UNIVERSITY OF CAPE COAST

CONSUMERS' ACCEPTABILITY OF FORTIFIED SOYA-MILLET-YAKEYAKE ("SOMILLYAKE") AND ITS NUTRITIONAL COMPOSITION

LYDIA DONKOR

2024

UNIVERSITY OF CAPE COAST

CONSUMERS' ACCEPTABILITY OF FORTIFIED SOYA-MILLET-YAKEYAKE ("SOMILLYAKE") AND ITS NUTRITIONAL COMPOSITION

BY

LYDIA DONKOR

Thesis submitted to the Department of Vocational and Technical Education of the Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast, in partial fulfilment of the requirements for award of Master of Philosophy Degree in Home Economics

DECEMBER 2024

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature: ………………………. Date: ………………………...

Name: ……………………………………………………………………..

Supervisor's Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Supervisor's Signature: ………………………. Date: ……..………………….

Name: ……………………………………………………………………..

ABSTRACT

The study examined consumers' acceptability of fortified soya-millet-yakeyake ("Somillyake") and its nutritional composition in the Cape Coast Metropolis. This investigation was guided by six objectives which were transformed into three research questions and three hypotheses respectively. The pre-experimental design, specifically the static-group comparison design as well as the cross-sectional survey design were employed in the conduct of this investigation. The population of this study comprised yakeyake consumers within the Duakor community. Using a purposive sampling technique, questionnaires were administered to 75 panel members for the sensory evaluation test. Sixty-five (65) questionnaires were however filled and returned, this resulted in an 87% response rate. Hence, all the analyses on the sensory evaluation were based on 65 respondents. The data gathered were analysed using means and standard deviations as well as one-way repeated measures (ANOVA). It was discovered that respondents had high preference for food sample 3 (i.e., CSMY 2) as the most preferred somillyake endorsed by the panellists due to the savoury aroma and aftertaste of the product. It was therefore concluded that the endorsement of food sample 3 as the overall acceptable food sample was as a result of the fact that the product had savoury sensory attributes such as aroma and aftertaste which were most preferred by respondents. Dieticians, nutritionist, public health workers, and dietetics are therefore encouraged to educate and counsel yakeyake consumers and the general public on the importance of adding soya beans and millet to their diets since soya beans and millets have important sensory attributes and nutritional contents required for body growth and nourishment.

ACKNOWLEDGEMENTS

I would like to express my heartfelt thanks to my supervisor, Prof. (Mrs.) Sarah Darkwa. Her warm and supportive guidance, comments, and professional advice were invaluable in completing this thesis successfully. I cannot adequately convey my appreciation for her timely and outstanding contributions. Dear Prof. Darkwa, may you be abundantly blessed by Yahweh for your kindness and assistance.

I am deeply grateful to Mr. Stephen Adu, Mr. Enoch Ewoenam Tsey, and Mr. Francis Ankomah for their continuous encouragement and support during the writing of this thesis. I also extend my appreciation to Mrs. Mercy Ahadzi, Ms. Samuella Darkwah Sarkodie, Mrs. Belinda Osei, and Mrs. Moses Aboah for their invaluable assistance during the data collection process.

I extend my gratitude to the pastor and leaders of Global Evangelical Church, Duakor branch, for allowing me to use their church compound for the sensory evaluation. I am thankful to the residents of the Duakor community who participated in the sensory evaluation and completed the questionnaires. Your cooperation is greatly appreciated.

I also want to express my gratitude to the Sponsors of the Samuel Emelia Brew Butter-SGS-GRASAG-UCC grant for providing me with a grant that supported my research endeavours. Lastly, I extend my heartfelt thanks to everyone who contributed in various ways to the successful completion of this thesis.

DEDICATION

To my family

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

Background to the Study

The food we eat and its health implications is one of the main concerns of contemporary society and this is increasingly attracting the attention of public institutions, pushing for plans, programmes and strategies that attempt to resolve the main issues that affect food production (Chinea et al., 2020). When contemplating ways to improve one's health, food is frequently the initial consideration. Adopting a healthy diet is a pathway to well-being and should be an integral component of any strategy aimed at preventing future health issues and managing existing ailments (Nielsen, 2016). Understanding the connection between food intake and health results is essential for changing unhealthy eating patterns (Diaz-Mendez & Gomez-Benito, 2008). However, selecting a particular food is often accompanied by complex decision-making process due to the uncertainty about which foods are truly nutritious and the challenges of balancing nutritional qualities against factors like price and taste (Mahele et al., 2015).

Cassava, a root tuber, stands as a primary food crop in Africa's tropical regions and serves as a crucial energy source for millions of people in this area (Allem, 2002). In Latin America, Asia and Africa, approximately 600 million individuals rely on cassava as a source of sustenance and income (Okogbenin et al., 2002). It is extensively utilised for ensuring food security due to its mature edible tuber's ability to be stored underground for up to three years. This characteristic makes it function as a household food reserve that can be utilised during unfavourable climate conditions when the production of other foods is limited.

Bayata (2020) noted that the levels of cyanide in the edible part of the cassava root varied within the range of 3.83 to 0.91 mg/kg. Cassava plants come in various types, broadly classified as either ‘bitter’ or ‘sweet’ cassava based on the levels of cyanide they contain (Navia &Villada, 2012). Hence, the roots of 'bitter' cassava have a notably elevated cyanide concentration. On average, 'bitter' cassava peels and pulps contain approximately 650 ppm and 310 ppm of total cyanide, respectively, while the equivalent parts of 'sweet' cassava have less than 200 ppm and 38 ppm of total cyanide, respectively (Ibegbulem & Chikezie, 2018). Cassava’s nutritional quality is significantly affected by its cyanide content. However, data indicated that in the year 2000, Africa contributed to 45% of the global cassava root production, while Asia and Latin America, including the Caribbean, accounted for 28% and 19% respectively, out of a total of approximately 172 million tons (FAO, 2001; FAO, 2012).

In Ghana and various regions across Africa where cassava is a primary staple food, there is a risk of illnesses resulting from prolonged consumption of certain levels of cyanide if cassava roots are not adequately processed. Yusuf et al. (2014) conducted a study involving 180 participants in the Zaria metropolis town. Among them, 100 were consumers of gari, and the remaining 80 did not consume gari. The researchers assessed visual acuity using the Snellen’s chart and colour vision using the Ishihara’s chart. The study revealed a significant decline in visual acuity among gari consumers compared to non-consumers ($P<0.05$). Additionally, the incidence of colour blindness was higher in gari consumers than in non-consumers. The research findings indicated a correlation between visual defects and the frequency of gari consumption, the duration of gari consumption, and the consumer's age. Conclusively, Yusuf et al. (2014) found that the widespread occurrence of visual impairments among gari consumers resulted from prolonged exposure to unsafe levels of cyanide in gari. This prolonged exposure led to a significant increase in the rates of blindness and severe visual impairment, particularly among individuals aged 40 years and above.

Traditionally, cassava tubers are processed by various methods into numerous products and utilized in various ways according to local customs and preferences (Julie et al., 2009). The major uses of cassava in Ghana and in other African countries include flour production, feed for livestock, ethanol production, confectioneries, starch for the manufacture of textiles, paints, adhesives, pharmaceuticals, chips, pellets, and gari, a white granular flour slightly fermented with sour taste (Nwosu, 2005; Philip et al., 2005; Adebayo, 2009; Aniedu et al., 2012). Cassava can also be boiled, pounded, or stirred in boiled water to obtain fufu, which is popular in Nigeria, Ghana, and to some extent in Cameroon (Hahn, 1997). In Ghana, cassava is often transformed into numerous foods including yakeyake which is often consumed by a larger percentage of the Ghanaian populace on regular basis.

Yakeyake or steamed grated cassava is gluten free steamed pudding made out of cassava and is popular among the Ewes of Ghana, Ivory Coast and Togo. This authentic recipe does not require the use of cassava only but also a little bit of corn flour is often added in order to have a fluffy texture. In preparing yakeyake, large peeled cassava is often soaked in water over night in order to get rid of any toxin that may be present in the cassava. Other ingredients such as water, salt and corn flour are also added. This simple dish is often served with ground pepper, stew, onions, tomatoes, fried fish or fried chicken or soup (Fafa, 2009)

Similarly, Eshun (2012) indicated that one major issue that has emerged regarding the diet of most Africans is the issue of protein-energy malnutrition. Soya bean is an important source of vegetable oil and protein that could make the diet of many Ghanaians nutritious. These are often in high demand for high protein and oil content. Nkama and Badua (2000) indicated that soya bean meal is the world's most valuable source of protein. Compared to other protein-rich foods, such as meat, fish and eggs, soya bean is by far the cheapest. It contains about 40% of crude protein compared to 18% for fish and beef. It is also rich in calcium, iron, phosphorus and vitamins. With the exception of methionine amino acid, it is the only source of protein that contains all other essential amino acids (Abbey et al., 2001; Kure et al., 1998; Ihekoronye & Ngoddy, 1985).

Millet is one of the most important drought-resistant whole grains in dry areas of Asia and Africa. It has been receiving specific attention because of its excellent nutritive value and potential health benefits (Saleh et al., 2013). Generally, millets are rich sources of fibre, minerals and B-complex vitamins. Millets are also rich in health promoting phytochemicals like polyphenols, lignans, phytosterols, phyto-oestrogens, phytocyanins which function as antioxidants, immune modulators, detoxifying agents, and hence protect against age-related degenerative diseases like cardiovascular diseases (CVD), diabetes, cancer, among others (Rao et al., 2017). Saleh et al. (2013) indicated that, being a non-glutinous grain, millets are safe for people suffering from gluten allergy and celiac disease. Similarly, they are non-acid forming, easy to digest and non-allergenic.

Statement of the Problem

In sub-Saharan Africa, carbohydrate foods are typically based on a range of primary root tubers such as cassava, yams and maize. The Ghana Exports Promotion Authority (GEPA) reported in 2019 that cassava holds significant importance as a root crop in Ghana. In Ghana, over 70% of farmers engage in cassava production, and the sector contributes to about 22% of Agricultural GDP (Englyst et al., 2007). Given the carbohydrate-centric nature of Ghanaian diets, many families base their meal planning around cassava. In Ghana, carbohydrates-rich crops like corn, rice, cassava, yam, and plantain undergo various processing methods before being consumed. The specific processing technique used for each carbohydrate food significantly impacts its properties and has a notable influence on physiological functions within the human body (Englyst et al., 2007).

A study conducted by Aparicio-Saguilan et al. (2013) focused on the addition of tortilla to unripe banana and cassava flours. Findings of this study revealed that protein and dietary fibre content decreased in the mixture. Chinwe et al. (2016) also looked at sensory and comparative analysis of ordinary gari and cocos gari (gari fortified with coconut milk, sugar and vanilla). Results showed that apart from appearance, there was a statistically significant difference between cocos gari and ordinary gari in terms of crispiness, flavour, sweetness and mouth feel.

Eshun (2012) indicated that one major issue that has emerged regarding the diet of most Africans is the issue of protein-energy malnutrition. Since the lack of protein in many Ghanaian diets has the likelihood of causing malnutrition and increasing the risk of kwashiorkor among individuals, the current investigation seeks to examine the proximate composition of somillyake (i.e., a combined mixture of soybean flour, millet flour and grated cassava) and consumers' acceptability in the Cape Coast Metropolis. Thus, compared to the commercially-made yakeke the researcher anticipated that the addition of soya beans and millet to traditional yakeyake will go a long way to resolve the issue of malnutrition among individuals who often consume yakeyake.

The addition of soya beans as well as millet in the meal choice of Ghanaians have countless benefits. For instance, Soya beans is an important source of vegetable oil and protein that could make the diet of many Ghanaians nutritious. In their study, Nkama and Badua (2000) highlighted that the relevance of soya beans in Ghanaian diets cannot be overemphasised, in that, soya beans is a high-quality protein food that helps in reducing the risk of several health problems such as cardiovascular diseases, stroke coronary heart disease, cancer as well as improving bone health. Similarly, the addition of millet in Ghanaian diet has countless benefits. For instance, millet contains fibre, which contributes to digestive health and helps to regulate bowel movements. Millet also has prebiotics properties, which stimulate the growth of probiotics within the microbiome; this is important for gut health and the immune system in general (Edge et at., 2005; Miller, 2001). Since the nutritional benefits of soya beans and millet cannot be overemphasised, the researcher sought to the nutritional composition and consumers' acceptability of somillyake (i.e., a combined mixture of soya bean flour, millet flour and grated cassava) in the Cape Coast Metropolis.

Purpose of the Study

The study sought to examine consumers' acceptability of fortified soya-millet-yakeyake ("Somillyake") and its nutritional composition.

Objectives of the Study

Specifically, the study sought to:

1. determine the nutritional composition of soya bean flour, red millet flour, and grated cassava flour.
2. evaluate the nutritional composition of commercially-made yakeyake
3. examine the nutritional composition of somillyake (i.e., a combined mixture of soya bean flour, millet flour, and grated cassava).
4. compare the nutritional compositions of commercially-made yakeyake and "somillyake,"
5. identify the functional properties of commercially-made yakeyake and "somillyake"
6. evaluate consumers' acceptability of commercially-made yakeyake and "somillyake"

Research Question

The study was guided by the following research question:

1. What is the nutritional composition of: (a) soya bean flour, red millet flour, grated cassava flour, (b)commercially-made yakeyake, and (c) somillyake?

Hypotheses

The study tested the following hypotheses:

1. H_0: There is no statistically significant difference between the nutritional composition of commercially-made yakeyake and the different ratios of somillyake
2. H_0: There is no statistically significant difference in the functional properties of commercially-made yakeyake and the different ratios of somillyake
3. H_0: There is no statistically significant difference in the sensory properties of commercially-made yakeyake and the different ratios of somillyake

Significance of the Study

It is hoped that "Somillyake," a fortified yakeyake would be well accepted by consumers so it improves the nutritional status of its consumers. Once, successful, "Somillyake" could be recommended for individuals who enjoy eating yakeyake.

Delimitation

The study selected only yakeyake among several carbohydrate foods consumed in Ghana to fortify.

Limitations

Research of this kind highlighted certain challenges that could impact the accuracy of the responses. Using self-reported data from sensory evaluation questionnaires can introduce biases, as the accuracy and reliability of the results depend on the honesty of the respondents' answers. Identifying and excluding participants who provide inaccurate information is difficult. However, respondents were guaranteed confidentiality, and informed consent was obtained to encourage them to provide truthful and unbiased data.

Organisation of the Study

This research report is organised into five chapters. Chapter one provides a background to the study, statement of the problem, purpose of the study, hypotheses, significance of the study as well as delimitations and limitations. Chapter two provides information on relevant and related literature on product development and consumers' acceptability. The literature review provides a conceptual as well as empirical review based on the objectives of the study. Chapter Three presents the research methodologies used for the study. These comprises the research design, study area, population, sampling procedures, data collection instruments, data collection procedures and data processing and analysis. Chapter Four covers data analysis and interpretation of the results. Chapter Five presents summaries, conclusion and recommendations, as well as probable areas recommended for further studies.

CHAPTER TWO

LITERATURE REVIEW

The study sought to examine consumers' acceptability of fortified soya-millet-yakeyake ("Somillyake") and its nutritional composition. This chapter reviewed related literature on the nutritional components of soya bean, millet and yakeyake.

Theoretical Framework

The study is grounded in the Planned Behaviour Theory developed by Ajzen (1985). The theory has been widely used in many behavioural domains; prediction, adoption and change of behaviour and technology (Ajzen, 2020). According to the theory, the primary motivator behind behaviour is the desire or purpose to engage in that behaviour. The underlying motivational factors (i.e., attitude toward the behaviour, subjective norm, and perceived behavioural control) are responsible for shaping an individual's intention (Steinmetz et al., 2016). A critical analysis of the Theory of Planed Behaviour reveals that an individual's belief of the outcome of a particular behaviour forms the foundation and rationale for the person's engagement in the said behaviour (Akyea-Mensah, 2020).

In her view, Akyea-Mensah (2020) explains that individuals' preferences for food products are highly influenced by beliefs that the outcome will be positive. Beliefs about food include the health implications, its appropriateness for certain occasions, functions or group of people. Individuals utilise both inherent and external informational signals to create perceptions regarding the quality of food items and to decide on future buying and consumption choices (Prinyawiwatkul, 2020).

When consumers have knowledge that consumption of "Somillyake" will lead to a positive outcome, such as improve health benefits, high nutritional value and good taste, they are more likely to accept and consume the product. Figure 1 presents the interconnectedness of the variables captured in the Theory of Planned Behaviour.

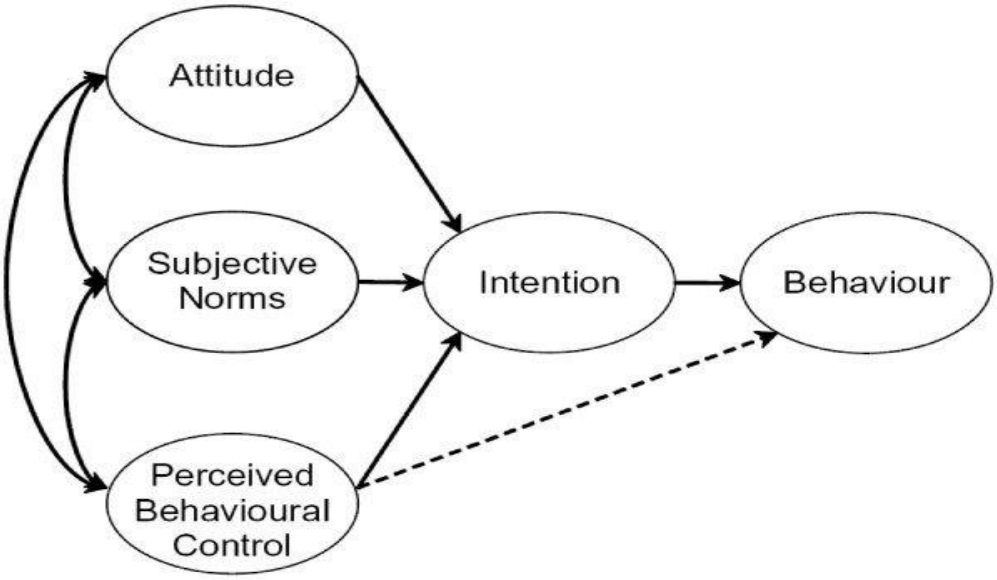


Figure 1- Planned Behaviour Theory

Source: Adopted from Ajzen (1985).

Conceptual Review

This section provides definitional issues to some concepts used in the study. Details of these concepts are provided in the subsequent paragraphs.

Soya Bean

Soya bean belongs to Leguminosae and Papilionaceae families (Shea et al., 2020). This crop is versatile, it thrives in various types of climates and soil (Siamabele, 2019). Soya bean, cultivated in nearly every continent worldwide, is among the significant food and industrial crops (Haruna et al., 2017). It is a legume extensively planted and utilized globally, because of its valuable seed composition (Shea et al., 2020). History suggests that the growing of wild soya bean (*Glycine soja*) for domestic purposes occurred during the Shang Dynasty, 1700–1100 B.C (Shea et al., 2020). With regard to production techniques, geographical growing areas, and versatility in end use, soya beans are considered one of the most adaptable crops (Shea et al., 2020).

According to Food and Agriculture Organization of the United Nations (FAO) (2013), soya beans contribute about 44% to global oil crop output. Soya beans are unique because of their high concentration of isoflavones and weak estrogenic characteristics. Among the isoflavones, it is genistein that affect signal transduction (Siamabele, 2019). Contemporary soya bean cultivars are typically bushy and erect, ranging in height from 20 to 180 cm, with few primary branches and no secondary branches. The leaflets are typically ovate to lanceolate in shape with a pointed tip (Shea et al., 2020).

Soya bean is a highly valuable and profitable crop. The commercial profitability of soya bean cultivation relies on the utilization of both its by-products, namely meal and oil. Soya bean protein and oil respectively contribute to about two thirds and one third of the crop's overall economic value (FAO, 2013). Soya bean is a significant source of both vegetable protein and oil (Eden

& Rumambarsari, 2020). Despite accounting for only about 35% of the seed's dry weight, soya bean meal makes up 70% of the seed's overall value (Shea, et al, 2020). For numerous centuries, individuals in Asia and other regions of the world have utilized soya bean seeds to create a diverse range of fresh, fermented, and dried foods (Pratap et al., 2012).

Cassava as a Root Tuber

Cassava (*Manihot esculenta*) is a plant that is short-lived, shrubby, and perennial, capable of reaching a height of 3 meters or beyond (Akyea-Mensah, 2020; Kocke, 2019). With an estimated global output of around 276 million metric tons per year, cassava is among the most significant food crops worldwide (Sanginga & Mbabu, 2015). Research indicates that the origin of cassava can be traced back to the Amazonian region (FAO, 2013; Kocke, 2019). After being introduced to Ghana in the 15th century, cassava was cultivated in areas near trading ports, forts, and castles, and it eventually became the primary food source for both the Portuguese and the enslaved individuals (Bayitse et al., 2017). Cassava cultivation has significantly increased since the 1900s, and currently, millions of people worldwide grow the crop (FAO, 2013; Weigand, 2018). Cassava is the most extensively grown root crop in tropical regions (FAO, 2013).

The cassava plant has an upright stem with noticeable leaf scars and varying levels of branching (Akyea-Mensah, 2020). In times of drought, cassava experiences a decrease in leaf production, which persists until the next rainfall (FAO, 2013). While the roots have a water content of over 60 percent, the dried root tuber has a significant amount of carbohydrates (FAO, 2013).

Cassava is the primary source of carbohydrates among all the staple crops (Bayitse et al., 2017).

Cassava is a crucial food crop that serves as a valuable reserve during times of famine (Weigand, 2018). Approximately 800 million people, globally, depend on cassava for food. In Ghana, cassava is the second most consumed food crop after maize (Mahama, 2019; Rice & Curtis, 2021). Cassava's resilience as a crop, due to its capacity to endure harsh growing conditions and be stored underground for extended periods, makes it a valuable contributor to food security (Amelework et al., 2021). Cassava has the ability to survive in soils with low pH levels, which enables it to flourish in soil that is depleted and of poor quality (Bayitse et al., 2017). To conserve water in the dry season, the cassava plant undergoes leaf shedding. However, during the rainy season, the stem produces new leaves (Zierer et al., 2021).

About ninety percent of small-scale farmers, who typically own small landholdings, grow these crops (Mahama, 2019). The plant is commonly referred to as "the food of the poor" because it is predominantly grown by rural farmers who have low incomes (Weigand, 2018). Bitter cassava roots contain substantial amounts of linamarin and lotaustralin, which convert into hydrogen cyanide (HCN) when being processed or consumed (Kocke, 2019). Bitter cassava, unlike sweet varieties have a high starch content and utilised for industrial purposes (Akyea-Mensah, 2020).

Akyea-Mensah (2020) explains that the amount of cyanide in cassava tubers differs depending on the variety. He further explained that most varieties have a cyanide content ranging from 150 to 400 mg per kilogram of fresh cassava. In Ghana, the popular varieties of cassava grown by farmers includes Ankrah, Agege, Tuaka, Afraim plains, among others (Akyea-Mensah, 2020). In many Ghanaian communities, the stem colour, leaves, tuber, stem branching, height, and yield capacity are used to differentiate cassava varieties. Cassava is a significant source of calories, protein, and fat in the human diet in terms of nutritional composition (Akyea-Mensah, 2020).

In order to render them safe for human consumption, majority of cassava roots, particularly bitter cassava, must undergo treatment. Various techniques, both traditional and contemporary, are utilized for processing cassava in different regions of the world. It is noteworthy that all current methods are adaptations of traditional practices (Weigand, 2018). Traditional methods used for processing cassava include techniques such as soaking, chipping, cooking, drying, etc. Akyea-Mensah (2020) posits that the primary objective of cassava processing is to produce a food product that is safe for consumption.

Millet

Millets are small-seeded cereal crops that belong to the Gramineae family. With the exception of finger millet and teff which belong to the tribe *Eragrostideae*, the majority of millets are part of the tribe *Panicoideae* (Ramashia et al., 2021). Millets are forage grasses that are categorized within the *Poaceae* food family (Bunkar et al., 2021). It is thought that millet originated in East Africa, specifically in Ethiopia (Karuppasamy, 2015; Abormegah, 2019).

In terms of global production, millets yield about 4.5-5 million tonnes annually. India is the largest producer, accounting for over half of the total quantity (2.5 million tons), while some African countries produce approximately 2 million tons (Abah et al., 2020). Millet is a highly nutritious nutri-cereal that has essential nutrients, protein, dietary fibre, B-vitamins, and minerals like calcium, iron, zinc, potassium, and magnesium (Dayakar et al., 2017).

Abah et al. (2020) differentiated between three cultivars of millet grains according to grain colour; brown, light brown and white. The primary use of white cultivars is for baking, while brown and light brown varieties are for making porridge. In Southern Africa, the brown cultivar is specifically grown for producing traditional opaque beer. The major millets are Pearl millet (*Pennisetum glaucum*), Foxtail millet (*Setaria italica*), Proso millet or white millet (*Panicum miliaceum*), and Finger Millet (*Eleusine coracana*). Minor millets include Barnyard millet (*Echinochloa spp*.), Kodo millet (*Paspalum scrobiculatum*), little millet (*Panicum sumatrense*), Guinea millet (*Brachiaria deflexa*), and Brown top millet (*Urochloa ramose/Brachiaria ramose/ Panicum ramosum*) (Bunkar et al., 2021). Different types of millets require specific soil conditions to support their growth. Millets, in general, can grow in low fertile soils. For instance, pearl millet can be cultivated in sandy soils, while finger millet performs well in saline soils. Barnyard millet, on the other hand, grows well in low-fertile soils (Karuppasamy, 2015).

Millet grains are typically subjected to traditional processing methods like decorticating, malting, fermentation, roasting, flaking, and grinding to enhance their edible, nutritional, and sensory qualities before consumption. Both modern and traditional methods are used for processing millet grains.

Value-added products, including soaked, cooked, malted, fermented, popped or puffed, extruded, and multigrain flour, can be manufactured using modern processing methods. Millet grains can be processed using both traditional and modern techniques to enhance their nutritional and sensory properties. Traditional methods include drying the grains in the sun for a week before storing them for future use. However, the small size of millet grains makes them difficult to handle, and they are susceptible to fungal diseases. Despite being highly beneficial and nutritious, millets are not extensively researched or innovated compared to conventional cereal grains such as wheat, rice, maize, and sorghum (Abah et al., 2020).

Millets are considered nutri-cereals that are abundant in nutrients, including protein, essential fatty acids, dietary fiber, B-vitamins, and minerals like calcium, iron, zinc, potassium, and magnesium (Dayakar et al., 2017). Millets are considered as important sources of essential amino acids due to their protein content. Additionally, millets are abundant sources of phytochemicals and micronutrients (Demuyakor et al., 2013). Millets provide significant amounts of magnesium and phosphorus, which play important roles in human health. Magnesium has been shown to have beneficial effects in reducing the occurrence of migraines and heart attacks, while phosphorus is a crucial component of adenosine triphosphate (Bunkar et al., 2021).

Millets are free from gluten, non-acidic, and easy to digest with a low glycemic index. These properties make it a suitable choice for people with celiac disease and diabetes as its consumption can help regulate blood glucose levels. Millet grains are rich in dietary fibre, carbohydrates, iron, and calcium compared to other cereal grains. Additionally, they have a high concentration of magnesium and phosphorus, which can help in reducing migraines and heart attacks while serving as an essential component of adenosine triphosphate (Abah et al., 2020).

For example, pearl millet is abundant in resistant starch, both soluble and insoluble dietary fibres, minerals, and antioxidants. It comprises a considerable amount of dry matter, ash, crude fibre, crude fat, crude protein, and starch. Additionally, the protein in foxtail millet could be utilised as a functional food ingredient, and its essential amino acid composition could serve as an extra protein source to complement most cereals (Demuyakor et al., 2013).

Millets can provide advantages for overall well-being such as decreasing blood sugar levels in individuals with diabetes, regulating blood pressure, assisting with thyroid, cardiovascular, and celiac diseases (Dayakar et al, 2016). Millets have a significant quantity of dietary fiber, B-complex vitamins, essential amino and fatty acids, and vitamin E. They are exceptionally rich in minerals such as iron, magnesium, and phosphorous, and potassium, and release a lower proportion of glucose slowly, resulting in satiety that lowers the risk of diabetes. These grains are mainly composed of carbohydrates, with the protein content ranging from 6 to 11 percent, and fat ranging from 1.5 to 5 percent (Dayakar et al., 2017).

Sensory Evaluation

One of the primary objectives of the food industry is to understand the impact of food products on consumers' senses (Choi et al., 2013). The acceptability of food products by consumers ultimately depends on how the product appeal to their senses. According to Rochmawati (2019), people consume food because it stimulates their senses and makes it appealing to consume. Sensory evaluation is a scientific discipline that involves evoking, measuring, analyzing, and interpreting reactions to the characteristics of food and other materials as they are perceived by the senses of sight, taste, touch, and hearing (Stone & Sidel, 2004).

Lawless and Heyman (2010) opine that the concept of sensory evaluation encompasses all four activities stated in the definition of Stone and Sidel (2004). Singh-Ackbarali and Maharaj (2014) posit that when it comes to choosing a food product, its palatability is the primary factor for a consumer, and factors such as nutrition and wholesomeness are of secondary importance. This highlights the responsibility of food industry producers to ensure that their products are pleasing to the consumer's senses. The degree to which a consumer finds a food product acceptable depends on how well the product meets their desired standards of taste, flavour, texture, etc. Sensory evaluation, as explained by Rochmawati (2019), involves utilising human senses to measure the texture, appearance, aroma, and flavour of food products.

Sensory evaluation has become important in the evaluation of various products, particularly food products, as it provides valuable information for a variety of purposes. These include quality control, shelf-life assessment, analysis of process variation, product enhancement, cost reduction, development of new products, and market analysis (Rochmawati, 2019).

The perceived attributes and intensities of a product’s characteristics can be effectively captured using descriptive sensory analysis, which is considered the most potent method (Suwonsichon, 2019). The goal of sensory evaluation is to assess the characteristics of food quality and to what extent they meet the legal requirements of food products and consumer preferences (Nemeth et al., 2020).

To conduct a scientific sensory evaluation of a product, a series of steps need to be followed, which include defining the problem, screening, test design, panel selection, instrumentation, and interpretation of results. (Sharif et al., 2017). Senapati and Sahu (2020) argue that sensory evaluation involves a scientific process of eliciting, measuring, analyzing, and interpreting psychological and physiological responses to the physical properties of a food product. Panel members should be carefully selected, calibrated, and validated to make results scientific (Singh-Ackbarali & Maharaj, 2014).

Sight/Appearance of the Product

The visual appearance of food is a crucial factor in determining its quality, as it is often the first characteristic evaluated subjectively by the consumer. The human eye can detect wavelengths of light ranging from approximately 400 nanometers and up, providing valuable information about the appearance of food products (Nemeth et al., 2020). Sharif et al. (2017) opines that the sense of sight plays a crucial role in the acceptance or rejection of food products. The size, shape, and texture of food also convey information about its quality and can therefore impact its acceptability and desirability. (Adu-Gyamfi, 2018).

Taste of the Product

The perception of food components after they are dissolved in saliva, oil, or water by taste receptors located on the tongue, mouth, or throat is referred to as taste (Sharif et al., 2017). Adu-Gyamfi (2018) posits that the perception of taste is influenced by the intensity of sweet, fatty, and bitter components of food or beverages, as well as individual factors such as personal preferences, health concerns, and convenience.

Flavour of the Product

It can be challenging to interpret the numerous volatile compounds found in food products, as their volatility can vary greatly. Analysing the odours and flavours produced by these compounds can be challenging because strong peaks may produce weak odours, while weak peaks may produce strong odours. Additionally, when it comes to smell, it is a perception of a mixture and cannot be analysed through analytical testing (Mason & Nottingham, 2002). Hot foods are easier to smell compared to cold foods (Choi, 2013). According to Choi et al. (2013), adaptation is the gradual decrease in the ability to detect different odours over time, which prevents sensory overload. They note that human sensitivity to odours varies depending on factors such as hunger, satiety, mood, concentration, presence or absence of respiratory infections, and gender (Choi, 2013).

Touch/Texture of the Product

Texture of a food product can be evaluated as mechanical (hardness and chewiness), geometric (graininess and crumbliness) and mouth-feel (oiliness and moistness). These attributes are experienced during the process of biting, chewing and swallowing (Sharif et al., 2017). The sense of touch provides us with information about a food's texture through sensations we feel in our mouth or on our skin. (Choi, 2013).

Affective Test

Affective test can be categorised into two main groups (preference tests and acceptance tests). Preference tests are used to allow consumers to make a choice between samples. It answers the question "which one of the samples do you prefer?" Acceptance tests are used to determine consumer acceptance of a product. A degree of liking a product is rated by the use of the hedonic scale. The scale is a category-type scale with an odd number (five to nine) categories ranging from "dislike extremely" to "like extremely." A neutral midpoint (neither like nor dislike) is included (Choi, 2013).

Analytical Test

Garcia-Gomez et al., (2022) indicate that in analytical tests, it is essential to have a trained sensory panel with the capability to assess the food product both qualitatively and quantitatively, while also defining its sensory attributes comprehensively. Difference testing, which is the simplest sensory test identifies the differences that exist between food products. Difference testing is a good step to determine the complex sensory evaluation of the products. Examples of difference test include triangle test, paired comparison test, and duo-trio test.

