PROXIMATE ANALYSIS OF RICE (*Oryza sativa*)

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CERTIFICATION

This is to certify that this project work titled "**PROXIMATE ANALYSIS OF RICE (*Oryza sativa*)"** Was carried out by Faith Obehi EHIZUA with matriculation number LSC2009771, of the Department of Science Laboratory Technology (Biochemistry Techniques), Faculty of Life Sciences, Benin City, Edo State, under the supervision of Dr. A. ORUPKE.

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DEDICATION

With deepest gratitude, I dedicate this work to Almighty God, whose boundless strength, grace, patience, and provision have sustained me throughout this journey. I also lovingly dedicate it to my parents, whose unwavering support, encouragement, and sacrifices have been my constant source of inspiration.

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STUDENT'S THESIS

AUTHOR'S STATEMENT

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ABSTRACT

Rice (*Orysa sativa*) is still one of the most important staple foods in the world, and it is very important for Nigeria's food security, economy, and nutrition. Even though Nigeria has good weather for growing rice, a lot of people still depend on imported rice because they think it is better in terms of quality, taste, and processing standards. This study concentrated on the proximate analysis of both local and imported rice varieties, specifically highlighting Ekpoma local rice. The various nutritional composition: moisture, ash, crude protein, fat, fiber, and carbohydrates were determined using set standard and their quality characteristics were compared. The results showed that the rice samples were very different from each other. Ekpoma local rice had considerable amounts of carbohydrates and protein, which means it could be good for you and safe to eat. The differences seen between local and foreign rice varieties were mostly due to differences in how they were milled, how well they were processed, and the conditions in which they were grown. The study shows that Nigerian local rice varieties, especially Ekpoma rice, are very nutritious and possess all the relevant nutrients for general body function and doesn't pose threat.

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Rice (*Oryza sativa*), a cereal crop belonging to the Gramineae family, a large monocot family, comprising approximately 600 genera and nearly 10,000 species is one of the most essential food sources globally (Ajala *et al*., 2015). It serves as the primary staple for more than half of the world's population. As a vital agricultural commodity, rice plays a crucial role in ensuring global food security. It nourishes over two-thirds of the global population and is not only central to daily diets but also carries significant cultural and economic value in numerous societies (Harbinson *et al*., 2021). From the mountainous rice terraces of Southeast Asia to the expansive paddies in Africa and the Americas, rice farming is widespread. Beyond its nutritional contribution, rice is deeply embedded in the cultural heritage, social systems, and livelihoods of communities across the globe. In Nigeria, rice consumption has experienced a sharp increase, growing at an estimated rate of 10% annually, largely due to shifts in consumer preferences (Oluwaseun *et al*., 2024)

Proximate analysis refers to a standard method used in food and feed studies to determine the basic nutritional composition of a sample. It typically involves measuring key components such as moisture content, crude protein, crude fat (also known as ether extract), ash (mineral content), and crude fiber. After these values are obtained, the remaining portion, known as nitrogen-free extract (NFE), is calculated. This NFE is considered to represent the carbohydrate fraction. The term “crude” is often used before protein, fat, and fiber to indicate that these values are general estimates, not refined measurements of specific compounds (Hart *et al*., 1971).

Rice serves as a primary energy source for a large portion of the global population, especially in developing countries where it is consumed in large quantities daily. The nutritional quality of rice is closely linked to its proximate composition, which includes moisture, ash, crude protein, fat, fiber, and carbohydrate. These components are vital indicators of the food’s capacity to support human health and development (Hayashi, 2004).

Carbohydrates are the most abundant macronutrient in rice, comprising approximately 75–80% of the grain, predominantly in the form of starch (Oko *et al*., 2011). This high carbohydrate content makes rice an excellent source of energy, especially for populations with high calorie demands due to physical activity or limited food variety. The reliance on rice to meet increased caloric needs further emphasizes its role in energy provision. However, overdependence on highly milled rice, which often lacks essential vitamins such as vitamin B1 (thiamine), can contribute to nutritional deficiencies such as beriberi, a disease resulting from thiamine deficiency. This highlights the importance of retaining the nutrient-rich outer layers of the rice grain during processing (Abbas *et al*., 2011).

Protein, another essential proximate component, accounts for about 7% of the rice grain. Despite its relatively low quantity, rice protein is of high quality. It exhibits a remarkable digestibility rate of 93%, a biological value of 74%, and a protein efficiency ratio ranging between 2.02% and 2.04% (Eggum, 1973). These values indicate rice protein’s capacity to be effectively utilized by the human body for growth and repair. Furthermore, rice contains a complete set of amino acids, including a relatively high concentration of lysine about 4% which is particularly important since lysine is often limited in many other cereal grains (Bressani *et al*., 1971; Juliano, 1993).

