is a need for embedding the SDGs across all faculties to create knowledge and awareness among all students. This was found to be influenced by the campus food environment, peers, convenience, financial constraints and insufficient time management. This indicates the need for targeted interventions that improve the campus food environment. The GDQS highlighted that 99% of the respondents are at risk for NCDs; thus, it is imperative to develop the university food system to effectively change students' eating behaviours and mitigate the barriers to food and nutrition sustainability. Students eat high-kilojoule foods that increase their carbon footprints. They are unaware of how their dietary choices affect the environment. As a result, more research needs to be conducted regarding carbon footprint calculators to obtain precise results. The SAFBUC shows great potential at the university level but can also be improved to increase consciousness around food and nutrition sustainability.

### **4.18.2 Implications for education and policy**

In the context of South Africa, the pursuit of food and nutritional sustainability among university students requires the implementation of targeted educational initiatives and policy interventions. University campuses represent key environments for fostering awareness regarding sustainable food systems and integrating sustainability principles into academic curricula. Academic programmes concerning food security, environmental science, public health, and nutrition ought to encompass practical elements that educate students on sustainable agricultural methodologies, strategies for minimising food waste, and principles of healthy dietary practices (Dube, Booysen and Chili 2024). Educating students on the environmental, social, and economic implications of food and their choices is vital for developing informed future leaders.

Policy initiatives must guarantee that all students, particularly those from disadvantaged backgrounds, have access to affordable and nutritious food options. Universities can support food security through the establishment of subsidised meal programmes, food banks, and collaborations with local farmers to supply fresh produce (Wall et al. 2022). The promotion of plant-based dietary practices and efforts to reduce the carbon footprint linked to campus food services should be advanced through policies that advocate for sustainable sourcing and effective waste management techniques. Additionally, the establishment of platforms for student-driven initiatives aimed at food sustainability, such as community gardens and sustainable food markets, will facilitate student engagement in the practical applications of their academic learning (Andrianarison 2022). Government policies ought to be aligned with these initiatives by endorsing sustainable agricultural practices and allocating resources for universities to implement food security programmes effectively. Overall, the incorporation of food and nutritional sustainability into higher education and policy frameworks holds the potential to profoundly influence South Africa's enduring food security and environmental sustainability, while simultaneously empowering students to be agents for change.

#### **4.18.3 Future research directions on food sustainability**

One method that has demonstrated efficacy in mitigating eating behaviours among university student populations is the initiation of nutritional education programmes. Despite the difficulties associated with tailoring and modifying nutritional education programmes to align with the distinct requirements of young adults, their execution is critically significant for the enhancement of public health. Chapter 4 encompasses the findings of the research that address all the objectives established within the study. The results presented in this chapter highlight significant concerns regarding the domains of food and nutritional sustainability, the knowledge base, awareness, perceptions, motivations, and obstacles encountered by young adult consumers, as well as diet quality, carbon emissions, and potential interventions that could improve the food systems within university settings. The subsequent chapter will synthesise conclusions derived from the analysed data and propose relevant recommendations informed by these conclusions.

## CHAPTER 5

### CONCLUSION AND RECOMMENDATIONS

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#### 5.1 Introduction

This chapter draws inferences from the study's main findings. It outlines the summary of the study's findings, strengths, limitations, and recommendations, which are also discussed to assist and offer direction for further investigations and possible interventions. This study aimed to determine the awareness, knowledge and attitudes of food and nutrition sustainability, and food choice drivers among students at the DUT through a survey, and appraised the diet quality and the impact of diet on the environment among university students. The findings of the study culminated in an event focused on promoting consciousness regarding food and nutrition sustainability among university students.

#### 5.2 Summary of the findings

This study aimed to research four distinct objectives:

*Objective 1: To determine awareness, knowledge and attitudes of food and nutrition sustainability, and food choice drivers among students at the DUT through a survey.*

A substantial 54.8% of students were unfamiliar with the SDGs, and the remaining 45.2% heard of it but lacked knowledge. Significant proportions of students never heard of product environmental footprint (65.2%), life cycle assessment (66.2%), greenwashing (64.9%), and food miles (58.5%), ( $p < 0.001$ ). This study, therefore, highlights the need for knowledge and awareness of food and nutrition sustainability among students. There was significant agreement that students knew what a healthy diet comprised of; they understood the impact of a diet on health, and they knew what a sustainable diet consisted of ( $p < 0.05$ ). One of the food choice drivers that contributed to students being unable to have a healthy diet is that they found it challenging to avoid unhealthy food options ( $n = 120$ ), and some claimed that the cost of healthy foods was too expensive ( $n = 103$ ). The lack of information, lack of culinary knowledge, food customs, and traditions are shown to hinder the purchasing of plant-based foods to a moderate extent. Food preferences and taste were among the significant hindrances, followed by cost and ease of purchase ( $p < 0.001$ ). Regarding the respondents' attitudes and practices towards sustainable nutrition and the environment, this was influenced by the elevated cost of plant-based foods versus non-plant-based foods. Respondents rarely looked at eco-

labels or labels in general when purchasing food products; this indicates that the R3337 food labelling regulation front-of-pack-labelling promises to be effective in ensuring that consumers become more aware of the foods they purchase and consume in South Africa. The sustainable food and nutrition questionnaire highlighted that young adults can help South Africa transition to a sustainable food system because they are more adaptable to change.