Panel Selection

Typically, sensory analysis is conducted by panelists through controlled experiments in appropriate environmental settings. Rochmawati (2019) distinguishes between two categories of panelists, untrained panelists and trained panelists. Sensory evaluation employs both trained and untrained panels, and the extent of training of the panels differs with regards to the type of sensory analysis. Different levels of panel training are necessary for different types of sensory analysis. The necessary level of training relies on factors such as the degree of differences to be perceived, the number of panelists required for the tests, and the time and value of the analysis in relation to the product type (Adu-Gyamfi, 2018).

To ensure dependable and authentic data, sensory properties of food products are assessed by a group of panelists who are specifically trained for this purpose, referred to as sensory panelists. This helps to eliminate various errors or biases that may result from psychological and physiological factors. Hence, the mental state and physical well-being of the panels or tester, as well as the testing environment's ambiance, should be taken into account as they can impact their assessments.

Empirical Review

This aspect of the literature reviewed empirical studies based on the respective objectives of the study. Details of these empirical studies are provided in the subsequent paragraphs.

Nutritional Composition/Proximate Composition of Soya Bean

In a study conducted by Eden and Rumambarsari (2020), the proximate analysis of soya bean and red bean cookies was analysed in accordance with the Indonesian National Standard. Proximate analysis components included protein, ash, fat, water, and carbohydrates. The researchers used three different cookie samples, one soya bean cookie sample, and two red bean cookie samples. The study revealed that soya bean cookies had an ash content of 1.02%, water content of 10.744%, fat content of 22.8%, protein content of 5.375%, and carbohydrate content of 65.256%. When compared to the Indonesian National Standard, the study showed that soya bean cookies met the national standard for ash levels, but did not meet the standard for protein, water, and carbohydrate levels. The study attributed the chemical loss in the soya bean sample to storage duration, which has the potential to alter the nutritional value and quality of the cookies

Szostak et al. (2020) conducted a study in Poland to compare the nutritional value of two soya bean cultivars (Amandine and Merlin) based on their protein and fat content. The researchers discovered that the Amandine cultivar had significantly higher levels of crude ash, crude protein, and crude fibre compared to the Merlin cultivar. Specifically, the study found that the crude fibre content in the Amandine cultivar was 85.0 g kg^{-1}, while it was 76.5 g kg^{-1} in the Merlin cultivar. The Merlin cultivar had a crude ash content of 53.80 g kg^{-1}, while the Amandine cultivar contained 54.10 g kg^{-1}. In addition, the Amandine cultivar had 331.7 g kg^{-1} of crude protein, whereas the Merlin cultivar contained 293.4 g kg^{-1} of crude protein. The crude fat content of the two cultivars was 187.5 g kg^{-1} and 205.6 g kg^{-1} for Amandine and Merlin, respectively.

Bayero et al. (2019) conducted a study in Nigeria to analyse the proximate composition and mineral contents of soya beans. According to the study, soya bean is a valuable source of high-quality protein, oil, and other essential nutrients. The proximate composition of soya bean was found to be Moisture 8.13%, Crude Protein 39.24%, Crude Fibre 6.84%, Crude Lipid 30.31%, Ash 4.61%, and Carbohydrate 5.08%. The average mineral contents (%), as determined by the study, were 0.003 (Na), 0.216 (K), 0.281 (Mg), 0.324 (Ca), 0.722 (P), 0.003 (Zn), 0.002 (Cu), 0.291 (Mn), and 0.018 (Fe). These findings suggest that soya bean can serve as a valuable source of macronutrients and minerals in Nigeria.

Nutritional Composition/ Proximate Composition of Millet

Ramashia et al. (2019) conducted a review on the nutritional content of finger millet. According to their findings, finger millet has a high concentration of carbohydrates, dietary fibre, essential amino acids, and phytochemicals. Additionally, it contains essential minerals and is gluten-free. Compared to other cereal grains, finger millet has a superior nutritional profile, although it is often neglected and underutilised. The nutritional composition of finger millet reduces the risk of various health conditions, including diabetes mellitus, high blood pressure, and gastrointestinal tract disorders, when consumed.

Abah et al. (2020) conducted a study on nutritional value of cereals. According to the review, cereal grains are a valuable source of carbohydrates and starch, but contain low levels of protein, fat, vitamins and other nutrients. They are rich in minerals and vitamins, including vitamin E which functions as an antioxidant. While cereal grains can contribute to the daily protein requirements, they lack the essential amino acid lysine and should not be relied upon as the sole source of dietary protein. The carbohydrate content of cereal grains ranges from 58 to 72%, with protein at 8 to 13%, fat at 2 to 5%, and indigestible fibre at 2 to 11%. Cereal grains have a caloric content of 300 to 350 kcal/100 g, with carbohydrates mainly in the form of digestible starches and sugars. The functional properties of millet were also examined, and various authors report that millet has favourable functional properties such as bulk density, oil and water absorption capacity, least gelatinization temperature, among others.

Jukanti et al. (2016) conducted a study to analyse the nutritional composition of pearl millet. Their findings revealed that pearl millet is a rich source of nutrients such as dietary fibre, energy and proteins coupled with essential minerals, some vitamins, amino acids, and antioxidants. The study found that in Vitro Protein Digestibility (IVPD) in pearl millet varies from 60.5% to 76.9% whereas protein content in pearl millet is between 8 to 24%. Additionally, pearl millet has a total fat content of 4.7% and carbohydrate content of 55.3% to 75.4%. Potassium (K), magnesium (Mg) and Phosphorus (P) were found to be the main mineral components contained in pearl millet grain. The study further found that pearl millet is rich in B-vitamins however, it does not contain vitamin C. These nutrients are beneficial in preventing various sickness in humans, such as cancer, diabetes, neuro-degenerative diseases and cardiovascular diseases. The study suggested that improved crop management, genetic improvement, and grain processing could help to maximize the positive attributes of pearl millet.

The study by Ramashia et al. (2021) researched the nutritional constituent of pearl millet. The study revealed that pearl millet has high nutritional value in terms of high levels of energy, dietary fibre, proteins with a balanced amino acid profile, many essential minerals, some vitamins, and antioxidants. The protein content of pearl millet grain ranges from 8 to 24 % and the in vitro protein digestibility (IVPD) from 60.5 % to 76.9 %. Total carbohydrate content of pearl millet ranges from 55.3 to 75.4 g/100 g. The fat content of pearl millet grain [4.7 %]. Phosphorus (P), potassium (K) and magnesium (Mg) are the major mineral constituents of pearl millet grain. The study revealed that pearl millet is rich in B-vitamins however, it does not contain vitamin C. These nutrients play a significant role in prevention of ailments such as diabetes, cancer, cardiovascular and neuro-degenerative diseases. The study revealed that here is great potential for harnessing these positive attributes through genetic improvement, improved crop management, and grain processing and food.

Nutritional Composition/Proximate Composition of Yakeyake (Grated Cassava)

The study by Kouassi et al. (2022) evaluated the qualities of pressed fermented cassava doughs from five major producing areas in Cote d'Ivoire. The study specifically analyzed the physicochemical properties and fermenting flora of sampled cassava doughs from Abidjan, Jacqueville, Dabou, Yamoussoukro and Grand-Lahou. Generally, the study revealed that cassava dough has higher starch, dietary fibre, and moisture contents. However, the sources of the cassava dough were found to determine their chemical content. Comparatively, the study revealed that the observed dry matter values of dough from Dabou, Jacqueville and Abidjan were 1.15%, 0.99% and 0.66% respectively. However, significant differences were recorded for doughs from

Yamoussoukro (0.44%) and Grand-Lahou (1.03%). The moisture contents recorded for pressed fermented cassava doughs varied from 0.44% (dough from Yamoussoukro) to 0.66% (dough from Abidjan). It was revealed that doughs from the other production areas recorded higher values for moisture contents even though they were not statistically different. The dough from Grand-Lahou had much moisture content (1.03%) whilst those from Yamoussoukro were drier (0.44%). However, dough from Yamoussoukro had the highest ash content (0.08%) whilst those from Jacqueville areas recorded the lowest (0.04%). Furthermore, results showed that doughs from Yamoussoukro were more acidic (0.54 mg/L). The pH of doughs varied from 4.16 ± 0.10 (Abidjan) to 4.60 ± 0.02 (Yamoussoukro).

The study by Nilusha et al. (2021) aimed at exploring the characteristics of cassava varieties in food applications in Sri Lanka. Flours were prepared from five cassava varieties: Shani, MU51, Kirikawadi, Swarna, and Suranimala. The study examined the physicochemical functional, proximate composition and antioxidant properties of cassava flour using standard methods. Findings from the study revealed that cassava flours used for the study contained less than one percent crude fat and less than two percent crude protein. Specifically, the study revealed that flour from Suranimala contained the lowest amount of cyanide (4.85 mg/kg) whiles flour from MU51 contained the highest (48.05 mg/kg). The study found that total amylose contents and starch of flours were significantly lower than those of wheat flour. Comparatively wheat flour and flour from Suranimala contained similar amylopectin content. It was again found that flours from cassava varieties used in the study had high water solubility index, oil absorption capacity, water absorption capacity, swelling power, emulsion stability and emulsion activity than those of wheat flour. Phenolic compounds were highly found in Swarna (4.44 mmol GAE/100 g dry weight) among the five varieties. The study revealed that the cassava flours are suitable for bakery foods, weaning foods and edible films.

The study by Chisenga et al. (2019) assessed the proximate composition of Cassava flours from six cassava varieties (Katobamputa, Chila, Kariba, Kampolombo Mweru, and Bangweulu) for dry matter, cyanides, particle size distribution, whiteness index, starch yields and proximate contents. They saw that the lipid, moisture, ash, fibre and protein contents were in the range 1.21–1.87, 10.43–11.18, 1.21–1.78 0.15–0.63, and 0.03–0.60% for, Katobamputa, Bangweulu, Kariba, Mweru, Kampolombo and Chila respectively. On the average, the study found that particle size distribution was (35.56–48.52 µm) and (250.44–334.34 µm) however, there was variations across varieties. The packed and bulk density ranged from 0.62–0.67 and 0.40–0.47 g/cm^3 respectively. The study found a positive correlation between bulk density and moisture content of cassava flour. The study further found variation in cassava root dry matter contents across the varieties in the range 40.04–47.25% and correlated negatively with ash content and lipid. However, a positive correlation was found between cassava root dry matter content and fibre. The study revealed that starch produced across the cassava varieties were between 20.76 and 28.31%. It was further found that cassava cyanide contents across the varieties were between 23.60–238.12 and 8.62–15.48 mg HCN/kg for flours and roots respectively. Between 60.76–93.86% reduction in cyanide was recorded. Yellowness was in the range 6.52–8.15 with greenness in the range −0.03 to 0.44 and the degrees of lightness was between 93.65 and 94.55. The whiteness index of flours was in the range 89.90 to 91.46. The study further found that fibre content correlated negatively with Whiteness index. Results from the study indicate that variations in fibre, flour particle size and ash content resulted in differences in the quality traits among the cassava varieties.

Product Development and Consumer Acceptability

Sirangelo (2019) opines that sensory descriptive analysis of food products is an effective tool to understand consumer satisfaction and ensure market success of food products. Sirangelo (2019) further opines that when the appearance, flavour or texture of a particular food product is not in favour of consumers, they won't purchase it. It can therefore be said that success of food products or its acceptability on the food market is dependent on how appealing it is to the senses of the consumer.

Lysak et al. (2019) assessed consumer acceptance and willingness to pay for novel value-added products made from breadfruit in the Hawaiian Islands. Specifically, the study investigated consumer acceptance and willingness to pay for breadfruit when they are provided with or without comprehensive product information about the product and its cultural relevance, nutritional benefits and potential contribution to increase local food security. The study revealed providing consumers with information about product increased their acceptance by 1 point on the hedonic scale. In addition, there was an increase in respondents' willingness to pay for when detailed information is provided. The study concluded that repeated exposure and building a positive narrative around breadfruit products may increase consumer acceptability.

The study by Siddiqui et al. (2022) reviewed 133 research articles on the strategies to avoid food neophobia (rejection) and increase consumer acceptance of new food trends. The study revealed that tasting of foods is one of the most effective ways to increase the acceptance of new foods. The study also found that food neophobia can be reduced through education, income, taste and exposure to novel foods. Food innovation, the manufacturer's features and market circumstances were also found to exert influence on consumers' preference and acceptability of new food products.

The study by Bothma et al. (2020) examined the development and consumer acceptability of soup made from *Clarias gariepinus*. The study employed sensory analysis and a consumer panel in evaluating the aroma, taste, texture and aftertaste of *Clarias gariepinus* soup. The study revealed that the taste, texture and aroma of food product to a greater extent influence the level at which consumers develop preference for the product. The study also revealed that the income of consumers also plays a role in how they accept food products. The study further revealed that the nutritional composition of food influences its acceptability. Specifically, the study found that the moderate fat, carbohydrate and energy content, and low dietary fibre, made *Clarias* gariepinus soup suitable for the needs of low-income groups in rural communities.

Chapter Summary

This chapter presented the review of relevant literature on the topic under investigation. The chapter was divided into three sections: theoretical framework, conceptual review and the empirical review. The theoretical framework revolved around the Theory of Planned Behaviour proposed by Ajzen (1985). The theory suggests that consumers' acceptance or rejection of Somillyake is highly and positively dependent on their behavioural beliefs of the outcome of the consumption of Somillyake. Such beliefs include consumers' expectations of the health outcomes, as well as the visual appeal of the product. The conceptual review presented a review of concept related to the study. The section presented a discussion on concept such as the concept of soya beans, cassava as a root tuber, the concept of millet, the concept of sensory evaluation, among other concepts. The empirical review presented an outlook of various studies done in relation to this study. The section specifically focused on the proximate composition of soya beans, cassava and millet respectively.

CHAPTER THREE

RESEARCH METHODOLOGY

The study sought to examine consumers' acceptability of fortified soya-millet-yakeyake ("Somillyake") and its nutritional composition. This chapter presents the research methods that were employed to carry out the study. Basically, the chapter encompasses the research design, study area, population, sampling procedure, panel members, methods and materials, data collection instruments, data collection procedures, ethical consideration, as well as data processing and analysis. Sensory evaluation of the new product was carried out under this chapter. To undertake the sensory evaluation, questionnaires were administered to 75 research respondents who were willing to voluntarily participate in the study after church. Respondents were required to spend 30-40 minutes in evaluating the sensory properties of four food samples and indicate the most preferred. Respondents were required to evaluate attributes such as the colour, the texture, aroma/flavour, taste, aftertaste as well as the overall acceptability of each of the four food samples

Research Design

Research design is the overall plan of a researcher to obtain responses to research questions or to test hypotheses of a particular study (Amedahe & Asamoah-Gyimah, 2015). In line with this study's aim of examining the proximate composition of somillyake (i.e., a combined mixture of soya bean flour, millet flour and grated cassava) and consumers' acceptability, the pre-experimental design, specifically the static-group comparison design as well as the cross-sectional survey design were used for this study.

The static-group comparison involves at least two groups. One group often receives a new unusual treatment while the other group receives a traditional or usual treatment. Both groups are then posted. In this study, static group comprised the commercially-made yakeyake whereas the treatment group comprised the somillyake (i.e., a combined mixture of soya bean flour, millet flour and grated cassava). The nutritional components of both the commercial yakeyake (i.e., the control group) and the "somillyake" (i.e., the treatment group) were then tested in the food laboratory. After testing the nutritional component of the food samples in the laboratory, the results were compared to determine which of the food samples had a better nutrient profile.

Similarly, the descriptive survey design was used for this study. This is a type of design where researchers are often interested in the opinions of a large group of people about a particular topic or issue (Fraenkel et al., 2012). This design was appropriate for this study since this study sought to gather information from panel members and describe it as it is, without any form of manipulation. In addition, since the sensory evaluation questionnaire form was used to gather data on respondents' acceptability of the different food samples, the descriptive survey design was used to describe the views of respondents regarding the degree of acceptability of the food samples. The study was cross-sectional in nature.

Study Area

Duakor, a migrant community in the Cape Coast Metropolis was selected as the study area. It is located on Ghana's southern coast, between the historic towns of Cape Coast and Elmina. The residents of Duakor are mostly descendants of migrants from the Volta region. Fishing forms the core of Duakor's economy, with most of the men involved in fishing-related jobs. The women on the other hand are into cassava processing and fish-mongering. Duakor was selected for the study because almost all the individuals within the community consume "yakeyake" as their traditional diet. Individuals who were 18 years and above were included in the study.

Population

Duakor has a population of 1,351 (GSS, 2021) and qualifies as a village based on the population and level of infrastructural development. Community members also exhibit what the renowned sociologist, Emile Durkheim calls mechanical solidarity, in that, they engage in similar economic activities and general lifestyle (Ritzer, 2008). The study population comprised all yakeyake consumers who were 18 years and above within the Duakor community.

Sampling Procedures

Seventy-five (75) panel members were selected for the sensory evaluation test. This sample was chosen based on the assertion of Choi (2013), since the preference test (a type of affective test) was adopted for this study. To get the individual respondents, the purposive sampling technique was used to engage the respondents in the study. Lewis-Beck et al. (2003) explained purposive sampling (also known as judgment, selective or subjective sampling) as a non-probability sampling technique in which researcher relies on his or her own judgment when choosing members of the population to participate in the study.

Choi (2013) proposed that, to test a new product, 75-150 individuals should be used. In view of that, seventy-five (75) panellists were used for the sensory evaluation because the study was conducted in a community that had a small population. Similarly, these panellists were used for the study because they were willing and available during the time of the sensory test and also, they comprised people who ate both the commercially-made yakeyake and the somillyake (i.e., a combined mixture of soya bean flour, millet flour, and grated cassava). Since the panellists were not trained, they were oriented on the sensory evaluation test to be done. Prior to the selection of these panel members, they were asked if they were allergic to any of the ingredients used in preparing the test foods. Also, anyone with respiratory infections like a cold was not included in the study. Respondents who may not be aware of whether they are allergic to any of the ingredients used in the preparation of the test foods were also exempted from the study.

Inclusion and Exclusion Criteria

Respondents who were used for the sensory evaluation had to meet the following criteria:(1) respondents were between 18-50 years, (2) they were not expected to be on any medication of any kind and should be available throughout the duration of the study, (3) they should not be allergic to be yakeyake, soya bean, and millet.

Recruitment and Training of Field Assistants

Three field assistants were recruited and trained to assist in the data collection. The purpose of the study was well explained to all the field assistants. Field assistants were trained to explain the purpose of the study to all respondents. Similarly, in order to avoid the issue of language barrier for respondents who may not be able to read and write in English, field assistants were trained to translate the content of the questionnaire to the respondents in order to enhance comprehension.

Data Collection Procedures

The commercially-made yakeyake was purchased from a well-known yakeyake seller within the Duakor community. The various proportions or ratios of the fortified somillyake (i.e., a combined mixture of soya bean flour, millet flour, and grated cassava) on the other hand were locally prepared by the researcher by adapting an approved method proposed by Yusuf et al. (2014). In terms of the proximate composition, three different samples were prepared by the researcher. The proportion of the mixtures were as follows: CSMY 1- Cassava-Soya-Millet-Yakeyake in the ratio 50:30:20, CSMY 2- Cassava-Soya-Millet-Yakeyake in the ratio 60:30:10 and CSMY 3- Cassava-Soya-Millet-Yakeyake in the ratio 80:15:5.

In furtherance, since cassava, millet, and soya bean were the chief ingredients required for the preparation of the "somillyake", the researcher purchased the cassava from the Jukwa local market in the Cape Coast Metropolis. Similarly, the soya bean and millet were purchased from market women in a local market in the Cape Coast Metropolis called Kotokuraba Market. Both the commercially-made yakeyake and the "somillyake" were served with pepper sauce and fried fish with some chopped vegetables. It is also important to emphasise that in terms of the specific species/varieties of the chief ingredients used in preparation of the "somillyake", *Manihot esculenta* (i.e., sixmonth casava) was purchased for the conduct of the study. Similarly, *Eleusine coracana* (i.e., red millet) which is commonly known as finger millet was used in the preparation of the "somillyake". This variety of millet which is often known for its reddish grains, is widely cultivated in Africa and Asia and is valued for its high nutritional content and drought tolerance. In terms of soya beans which happens to be the last chief ingredient, TGX 1448-2E (i.e., a variety of soyabeans that is generally high in protein, with good adaptability to local soil and climate conditions) was used in the preparation of the "somillyake". Additionally, an introductory letter (See Appendix A) was taken from the Department of Vocational and Technical Education of the University of Cape Coast for entry into the community. Necessary ethical clearance was obtained from the University of Cape Coast (UCC) Institutional Review Board (IRB).

Data Collection Instrument

Proximate analysis, functional property analysis, and sensory analyses of the four food samples were carried out. A self-developed and validated questionnaire was then administered to the sensory panel to gather relevant information on the sensory properties of the four food samples. The researcher adopted the paired difference testing classical technique proposed by Lawless and Heymann (2013). This was because, the goal of the researcher was to determine whether the four different food samples possess different sensory properties. Another reason for the adoption of this technique was the fact that, it helped the researcher to ascertain which sample or samples are similar, as well as which sample was most preferred by the respondents.

The sensory evaluation questionnaire consisted of two sections (Sections A and Section B) with 30 items. The first section of the questionnaire (Section A) solicited information on the demographic characteristics of the respondents. These demographic characteristics include gender as well as the age-range of respondents. The second section (Section B) was made up of 28 items on a 4-point Likert-type scale [i.e. Dislike very much (1), Dislike moderately (2), Liked moderately (3) and Liked very much (4)] which solicited information on respondents' assessment of four different food samples, thus a commercially-made yakeyake as well as three different samples of fortified soya-millet-yakeyake (i.e., modified yakeyake) to determine if significant differences exist among the food samples. In view of that, respondents were asked to tick [√] a range of attributes (i.e., Appearance, Colour, Texture, Aroma/Flavour, Taste, Aftertaste, and overall acceptability) to determine their assessment and degree of acceptability of the four food samples using the Likert-type scale provided.

Administration of Instrument

A date and time were scheduled with the respondents for the data collection. The instrument was administered to 75 research respondents from the Global Evangelical church who were willing to voluntarily participate in the study after church. Respondents were required to spend 30-40 minutes in evaluating the sensory properties of four food samples and also indicate the most preferred. Respondents were required to evaluate attributes such as the colour, the texture, aroma/flavour, taste, aftertaste as well as the overall acceptability of each of the four food samples.

Proximate Analysis

An amount (50 g) of each sample was taken proximate nutrients were analysed. The following nutrients were determined.

Moisture Determination

Porcelain crucibles were washed dried and weighed. About 10-12g of the fresh raw flour samples were put into clean oven-dried crucibles and weighed. The crucibles containing the sample were spread over the base of the convection oven to ensure equal distribution of heat. The convection oven was manufactured by the Thermo Fisher Scientific Company. This company is known for manufacturing quality laboratory convection ovens with precise temperature control, commonly used in analytical and industrial laboratories. The samples were then kept in a thermostatically controlled oven at 105˚C for 48 h. At the end of the period the samples were removed, cooled in a desiccator and weighed. Each determination was done thrice. The moisture content was then calculated as the percentage water loss by the sample (Doe-Addo et al., 2024). The equation used in calculating the percent moisture is given by:

$$\text{Moisture (\%)} = \frac{Initial\ weight - Final\ weight}{Initial\ weight} \times 100$$

Steps

Initial Weight: The food sample was weighed before drying (This includes the moisture content)

Final weight: The food sample was weighed again after drying (This represents the weight of the dry matter alone)

Ash Determination

The dried raw flour samples were then heated gently in oven at 105°C for about an hour and then transferred to furnace at a temperature of 550°C overnight, the heating continued until all the carbon particles were burnt away. The ash in the dish was removed from a muffle furnace which was manufactured by Nabertherm, a well-known German company. The sample was then allowed to cool in a dessicator and weighed. The ash content was then calculated as a percentage of the original sample (Doe-Addo, et al. 2024). The equation used in calculating the percent ash is given by:

$$\text{Ash (\%)} = \frac{Weight\ of\ Ash}{Initial\ weight\ of\ sample}\ x\ 100$$

Steps

Initial Weight of Sample: The initial food sample was weighed before ashing

Weight of Ash: After burning off all the organic material (in a muffle furnace at high temperature), the remaining inorganic residue (the ash) was weighed.

Oil/ Fat Determination

Reagents

1: Petroleum Spirit

Procedure

About 10- 12g of the milled raw flour samples were weighed into a 50 ×10mm soxhlet extraction thimble. This was transferred to a 50 mL capacity soxhlet extractor. A clean dry 250 mL round bottom flask was weighed. About 150 mL Petroleum spirit was added and connected to the soxhlet extractor and extraction was done for 6 hours using a heating mantle as a source of heating.

After the 6 hours the flask was removed and placed in an oven at $60^{o}{}_{C}$ for 2 hours. The round bottom flask was removed, cooled in a desiccator and weighed (Doe-Addo et al., 2024). The percentage fat/oil was calculated as followed.

Calculation

$$\text{Crude Fat (\%)} = \frac{\text{W (g)} \times 100}{\text{Sample (g)}}$$

Where W is Weight of Oil

Carbohydrate Determination

Reagent

1: **Glucose Solution**

Stock solution: (1 mL is equivalent to 0.25 mg glucose), 0.250g D-glucose (dried in a vacuum oven at 70 ^{0}C over P_2O_5) was dissolved in water and diluted to 1L. Working standards: a range from 0 – 20 mL stock solution was pipetted into 50 mL flasks such that 2 mL of each standard gives a range from 0- 0.20 mg glucose and diluted to volume.

2: **Anthrone Reagent**

Seven hundred and sixty millilitres (760 mL) concentration of H_2SO_4 was carefully added to 330ml water in a boiling flask and kept cool while mixing. One-gram (1 g) anthrone and 1 g of thiourea were added and dissolved using a magnetic stirrer. The mixture was transferred into a dark bottle and left for 2 h before use.

Procedure Extraction

Fifty milligram (50 mg) of the milled raw flour samples was weighed into a 50ml conical flask, 30 mL of distilled water was added and a glass bubble placed in the neck to simmer gently on a hot plate for 2 h. It was topped up to

30 mL periodically and allowed to cool slightly, and then filtered through a No.44 Whatman paper into a 50 mL volumetric flask and dilute to volume when cool. The extract was prepared shortly before colour development. A blank was prepared by taking it through the same procedure.

Colour Development

Two millilitres (2 mL) of each standard was pipetted into a set of boiling tubes and 2 mL of the extract and water blank was also pipetted into boiling tubes. Standards and samples were treated the same way. Ten millilitres (10 mL) of anthrone solution were added rapidly to mix and the tubes immersed in running tap water. The tubes were placed in a beaker of boiling water in a dark fume cupboard and boiled for 10 min.

The tubes were then placed in cold water and allowed to cool in the dark. The optical density was measured at 625 nm or with a red filter using water as a reference. A calibration graph was prepared from the standards and used to obtain mg glucose in the sample aliquot. The blank determination was treated same way and subtraction done where necessary.

$$\text{Soluble carbohydrates (\%)} = \frac{\text{C (mg)} \times \text{extract volume (ml)}}{10 \times \text{aliquot (ml)} \times \text{sample wt (g)}}$$

Where C = carbohydrate concentration from the calibration graph

Protein Determination

Protein present in food was calculated from nitrogen concentration of the food. The Kjeldahl was used in the determination of protein. The method is divided into three steps: digestion, neutralization or distillation and titration (Doe-Addo et al., 2024).

Digestion

About 0.2 g of the raw flour sample was weighed using a 100 ml Kjeldahl flask. Four point four millilitres (4.4 mL) of the digestion reagent was added and the samples digested at 360^{o}C for two hours. A blank was prepared (digestion of the digestion mixture without sample) were carried out in the same way. After the digestion, the digests were transferred quantitatively into 50 mL volumetric flasks and made up to the volume.

Distillation

A steam distillation apparatus was set up. The distillation apparatus was flushed with distilled water for about twenty (20) minutes. After flushing out the apparatus, five (5) millilitres of boric acid indicator solution was poured into a 100 ml conical flask was placed under the condenser of the distillation apparatus with the tip of the condenser completely immersed in the boric acid solution. An aliquot of the sample digest was transferred to the reaction chamber through the trap funnel. Ten millilitres (10 mL) of alkali mixture (i.e., 40% concentrated sodium hydroxide [NaOH]) was added to commence distillation immediately and about 50 mL of the distillate was collected.

Titration

The distillate was titrated with 0.1N HCl solution until the solution changed from green to the initial colour of the indicator (wine red). Digestion blanks were treated the same way and subtracted from the sample titre value. The titre values obtained were used to calculate the nitrogen and hence the protein content. The conversion factor used was 6.25.

$$\%\text{Total Nitrogen } (\%N) = \frac{(\text{Sample titre value} - \text{Blank titre value}) \text{ X } 0.1 \text{ x} 0.01401 \text{ x } 100}{sample\ weight\ X\ 10}$$

% Protein = %N x 6.25

Crude Fibre Determination

Reagents

1: Sodium hydroxide, 1.25%

Dissolve 12.5 g NaOH in 700 mL distilled water in a 1000 mL volumetric flask and dilute to volume.

2: Sulphuric Acid, 1.25%

Add 12.5 mL concentration of sulphuric acid to a 1000 mL volumetric flask containing 400 mL distilled water and dilute to volume.

Procedure

About 1 g of the raw flour sample was weighed and placed in a boiling flask, 100 mL of the 1.25% sulphuric acid solution was added and boiled for 30min. After the boiling, filtration was done in a numbered sintered glass crucible. The residue was transferred back into the boiling flask and 100 mL of the 1.25% NaOH solution was added and boiled for 30 mins. Filtration continued after the boiling and the residue washed with boiling water and methanol. The crucible was dried in an oven at 105 degrees Celsius overnight and weighed. The crucible was placed in a furnace at 500 degrees Celsius for about 4 h. The crucible was slowly cooled to room temperature in a desiccator and weighed (Doe-Addo et al., 2024).

Calculation

$$\%\text{ Crude fibre} = \frac{\text{weight loss thro ashing}}{\text{Sample weight}} \times 100$$

Functional Properties

1. ***Hydration Capacity (HC)***

One-gram of the prepared food samples (i.e., commercially-made yakeyake and the three different products of the "somilyake") were placed in 50 mL centrifuge tubes. Ten millilitres (10 mL) of distilled water was added to the tube and the samples and shaken using orbital shaker (250 rpm for 15 min). The tubes were then centrifuged for 15 min at 10,000 rpm to collect the supernatant very carefully by decanting and the tubes were weighed further (Awuchi et al., 2019).

$$\text{Hydration Capacity} = \frac{weight\ of\ tube\ and\ food\ sample\ (g) - weight\ of\ tube\ (g)}{weight\ of\ food\ sample\ (g)}$$

2. ***Swelling Capacity (SC)***

The swelling capacity described by Awuchi et al. (2019) were followed as the method for determining swelling capacity in this study. One gram of the prepared food sample was dispensed into calibrated 50 ml measuring cylinder. Ten millilitres (10 mL) of distilled water was added to the samples and the volume noted. The cylinder was left to stand undisturbed for about 1 hour. Volume occupied by the sample was recorded and the swelling capacity was calculated as follows:

$$Swelling\ capacity = \frac{volume\ occupied\ by\ sample\ after\ swelling}{initial\ volume\ occupied\ by\ sample}$$

3. Bulk Density

In terms of bulk density, the method proposed by Awuchi et al. (2019) were followed in determining the bulk density in this study. Ten grams of the prepared food samples were taken in 100 mL measuring cylinder. The cylinder was tapped until no visible decrease in volume was noticed. Bulk density (g/cm^3) was calculated as follows:

$$Bulk\ density = \frac{weight\ of\ sample}{volume\ occupied\ by\ sample}$$

4. Emulsion Activity

The emulsion activity and stability described by Yasumatsu et al. (1972) were followed as method for the emulsion in this study. One gram (1 g) sample, 10 mL distilled water and 10 mL soya bean oil was prepared in calibrated centrifuge tube. The emulsion was centrifuged at 2000 rpm for 5 min. The ratio of the height of emulsion layer to the total height of the mixture was calculated as emulsion activity in percentage.

Ethical Considerations

Ethical clearance (See Appendix B) was taken from the Institutional Review Board (IRB) in the University of Cape Coast through the administrator in the Vocational and Technical Education Department to seek permission to the various institutions or laboratories where the studies was conducted. The conduct of the study adhered strictly to ethical issues regulating the conduct of any research. Confidentiality, anonymity, and privacy were religiously adhered to. Consent of respondents were also sought before the commencement of the data collection process.

That is to say, all respondents who were willing to participate in the study were assured of confidentiality and anonymity. Respondents were identified using codes in order to ensure anonymity and confidentiality. Names of respondents were not written, rather, unique numbers were assigned to each participant.

Data Processing and Analysis

The sensory evaluation questionnaires were scrutinised systematically to ensure their completeness. Respondents who did not respond to more than 10% of the items on the questionnaire were eliminated (Martin & Bridgmon, 2012). The questionnaires were then numbered from one to the last number. The data was screened for entry errors and outliers. All statistical analyses were performed using Statistical Package for Service Solution (SPSS) software version 25.00. Statistical significance was set at $p \leq 0.05$. The subsequent paragraphs provide details on the statistical tools used in conducting the analysis based on the respective research questions and hypotheses.

