KOFORIDUA TECHNICAL UNIVERSITY

FACULTY OF APPLIED SCIENCE AND TECHNOLOGY

DEPARTMENT OF TOURISM AND HOSPITALITY MANAGEMENT

PRODUCTION OF BISCUITS USING WHEAT FLOUR AND KIDNEY BEAN FLOUR

BY

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF HOSPITALITY MANAGEMENT OF THE FACULTY OF APPLIED SCIENCE AND TECHNOLOGY, KOFORIDUA TECHNICAL UNIVERSITY IN PARTIAL FULFILMENT OF THE NREQUIREMENT FOR THE AWARD OF BACHELOR OF TECHNOLOGY IN HOSPITALITY AND TOURISM MANAGEMENT

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DECLARATION

I hereby declare that these research findings are the result of my original work and that no part of it has been presented for another certificate in this institution or elsewhere.

…………………………… 4th December, 2023.
……………………………

SANDRA YEBOAH-DWAMENA **DATE**

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SUPERVISOR CERTIFICATION

I hereby declare that this project work was supervised in accordance with Koforidua Technical University guidelines for the supervision of the project.

…………………………… 04/12/2023 …………………

PROFESSOR JOHN OWUSU **DATE**

(SUPERVISOR)

DEDICATION

This work is dedicated to God for His strength and wisdom to embark on this project work because, without Him, it would not have been possible to accomplish this work. Also, I dedicate this work to my Mother: Mercy Sarfoah, and siblings.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Biscuit is made from mainly wheat, which is an imported commodity. Wheat is imported into Ghana using huge foreign exchange, and this makes the product made from it expensive. In this study, kidney beans' inclusion in composite biscuit production was explored. Wheat flour was replaced at percentages of 0, 25, 50, 75, and 100%% to obtain biscuit treatments T1 (Control), T2, T3, T4, and T5 respectively. Standard methods were used were used to determine the proximate composition of the composite biscuit produced. Sensory evaluation was carried out with a sensory panel of fifty-three (53) using a 9-point hedonic scale in which 1 means dislike extremely and 9, like extremely based on sensory qualities colour, appearance, taste, aroma, texture, crispiness, brittleness, and overall acceptability. In terms of the proximate composition of the biscuits, ash, fibre, and protein contents generally improved with increment in the beans flour addition, but fat and carbohydrate contents generally showed a downward trend. In addition, the sensory respondents showed an increased preference for most sensory qualities as the bean flour content of the biscuit increased. The results of the sensory evaluation indicated that the composition of the biscuits had a positive impact on various sensory attributes, including color, aroma, texture, taste, brittleness, appearance, crispiness, and overall acceptability, as well as on some proximate composition. The study therefore recommended that beans should be added to wheat in the manufacture of biscuits to give a nutritious product, sensory evaluation should be carried out using a much bigger sample size to give more reliable results on the sensory response of consumers, and education of consumers on the nutritional advantages of wheat and beans flour biscuit should be done to help increase consumer acceptability and adoption.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Kidney beans are the most important economic variety of the genus Phaseolus; scientifically known as Phaseolus vulgaris (Common Beans), and referred to as Rajmah, Bakla in Hindi, Haricot bean in English, and Haricot common in French (Bedier et al., 2021). In developing countries and many cultures, and also in Ghana, one of the most important traditional plant-based diets has been the kidney beans (Shimelis and Rakshit, 2007). Beans have applications in ready-to-eat snack food markets and other baked products like torillas (Ramírez-Jiménez et al., 2018). Dry beans are consumed primarily as whole products or parts of the product and are a highly effective functional food with numerous health benefits (Cristiane and Marzia, 2014). In spite of the high nutritive value of beans, it has large amounts of anti-nutritional factors including phytic acid, trypsin inhibitors, tannins, and saponin, which can affect the absorption of protein and certain minerals (Shimelis and Rakshit, 2007). According to Singh et al. (2019), kidney beans contain some anti-nutritional factors such as phytates, protease and amylase inhibitors, lectins, and tannins, which impede the activity of some enzymes and the absorption of metabolites. Wang et al. (2009) estimated that kidney beans have 21.5-27.1% protein, 1.1-1.2% fat, 61.7% carbohydrates (36.1% starch), 7.0-20% fiber, and 3.0-4.4% ash. Kidney beans possess an excellent nutritional profile with 22.7% protein, 3.5% mineral, 1% fat, and 57.7% carbohydrates out of which total carbohydrates have 38.6% starch and 18.8% dietary fiber (60% insoluble and 40 % soluble) (Bedier et al. 2021). The protein of kidney beans has the highest lysine content of about 5% (Hayat et al., 2014). By using cereals and other sulfur-containing products with beans, optimum amount of essential amino acids are obtained (Boye et al., 2010). The glutamic and aspartic acids are mainly acidic and present in raw as well as processed beans (Audu and Aremu, 2011). Water blanching of kidney beans could reduce its anti-nutrients, and enhance the nutrient composition for better nutrient uptake. Singh et al. (2018) reported that phenolic compounds, such as phenolic acids, flavonols, flavones, isoflavones, anthocyanin, and tannins that are identified and characterized in food legumes have a wide range of physiological properties, such as anti-allergic, anti-inflammatory, anti-atherogenic and antimicrobial.

The ready-to-eat nature of biscuit, its reasonable cost, high nutritional value, its availability in different nutritional value, its availability in different flavours and taste, as well as its extended shelf life have made it a very popular bakery product (Bedier et al., 2021; Elhassaneen, et al., 2016). Usually, biscuit is produced from wheat flour, which lacks fibre and some essential amino acids (Dhankhar et al., 2019). Nowadays, in the whole of the world, the trend is that many consumers have become aware of the need to be health-conscious, and now have preference for food which provides additional health benefits beyond its basic nutritional requirements (Baba et al., 2015; Ndife et al., 2009). Therefore, there is a trend to produce functional biscuits made from wheat flour and health-promoting compounds from non-wheat flour known as functional ingredients. Biscuits are a prominent ready-to-eat baked snack among people. Globally the association of wheat consumption with such health problems are celiac disease makes it pertinent to utilize composite flour in biscuit manufacture (Kiin-kabari and Giami, 2018). Composite flour is desirable in this regard because it improves the nutritional value of food products such as bakery products, especially when blended with legumes such as pigeon peas. Biscuits have been suggested as a better use for composite flour than bread due to their ready-to-eat form, wide consumption, relatively long shelf life, and good eating quality (Adeola and Ohizua, 2018).

Beans are highly nutritious. They are a rich source of protein, complex carbohydrates, resistant starch, minerals, and fiber. Beans are classified as low glycemic index foods because the starch is digested slowly into glucose (Eyaru et al., 2019). Low glycemic index foods help to lower postprandial glucose response and therefore assist in diabetes management. Other health benefits reported include reduced risk of obesity, coronary heart disease, and colon cancer (Brand Miller and Barclay, 2017). Beans flour is used in baking as a dough conditioner and as an alternative flour in the production of gluten-free products. In spite of the health benefits of beans that have been presented, bean consumption in Ghana is low, therefore, this study seeks to identify the sensory properties of biscuits produced using bean flour in promoting local manufacturing products in Ghana.