***Objective 2:*** *To determine the dimensions of diet quality for nutrient adequacy and NCD risk among students at the DUT through the GDQS.*

In this study, the diets of students were assessed using the 24-hour food recall. The prevalence of inadequate intake was calculated using the cut-point method, highlighting specific nutrient deficits among the men and women. This study reveals that while most male respondents met or exceeded their carbohydrate and protein needs, they exhibited notable deficiencies in various essential micronutrients, such as calcium, magnesium, vitamin D, vitamin K, and folate. Additionally, the consumption of fats and dietary fibre was insufficient for a substantial segment of the cohort. These results underscore the necessity for dietary enhancements, particularly concerning micronutrient intake and fibre consumption, to align with established dietary recommendations more effectively. Overall, the data highlighted several critical nutrient inadequacies among the women, particularly in dietary fibre, calcium, magnesium, vitamin D, vitamin K, and folate. Although protein and carbohydrate consumption typically met or exceeded the guidelines, numerous women within the study failed to achieve adequate levels of crucial vitamins and minerals. These results imply an imperative for enhanced dietary variety and nutrient density, particularly regarding nutrients such as calcium, magnesium, and vitamin D.

According to the GDQS, zero respondents were under the low risk category for nutrient inadequacy and NCDs. Only one respondent was classified as moderate risk. Three-hundred and ninety-nine respondents were classified under the high risk category, which was concerning. The empirical findings indicated a notable prevalence of increased risk for nutrient deficiencies and associated NCD outcomes within the study cohort.

***Objective 3:*** *To investigate the environmental impact of diet among university students at the DUT using online carbon footprint calculators.*

In this study, the male student's carbon footprint was the highest, and higher for both males and females compared to other country's studies. The food carbon footprint calculator used to

assess respondents' diet emissions did not contain all food items. As a result, more research regarding food carbon footprint calculators needs to be explored to obtain more accurate data.

***Objective 4:** To promote sustainable dietary practices through the implementation of the SAFBUC.*

The SAFBUC was an initiative aimed at addressing food and nutrition sustainability through the promotion and consumption of fruits and vegetables which students would like to consume. The challenge also brought unity among students and allowed them to create innovative products using local, seasonal, and affordable ingredients. This challenge showed that food environments can change through a participatory approach.

### **5.3 Strengths of the study**

This study had several strengths:

- Respondents from the study learnt about food and nutrition sustainability and how their diet impacts the environment. They also acknowledged that their food environment significantly influences their food choices.
- Each phase of this study was validated through methods detailed in Chapter 3 to ensure the data was accurate and reliable. For example, the cross-sectional sustainable food and nutrition questionnaire was adapted using validated questionnaires, and the adapted questionnaire was reviewed by the university statistician to ensure that it was aligned with the objectives and thereafter piloted before the recruitment of the main study respondents.
- The principal researcher and fieldworker, who were trained before the commencement of the data collection process, conducted the 24-hour food recall. Respondents were eager to determine their level of knowledge regarding food and nutrition sustainability and what constitutes a healthy diet.
- Two open-ended questions were included throughout the questionnaire to allow respondents to freely give their opinions about the questions:

- What does sustainability mean to you?
- What do you consider a healthy diet?
- The sample size was calculated using the recommended variance to obtain reliable results.
- The university statistician and supervisory personnel played a pivotal role in guaranteeing the integrity and quality of the data collected for this research study.
- The 24-hour food recall methodology was used to assess dietary adequacy. A comprehensive dietary toolkit comprising food samples and household measurement instruments was utilised to assist respondents in accurately reporting the portion sizes.
- The GDQS was used to determine the dimensions of diet quality for nutrient adequacy and NCD risk among students at the DUT.
- The implementation of the SAFBUC showed tremendous success among students from the various faculties, and it can be adapted or implemented at the primary school, high school, and university levels throughout the country.

#### **5.4 Limitations of the study**

Despite the strengths of this study, it is important to acknowledge the following limitations of the study:

- University strikes from 3–16 August 2023 hindered the data collection progress.
- The questionnaire was printed and distributed to students since the student researcher could not obtain the virtual private network (VPN) from the institution to access Research Electronic Data Capture (REDCap) out of campus. The questionnaire was therefore captured using Microsoft Forms.
- One week of study leave from the 25 September 2023 to 2 October 2023 delayed data collection on ML Sultan Campus.
- There are limitations to using the 24-hour food recall method, since respondents may have underreported their portion sizes when describing the quantity and type of foods

they consumed. Although food aids were used to assist with portion size identification, the 24-hour food recall relies on recent memory and respondents' ability to recall details about all food eaten over 24 hours.

- The FoodFinder 3 license took a long time to be activated to capture the 24-hour food recalls.
- It was not possible to calculate the Estimated Energy Requirement (EER), since no body mass index physical activity level were recorded in this study.
- The food carbon footprint calculator used to assess respondents' diet emissions did not contain all food items, for example, samosas, other cool drinks besides Coca-Cola, protein powders, biscuits, and Powerade.
- Since the respondents were from different faculties, there was difficulty in choosing an appropriate date for the SAFBUC to accommodate every participating student.

## **5.5 Recommendations of the study**

The following recommendations are made from the findings of this study:

- The EER was not an objective aligned with this study; hence, it was not considered. However, for future reference, the body mass index and physical activity levels of respondents should be recorded so that the Estimated Energy Requirement can be calculated.
- More research regarding food carbon footprint calculators and databases is urgently required in South Africa to ensure accurate results.
- Advertising of the SAFBUC earlier in the academic year can increase the number of respondents across all faculties and allow more time for planning.
- Plant-based foods should be incentivised or zero-rated to mitigate the elevated price barrier hindering young adult consumers from purchasing these products.
- Designing and implementing policies to improve university food environments is urgently needed to transform young adult consumers' food choices to improve their overall health and well-being.

