PROCESSING OF RICE INTO GROUND RICE FLOUR FOR PRODUCTION OF MAINDISH AND SNACKS

By

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CERTIFICATION

This is to certify that this project was carried out by **ABDULRAUF ROHEEMAT BUKOLA** of matric number **HND/23/HMT/FT/0128** it has been read and approved as meeting part of the requirements for the awards of Higher National Diploma in Hospitality Management in the Department of Hospitality.

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DEDICATION

I dedicate this project work to Almighty God for His protection, guidance and inevitable mercy over my lives throughout the research work. I also dedicate to my able parents for their supports morally, financially and spiritually towards my course of study.

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ABSTRACT

This research investigated the processing of rice into ground rice flour and its utilization in the production of main dishes and snacks. Locally sourced rice grains were cleaned, milled, and sieved into fine flour, which was then used to prepare selected food products such as doughnut and meat pie. The aim was to evaluate the suitability of rice flour as an alternative to wheat flour in food processing and to assess consumer acceptability of the products. A sensory evaluation was conducted using a panel of assessors who rated the products based on appearance, colour, flavour, texture, and overall acceptability. The results revealed that both doughnut and meat pie prepared from instant rice flour were highly acceptable, with most attributes rated between excellent and very good. Appearance and flavour were most appreciated in the doughnut, while colour and texture were strongly rated in the meat pie. The findings suggest that rice flour can effectively substitute wheat flour in snack and pastry production without significant compromise in quality. The study concludes that rice flour not only supports diversification of rice utilization but also reduces dependence on imported wheat, thereby promoting food security and encouraging the consumption of locally grown rice.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Flour is a finely ground powder obtained by milling grains or other food sources. In everyday life, flour plays a crucial role in the preparation of snacks, bread, and a wide variety of convenient foods. However, there is a common misconception that flour is made exclusively from wheat. In reality, other cereals, such as rice, can also be processed into flour and used in similar applications. Rice (Oryza sativa), as defined by Webster's Dictionary, is an annual cereal grass cultivated worldwide for its edible seeds (Trey, 2019). It is one of the most significant food crops globally, especially in regions where it is consumed daily—sometimes even multiple times a day. Although wheat remains the most prominent cereal in flour production, rice is increasingly recognized for its potential in both traditional and modern food products.

Structurally, the rice grain shares similarities with the wheat grain, making it a viable substitute or supplement in flour-based recipes. The blending of rice flour with wheat flour results in what is known as "composite flour." While the texture and taste of composite flour products may differ slightly from those made with pure wheat flour, they often retain high quality and may offer superior nutritional value (Isla, 2018).

Rice has a rich history and a wide geographical distribution. It originated in China and spread to regions such as Sri Lanka, West Asia, and Greece—believed to have been introduced by the armies of Alexander the Great around 300 B.C. By 800 A.D., rice was introduced to East Africa through trade with India and Indonesia. In North America, its introduction is less certain, though one popular account involves a shipwreck off the Carolinas. The ship's captain, in exchange for repairs, gifted the locals a bag of rice. Additionally, enslaved Africans are believed to have brought rice seeds and cultivation knowledge with them. By the 1700s, the U.S. was exporting hundreds of tons of rice, and after the Civil War, rice farming expanded across the southern states.

Today, rice is predominantly cultivated in U.S. states such as California, Mississippi, Texas, Arkansas, and Louisiana. Advanced farming technologies have made rice cultivation more efficient—requiring about seven man-hours per acre in the U.S., compared to up to 300

man-hours in many parts of Asia. While the average American consumes around 25 pounds of rice per year, consumption in parts of Asia ranges from 200 to 400 pounds annually (Helder, 2018).

Rice is a highly adaptable crop, capable of growing in various environments—including arid deserts and wet, swampy regions. The plant typically grows to a height of 2 to 6 feet. There are numerous rice varieties across the globe, differing in grain shape, size, and color. In West Africa, for instance, native varieties of rice come in brown, yellow, and red hues. Prior to the widespread cultivation of Oryza sativa about 67 years ago, West Africans predominantly grew Oryza glaberrima—a species still cultivated in parts of Mali, Sierra Leone, and Nigeria. Commercially, white and red rice are the two main types recognized, with white rice generally being more preferred and fetching higher market prices.

Rice thrives best in humid environments such as coastal plains, river basins, and delta regions. In some cases, land is deliberately flooded to support rice farming. Beyond its use as a staple food for humans, rice also serves as feed for livestock and poultry. Additionally, it is an important raw material in the production of starch and alcoholic beverages such as beer. Rice has excellent storage properties and can be easily transported over long distances, further enhancing its commercial and agricultural value

1.2 Statement of the Problem

One of the major challenges facing the adoption of rice flour in Nigerian cuisine is a general lack of awareness and proper orientation. Many people are unfamiliar with alternative flour sources and have grown accustomed to using only wheat flour. As a result, the idea of producing flour from cereals or tuber crops such as rice is often met with skepticism. There is a widespread belief that flour used for snacks and baked goods must come exclusively from wheat, and this misconception limits the acceptance and purchase of rice flour.

Due to this lack of knowledge, many individuals do not understand how to properly use rice flour in food preparation. They are unsure of the right proportions or methods needed to achieve good results, and this uncertainty leads them to doubt the effectiveness of rice flour compared to wheat flour. In essence, ignorance becomes a barrier to the integration of rice flour into local food practices.

Additionally, there are concerns about the processing of locally produced rice. Before it can be milled into flour, the rice must go through several steps: removing stones and impurities, thorough washing, sun drying, and finally grinding it into a fine powder. This process can be time-consuming and discouraging, especially for people who lack the patience or resources to carry it out. As a result, many prefer the convenience of pre-packaged wheat flour, which is readily available in markets and requires no extra effort to prepare.

Until proper education, awareness, and access to efficient rice processing methods are provided, the full integration of rice flour into Nigerian meals and snacks will continue to face resistance.