1.2 Problem statement

Nutrition is crucial in influencing children's intellectual and physical abilities. Maintaining nutrient-rich meals in families is more than simply an issue of present well-being; it is an investment in developing a strong and productive future population. According to Frempong and Annim (2017), the profits of a well-nourished population manifest both directly (by lowering public health care expenses) and indirectly (by encouraging an atmosphere favourable to economic growth).

However, the obstacles to accomplishing this aim are numerous. For starters, early-life malnutrition jeopardizes a child's immediate health; it also has long-term consequences, impairing physical and cognitive development, impeding academic achievement, and, as a result, affecting their eventual economic contributions and productivity (Frempong and Annim, 2017).

Biscuits stand out as a ubiquitous, ready-to-eat snack in today's worldwide nutritional environment. The dominance of wheat as a key component in biscuits, on the other hand, provides its own set of issues. Despite widespread intake, wheat is low in some vital component, including fiber and essential amino acids. Furthermore, its relation with health difficulties, particularly celiac disease, emphasizes the necessity for component variety in biscuits. The use of composite flour, particularly those supplemented with legumes, is one potential route in this regard since it not only addresses these nutritional inadequacies but also improves the overall health profile of baked foods (Adeola and Ohizua, 2018).

Beyond the nutritional element, this dilemma has an economic dimension, particularly for nations like Ghana. The country's reliance on wheat imports causes a severe drain on its foreign exchange reserves. Global wheat output is expected to reach 760 million tonnes in 2020, with major countries such as China, India, Russia, and the United States directing the market. Ghana's reliance on this global commodity exposes it to market volatility and limits its financial resources.

Finally, adapting to the changing tastes of consumers is critical. The repetition of wheat-based biscuits may not only result in gastronomic boredom but may also diminish consumer interest and market demand over time. Introducing variation in flavour and nutrition can revitalize this sector and better fulfill consumers' different interests.

1.3 Objectives of the study

1.3.1 Main objective

The main objective of the study was to find out about whether beans could be combined with wheat to produce biscuits.

1.3.2 Specific objectives

The specific objectives used for the study were to:

i. Find out the proximate composition of the biscuit produced from different combinations of wheat flour and kidney beans flour

ii. Determine the effect of different proportions of wheat flour and kidney beans flour on the sensory parameters of the biscuit produced

iii. **Assess the overall acceptability of the biscuit made with different proportions of wheat flour and kidney beans flour**

1.4 Research questions

The following questions were taken into account in the study;

i. How does the proximate composition of biscuits vary across different combinations of wheat flour and kidney beans flour?

ii. How do different proportions of wheat flour and kidney beans flour influence the sensory parameters of the biscuit produced?

iii. What is the influence of different proportions of wheat and kidney beans flour on the overall acceptability of biscuit made with them?

1.5 Scope of the study

The research studies was limited to the production of biscuits with wheat flour and kidney beans combination. The qualities of the biscuits assessed were the proximate composition and the sensory aspects.

1.6 Significance of the study

The use of kidney bean flour in the making of biscuits has the potential to significantly change the biscuit business while also providing customers with a wider range of healthful options.

Combining wheat and kidney bean flour might significantly improve the nutritional profile of biscuits. Kidney beans have a high protein, fiber, and mineral content. As a result, biscuits manufactured from this blend might provide customers with a healthier snack option. This is especially important in a world coping with nutritional health issues. If the raw ingredients for biscuit manufacture change, wheat imports patterns may need to change. This might lead to less reliance on wheat imports, saving money and supporting local agricultural goods. The addition of kidney bean flour may open the way for the development of a wide variety of biscuit flavours and varieties. A diverse product range would provide customers with additional options, thereby alleviating any boredom associated with eating exclusively wheat-based biscuits. This variant might also accommodate various taste preferences, dietary demands, and nutritional requirements. Wheat consumption may fluctuate as a result of diversifying the components used in biscuit making. This might have an impact on global wheat trade dynamics, import costs, and the general economic balance between wheat-producing and wheat-importing countries.

1.7 Organization of the study

The report is divided into five chapters. Chapter one is about the introduction, which consists of the background, statement of the problem, objectives of the study, research questions, significance of the study, scope of the study, limitations of the study, and organization of the study. Chapter two deals with the review of literature relevant to the study. Chapter three focuses on the methodology used for the study. Chapter four is about the results and discussions. Chapter five deals with the summary, conclusions, and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

Biscuits is a small baked product usually made from flour, sugar, and fat. It is different from other baked products like bread and cakes as biscuit has low moisture content. Its moisture content is usually less than 4% and thus it has a long shelf life, perhaps six months or longer (Mamat et al., 2021). It is flat and crisp and may be sweetened or unsweetened according to preferences (Usman et al., 2019). Biscuit is made from a dough. Basically, there are two types of biscuit dough; hard and soft. The hard or developed dough is used to make semi-sweet biscuits. Hard dough has high water content and relatively low fat and sugar content. Soft dough, as compared to stiff dough, has a higher moisture content and a softer, more malleable texture. It is frequently used in baking to produce light, fluffy breads, rolls, pastries, and other baked items. The principal ingredients of biscuit dough are soft wheat flour, sugar, fat, and water. They are mixed with other minor ingredients such as baking powder, skimmed milk, and emulsifier to form dough containing a well-developed gluten network (Mamat et al, 2021). The physical and chemical characteristics of flours affect their functionality. The starches, protein, lipid, fat, and sugar also influence the functionality of the flour (Awuchi et al., 2019).

2.2 Biscuit production

Biscuits can be made from hard dough, hard sweet dough, or short or soft dough. It is produced by mixing various ingredients like wheat flour, fat sweetener, and water to form dough which is allowed to rest for a period and then passed between rollers to make a sheet. The dough formed unlike bread is not allowed to ferment, and then it is baked in the oven (Usman et al., 2019).

2.3 Classifications of biscuits

In the manufacture of biscuits, the dough used may be soft or hard. Based on the method used in the manufacturing of biscuits, they may be categorized into three (3) as spongy goods, crackers, and sweet dough (Usman et al., 2019).

The sponge goods are sponge cakes or biscuit bread, which are mostly light cakes produced using eggs, flour, and sugar. They are sometimes leavened with baking powder. The cake is much more like a cookie, and is thin and crispy (Figure 2.1). It is more difficult to make sponge goods, and this and its delicate texture make it more expensive than the daily staple pies (Nasution et al., 2020).

Crackers are flat dry baked foods (Figure 3.2) typically made with flour, and are usually regarded as a nutritious and convenient way to consume staple food or cereal grains. Before it is baked, flavourings or seasonings like salt, herbs, seeds, or cheese may be added to the dough or sprinkled on top. Crackers may be consumed either alone or in combination with other food items such as cheese or slices, dips, or soft spreads such as jam, butter, or peanut butter (Nasution et al., 2020).