- The food environment at DUT needs to transform to inspire lifelong change in each student and develop cost-effective meat alternatives and healthy snacks.
- The university should align sustainability and its departments' curricula to the SDGs across all faculties to increase knowledge and awareness among all students.
- The university should encourage the consumption of fruits and vegetables with campus initiatives, such as community gardens and the selling of healthy food options.
- Continued research is required to ensure that food security, nutrition and food and nutrition sustainability continue to be a priority in the 2030 development agenda to drive efforts towards The Conference of the Parties 29 (COP29) food system and climate initiatives.

## **5.6 Conclusion**

This study highlights young university students' lack of knowledge and awareness of food and nutrition sustainability. The study underscores the need for targeted educational interventions to bridge the knowledge gap and empower young adults to make informed, sustainable food choices. The study's objectives were achieved, and implementing the SAFBUC at the DUT shows tremendous promise for success at the university level. The food environment within university campuses has a significant impact on the diet of students. Emerging regional trends indicate a collective necessity for initiatives that foster healthier dietary selections on campuses, highlighting the importance of establishing environments congruent with national dietary guidelines. The reported evidence underscores the critical need to address the detrimental food environments within academic institutions to protect the health and well-being of students. Given the interconnections inherent in the food system, the challenges associated with achieving the SDGs have been presented and must be considered within a broader context.

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## APPENDIX A

### GATEKEEPER PERMISSION

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*Directorate for Research and Postgraduate Support  
Durban University of Technology  
Open House  
P.O. Box 1334, Durban 4000  
Tel: 031-3732576/7  
Fax: 031-3732946*

30 June 2023

Ms Sanrika Sahadeo  
c/o Department of Consumer Sciences: Food and Nutrition  
Faculty of Applied Sciences  
Durban University of Technology

Dear Ms Sahadeo

#### **PERMISSION TO CONDUCT RESEARCH AT THE DUT**

Your email correspondence in respect of the above refers. I am pleased to inform you that the Institutional Research and Innovation Committee (IRIC) has granted **Gatekeeper Permission** for you to conduct your research "Food and nutrition sustainability knowledge and diet among students at the Durban University of Technology" at the Durban University of Technology. **Kindly note that this letter must be issued to the IREC for approval before you commence data collection.**

The DUT may impose any other condition it deems appropriate in the circumstances having regard to nature and extent of access to and use of information requested.

Upon completion of your research project, you are requested to share the summary of your key research findings.

Kind regards,  
Yours sincerely

**DR V GOVENDER**  
ACTING DIRECTOR: RESEARCH AND POSTGRADUATE SUPPORT DIRECTORATE

## APPENDIX B

### INFORMATION LETTER

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**Title of the Research Study:** Food and nutrition Sustainability knowledge and diet among students at the Durban University of Technology

**Principal Investigator/s/researcher:** Sanrika Sahadeo, Postgraduate Diploma in Food and Nutrition

**Co-Investigator/s/supervisor/s:** Dr Ashika Naicker, Ph.D. Nutrition, Dr O Makanjana Ph.D. Food and Nutrition

#### **Brief Introduction and Purpose of the Study:**

Good day student, I hope you are keeping well.

I am a Master's candidate in Consumer Science: Food and Nutrition at the Durban University of Technology. I would like to invite you to participate in the study titled, "Food and nutrition Sustainability knowledge and diet among students at the Durban University of Technology". This study aims to appraise the diet quality and the impact of diet on the environment for the purpose of developing a contextualised consumer education tool on food and nutrition sustainability. Through informed consent, 385 students at the Durban University of Technology studying at Steve Biko, Ritson and ML Sultan campus will be selected to participate in the study.

#### **What is Research:**

Research is a systematic search or enquiry for generalised new knowledge.

#### **Outline of the Procedures:**

- You will be given an information letter on the details regarding the study to be conducted.

- After being informed, I will request permission from you via a consent letter.
- A survey will then be administered after receiving informed consent to participate in the study; the survey will include general questions regarding your knowledge and practices on sustainability.
- Thereafter two 24 hour-food recalls will be conducted, one immediately after the survey and one on a Monday.

**Eligibility criteria:**

- Registered undergraduate and postgraduate DUT students studying at the Steve Biko, Ritson, and ML Sultan campus.
- Able and disabled respondents.
- Age range of 18–34 years.

**Exclusion criteria:**

- Respondents younger than 18 years or older than 34 years of age.
- DUT staff, cleaners, maintenance workers, and security guards.
- Respondents that were involved in the pilot questionnaire.
- Respondents located out of the specified locations (Steve Biko, Ritson and ML Sultan campuses).

**Risks or Discomforts to the Participant:**

There are no potential risks to you should you participate in this study.

**Reason/s why the participant may be withdrawn from the Study:**

- You have the right to withdraw from the study at any time.

**Benefits:**

- The results and recommendations will assist in making students at the Durban University of Technology more aware of sustainable living and dietary choices that will assist in improving food and nutrition sustainability.

**Remuneration:**

- You will not receive any remuneration for participation in this study.

**Costs of the Study:**

- You will not incur any costs for being part of the study.

**Confidentiality:**

- All information collected from this study will be kept strictly confidential.
- You will remain anonymous during the completion of the survey; a participant number will be allocated to you.
- Access to data will only be granted to the researcher and supervisor to protect the participant. All information collected from this study will be kept strictly confidential.

**Results:**

Results and findings will be made available to you through the student 'Research and Innovation' newsletter.

**Research-related Injury:**

This study poses no threats to your health, nor does it inflict any in type of mental or physical injury should you choose to participate.

**Storage of all electronic and hard copies including tape recordings**

- Data will be stored in the Durban University of Technology server. Only the researcher and supervisor will have access to the de-identified data which will be password protected. Data will be stored for five years in the Department of Consumer Sciences: Food and Nutrition and thereafter disposed of. All hard copies of data will be stored in

sealed boxes in a secure room in the department of Consumer Science: Food and Nutrition and thereafter shredded. All electronic datasets will be disposed of in any storage devices or applications permanently after 5 years.

