UNIVERSITY OF CAPE COAST

ASSESSING THE GLYCEMIC INDEX OF THREE TYPES OF KENKEY: 'NTƷW DOKONO', 'NSINHON DOKONO' AND 'DOKONO PA'

RUBY ABAKAH-TAWIAH

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BY

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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: Ruby Abakah-Tawiah

Supervisors' Declaration

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

Principal Supervisor's Signature: ..... Date: .....

Name: Prof. (Mrs). Sarah Darkwa

ABSTRACT

Locally consumed foods in Ghana are carbohydrate based and this has an impact on glycemic index and load. High glycemic index foods contribute to type 2 diabetes. The study therefore sought to assess the glycemic index and load of 'ntɜw dokono', 'nsinhon dokono' and 'dokono pa' popularly consumed in the Western region especially in the Sekondi-Takoradi Metropolis. Three research objectives and two hypotheses guided the study. Purposive sampling and inclusion criteria were used to recruit 10 volunteers for the study. Mean, standard deviation, One-way ANOVA were the statistical tools employed to analyze data collected. The results provided the percentages of dry matter, moisture, ash, protein, fat and oil, fibre, and carbohydrate in the food samples. The glycemic indices of the test foods were low (34.60, 43.54 and 57.78 for 'Dokono Pa', 'ntɜw dokono' and 'Nsinhon Dokono' respectively). The glycemic load for Dokono Pa' was 26.82, 'ntɜw dokono' was 35.20 and 'Nsinhon Dokono' was 49.64. The first and second hypothesis showed a significant difference in the Glycemic Index (GI) and Glycemic Load (GL) of 'Dorkon Pa', 'ntɜw dokono'and 'Nsinhon Dokono'. From the study, it was recommended that these foods be consumed in moderation.

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DEDICATION

I dedicate this work to my husband, Mr. Franklin Nti Duah.

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CHAPTER ONE

INTRODUCTION

Maize (*Zea mays*) crop covers over 33 million hectares in Sub-Saharan Africa (SSA) (FAOSTAT, 2019). The crop is cultivated on about 17% of the estimated 200 million acres of arable land in the SSA, is cultivated in a variety of regions, and is consumed by individuals with diverse socioeconomic and dietary backgrounds. About 300 million residents of the SSA rely on maize for sustenance and income. About 96% of SSA's maize is produced in the following nations: South Africa, Nigeria, Ethiopia, Tanzania, Malawi, Kenya, Zambia, Uganda, Ghana, Mozambique, Cameroon, Mali, Burkina Faso, Benin, DR Congo, Angola, Zimbabwe, Togo, and Côte d'Ivoire (FAOSTAT, 2019).

Dankyi et al. (2005), states that Ghana's Agricultural industry and food security rely on maize. In Southern Ghana, maize production begins in mid-May and ends in August. Due to unimodal rainfall, Northern Ghana producers have only one maize growing season, beginning in July Dankyi et al. (2005). According to Abudulai et al. (2014), rain-fed smallholder farmers with limited resources produce most of the maize in Ghana. Most of Ghana's natural zones, especially the Northern Savannah, support the crop. It provides carbohydrates in several Ghanaian homes. It almost replaced sorghum as well as pearl millet in Northern Ghana (Abudulai et al. (2014).

Kenkey is one of Ghana's most well-known dishes prepared by indigenous food manufacturers. According to Halm et al. (2003), low-wage employees consume kenkey. Ghana produces two primary types of kenkey including Ga-Kenkey and Fanti-Kenkey. (Obodai et al., 2014). The Central and Western Regions of Ghana produce the Fanti-Kenkey. There are two primary

varieties of Fanti Kenkey, this includes “nt3w and “nsinhon dokono”. The corn dough is covered in plantain, banana, or “kemtefe” leaves before cooking (Halm et al., 2004). “Dokono pa” is another type of kenkey consumed in the Eastern Region.

Maize contains carbohydrates, protein, fibre, and fat. Carbohydrates fuel most diets. Different carbohydrate foods react faster to insulin. Different glucose release rates cause this (Lin et al., 2010). Diabetes is defined as high blood glucose or blood sugar. Blood glucose from food provides energy. Insulin enables cells to utilize glucose from food as a source of energy. Glucose remains in your blood and does not enter your cells if your body does not correctly produce or utilize insulin. This can lead to conditions such as diabetes.

Global studies on the causes of cardiovascular disease discovered that dietary carbohydrates are the greatest predictor of post-meal blood glucose levels. Considering that heart disease kills approximately 75% of diabetics, controlling diabetic dyslipidemia is essential for preventing cardiovascular disease (CVD) (Jenkins et al., 2015; Wormenor, 2015).

The glycemic load, abbreviated as GL, refers to a measure of how much sugar a single serving of food will add to a person's blood sugar level following digestion. When deciding what to consume to maintain healthy blood sugar levels, diabetics and other healthy individuals take this into consideration. The GL as well as GI of the international food menu have been determined and standardized, making it simpler to select foods from the intercontinental food list using GL.

Contrarily, consumption of the great majority of Ghana's staple foods such as fante-kenkey is restricted due to their unknown Glycemic index, making

it difficult to comprehend the rate at which this meal is turned to glucose in the body in order to determine any potential adverse health effects.

Glycemic index is a chemical measurement of how simple or complex a carbohydrate is, whether they are sugars or polysaccharides, and whether they are available or not. It is a procedure used to grouped foods based on their propensity to elevate the level of blood glucose (Whitney & Rolfes, 2002; Brand-Miller et al., 2014).

According to Liu et al. (2000), consuming meal with high GL for an extended period of time is linked to a greater chance of developing diabetes type 2 and other chronic ailments. GI and GL do not have a direct relationship. For instance, a food with a more GI may have a less GL if consumed in tiny amount. However, the amount of food one consumes can cause him/her to have a high GL even if it has a low GI (Mendosa, 2008). The majority of the time, foods with a less GI value also has a less GL value.

Statement of the Problem

Due to the increase in diabetes cases in Ghana, the GI, a measure of how meals impact the level of blood glucose, has become a concern. Kenkey is undoubtedly one of the well-known Ghanaian staple meals. Most people prefer eating it with fried fish and pepper sauce, or beans stew (Halm et al., 2004). However, the glycemic index of "ntɜw dokono", "nsinhon dokono", and "dokono pa" is not known.

Eli-Cophie et al. (2016) conducted a study in Ghana and the West Africa Sub-Region in 2016 to ascertain the glycemic index of five (5) indigenous foods and their suitability for diabetic patients. Fufu (locally pounded), kenkey (Ga), banku, Tuo Zaafi (TZ), and fufu (processed flour) were used as staple foods. In

their recommendation, they suggested that additional research be conducted on all locally available, carbohydrate-rich Ghanaian foods which GIs are presently unknown.

Ga-Kenkey is different from the other kinds of kenkey in terms of fermentation level and even the leaves used to wrap it. The study was to determine the glycemic load as well as index of "nt3w dokono", "nsinhon dokono" and "dokono pa" so they may be recommended to the public in general most especially, those suffering from diabetes ailment.

Purpose of the Study

The main purpose of the research work was to examine the GI as well as the GL of three types of kenkey ("nt3w dokono", "nsinhon dokono" and "dokono pa") commonly eaten in Ghana. This was done to determine their health and nutritional effect on Ghanaians, especially diabetics.

Significance of the Study

Hopefully, the findings may inform both diabetics and pre-diabetics in selecting a particular type of kenkey that may be good for their health. Secondly, it may provide vital information to nutritionists and dietitians about the glycemic index of the three (3) types of Kenkey to enable them to counsel people living with diabetes.

Moreover, people could be encouraged to eat these kenkeys which may have a low glycemic index and thus may be beneficial to them for weight management and blood sugar control.

Finally, the findings of this research work will be disseminated to a broad range of readers, including instructors, students, health practitioners, and

other researchers with an interest in the GL of local foods, as well as contribute to the existing literature.

Objectives of Study

This research work sought to obtain the following objectives;

1. determine moisture, ash, protein, fat, fibre, and carbohydrate contents of the three (3) types of kenkey.
2. Evaluate the glycemic index of the three (3) types of kenkey
3. determine the glycemic load of the three (3) test foods ("nt3w dokono", "nsinhon dokono" and "dokono pa'").

Research Questions

Below are the research questions for the study;

1. What are the moisture, ash, protein, fat, fibre and carbohydrate content of the three types of kenkey?
2. What is the glycemic index (GI) of the three types of kenkey?
3. What is the glycemic load (GL) of the three test foods ("nt3w dokono", "nsinhon dokono" and "dokono pa'").

Research Hypothesis

Ho 1: There is no statistically significant difference in the glycemic index of "nt3w dokono", "nsinhon dokono" and "dokono pa".

Ho 2: There is no statistically significant difference in the glycemic load of "nt3w dokono", "nsinhon dokono" and "dokono pa".

Delimitation

The study was delimited to determine the glycemic load and index of "nt3w dokono", "nsinhon dokono" and "dokono pa". The investigation was restricted to individuals without diabetes. The research centred on post-meal

level of blood glucose after food ingestion; and so, individuals who had history of diabetes as well as high levels of blood glucose were ruled ineligible for participation.

Limitation

First and foremost, the investigation relied on samples of laboratory to acquire data; thus, there is a chance of the study being substandard because the apparatus and chemicals utilized could have certain limitations that the researcher was not aware of. The sample size used was few and this may affect the generalizability of the outcome.

Furthermore, the study anticipated that the chosen volunteers would follow the experiment's criteria and conditions because they were assumed to be honest individuals. This, however, was not confirmed. Finally, the study's outcomes and conclusions might not be applicable in the near future because GL, GI, and health nutrition issues change with time.

CHAPTER TWO

LITERATURE REVIEW

Introduction

The chapter two (2) reviewed literature on maize, maize production in Ghana, economic importance of maize, consumption of maize, traditional method of making kenkey, digestion of carbohydrate and diabetes. Other literature was on glycemic index and load of food and obesity.

Maize

Maize (*Zea mays L.*), is biennial plant belonging to the *Gramineae (Poaceae)* family. Meaning, it belongs to the grass family and has the typical grass structure, with easily discernible nodes and internodes on the stem (Awata et al., 2019). Individual leaves develop from the opposite sides of each node. The inflorescences of the male as well as the female are on separate portions of the plant. It bears grains on the side branches as opposed to the ones at the end. Maize is an allogamous species; its natural population is typically quite diverse. It thrives in numerous agricultural and natural environments (FAO, 2003; Adesiyan, 2015).

Wheat, rice, and maize, all of which are grains, are the three (3) main crops widely grown globally. After wheat and rice, maize is regarded as the crop with the greatest yield per a hectare and ranks the third in both total production and total area harvested. It is a crop that is cultivated in numerous countries ((FAO, 2003; Adesiyan, 2015). According to Pratap and Kumar (2014), maize is cultivated on an area of approximately millions of hectares where approximately 100 million hectares are cultivated by 125 emerging countries.

With a global output of 845 million tonnes and a global productivity of 5.21 tons/ha, the majority of the crop's production is located in low- and low-middle-income nations. Although yields vary significantly from country to country, maize is cultivated on every continent.

Maize Production in Ghana

According to Agyare et al. (2013), Ghana's most significant grain crop is presently maize. It caters for 55 percent of Ghana's total production of food. It is regarded as one of the most crucial commodities for the nation's agricultural and overall food.

According to Darfour and Rosentrater (2016), maize cultivation in Ghana dates back to the late 16th century. As soon as it was introduced to the country, maize became an essential staple crop in the South. Gauge et al. (2012) say that a significant portion of the grain produced from maize is the primary source of nutrition in the households of the growers. Since 1965, maize production has increased as have annual yields by approximately 1.1% (IFPRI, 2014),

According to FAO (2015) cited by Adesiyan (2015), maize production increased from about 2.4 million metric tonnes in the year 1961 to 10.6 million metric tonnes in 2005. This is because more land was utilized for maize cultivation. From 2005 to 2012, the area used to cultivate maize increased from 750,000 ha to 1,042,083 ha. After that, there was a gradual decline until 2014, followed by a precipitous decline to 883,031 ha in 2016. FAOSTAT (2019), reports that since 2017, the total harvested area has gradually increased to one million hectares. From approximately 1.5 million metric tonnes per hectare in

2005 to approximately 2.0 million metric tonnes per hectare in 2017, the yield of maize in Ghana has increased.

In addition, production has increased from 1,171,000 metric tonnes in 2005 to 2,011,179 metric tonnes in 2017. There were temporary decreases in output in 2011 and from 2013 to 2016, but overall, it has been increasing. From 12,073 Mt in 2007 to 3,977 Mt in 2017 (FAOSTAT, 2019), Ghana's exports of maize have decreased gradually over the past decade. This could be as a result of the fact that greater amount of the country's maize is used for domestic consumption. Imports, on the other hand, have decreased from a height of 100,000 tonnes in 2006 to just 40,661 tonnes in 2017 (FAOSTAT, 2019).

According to Dankyi et al. (2005), rainfall is the primary determinant of how much maize is grown in Ghana. This results in significant variations in yield, which are primarily caused by variations in rainfall. In Ghana, where each person consumes an average of 45 kilograms of maize per year (MoFA, 2016), growing maize is not only a way to earn money, but it also helps many low-income families obtain enough food. According to Darfour and Rosentrater (2016), Ghana sells one million metric tonnes of maize annually. According to a study conducted by Acquah and Kyei (2012), more than 20 percent of the income of peasant Ghanaian farmers comes from the cultivation of maize.

Economic Importance of Maize

Maize is among the world's three most essential food crops. The most significant food crop in Sub-Saharan African countries is maize. It is a crop that provides a great deal of food, it is simple to prepare, can be broken down rapidly, and is less expensive than other cereals. (International Institute of Tropical Agriculture (IITA), 1985; FAOSTAT, 2019) Maize is a useful commodity that

can be cultivated in a variety of agro-ecological areas. Each component of maize grain is utilized in the production of diverse array of consumable as well as non-consumable items. The entire vegetation demonstrates its monetary value. In developed nations, maize is basically used as animal fodder and also as raw material for industiries.

However, the majority of maize consumption occurs in poor nations. Approximately half of the inhabitants of sub-Saharan Africa rely on maize as their primary source of nutrition, according to estimates. Maize is rich in numerous nutrients, including carbohydrates, vitamins minerals as well as protein. It is the primary constituent in numerous starchy African foods and beverages, including cereal, pastes, grits, and beer. After the dry season, people consume fresh maize that has been dried, baked, roasted, or boiled, which helps satisfy their hunger. Ethanol fuel, also known as ethyl alcohol, is produced from a significant portion of the global maize crop. It is a variety of alcohol used to produce alcoholic beverages.