Research Question 1

Calculations from the nutrient analysis were done using standard equations. Thus, for each chemical and microbiological food test, three readings were obtained, and the averages were calculated. Data on research questions 1a, 1b and 1c were answered using descriptive statistics such as means and standard deviations as well as frequency percentages. The data analyses and interpretation were done by comparing the percentages, means, and standard deviations of the chemical compositions of various food samples.

Hypothesis 1

One-way Analysis of variance (ANOVA) was used to test this hypothesis in order to ascertain whether significant differences existed in the proximate composition between commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake. Before the analysis, assumptions underlying the use of One-way ANOVA were checked. First, the normality assumption test was carried out and thus, Shapiro-Wilk test was performed to test the normality of the data. All assumptions underlying the usage of this statistical procedure (such as normality assumption and homogeneity assumption) were duly tested and met. This gave the green light for the researcher to this analysis.

Hypothesis 2

Data on hypothesis 2 was also tested using One-way Analysis of variance (ANOVA). This was done to ascertain whether significant differences existed in the functional properties of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake. All assumptions underlying the usage of this statistical procedure (such as normality assumption and homogeneity assumption) were duly tested and met. This gave the green light for the researcher to this analysis.

Hypothesis 3

The data gathered on this hypothesis was tested using one-way repeated measures ANOVA. With this analytical procedure, each participant was exposed to two or more different conditions. In the case of this study, each participant during the sensory evaluation was exposed to four different conditions, that was, the commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (CYM 1, CYM 2, CYM3 and CYM 4). This warranted the usage of the one-way repeated measures ANOVA as an analytical tool that tested this hypothesis. Prior to the conduct of this analysis, the Mauchly's test of sphericity was checked in order to assess the statistical assumption of sphericity.

CHAPTER FOUR

RESULTS AND DISCUSSION

The study sought to examine consumers' acceptability of fortified soya-millet-yakeyake ("Somillyake") and its nutritional composition. The pre-experimental design, specifically the static-group comparison design as well as the cross-sectional survey design were employed in the study. A sensory evaluation questionnaire form as well as apparatuses such as beakers and desiccators were respectively used in collecting data for the sensory evaluation and the proximate analysis. Out of the 75 questionnaires administered to respondents, 65 were retrieved providing a response rate of 87%.

Demographic Characteristics of Respondents

Demographic distribution of respondents such as gender and age were presented.

Table 1- *Demographic Characteristics of Respondents* (n = 65)

Variables	Frequency	Percentage (%)
Gender		
Male	29	44.6
Female	36	55.4
Age-range		
18-23 years	19	29.2
24-29 years	25	38.5
30-35 years	9	13.8
36-41 years	6	9.2
Above 41 years	6	9.2

Source: Donkor (2023)

Table 1 shows that out of the 65 respondents, 36 were females (55.4%) while 29 (44.6%) were males. Majority of the respondents (25) (38.5%) were within the age bracket of 24-29 years, 19 (29.2%) were within age bracket of 18-23 years, 9 (13.8%) were within the ages of 30-35 years. Nine-point two percent (9.2%) of the respondents (6 people) were within the ages of 36-41 years. Those above 41 years also formed 9.2% of the respondents.

Research Question 1a

What is the proximate composition of soya bean flour, red millet flour, and grated cassava flour?

This research question was interested in finding out the proximate composition of soya bean flour, red millet flour, and grated cassava flour. The proximate composition (moisture, protein, fat, ash, carbohydrate (CHO), dry matter and fibre) were determined. Means and standard deviations were used to analyse the raw data received from the laboratory based on the respective food samples. Details of the results are presented in Table 2.

Table 2- *Proximate Composition of Soya Bean Flour, Red Millet Flour, and Grated Cassava Flour*

Food Samples	Dry Matter %	Moisture %	Ash %	Protein %	Fat %	Fibre %	CHO %
Commercial Cassava	51.20±0.02	48.80±0.02	1.97±0.03	2.81±0.06	0.31±0.01	2.75±0.13	92.16±0.12
Researcher's Cassava	54.09±0.04	45.91±0.04	1.79±0.07	3.30±0.13	0.35±0.03	2.78±0.11	91.78±0.09
Soya Flour	95.60±0.09	4.40±0.09	6.66±0.08	39.52±0.06	9.59±0.15	4.75±0.18	39.48±0.08
Millet Flour	93.19±0.16	6.81±0.16	1.45±0.08	10.69±0.43	3.15±0.06	2.91±0.01	81.80±0.36

Source: Donkor (2023)

-Data is represented as mean ± standard deviation

-Values are averages of triplicate determinations

The result as presented in Table 2 shows some variations in the proximate/nutritional composition of soya bean flour, red millet flour, and grated cassava flour (i.e. both commercial grated cassava and researcher's grated cassava). The results showed that soya bean flour had the highest value of dry matter (95.6%) compared with the other food samples. Similarly, in terms of moisture, grated commercial cassava recorded the highest value for moisture (48.8%) compared with the other food samples. In terms of ash content and protein content as nutritional compositions, the results in Table 2 show that soya bean flour recorded the highest values for ash content (6.66%) and protein content (39.52%) compared with the other food samples. Similarly, Table 2 revealed that soya bean flour recorded the highest values for fat (9.59%) and fibre content (4.75%) relative to other food samples such as grated cassava and red millet flour. In terms of carbohydrate, commercial cassava recorded the highest value (92.16%) compared to the other food samples in Table 2.

Soya bean flour had a high proximate/nutritional composition in terms of dry matter, ash, protein, fat, and fibre content compared with other food samples such as red millet flour and grated cassava flour. This study suggests that soya bean flour has high amount of minerals, fatty acids, amino acids, as well as cellulose and vitamins required for nourishment of the body compared to grated cassava which is mainly starchy that provides the body with glucose. Grated commercial cassava had the highest carbohydrate and moisture content probably because it is able to retain a lot of water relative to soya bean flour and red millet flour. Grated cassava has a higher starchy content and comparatively a higher water holding capacity compared with soya bean flour and red millet flour.

Research Question 1b

What is the proximate composition of commercially-made yakeyake?

Proximate composition (such as moisture, protein, fat, ash, carbohydrate (CHO), dry matter and fibre) were determined for the commercially-made yakeyake. Means and standard deviations were used to analyse the data collected from the laboratory. Details of the results are presented in Table 3.

Table 3- *Proximate Composition of Commercially-Made Yakeyake*

Food Sample	Dry Matter %	Moisture %	Ash %	Protein %	Fat %	Fibre %	CHO %
Commercially-Made yakeyake (Control)	45.54±0.34	54.46±0.34	2.61±0.24	11.99±.014	15.38±0.11	4.61±0.19	65.41±0.28

Source: Donkor (2023)

-Data is represented as mean ± standard deviation

-Values are averages of triplicate determinations

Table 3 presents the proximate composition of commercially-made yakeyake. Carbohydrate (65.4%), moisture (54.5%), dry matter (45.5%), fat (15.4%), protein (12.0%), fibre (4.61%) and ash content (2.61%) were obtained. This suggests that the commercially-made yakeyake had high starch content and less ash content. With the commercially-made yakeyake recording a high value for carbohydrate, individuals who consume it are likely to provide their bodies with glucose which is often converted into energy to support body functions and physical activities.

Commercially-made yakeyake had high nutritional compositions in terms of carbohydrate, moisture, dry matter, fat, protein and fibre which was not surprising since commercially-made yakeyake is often prepared using grated cassava which contains a lot of starch. On the contrary, this finding suggests that commercially-made yakeyake may contain less amount of mineral elements required for body growth since the food sample recorded a low ash content. Although consumers of commercially-made yakeyake are likely to obtain enough energy, they also have a higher likelihood of not obtaining certain vital mineral elements required for proper body functioning.

Research Question 1c

What is the proximate composition of somillyake?

Samples of "somillyake" in three different ratios (i.e., 50:30:20, 60: 30:10, and 80:15:5) were analysed for moisture, protein, fat, ash, carbohydrate (CHO), dry matter and fibre. Means and standard deviations were used to analyse the data collected from the laboratory. Details of the results are presented in Table 4.

Table 4-*Proximate Composition of Soya-millet-yakeyake (somilyake)*

Food Samples	Dry Matter %	Moisture %	Ash %	Protein %	Fat %	Fibre %	CHO %
CSMY 1	46.39±0.42	53.61±0.42	3.24±0.15	23.21±0.28	18.53±0.09	8.28±.015	46.74±0.43
CSMY 2	46.30±0.16	53.70±0.16	3.44±0.06	25.13±0.18	19.17±0.14	8.21±0.05	44.04±0.15
CSMY 3	50.35±0.56	49.65±0.56	2.94±0.10	16.42±0.42	17.51±0.28	5.03±0.06	58.10±0.50

Source: Donkor (2023)

-Data is represented as mean ± standard deviation

-Values are averages of triplicate determinations

- CSMY 1 Cassava-Soya-Millet-Yakeyake in the ratio 50:30:20
- CSMY 2- Cassava-Soya-Millet-Yakeyake in the ratio 60:30:10
- CSMY 3- Cassava-Soya-Millet-Yakeyake in the ratio 80:15:5

The results in Table 4 presents the proximate/nutritional composition of three different samples of fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2, and CSMY 3) in three different ratios (i.e., 50:30:20, 60: 30:10, and 80:15:5). A thorough inspection of the results in Table 4 shows that CSMY 3 had the highest value of dry matter (50.3%) compared with that of CSMY 1 (46.39) and CSMY 2 (46.30). In terms of moisture as nutritional component, the results in Table 4 shows that CSMY 2 recorded the highest value of moisture (53.7%) relative to CSMY 1 (53.6%) and CSMY 3 (49.7%). A thorough inspection of the results in Table 2 further revealed that, in terms of nutritional composition for the three different samples of fortified soya-millet-yakeyake, CSMY 2 recorded the highest values for ash content (3.4%), protein content (25.13%), and fat content (19.17%) compared with the other food samples (i.e., CSMY 1 and CSMY 3). The results further revealed that in terms of fibre as a nutritional component, CSMY 1 recorded the highest value of fibre (8.28%) compared to the other of samples of fortified soya-millet-yakeyake. Finally, the results in Table 4 shows that in terms of CHO as a nutritional component, CSMY 3 recorded the highest value of carbohydrate (58.1%) compared with CSMY 1 (46.74%) and CSMY 2 (44.04%) respectively.

The findings of the study revealed that CSMY 3 recorded the highest value of dry matter and carbohydrate compared with CSMY 1 and CSMY 2. The findings of this study further discovered that CSMY 2 recorded the highest value of moisture, ash content, protein content and fat content relative to the other food samples (i.e., CSMY 1 and CSMY 3). The findings of the study finally discovered that CSMY 1 recorded the highest value of fibre (8.28%)

compared to the other of samples of fortified soya-millet-yakeyake. Findings suggest that proximate/nutritional composition of somillyake, CSMY 2 and CSMY 1 were more likely to provide the body with more essential nutrients (i.e., ash content, protein, fat, moisture, and fibre) required for body growth and nourishment compared to CSMY 3 which recorded the highest values for fewer nutrients such as CHO and dry matter.

Hypotheses Testing

Three (3) hypotheses were also tested. Details on each of these hypotheses are presented in the subsequent paragraphs.

Hypothesis 1

H_0: There is no statistically significant difference in the proximate composition of commercially-made yakeyake and somillyake in a ratio of 50:30:20, 60: 30:10, and 80:15:5.

This hypothesis sought to determine whether significant differences exist in proximate composition of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., somillyake). In order to achieve this objective, samples of the commercially-made yakeyake as well as the three different products of the fortified yakeyake were analysed chemically in the laboratory. Proximate composition (such as moisture, protein, fat, ash, carbohydrate (CHO), dry matter and fibre) were determined for all the samples. One-way Analysis of variance (ANOVA) was used to test this hypothesis in order to ascertain whether significant differences existed in the proximate composition of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake. In this case the commercially-made yakeyake served as the control variable whiles the different products of the fortified soya-millet-yakeyake served as the independent variables.

Before the analysis, assumptions underlying the use of One-way ANOVA were checked. First, the normality assumption test was carried out and thus, Shapiro-Wilk test was performed to test the normality of the data. Details of the results are presented in Table 5.

Table 5- *Test of Normality*

Proximate Composition	Food Samples	Shapiro-Wilk Statistic	df	Sig.
DM	CSMY 1	.803	3	.121
	CSMY 2	.831	3	.192
	CSMY 3	.801	3	.117
	Control	.821	3	.165
Moisture	CSMY 1	.803	3	.121
	CSMY 2	.831	3	.192
	CSMY 3	.801	3	.117
	Control	.821	3	.165
Ash	CSMY 1	.960	3	.615
	CSMY 2	.978	3	.717
	CSMY 3	.984	3	.761
	Control	.904	3	.397
Protein	CSMY 1	.790	3	.090
	CSMY 2	.815	3	.151
	CSMY 3	.914	3	.433
	Control	.979	3	.725
Oil/Fat	CSMY 1	.969	3	.665
	CSMY 2	.918	3	.444
	CSMY 3	.967	3	.652
	Control	1.000	3	.960
Fibre	CSMY 1	.961	3	.619
	CSMY 2	.989	3	.798
	CSMY 3	.858	3	.263
	Control	.988	3	.787
CHO	CSMY 1	1.000	3	.997
	CSMY 2	.830	3	.188
	CSMY 3	.801	3	.117
	Control	.975	3	.695

*Significant at .05 level; Source: Donkor (2023)

An inspection of the results in Table 5 shows that the normality assumption was not violated since the p-values of the "food samples" captured under the respective "proximate compositions" were greater than .05 (i.e., p >.05) and consequently not significant. Similarly, a visual inspection of the Q-Q plot for the aforementioned "food samples" captured under the respective "proximate composition" provides enough evidence to suggest that the normality assumption was duly satisfied (see Appendix D). There was the need to conduct a test for homogeneity of variance to ensure the variances were the same across all the "food samples" captured under the respective "proximate compositions Details of the results are presented in Table 6.

Table 6- *Test of Homogeneity of Variance*

Parameters	Levene Statistic	df1	df2	Sig.
Dry matter	2.688	3	8	.117
Moisture	2.688	3	8	.117
Ash	2.325	3	8	.151
Protein	2.449	3	8	.138
Oil_Fat	1.843	3	8	.218
Fibre	1.913	3	8	.206
CHO	1.486	3	8	.290

*Significant at .05 level; Source: Donkor (2023)

Table 6 clearly shows that the homogeneity of variance assumption was not violated since the p-values of each of the nutrient parameters were greater than .05 (i.e., p >.05) and consequently not significant. This implies that the variances were the same (equal variance assumed). Following meeting the normality and homogeneity of variance assumptions of ANOVA, the actual test was conducted to determine the differences that existed in proximate composition of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake. Table 7 presents the results of the ANOVA test.

Table 7- *ANOVA Test*

Nutrient Parameters		Sum of Squares	df	Mean Square	F	Sig.
Dry Matter	Between Groups	42.347	3	14.116	89.524	.000
	Within Groups	1.261	8	.158		
	Total	43.608	11			
Moisture	Between Groups	42.347	3	14.116	89.524	.000
	Within Groups	1.261	8	.158		
	Total	43.608	11			
Ash	Between Groups	1.183	3	.394	43.461	.000
	Within Groups	.073	8	.009		
	Total	1.256	11			
Protein	Between Groups	333.012	3	111.004	1468.566	.000
	Within Groups	.605	8	.076		
	Total	333.617	11			
Oil Fat	Between Groups	24.849	3	8.283	282.797	.000
	Within Groups	.234	8	.029		
	Total	25.084	11			
Fibre	Between Groups	35.520	3	11.840	729.534	.000
	Within Groups	.130	8	.016		
	Total	35.650	11			
CHO	Between Groups	894.892	3	298.297	2217.864	.000
	Within Groups	1.076	8	.134		
	Total	895.968	11			

*Significant at .05 level; Source: Donkor (2023)

There was a statistically significant difference in the proximate composition of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake based on the following nutrients: dry matter % [$F(3, 8) = 89.52$, $p < .001$], moisture% [$F(3, 8) = 89.52$, $p < .001$], Ash % [$F(3, 8) = 43.46$, $p < .001$], Protein% [$F(3, 8) = 1468.57$, $p < .001$], Fat % [$F(3, 8) = 282.80$, $p < .001$], Fibre % [$F(3, 8) = 729.53$, $p < .001$], and CHO % [$F(3, 8) = 2217.86$, $p < .001$].

The findings suggest that there were significant differences in the proximate composition (i.e., in terms of dry matter, moisture, ash content, protein, fat, fibre and carbohydrate) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake. To make the results clearer, descriptive statistics of commercially-made yakeyake (control) and the three different products of the fortified soya-millet-yakeyake with their respective proximate compositions are presented in Table 8.

Table 8- *Descriptive Statistics in terms of the Proximate Composition of Commercially-made Yakeyake and the Three Different Products of Fortified/Modified Yakeyake*

Proximate Composition		**Mean**	**Std. Deviation**
Dry Matter %	CSMY 1	46.3857933	.41547919
	CSMY 2	46.3046567	.16380763
	CSMY 3	50.3459000	.56244736
	Control	45.5364967	.33896350
	Total	47.1432117	1.99107569
Moisture %	CSMY 1	53.6142067	.41547919
	CSMY 2	53.6953433	.16380763
	CSMY 3	49.6541000	.56244736
	Control	54.4635033	.33896350
	Total	52.8567883	1.99107569
Ash %	CSMY 1	3.2392400	.14764040
	CSMY 2	3.4421533	.05824422
	CSMY 3	2.9398633	.10264411
	Control	2.6107233	.02401593
	Total	3.0579950	.33789570
Protein %	CSMY 1	23.2091233	.28242012
	CSMY 2	25.1348567	.17758889
	CSMY 3	16.4216433	.41520473
	Control	11.9896200	.13657472
	Total	19.1888108	5.50715657
Fat %	CSMY 1	18.5331200	.09162509

	CSMY 2	19.1721333	.13741465
	CSMY 3	17.5103000	.27811578
	Control	15.3769333	.11195454
	Total	17.6481217	1.51007811
Fibre %	CSMY 1	8.2824467	.14737021
	CSMY 2	8.2075767	.05207679
	CSMY 3	5.0267800	.05669086
	Control	4.6077733	.19306496
	Total	6.5311442	1.80024482
CHO %	CSMY 1	46.7360700	.42559046
	CSMY 2	44.0432800	.14739837
	CSMY 3	58.1014133	.50422246
	Control	65.4149500	.28442359
	Total	53.5739283	9.02505813

Source: Donkor (2023)

-Values are averages of triplicate determinations

- CSMY 1- Cassava-Soya-Millet-Yakeyake in the ratio 50:30:20
- CSMY 2- Cassava-Soya-Millet-Yakeyake in the ratio 60:30:10
- CSMY 3- Cassava-Soya-Millet-Yakeyake in the ratio 80:15:5

The descriptive statistics in Table 8 provided the mean and standard deviations. Even though differences existed in the mean scores among the various food samples and their respective nutritional composition, the results failed to show whether the observed differences were significant or not, and if significant, where the differences lie. A post hoc test (multiple comparison analysis) was conducted. The Turkey HSD was performed as a follow-up because equal variances were assumed and the sample size among the levels were equal as assumed in this study. The result of the post hoc are presented in Table 9.

Table 9- *Multiple Comparisons/ Post- Hoc Test (Turkey HSD)*

Dependent Variable	(I) Sample	(J) Sample	Mean Difference (I-J)	Std. Error	Sig.
DM	CSMY 1	CSMY 2	.08113667	.32421680	.994
		CSMY 3	-3.96010667*	.32421680	.000
		Control	.84929667	.32421680	.114
	CSMY 2	CSMY 1	-.08113667	.32421680	.994
		CSMY 3	-4.04124333*	.32421680	.000
		Control	.76816000	.32421680	.161
	CSMY 3	CSMY 1	3.96010667*	.32421680	.000
		CSMY 2	4.04124333*	.32421680	.000
		Control	4.80940333*	.32421680	.000
	Control	CSMY 1	-.84929667	.32421680	.114
		CSMY 2	-.76816000	.32421680	.161
		CSMY 3	-4.80940333*	.32421680	.000
Moisture	CSMY 1	CSMY 2	-.08113667	.32421680	.994
		CSMY 3	3.96010667*	.32421680	.000
		Control	-.84929667	.32421680	.114
	CSMY 2	CSMY 1	.08113667	.32421680	.994
		CSMY 3	4.04124333*	.32421680	.000
		Control	-.76816000	.32421680	.161

	CSMY 3	CSMY 1	-3.96010667*	.32421680	.000
		CSMY 2	-4.04124333*	.32421680	.000
		Control	-4.80940333*	.32421680	.000
	Control	CSMY 1	.84929667	.32421680	.114
		CSMY 2	.76816000	.32421680	.161
		CSMY 3	4.80940333*	.32421680	.000
Ash	CSMY 1	CSMY 2	-.20291333	.07778459	.115
		CSMY 3	.29937667*	.07778459	.020
		Control	.62851667*	.07778459	.000
	CSMY 2	CSMY 1	.20291333	.07778459	.115
		CSMY 3	.50229000*	.07778459	.001
		Control	.83143000*	.07778459	.000
	CSMY 3	CSMY 1	-.29937667*	.07778459	.020
		CSMY 2	-.50229000*	.07778459	.001
		Control	.32914000*	.07778459	.012
	Control	CSMY 1	-.62851667*	.07778459	.000
		CSMY 2	-.83143000*	.07778459	.000
		CSMY 3	-.32914000*	.07778459	.012
Protein	CSMY 1	CSMY 2	-1.92573333*	.22447960	.000
		CSMY 3	6.78748000*	.22447960	.000
		Control	11.21950333*	.22447960	.000

	CSMY 2	CSMY 1	1.92573333*	.22447960	.000
		CSMY 3	8.71321333*	.22447960	.000
		Control	13.14523667*	.22447960	.000
	CSMY 3	CSMY 1	-6.78748000*	.22447960	.000
		CSMY 2	-8.71321333*	.22447960	.000
		Control	4.43202333*	.22447960	.000
	Control	CSMY 1	-11.21950333*	.22447960	.000
		CSMY 2	-13.14523667*	.22447960	.000
		CSMY 3	-4.43202333*	.22447960	.000
Oil Fat	CSMY 1	CSMY 2	-.63901333*	.13973794	.008
		CSMY 3	1.02282000*	.13973794	.000
		Control	3.15618667*	.13973794	.000
	CSMY 2	CSMY 1	.63901333*	.13973794	.008
		CSMY 3	1.66183333*	.13973794	.000
		Control	3.79520000*	.13973794	.000
	CSMY 3	CSMY 1	-1.02282000*	.13973794	.000
		CSMY 2	-1.66183333*	.13973794	.000
		Control	2.13336667*	.13973794	.000
	Control	CSMY 1	-3.15618667*	.13973794	.000
		CSMY 2	-3.79520000*	.13973794	.000
		CSMY 3	-2.13336667*	.13973794	.000

Fibre	CSMY 1	CSMY 2	.07487000	.10401755	.887
		CSMY 3	3.25566667*	.10401755	.000
		Control	3.67467333*	.10401755	.000
	CSMY 2	CSMY 1	-.07487000	.10401755	.887
		CSMY 3	3.18079667*	.10401755	.000
		Control	3.59980333*	.10401755	.000
	CSMY 3	CSMY 1	-3.25566667*	.10401755	.000
		CSMY 2	-3.18079667*	.10401755	.000
		Control	.41900667*	.10401755	.016
	Control	CSMY 1	-3.67467333*	.10401755	.000
		CSMY 2	-3.59980333*	.10401755	.000
		CSMY 3	-.41900667*	.10401755	.016
CHO	CSMY 1	CSMY 2	2.69279000*	.29944131	.000
		CSMY 3	-11.36534333*	.29944131	.000
		Control	-18.67888000*	.29944131	.000
	CSMY 2	CSMY 1	-2.69279000*	.29944131	.000
		CSMY 3	-14.05813333*	.29944131	.000
		Control	-21.37167000*	.29944131	.000
	CSMY 3	CSMY 1	11.36534333*	.29944131	.000
		CSMY 2	14.05813333*	.29944131	.000
		Control	-7.31353667*	.29944131	.000

Control	CSMY 1	18.67888000*	.29944131	.000
	CSMY 2	21.37167000*	.29944131	.000
	CSMY 3	7.31353667*	.29944131	.000

*The mean difference is significant at the 0.05 level; Source: Donkor (2023)

The results from the post hoc (Table 9) showed a statistically significant difference in the mean scores of “CSMY 3” and “commercially-made yakeyake” in terms of dry matter as a nutritional composition ($p < .001$). Similarly, there was also a statistically significant difference in the mean scores of CSMY 3” and “commercially-made yakeyake” in terms of moisture as a nutritional composition ($p < .001$). A thorough inspection of the results in Table 9 further revealed statistically significant differences in the mean scores of “CSMY 1” and “commercially-made yakeyake” ($p < .001$), “CSMY 2” and “commercially-made yakeyake” ($p < .001$), as well as “CSMY 3” and “commercially-made yakeyake” ($p = .012$) in terms of ash content as a nutritional composition. The results from the multiple comparison also revealed statistically significant differences in the mean scores of “CSMY 1” and “commercially-made yakeyake” ($p < .001$), “CSMY 2” and “commercially-made yakeyake” ($p < .001$), as well as “CSMY 3” and “commercially-made yakeyake” ($p < .001$) in terms of protein as a nutritional composition.

Table 9 revealed statistically significant differences in the mean scores of CSMY 1” and “commercially-made yakeyake” ($p < .001$), “CSMY 2” and “commercially-made yakeyake” ($p < .001$), as well as “CSMY 3” and “commercially-made yakeyake” ($p < .001$) in terms of fat. Similarly, in terms of fibre content, the results revealed statistically significant differences in the mean scores of CSMY 1” and “commercially-made yakeyake” ($p < .001$), “CSMY 2” and “commercially-made yakeyake” ($p < .001$), as well as “CSMY 3” and “commercially-made yakeyake” ($p =.016$). Lastly a thorough inspection of the results in Table 9 revealed statistically significant differences in the mean scores of CSMY 1" and "commercially-made yakeyake" ($p < .001$), "CSMY 2" and "commercially-made yakeyake" ($p < .001$), as well as "CSMY 3" and "commercially-made yakeyake" ($p < .001$) in terms of carbohydrate as a nutritional composition.

The post hoc (multiple comparison test) suggests that, in terms of dry matter, the mean score for "CSMY 3" (M=50.53) was greater than the mean score for "commercially-made yakeyake" (M=45.54). This implies that the amount of nutrients available in "CSMY 3" outweigh the amount of nutrient available in the "commercially-made yakeyake". The consumption of "CSMY 3" has the higher likelihood of promoting body growth and maintenance compared with the consumption of "commercially-made yakeyake." The results of the post hoc also suggest that, in terms of moisture content, the mean score of commercially-made yakeyake (M= 54.46) was greater than the mean score of "CSMY 3" (M=49.65). This result suggests that commercially-made yakeyake contains a lot of water compared with "CSMY 3."

Results from the multiple comparison also suggest that, in terms of ash content, the mean score of CSMY 2 (M= 3.44) was greater than the mean scores of CSMY 1 (M= 3.23), CSMY 3 (M= 2.94) and commercially-made yakeyake (M= 2.61) respectively. The implication of this results suggests that CSMY 2 contains greater percentage of minerals required for body growth relative to CSMY 1, CSMY 3, and commercially-made yakeyake. The results of the post hoc further suggest that in terms of protein, the mean score of CSMY 2 (M= 25.13) was greater than the mean scores of CSMY 1 (M= 23.21), CSMY 3 (M= 16.42) and commercially-made yakeyake (M= 11.99) respectively. This implies that CSMY 2 contains greater percentage of protein required for repairing worn-out tissues compared with CSMY 1, CSMY 3, and commercially-made yakeyake.

Again, post hoc results suggest that in terms of fats, the mean score of CSMY 2 (M= 19.17) was greater than the mean scores of CSMY 1 (M= 18.53), CSMY 3 (M= 17.51) and commercially-made yakeyake (M= 15.38) respectively. This implies that CSMY 2 contain greater proportion of essential fats and vitamins required for bodily nourishment compared with CSMY 1, CSMY 3, and commercially-made yakeyake. The results from the multiple comparison further suggest that, in terms of fibre, the mean score of CSMY 1 (M= 8.28) was greater than the mean scores of CSMY 2 (M= 8.21), CSMY 3 (M= 5.03) and commercially-made yakeyake (M= 4.61) respectively. This implies that CSMY 1 contain greater proportion of roughages required for free bowel movement compared with CSMY 2, CSMY 3, and commercially-made yakeyake. Lastly, in terms of carbohydrates, the results from the post hoc suggests that the mean score of commercially-made yakeyake (M= 65.41) was greater than the mean scores of CSMY 1 (M= 46.74), CSMY 2 (M= 44.04), and CSMY 3 (M= 58.10). The implication of this result is that commercially-made yakeyake contains greater proportion of glucose compared with CSMY 1, CSMY 2 and CSMY 3.

There were significant differences in the proximate composition (i.e., in terms of dry matter, moisture, ash content, protein, fat, fibre and carbohydrate) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3). Thus, in terms of dry matter, the amount of nutrients available in "CSMY 3" outweighed the proportion of nutrient available in the "commercially-made yakeyake". Further, the moisture content of commercially-made yakeyake was greater than the proportion of moisture in "CSMY 3." For Ash content, CSMY 2 contains greater proportion of minerals required for body growth relative to CSMY 1, CSMY 3, and commercially-made yakeyake. It was also evident in the findings of the current study that CSMY 2 contains greater percentage of protein required for repairing worn-out tissues compared with CSMY 1, CSMY 3, and commercially-made yakeyake.

CSMY 2 contained greater proportion of essential fats and vitamins required for body nourishment compared with CSMY 1, CSMY 3, and commercially-made yakeyake. CSMY 1 contained greater proportion of fibre and roughages required for free bowel movement in order to avoid constipation compared with CSMY 2, CSMY 3, and commercially-made yakeyake. Carbohydrate in commercially-made yakeyake contained greater proportion of glucose compared with CSMY 1, CSMY 2 and CSMY 3.

Hypothesis 2

H_0: There is no statistically significant difference in the functional properties of commercially-made yakeyake and somillyake in a ratio of 50:30:20, 60: 30:10, and 80:15:5.

The goal of this hypothesis was to find out whether significant differences existed in the functional properties of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., somillyake). In order to achieve this objective, fortified food samples of the commercially-made yakeyake as well as the three different products were sent to the laboratory for testing. Functional properties (such as hydration capacity, swelling capacity, bulk density and emulsion activity) were determined for all the samples. One-way Analysis of variance (ANOVA) was used to test this hypothesis in order to ascertain whether significant differences existed in the functional properties of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake. In this case, the commercially-made yakeyake served as the control variable whereas the three different products of the fortified soya-millet-yakeyake served as the independent variables.

Shapiro-Wilk test was performed to test the normality of the data as a requirement for one-way ANOVA. Details of the results are presented in Table 10.

Table 10- *Test for Normality (ANOVA) for Hypothesis Two*

Functional Properties	Food Samples	Shapiro-Wilk		
		Statistic	df	Sig.
Hydration Capacity	CSMY 1	.996	3	.885
	CSMY 2	.873	3	.304
	CSMY 3	.997	3	.893
	Control	.846	3	.231
Swelling Capacity	CSMY 1	.985	3	.762
	CSMY 2	.996	3	.873
	CSMY 3	.881	3	.328
	Control	.782	3	.071
Bulk Density	CSMY 1	.954	3	.589
	CSMY 2	.838	3	.210
	CSMY 3	.968	3	.654
	Control	.780	3	.068
Emulsion Activity	CSMY 1	.945	3	.548
	CSMY 2	.990	3	.804
	CSMY 3	.966	3	.647
	Control	.812	3	.143

*Significant at .05 level; Source: Donkor (2023)

Table 10 shows that the normality assumption was not violated since the p-values of the "food samples" captured under the respective "functional properties" were greater than .05 (i.e., p >.05) and consequently not significant. Similarly, a visual inspection of the Q-Q plot for the aforementioned "food samples" captured under the respective "functional properties" provides enough evidence to suggest that the normality assumption was satisfied (see Appendix D).

Based on this, there was the need to conduct a test for homogeneity of variance to ensure the variances were the same across all the "food samples" captured under the respective "functional properties." Table 11 provides details on the test for homogeneity of variance.

Table 11-*Test of Homogeneity of Variance*

Functional Properties	Levene Statistic	df1	df2	Sig.
Hydration Capacity	2.916	3	8	.101
Swelling Capacity	12.352	3	8	.302
Bulk Density	1.927	3	8	.204
Emulsion Activity	1.829	3	8	.220

*Significant at .05 level; Source: Donkor (2023)

As shown in Table 11, the homogeneity of variance assumption was not violated since the p-values of all the "functional properties" were greater than .05 (i.e., p >.05) and consequently not significant. This implies that the variances were the same (equal variance assumed). In view of the fact that the normality and homogeneity of variance assumptions of ANOVA were duly satisfied, the actual test was conducted to determine the differences that exist in functional properties of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake. Table 12 presents the actual results of the ANOVA test.