- This information will only be available to the research team for a retention period of 5 years.

### **Persons to contact in the Event of Any Problems or Queries**

Principal researcher: Sanrika Sahadeo, Postgraduate Diploma in Food and Nutrition: Consumer Sciences, cell number 0614959287 or [sanrika11@gmail.com](mailto:sanrika11@gmail.com)/[21804701@dut4life.ac.za](mailto:21804701@dut4life.ac.za)  
Supervisor: Dr. A. Naicker, PhD: Nutrition, cell number: 0313732333 or email [ashikan@dut.ac.za](mailto:ashikan@dut.ac.za) or the DUT - Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Acting Director: Research and Postgraduate Support on [researchdirector@dut.ac.za](mailto:researchdirector@dut.ac.za).

## APPENDIX C

### CONSENT LETTER

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**Full Title of the Study:** Food and nutrition Sustainability knowledge and diet among students at the Durban University of Technology

**Names of Researcher/s:** Sanrika Sahadeo, Postgraduate Diploma in Food and Nutrition

**Statement of Agreement to Participate in the Research Study:**

- I hereby confirm that I have been informed by the researcher, Sanrika Sahadeo, about the nature, conduct, benefits, and risks of this study - Research Ethics Clearance Number: 102/23,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

<b>Full Name of Participant</b>	<b>Date</b>	<b>Time</b>	<b>Signature/Right Thumbprint</b>
---------------------------------	-------------	-------------	-----------------------------------

I, Sanrika Sahadeo (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

<b>Full name of researcher</b>	<b>Date</b>	<b>Signature</b>
<b>Full name of witness (if applicable)</b>	<b>Date</b>	<b>Signature</b>
<b>Full name of legal guardian (if applicable)</b>	<b>Date</b>	<b>Signature</b>

## **APPENDIX D**

### **SUSTAINABLE FOOD AND NUTRITION QUESTIONNAIRE**

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### **SUSTAINABLE FOOD AND NUTRITION QUESTIONNAIRE**

Dear participant,

By participating in this survey, you will be volunteering to contribute to the research study on food and nutrition sustainability and the development of a consumer education tool to create awareness.

Your assistance in the completion of this survey is deeply appreciated. It will take approximately 30 minutes of your time. Your responses will be confidential, and we do not collect identifying information such as your name.

Your participation in this research study is voluntary. If you decide to participate in this research survey, you may withdraw at any time and can choose not to answer specific questions. If you decide not to participate in this study or if you withdraw from participating at any time, you will not be penalised. Should you wish to participate in this study, your answers will not be shared with anyone but will be used anonymously for only scholarly purposes by the researcher.

**For each question tick the response option that best applies to you.**

**A. Socio-Demographic Information**

1. What is your dut4life email address and cell phone number? (Note this information is only required to contact you to complete the second food recall)

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2. What gender were you assigned at birth?

Male	Female

3. What is your race?

Black	White	Indian	Coloured	Other

4. What is your age group (in years)?

18-26	27-34

5. Which campus are you based at?

Steve Biko	Ritson	ML Sultan

6. Which faculty are you from?

Accounting and Informatics	Applied Sciences	Management Sciences	Engineering and the Built Environment	Health Sciences	Arts & Design

7. What is your current level of study?

First year	Second year	Third year	Fourth year	Postgraduate

## B. Knowledge and awareness

8. Indicate your level of awareness and knowledge of the following items/terms:

	I have never heard of it	I have heard of it but know nothing about it	I have heard of it and know a little about it	I have heard of it and know a lot about it
8.1 The Sustainable Developmental Goals (SDGs)				
8.2 Sustainable nutrition				
8.3 Sustainable/green products				
8.4 Product lifecycle				
8.5 Carbon footprint				
8.6 Product Environmental Footprint (PEF)				
8.7 Life cycle assessment (LCA)				
8.8 The term “green washing”				
8.9 The term “recycled”				
8.10 The term “energy efficient”				
8.11 The term “eco-friendly”				
8.12 The term “Food miles”				
8.13 The term “eco-label”				

9. What does sustainability mean to you?

10. What do you consider a healthy diet?

11. Which of the following foods do you think harms the environment **the most**? (Select ONE option only)

Red Meat	Fish	Chicken	Vegetables(e.g. green beans, madumbes, pumpkin, sweet potatoes etc)

12. From where/whom have you heard about foods that do not harm the environment? (Tick all that apply)

12.1 Community	
12.2 University curriculum	
12.3 The internet	
12.4 Another source	
12.5 All of the above	

If you selected 'another source', specify the source \_\_\_\_\_

13. Have you ever had access to educational material on foods that have an impact on the environment?

Yes	No

14. Which ONE of the following has the least impact on the environment?

A diet based on vegetables and fruit, chicken protein, fish and legumes, reduced fat and less sugar.	A diet that that places a strong emphasis on nuts and little or no sweet foods. Consisting of unlimited animal products and fats; with no snacks.	A diet based on red meat, in which vegetables and fruit are consumed less, fats are not restricted, and dessert is free.