High demand for ethanol production has led to an increased in the quantity of land used to cultivate maize (Afiff et al., 2013). This has increased the likelihood that more land will be used to cultivate maize. In the past few years, nearly 40 percent of maize is believed to have been used to produce ethanol, a fuel. Wallington et al. (2012) state that 27% of this quantity is converted into ethanol and the remaining 12% is used to feed animals as distillers' dry grain waste. About 13% of the total income was derived from exports, while only 4% was used to produce high glucose maize syrup. The remaining 7% is utilized in numerous ways, including the production of liquor

and other alcoholic beverages, maize oil, maize flour, corn syrups, and other industrial products.

Consumption of Maize

According to a study by Baributsa et al. (2010), more than 116 million tonnes of maize are consumed annually on a global scale. Africa consumes 30% of this total, while Sub-Saharan Africa consumes 21%. In countries where maize is a significant source of nutrition, about 50g is consumed daily per person. In Africa, people consume between 52 and 328g of maize per day, and in America, 267g per person per day (Ranum et al., 2014).

In spite of a small but steady increase in global maize production over the years, the amount of this cereal consumed by humans has remained relatively constant. Many people, particularly in Africa, continue to consume maize as their primary source of nutrition. According to Ranum et al., (2014) in nations with a high income per capita, 70% of maize will likely be used to sustain animals, while only 3% will be consumed directly by humans. The remaining maize will be processed into biofuels, industrial products, and seeds.

Since 1980, 22 to 25 percent of the carbohydrate foods consumed in Africa have been derived from maize, which makes it the largest source of energy. Maize's significance as a staple food varies from country to country on the African continent. According to Smale et al. (2011), in Southern Africa about 85 kg of maize is consumed by each person per year, making it the highest in Africa as compared to 27 kg in East Africa and 25 kg in both West and Central Africa.

Depending on the country, the crop undergoes various processes and is cooked in a variety of methods. Maize is largely used to produce porridge in the

Eastern as well as Southern Africa. Fresh maize is either boiled or roasted on the stalk and eaten as snack in African countries. All over the world, maize that has been ground into flour, also known as "cornmeal," is used to prepare staple foods such as banku, tuo zafi, akple, and cornflakes.

Nutritional Composition of Maize

Standardized official methods should be used in determining the nutritional composition of maize to ensure accuracy of results (IITA, 1985).

The kernel of maize grain is made up of approximately 10.4% water, 6.8% to 12% protein content, 4% fat, 1.2% ash, 2.0% dietary fibre, as well as 72% to 74% carbohydrates. In addition, it contains minerals including calcium, phosphorus, iron, sodium, potassium, zinc, copper, magnesium as well as manganese in varied concentrations of 7 mg/100 g, 210 mg/100 g, 2.7 mg/100 g, as well as 2.7 mg/100 g (Kulp & Joseph, 2000).

Table 1: Proximate composition of Maize

Chemical Constituent	Pericarp	Endosperm	Germ
Starch	7.30	87.60	8.30
Protein	3.70	8.00	18.40
Fat	1.00	0.80	33.20
Sugar	0.34	0.62	10.80
Crude fibre	86.70	2.70	8.80
Ash	0.80	0.30	10.50

Source: (Nuss & Tanumihardjo, 2010)

Kenkey

Ghana, a nation in West Africa, is the largest producer of kenkey, particularly along its coastal areas. Historically, two distinct ethnic groups produce it: the people of Ga in the Greater Accra as well as the Fantis in Ghana's Central and Western Regions. Kenkey is significantly more important for low-income city dwellers than for those living in rural areas, just as bread is notably important for low-income Europeans. Very little kenkey is consumed in the Northern region, where sorghum rather than maize is grown (Amoa-Awua & Oduro-Yeboah, 2010).

There are basically two (2) varieties of kenkey including ga-kenkey, also called "komi", as well as fanti-kenkey, also refered to as "dokono". Depending on the variety of kenkey, maize dough is fermented into sour dough before being wrapped in maize husks or leaves of plantain and cooked (Obodai et al., 2014). Salt is usually added during production of the Ga-kenkey, whereas Fanti-kenkey fermentation process lasts marginally longer. A few additional kenkey varieties are also produced in addition to the Ga and Fanti variants. Instead of whole cereals, the majority of these variations utilize maize that has been dehulled or refined (Obodai et al., 2014).

Akporhi also called Nsihu is among the varieties of kenkey made from refined maize. It is largely prepared in Ghana's Central, Western, and Volta Regions. It is made by dehulling the corn, milling it, and lastly recombining the milled corn with water to produce dough that ferments for only twenty-four hours. After shaping this dough into spheres, it is steamed (Amoa-Awua & Oduro-Yeboah, 2010)

Traditional Method of Making Kenkey

Raw material for producing kenkey

The most essential ingredient in kenkey making is maize, which is obtained as a basic material. It is the most significant cereal crop grown in the regions of Ghana. It is planted in different amounts all over the nation. In most of the regions of Ghana, maize is the main staple crop. Halm et al. (2004), report that the preponderance of cultivated maize is processed into kenkey for human consumption.

Cleaning

Cleaning the corn that will be used to make kenkey entails removing any foreign particles. This can be achieved using a variety of techniques, such as winnowing, handpicking, sieving, or sedimentation, or a combination of these. Throughout these operations, chaff and stones are eliminated. The grains are kept in large container filled with water after which it is stirred with a wooden spoon during the sedimentation process. This enables the grains (high-quality) to sink to the base of the receptacle, while the immature grains, grains damaged by insects, as well as infected grains float on top. Using tiny baskets or sieves, the latter are gathered for use as animal feed. After that, the high-quality maize is rinsed in water again prior to soaking (Halm et al., 2004).

Steeping

The maize is soaked in very clean water for one to three days before they are milled. The length of time that the grains are submerged in water is determined by the initial moisture content of the grains as well as the grains' hardness. Most indigenous varieties are soaked for one day. However, some

hybrid maize grains which have hard kernels are soaked for about 3 days to soften them for easy milling (Amoa-Awua & Oduro-Yeboah, 2010).

Milling and Preparation of Dough

The maize is ground into very smooth flour after being soaked using a corn mill. This flour is then combined with water to create dough which has about 50–55% moisture content. The amount of water utilized in the dough-making process is of utmost importance, as it determines the fermentation rate, the quality as well as the lifespan of the dough. About 17 to 44 litres of water are required to process 100 kg of maize (Halm et al., 2004). This value is extremely variable between cultivators. Plahar and Leung (1982) cited by Amoa-Awua and Oduro-Yeboah, (2010) discovered that, moisture content as low as 45% decreased the rate of the formation of acid as well as quick start of the growth of mould, whereas a greater content of moisture between 65% and 80% created a greater acid concentration as a result, a significant amount of sourness in the product.

Fermentation

The dough is left to ferment for two days to make it ready to use for the preparation of different product, including kenkey, banku as well as koko. The texture of a product produced from dough fermented for twenty-four hours is undesirable; however, this dough can be combined with dough that has been fermented for longer to achieve the desired texture. Traditional food processors occasionally back-slop with aged dough, to accelerate the fermentation process. Back sloping can reduce the duration of fermentation to twenty-four hours (Obodai et al., 2014).

In most instances, all of the fermenting dough is utilized either on the second or the third day. However, if the dough is not used after three days, it will continue fermenting and this could lead to the development of high acid in the dough as well as aroma that is not desirable. Some commercial manufacturers said when less amount of water is used in making the dough; it can stay longer without negatively impacting the acceptability of consumers.

Two days after the dough has attained the desired acidity, it can be sun-dried in the open air. Producers of kenkey in larger quantities do not recommend the use of dough that has been fermented for 24 hours; however, 24-hour dough can be combined with dough that has been fermented for three days to accomplish the qualities desired (Halm et al., 2004). Some commercial manufacturers advocate 'back sloping' as a method for enhancing fermentation by combining old and new dough. This technique, also known as "back sloping," results in a 24-hour fermentation period, during which the dough appears to acquire all of the desired characteristics (Obodai et al., 2014). It appears that fermentation cannot occur for more than three days. According to Halm et al. (2004), prolonged storage may lead to unacceptable qualities such as unpleasant aromas as well as excessive acid level with severe sourness in the final product.

Preparation of “aflata”

Two or three parts of water are added to a portion of fermented dough in order to transform it into slurry. This slurry is then cooked with continuous stirring until it transforms into “aflata”, a gelatinous and adhesive substance. During the procedure, salt is usually added to the Ga-kenkey mixture. After thoroughly combining the “aflata” with a part of the uncooked dough that has

been fermented with the use of a wooden ladle, the mixture is left to chill. The ratio of the "aflata" to the uncooked dough is determined by the kenkey type and consumer preference (Halm et al., (2004).

Among the typical Ga people, kenkey is a primary staple food, and the typical ratio of the "aflata" to raw dough is one-part "aflata" to one-part dough. Some manufacturers, however, combine one-third of the undercooked dough with two-thirds of the "aflata", while others combine one-third of the "aflata" with two-thirds of the uncooked dough. The consistency of the kenkey prepared is dependent on the "aflata" incorporated into the dough prior to cooking.

According to Obodai et al. (2014), panelists awarded the highest possible score to kenkey made from one part of "aflata" to one part of uncooked dough during sensory evaluation of kenkey. According to the panelists, "aflata" is necessary to achieve the desired texture in kenkey. Amoa-Awua and Oduro-Yeboah, (2010) confirms that, "aflata" functions as a binder and is responsible for kenkey's firm and semi-sticky texture. This ingredient, when combined with fresh, fermented dough, confers the ability to shape the final product into spheres and other shapes (Halm et al., (2004)

Moulding and Packaging

To make Ga-kenkey, the mixture is moulded into balls of even size and weighing approximately 300 g each, which are then wrapped in cleaned and pre-wet maize husks. According to Halm et al. (2003), fanti-kenkey is first formed into shapes, then enclosed in bags of polyethylene, and then enveloped in leaves of plantain.

Cooking

To ensure that the kenkey balls do not stick to the aluminum cooking vessels when cooking, either husks of maize or leaves of plantain are placed at the base of the cooking pot after which the kenkey balls are placed on them (Amoa-Awua & Oduro-Yeboah , 2010). The pot is then filled with boiling water and the opening at the top is covered completely with fabric or plastic to prevent steam from escaping. It takes approximately three to three and a half hours to cook the kenkey. Cooking time is dependent not only on the quantity of the "aflata" added to unprocessed dough, but also on the degree to which "aflata" has been previously cooked. For kenkey with a lower "aflata" concentration, longer boiling durations are required. When the kenkey balls are cooked completely, they are taken out of the pot and placed in bowls which are lined with polythene bags. These polythene bags are often used to keep the kenkey balls warm until they are all sold out and consumed (Halm et al., (2003).

Kenkey Water and its Use

The water remaining in the vessel after cooking is known as kenkey water. This kenkey water is ingested as a light porridge. It is said to be used in treating malaria, diarrhoea, and jaundice. The quantities of carbohydrates and electrolytes in kenkey water can be compared to those in Oral Rehydration Salts, as determined by Halm et al. (2004). Therefore, kenkey water is utilized in Ghana's oral rehydration procedure.

Preparation of "Nsihon Dokono"

"Nsihon", also known as "akporhi", has a consistency comparable to that of kenkey. It is made from maize whose husks have been removed, "Nsihon" is particularly popular in Ghana's Western and Central Regions

(Amoa-Awua & Oduro-Yeboah , 2010). To prepare "Nsihon", the maize is first cleaned by removing foreign particles from it. The maize is then undergoes dehulling and winnowing to take of the chaff and shells. After its hulls have been removed, maize is cleansed and allowed to soak in water for twenty-four hours. After the steep water has been drained, the corn is ground using corn mill into fine flour.

The maize flour is then mixed with water to make dough, which is fermented for six to twenty-four hours. When the steeped water is incorporated into the dough-making process, the fermentation time can be reduced to a maximum of six hours. After the process of fermentation is complete, one half of the dough is heated until it becomes "aflata", a type of puree. This paste is then combined with the raw dough from the remaining half of the paste and formed into balls. To prepare "nsihon", the balls are enveloped in leaves of plantain and steamed for at least two hours (Amoa-Awua & Oduro-Yeboah , 2010).

Problems Associated with Traditional Method of Kenkey Production

The main problems related to producing and consuming kenkey is contamination by aflatoxins as well as other mycotoxins coming from the maize grains and maize leaves used in the preparation process. The majority of commercially available maize contains mould, especially mycotoxin-producing species such as *Apergillus flavus* and *Aspergillus parasiticus,* which generate aflatoxins. This contamination occurs frequently (Halm et al., 2004)

According to Amoa-Awua and Oduro-Yeboah, (2010)), there is a problem with the presence of aflatoxins in maize products especially in Ghana,

which raises concerns for public health. The grain's moisture content and storage conditions have a great effect on the mould contamination of maize.

Additionally, commercially available maize frequently displays fumonisis, which is caused by specific species of the genus Fusaria (Kpodo et al., 2000; Amoa-Awua & Oduro-Yeboah, 2010). Mould contamination of the crop is possible if it rains intermittently prior to harvesting of the dry matured maize. Mould can be avoided, however, by mechanically drying mature grains to a moisture content of no more than 12 percent and storing them appropriately after a timely harvest. By preparing kenkey for an extended period of time (approximately three hours), any potential mycotoxins, including citrinin, are eliminated.

Although their aggregate concentration has decreased, heat has little effect on aflatoxins, so they persist after treatment has been completed (Halm, 2006). The second potential issue that may arise during the production of kenkey is the possibility that the fermented dough and steeped grains will spoil due to the proliferation of bacteria that cause spoilage. Due to the presence of such microorganisms, the manufacturer may incur a financial loss. This is due to the fact that the organisms emit offensive odours that customers consider unacceptable. Higher pH levels are more conducive to the growth and survival of spoilage-causing microorganisms. Halm (2006) discovered that the risk of encountering this issue is significantly reduced when the fermentation process that occurs during the steeping phase results in a dramatic decrease in pH and acidic conditions.

Harmful microorganisms are able to survive and grow during kenkey production (Halm et al., 2004; Halm, 2006). The kenkey is heated at a high

temperature for approximately three hours, which is sufficient time to eliminate any remaining pathogenic microorganisms and the majority of their toxins.