Table 12- *ANOVA Test*

Functional Properties		Sum of Squares	df	Mean Square	F	Sig.
Hydration Capacity	Between Groups	.062	3	.021	45.735	.000
	Within Groups	.004	8	.000		
	Total	.065	11			
Swelling Capacity	Between Groups	.096	3	.032	14.458	.001
	Within Groups	.018	8	.002		
	Total	.113	11			
Bulk Density	Between Groups	.003	3	.001	83.191	.000
	Within Groups	.000	8	.000		
	Total	.003	11			
Emulsion Activity	Between Groups	7.604	3	2.535	1021.996	.000
	Within Groups	.020	8	.002		
	Total	7.623	11			

*Significant at .05 level; Source: Donkor (2023)

The results from the ANOVA test (Table 12) shows a statistically significant difference in the functional properties of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake based on the following parameters: Hydration Capacity [$F(3, 8) = 45.74$, $p < .001$], Swelling Capacity [$F(3, 8) = 14.46$, $p = .001$], Bulk Density [$F(3, 8) =$

83.19, $p < .001$], and Emulsion Activity [$F (3, 8) = 1021.99$, $p < .001$]. The implication of this study suggests that there are significant differences in the functional properties (i.e., in terms of, hydration capacity, swelling capacity, bulk density and emulsion activity) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake. To make the results clearer, descriptive statistics of commercially-made yakeyake (control) and the three different products of the fortified soya-millet-yakeyake with their respective functional properties are presented in Table 13.

Table 13- *Descriptive Statistics in terms of the Functional Properties of Commercially-made Yakeyake and the Three Different Products of Fortified/Modified Yakeyake*

Functional Properties		**N**	**Mean**	**Std. Deviation**
Hydration Capacity	CSMY 1	3	2.6445300	.01924502
	CSMY 2	3	2.8182967	.01294952
	CSMY 3	3	2.7559233	.00960019
	Control	3	2.6574133	.03417783
	Total	12	2.7190408	.07703733
Swelling Capacity	CSMY 1	3	1.2716200	.01412483
	CSMY 2	3	1.3556300	.00988194
	CSMY 3	3	1.4281667	.00201867
	Control	3	1.1900400	.09233045
	Total	12	1.3113642	.10151427

Bulk Density	CSMY 1	3	.7214300	.00502606
	CSMY 2	3	.7245900	.00441745
	CSMY 3	3	.7182100	.00168253
	Control	3	.6830833	.00251886
	Total	12	.7118283	.01777143
Emulsion Activity	CSMY 1	3	37.1119967	.05590365
	CSMY 2	3	38.2032967	.05463600
	CSMY 3	3	38.6984200	.01306708
	Control	3	39.2783700	.06032295
	Total	12	38.3230208	.83248968

Source: Donkor (2023)

The descriptive statistics as displayed in Table 13 only gave the mean and standard deviations. Even though differences existed in the mean scores among the various food samples and their respective functional properties, the results failed to show whether the observed differences were significant or not, and if significant, where the differences lie. A post hoc test (multiple comparison analysis) was conducted. The Turkey HSD was performed as a follow-up because equal variances were assumed and the sample size among the levels were equal as assumed in this study. The result of the post hoc are presented in Table 14.

Table 14- *Multiple Comparisons/ Post-Hoc Test (Turkey HSD)*

Dependent Variable	(I) Sample	(J) Sample	Mean Difference (I-J)	Std. Error	Sig.
Hydration Capacity	CSMY 1	CSMY 2	-.17376667*	.01731256	.000
		CSMY 3	-.11139333*	.01731256	.001
		Control	-.01288333	.01731256	.877
	CSMY 2	CSMY 1	.17376667*	.01731256	.000
		CSMY 3	.06237333*	.01731256	.029
		Control	.16088333*	.01731256	.000
	CSMY 3	CSMY 1	.11139333*	.01731256	.001
		CSMY 2	-.06237333*	.01731256	.029
		Control	.09851000*	.01731256	.002
	Control	CSMY 1	.01288333	.01731256	.877
		CSMY 2	-.16088333*	.01731256	.000
		CSMY 3	-.09851000*	.01731256	.002
Swelling Capacity	CSMY 1	CSMY 2	-.08401000	.03835395	.205
		CSMY 3	-.15654667*	.03835395	.015
		Control	.08158000	.03835395	.224
	CSMY 2	CSMY 1	.08401000	.03835395	.205
		CSMY 3	-.07253667	.03835395	.303
		Control	.16559000*	.03835395	.011

	CSMY 3	CSMY 1	.15654667*	.03835395	.015
		CSMY 2	.07253667	.03835395	.303
		Control	.23812667*	.03835395	.001
	Control	CSMY 1	-.08158000	.03835395	.224
		CSMY 2	-.16559000*	.03835395	.011
		CSMY 3	-.23812667*	.03835395	.001
Bulk Density	CSMY 1	CSMY 2	-.00316000	.00299863	.725
		CSMY 3	.00322000	.00299863	.714
		Control	.03834667*	.00299863	.000
	CSMY 2	CSMY 1	.00316000	.00299863	.725
		CSMY 3	.00638000	.00299863	.223
		Control	.04150667*	.00299863	.000
	CSMY 3	CSMY 1	-.00322000	.00299863	.714
		CSMY 2	-.00638000	.00299863	.223
		Control	.03512667*	.00299863	.000
	Control	CSMY 1	-.03834667*	.00299863	.000
		CSMY 2	-.04150667*	.00299863	.000
		CSMY 3	-.03512667*	.00299863	.000
Emulsion Activity	CSMY 1	CSMY 2	-1.09130000*	.04066103	.000
		CSMY 3	-1.58642333*	.04066103	.000
		Control	-2.16637333*	.04066103	.000

CSMY 2	CSMY 1	1.09130000*	.04066103	.000
	CSMY 3	-.49512333*	.04066103	.000
	Control	-1.07507333*	.04066103	.000
CSMY 3	CSMY 1	1.58642333*	.04066103	.000
	CSMY 2	.49512333*	.04066103	.000
	Control	-.57995000*	.04066103	.000
Control	CSMY 1	2.16637333*	.04066103	.000
	CSMY 2	1.07507333*	.04066103	.000
	CSMY 3	.57995000*	.04066103	.000

*The mean difference is significant at the 0.05 level; Source: Donkor (2023)

The results of the post hoc (Table 14) showed a statistically significance difference in the mean scores of “CSMY 2” and “commercially-made yakeyake” ($p < .001$), as well as CSMY 3” and “commercially-made yakeyake” ($p = .002$), in terms of hydration capacity as a functional property. The results of the multiple comparison also showed a statistically significant difference in the mean scores of “CSMY 2” and “commercially-made yakeyake” ($p =.011$), as well as CSMY 3” and “commercially-made yakeyake” ($p < .001$) in terms of swelling capacity as a functional property.

Similarly, in terms of bulk density as a functional property, the results of the post hoc showed a statistically significant difference in the mean scores of “CSMY 1” and “commercially-made yakeyake” ($p < .001$), “CSMY 2” and “commercially-made yakeyake” ($p < .001$), as well as CSMY 3” and “commercially-made yakeyake” ($p < .001$). The results of the post hoc showed a statistically significant difference in the mean scores of “CSMY 1” and “commercially-made yakeyake” ($p < .001$), “CSMY 2” and “commercially-made yakeyake” ($p < .001$), as well as CSMY 3” and “commercially-made yakeyake” ($p < .001$), in terms of emulsion activity as a functional property.

The post hoc test suggests that in terms of hydration capacity, the mean score of “CSMY 2” ($M = 2.82$) was greater than the mean scores of “CSMY 3” ($M = 2.76$) and that of commercially made yakeyake ($M= 2.66$). This result implies that the amount of water retained or absorbed by “CSMY 2” to ensure desirable consistency and also create a quality food product was higher compared to the water absorbed by “CSMY 3” and the commercially made yakeyake. That is to say, the ability of “CSMY 2” to record a higher water capacity could be attributed to quantity of carbohydrate, protein, and fibre present in the food sample. The water holding capacity of a food sample could be attributed to the higher amount of carbohydrate, fibre and protein present in the food sample.

The results of the multiple comparison also suggest that in terms of swelling capacity, the mean score of “CSMY 3” (M= 1.43) was higher than the mean scores of “CSMY 2” (M= 1.36) and “commercially-made yakeyake” (M= 1.19). “CSMY 3” as a food sample has a higher ability to absorb water and swell relative to “CSMY 2” and the commercially made yakeyake. This suggests that “CSMY 3” as a food sample had a higher starch content (i.e., 80% cassava, 15% protein and 5% fibre) compared with “CSMY 2” and the commercially made yakeyake. There is a direct relationship between the starch content in a particular food sample and the swelling capacity of the that particular food. That is to say, food samples that have high starch content, especially for branched amylopectin starch content, have a higher likelihood of recording a higher swelling capacity relative to food samples that have low starch content.

The results of the multiple comparison further suggest that in terms of bulk density, the mean score of “CSMY 2” (M= 0.723) was greater than the mean scores of “CSMY 1” (M=0.721), “CSMY 3” (M= 0.718), and that of commercially made yakeyake (M= 0.683). This result implies that “CSMY 2” as a food sample has a higher bulk density compared with the bulk density of “CSMY 1,” “CSMY 3,” and commercially made yakeyake. Since bulk density measures the heaviness of a particular food sample and also determines the required packaging material for the said food sample, it can be inferred that, a denser or compactible packaging material will be required for packaging and transporting “CSMY 2” relative to CSMY 1,” “CSMY 3,” and commercially made yakeyake, due to the high bulk density of “CSMY 2” as a food sample. The high bulk density of “CSMY 2” could be attributed to the initial moisture content of the food product as well as the starch content of “CSMY 2”, since moisture and starch contents form the main structure and bulk density of a food product.

Again, the post hoc results suggest that in terms of emulsion activity, the mean scores of commercially made yakeyake (M= 39.28) was greater than the mean scores of “CSMY 1” (M= 37.11), “CSMY 2” (M= 38.20), and “CSMY 3” (M= 38.70). The results imply that commercially made yakeyake has a higher emulsion activity compared with CSMY 1, CSMY 2, and CSMY 3, suggesting that since emulsion capacity of food often measures the ability of soluble proteins, water, and non-polar amino acids residues to migrate to the water or oil interface of food products, it can be inferred that the “commercially made yakeyake” exhibited a high “water-in-oil” emulsion activity due to the high moisture content of the “commercially made yakeyake” relative to CSMY 1, CSMY 2, and CSMY 3 which had a lesser moisture content. That is to say since “commercially made yakeyake” recorded a high moisture content, it could be inferred that an emulsion of “water-in-oil” activity is formed, where the dispersed phase is water and the continuous phase is oil. This could be attributed to the amount of oil and non-polar amino acid residue on the surface of protein, water, and other components of the "commercially made yakeyake."

Findings showed significant differences in the functional properties (i.e., in terms of hydration capacity, swelling capacity, bulk density and emulsion activity) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3). Thus, in terms of hydration capacity, the findings showed that the amount of water absorbed by "CSMY 2" to ensure desirable consistency and also create a quality food product was higher compared to the water absorbed by "CSMY 3" and the commercially made yakeyake. In terms of swelling capacity, "CSMY 3" recorded a higher swelling capacity relative to the swelling capacity of "CSMY 2" and "commercially-made yakeyake." It was further discovered that in terms of bulk density, "CSMY 2" as a food sample had a higher bulk density compared with the bulk density of "CSMY 1," "CSMY 3," and commercially made yakeyake. In terms of emulsion activity, commercially made yakeyake as a food product recorded a higher emulsion activity compared with CSMY 1, CSMY 2, and CSMY 3.

Hypothesis 3

H_0: There is no statistically significant difference in the sensory properties of commercially-made yakeyake and somillyake in a ratio of 50:30:20, 60: 30:10, and 80:15:5.

This hypothesis sought to assess consumers' acceptability regarding the sensory properties of the commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., somillyake). In order to achieve this objective, data was collected from 65 panelists who evaluated the sensory properties and also indicated their acceptability/preferences for the commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (Control, CSMY 1, CSMY 2, and CSMY 3). The data gathered on this hypothesis was tested using one-way repeated measures ANOVA. With this analytical procedure, each participant was exposed to two or more different conditions. In the case of this study, each participant during the sensory evaluation was exposed to four different conditions, that is, the commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (Control, CSMY 1, CSMY 2, and CSMY 3). This warranted the usage of the one-way repeated measures ANOVA as an analytical tool to test this hypothesis.

Prior to the conduct of this analysis, the Mauchly's test of sphericity was checked in order to assess the statistical assumption of sphericity. Details of the results are presented in Table 15.

Table 15- *Mauchly's Test of Sphericity Assumption*

Parameters	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Appearance	.933	4.323	5	.504	.953	1.000	.333
Colour	.870	8.746	5	.120	.911	.955	.870
Texture	.885	7.632	5	.178	.930	.977	.885
Aroma	.988	.777	5	.978	.992	1.000	.333
Taste	.914	5.673	5	.339	.941	.989	.333
Aftertaste	.955	2.878	5	.719	.972	1.000	.333
Overall Acceptability	.893	7.082	5	.215	.929	.976	.333

*Significant at .05 level; Source: Donkor (2023)

As shown in Table 15, the variances of the differences between each of the parameters of sensory evaluation on all combinations of the food samples were equal as indicated by the Mauchly's Test of Sphericity, appearance, $\chi^2(5) = 4.32, p = .50$; colour $\chi^2(5) = 8.75, p = .12$; texture, $\chi^2(5) = 7.63, p = .18$; aroma, $\chi^2(5) = .78, p = .98$; taste, $\chi^2(5) =5.67, p = .34$; aftertaste, $\chi^2(5) = 2.88, p = .72$; overall acceptability, $\chi^2(5) = 7.08, p = .22$. Table 16 presents the test for the mean differences.

Table 16- *Tests of Within-Subjects Effects*

Source	df	Mean Square	F	Sig.	Partial Eta Squared
Appearance	3	14.404	38.390	.000	.375
Error (Appearance)	192	.375			
Colour	3	2.021	4.946	.002	.072
Error (Colour)	192	.409			
Texture	3	2.260	4.905	.003	.071
Error (Texture)	192	.461			
Aroma	3	3.231	8.699	.000	.120
Error (Aroma)	192	.371			
Taste	3	1.585	4.043	.008	.059
Error (Taste)	192	.392			
Aftertaste	3	1.733	4.635	.004	.068
Error (Aftertaste)	192	.374			
Overall Acceptability	3	4.722	9.792	.000	.133
Error (Acceptability)	192	.482			

*The mean difference is significant at the .05 level; Source: Donkor (2023)

As shown in Table 16, the results indicate that in terms of appearance, the mean scores for the four food samples were statistically significantly different, F (3, 192) = 38.39, p < .001, partial eta squared = .375. This results imply that 37.5% of the variances in appearance was explained by the various food samples. In terms of colour, the results showed a statistically significant difference in the mean scores for the four food samples, F (3, 192) = 4.95, p = .002, partial eta squared = .072. The implication of this result suggests that 7.2% of the variances in colour was explained by the four food samples.

The results of this study further showed a statistically significant difference in the mean scores for the four food samples in terms of texture, F (3, 192) = 4.95, p = .003, partial eta squared = .071. This shows that the four food samples all together explained 7.1% of the variances in texture. The results as displayed in Table 16 also revealed a statistically significant difference in the mean scores for the four food samples in terms of aroma, F (3, 192) = 8.70, p < .001, partial eta squared = .120. This implies that the four food samples all together explained 12% of the variances in the aroma of the food samples.

It was further discovered that in terms of taste, the mean scores for the four food samples were statistically significantly different, F (3, 192) = 4.04, p = .008, partial eta squared = .059. This shows that 5.9% of the variances in appearances was explained by the various food samples. In terms of aftertaste, the results displayed in Table 16 revealed a statistically significant difference in the mean scores for the four food samples, F (3, 192) = 4.64, p = .004, partial eta squared = .068. This implies that the four food samples all together explained 6.8% of the variances in the aftertaste of the food samples.

Finally, the results showed a statistically significant difference in the mean scores for the four food samples in terms of overall acceptability, F (3, 192) = 4.72, p < .001, partial eta squared = .133. This shows that the four food samples all together explained 13.3% of the variances in the overall acceptability of the food samples. The results were followed up with pairwise comparison using Bonferroni test. Table 17 presents details on the post hoc results.

Table 17- *Pairwise Comparison*

		(J) Attributes	Mean Difference (I-J)	Std. Error	Sig.
Appearance		2	-.985*	.113	.000
	1	3	-.892*	.112	.000
		4	-.938*	.120	.000
		1	.985*	.113	.000
	2	3	.092	.097	1.000
		4	.046	.099	1.000
		1	.892*	.112	.000
	3	2	-.092	.097	1.000
		4	-.046	.102	1.000
		1	.938*	.120	.000
	4	2	-.046	.099	1.000
		3	.046	.102	1.000
Colour		2	-.385*	.133	.031
	1	3	-.338*	.112	.022
		4	-.323*	.116	.043
		1	.385*	.133	.031
	2	3	.046	.099	1.000
		4	.062	.107	1.000
		1	.338*	.112	.022
	3	2	-.046	.099	1.000
		4	.015	.102	1.000
		1	.323*	.116	.043
	4	2	-.062	.107	1.000
		3	-.015	.102	1.000
Texture		2	-.385*	.133	.031
	1	3	-.338*	.112	.022
		4	-.323*	.116	.043
		1	.385*	.133	.031
	2	3	.046	.099	1.000
		4	.062	.107	1.000
		1	.338*	.112	.022
	3	2	-.046	.099	1.000
		4	.015	.102	1.000

		1	.323*	.116	.043
	4	2	-.062	.107	1.000
		3	-.015	.102	1.000
Aroma		2	-.369*	.113	.010
	1	3	-.508*	.105	.000
		4	-.415*	.105	.001
		1	.369*	.113	.010
	2	3	-.138	.105	1.000
		4	-.046	.108	1.000
		1	.508*	.105	.000
	3	2	.138	.105	1.000
		4	.092	.105	1.000
		1	.415*	.105	.001
	4	2	.046	.108	1.000
		3	-.092	.105	1.000
Taste		2	-.338*	.101	.008
	1	3	-.323*	.096	.008
		4	-.231	.113	.276
		1	.338*	.101	.008
	2	3	.015	.104	1.000
		4	.108	.122	1.000
		1	.323*	.096	.008
	3	2	-.015	.104	1.000
		4	.092	.120	1.000
		1	.231	.113	.276
	4	2	-.108	.122	1.000
		3	-.092	.120	1.000
Aftertaste		2	-.231	.113	.276
	1	3	-.385*	.102	.002
		4	-.123	.109	1.000
		1	.231	.113	.276
	2	3	-.154	.103	.850
		4	.108	.116	1.000
		1	.385*	.102	.002
	3	2	.154	.103	.850
		4	.262	.099	.061
		1	.123	.109	1.000
	4	2	-.108	.116	1.000
		3	-.262	.099	.061

		2	-.538*	.118	.000
Overall	1	3	-.554*	.120	.000
Acceptability		4	-.523*	.139	.002
		1	.538*	.118	.000
	2	3	-.015	.111	1.000
		4	.015	.131	1.000
		1	.554*	.120	.000
	3	2	.015	.111	1.000
		4	.031	.110	1.000
		1	.523*	.139	.002
	4	2	-.015	.131	1.000
		3	-.031	.110	1.000

*. The mean difference is significant at the .05 level; Source: Donkor (2023)

From the post hoc (Table 17), there were significant differences in the appearance of food sample 1 and food sample 2 ($p < .001$), food sample 1 and food sample 3 ($p < .001$), as well as food sample 1 and food sample 4 ($p < .001$). The results also showed significant differences in the colour of food sample 1 and food sample 2 ($p = .03$), food sample 1 and food sample 3 ($p = .02$), as well as food sample 1 and food sample 4 ($p = .04$). A thorough inspection of the results in Table 17 further showed significant differences in the texture of food sample 1 and food sample 2 ($p = .03$), food sample 1 and food sample 3 ($p = .02$), as well as food sample 1 and food sample 4 ($p = .04$).

In terms of aroma, the results of the post hoc showed significant differences in the mean scores of food sample 1 and food sample 2 ($p = .01$), food sample 1 and food sample 3 ($p < .001$), and food sample 1 and food sample 4 ($p =.001$). In terms of taste, the post hoc results showed significant differences in the mean scores of food sample 1 and food sample 2 ($p =.008$) as well as food sample 1 and food sample 3 ($p =.008$). However, there was no significant difference between the taste of food sample 1 and food sample 4 ($p = .276$). The post hoc result indicates that, there was a significant difference in the aftertaste of food sample 1 and food sample 3 ($p = .002$). However, in terms of aftertaste, the results showed no significant differences in the mean scores of food sample 1 and food sample 2 (p = .276) as well as food sample 1 and food sample 4 (p = 1.00). Finally, in terms of overall acceptability, the post hoc results showed significant differences in the mean scores of food sample 1 and food sample 2 ($p < .001$), food sample 1 and food sample 3 ($p < .001$), as well as food sample 1 and food sample 4 ($p = .002$).

In order to make the results clearer, there was the need to inspect the descriptive statistics. Details of the descriptive statistics are presented in Table 18.

Table 18- *Descriptive Statistics*

Dimensions	Products	Mean	Standard Deviation
Appearance	1	2.4462	.58712
	2	3.4308	.68395
	3	3.3385	.77615
	4	3.3846	.84210
Colour	1	2.9077	.67830
	2	3.2923	.86101
	3	3.2462	.84836
	4	3.2308	.84353
Texture	1	2.9538	.67154
	2	3.2615	.81542
	3	3.3385	.73478
	4	3.3538	.87376
Aroma	1	2.9231	.81601
	2	3.2923	.76492

	3	3.4308	.82858
	4	3.3385	.77615
Taste	1	3.0923	.72291
	2	3.4308	.63662
	3	3.4154	.76836
	4	3.3231	.88579
Aftertaste	1	3.0615	.70438
	2	3.2923	.76492
	3	3.4462	.68536
	4	3.1846	.78844
Overall Acceptability	1	2.6923	.72722
	2	3.2308	.76586
	3	3.2462	.82974
	4	3.2154	.96002

Source: Donkor (2023)

As displayed in Table 18, the post hoc results suggest that in terms of appearance, the mean score of food sample 2 (M = 3.43) was greater than the mean scores of food sample 1 (M = 2.45), food sample 3 (M = 3.34) and food sample 4 (M = 3.38) respectively. The implication of this result suggests that food sample 2 (i.e., CSMY 1) appeared more appealing to respondents compared to the other food samples. This could be attributed to the content of soya bean and red millet present in food sample 2. That is to say, unlike the other food samples, food sample 2 had less content of cassava and more percentage content of soya bean and red millet (i.e., 50:30: 20).

In terms of colour as an attribute of evaluation, the results of the post hoc test showed that respondents preferred the colour of food sample 2 (M = 3.29) relative to the colour of food sample 1 (M = 2.91), food sample 3 (M = 3.25) and food sample 4 (M = 3.23) respectively. This result was not too surprising since food sample 2 obtained the highest score in terms of appearance. Thus, since the appearance of a food sample and the colour of a food sample are somehow related, the results were expected to move in this direction.

The results of the post hoc test further showed that in terms of texture, participant had high preference for the texture of food sample 4 (M = 3.35) compared to the textures of food sample 1 (M = 2.95), food sample 2 (M = 3.26) and food sample 3 (M = 3.34) respectively. The preference for the texture of food sample 4 (i.e., CSMY 3) could be attributed to the stiff nature of the food sample, and this could be due to the high percentage content of cassava in food sample 4 relative to the other food samples. In terms of aroma as an evaluation attribute, the post hoc test revealed that respondents preferred the aroma of food sample 3 (M = 3.43) compared to the aromas of food sample 1 (M = 2.92), food sample 2 (M = 3.29) and food sample 4 (M = 3.34) respectively. The high preference of the aroma of food sample 3 could be attributed to the high content of soya bean and millet present in the sample. This to a very large extent gave the product a savoury smell and flavour.

It was also evident in the results of the post hoc that, in terms of taste, most of the respondents preferred the taste of food sample 2 (M = 3.43) compared to the tastes of food sample 1 (M = 3.09), food sample 3 (M = 3.42) and food sample 4 (M = 3.32). In terms of aftertaste, most of the respondents preferred the aftertaste of food sample 3 (M = 3.45) relative to the aftertastes of food sample 1 (M = 3.06), food sample 2 (M = 3.29) and food sample 4 (M = 3.18). This seems to suggest that the proportion of grated cassava, soya beans and millet contents in food sample 3 (i.e., 60:30:10) gave respondents a desirable aftertaste upon consuming the product.

Finally, in terms of "overall acceptability," most of the respondents expressed high preference for food sample 3 (M = 3.25) compared to food sample 1 (M = 2.69), food sample 2 (M = 3.23) and food sample 4 (M = 3.22). Thus, the results suggest that food sample 3 (i.e., CSMY 2) was the most preferred somillyake. This perhaps could be attributed to the proportions (i.e., 60:30:10) of grated cassava, soya beans and red millet contents present in the food sample. The choice of sample 3 by respondents could also be attributed to the fact that the product had the sensory attributes most preferred by the respondents (consumers). Moreover, it can be inferred that sample 3 was most preferred because it had attributes similar to the commercially made yakeyake, which consumers are often used to.

The findings of this study showed significant differences in the sensory properties (i.e., in terms of appearance, colour, texture aroma, taste, aftertaste and overall acceptability) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3). Thus, the findings of the study revealed that respondents had high preference for food sample 2 in terms of appearance, colour and taste compared to the other food samples. It was further found that respondents preferred the aroma and aftertaste of food sample 3 compared to the other food samples. The findings of this study also showed that respondents preferred the texture of food sample 4 compared to the other food samples. Finally, in terms of overall acceptability, the findings of this study showed that respondents had high preference for food sample 3 relative to other food samples. This implies that food sample 3 was the most preferred somillyake endorsed by the panelists. The endorsement of food sample 3 as the overall acceptable food sample could be attributed to the fact that the product had the sensory attributes most preferred by the respondents (consumers).

Discussions

This section discusses the results of the study as presented in the previous paragraphs. The discussion was organised under the following topical issues:

1. Proximate composition of soya bean flour, red millet flour and grated cassava flour
2. Proximate composition of commercially-made yakeyake
3. Proximate composition of "somillyake"
4. Proximate composition of commercially-made yakeyake and the three different products of "somillyake"
5. Functional properties of commercially-made yakeyake and the three different products of "somillyake"
6. consumers' acceptability regarding the sensory properties of the commercially-made yakeyake and the three different products of "somillyake"

Proximate Composition of Soya Bean Flour, Red Millet Flour and Grated Cassava Flour

The findings of this study showed that soya bean flour had good proximate composition in terms of dry matter content, ash content, protein content, fat content and fibre content compared with other food samples such as red millet flour and grated cassava flour. The implication of this study suggests that soya bean flour has high amount of nutrients such as minerals, fatty acids, amino acids, as well as cellulose and vitamins required for the nourishment of the body compared to grated cassava which is mainly a starchy diet that provides the body with glucose. The findings of this study further revealed that, grated commercial cassava has the highest carbohydrate and moisture content in terms of proximate composition. This result implies that grated cassava as a starch diet is able to retain a lot of water relative to soya bean flour and red millet flour. That is to say, grated cassava has a higher starch content and a higher water holding capacity compared with soya bean flour and red millet flour.

The nutritional composition of soya bean agrees with the findings of Etiosa et al. (2017) who reported that soya bean is a valuable source of nutrients such as protein, fatty acids, and vitamins. Their study concluded that soya bean is an important food that can improve the nutritional status of underprivileged population. The findings of this study are also consistent with that of Bayero et al. (2019) who discovered that soya bean is a valuable source of macronutrients and minerals. According to their study, soya bean is a valuable source of high-quality protein, oil, and other essential nutrients.

The findings of this study support the findings of Jukanti et al. (2016) who reported that pearl millet is a rich source of nutrients such as dietary fibre, energy and proteins coupled with essential minerals, some vitamins, amino acid profile, and antioxidants. Further, findings support that of Ramashia et al. (2021) who reported that pearl millet has high nutritional value in terms of high levels of energy, dietary fibre, proteins with a balanced amino acid profile, essential minerals, vitamins, and antioxidants.

The findings that grated commercial cassava has high carbohydrate and moisture content in terms of proximate composition also supports findings of several authors (Chisenga et., 2019; Nilusha et al, 2021; Kouassi et al., 2022). For instance, in their study, Kouassi, et. al. (2022) assessed the proximate composition of fermented cassava doughs from five major producing areas in Cote d'Ivoire. The authors discovered that cassava dough has higher starch, dietary fibre, and moisture contents. The findings of this investigation is also consistent with Chisenga et al. (2019) who examined the proximate composition of cassava. The authors discovered that grated cassava has rich content in moisture, ash, fibre and protein but contains less minerals such as vitamins.

Proximate Composition of Commercially-Made Yakeyake

The findings of the study showed that commercially-made yakeyake has good nutritional compositions in terms of carbohydrate, moisture, dry matter, fat, protein and fibre. The findings that commercially-made yakeyake recorded a high value in carbohydrate was not surprising since commercially-made yakeyake are often prepared using grated cassava which contains a lot of starch.

On the contrary, the findings of the study suggest that commercially-made yakeyake contained less amount of mineral elements required for bodily growth since the food sample recorded a low ash content. The implication of this results is that although consumers of commercially-made yakeyake are likely to obtain enough energy from the consumption of such food, consumers also have a higher likelihood of not obtaining certain vital mineral elements required for proper body functioning.

The findings of this study support the assertion of Chisenga et al. (2019) who discovered that cassava flour used in preparing Yakeyake is rich in moisture, ash, fibre and protein but contains less minerals such as vitamins. The findings of this study are also in agreement with that of Kouassi et al. (2022) who evaluated the qualities of pressed fermented cassava doughs. The authors reported that cassava dough has higher starch, dietary fibre, and moisture contents. Additionally, the findings of this investigation are inconsistent with that of Nilusha et al. (2021) who explored the characteristics of cassava varieties in food applications in Sri Lanka. Nilusha et al. (2021) discovered that cassava flours used for the study was contained less than one percent crude fat and less than two percent crude protein than that of wheat flour. Their study further revealed that the cassava flours are suitable for bakery foods, weaning foods and edible films

Proximate Composition of "Somillyake"

The findings of the study showed that CSMY 3 recorded the higher values of dry matter and carbohydrate compared with CSMY 1 and CSMY 2.

The findings of this study further discovered that CSMY 2 recorded the highest value of moisture, ash content, protein content and fat content relative to the other food samples (i.e., CSMY 1 and CSMY 3). Finally, CSMY 1 recorded the highest value of fibre (8.28%) compared with other samples of fortified soya-millet-yakeyake. The findings of this study suggest that in terms of the proximate/nutritional composition of somillyake, CSMY 2 and CSMY 1 were more likely to provide the body with more essential nutrients (i.e., ash content, protein, fat, moisture, and fibre) required for body growth and nourishment compared to CSMY 3 which recorded the highest values for few nutrients such as CHO and dry matter.

These findings were in line with findings of Etiosa et al. (2017) who reported that soya beans are a valuable source of macronutrients and minerals, particularly protein and phosphorus, that could be utilised to improve the nutritional status of the underprivileged population in developing countries. This finding is in agreement with the findings of this current study which also found that food samples CSMY 2 and CSMY 1 which contain a lot of soya bean has the potential to supply the body with vital nutrients necessary for growth and nourishment, including ash content, protein, fat, moisture, and fibre. The findings of the current study are also consistent with the findings of the study conducted by Szostak et al. (2020). In their study, Szostak, et al., (2020) conducted a study to compare the nutritional content of two soya bean species (Amandine and Merlin) based on their protein and fat content. The authors discovered that generally, soya beans have higher levels of crude ash, crude protein, and crude fibre which improve human growth and development.

The findings from this study showed that food samples CSMY 2 and CSMY 1 contained a lot of millet and had essential nutritional value that improve growth and nourishes the body are in agreement with that of Ramashia et al. (2019) who revealed that the nutritional composition of finger millet reduces the risk of various health conditions, including diabetes mellitus, high blood pressure, and gastrointestinal tract disorders, when consumed. Findings also support that of Abah et al. (2020) who reported that millets are rich in minerals and vitamins, including vitamin E which functions as an antioxidant that protects the body from the negative effects of free radicals that are often present in the atmosphere. Findings also support that of Jukanti et al. (2016) who found that millet is rich in B-vitamins however, it does not contain vitamin C. Their study revealed that these nutrients are beneficial in preventing various diseases in humans, such as cancer, diabetes, neuro-degenerative diseases as well as cardiovascular related diseases.

Proximate Composition of Commercially-Made Yakeyake and the Three Different Products of "Somillyake"

The findings of the study revealed significant differences in the proximate composition (i.e., in terms of dry matter, moisture, ash content, protein, fat, fibre and carbohydrate) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3). Thus, in terms of dry matter, the findings of the study showed that the amount of nutrients available in “CSMY 3” outweighed the proportion of nutrient available in the “commercially-made yakeyake”. The implication of this result suggests that, since dry matter connotes the nutrients remaining in a particular food after water has been evaporated from the food, the consumption of foods high in dry matter content promotes bodily growth and maintenance. That is to say, the consumption of “CSMY 3” has the higher likelihood of promoting bodily growth and maintenance compared with the consumption of “commercially-made yakeyake.”