1.3 Aims and Objectives of the Study

The primary objective of this study is to critically explore the use of rice flour in the preparation of Nigerian main dishes and snacks. In addition to this, the study aims to achieve the following specific objectives:

i. To analyze the nutritional composition of rice flour ii. To evaluate the health benefits of rice flour in human nutrition iii. To assess the significance of rice flour in the hospitality and food service industry

1.3.2 General Objective:

The general objective of this study is to processing of rice into ground rice flour for production of maindish and snacks, with a focus on its nutritional value, functional benefits, and relevance in the food and hospitality industry.

1.3.2 Specific Objectives:

The study aims to:

i. Identify the steps involved in processing rice into flour suitable for snacks.

ii. Identify the nutritional composition of rice flour.

iii. Examine the health benefits of rice flour in human diets.

vi. To access the acceptability level of the end product

1.4 Research Questions

In the course of this study, the following research questions will be addressed:

i. What are the key steps involved in processing rice into flour suitable for food production?
ii. What is the nutritional composition of rice flour?
iii. 3 How does the inclusion of rice flour in the human diet contribute to health and nutrition?
iv. What factors influence the consumer acceptability of rice flour as a substitute in food products?

1.5 Significance of the Study

This research is aimed at promoting self-reliance by encouraging the use of locally sourced products, particularly rice flour, as an alternative to imported flours such as wheat, barley, and oats. By effectively incorporating rice flour into the production of high-quality and acceptable snacks, this study seeks to enhance product appeal, boost sales, and reduce overall production costs. Ultimately, it supports local agriculture, reduces dependency on foreign imports, and contributes to the growth of the local food processing industry.

1.6 Scope of the Study

This study focuses on the processing of rice into flour and its utilization in the preparation of Nigerian main dishes and snacks. It covers the methods of producing rice flour, its nutritional composition, and its application in various food products. The study is limited to selected types of rice commonly grown and consumed in Nigeria. It also examines the acceptability of rice flour-based products among consumers, as well as the relevance of rice flour in the hospitality and food service industry. The research does not include large-scale industrial processing but concentrates on small to medium-scale production methods that are practical and accessible within the local context.

1.7 Limitations of the Study

This study, while valuable, is not without its limitations. It is confined to a specific geographical location, which may affect the generalizability of the findings to other regions with different rice varieties or culinary practices. The research also faced constraints in terms of time and available resources, limiting the scope of data collection and the scale of experimentation. Additionally, only a few locally available rice types were used for flour production, which may not represent the full range of rice varieties suitable for similar applications. The study relied on small-scale production methods rather than industrial processing, and consumer acceptability tests were limited to a small group of participants. These factors may influence the extent to which the findings can be applied to broader or commercial contexts.

1.8 Definition of Terms

1. **Rice Flour:** A fine powder obtained by grinding cleaned and dried rice grains, used as an ingredient in cooking and baking.

2. **Processing:** The series of actions or steps taken to transform raw rice grains into ground rice flour suitable for food production.

3. **Main Dish**: A primary or central food item in a meal, typically prepared using rice flour as a key ingredient in this study.

4. **Snacks**: Light or small portions of food, often made using rice flour, intended to be eaten between meals or as appetizers.

5. **Grinding:** The mechanical process of crushing rice grains into a fine powder to produce rice flour.

6. Composite Flour: A mixture of rice flour and other cereal flours, such as wheat flour, used to enhance nutritional or functional qualities in food products.

7. Nutritional Composition: The content of nutrients such as carbohydrates, proteins, fats, vitamins, and minerals present in rice flour.

8. Hospitality Industry: Businesses and services that prepare and serve food and beverages to customers, including hotels, restaurants, and catering services.

CHAPTER TWO
LITERATURE REVIEW

2.0 Literature Review

2.1 Introduction

Rice (*Oryza sativa*) is one of the most important and widely consumed cereal crops globally, especially in Asia and sub-Saharan Africa. It provides more than 20% of the world's caloric intake and serves as a staple for over half of the global population (FAO, 2021). In Nigeria, rice is not only a dietary staple but also a key economic crop that supports millions of households through farming, processing, and marketing (CBN, 2020). The growing demand for rice has encouraged research into its various value-added forms, including its conversion into flour for diversified food use.

Traditionally, rice is consumed as whole or parboiled grains. However, in recent years, there has been a shift toward adding value to rice through its transformation into rice flour. This growing interest is driven by both health considerations—such as the rise in gluten intolerance—and the food industry's need for diverse raw materials for innovative product development. Ground rice flour has become increasingly valuable in this regard due to its functional versatility, particularly in the formulation of gluten-free, culturally appropriate, and health-conscious food products (Juliano, 1993; Patindol & Wang, 2002; Shobana et al., 2009).

Ground rice flour is now commonly used in the preparation of both traditional main dishes—such as *tuwo shinkafa*, *masa*, and rice-based *moi-moi*—and modern snacks, including rice crackers, cookies, pancakes, doughnuts, and flour blends for baking. Its light texture, bland flavor, and high digestibility make it suitable for a wide range of food products. Moreover, because rice is naturally gluten-free, rice flour is ideal for individuals with celiac disease or wheat allergy, and its use in food processing continues to expand (Onwuka et al., 2011; Adebayo et al., 2013).

The increasing demand for locally processed foods, coupled with technological advancements in small- and medium-scale agro-processing, has made rice flour an attractive raw

material in food product development (Olapade & Aworh, 2012). Additionally, local processing helps reduce the importation of wheat flour and enhances the economic value of locally grown rice. This aligns with national food security strategies and promotes self-sufficiency in staple food production (FMARD, 2017).

Furthermore, the processing of rice into flour contributes to reducing post-harvest losses, which remain a major challenge in Nigeria's agricultural sector. By converting rice into shelf-stable flour, producers can extend the product's usability and create market-ready food items with longer shelf life and reduced storage risks (Adegunwa et al., 2014). The use of rice flour in snack production also offers opportunities for nutritional enrichment, particularly when combined with other protein-rich legumes such as soybeans or groundnut.

2.2 Key Steps in Processing Rice into Flour Suitable for Food Production

The conversion of rice into flour suitable for food applications involves a sequence of carefully controlled steps. Each stage contributes significantly to the final quality of the flour, including its texture, nutritional value, shelf life, and functional properties in different food products. The processing sequence must adhere to principles of food hygiene, safety, and quality assurance to ensure that the flour produced is both safe for consumption and suitable for a wide range of culinary uses.