When purchasing corn which is packaged in sacks from the general market, it is common for the corn to contain a great deal of debris. This debris includes thread of nylon, pieces of corn cobs, stones or dead insects. Kenkey producers find manual cleaning of maize (sifting and picking out undesirable components) to be very time wasting and laborious process as a result of the large quantities of maize they handle. Consequently, cleaning of maize is poorly done. During the milling process, metal pieces that have been peeled off from the grinding mill may also fall into the dough.

Storage and Shelf-Life of Kenkey

kenkey is kept in a large container which is lined with plastic material to retain their heat till they are sold out. Halm et al., (2004) states that Ga Kenkey has moisture content of 62–68%, a pH of 3.7, and an expiration life of 3–4 days without refrigeration. On the other hand, Fanti kenkey has a marginally longer lifespan of approximately 5 to 9 days (Atople, 2006; Halm et al., 2004).

Nutritional Value of Kenkey

Kenkey's carbohydrate content is released slowly over an extended period of time, making it an ideal food for diabetics. Kenkey has a low glycemic index due to its large fibre content (Amoa-Awua & Oduro-Yeboah, 2010). This aids the body in managing its carbohydrate needs, resulting in enhanced glycemic index management. It is very beneficial for diabetics, people with a large amount of abdominal fat, and anyone else who wishes to maintain a healthy weight and physique due to its high nutrient content.

Beginning the fermentation process is the transmutation of maize into kenkey. This could increase the nutrient value of food by enhancing the production of the B vitamins, making proteins simpler to digest, and increasing the bioavailability of minerals. (Halm et al., 2003) say soaking maize for some time result in an increase in the amount of usable lysine by approximately 20% and after cooking, the quantity of lysine increases by 68%.

After two days of fermentation, the total amount of lysine that could be utilized increase by 22%. As the fermentation and heating processes persisted for longer, the quality of the available lysine improved significantly.

According to Amoa-Awua and Oduro-Yeboah (2010), maize dough made out of maize that has been steeped for four days and cooked for three hours contained 3.42 g of nitrogen. Reduced levels of proteinase inhibitors (such as trypsin inhibitors) and tannins in legumes as a result of lactic acid fermentation may be due to the fact that lactic acid fermentation makes more essential amino acids available. Amoa-Awua and Oduro-Yeboah (2010) discovered that the bacteria that produce lactic acid found in kenkey had varying abilities to degrade or turn off trypsin inhibitor depending on the conditions of the environment. During the process of fermentation, the amount of riboflavin in corn dough does not change significantly. However, when maize dough is cooked into banku and Ga-kenkey, between 33 and 36 percent of riboflavin is lost on average, the amount of thiamine in fermented corn dough rises from 339.1 mg/100 g of corn to 389.3 mg/100 g.

The Microbiological Value of Kenkey

During the process of soaking the corn and the fermenting the dough, both of which are parts of the processes of making kenkey, fermentation happens. Christian (1970) conducted research on the microbiological fermentation of maize dough fermentation during the preparation of kenkey. At the conclusion of the fermentation process, he discovered that bacteria that produce lactic acid as well as yeasts were coexisting. The bacteria included homofermenter *Pediococcus cerevisiae.*

Other researchers (Fields et al., 1981 cited by Amoa-Awua & Oduro-Yeboah, 2010) discovered that *heterofermentative L. fermentum, lactobacillus cellobiosus*, and *Pediococcus acidolactici* were the most prevalent bacteria that produce lactic acid in laboratory spontaneous fermentations of whole maize meal.Based on the pattern of carbohydrate fermentation, Halm et al. (1993) cited by Amoa-Awua and Oduro-Yeboah,(2010), determined that *L. fermentum* and *Lactobacillus reuteri* are the primary lactic acid bacteria responsible for maize fermentation during the production of kenkey.

It was discovered that *Pediococcus pentosaceus* and *P. acidilactici* are also fermenting organisms. In a study by Hayford et al. (1999) cited by Amoa-Awua and Oduro-Yeboah,(2010), genetic techniques were used to demonstrate that *L. fermentum* was the most prevalent lactic acid bacteria. Olasupo et al. (1997) used biochemical screening to determine that the most prevalent organisms were *L. plantarum, L. fermentum*, *Lactobacillus brevis*, and *Lactobacillus delbrueckii.* (Amoa-Awua & Oduro-Yeboah, 2010),

Jespersen et al. (1994) cited by Amoa-Awua and Oduro-Yeboah (2010), discovered that Candida, Saccharomyces, *Trichosporon, Kluveromyces*, and

Debaryomyces were present in fermenting maize dough used to make kenkey. Molecular studies have demonstrated that *Saccharomyces cerevisiae* and *Candida kusei* are the primary yeasts that ferment maize when it is made into kenkey (Halm et al., 2004). Jespersen et al. (1994) also reported that, mould is is always present in the early stages of fermenting the corn dough. Raw maize contained *Penicillium, Aspergillus*, and *Fusarium* species, some of which could produce mycotoxins. After 24 hours of fermentation, however, the early elevated counts of these msoulds disappeared (Amoa-Awua & Oduro-Yeboah, 2010).

Socio-Economic Value of Kenkey

Kenkey is an integral part of the African economy in terms of employment opportunities. Despite the fact that kenkey sellers originate from a diversity of cultures, greater number of them are home-owning female entrepreneurs. Due to the fact that the majority of these vendors employ others to run their businesses, they view themselves as managers. According to a study conducted by Tomlins and Johnson (2004) on the participation of various groups, the majority of merchants were female. Nonetheless, males now play a larger role in this lucrative business.

Kenkey vendors set up shops in various locations, including lorry station, parks, markets as well as unauthorized locations. In Ghana, selling kenkey in stores and on the street is a common source of revenue for street vendors and manufacturers of traditional foods. These initiatives have a substantial impact on the economies of Ghana. Kenkey is a food usually sold on the street that is inexpensive, and accessible to the impoverished. In addition, it offers households additional income opportunities for self-employment and

informal employment. Everyone along the supply chain benefits from the sale of kenkey.

In Ghana, the sale of kenkeys originates in people's homes. A woman with limited resources constructs a wooden structure to produce kenkey and sell. Kenkey significantly improves food security and nutrition therefore women, men, children, and students have access to nutritious, affordable, and delicious food (Tortoe et al., 2008). Numerous Ghanaians and other people in various regions of West Africa, including Nigeria, now eat kenkey.

Carbohydrates

According to Lin et al. (2010), carbohydrates are the primary energy source for all body functions, but notably brain functions. Carbon, hydrogen, and oxygen compose carbohydrate molecules. Carbohydrates are the form of food that the body can convert into usable energy most easily. When you consume carbohydrates, your body converts them to glucose, which is then converted to glycogen and deposited in your liver and muscles for future use (Lin et al., 2010).

Monosaccharides, disaccharides, and polysaccharides are the three primary chemical subgroups of carbohydrates. Polysaccharides are a subgroup of monosaccharides. Monosaccharides are sugars that can exist independently. They are also known as simple carbohydrates. Because disaccharides contain only two sugar groups, they are also known as simple carbohydrates. Polysaccharides are known as complex carbohydrates because they contain more than one sugar. The body can rapidly break down the simple carbohydrates (monosaccharides and disaccharides) found in fruits. This means that the body can use these carbohydrates as an immediate source of energy. Foods such as

rice, potatoes, and pasta contain complex carbohydrates, also known as polysaccharides. These carbohydrates are more difficult for the body to digest, but they provide more consistent energy for a long period.

Eli-cophie et al. (2016) state that carbohydrates are primary energy source in food and that they "spare" protein so that it can be utilized for its primary functions. Between 40 and 50 percent of the energy that most infants consume originates from carbohydrates. Complex carbohydrates are the most vital forms of carbohydrates for humans to consume.

According to Davis and Antony (2002), potato chips, cookies as well as candies are primarily composed of calories, whereas cereals and grains are essential sources of both carbohydrates and B vitamins. When preparing meals for children, it is essential to pay careful attention to the nutritional value of the food's carbohydrates. When infants and young children consume excessive amounts of sweets, biscuits, carbonated beverages, and other sweetened beverages, they lose their appetite for nutrient-dense foods. This can lead to obesity, tooth caries, and overall poor nutrition, so these foods should be consumed in moderation.

Diabetes

Iregbu and Iregbu (2016) defined diabetes as a condition that results from the pancreas not able to produce enough insulin or the cells of the body not able to use insulin correctly. Diabetes changes the body's large and small blood vessels in a number of ways. This speeds up the process by which cells all over the body die. Kyriakidis et al. (2016) said diabetes is a disease that affects the endocrine system and is marked by high blood sugar caused by insulin resistance or not enough insulin release. The main reason of diabetes is

either that the body's tissues can't respond to insulin or that the pancreas doesn't make enough insulin (Seeley et al., 2000). Nyarko et al. (2014) say that the condition is caused by the body inability to make sufficient insulin, which is needed for the body to absorb glucose. WHO (2015) reports that diabetes is a long-term illness which can be passed down from parents or picked up later in life.

Types of Diabetes

According to the International Diabetes Federation (2017), there are three primary varieties of diabetes with distinct causes. These are type 1 diabetes, type 2 diabetes and gestational diabetes.

Type 1 Diabetes

Diabetes type 1, which is also called juvenile diabetes typically, affects individuals under the age of 25. It is related to the requirement for insulin, and in diabetes type 1, the body's pancreas lacks the capacity to manufacture any insulin. This causes the blood sugar to rise uncontrollably. As the body digest fat cells to manufacture glucose, the number of liberated fatty acids increases, along with the number of ketones and ketoacids. This increase in unbound fatty acids could occur within hours or days. Dehydration occurs when the body produces more urine due to the loss of glucose and ketoacids. This illness, if left untreated, will result in keto-acidotic coma, which will be fatal if emergency medical care is not administered (Iregbu & Iregbu, 2016).

Type 2 Diabetes

Diabetes type 2 typically affects adults, and the majority of individuals with this forms of the disease lack symptoms and do not require insulin. According to Iregbu and Iregbu (2016), diabetes type 2 is the highly prevalent

form of the disease and is often linked to a family diabetes history, ageing, being overweight, as well as not getting enough exercise. In the early phases of the condition, the body continues to manufacture insulin as expected, however, its cells no longer respond to the hormone. This is known as insulin resistance. When the level of blood glucose goes up, it causes insulin levels to also rise, which temporarily compensates for resistance of insulin. The body production of insulin becomes inadequate and so starts to fall back after a certain number of years. Due to the presence of insulin, ketoacidosis does not occur, but a hypererosmolar coma, a less common type of coma, can occur if the situation is extremely dire.

Gestational Diabetes

During pregnancy, a woman may be diagnosed with gestational diabetes. This is also a diabetes type which is extremely rare and passed down from generation to generation. Surgical procedures, medications, malnutrition, infections, and other ailments can all contribute to the development of these conditions (National Diabetes Statistics and Basic Information, 2004).

Background on the Biochemistry of *Diabetes mellitus*

A cell needs regular supply of energy to function in the body. According to Piero (2006), glucose is the basic source of energy or fuel for the body. Glucose revolves through blood as a quick-acting energy source for the cells. Insulin is a hormone produced by the pancreas that helps maintain a healthy level of glucose in the blood. On the periplasmic side of the cell membrane, the hormone interacts with the receptor sites. It enables the correct pathways so that glucose can enter respiring cells and tissues.

According to Piero (2006), insulin accelerates the glycolysis process, which converts glucose into pyruvate. It also regulates glycogenesis when there is an excess of glucose in the cytosol, as well as lipogenesis when there is an excess of acetyl-coA. These biochemical processes are the inverse of those initiated by a hormone called glucagon. When the level of glucose is below the required level, it remains in the person's blood instead of moving into the cells (Belinda, 2004). To combat hyperglycemia, the body draws water from the cells and transfers it to the circulation. Unutilized sugar is eliminated via urination. Because the cells are attempting to eliminate excess glucose, diabetics frequently experience increased thirst and urination.

Additionally, they consume more water than they should. This results in glycosuria, which is simply the presence of sugar in the urine (Piero, 2006). As diabetes worsens, cells cease receiving glucose because there is insufficient insulin. The cells must therefore seek out alternative energy sources. In this instance, the cells derive their energy from the adipose tissue's stored fatty acids. Red blood cells, the cortex of the kidneys, and the brain derive no energy from lipids. Red blood cells lack the mitochondria, which are typically responsible for the beta-oxidation process. The barrier of the blood-brain prevents the entry of fatty acids into the brain. To provide energy to these cells and tissues, the acetyl produced by the breakdown of fatty acids is sent to the ketogenesis pathway, where it is used to produce ketone bodies. These cells and tissues can utilize ketone bodies as an alternative source of energy.

Ketone molecules are also eliminated from the body via urine. This condition is known as ketonuria, and it is a symptom of *Diabetes mellitus*. When ketone bodies accumulate inside the blood, it results in ketosis. Since ketone is

mostly acidic by nature, its accumulation in the blood reduces the pH of blood, which can result in acidosis. The disease ketoacidosis occurs when the body is both acidic and in a state of ketosis. Ketoacidosis is a disease that, if left untreated, can cause unconsciousness and ultimately death (Belinda, 2004).

Signs and Symptoms of Diabetes

The primary signs of uncontrolled diabetes include polyuria, polydipsia, and polyphagia. Polyuria refers to increased urination. Polydipsia signifies increased thirst. Polyphagia indicates an increase in hunger. The symptoms of type 1 diabetes can manifest rapidly (within weeks or months), whereas the symptoms of type 2 diabetes tend to manifest over a long period. and could be weak or absent (Cooke & Plotrick, 2008).

Diabetes can begin with additional signs and symptoms, but these are not the only ones. In addition to the previously listed side effects, you may experience double vision, a headache, fatigue, delayed wound healing, and itchy skin. A rise in the level of blood glucose for a long period may result in the lens of eye absorbing the glucose, which can alter the lens' shape and result in vision alterations. According to Cooke and Plotrick (2008), diabetic is a group of cutaneous conditions that may result from diabetes.

Complications of Diabetes

Patients with any form of diabetes are most likely to have persistent challenges. These typically manifest after ten to twenty years, but they may be the first indications for undiagnosed patients. Vein damage causes the most severe long-term complications. Diabetes increases the chance of developing cardiovascular and approximately 75% of diabetic fatalities are as a result of coronary artery disease.

Damage to tiny blood vessels is responsible for the majority of diabetes-related complications (Cukierman, 2005). Destructions of the nerves, kidneys as well as eyes are the most serious issues. Diabetes also increases the likelihood of developing heart conditions.