The findings of the study further discovered that the moisture content of commercially-made yakeyake was greater than the proportion of moisture in “CSMY 3.” The implication of this result suggest that commercially-made yakeyake contains a lot of water compared with “CSMY 3.” The findings of this investigation also revealed that in terms of ash content, CSMY 2 contains greater proportion of minerals required for body growth relative to CSMY 1, CSMY 3, and commercially-made yakeyake. The implication of this result suggests that CSMY 2 contains greater percentage of minerals required for body growth relative to CSMY 1, CSMY 3, and commercially-made yakeyake.

It was also evident in the findings of the current study that CSMY 2 contains greater percentage of protein required for repairing worn-out tissues compared with CSMY 1, CSMY 3, and commercially-made yakeyake. The findings of this study further revealed that CSMY 2 contains greater proportion of essential fats required for body nourishment compared with CSMY 1, CSMY 3, and commercially-made yakeyake. Again, the findings of this investigation revealed that CSMY 1 contain greater proportion of fibre and roughages required for easy digestion compared with CSMY 2, CSMY 3, and commercially-made yakeyake. Lastly, the findings of this study revealed that in terms of carbohydrate, commercially-made yakeyake contains greater proportion of glucose compared with CSMY 1, CSMY 2 and CSMY 3.

The findings that CSMY 3 contained a lot of dry matter was consistent with the findings of Chisenga et al. (2019) who reported that cassava contains high level of dry matter. Findings of this study are also in agreement with that of Nilusha et al. (2021) who reported that cassava is rich in dry matter and this makes it suitable for bakery foods, weaning foods and edible bakery products. Similarly, the findings that CSMY2 contains a lot of soya bean and has greater proportion of essential fats and vitamins required for body nourishment, supports the findings of Bayero et al. (2019) who discovered that soya bean is a valuable source of high-quality protein, oil, and other essential nutrients. This discovery is also in line with the findings of Etiosa et al. (2017) who revealed that soya beans contain valuable nutrients which can be employed to prepare functional foods with enhanced nutritional values.

Functional Properties of Commercially-Made Yakeyake and the Three Different Products of "Somillyake"

The findings of the study showed significant differences in the functional properties (i.e., in terms of hydration capacity, swelling capacity, bulk density and emulsion activity) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3). Thus, in terms of hydration capacity, the findings of the study revealed that the amount of water absorbed by “CSMY 2” to ensure desirable consistency and also create a quality food product was higher compared to the water absorbed by “CSMY 3” and the commercially made yakeyake. That is to say, the ability of “CSMY 2” to record a higher water capacity could be attributed to quantity of carbohydrate, protein, and fibre present in the food sample. In other words, the water holding capacity of a food sample could be attributed to the higher amount of carbohydrate, fibre and protein present in the food sample.

The findings of this study also revealed that in terms of swelling capacity, “CSMY 3” recorded a higher swelling capacity relative to the swelling capacity of “CSMY 2” and “commercially-made yakeyake.” The implication of this result is that “CSMY 3” as a food sample, has a higher ability to absorb water and swell relative to “CSMY 2” and the commercially made yakeyake. The implication of this results also suggest that “CSMY 3” as a food sample had a higher starch content (i.e., 80% cassava, 15% protein and 5% fibre) compared with “CSMY 2” and the commercially made yakeyake. This results make a lot of meaning since there is a direct relationship between the starch content in a particular food sample and the swelling capacity of the that particular food sample. That is to say, food samples that have high starch content, especially for branched amylopectin starch content, have a higher likelihood of recording a higher swelling capacity relative to food samples that have low starch content.

It was further discovered that in terms of bulk density, “CSMY 2” as a food sample had a higher bulk density compared with the bulk density of “CSMY 1,” “CSMY 3,” and commercially made yakeyake. The implication of this result suggest that since bulk density measures the heaviness of a particular food sample and also determines the required packaging material for the said food sample, it can be inferred that, a denser or compactible packaging material will be required for packaging and transporting “CSMY 2” relative to CSMY 1,” “CSMY 3,” and commercially made yakeyake, due to the high bulk density of “CSMY 2” as a food sample. The high bulk density of “CSMY 2” could be attributed to the initial moisture content of the food product as well as the starch content of “CSMY 2”, since moisture and starch contents form the main structure and bulk density of a food product.

The findings of this study finally revealed that in terms of emulsion activity, commercially made yakeyake as a food product recorded a higher emulsion activity compared with CSMY 1, CSMY 2, and CSMY 3. The implication of this result suggests that since emulsion capacity of food often measures the ability of soluble proteins, water, and non-polar amino acids residues to migrate to the water or oil interface of food products, it can be inferred that the “commercially made yakeyake” exhibited a high “water-in-oil” emulsion activity due to the high moisture content of the “commercially made yakeyake” relative to CSMY 1, CSMY 2, and CSMY 3 which had a lesser moisture content. That is to say since “commercially made yakeyake” recorded a high moisture content, it could be inferred that an emulsion of “water-in-oil” activity is formed, where the dispersed phase is water and the continuous phase is oil. This could be attributed to the amount of oil and non-polar amino acid residue on the surface of protein, water, and other components of the "commercially made yakeyake."

The findings that CSMY 2 has a high water-holding capacity compared to the other food samples CSMY 1 and CSMY 3 was similar to the findings of Eden and Rumambarsari (2020) who reported that food products containing high proportions of soya bean have the tendency of recording high hydration capacity. The authors indicated that, this could be attributed to the high protein and fibre content present in soya beans. This finding is also consistent with that of Kouassi et al. (2022) who examined the functional properties of fermented cassava dough. The authors reported that due to the high starch and fibre content present in the grated cassava, the cassava dough was able to record a high-water content. This discovery is in line with the findings of this study which discovered that food sample CSMY 2 recorded a high hydration capacity due to the high amount of carbohydrate, fibre and protein present in the food sample.

The findings that "CSMY 3" recorded a higher swelling capacity relative to the swelling capacity of "CSMY 2" and "commercially-made yakeyake" is consistent with the findings of Nilusha et al. (2021) who conducted a study to examine the functional properties of cassava varieties in food applications. The authors reported that cassava varieties used in the study had high water solubility index and high swelling power. The findings of this study also support the assertion of Kouassi et al. (2022) who revealed that the swelling capacity of a food product could be attributed to the water holding capacity of the said food product as well as the starch content of the food product.

Furthermore, the findings that commercially made yakeyake as a food product recorded a higher emulsion activity compared with CSMY 1, CSMY 2, and CSMY 3 agrees with the findings of findings of Nilusha et al. (2021) who conducted a study to examine the functional properties of cassava varieties in food applications. The authors discovered that cassava varieties used in the study had high water emulsion stability and emulsion activity. This to a very large extent could be attributed to the high moisture content present in cassava samples.

Sensory Properties and Consumers' Acceptability of Commercially-Made Yakeyake and the Three Different Products of "Somillyake"

The findings of this study revealed significant differences in the sensory properties (i.e., in terms of appearance, colour, texture, aroma, taste, aftertaste and overall acceptability) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3). The findings of the study revealed that respondents had high preference for food sample 2 in terms of appearance, colour and taste compared to the other food samples. This result suggests that food sample 2 (i.e., CSMY 1) appeared more appealing in terms of appearance, colour and taste to respondents compared to the other food samples. This could be attributed to the content of soya bean and red millet present in food sample 2. Unlike the other food samples, food sample 2 contained less cassava and more soya bean and red millet (i.e., 50:30: 20). It was further revealed that respondents preferred the aroma and aftertaste of food sample 3 compared to the other food samples. The high preference of the aroma and aftertaste of food sample 3 could be attributed to the high content of soya bean and millet present in the sample. This to a very large extent gave the product a savoury smell and flavour. The result could also suggest that that the proportion of grated cassava, soya beans and millet contents in food sample 3 (i.e., 60:30:10) gave respondents a desirable aftertaste upon consuming the product.

For this study, respondents preferred the texture of food sample 4 compared to the other food samples. The preference for the texture of food sample 4 (i.e., CSMY 3) could be attributed to the stiffy nature of the food sample, and this could be due to the high percentage content of cassava in food sample 4 relative to the other food samples. Finally, in terms of overall acceptability, the findings of this study showed that respondents had high preference for food sample 3 relative to the other food samples. By implication, the results suggest that food sample 3 (i.e., CSMY 2) was the most preferred somillyake endorsed by the panelists. The endorsement of food sample 3 as the overall acceptable food sample could be attributed to the proportions (i.e., 60:30:10) of grated cassava, soya beans and red millet contents present in the food sample. The choice of sample 3 by respondents could also be attributed to the fact that the product had the sensory attributes most preferred by the respondents (consumers).

The findings of this study corroborated the findings of Bothma et al. (2020) who reported that the aroma, taste, texture and aftertaste of food products are essential attributes that influences consumers' acceptability and preference for food items. Thus, since consumers are rational in their choices of food products, they often take into consideration the aforementioned attributes (i.e., aroma, taste, texture, colour, and aftertaste) of a given food product before making a final decision on which choice of food product to select. Bothma et al. (2020) further reported that the nutritional composition of food products also influences its acceptability by consumers. That is to say, before a rational consumer settles on selecting a particular food product, such a consumer often considers the nutritional contents of the food product.

Consumers are more likely to select more nutritious and appetising food products displayed on the shelves compared to food products that are not nutritious and appetising. This finding agrees with the discovery of this study which revealed that respondents had high preference for food sample 2 in terms of appearance, colour and taste compared to the other food samples. The findings of Bothma et al. (2020) also supports the findings of this current investigation on the basis that respondents had high preference for food sample 3 relative to other food samples. The choice of sample 3 by respondents could also be attributed to the fact that the product had the sensory attributes most preferred by the respondents (consumers).

The findings of this study are also consistent with the findings of Sirangelo (2019) who revealed that the success of food products or its acceptability on the food market is dependent on how appealing it is to the senses of the consumers. This assertion agrees with the current findings of this study on the basis that respondents bad a high preference for food sample 2 (i.e., CSMY 1) because the sample appeared more appealing in terms of appearance, colour and taste to respondents compared to the other food samples. Finally, the findings of this investigation also supports the findings of Lysak et al. (2019) who reported that when consumers are provided with a comprehensive product information (i.e., information about the product, its cultural relevance and nutritional benefits), their acceptance towards the food product increases. In relation to this study, it can be said that, since consumers participated in a sensory evaluation in assessing the attributes (i.e., appearance, colour, texture, aroma, taste and aftertaste) of the various food samples, they were in a better position to determine and select the food sample that suits their preference in terms of overall acceptability. In view of that it could be concluded that the choice of sample 3 by respondents could also be attributed to the fact that the product had the sensory attributes most preferred by the respondents (consumers).

Chapter Summary

The study examined consumers' acceptability of fortified soya-millet-yakeyake ("Somillyake") and its nutritional composition. The findings of the study showed that soya bean flour has good proximate/nutritional composition in terms of dry matter content, ash content, protein content, fat content, and fibre content compared with other food samples such as red millet flour and grated cassava flour. The findings of this study further showed that, grated commercial cassava recorded the highest carbohydrate and moisture content in terms of proximate composition. The findings of the study also revealed that commercially-made yakeyake recorded some high values for the nutritional/proximate compositions. Topmost among these proximate compositions include carbohydrate (65.4%), moisture content (54.5%), dry matter (45.5%), fat (15.4%), protein (12.0%), fibre (4.61%) as well as ash content (2.61%).

The findings of the study also showed that CSMY 3 recorded the highest value of dry matter and carbohydrate compared with CSMY 1 and CSMY 2. The findings of this study further revealed that CSMY 2 recorded the highest value of moisture, ash content, protein content and fat content relative to the other food samples (i.e., CSMY 1 and CSMY 3). The findings of the study also revealed that CSMY 1 recorded the highest value of fibre compared to the other food samples of fortified soya-millet-yakeyake. Generally, the findings of the study revealed significant differences in the proximate composition (i.e., in terms of dry matter, moisture, ash content, protein, fat, fibre and carbohydrate) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3). In terms of the functional properties, the findings of the study generally revealed significant differences in the functional properties (i.e., in terms of hydration capacity, swelling capacity, bulk density and emulsion activity) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3).

Finally, the findings of this study reported significant differences in the sensory properties (i.e., in terms of appearance, colour, texture, aroma, taste, aftertaste and overall acceptability) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3). The findings of the study revealed that respondents had high preference for food sample 2 (i.e., CSMY 1) because it had appealing appearance, appetising colour and savoury taste compared to the appearance, colour and taste of the other food samples. It was further revealed respondents preferred the aroma and aftertaste of food sample 3 compared to the other food samples. The findings of this study also revealed that respondents preferred the texture of food sample 4 compared to the other food samples. In terms of overall acceptability, the findings of this study discovered that respondents had high preference for food sample 3 (i.e., CSMY 2) relative to other food samples.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents a summary of the study, the conclusions drawn from the study, suggestions and recommendations for further studies were also captured in this chapter. The suggestions and recommendations for further studies were based on the findings of the study.

Summary

Overview of the Study

The study examined consumers' acceptability of fortified soya-millet-yakeyake ("Somillyake") and its nutritional composition. This study was guided by six objectives which were transformed into three research questions and three hypotheses. The pre-experimental design, specifically the static-group comparison design as well as the cross-sectional survey design were employed in the conduct of this investigation. The population of this study comprised yakeyake consumers within the Duakor community. Using a purposive sampling technique, questionnaires were administered to 75 panel members for the sensory evaluation test. Sixty-five (65) questionnaires were however filled and returned, resulting in an 87% response rate. Hence, all the analyses on the sensory evaluation were based on 65 respondents. The data gathered were analysed using means and standard deviations as well as one-way repeated measures (ANOVA).

Key findings

The study presents the following findings:

1. Findings showed that soya bean flour has good proximate/nutritional composition in terms of dry matter content, ash content, protein content, fat content, and fibre content compared with other food samples such as red millet flour and grated cassava flour. The findings of this study further showed that, grated commercial cassava recorded the highest carbohydrate and moisture content in terms of proximate composition.
2. Findings of the study showed that commercially-made yakeyake recorded some high values for the nutritional/proximate compositions. Topmost among these proximate compositions include carbohydrate (65.4%), moisture content (54.5%), dry matter (45.5%), fat (15.4%), protein (12.0%), fibre (4.61%) as well as ash content (2.61%).
3. (a)Findings of the study showed that CSMY 3 recorded the highest value of dry matter and carbohydrate compared with CSMY 1 and CSMY 2.

   (b)Findings of this study further showed that CSMY 2 recorded the highest value of moisture, ash content, protein content and fat content relative to the other food samples (i.e., CSMY 1 and CSMY 3).

   (c)Findings of the study also showed that CSMY 1 recorded the highest value of fibre compared to the other food samples of fortified soya-millet-yakeyake.
4. Findings of the study showed significant differences in the proximate composition (i.e., in terms of dry matter, moisture, ash content, protein, fat, fibre and carbohydrate) of commercially-made yakeyake and the

three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3).

(a)Thus, in terms of dry matter, findings of the study showed that the amount of nutrients available in "CSMY 3" outweighs the amount of nutrient available in the "commercially-made yakeyake".

(b)Findings of the study further showed that the moisture content of commercially-made yakeyake was greater than the amount of moisture in "CSMY 3."

(c)Findings of this investigation also showed that in terms of ash content, CSMY 2 contains greater proportion of minerals required for body growth relative to CSMY 1, CSMY 3, and commercially-made yakeyake.

(d) CSMY 2 contained greater percentage of protein required for repairing worn-out tissues compared with CSMY 1, CSMY 3, and commercially-made yakeyake.

(e)Findings showed that CSMY 2 contains greater proportion of essential fats required for body nourishment compared with CSMY 1, CSMY 3, and commercially-made yakeyake.

(f)Findings showed that CSMY 1 contained greater proportion of fibre and roughages required for bowel movement compared with CSMY 2, CSMY 3, and commercially-made yakeyake.

(g) Lastly, findings showed that in terms of carbohydrate, commercially-made yakeyake contains greater proportion of glucose compared with CSMY 1, CSMY 2 and CSMY 3.

5. Significant differences in the functional properties (i.e., in terms of hydration capacity, swelling capacity, bulk density and emulsion activity) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3) were reported.

   (a)In terms of hydration capacity the amount of water absorbed by "CSMY 2" to ensure desirable consistency and also create a quality food product was higher compared to the water absorbed by "CSMY 3" and the commercially made yakeyake.

   (b) In terms of swelling capacity, "CSMY 3" recorded a higher swelling capacity relative to the swelling capacity of "CSMY 2" and "commercially-made yakeyake."

   (c)The bulk density of "CSMY 2" as a food sample was higher compared with the bulk density of "CSMY 1," "CSMY 3," and commercially made yakeyake.

   (d)Emulsion activity of the commercially made yakeyake was higher compared to the emulsion activities of CSMY 1, CSMY 2, and CSMY 3.

6. There were significant differences in the sensory properties (i.e., in terms of appearance, colour, texture aroma, taste, aftertaste and overall

acceptability) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3).

(a) Respondents had high preference for food sample 2 (i.e., CSMY 1) because it had appealing appearance, appetising colour and savoury taste compared to the appearance, colour and taste of the other food samples.

(b) They also preferred the aroma and aftertaste of food sample 3 compared to the other food samples. The respondents preferred the texture of food sample 4 compared to the other food samples.

(c) Finally, in terms of overall acceptability, the findings of this study showed that respondents had high preference for food sample 3 (i.e., CSMY 2) relative to other food samples. This implies that food sample 3 was the most preferred somillyake endorsed by the panelists. The endorsement of food sample 3 as the overall acceptable food sample could be attributed to the fact that the product had the sensory attributes most preferred by the respondents (consumers).

Conclusions

Based on the findings of this study, it can be concluded that soya bean flour has high amount of nutrients such as minerals, fatty acids, amino acids, as well as cellulose required for the nourishment of the body compared to grated cassava which is mainly a starchy diet that provides the body with glucose. The findings of this study also provide enough evidence to conclude that, grated cassava is able to retain a lot of water (i.e., water holding capacity) relative to soya bean flour and red millet flour. It can further be concluded that commercially-made yakeyake contains less amount of minerals required for growth since the food sample recorded a low ash content. The implication of this results is that although consumers of commercially-made yakeyake are likely to obtain enough energy from the consumption of such food, consumers also have a higher likelihood of not obtaining certain essential mineral elements required for proper body functioning.

This study also concluded that in terms of the proximate/nutritional composition of somillyake, CSMY 2 and CSMY 1 are more likely to provide the body with more essential nutrients (i.e., ash content, protein, fat, moisture, and fibre) required for body growth and nourishment compared to CSMY 3 which recorded the highest values for few nutrients such as CHO and dry matter. The findings of this study further revealed that there were significant differences in the proximate composition (i.e., in terms of dry matter, moisture, ash content, protein, fat, fibre and carbohydrate) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3). It was also concluded that there are significant differences in the functional properties (i.e., in terms of hydration capacity, swelling capacity, bulk density and emulsion activity) of commercially-made yakeyake and the three different products of the fortified soya-millet-yakeyake (i.e., CSMY 1, CSMY 2 and CSMY 3).

The findings of this current investigation further revealed that respondents had high preference for food sample 2 because it had appealing appearance, appetizing colour and savoury taste compared to the appearance, colour and taste of the other food samples. It was also revealed that respondents preferred the aroma and aftertaste of food sample 3 compared to the other food samples. Finally, the findings of this study revealed that in terms of overall acceptability, respondents had high preference for food sample 3 relative to other food samples. The implication of this result suggests that food sample 3 was the most preferred somillyake endorsed by the panelists. The endorsement of food sample 3 as the overall acceptable food sample could be attributed to the fact that the product had the sensory attributes most preferred by the respondents (consumers).

Recommendations

Based on the findings of the study and the conclusion drawn, the following recommendations were made to guide the development of policy and practice:

1. Soya bean flour has good proximate/nutritional composition in terms of dry matter, ash, protein, fat, and fibre content. Thus, it could be recommended by health workers to clients who could benefit from it.
2. Consumption of soya-millet-yakeyake (i.e., CSMY 2 and CSMY 1) could be promoted among yakeyake consumers by dieticians since such products contained essential nutrients required for growth and development.

3. In view of the fact that commercially-made yakeyake recorded high content of carbohydrate in terms of its nutritional composition, consumers of yakeyake within the Duakor community are admonished by the findings of this study to consume the commercially-made yakeyake in moderation, since excess consumption of the food sample could increase consumers' glucose/sugar level, and this could subsequently expose consumers to some lifestyle diseases such as diabetes, hypertension among others. In view of that, consumers are encouraged to consider consuming either CSMY 2 or CSMY 1 products of the soyamilet-yakeyake (Somilyake) since these products contained essential nutrients in their right proportions which could enhance consumers' body growth and nourishment.
4. Consumers of yakeyake within Duakor community are also encouraged by the findings of this study to patronise the consumption of soya-millet-yakeyake (i.e., CSMY 2) since CSMY 2 has a higher hydration capacity in terms of the amount of water CSMY 2 absorbs to ensure desirable consistency and also create a quality food product.
5. Since consumers had high preference for food sample 3 (i.e., CSMY 2) in terms of overall acceptability, dieticians, nutritionist, public health workers, dietetics and other significant individuals within the health industry are encouraged to educate and counsel yakeyake consumers and the general public on the importance of adding soya beans and millet to their carbohydrate diets since soya beans and millets have important

sensory attributes (such as appealing appearance, appetising colour and savoury taste) endorsed by most consumers of yakeyake. Again, since soya beans and millet contain important nutrients such as protein, fibre, fat, and minerals, an inclusion of such food products to cassava related meals for instance will help reduce the cyanide content in cassava related meals like yakeyake. This to a very large extent will also help in nourishing the human body which will in turn promote healthy living.

REFERENCES

Abah, C. R., Ishiwu, C. N., Obiegbuna, J. E., & Oladejo, A. A. (2020). Nutritional composition, functional properties and food applications of millet grains. *Asian Food Science Journal*, *14*(2), 9-19.

Abbey, T. K., Alhassan, A., Ameyibor, K., Essiah, J. W., Fometu, E., & Wiredu, M. B. (2001). *Integrated Science for Senior Secondary Schools*. Unimax Maxmillan Ltd., Accra North. Ghana.

Abormegah, L. (2019). *Development of starter culture for the production of Degue, a West African traditional fermented milk product*. Doctoral dissertation, University of Cape Coast).

Adebayo, K. (2009). Dynamics of technology adoption, in rural-based cassava processing enterprises in South-West Nigeria. *International Journal of Agricultural Economics and Rural Development*, *2*(1), 15–24.

Adu-Gyamfi, C. (2018). *Determining the glycaemic load of varieties of fufu in Ghana*. Doctoral dissertation, University of Cape coast.

Ajzen, I. (1985). From intentions to actions: A theory of planned behaviour. In *Action control: From cognition to behaviour.* Berlin, Heidelberg: Springer.

Ajzen, I. (2020). The theory of planned behavior: Frequently asked questions. *Human Behavior and Emerging Technologies*, *2*(4), 314-324.

Akyea-Mensah, N. (2020). *Consumer Acceptability of Orange Fleshed Sweet Potato Fortified Gari* (Doctoral dissertation, University of Cape Coast).

Allem, A. C. (2002). The origins and taxonomy of cassava. *Biology, production and utilization*, *1*(2), 16-20.

Amedahe, F. K., & Asamoah-Gyimah, K. (2015). *Introduction to educational research*. Cape Coast: UCC Printing Press.

Amelework, A. B., Bairu, M. W., Maema, O., Venter, S. L., & Laing, M. (2021). Adoption and promotion of resilient crops for climate risk mitigation and import substitution: A case analysis of cassava for South African agriculture. *Frontiers in Sustainable Food Systems*, *5*, 617-783.

Aniedu, C., Aniedu, O. C., & Nwakor, N. (2012). Impact and adoption of value-added innovations in root and tuber crops among farmers in Imo State, Nigeria. *Global Journal of Science Frontier Research Agriculture and Veterinary Sciences, 12*(11), 1–5.

Aparicio-Saguilan, A., Osorio-Diaz, P., Agama-Acevedo, E., Islas-Hernández, J. J., & Bello-Perez, L. A. (2013). Tortilla added with unripe banana and cassava flours: Chemical composition and starch digestibility. *Cyta-Journal of Food*, *11*(1), 90-95.

Awuchi, C. G., Igwe, V. S., & Echeta, C. K., (2019). Functional properties of foods and flours. *International Journal of Advanced Academic Research Sciences, Technology and Engineering, 5*(11), 139-160.

Bayata, A. (2020). Determination of proximate composition and anti-nutritional content of cassava in Ethiopia. *Academic Journal of Chemistry*, *5*(8), 116-121.

Bayero A. S., Datti Y., Abdulhadi M., Yahya A. T., Salihu I., Lado U. A., Nura T. & Imrana B. (2019). Proximate Composition and the Mineral Contents of Soya Beans (Glycine max). *Chemistry Search Journal* *10*(2), 62 – 65.

Bayitse, R., Tornyie, F., & Bjerre, A. B. (2017). *Cassava cultivation, processing and potential uses in Ghana*. Handbook on Cassava. Nova Science Publishers, Inc, 313-333.

Bothma, C., Cronje, N., Koen, M. & Hugo, A. (2020). Product development and consumer acceptability of soup made from Clariasgariepinus. *Journal of Food*, *18*(1), 572-579.

Bunkar, D. S., Goyal, S. K., Meena, K. K., & Kamalvanshi, V. (2021). Nutritional, Functional Role of Kodo Millet and its Processing. *International Journal of Microbiology and Applied. Sci*ence *10*(01), 1972-1985.

Chinea, C., Suárez, E., & Hernández, B. (2020). Meaning of food in eating patterns. *British Food Journal*, *122*(11), 3331-3341.

Chinwe, O. U., Ozumba, I. C., Adejumo, O. A., Ayuba, O. L., & Nwosu-Caeser, B. S. (2016). Sensory and comparative analysis of ordinary gari and cocosgari (Nutritionally fortified). *International Journal of Research Studies in Agricultural Sciences*, *2*(8), 27-32.

Chisenga, S. M., Workneh, T. S., Bultosa, G., & Laing, M. (2019). Proximate composition, cyanide contents, and particle size distribution of cassava flour from cassava varieties in Zambia. *AIMS Agriculture and Food, 4*(4), 869–891.

Choi, S. E. (2013). Sensory Evaluation. In S. Edelstein, *Food Science: An Ecological Approach,* (pp. 84-111). Jones & Bartlett Publishers.

Choi, Y. M., Lee, S. H., Choe, J. H., Kim, K. H., Rhee, M. S., & Kim, B. C. (2013). Effects of supercritical carbon dioxide treatment on meat quality and sensory evaluation in soy sauce and hot-pepper paste marinated pork. *Food Science of Animal Resources*, *33*(5), 581-586.

Dayakar R. B., Bhaskarachary K., Arlene C., Sudha G.D., Devi G., & Tonapi, V, A. (2017). *Nutritional and health benefits of Millets.* ICAR Indian Institute of Millets Research (IIMR).

Dayakar, R. B., Vishala, A. D., Arlene C. G. D, &Tonapi, V. A, (2016). *Millet recipes, a healthy choice.* ICAR- Indian Institute of Millets Research, Rajendranagar, Hyderabad.

Demuyakor, B., Galyuon, I., Kyereh, S., & Ahmed, M. (2013). Evaluation of Agronomic Performance of Drought-Tolerant QTL Introgression Hybrids of Millet (Pennisetum glaucum L R. Br.) in the Guinea Savannah Zone of Ghana. *International Journal of Agriculture Sciences*, *5*(1), 354-364.

Diaz-Mendez, C., & Gomez-Benito, C. (2008). *Food consumption and health*. Retrieved from www.laCaixa.es/ObraSocial

Doe-Addo, K. S., Boakye, A., Zaukuu, J-L. Z., Oduro, I. N., & Ellis, W. O. (2024). Physico-mechanical measurements, functional properties, proximate composition of newly developed climate-resilient cowpea (*Vigna unguiculata*) varieties and their classification with near-infrared spectroscopy. *Food Nutrition and Health*, *1*(6), 1-12.

Eden, W. T., & Rumambarsari, C. O. (2020). Proximate analysis of soya bean and red beans cookies according to the Indonesian National Standard. *Journal of Physics*, *1567*(2), 22-33.

Edge, M. S., Jones, J. M. & Marquart, L. (2005). A new life for whole grains. *Journal of American Dietetic Association*, *105*(12), 1856-1860.

Englyst, K. N., Liu, S., & Englyst, H. N. (2007). Nutritional characterization and measurement of dietary carbohydrates. *European Journal of Clinical Nutrition*, *61*(1), 19-39.

Eshun, G. (2012). Nutrient composition and functional properties of bean flours of three soya bean varieties from Ghana. African *Journal of Food Science and Technology*, *3*(8), 2141-5455

Etiosa, O. R., Chika, N. B., & Benedicta, A. (2017). Mineral and proximate composition of soya bean. *Asian Journal of Physical and Chemical Sciences*, *4*(3), 1-6.

Fafa, G. (2009). *Yakeyake recipe.* Retrieved from http/www.myrecipejoint.com

Food and Agriculture Organisation [FAO] (2001). *Statistics.* Rome, Italy. Bulletin Statistics, *2*, 47-48.

Food and Agriculture Organisation [FAO] (2012). *Agricultural statistics*. Retrieved from http://faostat.fao.org.

Food and Agriculture Organization of the United Nations (FAO, 2013). *Save and Grow: Cassava. A guide to sustainable production intensification*. Rome.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th ed.). McGraw-Hill.

Garcia-Gomez, B., Fernández-Canto, N., Vázquez-Odériz, M. L., Quiroga-García, M., Munoz-Ferreiro, N., & Romero-Rodríguez, M. Á. (2022). Sensory descriptive analysis and hedonic consumer test for Galician type breads. *Food Control*, *134*, 108-765.

Ghana Exports Promotion Authority [GEPA] (2019). *Sector capabilities, cassava from Ghana.* Retrieved from https://www.gepaghana.org

Ghana Statistical Service [GSS]. (2021). *2021 population and housing census: Summary report of final results. Accra:* Author.

Hahn, S. K. (1997). *Traditional processing and utilization of cassava in Africa: IITA research guide, No. 41*.

Haruna, M., Abudulai, M., Denwar, N.N., Mohammed A.M. & Salifu A. B. (2017). *Farmers guide to successful soya bean production on Ghana*. Council for Scientific and Industrial Research.

Ibegbulem, C. O, & Chikezie, P. C. (2018). Comparative proximate composition and cyanide content of peeled and unpeeled cassava roots processed into gari by traditional methods. *Research Journal of Food and Nutrition, 2*(2),1-13

Ihekoronye, A. I., & Ngoddy, P. O. (1985). *Integrated food Science and technology for the tropics.* McMillan publishers.

Jukanti, A. K., Gowda, C. L., Rai, K. N., Manga, V. K., & Bhatt, R. K. (2016). Crops that feed the world 11. Pearl Millet (Pennisetum glaucum L.): An important source of food security, nutrition and health in the arid and semi-arid tropics. *Food Security*, *8*, 307-329.

Julie, A. M., Christopher, R. D., & Sherry, A. T. (2009). Nutritional value of cassava for use as a staple food and recent advances for improvement. institute of food technologists. *Comprehensive Reviews in Food Science and Food Safety, 8*, 181-192.

Karuppasamy, P. (2015). Overview on millets. *Biosciences*, *8*(13), 3269-3273.

Kocke, S. (2019). The perception of cassava in Malawi: A literature study about a root crop's implication on food security in the past and the present. Master's Thesis Uppsala University.

Kouassi, K. B., Nindjin, C., Kouassi, K. N. & Amani, N. G. (2022). Specific qualities of pressed fermented cassava doughs used for attiéké production based on their geographical origin in Côte d'Ivoire, *International Journal of Food Properties*, *25*(1), 2617-2626.

Kure, O. A., Bahago, E. J., & Daniel, E. A. (1998). Studies on the proximate composition and effect of flour particle size of acceptability of biscuits produced from blends of soya beans and plantain flours. *Namoda Technological Scope Journal, 3*(2), 17-22.

Lawless, H. T., & Heymann, H. (2010). *Sensory evaluation of food: principles and practices* (Vol. 2). New York: Springer.

Lawless, H. T., & Heymann, H. (2013). *Sensory evaluation of foods: Principles and practices* (2nd ed). Springer Science, Business, New York, NY.

Lewis-Beck, M., Bryman, A. E., & Liao, T. F. (2003). *The Sage encyclopedia of social science research methods.* Sage Publications.

Lysak, M., Ritz, C., & Henriksen, C. B. (2019). Assessing consumer acceptance and willingness to pay for novel value-added products made from breadfruit in the Hawaiian Islands. *Sustainability, 11*(11), 3135.

Mahama, S. S. M. (2019). *Gender dimensions in the adaptations to climate variation by Cassva farmers in the Awutu Senya District* (Doctoral dissertation, University of Cape Coast).

Mahele, N., Inversen, N., Hem, L. & Otnes, C. (2015). Exploring consumer preferences for hedonic and utilitarian food attributes. *British Food Journal, 12*(117), 3039-3063.

Martin, W. E., & Bridgmon, K. D. (2012). *Quantitative and statistical research methods: From hypothesis to results.* Retrieved from http://ebookcentraproquest.com.

Mason, R. L., & Nottingham, S. M. (2002). Sensory evaluation manual. *Brisbane: University of Queensland*.