In sweet dough, the product contains eggs, butter, and sugar. These ingredients make the dough very soft and moist. This dough rises after a long time. A plastic wrap is placed on the dough after its shape has been formed, and it is then place into the fridge. In the cold environment of the fridge, the dough needs time to develop its gluten (Nasution et al., 2020).

Figure 2.1 : Sponge cake (Nasution et al. 2020)

Fig. 2.2 Crackers

2.4 Beans

Beans belong to the family Leguminosae, and are used as vegetables for human or animal food. Beans is a rich source of protein, complex carbohydrates, folate, and iron. Fibre and soluble fibre are also high in beans. Blood cholesterol is lowered by soluble fibre (Sharples and Tripp, 2019). Beans also contain oligosaccharides, especially raffinose and stachyose (Popova and Mihaylova, 2019). Oligosaccharides are not digested in the intestinal tract of humans, so they remain there, and are digested by bacteria to produce gases such as methane, which are then released as flatulence (Payling, 2022).

2.4.1 Types of Beans

Different types of edible beans exist. These include black beans, black-eyed peas, cannellini beans, pinto beans, red beans, navy beans, kidney beans, and soybeans.

Black beans have hearty texture, and are usually used as a staple in many common diets and in some best vegetarian diets. Black-eyed peas are perhaps best known for their association with good luck and the New Year in the Americans (Sousa and Raizada, 2020). Cannellini beans is a type of kidney bean with large size and creamy white hue. Pinto beans are brown and speckled. They are rich in protein, manganese, fiber, and folate, and according to the American Society of Nutrition, their consumption can help to lower cholesterol levels of the body (Connor et al., 2022).

Red beans are a type of mung bean. They are often sweetened and incorporated into desserts, but can also be used in savoury dishes (Wang et al., 2022). Navy beans is white in colour and is used for baked beans, and in soups. The kidney beans is large, dark, and curved like the vital organ, kidney. Its colour can be white, light, or speckled, and are not the same as red beans. Kidney beans are best known for their appearances in chili or alongside rice (Studdert et al., 2020). Soybeans is a protein-packed beans, and their protein content makes them popular meat and dairy substitutes, but are also great on their own (Shurtleff and Aoyagi, 2019). The various types of beans are shown in Figures 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, and 2.10.

Fig.2.3 Black Beans

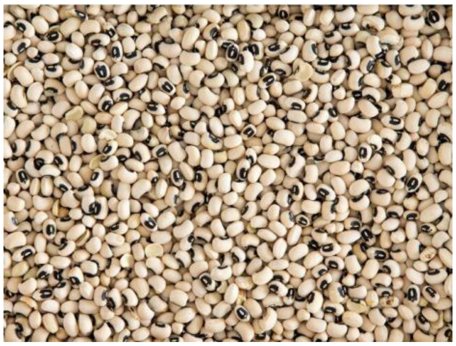

Fig. 2.4 Black-Eyed Peas

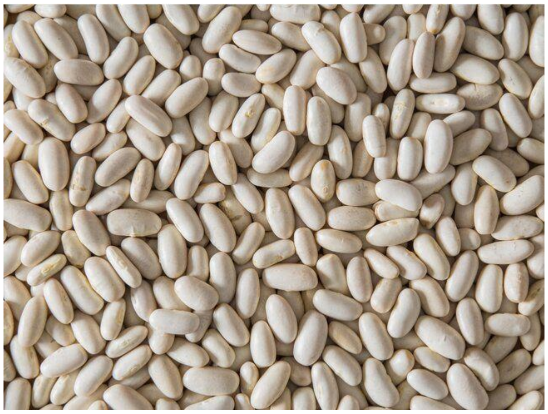

Fig.2.5 Cannellini Beans

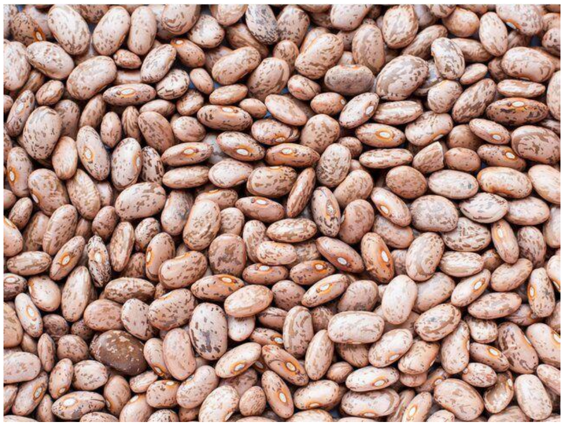

Fig. 2.6 Pinto Beans

Fig. 2.7 Red Beans

Fig. 2.8 Navy Beans

Fig. 2.9 Kidney Beans

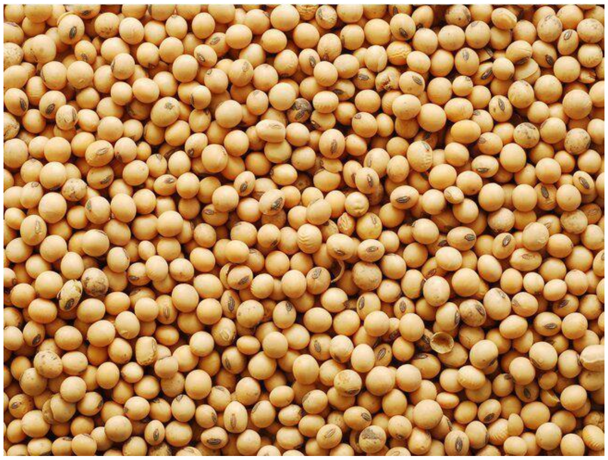

Fig. 2.10 Soybeans

2.5 Nutrients in beans

Dry edible beans are nutrient-rich foods containing a variety of vitamins, minerals, and other nutrients while providing a moderate number of calories. Beans provide protein, fiber, folate, iron, potassium, and magnesium while containing little or no total fat, trans-fat, sodium, and cholesterol. Because of their high concentration of health-promoting nutrients, consuming more beans in diet could improve overall health and also decrease the risk of developing certain diseases, including heart disease, obesity, and many types of cancers (Bamanyaki and Muchunguzi, 2020).

2.5.1 Fiber

Nutrition experts recommend that adults consume 25 to 38 grams of dietary fiber per day. Dietary fiber intake contributes to feelings of fullness or satiety and helps maintain the functioning of the digestive system. Beans are a rich source of soluble and insoluble fiber. The consumption of fiber also has been associated with decreasing total and low-density lipoprotein (LDL) cholesterol, as well as decreasing the risk of developing coronary heart disease, metabolic syndrome, stroke, hypertension, diabetes, obesity, and some gastrointestinal diseases (Bamanyaki and Muchunguzi, 2020).

2.5.2 Folate

The B vitamin folate is found prominently in beans. Folate, or its synthetic counterpart, folic acid, is essential for the production of red blood cells in the human body and the development of an embryo's nervous system during the early stages of pregnancy. Adequate intake of folic acid has been shown to reduce the risk of neural tube defects significantly in newborns. Synthetic folic acid is better absorbed in the body than naturally occurring folate. Some folate can be lost from dry beans and other legumes during the soaking and cooking process or can be reduced when the vitamin interacts with other food components, such as fiber. Quick soaking beans may lead to more folate losses than a more traditional long soak. In general, to maximize the natural folate content in beans, some researchers suggest using the slow-soak method and a cooking method that prepares the beans in 150 minutes or less (Bamanyaki and Muchunguzi, 2020).