Damage to the retina's blood vessels, known as diabetic retinopathy, can result in gradual vision loss and, in the worst cases, blindness (WHO, 2015). This damage can be avoided by treating diabetes as quickly as possible. Kidney damage can lead to inflammation, loss of protein in the urine, and kidney disease, which may require either dialysis or transplant of kidney in some cases (WHO, 2015). Diabetic neuropathy, also known as nerve loss, is the commonest impact of diabetes. The condition can cause, tingling, numbness, pain, as well as a distinct way of experiencing pain, which can be detrimental to the skin over time (WHO, 2015).

Diabetes can cause diabetic ulcer of the foot, which are extremely complex to be treated and frequently necessitate amputation. In addition, proximal diabetic neuropathy can result in painful muscle atrophy and paralysis. Some individuals with cognitive decline and diabetes have a connection between the two conditions (WHO, 2015). According to Cukierman et al. (2005), persons with diabetes are 1.2 to 1.5 times more likely than those without the disease to experience cognitive decline.

Psychological and Emotional Reactions of Living with Diabetes

According to Kucuk (2015), mental health is negatively impacted by diabetes and its complications. Browne et al. (2013) found in an online survey that 63 percent of respondents encountered significant diabetes-related discomfort as a result of adjusting to the disease. According to Browne et al.

(2013), diabetes can lead to depression, anxiety, impaired cognition, and food disorders. Numerous studies have linked type 2 diabetes to depression, anxiety, sexual dysfunction, suicidal ideation and cognitive impairments. Masmoudi et al. (2013) investigated anxiety and depression in over-60 type 2 diabetics. About 40.3% of patients had anxiety and 22.6% have depression. This was the consequence of their type 2 diabetes.

According to Warren et al. (2003), hyperglycemia elevates irritability, restlessness, and agitation. After receiving a diagnosis, individuals may exhibit numerous psychological and emotional disorders. A study by Tabong et al., (2018) has shown that patients are shocked, terrified, frustrated, sad, and prone to crying after diagnosis. A number of patients questioned their behaviour and expressed surprise at the findings (Zimmermann et al., 2018).

Yasmin et al. (2020) utilized a hybrid methodology of sequential explanatory design to better comprehend the experiences and treatment success of diabetes type 2 patients. Again, the study explored the perspectives of diabetes patients on mobile health solutions. This qualitative investigation followed a randomized control experiment conducted in Bangladesh. The study found that diabetes caused melancholy, tension, irritability, anger, and irritation in a random sample of eighteen individuals. The controlled investigation carried out at Bangladesh Institute of Health Science Hospital revealed that all patients had type 2 diabetes.

The sentiments, thoughts, and experiences of diabetic patients were investigated by Yilmaz et al., (2019). Patients reported experiencing negative emotions, irritability, grief, and a desire to never be alone at home. Additionally, patients requested less time alone at home. They later expressed contrition for

their actions. Hjelm et al. (2018) investigated the health, illness, and health care attitudes of African women who migrated to Sweden with Gestational Diabetes Mellitus.

According to the survey, women were concerned about recurrence and their offspring. Also, they were concerned about they not able to live a normal existence as well as changes in diabetes treatment. Mensah et al. (2017) found that gestational Diabetes mellitus impacts the mental health of Ghanaian mothers. After diagnosis, Kalra et al. (2018) discovered that patients experience mental distress. Untreated psychological distress leads to suicidal thoughts and attempts, according to (Chung et al. 2014; Tabong et al. 2018; Necho et alm., 2019). In a cross-sectional research study of diabetes patients in Bahirdar, Ethiopia, Necho et al. (2019) investigated the causes of suicide ideation and attempts. About 10.7 percent and 7.6 percent of patients attempted suicide. Each is significantly above the national average. Female patients were more likely than male patients to attempt suicide and had comorbid conditions such as depression. Again, it was mainly linked with social isolation as well as ineffective glycemic management. This supports what was earlier reported by Chung et al. (2014), who found that Chinese diabetic patients exhibited 15.3% more suicidal ideation and behaviours.

These psychiatric disorders may make the management of diabetes type 2 difficult for patients, resulting in poor health outcomes. Depression may interfere with diabetes patients' self-care, resulting in severe physical symptoms (Sulaiman et al. 2010). Despite the fact that these findings have disclosed a high rate of suicidal tendencies among diabetics, just few studies have been

statistically analyzed, and their primary focus was on suicides caused by Diabetes mellitus.

Management of Diabetes

Managing one's lifestyle choices appears to be a crucial component of diabetes mellitus treatment. According to Inzucchi (2002), it is widely recognized as a crucial component in preventing diabetes as well as cardiovascular disease. Meta-analyses indicate that lifestyle interventions, which include diet as well as exercise, led to about 63% decrease in diabetes prevalence among the populations. The impact of lifestyle modification programmes on the incidence of diabetes has not been documented, despite the fact that these programmes have shown a remarkable improvement in diabetes risk factors. Included in the treatment of diabetes mellitus is the management of lifestyle factors, such as diet and exercise. It is long-term beneficial to one's health and life quality (Inzucchi, 2002).

The objective of dietary management is to accomplish optimal metabolic regulation by striking a balance between the amount of meal consumed, the quantity of physical work engaged in, as well as the medication used to prevent problems. According to Piero (2006), the objective of the diet of a type 2 diabetic patient should be to obtain improved glycemic and lipid levels as well as healthy weight loss. Despite the fact that vital lifestyle modifications in the treatment of diabetes have been emphasized, the majority of diabetics are unable to achieve their target glucose concentrations without the aid of pharmacotherapy.

According to Inzucchi (2002), numerous oral hypoglycemia has been used to assist diabetics in maintaining their blood glucose levels within the

required range. These hypoglycemias function through a variety of mechanisms. Thiazolidinedione (TZDs) ensures normoglycemia by increasing sensitivity of insulin predominantly by enhancing peripheral glucose disposal as well as inhibiting hepatic production of glucose. Sulfonylureas and the nonsulfonylurea regulate endogenous insulin secretion to achieve normoglycemia. Alpha-glucosidase inhibitors function by postponing the intestinal absorption of carbohydrates.

According to Curtis (2007), the mechanism of action of metformin includes a decrease in hepatic gluconeogenesis and an increase in peripheral mobilization of glucose as well as disposal. Injections of synthetic insulin may also be used in treating type I diabetes. Despite the presence of several effective oral hypoglycemic medicines for managing diabetes type 2, between 5 and 10 percent of the diabetic population experiences secondary failure, according to Curtis (2007).

Secondary failure can be caused by a decline in beta cell function, medication non-adherence, an increased in body mass, a decrease in physical activity, dietary changes, or illness. The high cost of hypoglycemic medications and the risk of adverse effects for patients are two significant disadvantages associated with their use. In addition, plant-based medications have proven to be highly effective in the treatment of diabetes. According to Piero (2006), there is a new method globally to use Phyto drugs to prevent the negative side effects linked with the conventional hypoglycemic medications.

Glycemic Index

The Glycemic Index paradigm with the intention of assisting diabetics in regulating the post-meal rise in blood sugar was developed in 1980. Jenkins et al. (1981) developed it as a method to categorize the various types of carbohydrates and high-carbohydrate meals based on how they affect postprandial glycaemia. It was believed that it referred to foods such as sweet potatoes, rice, cereals, and other foods that derive approximately 80 percent of their energy from carbohydrates. Since the beginning of the 1980s, scientists have debated whether GI should be regarded as a risk factor that must be managed in order to reduce the chance of getting chronic diseases.

The glycemic index is a beneficial nutritional concept that teaches us how eating carbohydrate-rich foods affects our bodies and how this impacts our health (Foser-Powell et al., 2002). Brand-Miller et al. (2014) reported that, the glycemic index is a chemical measurement of how simple or complex a carbohydrate is, whether they are sugars or polysaccharides, and whether they are available or not. It is a procedure used to group foods based on their propensity to elevate the levels of blood glucose.

Again, the GI compares foods with the same quantity of easily digestible carbohydrates and assigns a value to the quality of those carbohydrates. Comparing the amount of pure glucose that causes a group of healthy study participants' blood glucose levels to rise to the amount of a particular substance that causes the same group's blood glucose levels to rise yields the number.

The GI is a measurement of how carbohydrates in food influence the levels of blood sugar. Because they raise glucose levels the most rapidly and substantially, white bread as well as glucose is frequently utilized as standard

meals. When calculating the GI of various foods, a value of 100 is assigned to either glucose or white bread, which has the highest GI index conceivable. Multiplying the value on the glucose scale by 100/70 yields the value on the bread scale. This is done so that the GI numbers can be converted from one scale to another.

A food's GI is low if its value on the bread scale is below 70. A substance is considered a high GI food if its value is greater than 100 (Atkinson et al., 2008). According to International lists of GI and GL values, there are items with proportionally lower values than glucose or white bread depending on their impact on serum glucose levels. The figures for these foods are proportionally lower than those for white bread.

People believe that a food with a low glycemic index is healthful because the rise in blood sugar it causes after consuming it is significantly less than after consuming a food with a high glycemic index. FAO/WHO (1998) collaborated to assemble a group of experts whose mission was to examine all previous research on the function carbohydrates play in health and nutrition of humans. The group agreed that GI procedure should be used to categorize carbohydrate-rich diets.

In addition, they recommended combining the GI values of meals with information about how foods are prepared when deciding what to consume. The group recommended that individuals consume a high-carbohydrate diet (one that derives at least 55% of its energy from carbohydrates), with most carbohydrate-rich foods being high in terms of non-starch polysaccharides with low glycemic index. This was done to properly regulate our physical fitness.

Glycemic Load

The glycemic response is influenced by both the quantity as well as the quality of carbohydrates. Glycemic Index (GI) compares equivalent amounts of carbohydrates and provides a measure of their quality without looking at their quantity. In 1997, Harvard University researchers developed the Glycemic Load (GL) concept to measure the overall glycemic impact of a food's portion (Liu et al., 2000). To calculate a food's GL, you must first calculate the GI value of the food by multiplying the number of grammes of carbohydrates in a serving by the GI value of the food and dividing by 100 (American Diabetes Association, 2012).

In general, it is believed to provide a more precise estimation of how much a diet influences the amount of insulin the pancreas produces and the amount of glucose in the blood serum. Therefore, the GL provides a fast method for measuring the relative glycemic effect of a serving size considered "typical" for the food. The greater the glucose loads of a food, the greater the blood sugar spike it will cause and the more insulin your body will produce.

According to a 2000 study by Liu et al., consuming diet high in GI value is linked to a high chance of developing type II diabetes as well as coronary heart disease. GI and GL do not have a direct relationship. For instance, a food with a high GI could have a low GL value if consumed in tiny quantities. However, the amount of food consumed can cause it to have a high GL even if it has a low GI (Mendosa, 2008). The majority of the time, foods with a low GI value also has a low GL value. However, the GL value of high-GI foods may vary depending on the type of carbohydrate they contain. For instance, the

glycemic index (GI) of watermelon is quite high at 72, as the fruit's carbohydrates are rapidly converted into glucose.

According to Foster et al. (2002), the GL of watermelon is relatively modest. This is as a result of the fruit's high content of water and relatively low content of carbohydrate overall. The GL concept provides an answer to the question of whether the glycemic index alone is a reliable method to determine whether a food is healthy or unhealthy. For instance, the GI of carrots is as high as 131, but the GL is quite low because it contains only 7 g of carbohydrates. Undoubtedly, 700 grammes of carrots are required to produce a glycemic response that is about 1.3 times of 100 grammes of white bread, which contains 50 grammes of carbohydrates. Carrots contain 50 g of carbohydrates (Gross et al., 2004).

According to Venn and Green (2007), a diet low in GL can be achieved by selecting meals which has high carbohydrate content with a low glycemic index and consuming these foods in modest quantities. In contrast, a low-GL diet may consist of foods that are high in fat and protein but low in carbohydrates. Given the variety of meals that can be included in a limited GL diet, it is evident that GL value alone should not be the only consideration when selecting meals. It is essential to know the other characteristics of the food, such as its fat content, fat type, energy content, protein content, and recommended serving size.

GL can be determined by various methods. There are both direct and indirect methods for determining GL. In the indirect method, the GI of a food is multiplied by the quantity of readily accessible carbohydrates in the consumed meal.

Glycemic Load and Health

Numerous research works have revealed that glycemic load is strongly linked with a wide range of non-communicable diseases (NCDs) (Wang, et al., 2013). It has positive effects in terms of increasing or decreasing the chance of getting them. High GL diets are associated with an increased chance of getting some chronic diseases, whereas low GL foods are believed to decrease the chance of certain chronic diseases.

Glycemic Load and Diabetes

According to Barclay et al., (2008) both the GI and GL of the overall meal have been linked to an increased chance of contracting diabetes type 2 in both men and women. According to Wang et al. (2013), diabetes is a category of metabolic diseases characterized by either hyperglycemia or hypoglycemia and intolerances of glucose. According to Willett et al. (2002), hyperglycemia is linked to loss of pancreatic function of the cell, which could lead to glucose intolerance and, ultimately, irreversible diabetes.

Given that diabetes is predominantly a disorder of glucose breakdown, it is essential to comprehend the carbohydrate types that affect the risk and progression of the disease (ADA, 2001). A meal which increases the level of blood glucose as well as insulin may increase the likelihood of developing diabetes type 2. Willet et al. (2002) observed that, women who consumed a diet rich in dietary fibre and low in GL had a lower chance of developing diabetes than those who consumed a diet low in cereal fibre and high in GL. This information was utilized to test the assumption that foods which has high glycemic burden raise the chance of developing diabetes type 2.

Riccardi et al. (2008) suggest that consuming more low-GL and fibre-rich meals may enhance the level of blood glucose homeostasis and reduce the incidence of hypoglycemia. Roberts (2000) demonstrated that carbohydrate glycemic causes appetite and carbohydrate cravings. In addition, they demonstrated that consuming low-GI foods as opposed to high-GI meals lead to increased satiety, delayed the onset of appetite, and reduced intake of food.

Glycemic Load and Obesity

Obesity prevalence has multiplied d rather than decreased, according to Hui and Bell (2003). This situation was highlighted when the Western Dietary Guidelines convinced people to consume carbohydrates instead of lipids. This is a result of consuming more calories from carbohydrates than fat (Hui & Bell, 2003). Low GL meals decrease appetite and increase satiety, according to research (Brand-Miller et al., 2002). Individuals who ingest a high GL meal will have difficulties with weight lose because high GL meals stimulate appetite some hours following consumption of meal (Hui & Bell, 2003). This is in line with the notion that the GL of a product has a substantial impact on obesity management.