Miller, G. (2001) Whole grain, fiber and antioxidants. In: Spiller, G.A. (ed). *Handbook of dietary fiber in Human Nutrition*. Boca Raton, FL: CRC Press.

Navia, D. P., & Villada, H. S. (2012). Thermoplastic cassava flour. *Thermoplastic Elastomers*, *1*(2), 23-38.

Nemeth, D., Balazs, G., Bodor, Z., Zaukuu, J. L. Z., Kovacs, Z., & Kappel, N. (2020). Food quality attributes of melon (Cucumis melo L.) influenced by grafting. *Progress in Agricultural Engineering Sciences*, *16*(S1), 53-66.

Nielsen, C. (2016) *Global ingredient and out-of-home dining trends report.* Retrieved from https://www.nielsen.com.

Nilusha, R. A. T., Jayasinghe, J. M. J. K., Perera, O. D. A. N., Perera, P. I. P., & Jayasinghe, C. V. L. (2021). Proximate composition, physicochemical, functional, and antioxidant properties of flours from selected cassava (Manihot esculenta Crantz) varieties. *International Journal of Food Science*, *2021*.

Nkama I, & Badua, M. H. (2000) Weaning Food Produced from Blends of Sorghum and Soya bean. *Journal of Nutrition and Science, 8*(2), 1-4.

Nwosu, O. S. U. (2005). *Cassava cultivation, varieties available and land preparation*. Presented at State workshop on empowering the grass-roots through promotion of commercial cassava production and processing, Owerri, Nigeria.

Okogbenin, H. E., Egesi, S. K., Mba, C., Ekeokoro, E. U., Vicente, C., & Fegene, M. (2002). Genetic diversity assessment of cassava landraces and elite cultivation in Nigeria with simple sequence repeat (SSR). *NRCRI Umudike Annual Report*, 16-24.

Philip, T., Taylor, D., Sanni, I., Okechukwu, R., Ezedinma, C., Akorede, M., & Dixon, A. G. O. (2005). *The Nigerian cassava industry: Statistical hand-book.* Ibadan: International Institute of Tropical Agriculture (IITA).

Pratap, A., Gupta, S. K., Kumar, J., & Solanki, R. K. (2012). Soya bean. *Technological Innovations in Major World Oil Crops, Volume 1: Breeding*, 293-321.

Prinyawiwatkul, W. (2020). Relationships between emotion, acceptance, food choice, and consumption: some new perspectives. *Foods*, *9*(11), 1573.

Ramashia, S. E., Anyasi, T. A., Gwata, E. T., Meddows-Taylor, S., & Jideani, A. I. O. (2019). Processing, nutritional composition and health benefits of finger millet in sub-saharan Africa. *Food Science and Technology*, *39*, 253-266.

Ramashia, S. E., Mashau, M. E., & Onipe, O. O. (2021). Millets Cereal Grains: Nutritional Composition and Utilisation in Sub-Saharan Africa. *Food Science and Technology 2*(1), 414-425.

Rao, D. B., Bhaskarachary K., Arlene C. G.D., Sudha D. G., & Vilas, A. T. (2017). *Nutritional and health benefits of millets.* Indian Institute of Millets Research (IIMR) Rajendranagar, Hyderabad.

Rice, E., & Curtis, K. R. (2021). Drought-Tolerant Options for Southwest Agriculture: Grasses, Grains, and Legumes, *Finance and Economics,2(1), 1-7.*

Ritzer, G. (2008). *Sociological theory*. New York, NY: McGraw-Hill.

Rochmawati, N. (2019). *Food Science and Sensory Analysis*. OTTIMMO International Master Gourmet Academy

Saleh, A.S.; Zhang, Q.; Chen, J.; & Shen, Q. (2013). Millet grains: Nutritional quality, processing, and potential health benefits. *Food Science, 12,* 281–295.

Sanginga, N., & Mbabu, A. (2015). Root and tuber crops (cassava, yam, potato and sweet potato). In *proceedings of an action plan for African Agricultural Transformation Conference,* Dakar, Senegal.

Senapati, M., & Sahu, P. P. (2020). Meat quality assessment using Au patch electrode Ag-SnO2/SiO2/Si MIS capacitive gas sensor at room temperature. *Food Chemistry*, *324* (2020), 126893.

Sharif, M. K., Butt, M. S., Sharif, H. R., & Nasir, M. (2017). Sensory evaluation and consumer acceptability. *Handbook of Food Science and Technology*, 361-386.

Shea, Z., Singer, W. M., & Zhang, B. (2020). Soya bean production, versatility, and improvement. In *Legume Crops-Prospects, Production and Uses*. London, UK: IntechOpen.

Siamabele, B (2019). Soya beans production in Zambia: Opportunities and challenges. *American Journal of Agricultural and Biological Sciences*. 14, 55-60.

Siddiqui, S. A., Zannou, O., Karim, I., Kasmiati, Awad, N. M. H., Gołaszewski, J., Heinz, V., & Smetana, S. (2022). Avoiding food neophobic and increasing consumer acceptance of new food trends- A Decade of Research. *Sustainability*, 14(10391), 2-25.

Singh-Ackbarali, D., & Maharaj, R. (2014). Sensory evaluation as a tool in determining acceptability of innovative products developed by undergraduate students in food science and technology at the University of Trinidad and Tobago. *Journal of Curriculum and Teaching*, *3*(1), 10-27.

Sirangelo. T. M. (2019). Sensory descriptive evaluation of food products: A Review. *Journal of Food Science and Nutrition Research*, 2, 354-363.

Steinmetz, H., Knappstein, M., Ajzen, I., Schmidt, P., & Kabst, R. (2016). How effective are behaviour change interventions based on the theory of planned behaviour? A three-level meta-analysis. *Journal of Psychology 224*(3), 216–233.

Stone, H., & Sidel, J. L. (2004). Introduction to sensory evaluation. *Sensory Evaluation Practices (Third Edition). Academic Press, San Diego*, 1-19.

Suwonsichon, S. (2019). The importance of sensory lexicons for research and development of food products. *Foods*, *8*(1), 27-25.

Szostak, B., Glowacka, A., Kasiczak, A., Kieltyka-Dadasiewicz, A., & Bakowski, M. (2020). Nutritional value of soya beans and the yield of protein and fat depending on the cultivar and nitrogen application. *Journal of Elementology*, *25*(1), 5-57.

Weigand, J. M. (2018). *Diversifying Malawi's food security: Cassava's promise as a dual-purpose crop.* Master's thesis, University of Oslo.

Yasumatsu K, Sawada K, Maritaka S, Toda J, Wada T, Ishi K (1972). Whipping and emulsifying properties of soybean products. *Agriculture, Biology and Chemistry 36*, 719-727.

Yusuf, A. Z., Zakir, A., Shemau Z., Abdullahi, M., Halima, S. A., Abubakar, U., Sani, K. & Nuhu, M. (2014). Visual defects among consumers of processed cassava (gari). *African Journal of Food Science, 8(*1), 25-29.

Zierer, W., Rüscher, D., Sonnewald, U., & Sonnewald, S. (2021). Tuber and tuberous root development. *Annual review of plant biology*, *72*, 551-580.

APPENDIX A

INTRODUCTORY LETTER

UNIVERSITY OF CAPE COAST
COLLEGE OF EDUCATION STUDIES
FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF VOCATIONAL AND TECHNICAL EDUCATION

Direct: 03320-91097
Telegrams & Cables: University, Cape Coast

University of Cape Coast
Cape Coast

Our Ref: VTE/IAP/V.3/103

14th July, 2022

The Head
Institutional Review Board
UCC

Dear Sir,

INTRODUCTORY LETTER

We have the pleasure of introducing to you **Ms. Lydia Donkor** who is an M.Phil. student of this Department and working on the thesis topic **"Consumer Acceptability of Enriched Soya-Millet-Yakeyake (Somillyake)".**

Currently, she is at the data collection stage of her research work and we would be most grateful if you could assist her with the collection of data.

Thank you.

Yours faithfully,

Dr. Augustina Araba Amissah
HEAD OF DEPARTMENT

APPENDIX B

ETHICAL CLERANCE

UNIVERSITY OF CAPE COAST

INSTITUTIONAL REVIEW BOARD SECRETARIAT

TEL: 0558093143 / 0508878309
E-MAIL: irb@ucc.edu.gh
OUR REF: IRB/C3/VOL.1/0006
YOUR REF:
OMB NO: 0990-0279
IORG #: IORG0011497

27TH JANUARY 2023

Ms Lydia Donkor
Department of Vocational and Technical Education
University of Cape Coast

Dear Ms Donkor,

ETHICAL CLEARANCE – ID (UCCIRB/CES/2022/89)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted Provisional Approval for the implementation of your research on **Consumer Acceptability of Enriched Soya-Millet-Yakeyake ("Somillyake")** This approval is valid from 27th January 2023 to 26th January 2024. You may apply for a renewal subject to the submission of all the required documents that will be prescribed by the UCCIRB.

Please note that any modification to the project must be submitted to the UCCIRB for review and approval before its implementation. You are required to submit periodic review of the protocol to the Board and a final full review to the UCCIRB on completion of the research. The UCCIRB may observe or cause to be observed procedures and records of the research during and after implementation.

You are also required to report all serious adverse events related to this study to the UCCIRB within seven days verbally and fourteen days in writing.

Always quote the protocol identification number in all future correspondence with us in relation to this protocol.

Yours faithfully,

Kofi F. Amuquandoh

Ag. UCCIRB Administrator

ADMINISTRATOR
INSTITUTIONAL REVIEW BOARD
UNIVERSITY OF CAPE COAST

APPENDIX C

SENSORY EVALUATION QUESTIONNAIRE

SENSORY EVALUATION QUESTIONNAIRE

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATIONAL STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF VOCATIONAL AND TECHNICAL EDUCATION

Dear Respondent, I am Lydia Donkor and a student at the University of Cape Coast pursuing MPhil Home Economics (Food and Nutrition major). My research topic is; **consumers' acceptability of enriched soya-millet-yakeyake ("Somillyake").** This study seeks to assess the sensory properties of four different food samples, thus a commercially-made yakeyake as well as three different samples of enriched soya-millet-yakeyake (i.e., modified yakeyake) to determine if significant differences exist among the food samples. The data being collected is solely for academic purposes. Therefore, honest responses to the questions will be appropriate to evaluate the sensory properties of the aforementioned food samples and the most preferred by consumers. Every information provided would be used for that purpose. Your identity will not be exposed under any condition and the information provided will be treated as strictly confidential. In case you are allergic to any of the ingredients (soya bean, red millet, cassava) used in the preparation of the food samples, please do not volunteer to participate in this study.

Confidentiality and anonymity are assured. Your participation in this study is voluntary and do not hesitate to withdraw at any point if you desire to do so.

1

SECTION A: Background Information of Respondent

Kindly provide the right response by checking [√] in the blank spaces provided.

1. Gender: (a) Male [ ] (b)Female [ ]

2. Age-range: (a) 18-23 years [ ] (b) 24-29 years [ ] (c)30-35 [ ]

   (d) 36-41years [ ] (e) Above 41 years [ ]

INSTRUCTION FOR THE SENSORY EVALUATION

You have been presented with four (4) coded food samples (one of which is the reference sample). Taste the samples in the order presented (from left to right).

1. Please wash your mouth with the water provided before tasting the food samples.
2. Evaluate the food samples in the order they have been presented to you.
3. Kindly remember to wash your mouth with the water and spit out the contents into the cups provided before and after tasting each food sample.
4. Kindly taste each sample once. Do not repeat tasting of a sample more than once.
5. Please **tick** [√] the range of attributes provided based on your assessment of the food samples using the Likert-type scale provided.
6. Kindly **tick** [√] once.

	Sample 1 (CMY)			
ATTRIBUTES	**1**	**2**	**3**	**4**
Appearance	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Colour	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Texture	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Aroma/Flavour	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Taste	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Aftertaste	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Overall Acceptability	Not good [ ]	Good [ ]	Very good [ ]	Excellent [ ]

2

Sample 2 (SMY1)				
ATTRIBUTES	1	2	3	4
Appearance	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Colour	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Texture	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Aroma/Flavour	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Taste	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Aftertaste	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Overall Acceptability	Not good [ ]	Good [ ]	Very good [ ]	Excellent [ ]

Sample 3 (SMY2)				
ATTRIBUTES	1	2	3	4
Appearance	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Colour	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Texture	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Aroma/Flavour	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Taste	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Aftertaste	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Overall Acceptability	Not good [ ]	Good [ ]	Very good [ ]	Excellent [ ]

3

Sample 4 (SMY4)				
ATTRIBUTES	1	2	3	4
Appearance	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Colour	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Texture	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Aroma/Flavour	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Taste	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Aftertaste	Dislike very much [ ]	Dislike moderately [ ]	Liked moderately [ ]	Liked very much [ ]
Overall Acceptability	Not good [ ]	Good [ ]	Very good [ ]	Excellent [ ]

Comments:

....

....

....

....

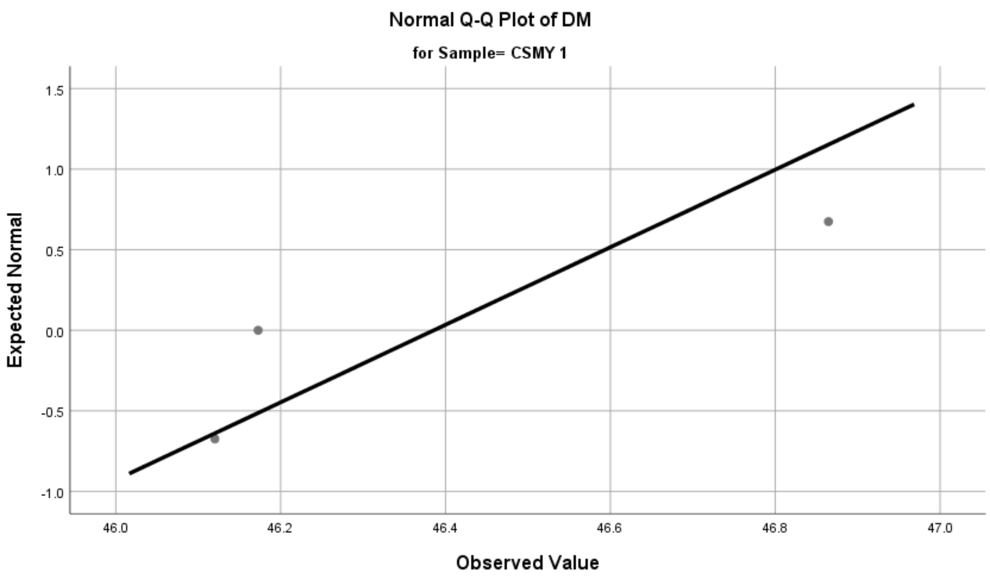
Thank you for your participation.

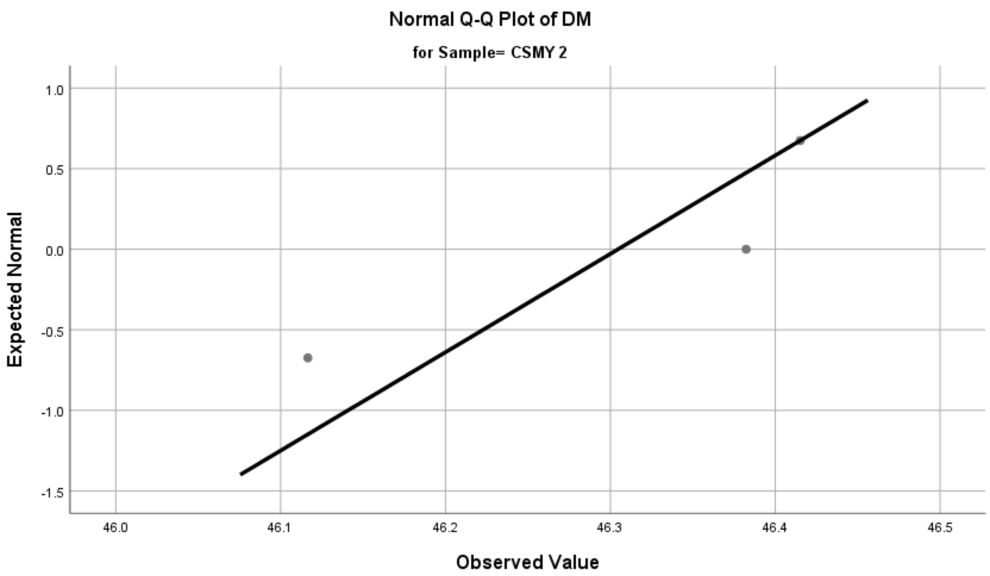
4

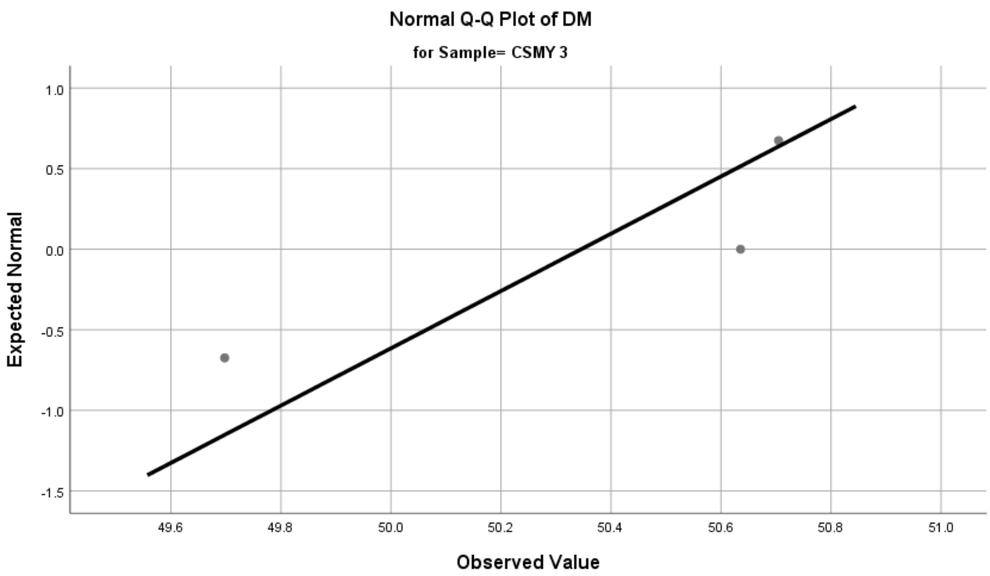
APPENDIX D

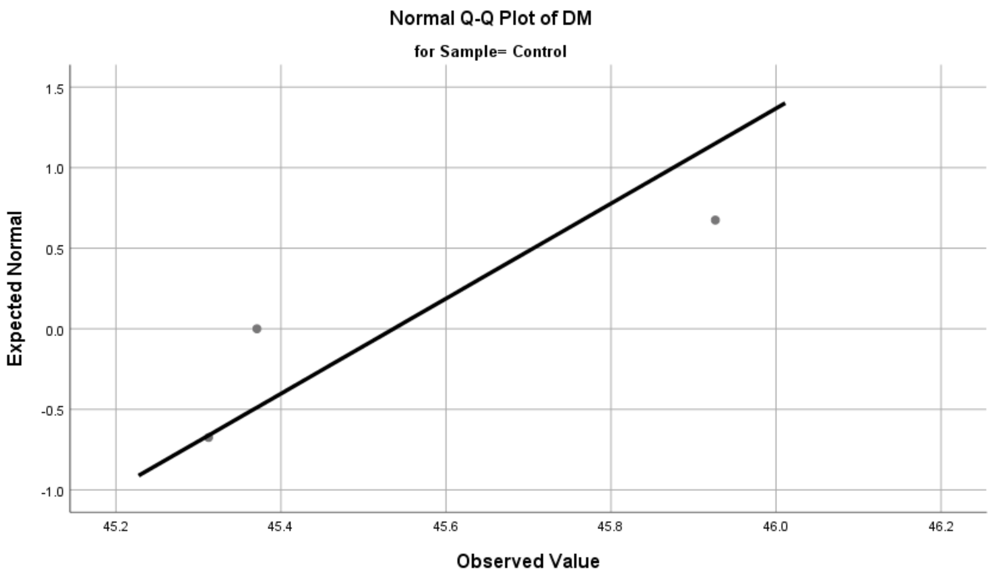
NORMALITY ASSUMPTION

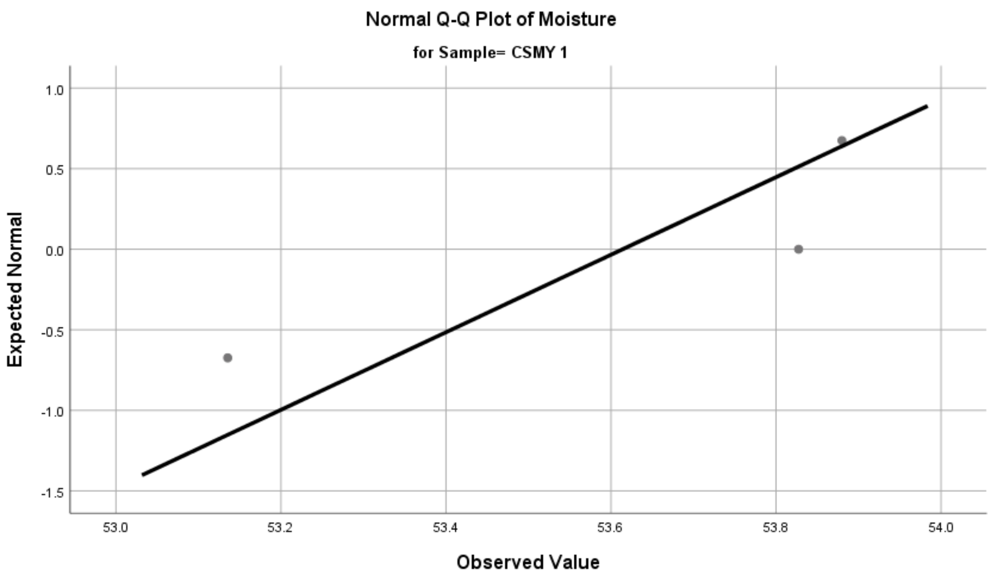
HYPOTHESIS 1

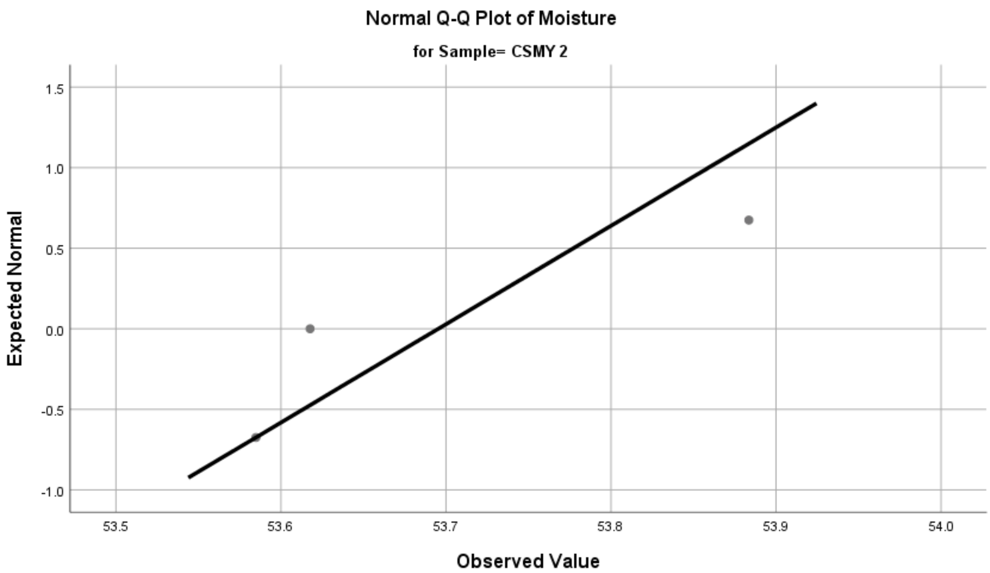


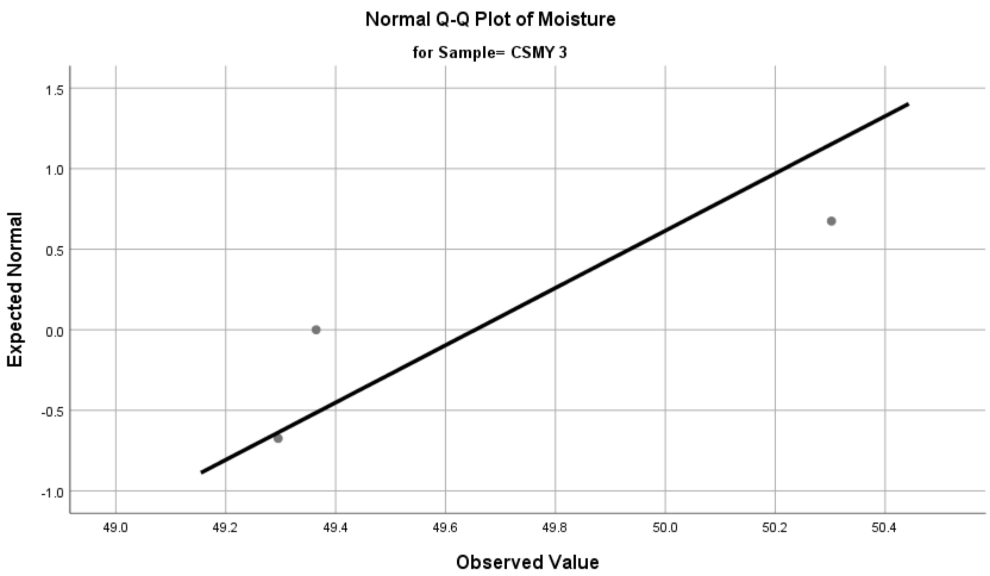


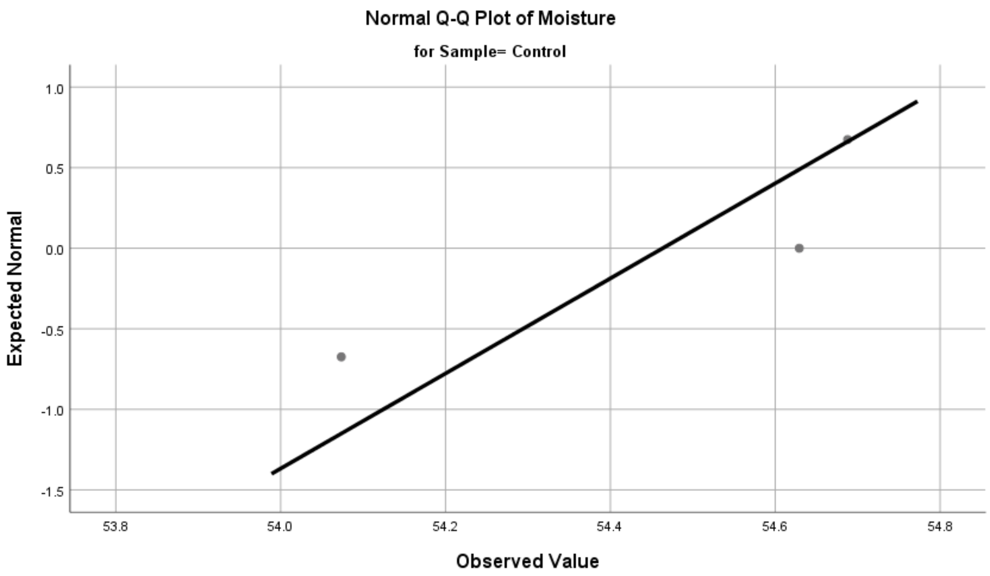

Normal Q-Q Plot of DM
for Sample= CSMY 3
Expected Normal
Observed Value
1.0
0.5
0.0
-0.5
-1.0
-1.5
49.6
49.8
50.0
50.2
50.4
50.6
50.8
51.0

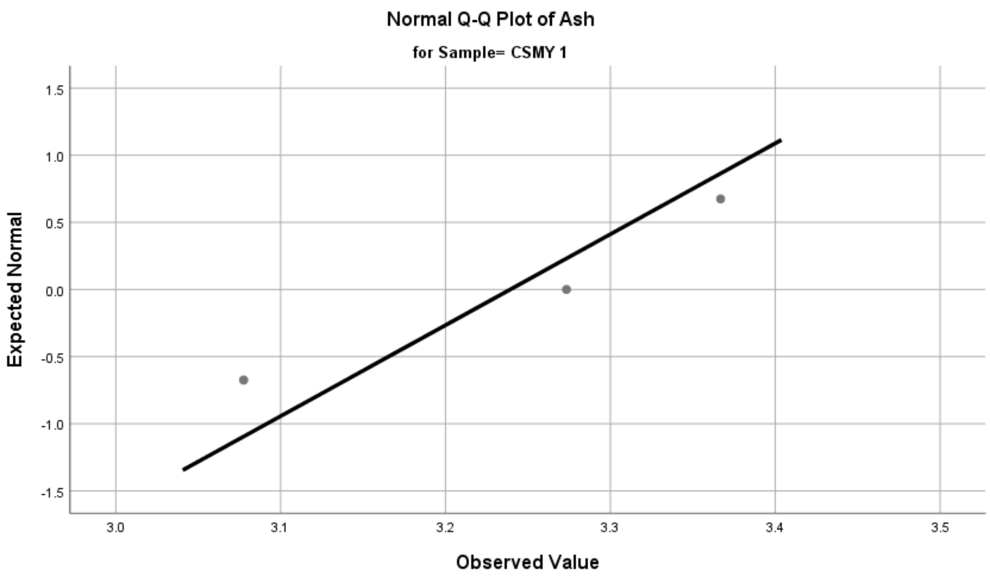

Normal Q-Q Plot of DM
for Sample= Control
Expected Normal
Observed Value
1.5
1.0
0.5
0.0
-0.5
-1.0
45.2
45.4
45.6
45.8
46.0
46.2

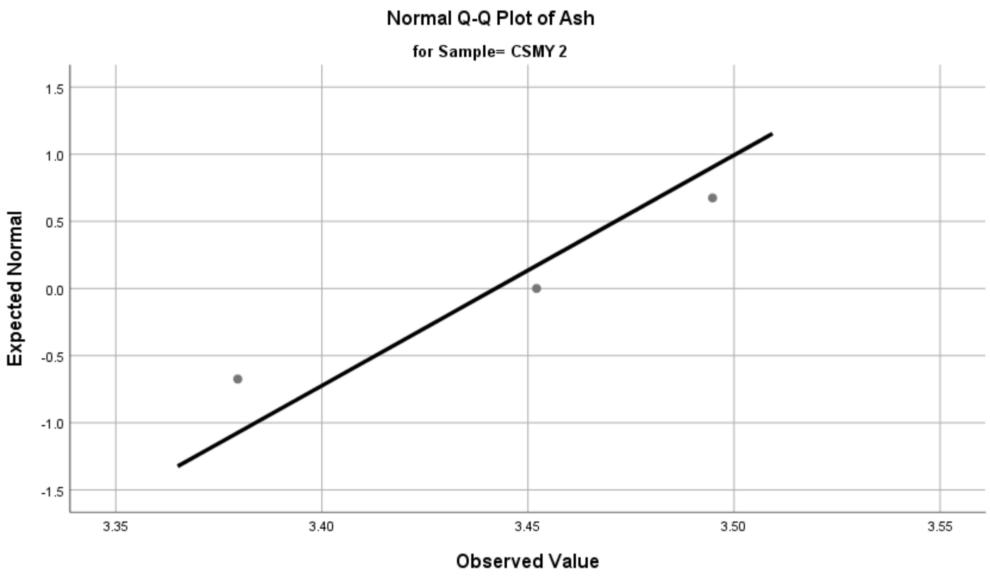

Normal Q-Q Plot of Moisture
for Sample= CSMY 1
Expected Normal
1.0
0.5
0.0
-0.5
-1.0
-1.5
53.0
53.2
53.4
53.6
53.8
54.0
Observed Value

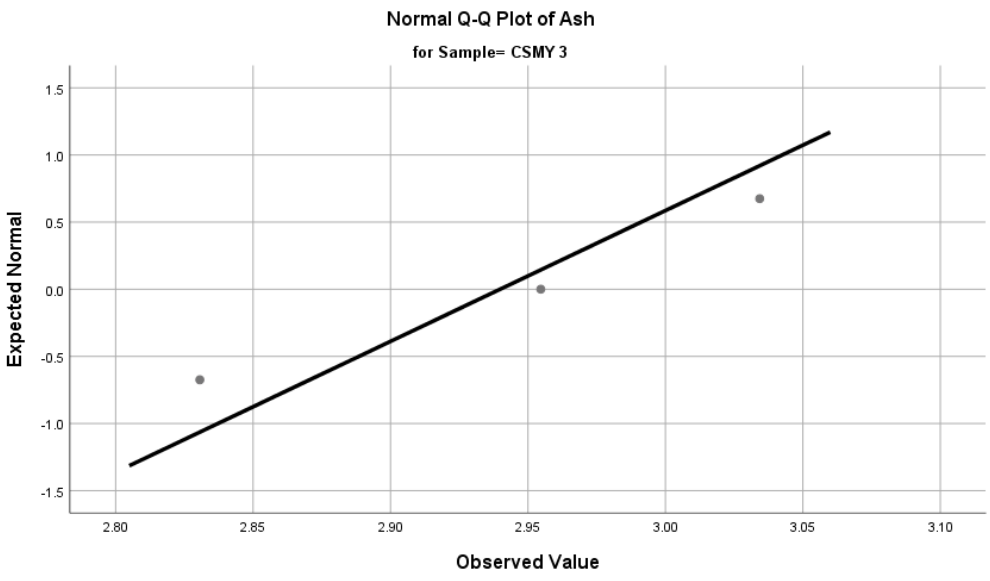

Normal Q-Q Plot of Moisture
for Sample= CSMY 2
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
53.5
53.6
53.7
53.8
53.9
54.0
Observed Value