1. Cleaning

The first step in rice flour production is the cleaning of raw rice grains to remove foreign materials such as stones, chaff, dust, broken grains, weed seeds, and other extraneous matter. This is critical because the presence of impurities can affect the grinding process and result in contamination or damage to milling equipment. Typically, mechanical cleaners such as sieves, destoners, and magnetic separators are used in industrial settings, while traditional handpicking or washing may be used in small-scale settings (Juliano, 1993).

Efficient cleaning ensures not only product safety but also reduces wear and tear on machines and improves the quality of the final flour output. According to Adegunwa et al.

(2014), poor cleaning prior to milling contributes significantly to increased microbial load and grit content in the final product.

2. Soaking

Soaking is a pre-treatment process where the cleaned rice grains are immersed in water for a period ranging from 2 to 12 hours, depending on the intended flour type and regional practice. This step serves to soften the rice kernels, making them easier to grind, and in some cases initiates slight fermentation that can influence flavor and nutrient availability (Olapade & Aworh, 2012).

Soaking can also aid in leaching out some anti-nutritional factors like phytic acid and tannins, especially when the rice is intended for infant foods or snacks. Additionally, soaking contributes to improved textural properties in the final flour, enhancing its binding and swelling capacities (Shittu et al., 2007).

3. Draining and Drying

After soaking, rice grains are drained and subjected to **drying**, which reduces their moisture content to levels below 14%—the safe limit for milling and storage. Proper drying is essential because high moisture content can lead to microbial growth, mold contamination, and poor flour texture.

There are different drying methods, such as sun drying, **oven drying**, or mechanical drying using hot air dryers. The drying method affects the starch structure and functional quality of the resulting flour. For example, hot-air drying helps preserve the starch's gelatinization properties, which are critical in snack and bakery applications (Adebowale et al., 2005).

4. Milling or Grinding

Once adequately dried, the rice is subjected to grinding or milling**.** This can be done using traditional stone mills, hammer mills, or burr mills. Milling can be performed as **dry milling** (using fully dried grains) or wet milling (where grains are ground with some moisture content and later dried).

- **Dry milling** is commonly used for producing flour intended for bakery products and snacks due to its ability to retain particle uniformity and reduce microbial contamination.
- **Wet milling**, on the other hand, is used when a smoother texture is desired, such as for porridges or steamed dishes.

Grinding efficiency affects flour particle size, which in turn influences water absorption, texture, and cooking behavior in food applications (Patindol & Wang, 2002).

5. Sieving and Packaging

The final stage is **sieving**, where the ground flour is passed through mesh screens of varying sizes to remove coarser particles and ensure uniform granule size. This step improves the textural consistency of the flour and makes it more appealing for both household and industrial food use.

In commercial production, sieving may be followed by blending**,** fortification, and packaging. Proper packaging in moisture-proof materials prevents the flour from absorbing humidity, odors, or pests. According to Onwuka et al. (2011), airtight and opaque packaging enhances the shelf life and acceptability of rice flour products, especially in hot climates like Nigeria.

2.3 Nutrient Component

Nutrient	**White Rice Flour (per 100g)**	**Brown Rice Flour (per 100g)**	Description / Notes
Carbohydrates	80–82 g	76–78 g	Main energy source, mostly in the form of starch.
Protein	5–6 g	7–8 g	Moderate protein content; quality depends on amino acid profile.
Fat	0.5–1 g	2–3 g	Higher in brown rice

			flour due to bran layer.
Fiber	1–2 g	4–5 g	Brown rice flour is richer in dietary fiber
Moisture	10–12 g	10–12 g	Affects storage stability.
Calcium	5–10 mg	10–15 mg	Important for bone health, varies by rice type.
Iron	0.3–0.8 mg	2–3 mg	Brown rice flour contains more iron from the bran.
Gluten	0 g	0 g	Naturally gluten-free, suitable for celiac patients.
Energy	~360 kcal	~370 kcal	High-energy food, primarily from carbohydrates.

2.3.1 Carbohydrates: Rice flour is composed of approximately 75–80% carbohydrates, mainly in the form of starch (amylose and amylopectin). The high carbohydrate content makes it a significant energy source, particularly in regions where rice is a dietary staple (FAO, 2021). The proportion of amylose affects texture and cooking behavior; high-amylose varieties produce firmer, less sticky flour, ideal for snacks and main dishes (Patindol & Wang, 2002).

2.3.2 Protein: Rice flour contains about 6–8% protein. While it lacks gluten—the elastic protein found in wheat—it contains essential amino acids such as lysine and methionine, although in lower quantities compared to legume-based flours (Olayiwola et al., 2011). Due to the absence of gluten, rice flour is particularly valuable in gluten-free diets and is recommended for individuals with celiac disease or wheat allergies.

2.3.3 Fat: The fat content of rice flour is relatively low, typically less than 2%. This contributes to its longer shelf life when stored properly. However, brown rice flour may contain slightly higher fat levels due to the retention of the bran layer, which also contributes additional nutrients and fiber (Adegunwa et al., 2014).

2.3.1 Fiber: The fiber content in white rice flour is about 1–2%, while brown rice flour may offer up to 4% due to its bran content (Onwuka et al., 2011). Dietary fiber aids digestion, regulates blood sugar, and contributes to satiety, making rice flour-based foods beneficial in balanced diets.

2.3.1 Vitamins and Minerals: Rice flour contains trace amounts of B-complex vitamins, including thiamine (B1), niacin (B3), and riboflavin (B2). It also provides small but valuable amounts of iron, magnesium, phosphorus, and zinc (FAO, 2021). However, the milling process in white rice flour production reduces the vitamin content compared to whole grain or brown rice flour. Enrichment or fortification is often recommended to compensate for nutrient losses during processing.