Empirical Review

The nutritional composition of maize has been studied worldwide over the years. Various researchers have conducted an experiment to discover the nutritional values of maize dishes and their impact on the health of human in relation to diabetes management.

Marina et al. (2013) conducted an experiment to determine the effect of fermentation process on nutritional composition and aflatoxins content of doklu, a dish made from fermented maize. They observed that maize Grains contains

14.2 ± 0.1 percentage moisture, 8.2 ± 0.7 protein 0.64 ± 0.01 fat, 60.5 ± 3.0 carbohydrates, 0.64 ± 0.01 total sugar, 1.85 ± 0.07 ash and 280.56 energy values. They noted that fermented corn dough which was produced by steeping maize in water for 72 hours contained 20.4 ± 0.2 moisture, 7.1 ± 0.3 protein, 0.18 ± 0.07 fat, 60.1 ± 2.1a carbohydrate, 0.16 ± 0.02 total sugar, 1.84 ± 0.14 ash and 270.42 energy value. Also, they discovered that, Doklu which is similar to kenkey made in Ghana contained 20.7 ± 0.1 percentage moisture, 6.9 ± 0.1 protein, 0.20 ± 0.07 fat, 60.2 ± 3.4 carbohydrate, 0.10 ± 0.01 total sugar, 1.66 ± 0.2 ash and 270.2 energy value. Marina et al. (2013) discovered that, the protein, fat and soluble sugar contents decreased significantly during the preparation of doklu, due to the fermentation process that occurred. This was attributed to either a rise in the catabolism of protein by the fermenting micro-organisms or the use of sugar as a source of carbon. Their observation was in line with that which was earlier reported by Binita and Kumar (1996), who noted a decrease in protein value of cereal-legume mix by the activities of yeast as well as bacteria.

The glycemic response of maize foods has also been an area of concern. Eli-Cophie et al. (2016) conducted an experiment to examine the GI of 5 staple carbohydrates foods in Ghana. They observe that, Ga-kenkey recorded low GI of 41, tuo zafi had medium GI (68) and banku recorded high GI (73). They noted that, the low GI obtained by *kenkey* could be as a result of it high fibre value (2.46/100 g) and less carbohydrate content compared to the other maize-based test meals. They further observed that, there was no statistically significant variation between the Glycemic Index of *Tuo Zafi* and *banku* ($p>0.05$). However, the Glycemic Index value of *banku* varied significantly from that of

kenkey. The low GI recorded by Ga *kenkey* agrees with an earlier experiment conducted by Brakohiapa et al. (1997) on the glucose response to certain Ghanaian meals, where they observed that *kenkey* causes low glucose response when consumed by people with good health. Also, the variation noted in the GI values of maize based meals are similar to those found in the reviewed International Table of GI and GL, in which popularly eaten corn granules in china obtained GI of 52 ± 3, chapatti, an indian staple made from maize flour recorded 59 GI and maize porridge made in China which is in line with Ghanaian maize porridge *obtained* GI of 68 ± 3 (Atkinson et al. 2008). Eli-cophie et al. (2016) concluded that, although all the test foods were prepared by boiling, they obtained different GI values. This implies that the GI of Ghanaian carbohydrate staples foods vary and this should guide the choice made by the general public in maintaining the glucose level of their blood.

Yeboah et al. (2019) carried out clinical trial to determine GI of five Ghanaian corn and cassava staple foods. They discovered that the GI of kafa, Abolo and apkle were 29, 58 and 69 respectively. Thus, Abolo recorded low GI while Abolo and Apkle had medium GI according to Brand-Miller et al. (2014) classification. Yeboah et al. (2019) reported that, kafa obtained low GI because immediately after cooking, it was allowed to completely cool at room temperature. When starchy meals are prepared and allowed to cool after preparation, the crystalline produced in the food changes into resistant starch which is harder to breakdown into simpler form (Annison & Topping, 1994)

CHAPTER THREE

METHODOLOGY

Introduction

The Chapter discussed the various processes which were engaged in to bring about a reliable result. The study looked at the study design, site the study took place, population, inclusion and exclusion criteria of getting the participants for the study. Other sections discussed in the Chapter included determination of nutrients content, data collection and ethical issues as well as the analysis of data.

Study Design

The experimental design was utilised in the research study. Experimental design, as defined by the International Encyclopaedia of Human Geography (2009), is the process of carrying out research in an objective and controlled way so as to increase precision and draw more specific conclusions in relation to a hypothetical statement. The most essential aspect of an experimental research work is that the design is ideal for determining the study purpose (Kumar, 2016). Experimental methods are time-consuming, difficult to execute, and expensive, particularly when measuring long-term effects (Best & Kahn, 2014).

Study Site

The investigation was carried out in Secondi-Takoradi Metropolis. Sekondi and Takoradi are considered to be twin cities in Ghana and together, they constitute Takoradi. Sekondi-Takoradi is the capital of the Sekondi-Takoradi Metropolitan Assembly in Ghana's Western Region. Sekondi-Takoradi, with a population of 445,205, is not only the most populous city in

the region but also a significant industrial and economic hub. The most important factories in the area are timber and plywood manufacturing companies, cocoa processing industries, shipbuilding and harbour companies, and railway maintenance, and crude oil production factory. The primary economic activities in the study area are fishing and farming (Ghana Statistical Service, 2021).

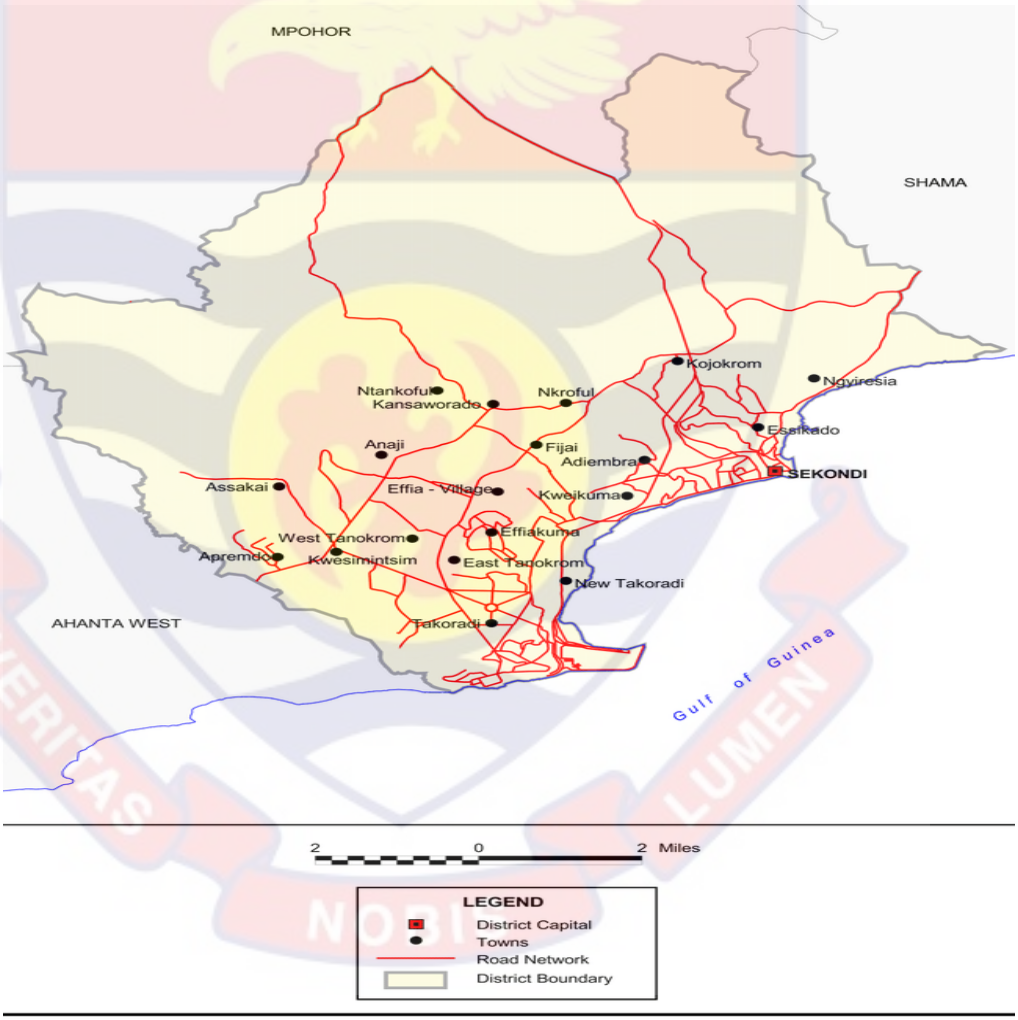

Figure 1: Map of Secondi - Takoradi Metropolis

Source: Adjei-Mensah et al., (2019)

Population

The population for the study comprised non-diabetics in the Secondi - Takoradi Metropolis, who normally have a BMI of between 18.5 kg/m² - 24.9 kg/m² and are not on any medication and are interested in participating in the study.

Sample and Sampling Procedure

The sample size consisted of ten (10) individuals made up of eight (8) males and two (2) females. The purposive sampling technique was utilized to select the 10 participants for the postprandial glucose level test. According to the international standard procedure, the GI value of food is obtained by ingesting 10 or more individuals 50 grams of digestible carbohydrates and then measuring the impact on their level of blood glucose over a period of two hours (Glycemic Index Foundation, 2017). The "obatanpa" maize was utilized because it is largely produced and consumed in the Western Region. The maize was bought from the producers at the farm and dried for one week to avoid any form of adulteration

Inclusion Criteria

The inclusion criteria were;

1. People with a BMI within the normal range of 18.5 – 24.9 kg/m^2.
2. Healthy individuals who do not have any diabetes history, cardiovascular disease (CVD), or ailment, as confirmed by a comprehensive medical examination.
3. People between 20 and 60 years of age.
4. Those who eat the test food as a staple and come from Western or Eastern Region

Exclusion Criteria

The exclusion criteria utilized comprised the following;

1. Obese or non-obese people who struggle with how their bodies use glucose.
2. People who have heart illness and for whom this type of test could be harmful or stressful, as well as those who take medicines which may impact the outcomes.
3. People aged 20 to 60 who had experienced diabetes, metabolic abnormalities, or any other sickness.

Proximate Analysis

All three kenkey samples ("ntɜw dokono", "nsinhon dokono" and "dokono pa") were approximately analyzed using 100 g of each. The parameters were determined on dry weight basis. The following nutrients were identified:

Determination of Moisture

Crucibles were cleansed, dried and weighed. Fresh samples weighing 10 to 12 grams were weighed in the oven-dried, spotless crucibles. The crucibles carrying the food samples were distributed throughout the base of the oven to achieve even heat dispersion. They were then kept at 105 degrees Celsius for 48 hours in a thermostatic oven. Samples were collected at the conclusion of the time and kept in a desiccator for 30 min to cool. Each food sample was then weighed three times. The moisture content was then computed as the sample's water loss percentage.

Determination of Ash

The test food samples were progressively heated in an oven at 105 ºC for approximately one hour after which they were moved to a furnace at 550 ºC and left overnight. The temperature was increased till all the carbon particles were consumed by combustion. The ash dish was taken out of the oven, allowed to cool in a desiccator, and then measured. The percentage of ash in the initial sample was subsequently determined.

Determination of Fat/Oil

The reagent that was utilized was petroleum spirit. 10–12 grams of the milled food samples were placed in a 50 mm by 10 mm Soxhlet extraction receptacle in order to carry out the procedure. Following this, a 50 ml capacity Soxhlet extractor was utilized. For the measurement, a 250-milliliter, spotless and dry round-bottom flask was used. After adding approximately 150 milliliters of petroleum spirit and connecting the Soxhlet extractor, extraction was conducted for about six (6) hours with a heating mantle as the primary heat source. After six hours, the flask was taken out and put in a 60 °C oven for about two hours. The round-bottom flask was deposited in a desiccator to be cooled prior to being weighed after being removed from the apparatus. The proportion of fat and oil was calculated using the following formula:

Crude fat (%) = [W (g) × 100] ÷ [Sample (g)], where W = Weight of Oil.

Protein Determination

Protein was determined using the Kjeldahl technique. Three processes make up the method: digestion, neutralization or distillation and titration.

Digestion

A 100 ml Kjeldahl flask was filled with about 0.2 g of the food sample. Digestion reagent of 4.4ml was added to each sample after which the samples were left to digest for 2 hours at 360 °C. A blank was prepared without a sample. When digestion was over, the digests were quantitatively transferred into 100 ml volumetric flasks (AOAC, 2008).

Distillation

An apparatus for steam distillation was assembled. Distilled water was utilized to cleanse the distillation apparatus for about 20 minutes. After cleaning the aparatus, 5 ml of boric acid was poured into a 100 ml conical flask and set beneath the distillation apparatus's condenser, with the tip of the condenser fully submerged in the boric acid solution. A trap funnel was utilized to transfer an aliquot of the sample digest into the chamber of reaction. The distillation process begun immediately by adding 10 ml of the alkali mixture and 50 ml of the distillate were collected (AOAC, 2008).

Titration

The distillate was titrated with 0.1 N HCl solution till the solution turned from the original indicator colour (wine red). Digestion blanks were done in the same manner and deducted from the titre value of the sample. The nitrogen content and protein were determined using the titre values that were obtained.. The conversion factor utilized was 6.25 (AOAC, 2008).

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

$$\% \text{ Protein} = \% \text{ N x } 6.25$$

Crude Fibre Determination

Reagents

Sodium hydroxide, 1.25 %

To obtain this 1.25 %, dissolve 12.5 g NaOH in 700 ml distilled water in a 1000ml volumetric flask and dilute to volume. Sulphuric Acid, 1.25 %. To obtain this, add 12.5 g conc. Sulphuric acid to a volumetric flask containing 400ml distilled water and dilute to volume.

Procedure

About 1g of the sample was weighed and put into a boiling flask and 100ml of the 1.25 % sulphuric acid solution was added and boiled for 30mins. Filtration was carried out in a numbered sintered glass crucible after the boiling. The residue was returned 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 was washed with hot water and methanol. The crucible was dried in an oven at 105 ºC overnight and weighed. The weighed crucible was then put into a muffle furnace (model LE 14/11) at 500 ºC for about 4 hours. The crucible was allowed to cool in a desiccator after which it was weighed (AOAC, 2008).