2.6 Health benefits of beans

Taking in more beans may reduce disease risk factors such as seen in the following:

2.6.1 Heart health

Elevated blood levels of triglycerides and cholesterol, especially cholesterol, are significant contributing factors to heart disease. High plasma levels of homocysteine have been associated with an increased risk for cardiovascular disease. A varied diet low in saturated fat with ample fiber especially soluble and B vitamins are among the recommendations for reducing cardiovascular disease risk factors. Several studies have shown that regular consumption of beans can help lower total and low-density lipoprotein (LDL) cholesterol and other risk factors for heart disease (Bamanyaki and Muchunguzi, 2020).

2.6.2 Diabetes risk

Diabetes is becoming more prevalent throughout the world as the global obesity epidemic continues. Eating a variety of legumes, including beans, may be valuable not only in the prevention of diabetes but also in the management of blood sugar levels. Beans are rich in complex carbohydrates (such as dietary fiber), which are digested more slowly. As a result, bean consumption has been shown to increase feelings of fullness and help regulate plasma glucose and insulin levels after meals. Legume fiber was among the fiber types associated with reducing the risk for metabolic syndrome, which includes glucose disturbances and increased risk of diabetes (Bamanyaki and Muchunguzi, 2020).

2.6.3 Cancer risk

Eating beans may reduce the risk of developing certain types of cancers due to their contribution of bioactive compounds to the diet, including flavonoids, tannins, phenolic compounds, and other antioxidants. These compounds act to decrease the risk of cancer, as well as other chronic diseases. Other researchers have shown that beans may have a synergistic effect when consumed in a diet containing other antioxidant-rich foods (such as fruits and vegetables) by decreasing oxidation in the body and reducing the overall cancer risk. Bean intake has been associated with a decreased risk of breast, stomach, colorectal, kidney, and prostate cancers in humans (Bamanyaki and Muchunguzi, 2020).

2.6.4 Overweight and obesity risk

Even though beans are not often promoted as a weight-loss food, regularly consuming nutrient-rich legumes may impact weight loss or management, although more research is needed. According to results from the National Health Nutrition Examination Survey from 1999 to 2002, people who consumed beans regularly had a lower body weight, lower waist circumference, and lower systolic blood pressure, in addition to a greater intake of dietary fiber, potassium, magnesium, iron, and copper. Consuming beans may contribute to feelings of short-term satiety as a result of the beans' fiber and protein content. (Didinger and Thompson, 2022).

2.7 Flour

The main ingredient in biscuit production is flour. Flour is powdered in form, and is obtained through grinding of raw grains, roots, nuts, or seeds. The most popular flour for bakery product is wheat flour. Wheat flour may be whole grain (made up of endosperm, germ, and bran) or refined (made up of only the endosperm) (Ajobiewe et al., 2022). There are different types of flour. These include all-purpose flour, bread flour, cake flour, pastry flour, whole wheat flour, oat flour, self-rising flour, and semolina.

All-purpose flour is one of the most commonly used types of flour, which is usually made from a blend of hard and soft wheat. This gives it a middle-of-the-road protein and starch content. It is made up of about 10-12% protein. If the flour has low protein content, it gives less gluten, and vice versa. Gluten is the main determinant of the structure and texture of bakery products (Wieser et al., 2023). Only hard wheat is used to make bread flour. Hard wheat contains more gluten, which helps to trap more air bubbles to make the dough to rise higher (Schopf et al., 2021). Cake flour obtained from soft wheat by milling it to fine particles, which give an almost a silky fee when touched. Its protein content is low. The low protein content of cake flour imparts a tender and fluffy texture to the flour. In addition, the acidity helps the dough with a large amount of sugar to rise, but not collapse (Patel et al., 2019). Pastry flour is made from soft wheat, and is finer than all-purpose flour. The protein content of pastry flour is between all-purpose flour and cake flours. This type of flour is ideal for tart crusts, pie dough, muffins, and some cookie batters (Dragomir and Bahaciu, 2019). The seed of wheat is basically made up of three portions. These are the germ, bran, and endosperm. To obtain the whole wheat flour, the entire kernels of the red wheat is ground. Whole wheat flour is made up of the germ, bran, and endosperm, but white flour has just the endosperm. The bulk of the fiber and proteins are found in the bran and the germ. Therefore whole wheat flour is higher in nutrients and dietary fibre. Whole wheat flour tears strands of gluten, thus inhibiting gluten development. Whole wheat is more absorbent than white flour (Kundu et al., 2019). Self-rising is made up of a blend of all-purpose flour, and salt. It specifically contains 1 cup of all-purpose flour, 1½ teaspoons of baking powder and ¼ teaspoon fine salt (Iqbal et al., 2022). Semolina is produced from durum wheat. The endosperm of durum wheat is ground coarsely to get semolina. Durum wheat is the hardest type of wheat, therefore semolina, which is produced from durum wheat has the highest gluten content among all flours (Cecchini et al., 2021).

2.7.1 Functional characteristics of flours

Functional characteristics of food material refer to intrinsic physicochemical properties that influence the behavior of proteins in food systems during processing and storage. They include hydration properties such as solubility, wettability, swelling, water binding, thickening, and gelling. In addition, there are surface properties such as emulsion, foaming, protein-lipid interactions, film formation, and lipid and flavor binding. In addition, are surface properties such as emulsion, foaming, protein-lipid interactions, film formation, and lipid, and flavor binding. Finally, there are structural/rheological properties comprising elasticity, grittiness, cohesiveness, chewiness, aggregation, gelation, stickiness, viscosity, texturization, fiber formation, dough forming ability, extrudability, and adhesion (Akubor and Igba, 2019).

2.7.2 Water absorption capacity of flour

Water absorption capacity is the amount of water that can be held per unit weight of the protein material. It is an index of the maximum amount of water that a food product would absorb and retain. The water absorption index is related to the hydrophilicity and gelation capacity of bio macro molecules such as starch and protein in flour (Katungi et al., 2010).

2.7.3 Oil absorption capacity of flour

Oil absorption capacity is the amount of oil, which can be retained per unit weight of the protein Material. The oil-absorbing mechanism involves capillary interaction that allows the absorbed oil to be retained. Hydrophobic proteins play the main role in oil absorption. The Oil absorption capacities of different legume flours are influenced by particle sizes, starch and protein contents, protein types, and non-polar amino acid side chain ratios on the protein molecule surface (Makunja, 2020).

2.7.4 Emulsion capacity of flour

The emulsion activity reflects the ability of a protein to aid in the formation of an emulsion and is related to the protein's ability to absorb the interfacial area of oil and water in an emulsion. Emulsion stability normally reflects the ability of proteins to impart strength to an emulsion. Resistance to stress and changes is therefore related to the consistency of the interfacial area over a defined period (Amin et al., 2019).