Compared to wheat flour, rice flour has a **lower protein content** and lacks the gluten network that gives wheat-based dough its elasticity. However, rice flour is easier to digest, making it suitable for infants, the elderly, and individuals with special dietary needs (Onwuka et al., 2011). Its hypoallergenic nature makes it one of the safest cereal flours for individuals with multiple food sensitivities. Additionally, the **glycemic index (GI)** of rice flour is relatively high, especially in refined white rice flour. This implies a rapid release of glucose into the bloodstream, which may not be ideal for individuals managing diabetes. However, blending rice flour with high-fiber or high-protein ingredients—such as legumes or vegetables—has been shown to reduce its glycemic impact and improve the nutritional profile of composite flours (Shobana et al., 2009; Adebayo et al., 2013).

Overall, rice flour is a valuable nutritional ingredient, especially when its limitations are addressed through blending and fortification strategies. Its composition supports its application in diverse food formulations, ranging from local main dishes like *tuwo shinkafa* and *masa* to modern snacks and baked products.

2.4 Health and Nutritional Benefits of Including Rice Flour in the Human Diet

The inclusion of rice flour in the human diet offers multiple nutritional and health benefits, making it a valuable alternative to wheat and other cereal-based flours. These benefits extend to both healthy individuals and those with special dietary needs. As food science continues to explore alternatives to conventional grains, rice flour has emerged as a functional and health-supportive ingredient in a variety of dishes and processed foods.

2.4.1. High Digestibility

Rice flour is easily digestible due to its relatively simple starch structure and low fiber content. This makes it suitable for people with weak digestive systems, including infants, the elderly, and patients recovering from gastrointestinal disorders. The low level of dietary fiber ensures it does not overly stimulate peristalsis, allowing for smooth digestion and efficient nutrient absorption (Juliano, 1993; FAO, 2004).

2.4.2. Gluten-Free Properties

One of the most significant nutritional advantages of rice flour is its natural absence of gluten—a protein found in wheat, barley, and rye. This makes it ideal for people with celiac disease or non-celiac gluten sensitivity, conditions that affect millions worldwide. The increasing global demand for gluten-free food products has led to rice flour becoming a staple in the formulation of alternative baked goods, snacks, and weaning foods (Shobana et al., 2009; Adegunwa et al., 2014).

2.4.3. Low Allergenicity

Rice is among the least allergenic grains, with very low incidence of hypersensitivity reactions, even among individuals with multiple food allergies. This makes rice flour a safe base ingredient for hypoallergenic diets and therapeutic food products for children with food intolerance (Onwuka et al., 2011). Its neutral flavor and smooth texture further enhance its compatibility in food formulations for individuals with dietary restrictions.

2.4.4. High Energy Content

With carbohydrate content ranging from 75–80%, rice flour is a high-energy food source. This is particularly beneficial in regions where energy malnutrition is common. It can be used in school feeding programs, emergency relief food, and supplementary diets for undernourished children and adults (FAO, 2021; Olayiwola et al., 2011). In the context of sports nutrition, rice flour can also serve as a quick energy source before or after intense physical activity.

2.4.5. Nutritional Fortification and Blending Potential

While rice flour is limited in protein and some essential amino acids, it can be fortified or blended with legumes and oilseeds like soybeans, groundnuts, or cowpeas to enhance its protein quality and micronutrient density. Such composite flours have shown improved nutritional profiles, with increased levels of lysine, iron, calcium, and zinc, which are often lacking in conventional cereal-based diets (Adebayo et al., 2013; Shobana et al., 2009). This makes rice-based composite flour an affordable and culturally accepted approach to addressing malnutrition.

2.4.6. Suitability for Special Diets and Infant Feeding

Due to its mild flavor, low fat content, and hypoallergenic nature, rice flour is commonly used in infant cereals and medical diets. Studies show that rice flour porridge and rice-based weaning mixes are effective in introducing solid foods to babies while minimizing the risk of food intolerance (Olapade & Aworh, 2012). When combined with milk or plant-based proteins, these preparations meet essential dietary needs during early childhood development.

2.4.7. Support for Blood Sugar Management (When Combined)

Though rice flour alone has a high glycemic index (GI), research indicates that when it is blended with fiber-rich or protein-rich foods, the GI can be significantly lowered, supporting better blood glucose control. This has implications for developing balanced meals for diabetic patients and others managing metabolic disorders (Shobana et al., 2009).

2.4.8. Functional Food Applications

Beyond nutrition, rice flour contains bioactive compounds such as gamma-oryzanol and phenolic acids (especially in brown rice flour), which possess antioxidant and cholesterol-lowering properties. These compounds have been linked to reduced risk of chronic diseases such as cardiovascular disease and certain cancers (Mohapatra et al., 2010).

2.5 Factors Influencing Consumer Acceptability of Rice Flour as a Substitute in Food Products

Consumer acceptability plays a central role in the successful introduction and sustainability of any food product, especially when such a product is intended to substitute an already established staple like wheat flour. The acceptability of rice flour-based food products is influenced by several interrelated factors, including **sensory quality**, **cultural familiarity**, **nutritional enrichment**, **product presentation**, and **economic considerations**.

2.5.1 Sensory Properties

One of the most significant factors influencing consumer choice is the sensory quality of food products. These include taste, texture, aroma, and visual appeal. Rice flour, in its natural form, has a mild taste and a pale white to slightly brownish color, depending on the degree of polishing. Products made from well-milled rice flour tend to have soft textures, which are desirable in many snacks and baked goods. However, poorly milled rice flour can result in a gritty or coarse texture, negatively impacting the mouthfeel and overall acceptability (Adegunwa et al., 2014).

Research by **Olapade and Aworh (2012)** on biscuit production from wheat–rice flour blends showed that inclusion of rice flour up to a certain percentage (typically 20–40%) can maintain acceptable sensory attributes without significant compromise in texture or flavor. Similarly, **Onwuka et al. (2011)** confirmed that rice flour-based snacks were rated high in taste and aroma when processed under good hygienic and milling conditions.

2.5.2 Cultural Familiarity and Traditional Use

In many Nigerian communities, especially in the northern region, rice flour has long been used in the preparation of traditional dishes like *masa*, *tuwo shinkafa*, and *waina*. This pre-existing cultural familiarity greatly enhances consumer willingness to try rice flour in other food formats, such as snacks, noodles, or baked products. In such settings, the transition from traditional to modern applications of rice flour is more seamless (Okaka & Isieh, 1990).