Calculation

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

Source: AOAC (2008).

Determination of the Carbohydrate Content of the Sample

The quantity of soluble carbohydrates in the samples were measured in accordance with Keeney et al (1982) and FAO (2008), using a standard laboratory procedure. The procedure comprised two stages; extraction of the substance and colour development.

Substance Extraction

About 0.01 g of each sample was placed in a 50 ml conical flask, and 30 ml of distilled water was added to each flask. A glass bubble was inserted into the flasks' neck and the flasks were boiled on a hotplate for 2 hours. The flasks were repeatedly replenished with 30 ml distilled water until they were removed from the hotplate after the 2 hours. The mixtures were allowed to cool after which they were filtered into a 50 ml volumetric flask, using No. 44 Whatman filter. The same method was used to produce a "blank" solution (AOAC, 2008).

Colour Development

A standard solution of 2 ml in addition to 2 ml of extract and water blank was pipetted into a set of hot tubes. The same treatment was given to the standards and samples. Anthrone solution of 10 ml was quickly added to the mixture and the tubes were made to submerge in flowing tap water. The tubes were later kept in a beaker of hot water and made to boiled for 10 minutes in a dark fume cabinet.

The tubes were submerged in cold water again after boiling for 10 minutes and left in the dark room to cool. A spectrophotometer from the CE 1000 series was used to measure the optical density at 625 nm for both the sample and the blank. A calibration graph was constructed by plotting

absorbance against concentration for the standard solution. The blank determination was carried out in the same way.

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

Where C = carbohydrate concentration from the calibration graph

Source: AOAC (2008)

Preparation of Test Foods

"Nt3w dokono"

About 1.0 kg of corn was weighed using the weighing scale and steeped in 4 litres (measured using measuring cup) of water for three days after which it was sent to the mill to be ground into flour. The flour was combined with 200 ml of water to produce dough, which was left to ferment overnight (12 hours). The dough was divided into two parts the following day. Half of the maize dough (600 grams) was combined with 500 millilitres of water and mashed in a cooking pot. The mixture was heated to 100 ºC on fir and stirred for 30 minutes with a stirring stick. The mixture was put into a mixing bowl and left to cool. The remaining 600 g of dough was mashed with about 500 ml of water in a mixing bowl and added to the prepared mixture and thoroughly combined. The mixture was formed into the desired shapes and sizes with the hand and enveloped in dry, cleaned plantain leaves. Water was kept into cooking pot and allowed to boil on fire. The kenkey was set on plantain leaves kept in boiling water and allowed to steam for three (3) hours at a temperature of 100 ºC until it was completely cooked. The flow diagram of how to prepare 'Nt3w Dokono' is shown in figure 2.

"Nsinhon dokono"

About 1.2 kg of corn was weighed with the measuring scale, cleaned and then dehulled by a machine to obtain refined maize a kernel. The refined maize kernel was immersed in 4 litres of water in a cleaned water container for two days. It was then extracted from the water and processed into flour at the grinding mill. The 1.2 kg of flour was combined with 500 ml of water with the hand to make dough. Overnight, the dough was made to stand and further ferment. The following day, the dough was divided into two portions (600 g each). Half of the maize dough was mashed with 500 millilitres of water in a cooking pot using the hand.

The mixture was then heated on fire at 100 ºC and stirred for 30 minutes with the stirring stick. It was then placed in a mixing bowl to cool. The remaining 600 grams of the dough was mixed in a mixing bowl with 400 millilitres of water and thoroughly combined with the prepared mixture. The mixture was shaped and encased in plantain leaves that had been thoroughly washed and dried. About 1 litre of water was kept in a cooking pot and placed on fire to boil. The kenkey was placed on top of plantain leaves in the boiling water and steamed for three hours at a temperature of at 100 ºC until thoroughly cooked. The flow diagram of how to prepare 'Nsinhon Pa' is shown in figure 2.

"Dokono pa"

About 1.2 kg of maize was measured with the scale and was thoroughly cleaned and steeped in 4 litres of water for two days. To the softened maize was added 200g of fresh sweet potatoes. The mixture of softened sweet potatoes and maize was ground into flour. The flour was then combined with 200 ml water and left to ferment overnight. The following day, the dough was cut into

two portions, 600g each. Half of the maize dough was mashed with 200 millilitres of water in a cooking pot, using the hand. The mixture was subsequently kept on fire and stirred at 100 ºC for 30 minutes.

The mixture was then placed in a mixing bowl and left to cool. The remaining 600g of dough was mashed with 200 ml of water and thoroughly combined with the cooked mixture, and then stirred with a stirring stick. After that, 50 grams of wheat flour were added to the mixture, which was then stirred until uniform. The mixture was shaped into the desirable shapes and sizes and wrapped in fresh plantain leaves. It was then placed on top of plantain leaves in the boiling water and steamed for three (3) hours at a temperature of at 100 ºC until thoroughly cooked. The flow diagram of how to prepare 'Dokono Pa' is shown in figure 2.

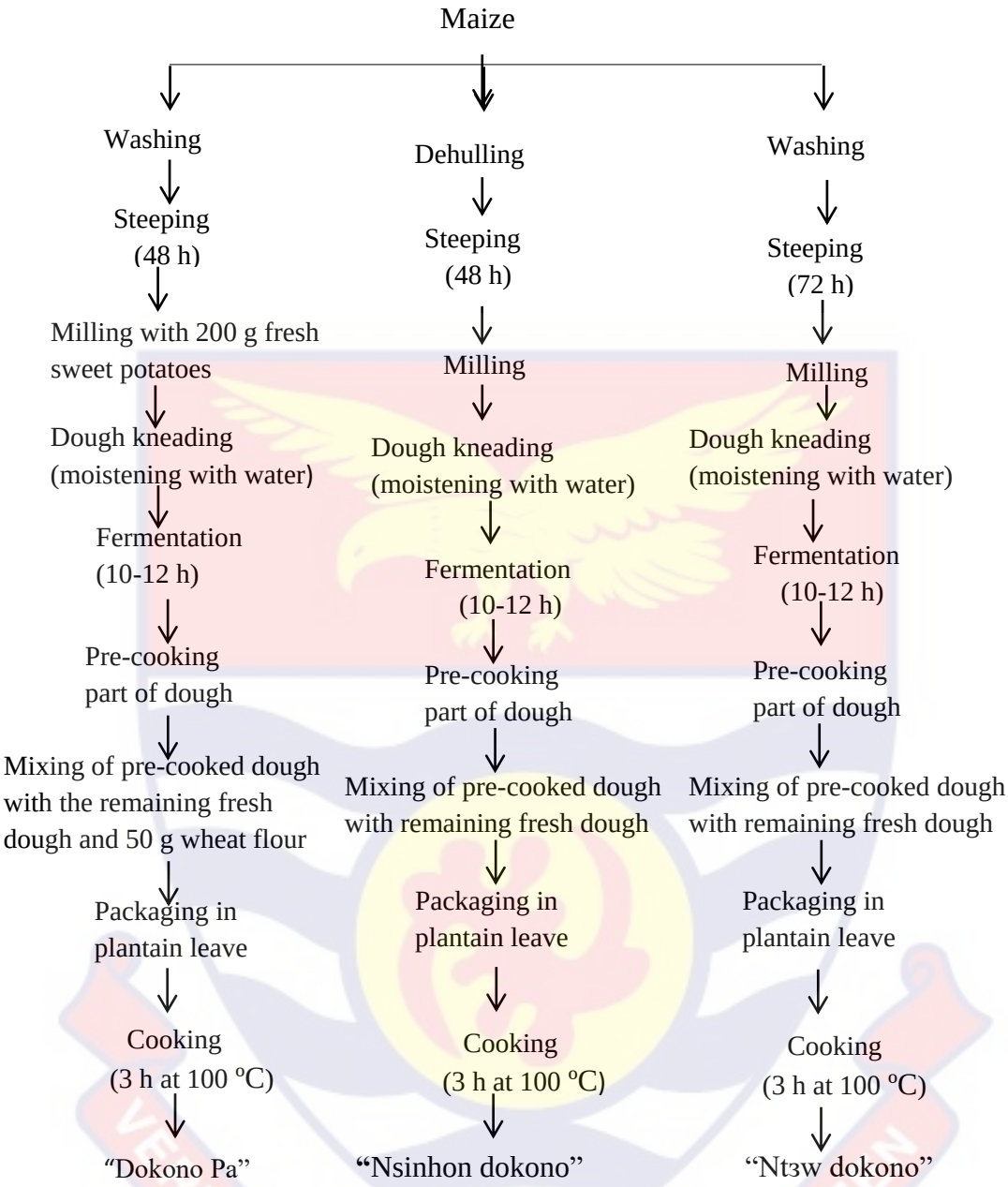

Figure 2: Flow diagram for preparing "Dokono Pa", "Nsinhon dokono" and "Ntɜw dokono"

Source: Marina et al., (2013)

Procedure for Anthropometric Measurement of Participants

The anthropometric measurements of the 10 volunteered participants for the glucose level test were obtained on the first day they visited the test centre. Each participant's age, sex, weight and height were taken. The anthropometric data were obtained in accordance with the International Standard of Glycemic Index test protocol as stated by Finocchiaro et al., (2012).

Fasting Blood Glucose Test (FBGT)

The participants were made to fast for 12 hours from 8:00pm to 8:00 am. On arriving to the Hospital for the test, they were allowed to rest for 30 minutes after which their fasting blood glucose levels were recorded. This process was executed by cleaning the finger of the participants with alcohol and pricking it using the lancet to obtain capillary blood. A glucose metre strip was kept into a glucometer and used to obtain the capillary blood and recorded.

Oral Glucose Tolerant Test (OGTT)

About 50 g of glucose was mixed with 200 ml water to prepare glucose solution for each subject to ingest as quickly as possible in about five minutes. At 30^{th}, 60^{th}, 90^{th} and 120^{th} minutes after ingesting the glucose solution, the subjects' capillary bloods were collected and measured for glucose levels.

Test Foods

Three weeks were utilized for the test administration. The quantity of each test food that gave an equivalence of 50g of the reference food was used for the test (147 g Nt3w Dokono, 144.2 g Nsinhon Dokono and 187.1g Dokono Pa). Each food sample was eaten with shito and fried fish.

The subjects were made to fast for 12 hours (8:00 pm to 8:00am) prior to the test. On the test day, each subject's FBS was recorded. The test food sample

was given to them to ingest within a given time. At 30th, 60th, 90th and 120th minutes after ingesting the test food, the participants' capillary blood were taken and measured for glucose. This was executed by cleaning the participant finger using the alcohol and pricking it with the use of lancet to obtain capillary blood. A strip was put into a glucometer and was used to draw the capilary blood which was used to test for glucose. The same procedure was repeated for all the other food samples.

Figure 3: Dokon pa with shito and fried fish

Figure 4: Nsihon dokon shito and fried fish

Figure 5: Nt3w dokon shito and fried fish

The investigation received written approval from both the UCCRIB and the Department of Vocational and Technical Education Department. The most obvious method to protect the subjects' welfare and interests in a real-world experiment is to protect their identities. The researcher guaranteed their safety in this instance by employing anonymity and concealment techniques. Participants were informed that their submitted information would be held in the strictest confidence possible.

In addition, it is essential to recognize that unethical conduct, such as study fraud and plagiarism, is forbidden in the research community. To prevent fraud and plagiarism, the researcher strictly adhered to the standards for how scientists should conduct research. To achieve this, the researcher employed a variety of techniques to acquire data from reputable sources, conducted an in-

depth analysis of this data, and then wrote a study report. Additionally, this study properly cites all ideas, works, and sources in both in-text and reference list.

The goals and reasoning behind the study were explained to the subjects before they participated in the research. During the whole study, the volunteers' right to privacy and the importance of their consent were also emphasized and kept safe. It was clear to the people who took part that they could choose to join or not, and if they did, they were supposed to stay neutral throughout the study. They were free to change their minds at any time without repercussions. Also, they were given the assurance that the data collected from them would be used only for the study.

Data Analysis

The anthropometric data was presented using percentile, median, mean as well as standard deviation

Mean as well as standard deviation were used to present the proximate content of the ash, protein, fat, fibre and carbohydrate present in the test foods with respect to objectives one. In the case of objectives two and three, descriptive statistics and inferential statistics were employed. Blood glucose levels data collected were analysed with use of IBM-SPSS version and Microsoft Excel.

The glycemic index of "ntɜw dokono", "nsinhon dokono" and "dokono pa" test foods' incremental area under the curve (IAUC) after consumption was computed. The available carbohydrate in the test foods (ntɜw dokono, nsinhon dokono and dokono pa) was used to calculate the glycemic load with the help of the trapezoid rule to determine the rise and fall in glycemic response after consuming the test foods (Wolever, 1991).

The percentage (%) Glycemic Index (GI) for each member was computed using the formula below;

GI (%) = (IAUC test food/ IAUC reference food) x 100.

. The GL were also computed using the formula below:

$$GL = \frac{(GI\ x\ grams\ of\ carbohydrate\ in\ a\ serving)}{100}.$$

The IAUC and GL were presented with the use of Microsoft Excel. Blood glucose level was analyzed by plotting the blood glucose concentration against time on a graph. The One-way Analysis of Variance (ANOVA) was used to test the two hypotheses. The results were presented in tables in Chapter Four discussion.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This Chapter presents the results obtained from the research work. All the results starting with the anthropometric characteristics of the participants and the research objectives as well as the hypotheses have been presented in tables and a figure. The results were discussed and the appropriate conclusions were drawn.

Anthropometric Characteristics of Participants

The anthropometric characteristic of the individuals who have volunteered to be part of the study on glycemic index determination have their ages and BMI calculated as presented in Table 2. The statistical tools employed were mean, standard deviation, median, minimum as well as maximum.

Table 2: Participants' Anthropometric Characteristics

	N	Mean	Standard deviation	Minimum	Maximum
Gender	10	1.20	0.42	1	2
Age	10	36.10	11.69	20.00	57.00
Weight/kg	10	67.42	6.17	58.30	76.90
Height/m	10	1.71	0.08	1.58	1.80
BMI(kg/m^2)	10	22.99	1.63	19.71	24.68

Source: field survey, Abakah-Tawiah, (2023)

Ten participants took part in the study as volunteers of which two were females and eight were males. The participants' mean age was 36.10; and was in the age bracket of 20 to 57 years. The minimum and maximum ages were within the inclusion age as prescribed by WHO (2006) and was consistent with the inclusion criteria as pre-determined in the methodology of the study. World Health Organization (2006) classified adults to be from the ages of 18 years and above. The result from the field thus aligned with the determination of WHO (2006) as to which age grouping qualifies to be used in determining GI as well as GL of food in an experiment.