15. The production of which of the following foods leads to higher CO<sub>2</sub> emissions per kg?

Vegetables	Meat and milk products

16. Which of the following aspects in the food sector has the largest impact on the environment? (Select ONE option only)

Production	Storage	Packaging	Transportation	Consumers diets	Unsure

17. To what extent do you agree or disagree with the following statements?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
17.1 I know what a healthy diet consists of					
17.2 I understand the impact that my diet has on my health					
17.3 I know what a sustainable/environmentally friendly diet consists of					
17.4 I understand the impact that my diet has on the environment					

18. For each of the following categories, select the ONE meal that you think is most environmentally friendly

<b>18.1 Category 1</b>		
Meal 1	Pasta with beef mince	
Meal 2	Pasta with vegetable and tomato sauce	
<b>18.2 Category 2</b>		
Meal 1	Beef burger	
Meal 2	Chicken burger	
Meal 3	Plant-based burger	
<b>18.3 Category 3</b>		
Meal 1	Chicken Shwarma	
Meal 2	Boerewors	
Meal 3	Chakalaka & pap	
<b>18.4 Category 4</b>		
Meal 1	Beef curry with potatoes	
Meal 2	Samp and beans	
Meal 3	Roast chicken, mashed potatoes, and beans	
Meal 4	Mushroom pasta, mashed potatoes, and beans	
<b>18.5 Category 5</b>		
Meal 1	100g Spinach	
Meal 2	100g Chicken	
Meal 3	100g Beef	
Meal 4	100g Hake	
Meal 5	100g Tofu from overseas (ship transport)	
<b>18.6 Category 6</b>		
Meal 1	Coffee	
Meal 2	Black tea	
Meal 3	Rooibos	
Meal 4	Green tea	
Meal 5	Bottled water	
Meal 6	Tap water	

### C. Barriers and Drivers of food choices

19. How important are the following to you when buying your food?

<b>The food should be...</b>	Very unimportant	Unimportant	Slightly unimportant	Slightly important	Important	Very important
19.1 Affordable						
19.2 Culturally acceptable						
19.3 Plant-based (flexitarian, vegetarian or vegan)						
19.4 Locally produced						
19.5 Seasonal						
19.6 Organic						
19.7 Simple, with no additives and based on foods with few ingredients that are not very processed						
19.8 Respectful of ecosystem biodiversity and with a low environmental impact						
19.9 Produced in companies that respect workers' social rights						
19.10 Result in the minimum amount of food waste during processing						
19.11 Packaged in biodegradable, compostable packaging						

20. Rate the extent that the following aspects prevent you from buying plant-based foods

	Very small extent	Small extent	Moderate extent	Large extent	Very large extent
20.1 Cost					
20.2 Lack of information					
20.3 Lack of culinary knowledge					
20.4 Food preferences and taste					
20.5 Food customs and traditions					
20.6 Ease of purchase (accessibility)					

21. What, if anything, stops you from eating a healthier diet at the moment? (Select ONE option only)

I don't need to eat a healthier diet/my diet is already healthy	I find it difficult to avoid unhealthy options	I find it difficult to form new, healthier habits	My mood makes it difficult to eat a healthier diet e.g., unhealthy foods help me to relax, or cope with stress etc	The cost of healthier foods makes it unaffordable for me	I find it difficult to eat healthy because I have no say on what type of foods are bought at home

#### D. Attitudes and practices towards sustainable nutrition and the environment

22. Which of the following statements best describes your perception of the cost of plant-based foods compared to non-plant-based foods?

Plant-based is much cheaper than non-plant based	Plant-based is cheaper than non-plant based	The cost is about the same	Plant-based is more expensive than non-plant based	Plant-based is a lot more expensive than non-plant based

23. Indicate your level of agreement that the food industry plays a vital role in influencing consumers to practice a zero-waste lifestyle

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

24. Indicate your level of agreement with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
24.1 The growing environmental issues (e.g., global warming) are a serious threat.					
24.2 The environment is currently the most pressing issue the world needs to deal with.					
24.3 I am concerned about the current environmental situation and what it entails for future generations.					
24.4 We are not doing enough in our country to protect the environment.					

25. Indicate the frequency with which you do the following

	Never	Rarely	Sometimes	Often	Always
25.1 I check whether the packaging of a product I purchase is recyclable or reusable					
25.2 I use my own shopping bag when shopping					
25.3 I read information on the product label					
25.4 I buy local products					
25.5 I pay attention to where the food is produced or grown					
25.6 I buy food that is in season					
25.7 I buy food in portions that are convenient for me to avoid food waste					
25.8 I take care that the products I buy are environmentally friendly					
25.9 I check nutritional information when making food purchases					
25.10 I substitute meat with more sustainable vegetarian products					
25.11 I search for more information about the manufacturing process of products (e.g., country of origin, ingredients, environmental footprint)					
25.12 I carefully examine all the information about the manufacturing process of products provided on the packaging (e.g., eco- labels, certifications, ingredient details)					
25.13 I seek information about the manufacturing process of products from additional sources (e.g., websites, discussion groups, friends)					
25.14 I separate my waste or garbage into plastic, paper, glass, food waste etc					
25.15 I use leftover food to make new dishes					
25.16 I look for any eco-logo or eco-label on the packaging to evaluate a product					

26. Indicate your level of agreement that young adult consumers can contribute towards a sustainable food system in South Africa through the following actions:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
26.1 Increasing the consumption of plant-based foods					
26.2 Reducing the consumption of meat products					
26.3 Conserving water					
26.4 Reducing food waste					

**THANK YOU FOR YOUR TIME**





## APPENDIX F

### IREC FINAL APPROVAL LETTER

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11 July 2023

Ms S Sahadeo  
P.O. Box 4284

Dear Ms Sahadeo

**Food and nutrition Sustainability knowledge and diet among students at the Durban University of Technology**  
**Ethical Clearance number IREC 102/23**

The Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

In addition, the IREC acknowledges receipt of your gatekeeper permission letter.

Please note that **FULL APPROVAL** is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).