2.5.3 Fortification and Flavor Enhancement

Rice flour is relatively low in protein and micronutrients compared to whole wheat flour. Therefore, food technologists often fortify it with protein-rich ingredients such as soybean flour, groundnut flour, or milk powder to improve its nutritional profile and functional characteristics. Additionally, the addition of spices, sweeteners, and flavor enhancers significantly improves taste and aroma, which are strong determinants of consumer acceptance (Adebayo et al., 2013).

Studies by **Ayo and Gaffa (2002)** demonstrated that fortifying rice flour with soy flour not only increased the protein content but also enhanced the flavor and texture of *masa*. Consumer panels consistently rated fortified products higher in acceptability than unfortified ones.

2.5.4 Packaging and Product Presentation

Attractive packaging and professional presentation have a substantial impact on consumer trust and perceived quality. In low-income or rural markets, rice flour is often sold in unbranded, loose packaging, which can negatively affect consumer perception. In contrast, neatly packaged rice flour with clear labeling, nutritional information, and usage instructions tends to gain more market appeal, especially among urban consumers (FAO, 2021).

Well-packaged rice flour products also stand out in retail settings, improving visibility and consumer confidence, especially when hygiene and food safety are clearly communicated through branding.

2.5.5 Price and Economic Considerations

Affordability is a practical factor influencing food choice in many households. The relative price of rice flour compared to conventional wheat or maize flour can affect its competitiveness in the market. When locally sourced rice flour is produced at low cost and sold competitively, it becomes a viable substitute for imported wheat flour, particularly in baking and snack production (FMARD, 2017).

Subsidies, local sourcing, and community-based processing initiatives can also reduce the cost of rice flour, making it more accessible to consumers and encouraging greater adoption in food enterprises.

2.5.6 Communication and Education

Awareness campaigns, cooking demonstrations, and food sampling are effective tools for educating consumers about the benefits and uses of rice flour. Studies show that when consumers are informed about the health benefits of rice flour—such as its gluten-free nature and digestibility—they are more likely to accept it as a regular ingredient in their meals (Shobana et al., 2009).

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter discusses the methodology employed in the study *"Processing of Rice into Ground Rice Flour for Production of Main Dish and Snacks."* It outlines the research design, study area, target population, sample size, sampling techniques, research instruments, data collection methods, and the techniques used for data analysis. The purpose of this methodology is to provide a systematic approach that ensures the reliability, validity, and accuracy of the findings.

3.1 Research Design

Research design is the overall plan, structure, and strategy of investigation conceived to obtain answers to research questions and control variance. It specifies the methods and procedures for collecting and analyzing the required information in a study. According to Kothari (2004), research design is "the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure.

The research adopted a **descriptive survey design** supported with an experimental approach. The descriptive aspect enabled the researcher to collect information from respondents concerning rice processing and its utilization for main dishes and snacks, while the experimental aspect involved practical processing of rice into ground flour to test its suitability in different food products. This design was considered appropriate because it provides both qualitative and quantitative data relevant to the study objectives.

3.2 Study Area

Study Area refers to the specific geographical location or environment where a research investigation is carried out, and it provides the context within which the study problem is examined. It is usually chosen based on the relevance of the area to the objectives of the research, accessibility of data, and availability of the target population. According to Kothari

(2004), the study area helps to delineate the scope of research by specifying "the physical, social, and economic environment in which data is collected and findings are interpreted.

The study was conducted within **Kwara State, Nigeria**, where rice cultivation and processing activities are predominant. The area was chosen because of its accessibility to rice farmers, millers, food processors, and consumers. The availability of rice processing centers and markets for rice-based food products makes the study area suitable for this research.

3.3 Target Population

Target Population is the entire group of people or elements that a researcher intends to study and generalize findings from. It represents those who possess the characteristics relevant to the research. For example, in this study, the target population includes rice farmers, processors, vendors, and consumers (Nworgu, 2015).

The target population for this study included:

- Rice farmers involved in rice cultivation.
- Local millers and processors engaged in converting rice into flour.
- Food vendors and households that prepare rice-based snacks and main dishes.
- Consumers of rice flour products within the study area.

This population was chosen to provide a comprehensive view of the production, processing, and consumption of rice flour.

3.4 Sampling Techniques

According to Kothari (2004), sampling techniques refer to "the procedure a researcher adopts in selecting items for the sample from the population." In other words, it determines how the sample will be chosen so that it accurately represents the population under study

A purposive and stratified random sampling technique was employed. Purposive sampling was used to identify respondents directly involved in rice production, processing, or consumption. Stratified random sampling was then applied to ensure fair representation across the four groups (farmers, millers, vendors, and consumers).

3.5 Sample Size

According to Sekaran & Bougie (2016), sample size is defined as "the number of elements to be included in the study, which should be large enough to allow for statistical analysis and generalization to the population.

A total of 50 respondents were selected for the study. This comprised 25 rice farmers, and 25 millers/processors. The size was considered adequate for obtaining diverse opinions while keeping the study manageable in terms of time and resources.

3.6 Research Instruments

According to Orodho (2003)**,** research instruments are "the means by which information is collected in order to achieve the objectives of the study.

3.7 Data Collection Techniques

According to Kothari (2004)**,** data collection techniques are "the means employed to gather the required data for a research study, which may be primary or secondary in nature."

In this study sensory evaluation will be used.