The result in Table 2 for BMI was consistent with the range as given by WHO (2006). The mean of BMI is 22.90 kg/m^2 while the minimum and maximum values of the set data were 19.71 and 24.50 respectively. The standard deviation of the BMI was 1.63. The weight as a factor in determining the BMI ranged from 58.30 kg to 76.90 kg. In a similar way, the heights in metre of the participants too were in the range of 1.58 to 1.80.

With the result in Table 2, the general anthropometric properties of the volunteered participants as shown suggested that the ten persons were healthy per the WHO (2006) criteria. The glycemic indice that were determined from the participants was based on the assumption prescribed by WHO (2006).

Objective 1: Analyze moisture, ash, protein, fat, fibre, and carbohydrate contents of the three types of kenkey.

In answering the research objective one on the proximate nutrients of the three types of the indigenous kenkeys, AOAC (2008) standard of proximate analysis determination was used. Ten grams of each kenkey type was taken and prepared for the detailed proximate analysis to be carried out on them. The chemical laboratory test had produced percentage Dry, moisture, ash, protein, fat, fibre and carbohydrate as presented in Table 3.

Table 3: Descriptive Result of Proximate Analysis of the Test Foods

Nutrient	Test Food	N	Mean	Std. Deviation
%DM	Nsinhon Dokono	3	27.34	0.19
	Nt3w Dokono	3	25.77	0.11
	Dokono Pa	3	31.61	0.50
%Moisture	Nsinhon Dokono	3	72.66	0.19
	Nt3w Dokono	3	74.23	0.11
	Dokon Pa	3	68.39	0.50
%Ash	Nsinhon Dokon	3	0.55	0.02
	Nt3w Dokono	3	1.16	0.12
	Dokono Pa	3	1.77	0.05
%Protein	Nsinhon Dokono	3	10.66	0.30
	Nt3w Dokono	3	11.21	0.17
	Dokono Pa	3	11.82	0.16
%Fat	Nsinhon Dokono	3	1.75	0.01
	Nt3w Dokono	3	1.93	0.01
	Dokono Pa	3	2.06	.022
%Fibre	Nsinhon Dokono	3	1.49	0.01
	Nt3w Dokono	3	5.04	0.01
	Dokono Pa	3	6.63	0.03
%CHO	Nsinhon Dokono	3	85.55	0.33
	Nt3w Dokono	3	80.66	0.24
	Dokono Pa	3	77.72	0.18

Source: field survey, Abakah-Tawiah, (2023)

The percentage dry matter (DM) for 'Nt3w Dokono' recorded the lowest mean value of 25.77 with a standard deviation of 0.11. 'Dokono Pa' had the highest mean value (31.61) with a standard deviation of 0.50.

Moisture was high in "Nt3w Dokono" with a mean value of 74.23 and standard deviation of 0.11 respectively as compared to "Nsinhon Dokono" and "Dokono Pa".

Percentage ash was more in "Dokono Pa" (1.77) followed by "Nt3w Dokono" (1.16) and "Nsinhon Dokono" respectively.

"Nsinhon Dokono" recorded the least mean values (10.66) of protein with a standard deviation of 0.30. The highest mean value (11.82) was seen in "Dokono Pa" with a standard deviation of 0.16.

The % Fat and Oil found in the three test foods shows that 'Nsinhon Dokono' had the least mean as compared to the other two test foods. The highest mean value was recorded for 'Dokono Pa'. The standard deviation for 'Nsinhon Dokono' and 'Dokono Pa' were 0.01 and 0.02 respectively.

The mean value of % Fibre content found in 'Nt3w Dokono' was less but it was more in 'Dokono Pa'. The corresponding standard deviations were 0.01 and 0.03 respectively. Percentage carbohydrate was less in 'Dokono Pa' (77.72) with a standard deviation of 0.18 but more in 'Nsinhon Dokono' (85.55).

The significant status of the nutrients present was presented in Appendix C. In quantifying the significant nature of the nutrients present in the three test foods, One-Way ANOVA as the appropriate statistical tool from IBM-SPSS version 24 for Windows was used. The quantity of the nutrients found in the test meal samples were significant ($p \leq 0.05$).

With regards to the analysis of results in Table 2 and Appendix C, it can therefore be concluded that the proximate values of the various components present in 'ntɜw dokono', 'nsinhon dokono' and 'dokono Pa' varied in quantity. The level of the variations was significant as confirmed in the One-Way ANOVA table (See Appendix C).

Objective 2: Determine the glycemic index of the three types of kenkey

In achieving the research objective two, the panelists were made to fast for 12 hours and their blood glucose established. The Participants were then fed with the three kenkey types and the rise in their glucose level determined. The results from the test were carried in triplicate and averages over time were plotted. Table 4 and Figure 2 present the results of glycemic index of 'Nsinhon Dokono', 'Ntɜw Dokono' and 'Dokono Pa' and the blood glucose time curve.

Table 4: Glycemic index of 'Nsinhon Dokono', 'Ntɜw Dokono' and 'Dokono Pa'

Test Food Samples	Glycemic Index (GI)
Nsinhon Dokono	57.78
Ntɜw Dokono	43.54
Dokono Pa	34.60

Source: field data, Abakah-Tawiah (2023)

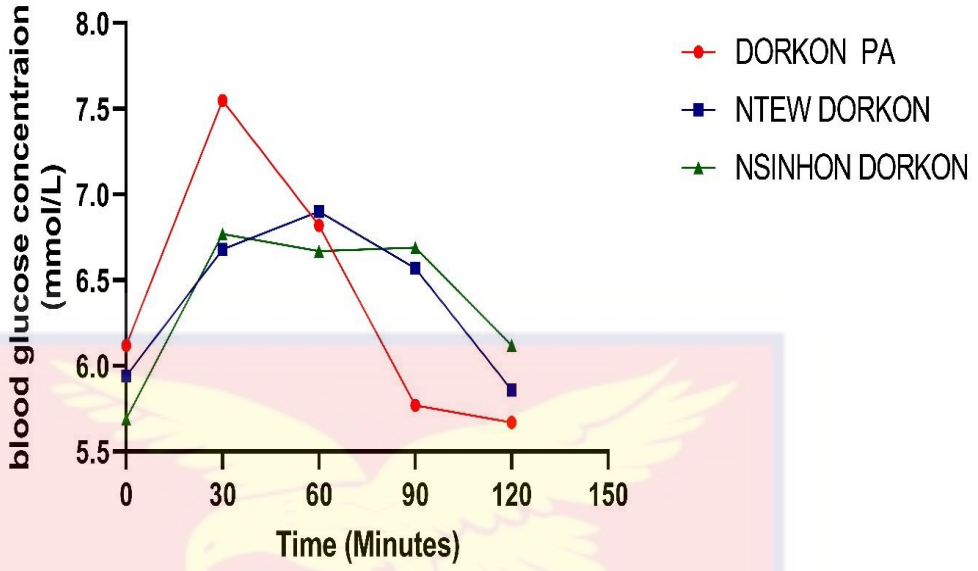

Figure 6: Blood glucose concentration

Source: field survey, Abakah-Tawiah (2023)

The result in table 4 indicates that the glycemic index value of 'Dokono pa' is 34.60, 'Nt3w dokono' has 43.5 and 'Nsinhon dokono' is 57.78. In reference to the values in Table 3, 'Dokono Pa' had the least glycemic value and the highest was for 'Nsinhon Dokono' ('Dokono Pa' < 'Nt3w Dokono' < 'Nsinhon Dokono').

The blood glucose concentration of participants measured in mmol/L when the three different kinds of kenkey were eaten is presented in finger 5. The 10 volunteers were made to undergo 12 hour fasting over the previous day and later in the morning, were fed with the test foods. The glucometer readings for each volunteer over the time ranges after eating the test meals foods were recorded. The graph of time and blood glucose concentration was plotted.

The glucose concentration in the blood after consuming 'dokono pa' at the 0 minute rose to about 6.1 mmol/L. At the 30th minute, the glucose concentration in the blood of the consumers rose to the peak value of about 7.6

mmol/L and started declining at the 60th minute. The declination of the glucose in the blood continued to the 90th minute to about 5.7 mmol/L. The glucose concentration in the blood of the consumers then begun to steadily decline from the about 5.7 mmol/L to about 5.6 mmol/L at the 120th minute.

The next graph line just after that of 'dokono pa' graph line when the graph was plotted was 'Nt3w dokono'. At the time of 0 minute, the glucose concentration was at about 5.95 mmol/L and had sharply increased to about 6.54mmol/L at the 30th minute. The increase in the glucose level in the blood continued to rise till the 60th minute to about 6.91 mmol/L. The glucose concentration however, begun to decline to the 90th and 120th minutes with 6.91mmol/L and 6.79mmol/L respectively.

The glucose time graph of the third test food ('Nsinhon dokono') had glucose concentration of about 5.7mmol/L at the 0th minute. The concentration of the glucose after consuming the 'Nt3w dokono' then begun to increase sharply till the 30th minutes. The glucose concentration in the blood of the consumers had then started to decline to 90th and 120th minutes with 6.8mmol/L and 6.1mmol/L respectively.

The high glycemic index of the test foods could lead to diabetic and other associated glycemic index influence. Piero (2006) had suggested how to address obesity and other type 2 diabetics which could lead to several diseases. Having knowledge about the high glycemic index of 'nt3w dokono', 'nsinhon dokono' and 'dokono pa' would guide the general public in their consumption.

Humans need to manage their life style to avoid diseases that relate to foods as noted by Inzucchi (2002). Therefore, the study result telling the glycemic index of the studied kenkey would be of a good source of relief to

local food consumers. The elite in Ghanaian society seem to be mindful of their diet and try to manage their health through food consumption. The result from the study would thus give them better information on their dieting.

Objective 3: Determine the glycemic load of the three test Foods

The glycemic load of 'ntɜw dokono', 'nsinhon dokono' and 'dokono pa' is a function of the quantity of carbohydrate available in the food multiplied by glycemic index and divided by 100. The result from the analysis using Microsoft Excel after the glycemic index was presented in Table 5.

Table 5: Glycemic load of 'ntɜw dokono', 'nsinhon dokono' and 'dokono pa'

Test Food	CHO	GI	GL
Nsinhon Dokono	85.92	57.78	49.64
Ntɜw Dokono	80.85	43.54	35.20
Dokono Pa	77.52	34.60	26.82

Source: field survey, Abakah-Tawiah (2023)

With reference to Table 5, the glycemic load of the test foods ranged from 26.82 to 49.64 and the minimum value was for 'Dokono Pa'. The next higher glycemic load was for 'Ntɜw Dokono' with a figure of 35.20. 'Nsinhon Dokono' also had 49.64 as its glycemic load. The difference in GI between the least GL and the next higher one was 8.38. This difference in the glycemic load value was about six times (5.92) the glycemic load value for 'Nsinhon Dokono'. A cursory look at the glycemic index values in Table 5 has a direct relation to the glycemic load. It was observed that the values starting from the bottom of the table through to the top kept increasing (that is dokono pa to Ntɜw dokono to Nsinhon dokono) with respect to the glycemic index. The same pattern was

observed for the glycemic load values where these also increased consistently from the bottom to the top in the table. Similar thing was also seen for the carbohydrate content where the values increased from the bottom in the table to the top. Thus confirming the formula for calculating the glycemic load of test food (GL) =$\frac{GI\ x\ grams\ of\ carbohydrate\ in\ a\ serving}{100}$).

The conclusion that could be drawn from the analyzed result is that the least glycemic load for the test foods was for 'Dokon Pa' and this was followed in ascending order by 'Nt3w Dokono' and 'Nsinhon Dokono' ('Dokono Pa' < 'Nt3w Dokono' < 'Nsinhon Dokono').

Research Hypotheses

Ho 1: There is no statistically significant difference in the glycemic index of 'Nt3w dokono', 'Nsinhon dokono' and 'Dokono Pa'.

To accept or reject the hypothesis, the data for the glycemic index was entered and analyzed with IBM-SPSS version 21 for Windows. The result of the descriptive and ANOVA have been presented in Tables 6 and 7. The results for each kenkey type had been taken in triplicate and the average found to compensate for error margins. The number as in the table represented the number of times the result had been entered.

Table 6: Descriptive Result of Glycemic Index of the Test Foods

Test Foods	N	Mean	Std. Deviation
Nsinhon Dokono	3	57.86	0.12
Nt3w Dokono	3	43.48	0.55
Dorkon Pa	3	34.83	0.21
Total	9	45.39	10.08

Source: field survey, Abakah-Tawiah (2023)

In referencehe to Table 6, the least mean and its corresponding standard deviation was for 'Dokono Pa' and the next high mean was for 'Nt3w Dorkon'. The test food with the highest mean was for 'Nsinhon Dokono'. The standard error associated with computation of the mean and standard deviation vlaues showed the extent to which these deviations were. The difference in the mean values of 'Nt3w Dokono' and that of 'Dokono Pa' was 8.65. The difference was about seven times the mean value of 'Nsinhon Dokono'.

The ANOVA reference table to determine the statistical significance is presented in Table 7. The p-value compared to the alpha value was lower than the significant- value ($p<0.05$). With the interpretation of the result, the glycemic index values between groups and within groups with respect to the test foods, was statistically significant.

Table 7: ANOVA Result of Glycemic Index of the Three Test Foods

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	811.78	2	405.888	3351.37	0.00
Within Groups	0.73	6	0.12		
Total	812.503	8			

Source:field survey, Abakah-Tawiah (2023)

Ho 2: **There is no statistically significant difference in the glycemic load of "nt3w dokono", "nsinhon dokono" and "dokono Pa".**

Hypothesis two testing was done by using one-way ANOVA as the statistical tool from IBM-SPSS version 21 for Windows. The data was collected in triplicate to reduce the error margin when taken the samples. The analyzed

result is presented in two tables. The descriptive result was presented in Table 8 while the ANOVA result was in Table 9.