2.7.5 Foam capacity of flour

Foaming is a result of proteins forming an interface that keeps air bubbles in suspension and prevents their collapse. As protein concentration is increased, the formation of interfacial protein membranes at the air–water interface is increased, and this enhances the encapsulation of air bubbles. The formation of foams where water molecules surround air droplets represents the non-polar phase and is related to the soft texture of food products. Some proteins and peptides in dispersion are capable of reducing the surface tension at the water-air interface that leads to foaming. Normally, foaming properties of proteins are measured by three indices, namely, foam expansion, foam capacity and foam stability (Kwaghsende et al., 2019).

2.7.6 Swelling power of flour

Swelling power of flour is defined as the maximum increase in volume and weight which protein undergoes when allowed to swell freely in water it is a measure of hydration capacity, because the determination is a weight measure of swollen starch and protein granules and their occluded water. The swelling capacity of flour is a function of the process conditions, nature of the material and the type of treatment. Biopolymers such as starch and proteins contribute to the development of these characteristics the extent of swelling in the presence of water depends on the temperature, availability of water, species of starch, and extent of starch damage due to thermal and mechanical processes and other carbohydrates and protein. High swelling power is reported to constitute better thickening as well as a bulking agent (Sharma and Devi, 2021).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Introduction

This chapter describes the preparation of ingredients for wheat flour and kidney beans flour cookies, the production of cookies, the sensory analysis of the biscuit, the proximate analysis of the cookies, and the analysis of data generated from the various determinations.

3.2 Ingredients and their sources

The ingredients used for the biscuit production were wheat flour, kidney beans, butter, sugar, ingredients, sodium bicarbonate and vanilla essence. The ingredients for the study were purchased from the Taifa Market in Accra, Greater Accra Region of Ghana.

3.3 Research design

The research design was the experimental research design. In the design, different percentages of kidney beans flour were used in combination with wheat (soft) flour of different percentages to produce the biscuit. In all, five (5) treatments were used for the study. The treatment which contained only wheat was the control.

3.4 Recipe used in the formulation of the biscuit

Biscuit was formulated using the ingredients and their quantities as indicated in Table 3.1. The various percentage composition of the wheat flour and the beans flour are shown in Table 3.2.

Table 3.1: Recipe for wheat flour and beans flour biscuit

Parameters	T1	T2	T3	T4	T5
Wheat Flour (g)	1000	750	500	250	0
Kidney Beans Flour (g)	0	250	500	750	1000
Butter (g)	500	500	500	500	500
Sugar (g)	200	200	200	200	200
Sodium bicarbonate (g)	10	10	10	10	10
Ginger Juice (ml)	15	15	15	15	15
Vanilla essence (ml)	15	15	15	15	15

Table 3.2: Percentage composition of wheat flour and beans flour in the biscuit

Treatment	Wheat flour (%)	Kidney beans flours (%)	Percentage %
T1	100	0	100
T2	75	25	100
T3	50	50	100
T4	25	75	100
T5	0	100	100

3.5 Preparation of beans for the biscuit production

The kidney beans were purchased with the intention of grinding them into flour. Prior to commencing the procedure, a thorough check ensured that the beans were clean and devoid of any debris (Figure 3.1). Subsequently, the beans were sifted through on a clean surface, eliminating any discoloured or broken beans, as well as extraneous objects like stones or twigs.

This involved soaking the beans in water for an extended period, followed by massaging them between palms to release the skins. After washing and draining the beans, the floating skins were easily removed. Following dehulling, the beans were spread out on clean cloth or baking sheet to air-dry for a few hours, reducing moisture content and facilitating easier grinding into flour. A second sifting through a fine-mesh screen was employed to achieve a uniform texture for the bean flour. Ultimately, the freshly prepared bean flour was stored in an airtight jar in cold, dry location, with a reminder to use it within a suitable timeframe to maintain freshness.

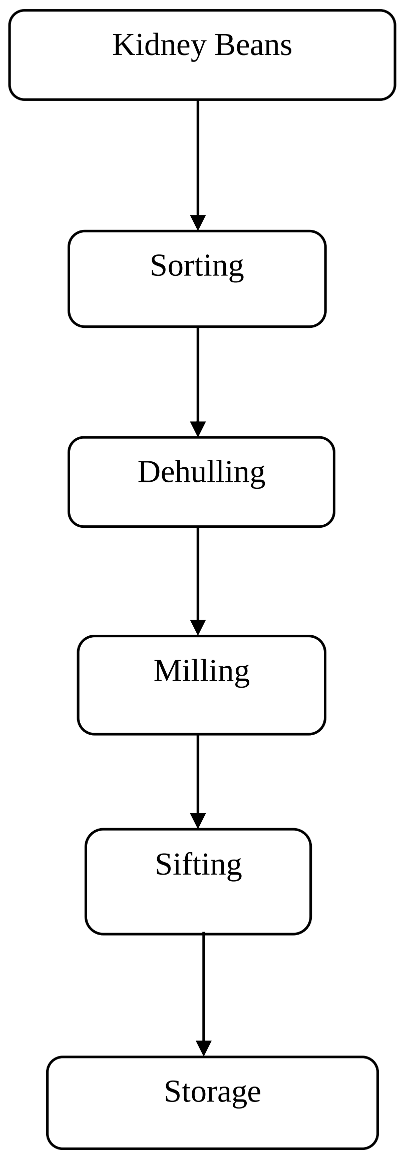

Fig. 3.1 A Block Diagram of the Kidney Beans Flour Production

3.6 Preparation of biscuits

The biscuits were produced following the creamy method described by Asghari et al. (2021). The butter, ginger juice and granulated sugar were creamed together until light and fluffy. Flour, sodium bicarbonate and vanilla essence were added to the cream and mixed in a bowel mixer to form dough. The dough was rolled to a uniform thickness, cut to a uniform diameter and baked in an oven at 180^{o}C for 15 min cooled at ambient temperature (27^{o}C) packaged in high density polyethylene, labeled and stored at ambient temperature for various determinations.

3.7 Sensory evaluation of wheat flour and beans

Fifty-three (53) sensory panelists were used to assess the sensory properties colour, taste, aroma, texture, appearance, brittleness, crispiness, and overall acceptability using a 9-point hedonic scale, where 1 means Dislike extremely, 2 means Dislike very much, 3 means Dislike much, 4 means Dislike Moderately, 5 means Neither like nor dislike, 6 means Like moderately, 7 means Like much, 8 means like very much and 9 means Like extremely. The treatments were coded with 3-digit numbers, and served to the sensory panelist in a random order. Water was provided to the panelists to wash their mouths in between tasting.

3.8 Proximate analysis

3.8.1 Carbohydrate /Nitrogen Free Extract

The total carbohydrate estimate of the cookies was obtained by subtracting the sum of moisture, ash, protein, fat and crude fibre from hundred and expressed as a percentage (Sambucetti and Zuleta, 1996; Ramalakshmi et al., 2007).