Sensory evaluation (taste panel): Respondents will participate in products testing and evaluate rice flour based food based on taste, texture, aroma, and overall acceptability

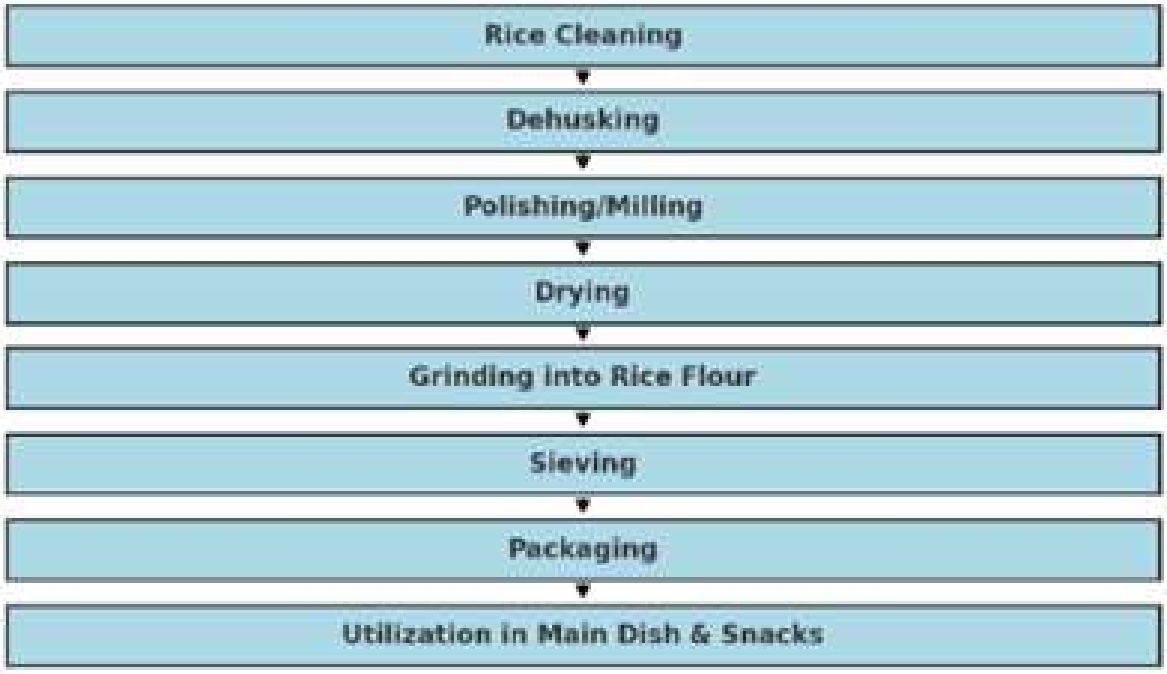
3.8 Data Analysis

According to **Creswell (2014)**, data analysis involves "organizing the data, conducting a preliminary read-through, coding, generating themes, and interpreting the meaning of the information in relation to the research problem.

The collected data were analyzed using both **quantitative and qualitative methods**. Quantitative data from questionnaires were coded and analyzed using descriptive statistics such as frequency tables, percentages, and mean scores. Qualitative data from interviews were thematically analyzed to capture key insights. Results from the experimental processing were analyzed based on sensory evaluation (taste, texture, color, aroma, and overall acceptability).

Methodology

Flow Chart Of Processing Rice Into Ground Rice Flour



Cleaning

Raw rice was cleaned to remove stones, dust, chaff, and other foreign particles using winnowing and sieving methods. This ensured that only wholesome grains were used.

Dehusking

The cleaned rice grains were dehusked using a dehusking machine to separate the husk from the edible kernel.

Milling/Polishing

The dehusked grains were polished/milled to remove the bran layer and to obtain smooth, edible rice grains suitable for flour production.

Drying

The milled rice grains were dried to a safe moisture content level of about 10–12%. Drying was carried out either by sun-drying or with a mechanical dryer to prevent spoilage and ensure easy grinding.

Grinding into Flour

The dried rice grains were ground into fine flour using a hammer mill/pulverizer.

Sieving

The ground flour was sieved using a fine mesh sieve to obtain uniform particle size suitable for food preparation.

Packaging

The sieved flour was packaged in clean, airtight polyethylene bags to maintain quality and extend shelf life.

Utilization in Main Dish and Snacks

The rice flour was then tested in the preparation of different dishes such as *tuwo (rice swallow)* and snacks like cakes, pancakes, and biscuits to evaluate its quality, taste, texture, and consumer acceptability.

Materials

The materials and equipment used for the partical:

- **Material**
    - Rice flour
    - Vegetable oil
    - Palm oil
    - Seasoning

- Salt
- Margarine
- Baking powder
- Active yeast
- Egg
- Milk
- Minced Beef
- Pepper
- Carrot
- Irish potatoes

- **Equipment:**
  - Cleaning tools (winnower, sieves, trays).
  - Dehusking machine.
  - Milling/polishing machine.
  - Drying equipment (mechanical dryer or sun-drying facilities).
  - Grinding machine (hammer mill or pulverizer).
  - Fine mesh sieve.
  - Packaging materials (polyethylene bags, labels, sealing machine).
  - Equipment
  - Knife and spatula
  - Trays
  - Sieve
  - Measuring cups and spoons
  - Mixing bowls
  - Frying pan

Recipe and Method of the selected items

Sample A

Doughnut Made From Rice Flour

Recipe	Quantity
Rice flour	2 cups
All-purpose flour (optional, improves texture; skip for gluten-free)	½ cup
Baking powder	2 teaspoons
Sugar	⅓ cup
Salt	¼ teaspoon
Butter or margarine (melted)	2 tablespoons
Egg	1 large
Milk (or water)	¾ cup (adjust to get soft dough)
Nutmeg (optional, for flavor)	½ teaspoon
Oil	for deep frying

Methods

1. In a bowl, combine rice flour, all-purpose flour (if using), baking powder, sugar, salt, and nutmeg. Mix well.
2. Add melted butter and egg.
3. Gradually pour in milk (or water), mixing until a soft, slightly sticky dough forms.
4. Lightly flour a surface and knead gently for about **5 minutes** until smooth.
5. Cover the dough and let it rest for **20–30 minutes** (this helps soften the rice flour texture).
6. Roll out the dough to about **½ inch thickness**.
7. Cut with a doughnut cutter (or use a round cutter and a bottle cap for the hole).
8. Heat oil in a deep pan until moderately hot (about 170–180°C).

9. Fry the doughnuts in batches until golden brown on both sides (about **2–3 minutes per side**).
10. Remove and drain on paper towels.
11. Serve plain, dust with powdered sugar, or glaze with melted chocolate/sugar glaze.

SAMPLE B

Rice Flour Swallow

Recipe	Quantity
Rice flour	2 cups
Water	3 cups

Methods

1. Boil water in a pot.
2. Reduce heat, gradually add rice flour while stirring continuously to avoid lumps.
3. Keep stirring until it thickens and forms a smooth, stretchy swallow (like amala or semovita).
4. Sprinkle a little water on top, cover, and allow to steam for 3–5 minutes.
5. Stir again and wrap in nylon/food wrap until ready to serve.