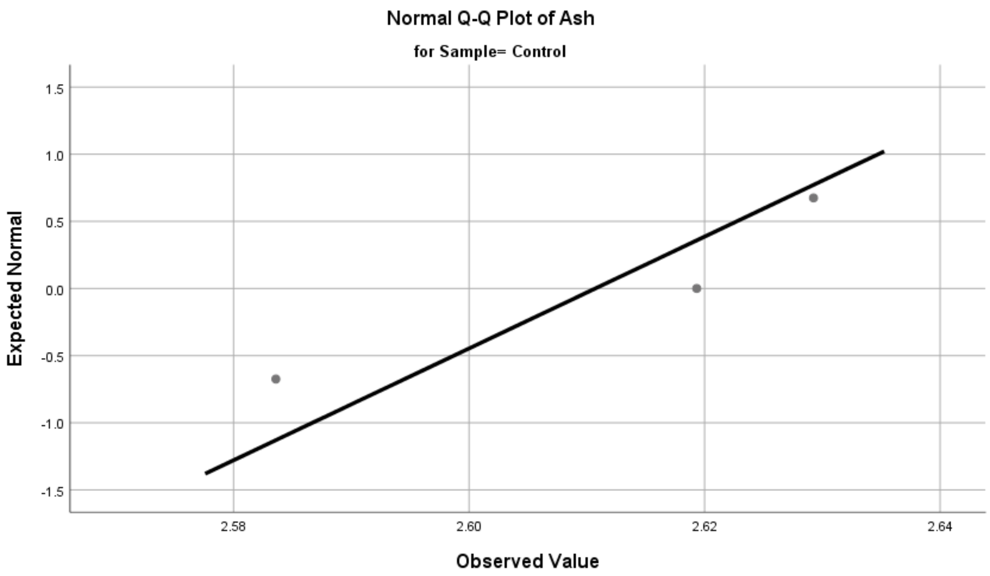

Normal Q-Q Plot of Moisture
for Sample= CSMY 3
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
49.0
49.2
49.4
49.6
49.8
50.0
50.2
50.4
Observed Value

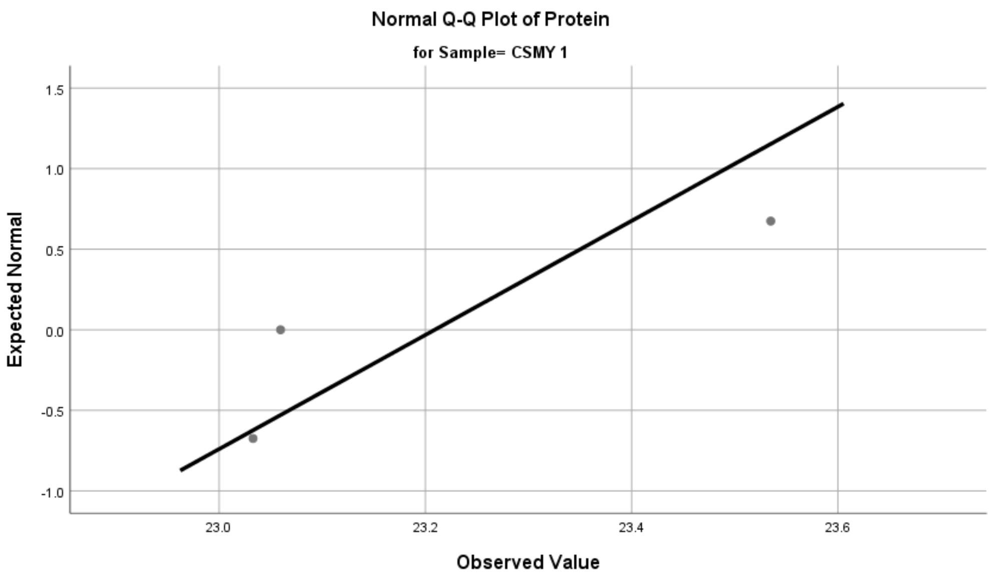

Normal Q-Q Plot of Moisture
for Sample= Control
Expected Normal
1.0
0.5
0.0
-0.5
-1.0
-1.5
53.8
54.0
54.2
54.4
54.6
54.8
Observed Value

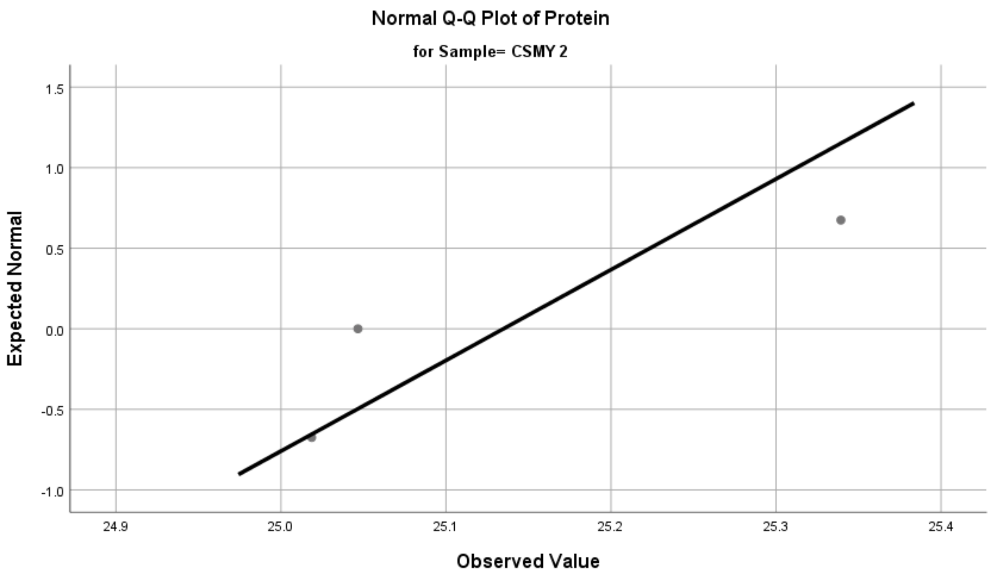

Normal Q-Q Plot of Ash
for Sample= CSMY 1
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
3.0
3.1
3.2
3.3
3.4
3.5
Observed Value

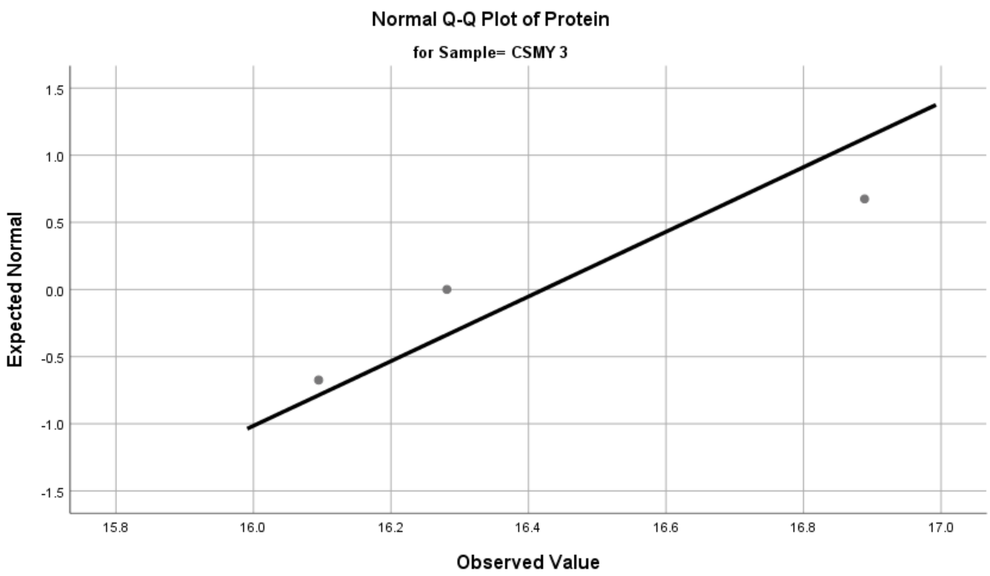

Normal Q-Q Plot of Ash
for Sample= CSMY 2
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
3.35
3.40
3.45
3.50
3.55
Observed Value

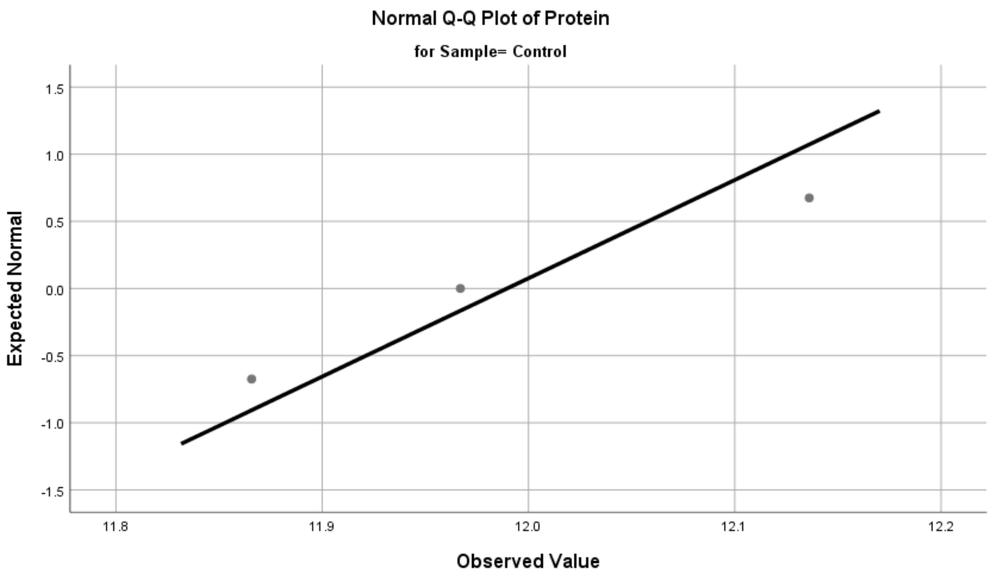

Normal Q-Q Plot of Ash
for Sample= CSMY 3
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
2.80
2.85
2.90
2.95
3.00
3.05
3.10
Observed Value

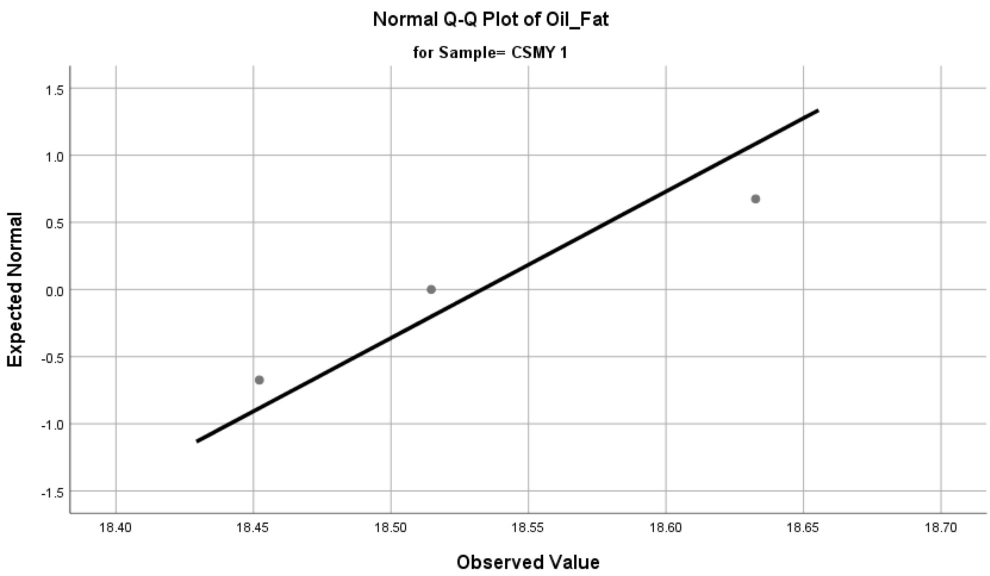

Normal Q-Q Plot of Ash
for Sample= Control
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
2.58
2.60
2.62
2.64
Observed Value

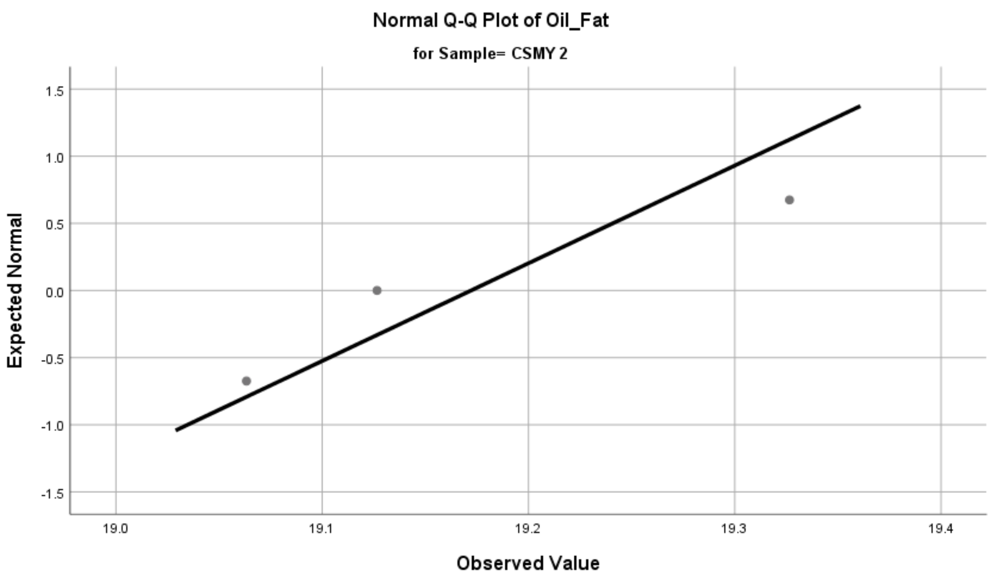

Normal Q-Q Plot of Protein
for Sample= CSMY 1
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
23.0
23.2
23.4
23.6
Observed Value

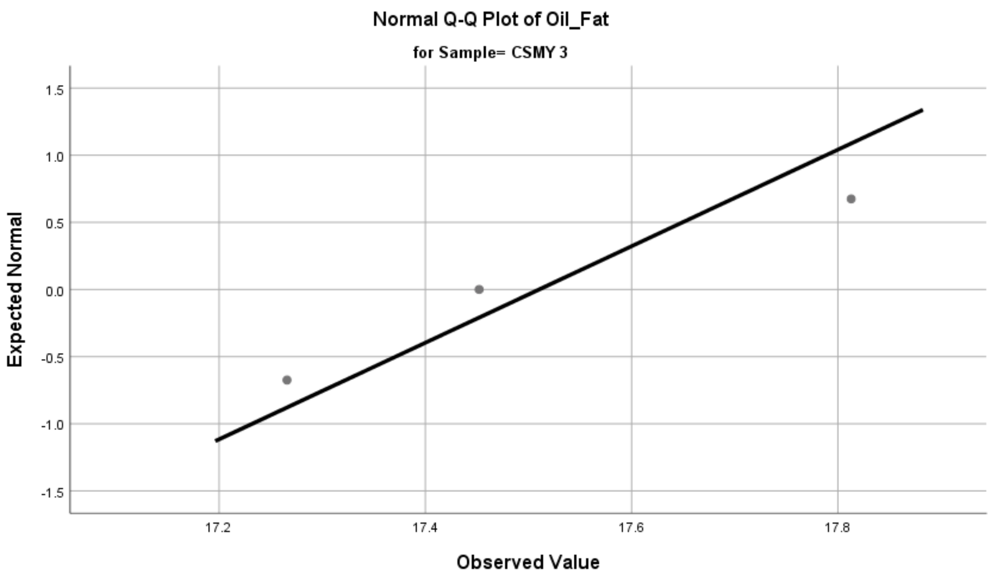

Normal Q-Q Plot of Protein
for Sample= CSMY 2
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
24.9
25.0
25.1
25.2
25.3
25.4
Observed Value

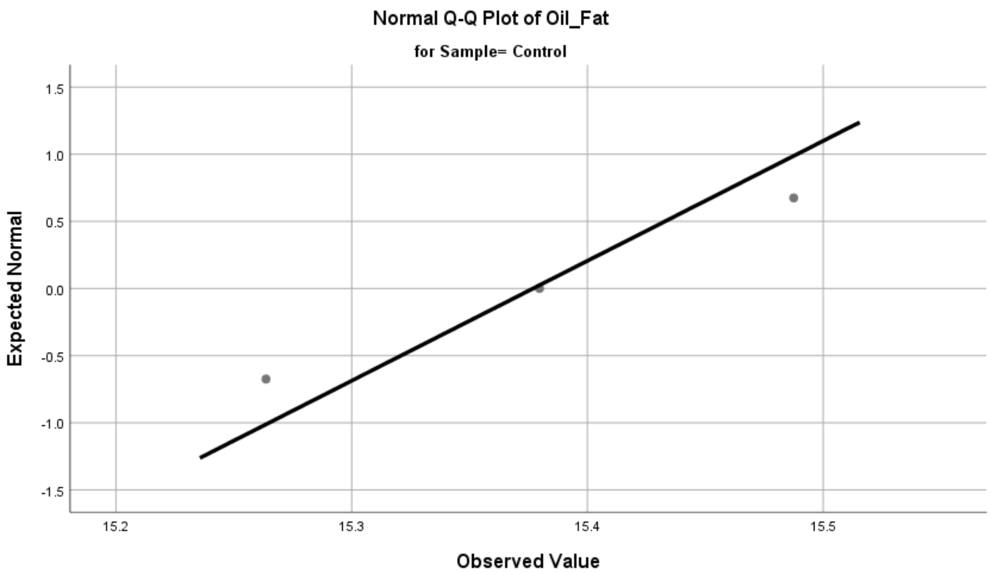

Normal Q-Q Plot of Protein
for Sample= CSMY 3
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
15.8
16.0
16.2
16.4
16.6
16.8
17.0
Observed Value

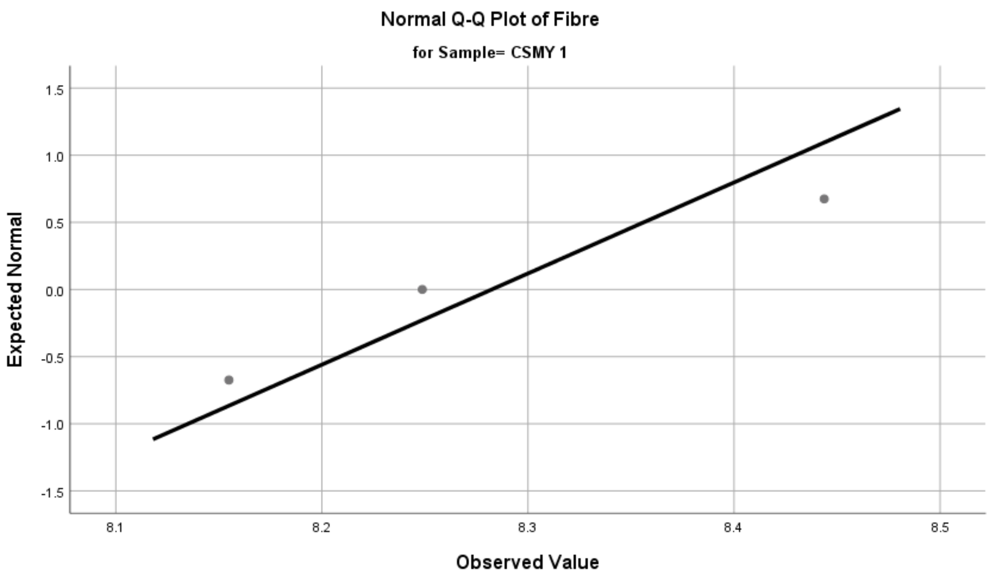

Normal Q-Q Plot of Protein
for Sample= Control
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
11.8
11.9
12.0
12.1
12.2
Observed Value


Normal Q-Q Plot of Oil_Fat
for Sample= CSMY 1
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
18.40
18.45
18.50
18.55
18.60
18.65
18.70
Observed Value

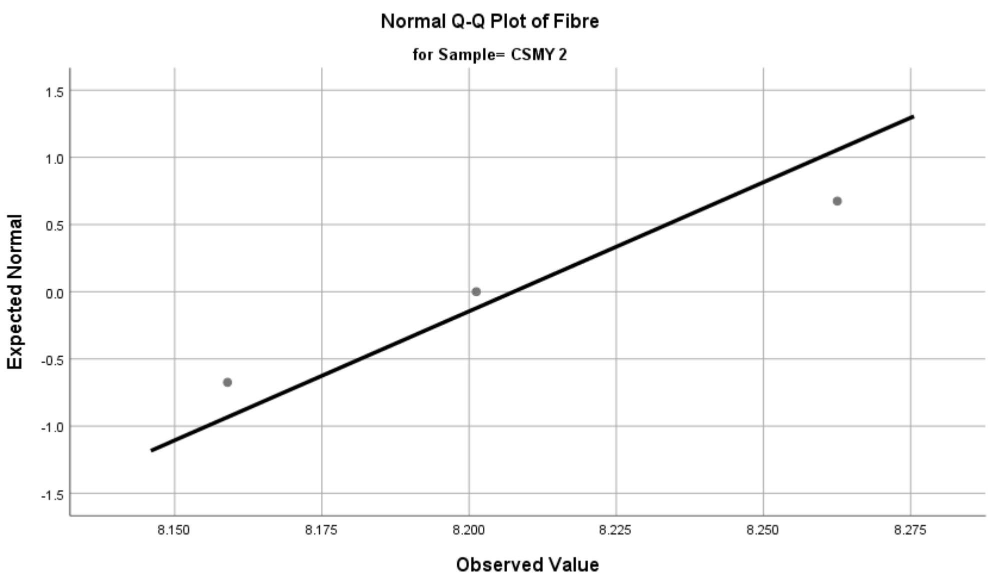

Normal Q-Q Plot of Oil_Fat
for Sample= CSMY 2
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
19.0
19.1
19.2
19.3
19.4
Observed Value


Normal Q-Q Plot of Oil_Fat
for Sample= CSMY 3
Expected Normal
Observed Value
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
17.2
17.4
17.6
17.8

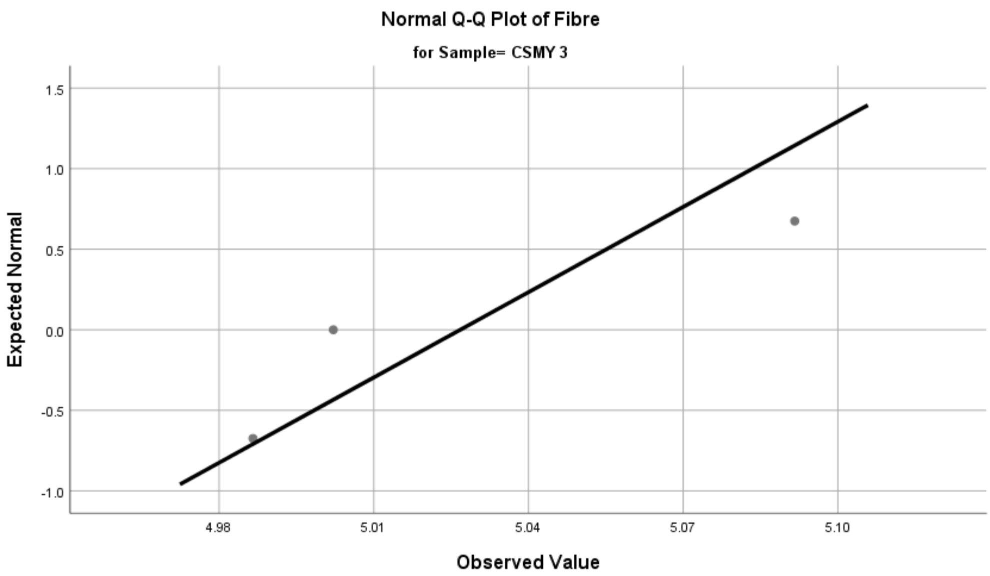

Normal Q-Q Plot of Oil_Fat
for Sample= Control
Expected Normal
Observed Value
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
15.2
15.3
15.4
15.5

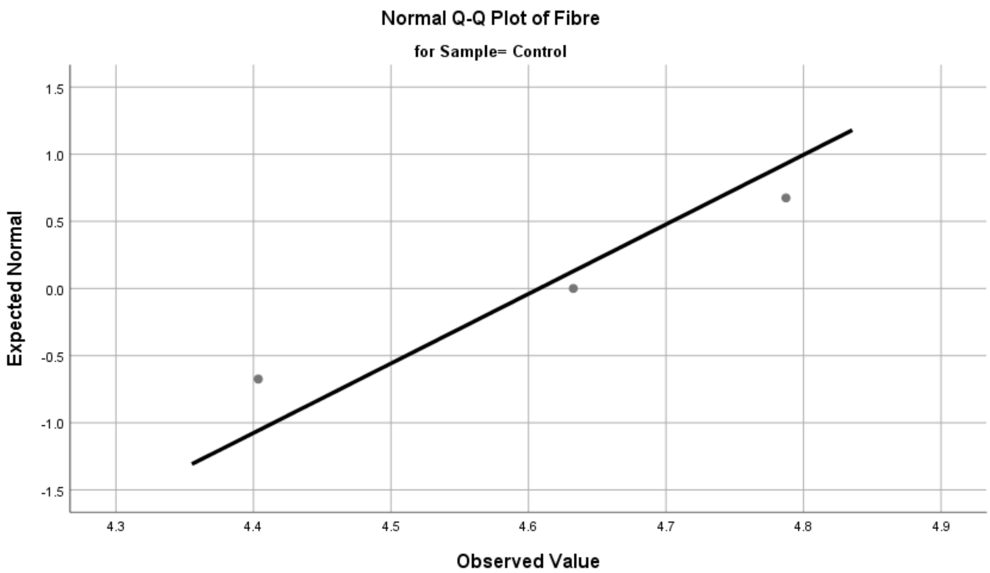


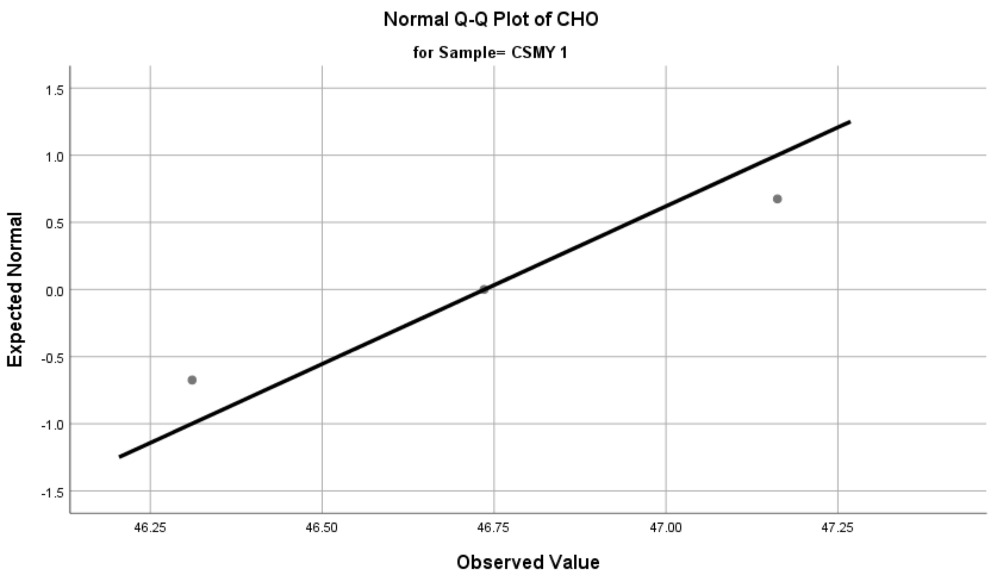
Normal Q-Q Plot of Fibre
for Sample= CSMY 1
Expected Normal
Observed Value
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
8.1
8.2
8.3
8.4
8.5

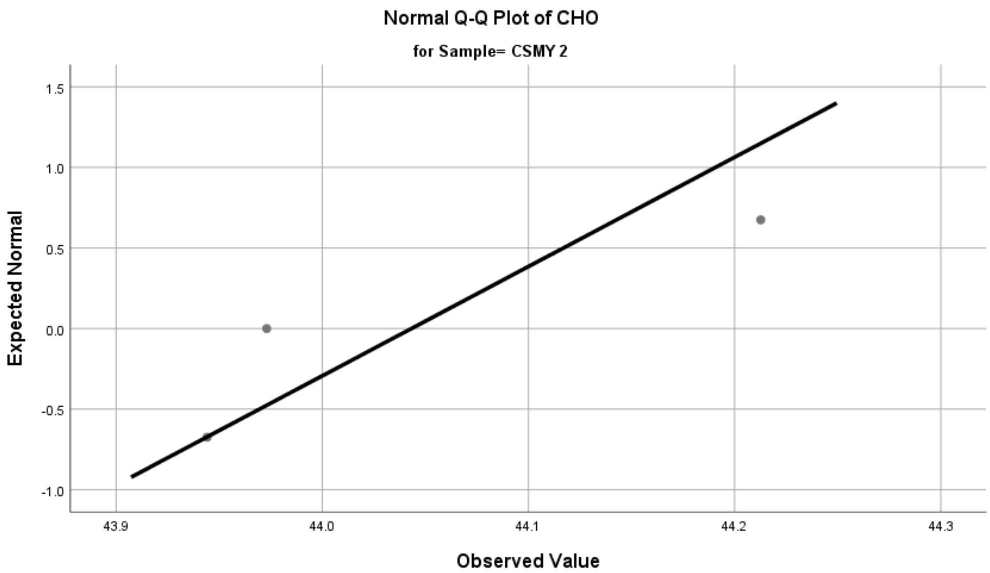


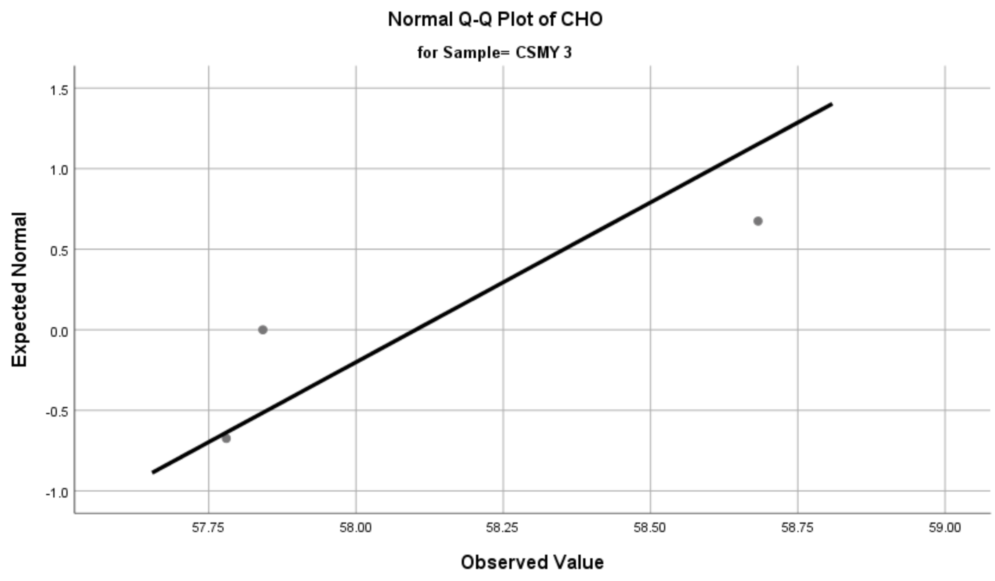
Normal Q-Q Plot of Fibre
for Sample= CSMY 2
Expected Normal
Observed Value
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
8.150
8.175
8.200
8.225
8.250
8.275

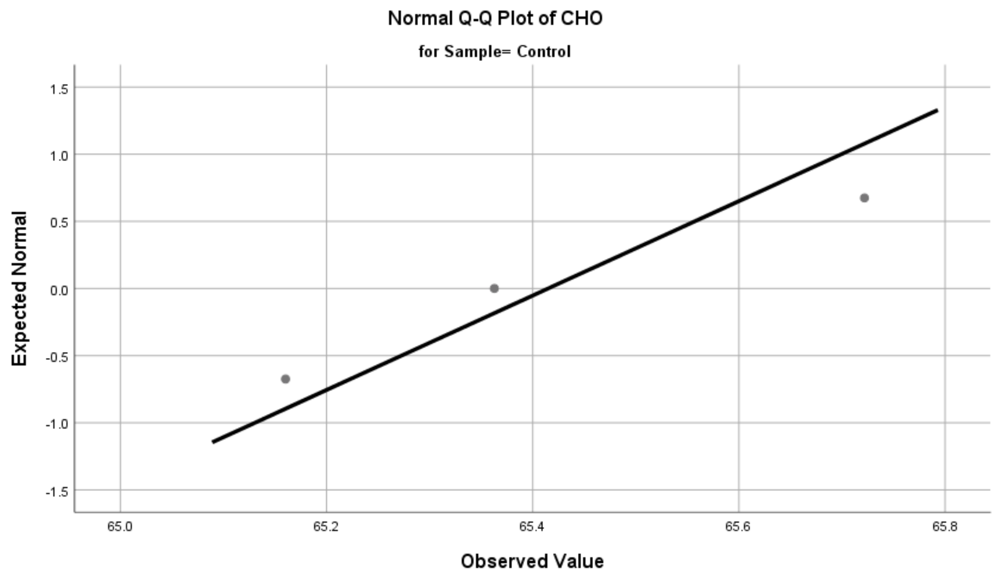

Normal Q-Q Plot of Fibre
for Sample= CSMY 3
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
4.98
5.01
5.04
5.07
5.10
Observed Value