3.8.2 Crude protein content determination

An amount of 2 grams of sample (cookies) were weighed using an analytical balance (Sartorius B120S, Germany) and placed in a digesting flask. Twenty-five millilitres of concentrated H_2SO_4 and Kjeldahal catalysts were added. Digestion was carried out in a digestion chamber until a clear solution was obtained. The digested sample was filtered into a 100ml volumetric flask and made to the mark with sixty millilitres distilled water and mixed well. Seventeen millilitres of NaOH and 10 ml of sample were put into the kjeldhal apparatus and heated for the distillation of ammonia. Twenty-five millilitres of 4% boric acid were measured into the conical flask to receive the liberated ammonia gas.

The nitrogen content was estimated by titrating the ammonium borate formed with standard 0.096N HCl using mixed indicator and titre values recorded. The appropriate formula was used to calculate the protein content. The procedure was repeated for each sample in triplicates (Ramalakshmi et al., 2007).

$$\text{Protein (\%)} = \frac{(A-B)\times 14.007\times 6.25}{W} \times 100$$

A= volume (ml) of 0.2 N HCL used sample titration

B= volume (ml) of 0.2 N HCL used sample titration

N= Normality of HCL

W= weight (g) of sample

14.007= atomic weight of nitrogen

6.25= the protein – nitrogen conversion factor

3.8.3 Crude fibre content determination

The sample used for the fat determination was used for the crude fibre analysis. The defatted sample was transferred into a 500ml Erlenmeyer flask and 0.5g of asbestos and 200ml of 1.25% boiling H_2SO_4 were added and connected to a condenser and set on a hot plate. The flask boiled for thirty minutes, content filtered out and washed with boiling water till the washings were no more acidic. The residues were put back into the flask, connected to the condenser and made to boil with 200ml 1.25% NaOH for thirty minutes. It was then filtered and washed with boiling water till filtrate was no longer basic and 15ml alcohol was used to do a final washing. Residues were transferred into silica crucibles and dried in an electric oven (Fisher Isotemp® Oven, Senior Model) for one hour at 100^{o}C. It was then cooled and the weight taken. Crucibles and contents were ignited in a muffle furnace for 30 minutes, cooled in a desiccator and weighed and loss in weight was determined. The procedure was replicated three times. Crude fibre content was calculated using the formula:

$$\% \text{ Crude fibre} = \frac{C1-C2}{C3} \times 100$$

C1= Weight of dried sample

C2 = Weight of ashed sample

C3 = Weight of defatted sample

3.8.4 Ash content determination

An amount of 2 grams of samples (cookies) were weighed using an analytical balance (Sartorius B120s, Germany). The weight of the crucible and each sample were determined and recorded. The crucible and its content were placed in a muffle furnace (Thermo Scientific) at a temperature of

600 ^{O}C for two hours. The crucibles were removed and allowed to cool after which it was weighed. The appropriate formula (Appendix A) was used to calculate the ash content. The procedure was repeated for each sample in triplicates (Ramalakshmi et al., 2007).

% Ash = $\frac{W2-W1}{W0} \times 100$

W2=Weight of Ashed sample

W1= Weight of empty crucible

W0= Sample weight

3.8.6 Moisture content determination

An amount of 2g samples (cookies) was weighed using an analytical balance (Sartorius B120s, Germany) The weight of the petri dish and each sample were determined and recorded. The petri dish and its content were placed in a drying oven (FISHER Isotemp® Oven, SENIOR MODEL) at a temperature of 105 ^{O}C for three hours after which the differences in weight were determined using the appropriate formula for calculation of the moisture content. The procedure was repeated for each sample in triplicates (Ramalakshmi et al., 2007).

% Moisture = $\frac{W1-W2}{W0} \times 100$

Wo= weight (g) of samples

W1= weight (g) of sample and crucible before drying

W2= weight (g) of sample and crucible after drying

3.8.7 Crude fat determination

An amount of 2 g of samples (cookies) which the moisture content had been determined was used. The beakers were weighed using an analytical balance (Sartorius B120s, Germany). The samples were transferred into a thimble and placed in the holding chamber of the Goldfish apparatus. An amount of petroleum ether (25ml) was poured into each of the beaker. Cotton wool (asbestos) was placed on top of each sample in the thimble, the thimbles were then inserted in the gaskets of the apparatus condenser. The beaker containing the solvents was also connected to the gaskets. The tap was then opened to allow free flow of water through the apparatus to facilitate the condensing of the solvent. The apparatus was switched on and the sample extracted for 4 hours within a rate of 5 drops per seconds. The beakers were and its content dried in an oven (Fisher Isotemp Oven, Senior Model) for 30 minutes cooled in a desiccator for 30 minutes and weighed on analytical balance (Sartorius B120s, Germany) to determine the difference in weight of the flask. The appropriate formula was used to calculate the fat content. The procedure was repeated for each sample in triplicates (Ramalakshmi et al., 2007).

% Crude fat = $\frac{W1}{W2} \times 100$

W1 =Fat weight

W2 = Sample weight

3.9 Energy

The energy of the cookie was determined by multiplying a factor four to the protein, a factor nine to the fat and a factor four to the carbohydrate and resultant summed up to obtain the energy of the various cookie samples. (Ramalakshmi et al., 2007). The formula used for energy calculation was:

Energy (Kcal/100g) = (4* Protein) + (9* Fat) + (4* carbohydrate)

3.10 Data analysis

All data obtained from various determinations was subjected to one-way Analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS) version 16.0. Means were separated using the least significant difference (LSD). Differences in means were regarded as significant at $p<0.05$.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of the results. The areas covered are the demographic characteristics of the sensory panelists who did the sensory evaluation of the biscuit produced from wheat flour and kidney beans flour, the sensory qualities of the biscuit, and the proximate composition of the biscuit.

4.2 Demographic characteristics of sensory panelists

The demographic information of the sensory panelists considered in this study were gender, status, and age.

4.2.1 Gender of the sensory panelists

The results on gender of the sensory panelists are found in Table 4.1. The members of the sensory panel were fifty-three (53). Out of this number, 20 representing 37.7% were males whiles 33 representing 62.3 were females. Most of the sensory panel members were females.

Table 4.1 Gender of the sensory panelists

Gender	Frequency	Percentage	Cumulative Percentage
Male	20	37.7	37.7
Female	33	62.3	100.0
Total	53	100.0	

4.2.2 Status of sensory panelists

The results on the status of the sensory panelist are found Table 4.2. The members of the sensory panel were fifty-three (53). Out of this number, 20 representing 66.1% were students whiles 18 representing 33.9 were lectures. Most of the sensory panel members were students.

Table 4.2 Status of sensory panelists

Status	Frequency	Percentage	Cumulative Percentage
Student	35	66.1	66.0
Lecturer	18	33.9	100.0
Total	53	100.0	

4.2.3 Age of sensory panelists

The results on the age of the sensory panelist are found Table 4.3. The age of the sensory panel were fifty-three (53). Out of this number, 22 representing 41.5% were of the age of 18-25 years, 15 representing 28.3% were of the age of 26-35 years, 10 representing 18.8% were of the age of 36-45 years, whiles 6 representing 11.3 were of the age of 46 and above. The future of every economy depends on the active force and as such the working force dominates the higher percentage which is 41.5%.