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

Yours Sincerely

Dr K Padayachy  
Deputy Chairperson: IREC

## APPENDIX G

### PRODUCT CRITERIA FOR THE SOUTH AFRICAN FOOD BOOST UNIVERSITY CHALLENGE (SAFBUC)

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### PRODUCT/RECIPE CRITERIA FOR THE SOUTH AFRICAN FOOD BOOST UNIVERSITY CHALLENGE

The product that you will be developing must follow these points:

- The food item must contain fruits and/or vegetables (**No meat products**).
- The product must be creative, affordable and trending.
- It must be simple to prepare and something students would like to purchase (For example, can be prepared by students who stay at residence with minimal cooking equipment).
- Products/recipes should provide essential nutrients suitable for student's health and well-being.
- Sustainability aspect of the product: Preference for recipes or products that use sustainable ingredients, reduce food waste, or have eco-friendly packaging.
- The products developed should be tasty and appealing to the student population.



# APPENDIX I

## NINE POINT HEDONIC SCALE USED TO CONDUCT SENSORY ANALYSIS AMONG FOOD AND NUTRITION STAFF DURING THE SAFBUC




Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Tingy Delight ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_




Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Muthis ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_






Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Burger ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_






Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_






Panelist id: A. Nandh  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Stira smathi ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely			✓	
Like very much		✓		✓
Like moderately	✓			
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Delicious → good curries






Panelist id: A. Nain  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Fruit Yoghurt ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much		✓	✓	✓
Like moderately				
Like slightly	✓			
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Not set.






Panelist id: A. Nain  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Veggie Pasta ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely		✓	✓	✓
Like very much	✓			
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Sweet Potato Chips ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately	✓	✓		
Like slightly		✓		
Neither like or dislike				✓
Dislike slightly			✓	
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

①

Panelist id: Jane  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 7 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour ✓	Taste/Flavour ✓	Texture/Mouthfeel ✓	Smell/Aroma ✓
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Next level!

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 3 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				✓
Like moderately	✓	✓	✓	
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: The product was dry but probably bc it stood out for awhile

✓

Panelist id: 1  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely		✓	✓	✓
Like very much	✓			
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments:

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments:

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: Jane  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 8

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Extremely good product.

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: Jane  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 2 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much			✓	
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Great alternative healthy snack.

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: Jane  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 4 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Absolutely loved this product

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: Jane  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 5 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Really tasty veg. patty.

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCES

Panelist id: DM  
 Date: 4 sept  
 Test no: 1  
 Recipe/Product ID code: veggie Pasta

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much	✓		✓	
Like moderately		✓		✓
Like slightly				✓
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Add a bit of Flavour so the Flavour can be more pronounced. In the dish

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCES

Panelist id: DM  
 Date: 4 sept  
 Test no: 1  
 Recipe/Product ID code: Main Tangy delight

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much	✓			
Like moderately		✓		
Like slightly			✓	✓
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Perhaps it would've worked better to layer yoghurt as a base, thin layer of regular choc then another layer of yoghurt so the taste gets to taste it all combined

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCES

Panelist id: DM  
 Date: 4 sept  
 Test no: 1  
 Recipe/Product ID code: Otera Smoothie

Balanced Version

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately	✓			✓
Like slightly				
Neither like or dislike			✓	
Dislike slightly		✓		
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: No wd. to contradict the journey of health that you were on

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Ultimate Veggie burger

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much	✓		✓	✓
Like moderately		✓		
Like slightly		Due to spice.		
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Processed cheese is a bit

Reduce the spiciness. The patty is tasty. Overall, a good dish!

Form on own

4

**DUT** DEPARTMENT OF FOOD AND NUTRITION IN CONSUMER & SCIENCE'S

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 3  
 Recipe/Product ID code: vegetable pst ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION IN CONSUMER & SCIENCE'S

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 2  
 Recipe/Product ID code: sweet potato long chips

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION IN CONSUMER & SCIENCE'S

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 4  
 Recipe/Product ID code: bangy delights ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION IN CONSUMER & SCIENCE'S

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 8  
 Recipe/Product ID code: OKA smoochie ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

Form an own

5

**DUT** DUTRIUM UNIVERSITY OF TECHNOLOGY  
**APPLIED SCIENCES** DEPARTMENT OF FOOD AND NUTRITION & COOKING SCIENCES

Panelist id: ORRA Smoothie ✓  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DUTRIUM UNIVERSITY OF TECHNOLOGY  
**APPLIED SCIENCES** DEPARTMENT OF FOOD AND NUTRITION & COOKING SCIENCES

Panelist id: Sweet Potato Long Chips  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much	✓	✓	✓	✓
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DUTRIUM UNIVERSITY OF TECHNOLOGY  
**APPLIED SCIENCES** DEPARTMENT OF FOOD AND NUTRITION & COOKING SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Fruit and yogurt popsicles ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DUTRIUM UNIVERSITY OF TECHNOLOGY  
**APPLIED SCIENCES** DEPARTMENT OF FOOD AND NUTRITION & COOKING SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES DEPARTMENT OF FOOD AND NUTRITION & DIETETICS

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 1 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓		✓	
Like very much				
Like moderately				
Like slightly		✓		
Neither like or dislike				
Dislike slightly				
Dislike moderately				✓
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES DEPARTMENT OF FOOD AND NUTRITION & DIETETICS

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 8 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately		✓		
Like slightly	✓		✓	
Neither like or dislike				✓
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES DEPARTMENT OF FOOD AND NUTRITION & DIETETICS

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 2 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓		
Like very much				✓
Like moderately			✓	
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES DEPARTMENT OF FOOD AND NUTRITION & DIETETICS

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 3 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓			
Like very much		✓	✓	
Like moderately				✓
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & DIETETICS & FOOD SCIENCE