Gbegiri Soup

Recipe	Quantity
Peeled beans (brown or white)	1 cup
Palm oil	2 tablespoons
Ground crayfish	1 tablespoon
Ground pepper (ata rodo or dry pepper)	1 teaspoon (to taste)
Seasoning cube	1
Salt	to taste

Methods

1. Cook peeled beans until very soft.
2. Mash or blend into a smooth paste.
3. Return to pot, add palm oil, crayfish, pepper, seasoning cube, and salt.
4. Stir well and simmer on low heat for 5–7 minutes until well combined.

Ewedu Soup

Recipe	Quantity
Fresh ewedu leaves	**2 cups (washed, finely chopped or blended)**
Potash (kaun/akanwu, optional for drawing)	**a pinch (dissolved in water)**
Water	**1 cup**
Seasoning cube	**½**
Salt	**to taste**

Methods

1. Boil water in a small pot, add potash water if using.
2. Add chopped/blended ewedu leaves.
3. Stir and cook until it becomes slimy and soft (about **5 minutes**).
4. Add seasoning cube and a little salt, stir, and set aside.

SAMPLE C

Meat pie made from rice flour

Recipe	Quantity
Rice flour	3 cups
All-purpose flour (optional, helps binding; skip	½ cup

for gluten-free)	
Baking powder –	1 teaspoon
Salt	½ teaspoon
Butter or margarine (cold, cubed)	150 g
Egg (for mixing)	1 large
Cold water	as needed to bring dough together
Minced beef or chicken	300 g
Onion (finely chopped)	1 medium
Garlic (minced)	1 clove
Carrot (diced)	1 medium
Potato (diced)	1 medium
Vegetable oil	2 tablespoons
Seasoning cube	1 piece (or to taste)
Curry powder	½ teaspoon
Thyme	½ teaspoon
Salt and pepper	to taste
Flour or cornstarch (for thickening)	1 tablespoon
Water or stock	½ cup

Methods

- Heat oil in a pan, add onion and garlic, and fry until soft.
- Add minced meat, stir, and cook until browned.
- Mix in diced carrots and potatoes, seasoning cube, curry, thyme, salt, and pepper.
- Add water/stock and cook until vegetables are tender.
- Stir in 1 tbsp flour or cornstarch to thicken the mixture.
- Allow filling to cool completely.
- In a bowl, mix rice flour, all-purpose flour (if using), salt, and baking powder.
- Rub in cold butter with fingertips until mixture looks like breadcrumbs.
- Add egg and mix.
- Gradually add cold water, a little at a time, until a smooth, firm dough forms (not sticky).

- Wrap in cling film and let it rest for 20–30 minutes.
- Preheat oven to 180°C (350°F).
- Roll out dough on a lightly floured surface (not too thin).
- Cut into circles using a round cutter or small plate.
- Place a spoonful of filling in the center of each circle.
- Fold over to form a half-moon shape, press edges with a fork to seal.
- Arrange on a greased baking tray.
- Brush tops with beaten egg for a golden finish.
- Bake for **25–30 minutes** until golden brown.
- Allow to cool slightly before serving

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents the results of the sensory evaluation carried out on the production of doughnut using instant rice flour. The sensory attributes considered include **appearance, colour, flavour, texture, and overall acceptability**. The panelists rated the product based on four scales: Excellent, Very Good, Good, and Fair. The results are summarized in the table below.

4.2 Section A: Demographic Characteristics of Respondents

The demographic details of respondents are presented below. Each variable is shown in tabular form with its corresponding frequency and percentage**.**

Table 4.2.1: Distribution of Respondents by Gender

Gender	Frequency	Percentage (%)
Female	**32**	**64.0**
Male	**18**	**36.0**
Total	**50**	**100.0**

Source: Data Analyzed from Researcher Field Survey 2025:

. Out of the 50 respondents, 32 (64.0%) were females while 18 (36.0%) were males. This indicates that the sensory panel was dominated by female respondents, showing higher female participation in the assessment.

Table 4.2.2: Distribution of Respondents by Age

Age (Years)	Frequency	Percentage (%)

16 – 25	8	16.0
26 – 45	32	64.0
45 and above	10	20.0
Total	50	100.0

Source: Data Analyzed from Researcher Field Survey 2025:

The majority of respondents (32, representing 64.0%) were between the ages of 26–45 years. 10 respondents (20.0%) were above 45 years, while only 8 respondents (16.0%) fell within the younger age group of 16–25 years. This shows that most of the respondents were adults within the active and productive age bracket.

Table 4.2.3: Distribution of Respondents by Educational Background

Educational Qualification	Frequency	Percentage (%)
GCE/WAEC	6	12.0
ND/NCE	23	46.0
HND/B.Sc	20	40.0
Ph.D	1	2.0
Total	50	100.0

Source: Data Analyzed from Researcher Field Survey 2025:

Most respondents were educated, with the majority holding ND/NCE (23, 46.0%) and HND/B.Sc (20, 40.0%). Only 6 (12.0%) had GCE/WAEC, while 1 (2.0%) possessed a Ph.D. This implies that the respondents were well-educated, which enhanced their ability to effectively participate in the sensory evaluation.

Table 4.2.4: Distribution of Respondents by Marital Status

Marital Status	Frequency	Percentage (%)
Single	16	32.0
Married	31	62.0
Others	3	6.0

Total	50	100.0

Explanation:

The majority of respondents (31, representing 62.0%) were married, while 16 (32.0%) were single. A small proportion (3, 6.0%) fell under the category of "others." This shows that most respondents were married individuals, which might reflect their interest in food-related assessments due to family responsibilities**.**

4.3 SECTION B: SENSORY EVALUATION

Table 4.3.1: SAMPLE A

Sensory Assessment of Doughnut Produced with Instant Rice Flour

Sensory Attribute	Excellent	Very Good	Good	Fair
Appearance	32	17	1	–
Colour	26	16	8	–
Flavour	24	22	4	–
Texture	23	21	6	–
Overall Acceptability	25	17	7	1

Discussion of Results

- **Appearance:** The majority of the panelists (32) rated the appearance of the doughnut as Excellent, while only 1 panelist rated it as Good. This implies that instant rice flour produced doughnuts with an appealing physical outlook.
- **Colour:** 26 panelists considered the colour as Excellent, 16 rated it as Very Good, and 8 rated it as Good. This shows that the colour quality was generally acceptable, though a few panelists observed moderate variation.