Table 4.3 Age of sensory panelists

Age	Frequency	Percentage	Cumulative Percentage
18 – 25	22	41.5	41.5
26 – 35	15	28.3	28.3
36 – 45	10	18.8	18.8
46 and Above	6	11.3	100.0
Total	53	100.0	

4.3 Sensory evaluation of wheat flour and beans flour biscuit

The sensory evaluation results on the biscuit made with wheat flour and beans are shown in Table 4.4. The sensory evaluation was based on a 9-point hedonic scale with 1 as dislike extremely and 9 as like extremely. The role of colour in sensory perception of food is crucial, and in this study, the

Table 4.4 Sensory evaluation of wheat flour and beans flour biscuit

Sensory parameter	T1	T2	T3	T4	T5
Colour	6.53 ± 1.96^{c}	7.37 ± 1.12^{e}	6.79 ± 1.40^{b}	6.35 ± 1.27^{d}	6.70 ± 1.17^{a}
Aroma	6.20 ± 1.74^{e}	7.37 ± 1.16^{b}	6.44 ± 1.25^{d}	6.61 ± 1.21^{c}	7.10 ± 1.29^{a}
Texture	5.47 ± 2.10^{e}	7.47 ± 1.17^{b}	6.56 ± 1.25^{c}	6.15 ± 1.23^{d}	7.10 ± 1.29^{a}
Taste	6.20 ± 1.82^{d}	7.26 ± 1.10^{b}	6.71 ± 1.21^{c}	6.20 ± 1.40^{d}	7.40 ± 1.27^{a}
Brittleness	6.53 ± 1.96^{c}	7.32 ± 1.29^{b}	6.44 ± 1.42^{d}	6.15 ± 1.35^{e}	7.20 ± 1.20^{a}

Appearance	$6.60{\pm}2.03^{c}$	$7.47{\pm}0.96^{b}$	$6.56{\pm}1.38^{c}$	$6.00{\pm}1.30^{d}$	$7.10{\pm}1.02^{a}$
Crispiness	$6.47{\pm}1.85^{d}$	$7.95{\pm}1.08^{b}$	$6.61{\pm}1.29^{c}$	$6.15{\pm}1.14^{e}$	$7.40{\pm}1.10^{a}$
Overall Acceptability	$7.13{\pm}2.03^{d}$	$7.84{\pm}0.96^{b}$	$7.22{\pm}1.26^{c}$	$7.00{\pm}1.34^{e}$	$7.65{\pm}1.23^{a}$

Means with different superscripts are significant at P<0.05. T1= 100% wheat flour, 0% beans flour, T2=75% wheat flour + 25% beans flour, T3= 50% wheat flour + 50% beans flour, T4= 25% wheat flour + 75% beans flour, T5= 100% beans.

biscuits generally became significantly (P<0.05) more visually appealing to the sensory respondents as the amount of beans flour in the biscuit increased. This may be due to the occurrence of Maillard reactions between reducing sugars and proteins, which give appearing colours (Ade Kuldip et al., 2015). Perception of aroma preference by the sensory respondents (Table 4.5) indicated that there was significant (P<0.05) enhanced preference for biscuit with increment in beans flour. Maillard reaction between reducing sugars and protein also lead to the production of pleasant aroma, and could account for the observation made for the aroma preference. A study by Samuel et al. (2021) indicated that there was increased level of aroma preference for biscuit by sensory panelists.

Texture plays a crucial role in enhancing the sensory perception of food, and in this study, the biscuits generally became significantly (P<0.05) more firm, tender, crisp and smooth to the sensory respondents. Öksüz and Karakaş (2016) also found an increase in texture preference of gluten-free biscuits containing buckwheat flour. Perception of taste by the sensory respondents indicated that there was significant (P<0.05) increase in taste preference for biscuit with increment in beans flour. Maillard reaction between reducing sugars and protein also lead to the production of good taste, and could account for the observation made for the taste. A study by Adefegha and Oboh (2013) found that although there was no significant difference (p > 0.05) between all the biscuits in aroma, colours, and texture a significant difference was observed in their taste and general acceptability; ranking the highest in taste and general acceptability. The perception of the sensory respondents on the brittleness of the biscuit also saw a significant increase ($P<0.05$). This may be due to the occurrence of Maillard reactions between reducing sugars and proteins, which give appealing brittleness (Laguna et al., 2013).

Appearance also plays a crucial role in sensory perception of food, and in this study, the biscuits generally became significantly ($P<0.05$) less visually appealing in appearance to the sensory the amount of wheat in the biscuit increased. This may be due to the occurrence of Maillard reactions between reducing sugars and proteins, which may give good appearance. In terms of the crispiness of the biscuit, the sensory respondents generally indicated a lower preference, suggesting that the crispiness of the biscuit reduced with increment of wheat in the biscuit. Maillard reaction between reducing sugars and protein also lead to the increased in the crispiness of the biscuit. A study by Vickers, (2017) also found that there is an increased level of crispiness in auditory components.

The overall acceptability of the biscuit product also saw a general significant increment in overall acceptability ($P<0.05$). A study by Samuel et al. (2021) gave a general increment in preference ratings for overall acceptability as the amount of wheat in composite biscuit made with orange-flesh sweet potatao reduced.

4.4 Proximate composition of wheat flour and beans flour biscuit

The proximate composition results of the biscuit are indicated in Table 4.5.

Table 4.5: Proximate composition of biscuit

Proximate parameter	**T1 (Control)**	**T2**	**T3**	**T4**	**T5**
Moisture (%)	22.07±0.52^{b}	20.55±0.78^{e}	22.85±0.73^{d}	22.18±0.68^{c}	21.44±0.51^{a}
Ash (%)	1.50±0.15^{b}	3.03±0.03^{e}	2.35±0.02^{d}	1.69±0.03^{c}	1.22±0.22^{a}
Fat (%)	3.79±0.05^{c}	3.06±0.05^{b}	3.10±0.09^{b}	3.05±0.05^{b}	2.74±0.07^{a}
Fiber (%)	2.20±0.02^{d}	2.65±0.05^{c}	2.48±0.02^{b}	2.10±0.02^{e}	2.37±0.04^{a}
Protein (%)	13.89±0.81^{b}	17.059±0.44^{d}	15.59±1.37^{c}	16.50±1.06^{e}	13.14±0.99^{a}
Carbohydrate (%)	56.64±0.57^{b}	53.46±0.33^{e}	54.76±0.76^{c}	54.30±1.23^{d}	59.08±0.99^{a}
Energy (kcal/100g)	315.42 ±1.86^{b}	309.60 ±2.61^{d}	309.29 ±2.07^{e}	310.69 ±2.37^{c}	313.56±1.44^{a}

Means with different superscripts are significant at P<0.05. T1= 100% wheat flour, 0% beans flour, T2=75% wheat flour + 25% beans flour, T3= 50% wheat flour + 50% beans flour, T4= 25% wheat flour + 75% beans flour, T5= 100% beans

Moisture content of the biscuit ranged from 20.55-22.85%. The moisture content of the biscuit did not give a specific trend. T4 exhibits the highest moisture content at 22.85%, whereas T5 displays the lowest moisture content at 20.55%. The higher moisture content of T4 may suggest possible differences in texture and shelf life when compared to the other treatments. Similarly, Galla et al.