Table 8: Descriptive Result of Glycemic Load of the Test Foods

Test Foods	N	Mean	St. Deviation
Nsinhon Dokono	3	49.88	1.02
Nt3w Dokono	3	35.29	0.37
Dokono Pa	3	26.92	0.09
Total	**9**	**37.36**	**10.08**

Source: field survey, Abakah-Tawiah (2023)

Table 9: ANOVA Result of Glycemic Load of the Three Test Foods

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	810.13	2	405.06	1024.50	0.00
Within Groups	2.37	6	0.40		
Total	**812.50**	**8**			

Source: field survey, Abakah-Tawiah (2023)

The results presented in Tables 8 and 9 shows the GL of the three test meals. The mean value of 26.92 for 'Dokono Pa' was less as compared to 'Nt3w Dokono' by 8.37. The mean value for 'Nsinhon Dokono' was the most high in reference to the other two kenkeys. The Standard deviation for each of the mean was correlated to the corresponding mean value.

In Table 9, the ANOVA result shows that there is difference between groups and within groups. The degree of freedom (df) that existed between the groups was 2 and that of the within groups was 6. The p-value of 0.00 was less than the alpha value of 0.05. In comparing the significant value of 0.00 to the

alpha value of 0.05, it can be concluded that, there is a statistically significant differences in the glycemic loads of 'ntɜw dokono', 'nsinhon dokono' and 'dokono Pa'.

Discussion of Results

The discussion of the results was linked to the research objectives and hypotheses that guided the study.

The first objective of the investigation was to examine the nutrient composition of 'ntɜw dokono', 'nsinhon dokono' and 'dokono Pa', using standardized official methods (AOAC, 2008; IITA, 1985). The results revealed that, the three varieties of kenkey contained moisture, carbohydrate, protein, fat, ash and fibre as observed in an earlier research by Fadahunsi et al. (2012). The quantities of these nutrients differed from that which was reported by Fadahunsi et al. (2012). The moisture content of "ntɜw dokono" was 73.10% in the study of Fadahunsi et al. (2012) but was 74.23% in the current research work. In the case of protein, Fadahunsi et al. (2012) reported 10.50% and the current study revealed of 10.66% for 'nsinho dokono'. The current proximate analysis results varied from that which was reported earlier by Nkrow (2020), however, the variation was insignificant.

"Nsinhon dokono" had the highest mean value for carbohydrate (85.55) and dokono pa recorded the least (77.72) among the three food samples. This may be as a result of either the maize used for "Nsinhon dokono" being dehulled before steeping. The values obtained in the three food samples were more than those reported in the work of Marina et al. (2013) where *doklu* which is similar to kenkey made in Ghana recorded 60.2 ± 3.4 carbohydrates. Mann et al (2007) reported that humans get their daily energy requirement from foods rich in

carbohydrates. Therefore, manual workers may rely on “nsinhon dokono” for energy.

“Dokono pa” had the highest mean value for fibre (6.63) follow by “nt3w dokono” (5.04) and “nsinhon dokono” recorded the least value of 1.49. The maize used for “nsinhon dokono” was refined before steeping and this might have accounted for the least fibre content recorded. Also, fresh sweet potatoe was added to “Dokono pa” and this might have resulted in the higher fibre value obtained. The three test foods recorded 10.66, 11.21 and 11.82 protein content for “nsinhon dokono”, nt3w dokono and “dokono pa” respectively. The values are higher than that which was obtained by “Daklu” (6.9 ± 0.1) in a similar work carried out by Marina et al. (2013).

The second research objective sought to exarmine the glycemic index of the three varieties of kenkey. The results showed that “dokono pa”, “nt3w dokono” and “nsinhon Dokono” obtained 34.60, 43.54 and 57.78 respectively. This shows that “dokono pa”, and “nt3w dokono” had comparatively low GI while “nsinhon dokono” had medium GI according to the classifications of Allen et al. (2012), Barclay et al. (2005) as well as Brand-Miller et al., (2003). The least GI obtained by “dokono pa” among the three test foods could be attributed to the more fibre content and lower carbohydrate content recorded respectively. Fibre slows down gastric emptying therefore has an impact on how the body responds to glucose (Lin et al. 2010).

The GI values obtained were similar to what was reported earlier in a study by Yeboah et al (2019), where Ga-kenkey and abolo prepared from fermented corn dough had GI values of 41 and 58 respectively. The low GI value for ‘nt3w dokono’ and ‘nsinhon Dokono’ might be due to the temperature

at which they were prepared. According to Jimoh et al. (2008), lower degrees of heat causes the cell wall of food to rupture during processing. Cooking temperature at 60 –90˚C according to Holm et al. (1988) cited by Allen et al. (2012) causes starch to gelatinize, increasing the amount of starch that alpha and beta amylases can access. Although all the test foods were prepared by boiling, they obtained different GI values. This implies that the GI of Ghanaian carbohydrate staples foods vary and this should inform the choice made by the general public in managing the glucose level of their blood (Eli-Cophie et al., 2016)

The third research objective was on the determination of glycemic load of the test meals. The results showed that the glycemic load for 'dokono Pa', 'ntew dokono' and 'nsinhon dokono' were 26.82, 35.20 and 49.64 respectively. Per the classification of GL by Das et al. (2007), the three varieties of kenkey recorded high GL values. The implication of these results is that 'dokono pa', 'ntɜw dokono' and 'nsinhon dokono' may impact blood glucose level of individuals negatively especially those living with diabetes.

Hypothesis 1 was to determine whether or not there was a statistically significant difference in the glycemic index of 'ntɜw dokono', 'Nsinhon dokono' and 'dokono pa'. It was established that the GI values between groups and within groups were statistically significant.

In the case of hypothesis 2, the results revealed that, there was a statistically significant difference in the glycemic load of the test meals ("ntɜw dokono", "nsinhon dokono" and "dokono Pa").

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This study was to assess the GI and GL values of three varieties of kenkey, "nt3w dokono", 'nsinhon dokono' and 'dokono pa'. Three research objectives and two research hypothesis guided this study. Maize as reported in literature contains carbohydrate and glucose which are needed in determining GL.

Literature was reviewed on themes that related to the research objectives and hypothesis. The theoretical and empirical literature review established the basis for the study. Experimental design was used to manipulate the variables in the study. A total of 10 volunteers made up of 8 males and 2 females were purposively sampled for the study. Ethical clearance was obtained from the UCCIRB before collecting data for the investigation. The data collected was analyzed using the appropriate statistical tools as stated in the methodology section of the study.

Summary of Key Findings

First of all, the three test food samples ('nt3w dokono', 'nsinhon dokono' and 'dokono Pa') had varied nutritional composition including protein, fibre, ash, dry matter, fat and carbohydrate.

Moreover, "Dorkono Pa", "nt3w dokono" and "nsinhon Dokono" had GI values of 34.60, 43.54 and 57.78 respectively. Therefore "dorkono pa" and "nt3w dokono" had low GI while "nsinhon Dokono" had medium GI.

Furthermore, the third research objective which was on the determination of glycemic load of the test foods found that 'Dokono pa', 'nt3w

dokono' and 'nsinhon dokono' got GL values of 26.82, 35.20 and 49.64 respectively. The three varieties of kenkey recorded high GL values.

Also, the finding from the first hypothesis revealed that there was a statistically significant difference in the glycemic index of 'ntɜw dokono', 'nsinhon dokono' and 'dokono pa' ($p<0.05$).

Finally, the ANOVA results of the second hypothesis showed that, there was a statistically significant difference in the glycemic load of the test meals ($p<0.05$).

Conclusion

The three varieties of kenkey prepared from corn dough contained significant percentages of DM, Moisture, Ash, Protein, Fat and Oil, Fibre, and CHO but these amounts varied.

The glycemic index of 'dokono pa', 'ntew dokono' and 'nsinhon Dokono' was low ("Dorkono Pa", "ntɜw dokono" and "nsinhon Dokono" had GI values of 34.60, 43.54 and 57.78 respectively).

The test foods had high glycemic load (Dokono pa', 'ntɜw dokono' and 'nsinhon dokono' obtained GL values of 26.82, 35.20 and 49.64 respectively) and therefore must be consumed in moderation. The moderate consumption of these varieties of kenkey would help individuals maintain good blood glucose levels.

The ANOVA analysis results of the first hypothesis should that there were statistically significant variation in the Glycemic Index values of the test foods.

Also, the ANOVA analysis results of the second hypothesis revealed that, there were statistically significant differences in the Glycemic Load values of 'dokono pa', 'ntɜw dokono' and 'nsinhon dokono' respectively.

Recommendation

The glycemic index of 'dokono pa', 'ntɜw dokono' and 'Nsinhon Dokono' was low but their glycemic loads were high. Therefore, these foods are recommended to be eaten in moderation to avoid spike in blood glucose level of consumers.

Also, people living with diabetes must seek guidance from dieticians and nutritionists before including these foods in their daily menu.

Suggested Area for Further Study

This study focused on using only ten volunteers from the Western Region of Ghana with one district. Hence, the scope of the study could be broadened to cover all the districts in the region.

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APPENDIX A

IRB CLEARANCE LETTER

UNIVERSITY OF CAPE COAST
INSTITUTIONAL REVIEW BOARD SECRETARIAT
TEL: 0558093143 / 0508878309
E-MAIL: irb@ucc.edu.gh
OUR REF: IRB/C3/Vol.1/0350
YOUR REF:
OMB NO: 0990-0279
IORG #: IORG0011497

29TH SEPTEMBER, 2023

Ms Ruby Abakah -Tawiah
Department of Vocational and Technical Education
University of Cape Coast

Dear Ms Abakah -Tawiah

ETHICAL CLEARANCE – ID (UCCIRB/CES/2023/80)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted Provisional Approval for the implementation of your research **Assessing the Glycemic Index of Three Different Types of Kenkey.** This approval is valid from **29th September, 2023** to **28th September, 2024**. You may apply for an extension of ethical approval if the study lasts for more than 12 months.

Please note that any modification to the project must first receive renewal clearance from the UCCIRB before its implementation. You are required to submit a 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 faithful

Kofi F. Amuquandoh
Ag. Administrator

APPENDIX B

SCREENING RECORD FOR PARTICIPANTS

1. Your age? 20 yrs-30yrs [ ] 31yrs-40yrs [ ] 51yrs-60yrs [ ]

2. Your gender: Female [ ] Male [ ]

3. Weight in Kilogram (Kg)----------

4. Height in centimetre (cm)----------

5. Blood pressure (mm/oL) ----------

6. Waist perimeter (cm) ----------

7. Body Mass Index (weight/height)----------

8. Would you volunteer to participate in the clinical trial? Yes [ ] No [ ]

Thanks for your time.

APPENDIX C

TEST FOODS QUESTIONNAIRE FOR PARTICIPANTS

The consumption of local foods is being encouraged and the afluent in society sometimes become skeptical about their glycemic status. This is to allow for volunteers to help demisfy if any issues relating the consumption of maize based foods like 'Nsinhon Dorkon', 'Ntew Dorkon' and 'Dorkon Pa'. The study is part for academic fulfilment to be awarded Mphil in Home Economics. Your participation and frank responses would be of vast help to the study. Any information given would be for the intended purpose and be guaranteed that your uniqueness would not be made known under any circumstances.

Date……. Panelist ID……

Section A: Background Information of Participant

1. What is your age (years)? ----------

*Please tick your **gender***

2. Gender: Male [ ] Female [ ]

3. Weight in Kilogram (Kg)----------

4. Height in centimetre (cm)----------

5. Waist circumference (cm) ----------

6. Blood pressure (mmol/L) ----------

6. Body Mass Index (Kg/m^2)----------

Section B: Test Foods

(Test to be taken for three times)

Time/min	**FBG** (mmol/L)	**Nsinhon Dorkon**			**Ntew Dorkon**			**Dorkon Pa**		
30										
60										
90										
120										

FBG-Fasting Blood Glucose

APPENDIX D

PROXIMATE ANALYSIS ON TEST FOODS

Sample	% DM	% Moist	% Ash	% Protein	% Fibre	% Fat/ Oil	% CHO
Nsinhon Dorkon							
Nsinhon Dorkon							
Nsinhon Dorkon							
Ntew Dorkon							
Ntew Dorkon							
Ntew Dorkon							
Dorkon Pa							
Dorkon Pa							
Dorkon Pa							

APPENDIX E

ONE - WAY ANOVA RESULT OF NUTRITIONAL COMPONENT OF THE TEST FOODS

		Sum of Squares	Df	Mean Square	F	Sig.
%DM	Between Groups	54.777	2	27.389	271.142	.000
	Within Groups	.606	6	.101		
	Total	55.384	8			
%Moisture	Between Groups	54.777	2	27.389	271.142	.000
	Within Groups	.606	6	.101		
	Total	55.384	8			
%Ash	Between Groups	2.224	2	1.112	207.517	.000
	Within Groups	.032	6	.005		
	Total	2.256	8			
%Protein	Between Groups	2.005	2	1.003	21.204	.002
	Within Groups	.284	6	.047		
	Total	2.289	8			
%Fat and Oil	Between Groups	.147	2	.073	339.200	.000
	Within Groups	.001	6	.000		

	Total	.148	8			
%Fibre	Between Groups	41.585	2	20.793	63147.114	.000
	Within Groups	.002	6	.000		
	Total	41.587	8			
%CHO	Between Groups	93.795	2	46.897	711.610	.000
	Within Groups	.395	6	.066		
	Total	94.190	8			

APPENDIX F

DESCRIPTIVE AND ANOVA RESULT OF GLYCEMIC INDEX

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound	57.78	58.00
NSINHON DORKON	3	57.8600	.12166	.07024	57.5578	58.1622	42.90	44.00
NTEW DORKON	3	43.4800	.55245	.31896	42.1076	44.8524	34.60	35.00
DORKON PA	3	34.8333	.20817	.12019	34.3162	35.3504	34.60	58.00
Total	9	45.3911	10.07784	3.35928	37.6446	53.1376	57.78	58.00

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	811.777	2	405.888	3351.371	.000
Within Groups	.727	6	.121		
Total	812.503	8			

APPENDIX G

GLYCEMIC LOAD DESCRIPTION AND ANOVA

Descriptive

GL

	N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Minim	Maxim
					Lower Bound	Upper Bound		
Nsinhon Dorkonnsinhon Dorkon	3	49.8800	1.02137	.58969	47.3428	52.4172	49.00	51.00
Ntew Dorkon	3	35.2867	.36679	.21177	34.3755	36.1978	35.00	35.70
Dorkon Pa	3	26.9200	.09165	.05292	26.6923	27.1477	26.82	27.00
Total	9	37.3622	10.07782	3.35927	29.6157	45.1087	26.82	51.00

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	810.128	2	405.064	1024.49	.000
Within Groups	2.372	6	.395		
Total	812.500	8			