- **Flavour:** The doughnut scored high on flavour, with 24 panelists rating it as Excellent and 22 as Very Good. This indicates that the use of rice flour did not negatively affect taste.
- **Texture:** 23 panelists rated the texture as Excellent, 21 as Very Good, and only 6 as Good. This suggests that the texture was satisfactory and close to that of conventional wheat-based doughnuts.
- **Overall Acceptability:** A total of 25 panelists rated the product as Excellent, 17 as Very Good, 7 as Good, and 1 as Fair. This demonstrates that doughnut produced from instant rice flour is generally well-accepted by consumers.

Table 4.3.2: SAMPLE B

Sensory Assessment of Main Dish (Swallow with Gbegiri and Ewedu Soup with Beef) Produced with Instant Rice Flour

Sensory Attribute	Excellent	Very Good	Good	Fair
Appearance	17	30	3	–
Colour	19	27	4	–
Flavour	17	25	8	–
Texture	18	24	8	–
Overall Acceptability	23	19	8	–

Discussion of Results

- **Appearance:** For the main dish, 17 panelists rated the appearance as Excellent while 30 rated it Very Good. This shows that the swallow made from rice flour was visually appealing and acceptable.
- **Colour:** The majority (19 Excellent and 27 Very Good) agreed that the colour was attractive and close to conventional products, though 4 still rated it as Good.

- **Flavour:** A total of 17 panelists rated the flavour Excellent while 25 considered it Very Good. However, 8 rated it as Good, indicating that though generally accepted, some improvement could be made in taste perception.
- **Texture:** 18 rated texture as Excellent, 24 as Very Good, and 8 as Good. This suggests that the instant rice flour swallow maintained a fairly smooth and satisfactory consistency.
- **Overall Acceptability:** 23 panelists rated the swallow as Excellent, 19 as Very Good, and 8 as Good. This implies that the swallow made from instant rice flour is widely acceptable and comparable to traditional alternatives.

Table 4.3.3:

Sensory Assessment of Meat Pie Produced with Instant Rice Flour

Sensory Attribute	Excellent	Very Good	Good	Fair
Appearance	32	15	3	–
Colour	22	27	7	–
Flavour	20	23	7	–
Texture	15	29	6	–
Overall Acceptability	22	23	5	–

Discussion of Results

- **Appearance:** 32 panelists rated the appearance of the meat pie as Excellent, 15 as Very Good, and 3 as Good. This indicates that instant rice flour gave the meat pie an attractive look similar to conventional meat pies.
- **Colour:** The colour received the highest number of Very Good ratings (27), while 22 rated it Excellent and 7 rated it Good. This suggests that while the colour was generally acceptable, some panelists noticed slight differences compared to traditional wheat-based pies.

- **Flavour:** 20 panelists rated flavour as Excellent, 23 as Very Good, and 7 as Good. This means the flavour was generally well accepted, although a few found it slightly different.
- **Texture:** With 15 Excellent, 29 Very Good, and 6 Good ratings, the texture of the rice flour meat pie was considered pleasant and close to expected standards, though fewer people rated it as Excellent compared to other attributes.
- **Overall Acceptability:** 22 rated overall acceptability as Excellent, 23 as Very Good, and 5 as Good. This shows that the rice flour-based meat pie was widely accepted, with a strong balance between Excellent and Very Good ratings.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This study focused on the **processing of rice into ground rice flour for the production of main dishes and snacks**. Rice was milled into flour and used in preparing selected food products such as doughnut and meat pie. Sensory evaluation was conducted to determine consumer acceptance in terms of **appearance, colour, flavour, texture, and overall acceptability**.

The results showed that doughnut and meat pie produced from instant rice flour were generally rated between *Excellent* and *Very Good* by the panelists across all attributes. For doughnut, the highest ratings were recorded in appearance and flavour, while for meat pie, higher ratings were observed in colour and texture. This implies that rice flour has strong potential as a substitute for wheat flour in the preparation of baked and fried snacks.

5.2 Conclusion

Based on the findings, it can be concluded that:

I. **Rice can be successfully processed into flour** and utilized in the preparation of various dishes and snacks.
II. **Rice flour-based products are acceptable** to consumers, as indicated by high scores in sensory evaluation.
III. Substituting wheat flour with rice flour can help reduce dependence on imported wheat and promote the utilization of locally grown rice.
IV. Rice flour maintains desirable sensory qualities in terms of appearance, flavour, colour, texture, and overall acceptability, making it a viable raw material in food processing industries.

5.3 Recommendation

I. **Encouragement of Local Processing:** Rice processing industries and small-scale entrepreneurs should be encouraged to invest in the production of ground rice flour as it provides a cheaper and readily available alternative to wheat flour.

II. **Government Support:** Government and relevant agricultural agencies should support local processors with modern milling machines, drying equipment, and packaging facilities to improve the quality and shelf-life of rice flour.

III. **Awareness Creation:** Public awareness campaigns should be carried out to educate households, caterers, and food vendors on the nutritional and economic benefits of using rice flour in the preparation of common main dishes and snacks.

IV. **Further Research and Development:** Food technologists and researchers should explore more innovative uses of rice flour, including fortification with legumes or other grains to enhance its protein content and nutritional value.

V. **Training and Capacity Building:** Training programs should be organized for farmers, processors, and food handlers on best practices in rice processing, storage, and hygienic preparation of rice flour-based foods.

VI. **Policy and Market Linkages:** Policy makers should create favorable conditions such as access to credit, subsidies, and market linkages to encourage large-scale production and commercialization of rice flour.

VII. **Promotion of Value Addition:** Since rice is widely cultivated in Nigeria, promoting value addition through rice flour processing will reduce post-harvest losses, enhance food security, and increase the income of farmers and processors.

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