(2017) conducted a study on biscuit production and found that variations in moisture content can significantly affect texture, shelf life, and sensory attributes of biscuits.

Ash content of the biscuit was in the range 1.22-3.03%. Generally, there was significant increment ($P<0.05$) of ash content of the biscuit as the amount of beans flour increased. Beans is a rich source of ash and this may account for the increment of ash content of the biscuit as the amount of beans flour in the biscuit increased. Dhankhar et al. (2019) similarly found in their study that ash content of different biscuit samples increased as the amount of wheat reduced in the biscuit. In their study, the ash content was highest for sample T4 (4.73%) and lowest for control (1.96%).

Also, the fat content of the biscuit was in the range of 2.74-3.79%. T3, T4, and T5 all exhibited comparable fat percentages ($p<.05$), whereas T1, which consisted of only wheat gave the lowest fat content at 2.74%. A study by Kandhro et al., (2008) indicated that fat content in biscuit produced ranged from 9.3 to 34.9%, and this is very high compared with the results of the present study.

Fiber content of the biscuit was also in the range of 2.10-2.65%. Generally, there was significantly higher ($P<0.05$) fibre content in the biscuit as the amount of beans increased and wheat decreased. The variation in the beans content of the biscuit may account for this. Beans are known to be rich in soluble and insoluble fiber (Bamanyaki and Muchunguzi, 2020). They also indicated that the consumption of fiber has been associated with decreasing total and low-density lipoprotein (LDL) cholesterol, as well as decreasing the risk of developing coronary heart disease, metabolic syndrome, stroke, hypertension, diabetes, obesity, and some gastrointestinal diseases.

The protein content of the beans also ranged from 13.14 to 17.059%. As can be seen, there is a significant increase in the protein content of the biscuit (P<0.05). The protein content in T5 is significantly higher at 17.06%. This treatment consists of 75% wheat flour and 25% beans, suggesting a potentially protein-enriched option compared to the other treatments. Similar findings were obtained by Khazaei and Vandenberg (2020), whose findings also indicated a generally increased level of protein in biscuit production as the amount of legume ingredients increases increased.

The carbohydrate content of the biscuit also ranged between 53.46 and 9.08%. The carbohydrate content in the biscuit also saw a significant reduction as the amount of beans increased and amount of wheat reduced (P<0.05). Wheat is a rich source of carbohydrate, and its reduction in the biscuit could account for the reduced carbohydrate content. A study on the nutritional composition of biscuits from wheat-sweet potato-soybean composite flour found that the carbohydrate content in the biscuits varied significantly based on the substitution of ingredients, with the highest carbohydrate content observed in the control biscuit and the lowest in the biscuit with the highest substitution of alternative flours (Sanchez et al., 2022).

The treatments had energy values of 309.29-315.42kcal/100g. Generally, the addition of more beans but less wheat to the biscuit reduced the energy content. The high carbohydrate content of wheat may account for this. A study on biscuits made from wheat-sweet potato-soybean composite flour reported a significant decrease in energy content as the substitution of ingredients increased, leading to a reduction in energy content (Sanchez et al., 2022).

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter gives the summary, conclusions, and recommendations.

5.2 Summary

The study was set to experiment with the use of kidney beans flour and wheat flour in the production of biscuit. The biscuit of different percentages of wheat flour and beans flour with one control (made up of only wheat) were produced. The proximate composition and the sensory qualities of the biscuit were determined. The proximate composition results showed that generally ash, fibre, and protein contents of the composite biscuits increased with increment in the beans flour addition, but fat and carbohydrate contents generally showed a downward trend as the amount of beans flour increased in the composite biscuit. In addition, the sensory respondents showed increased preference for most sensory qualities as the beans flour content of the biscuit increased.

5.3 Conclusions

The results have shown that there was a general significant improvement in the proximate composition of the biscuit made with beans flour. The composition of the biscuit therefore had significant effect on its nutritional composition. Biscuit of higher ash, fiber, and protein content, but lower energy could be produced from kidney beans and wheat. Also, the composition of the biscuit had positive impact on the various sensory attributes, thus inclusion of the beans flour generally gave higher sensory ratings, and higher overall acceptability of the biscuit. The results indicate that the addition of beans to the biscuit had a favorable effect on the sensory qualities, demonstrating the possibility of producing biscuits with improved sensory characteristics through the combination of beans and wheat flour. The findings highlight the possibility of creating biscuits with enhanced nutritional profiles and sensory qualities through careful formulation. This has significant implications for product development and consumer satisfaction in the food industry.

5.4 Recommendations

The following recommendations are made based on the results of the study:

(1) Biscuit manufacturers should broaden their component composition by integrating legumes like beans into their formulations to give a nutritious biscuit which meets the preference of the customer.

(2) The sensory evaluation should be carried out using much bigger sample size to give more reliable results on the sensory response of consumers.

(3) Education of consumers on the nutritional advantages of wheat and beans flour biscuit should be done to help increase consumer acceptability and adoption.

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APPENDIX 1

KOFORIDUA TECHNICAL UNVERSITY

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DEPARTMENT OF HOSPITALITY

PRODUCTION OF BISCUITS USING KIDNEY BEANS FLOUR

This research work seeks to determine consumer acceptability of biscuit made with various percentages of Wheat flour and Kidney beans flour. You are therefore required to provide sufficient information as possible. The information provided shall be kept confidential and used for research purposes only, Thank you.

Instructions: Please tick [ ] where necessary.

Section A SOCIO-DEMOGRAPHIC INFORMATION

Gender: a. Male [ ] b. Female [ ]

Status: a. Student [ ] b. Lecturer [ ] c. Others ………………………

Age: a. 18 - 25 [ ] b.26 - 35 [ ] c. 36 - 45 [ ] d. 46 and Above [ ]

Section B: Sensory Evaluation

Quantify the degree of likeness of the product before you and evaluate each given attribute one by one separately. Put a [] in the box that best describes your opinion of the product. Please try and give the reasons to your opinion under comments after evaluating the various samples.

Read carefully the following statements and tick against the appropriate option

1= Dislike extremely, 2 = Dislike very much, 3 = Dislike much, 4 = Dislike Moderately, 5 = Neither like nor dislike, 6= Like moderately, 7= Like much, 8= like very much, 9= Like extremely

LEVEL OF LIKENESS OF THE PRODUCT

SENSORY ATTRIBUTE	1	2	3	4	5	6	7	8	9
Color									
Aroma									
Texture									
Taste									
Brittleness									
Appearance									
Crispiness									
Overall Acceptability									

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PRODUCTION OF BISCUITS USING WHEAT FLOUR AND KIDNEY BEANS FLOUR

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