Normal Q-Q Plot of Fibre
for Sample= Control
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
4.3
4.4
4.5
4.6
4.7
4.8
4.9
Observed Value

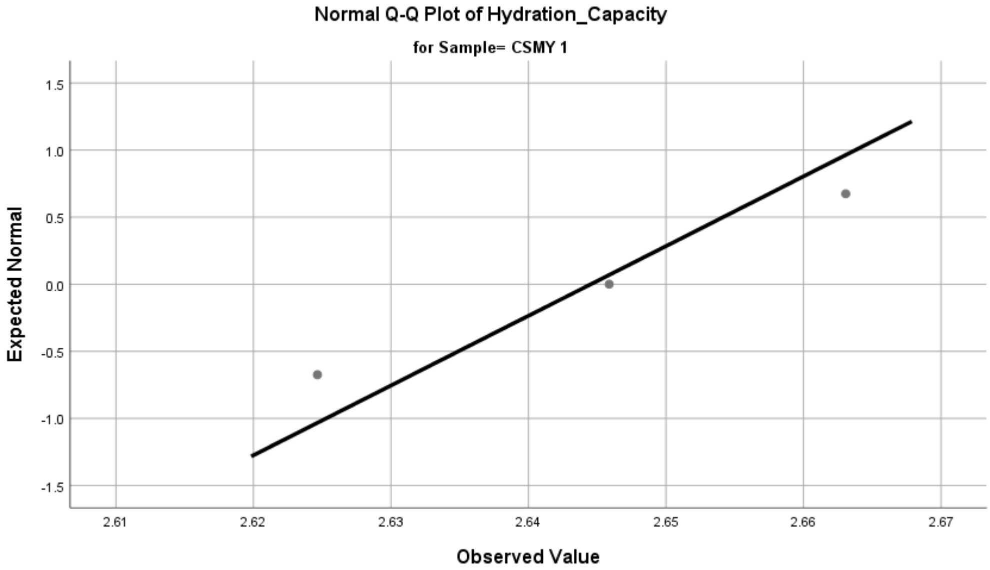

Normal Q-Q Plot of CHO
for Sample= CSMY 1
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
46.25
46.50
46.75
47.00
47.25
Observed Value

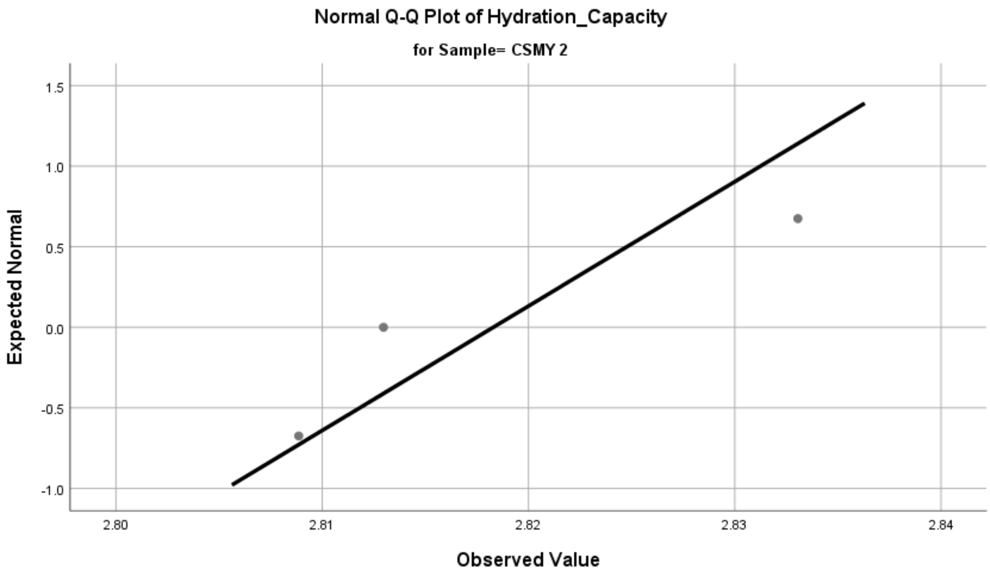

Normal Q-Q Plot of CHO
for Sample= CSMY 2
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
43.9
44.0
44.1
44.2
44.3
Observed Value

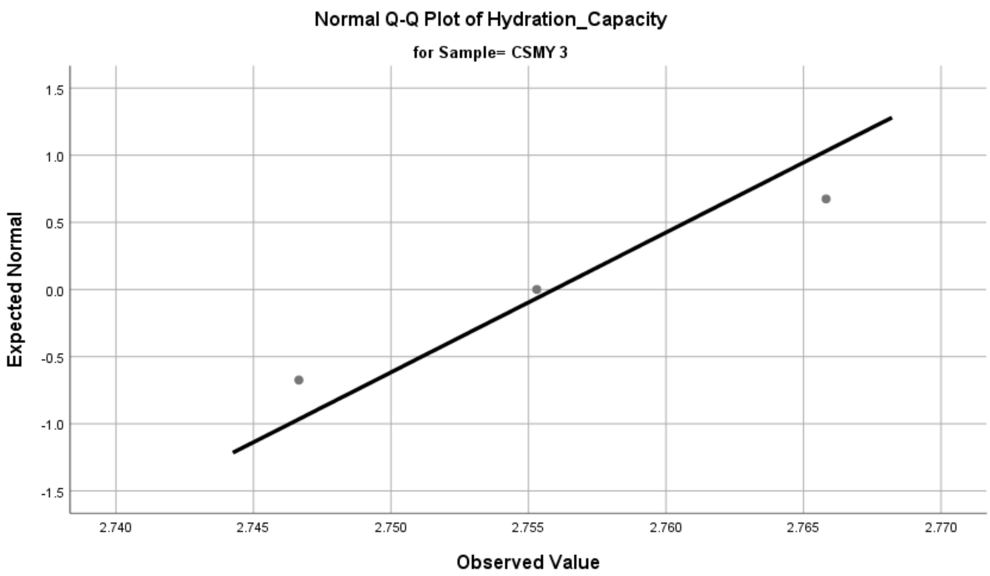

Normal Q-Q Plot of CHO
for Sample= CSMY 3
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
57.75
58.00
58.25
58.50
58.75
59.00
Observed Value

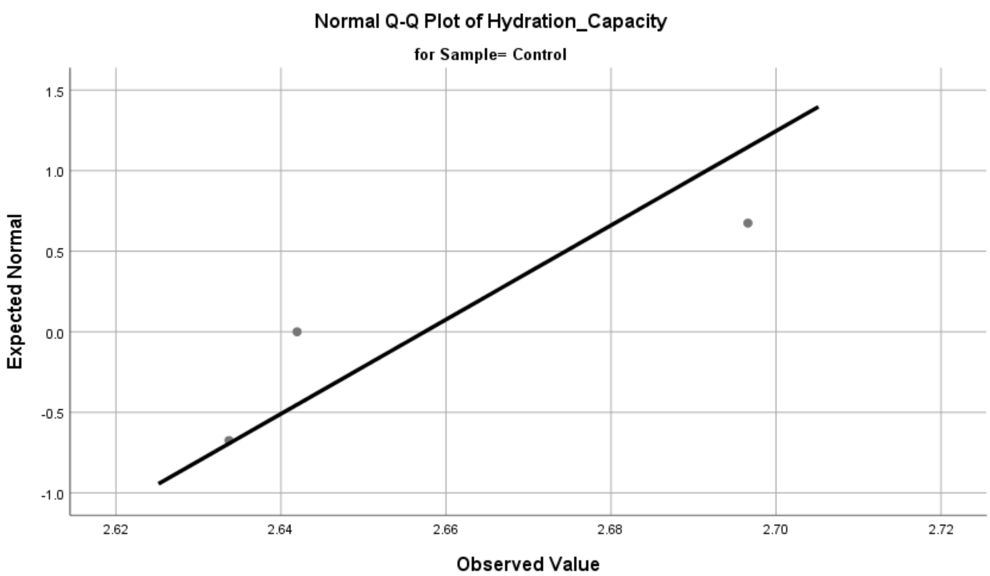

Normal Q-Q Plot of CHO
for Sample= Control
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
65.0
65.2
65.4
65.6
65.8
Observed Value

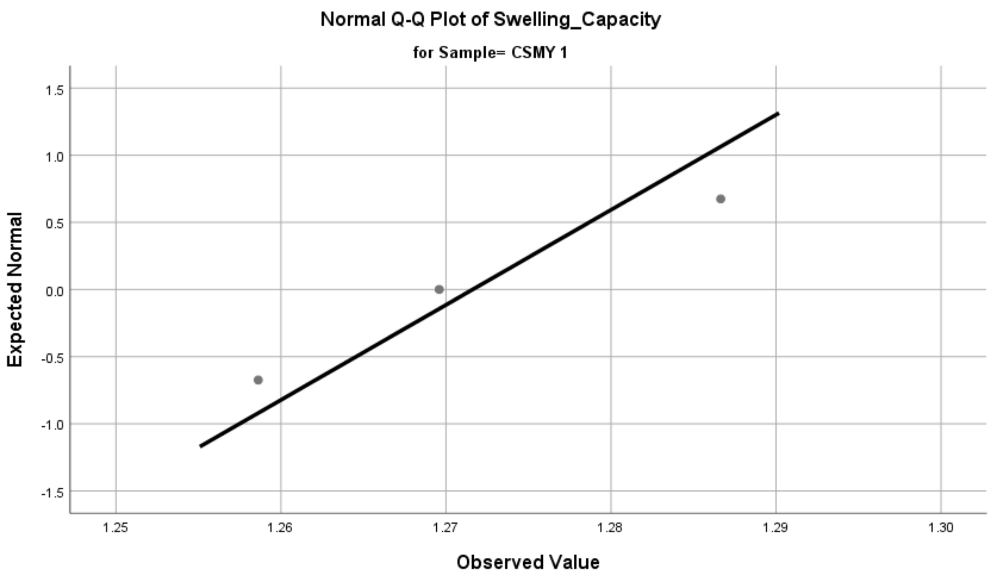
HYPOTHESIS 2

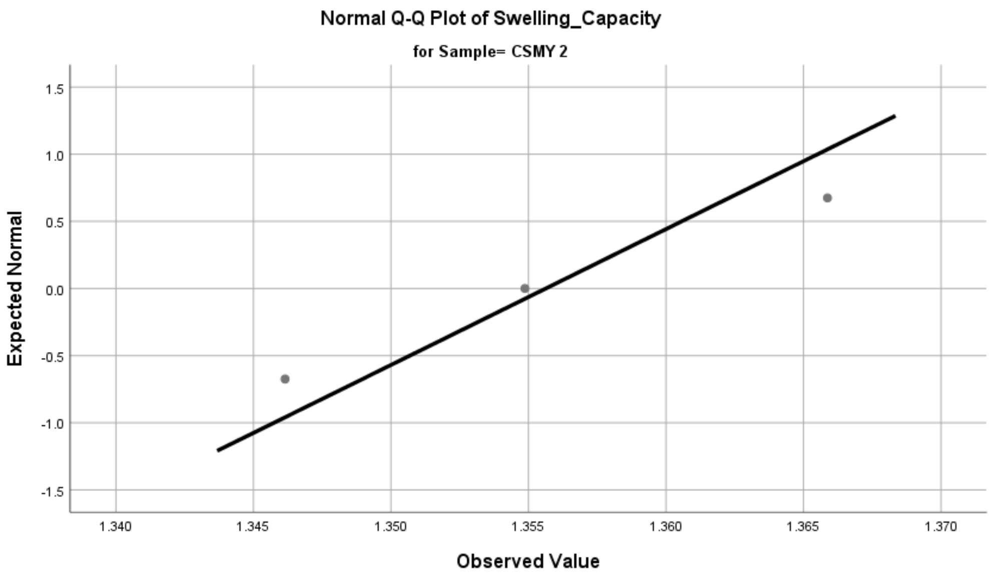


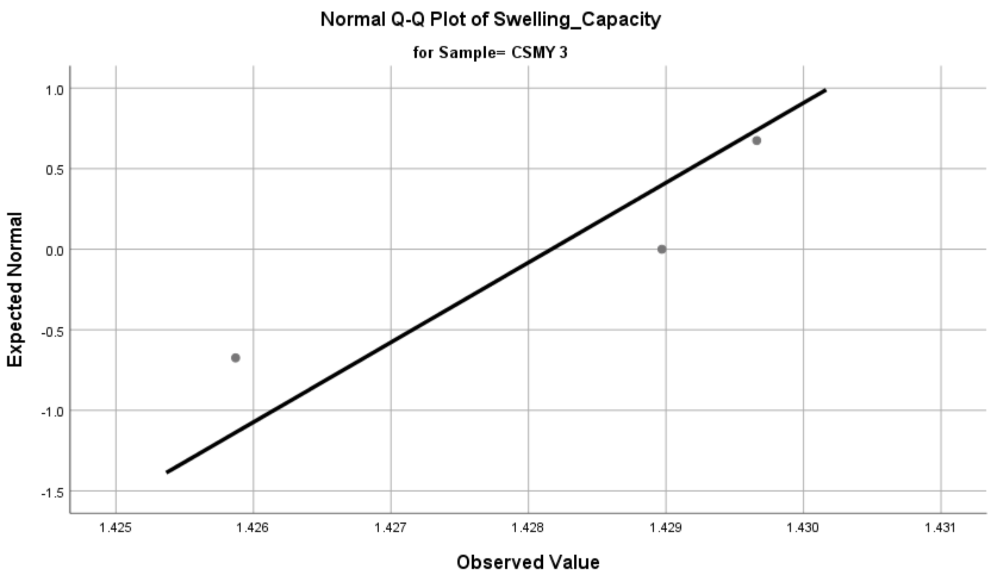


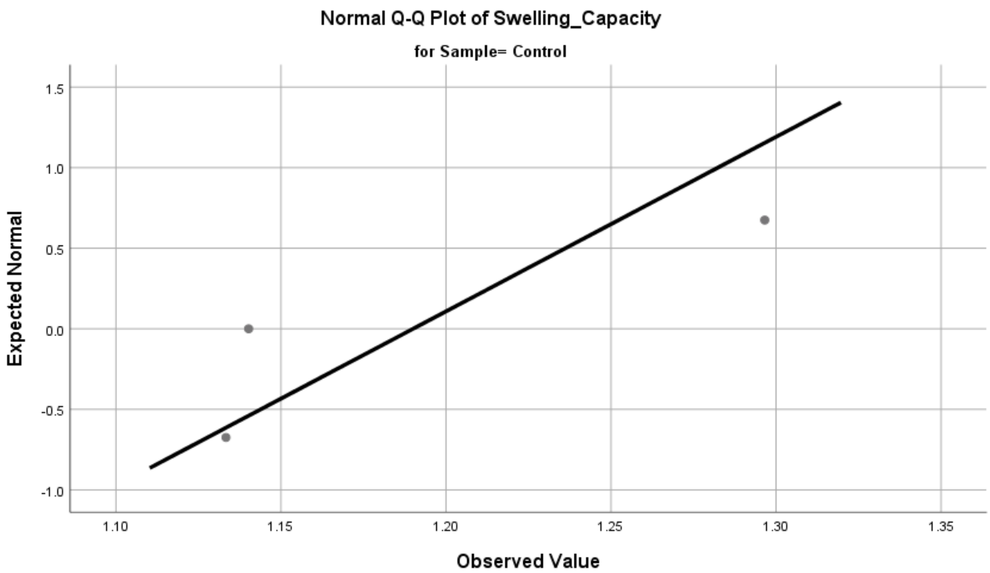

Normal Q-Q Plot of Hydration_Capacity
for Sample= CSMY 3
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
2.740
2.745
2.750
2.755
2.760
2.765
2.770
Observed Value

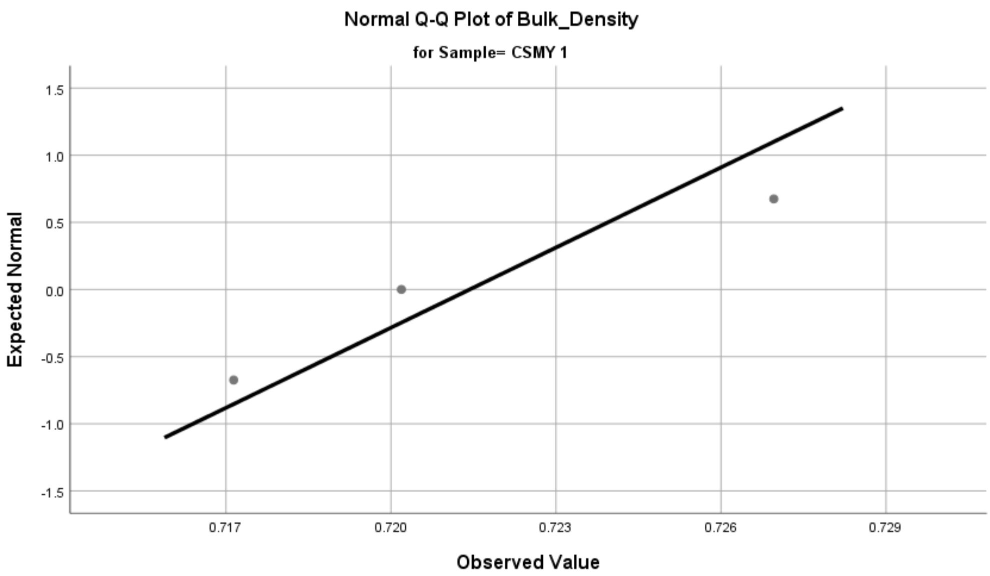

Normal Q-Q Plot of Hydration_Capacity
for Sample= Control
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
2.62
2.64
2.66
2.68
2.70
2.72
Observed Value

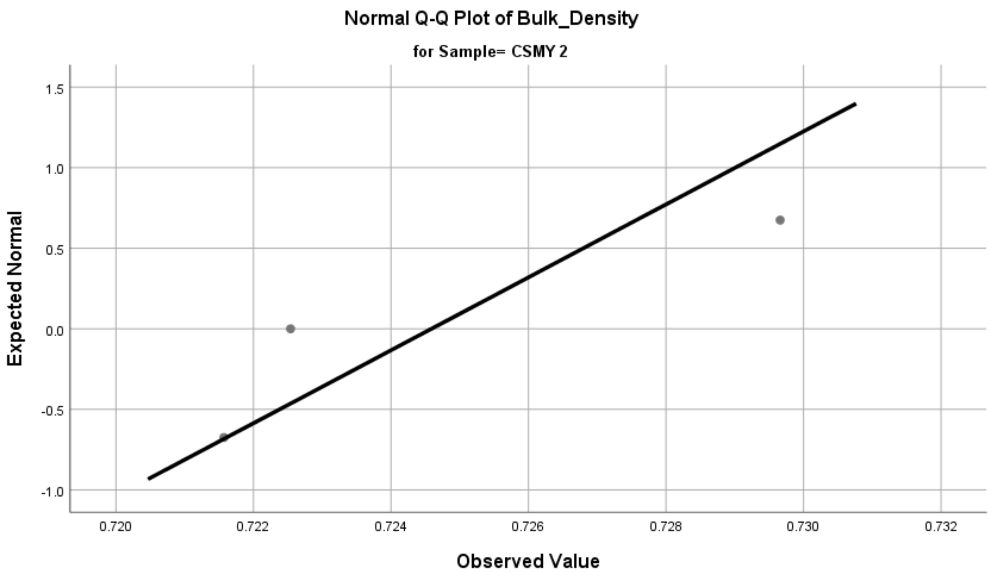

Normal Q-Q Plot of Swelling_Capacity
for Sample= CSMY 1
Expected Normal
Observed Value
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
1.25
1.26
1.27
1.28
1.29
1.30

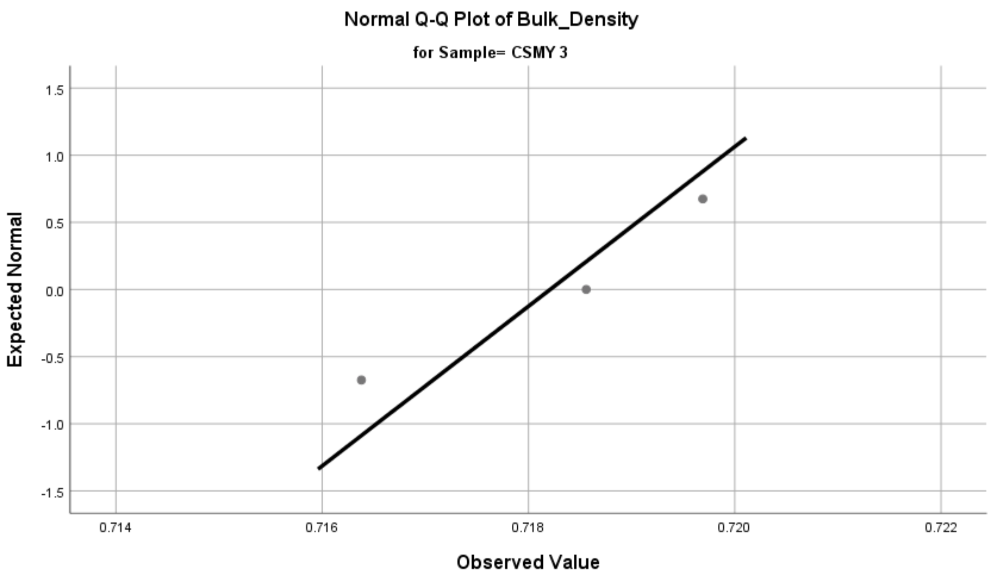

Normal Q-Q Plot of Swelling_Capacity
for Sample= CSMY 2
Expected Normal
Observed Value
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
1.340
1.345
1.350
1.355
1.360
1.365
1.370

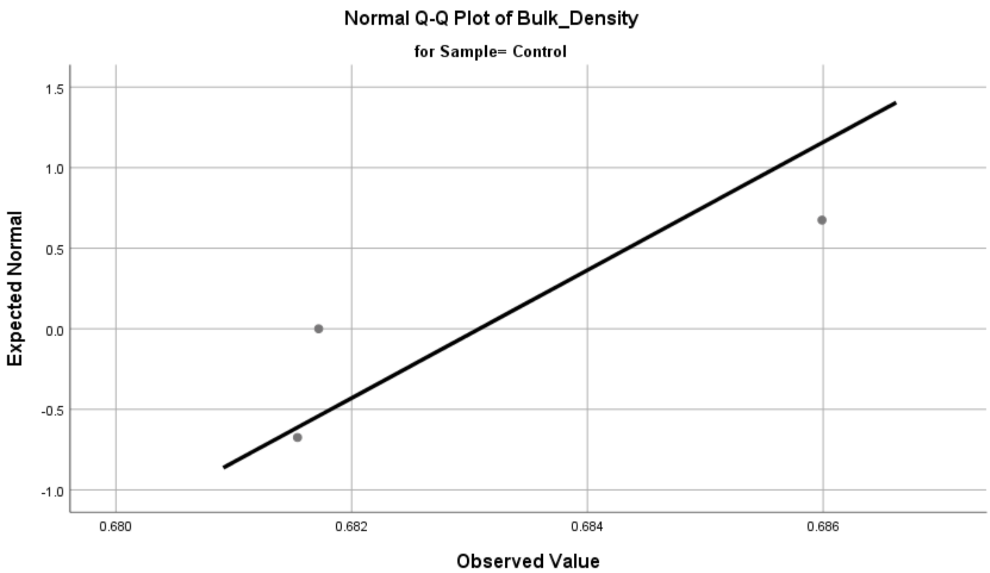

Normal Q-Q Plot of Swelling_Capacity
for Sample= CSMY 3
Expected Normal
Observed Value
1.0
0.5
0.0
-0.5
-1.0
-1.5
1.425
1.426
1.427
1.428
1.429
1.430
1.431

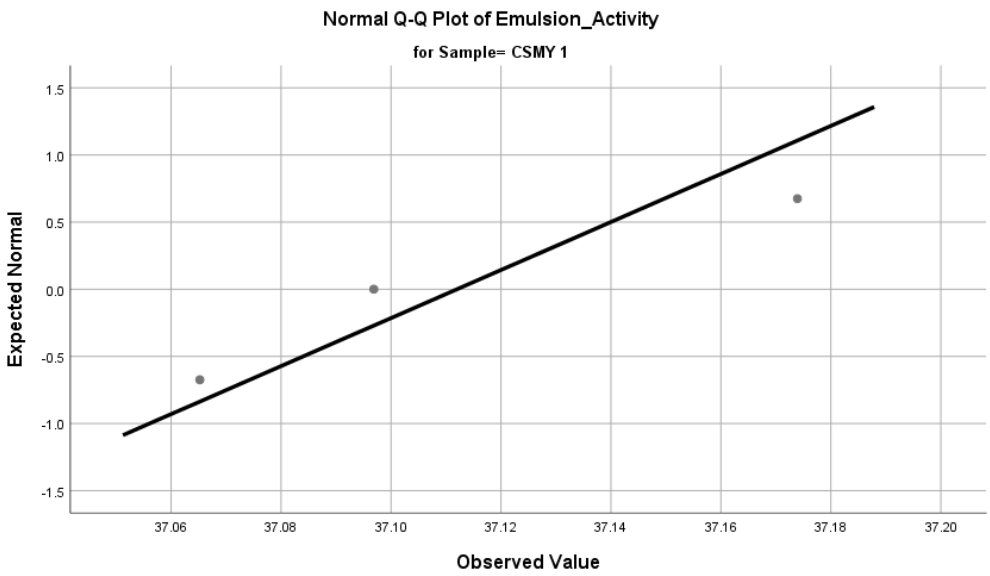

Normal Q-Q Plot of Swelling_Capacity
for Sample= Control
Expected Normal
Observed Value
1.5
1.0
0.5
0.0
-0.5
-1.0
1.10
1.15
1.20
1.25
1.30
1.35

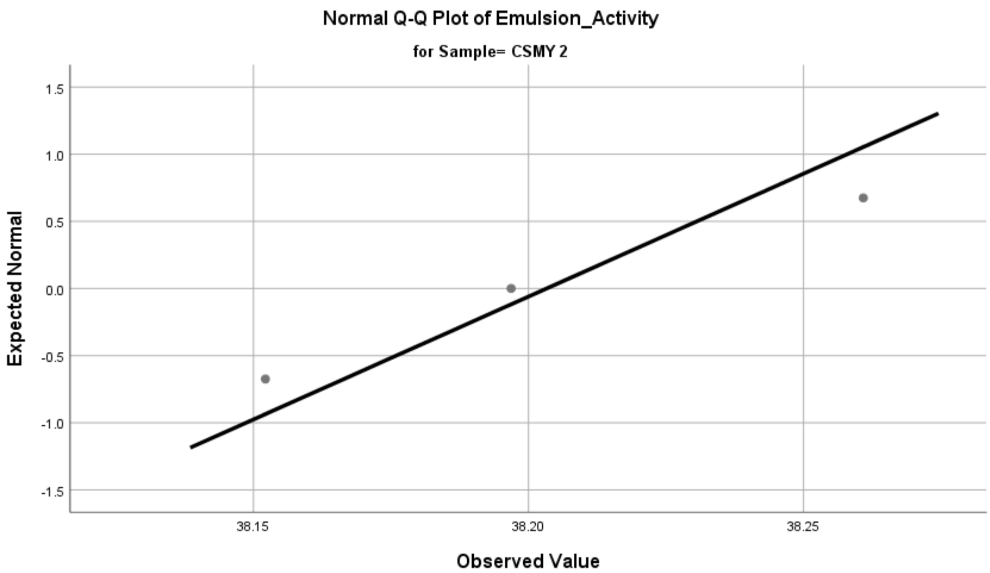

Normal Q-Q Plot of Bulk_Density
for Sample= CSMY 1
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
0.717
0.720
0.723
0.726
0.729
Observed Value

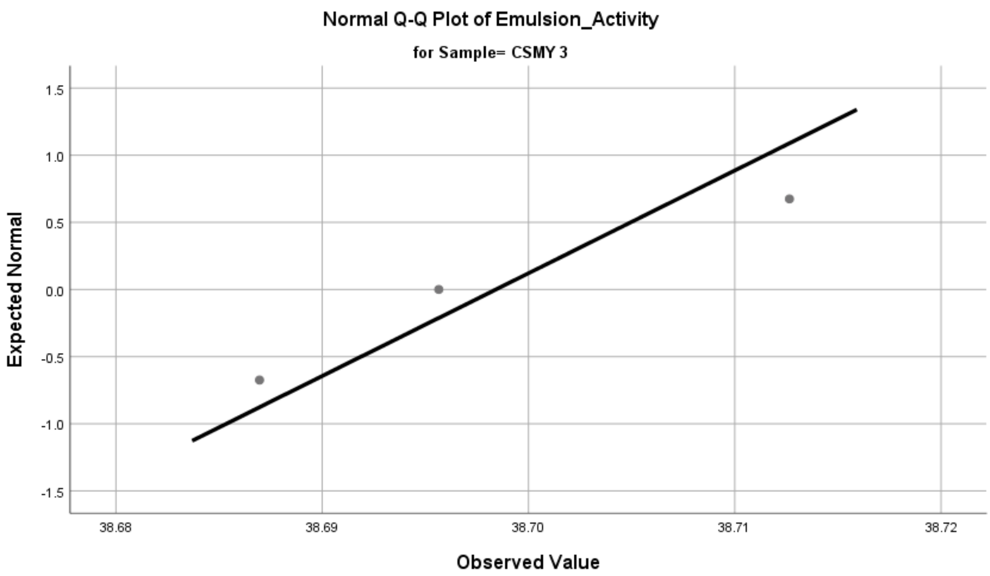

Normal Q-Q Plot of Bulk_Density
for Sample= CSMY 2
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
0.720
0.722
0.724
0.726
0.728
0.730
0.732
Observed Value

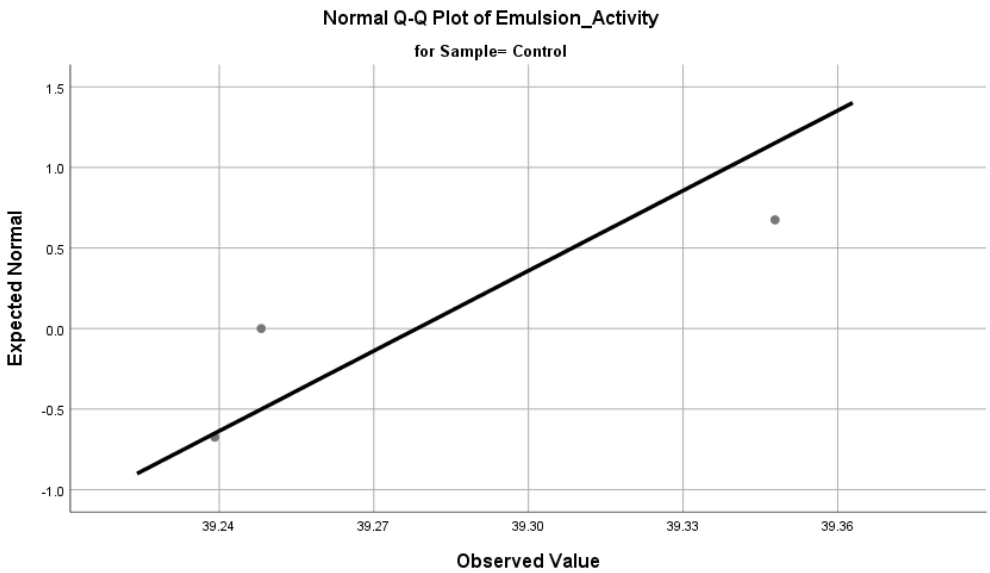

Normal Q-Q Plot of Bulk_Density
for Sample= CSMY 3
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
0.714
0.716
0.718
0.720
0.722
Observed Value


Normal Q-Q Plot of Bulk_Density
for Sample= Control
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
0.680
0.682
0.684
0.686
Observed Value


Normal Q-Q Plot of Emulsion_Activity
for Sample= CSMY 1
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
37.06
37.08
37.10
37.12
37.14
37.16
37.18
37.20
Observed Value


Normal Q-Q Plot of Emulsion_Activity
for Sample= CSMY 2
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
38.15
38.20
38.25
Observed Value


Normal Q-Q Plot of Emulsion_Activity
for Sample= CSMY 3
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
38.68
38.69
38.70
38.71
38.72
Observed Value


Normal Q-Q Plot of Emulsion_Activity
for Sample= Control
Expected Normal
1.5
1.0
0.5
0.0
-0.5
-1.0
39.24
39.27
39.30
39.33
39.36
Observed Value