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 7 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely		✓	✓	
Like very much	✓			
Like moderately				✓
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & DIETETICS & FOOD SCIENCE

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 4 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓		✓	
Like very much		✓		
Like moderately				
Like slightly				✓
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & DIETETICS & FOOD SCIENCE

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_



**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & DIETETICS & FOOD SCIENCE

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_



Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 1 - Popsical ✓  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately	X			
Like slightly				
Neither like or dislike			X	X
Dislike slightly		X		
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

⑦






Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 2 - Sweet potatoe long chips ✓  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly	X	X		
Neither like or dislike				X
Dislike slightly			X	
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_






Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 4 ✓  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much	X	X	X	X
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 5 - Ultimate plant based burger ✓  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much	X	X	X	X
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_



Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 7 - Sweet potatoe Muffin  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately	X		X	X
Like slightly		X		
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments:



Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments:



Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments:





Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments:

Panelist id: \_\_\_\_\_  
 Date: 04/08/2024 ✓  
 Test no: 1 ✓  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	X			
Like very much				
Like moderately				
Like slightly		X	X	
Neither like or dislike				
Dislike slightly				X
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_






Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_ ✓  
 Test no: 2 ✓  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	X	X	X	X
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_






Panelist id: 4  
 Date: 04/08/2024 ✓  
 Test no: 4 ✓  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	X	X	X	X
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_ ✓  
 Test no: 7 ✓  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much			X	
Like moderately	X	X		X
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 5  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much		X	X	X
Like moderately				
Like slightly	X			
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

9

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 1 Yoghurt popsize ✓  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓			
Like very much				
Like moderately				
Like slightly		✓	✓	✓
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 2  
 Recipe/Product ID code: Sweet Potato lay chip ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much			✓	
Like moderately		✓		✓
Like slightly	✓			
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: 14 ✓  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓			
Like very much		✓		
Like moderately			✓	✓
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES  
 DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 5 - Plant based patties ✓  
 Recipe/Product ID code: 5

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓			
Like very much		✓		
Like moderately			✓	✓
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF TECHNOLOGY  
**UNIVERSITY OF TULLYMORE**  
**WEXFORD**

**SCHOOL OF APPLIED SCIENCES**

**DEPARTMENT OF FOOD AND NUTRITION**  
**IN CONSUMER SCIENCES**

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: Sweet Potato Muffin  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓			
Like very much		✓	✓	✓
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF TECHNOLOGY  
**UNIVERSITY OF TULLYMORE**  
**WEXFORD**

**SCHOOL OF APPLIED SCIENCES**

**DEPARTMENT OF FOOD AND NUTRITION**  
**IN CONSUMER SCIENCES**

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF TECHNOLOGY  
**UNIVERSITY OF TULLYMORE**  
**WEXFORD**

**SCHOOL OF APPLIED SCIENCES**

**DEPARTMENT OF FOOD AND NUTRITION**  
**IN CONSUMER SCIENCES**

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF TECHNOLOGY  
**UNIVERSITY OF TULLYMORE**  
**WEXFORD**

**SCHOOL OF APPLIED SCIENCES**

**DEPARTMENT OF FOOD AND NUTRITION**  
**IN CONSUMER SCIENCES**

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: Ary Naecker  
 Date: 04/01/24  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 2 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately		X	X'	
Like slightly				
Neither like or dislike				X
Dislike slightly	X			
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 2 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately	X			
Like slightly		X	X	
Neither like or dislike				X
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 4 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	X	X	X	
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				X
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 1 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	X			
Like very much				
Like moderately			X	
Like slightly				
Neither like or dislike				X
Dislike slightly				
Dislike moderately		X		
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCE

Faculty of \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 7

Please indicate your degree of liking for the product

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	X	X	X	
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				X
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCE

Faculty of \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 3 ✓

Please indicate your degree of liking for the product

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	X	X	X	
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				X
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCE

Faculty of \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCE

Faculty of \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

Mrs E. Singh

11

**DUT** DEPARTMENT OF APPLIED SCIENCES  
DEPARTMENT OF FOOD AND NUTRITION  
DEPARTMENT OF CHEMISTRY & BIOTECHNOLOGY

Panelist id: \_\_\_\_\_  
Date: \_\_\_\_\_  
Test no: \_\_\_\_\_  
Recipe/Product ID code: chap Savoury ✓  
long

Please indicate your degree of liking for the product

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately	✓ looked interesting & crisp brown colour			
Like slightly		✓		
Neither like or dislike				
Dislike slightly			✓ soft	
Dislike moderately				✓ not pronounced
Dislike very much				
Dislike extremely				

Comments: Well done has scope to improve.

**DUT** DEPARTMENT OF APPLIED SCIENCES  
DEPARTMENT OF FOOD AND NUTRITION  
DEPARTMENT OF CHEMISTRY & BIOTECHNOLOGY

Panelist id: \_\_\_\_\_  
Date: \_\_\_\_\_  
Test no: \_\_\_\_\_  
Recipe/Product ID code: OLRA smoothie ✓

Please indicate your degree of liking for the product

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately		indicatedly		✓ spice
Like slightly	✓ smoothie	✓		
Neither like or dislike				
Dislike slightly				✓ but typical = smoothie okra = problem for me
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Name threw me ... okra sling

**DUT** DEPARTMENT OF APPLIED SCIENCES  
DEPARTMENT OF FOOD AND NUTRITION  
DEPARTMENT OF CHEMISTRY & BIOTECHNOLOGY

Panelist id: \_\_\_\_\_  
Date: \_\_\_\_\_  
Test no: \_\_\_\_\_  
Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments:

**DUT** DEPARTMENT OF APPLIED SCIENCES  
DEPARTMENT OF FOOD AND NUTRITION  
DEPARTMENT OF CHEMISTRY & BIOTECHNOLOGY

Panelist id: \_\_\_\_\_  
Date: \_\_\_\_\_  
Test no: \_\_\_\_\_  
Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments:

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: veg pasta ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much			✓	
Like moderately	✓	✓		✓
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: 1<sup>o</sup> control not pls = better.  
 ↓ ↓

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Slp. and miffin ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much	<u>cute</u> ✓			✓
Like moderately		✓	✓	
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: Sweet / savoury ?

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: veggie burger ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much		✓	✓	✓
Like moderately				
Like slightly	✓	<u>bitter dry</u>		
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: ww bread pls

**DUT** DEPARTMENT OF FOOD AND NUTRITION SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: tangy delight ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much		✓		✓
Like moderately	✓			
Like slightly				
Neither like or dislike				
Dislike slightly			✓	<u>frozen pls</u>
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: if get it-s would be great!  
 cost factor?

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 03  
 Recipe/Product ID code: Vegetable pasta ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much	✓		✓	
Like moderately		✓		✓
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 01  
 Recipe/Product ID code: Fruit and yoghurt popsicles ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 05  
 Recipe/Product ID code: Ultimate Veggie burger

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely		✓	✓	✓
Like very much	✓			
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF FOOD AND NUTRITION & CONSUMER SCIENCES

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: 4  
 Recipe/Product ID code: Tangy delights ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much		✓		✓
Like moderately	✓		✓	
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES DEPARTMENT OF FOOD AND NUTRITION & DIETETICS SCIENCES  
 DURHAM UNIVERSITY OF TECHNOLOGY  
 SPURWILL ROAD, LEazes, DURHAM, ENGLAND, DH1 1TA

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: Sweet potato muffins

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓	✓	✓
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES DEPARTMENT OF FOOD AND NUTRITION & DIETETICS SCIENCES  
 DURHAM UNIVERSITY OF TECHNOLOGY  
 SPURWILL ROAD, LEazes, DURHAM, ENGLAND, DH1 1TA

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: 1 ✓

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely	✓	✓		
Like very much			✓	
Like moderately				✓
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES DEPARTMENT OF FOOD AND NUTRITION & DIETETICS SCIENCES  
 DURHAM UNIVERSITY OF TECHNOLOGY  
 SPURWILL ROAD, LEazes, DURHAM, ENGLAND, DH1 1TA

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**DUT** DEPARTMENT OF APPLIED SCIENCES DEPARTMENT OF FOOD AND NUTRITION & DIETETICS SCIENCES  
 DURHAM UNIVERSITY OF TECHNOLOGY  
 SPURWILL ROAD, LEazes, DURHAM, ENGLAND, DH1 1TA

Panelist id: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 Test no: \_\_\_\_\_  
 Recipe/Product ID code: \_\_\_\_\_

Please indicate your degree of liking for the product.

	Appearance/Colour	Taste/Flavour	Texture/Mouthfeel	Smell/Aroma
Like extremely				
Like very much				
Like moderately				
Like slightly				
Neither like or dislike				
Dislike slightly				
Dislike moderately				
Dislike very much				
Dislike extremely				

Comments: \_\_\_\_\_

**APPENDIX J**  
**MICROSOFT FORMS LINK USED TO CONDUCT SENSORY**  
**ANALYSIS BY STUDENTS WHO RATED THEIR TOP THREE**  
**FAVOURITE PRODUCTS FROM THE SAFBUC**

---

MS Forms Link for students to rate the top three favourite products from the South African Food Boost University Challenge:

[https://forms.office.com/pages/responsepage.aspx?id=0TAZS\\_QStUC0jL2GEXQp2CFJZ5J\\_X9ILsDsQ5FDd6XtURDNFUVA0SUpFMIRKM1NIWjNQUVIMQURTNi4u&route=shorturl](https://forms.office.com/pages/responsepage.aspx?id=0TAZS_QStUC0jL2GEXQp2CFJZ5J_X9ILsDsQ5FDd6XtURDNFUVA0SUpFMIRKM1NIWjNQUVIMQURTNi4u&route=shorturl)

**APPENDIX K**  
**PLAGIARISM REPORT**

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# APPENDIX L

## EDITOR'S LETTER

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### Nicolene Barnard

**Proofreading | Technical Editing | Metadata Specialist | Indexing**

PO Box 26959, Langenhovenpark, 9330 | 073 339 7739 |

Nicolene.Barnard1@gmail.com

12 December 2024

#### CONFIRMATION OF EDITING AND PROOFREADING

I hereby confirm that I have verified all references, and have done the technical layout and language editing for the following dissertation:

Student: Sanrika Sahadeo  
Title: Food and nutrition sustainability knowledge and diet among students at the Durban University of Technology  
Department: Department of Food and Nutrition: Consumer Science, Faculty of Applied Sciences, Durban University of Technology

My work for the student included the technical layout of the document, as well as language editing for grammar, punctuation, spelling, and sentence structure. I tried to keep as much as possible of the student's own writing style while making sure that the student's intended meaning was not altered in the editing process. I also checked the list of references making sure that dates, spelling, and names used in the text are consistent with those listed in the reference list.

I have a B.Bibl. (Hons.) Degree and have worked as a cataloguer, metadata specialist and librarian for 33 years. I am an expert in the field of bibliographic information and resources. I have also completed a Copy-Editing course at the University of Cape Town.

Disclaimer: The ultimate responsibility for accepting or rejecting the changes and recommendations rests with the student and I cannot be held responsible for any layout or language issues that might have emerged as a result of subsequent amendments to the text.

Yours sincerely,

Nicolene Barnard