The ash content of rice, though present in small quantities, provides an estimate of its mineral content. Minerals such as calcium (Ca), iron (Fe), zinc (Zn), copper (Cu), potassium (K), chromium (Cr), manganese (Mn), and sodium (Na) are essential micronutrients required in trace amounts. These elements contribute significantly to biological functions including nerve signaling, sugar metabolism, enzymatic activities, and maintaining cardiac function. However, while these minerals are essential, their concentrations must be regulated, as excessive intake can be harmful to health (Milena *et al*., 1993).

Moisture content in rice, typically around 12%, influences the grain's shelf life and microbial stability. High moisture can encourage spoilage and microbial growth, whereas lower moisture supports better preservation during storage. Additionally, crude fiber content aids in digestive health, although it is present in limited quantities in polished rice (Verma *et al*., 2017).

Overall, the nutritional value of rice is closely tied to the levels and balance of its proximate components. Understanding and preserving these nutrients, especially during processing, is essential in ensuring rice contributes effectively to nutritional health and prevents diet-related deficiencies in populations that depend heavily on it.

Ekpoma, located in Edo State, Nigeria, is positioned within the humid tropical zone and benefits from a climate characterized by a long wet season and moderate dry season. The wet season, which spans from March to November, brings abundant rainfall accompanied by thunderstorms and surface runoff (Alens, 2017). These prolonged periods of rainfall create favorable conditions for rice farming, as rice requires a substantial and consistent water supply during its growing cycle.

The town lies on the Esan Plateau, featuring an undulating topography that aids in natural water drainage. Although the subsurface aquifers are relatively poor due to the geological presence of sedimentary rocks and limited catchment basins, surface water remains accessible (Odemerho, 1988). Two rivers, Ogedekpe and Ibiekuma, drain the region, with River Ibiekuma notably dammed at the Ambrose Alli University campus to support irrigation and domestic water supply (Alens, 2017). This dammed water source proves especially useful for sustaining rice cultivation during short dry spells within the growing season.

Furthermore, Ekpoma's tropical climate ensures high humidity and adequate temperatures throughout most of the year, which are ideal for the growth of rice crops (Iloeje, 1982). Despite challenges related to underground water retention, the presence of these rivers and the region's long rainfall season make Ekpoma naturally suited for seasonal rice farming, especially with appropriate water conservation and land management practices.

1.2 HYPOTHESIS

H_0: There is no significant difference in the proximate composition of local, foreign, and Ekpoma rice samples.

H_1: There is a significant difference in the proximate composition of local, foreign, and Ekpoma rice samples.

1.3 SCOPE OF THE STUDY

This study focuses on the proximate analysis of selected rice samples obtained from three sources: local Nigerian rice (excluding Ekpoma), imported (foreign) rice, and rice cultivated in Ekpoma, Edo State. The analysis will be limited to six proximate parameters: moisture content, ash, crude protein, crude fat, crude fiber, and carbohydrates. The study does not cover mineral content analysis or sensory evaluation. All laboratory analyses will be carried out under standardized conditions.

1.4 AIM AND OBJECTIVE OF STUDY.

Aim:

Proximate analysis of rice (*Oryza sativa*)

Objective:

The objective is to assess the nutritional value of each sample and evaluate the suitability of Ekpoma rice as a healthy alternative. This will help promote informed dietary choices and support local rice production.

1.5 STATEMENT OF THE PROBLEM

In Nigeria, rice is one of the most widely consumed staple foods, yet there is growing concern about the nutritional quality of both locally produced and imported varieties. While foreign rice is often perceived to be of higher quality, its heavy consumption may not be nutritionally superior to local alternatives. Moreover, there is limited scientific data on the nutritional composition of rice cultivated in Ekpoma, a region that has shown potential for rice farming. This lack of comparative information has led to consumer uncertainty, possible dietary deficiencies, and a general undervaluation of local rice. Therefore, it becomes essential to assess and compare the proximate composition of local, foreign, and Ekpoma rice to evaluate their nutritional adequacy.

1.6 JUSTIFICATION OF THE STUDY

Given the rising demand for rice in Nigeria and the growing health consciousness among consumers, this study is justified as it provides empirical data on the nutritional quality of different rice types. By evaluating and comparing the proximate compositions of local, foreign, and Ekpoma rice, the study can help promote evidence-based dietary choices and support the development of local rice farming industries. Additionally, the findings could inform policy decisions aimed at improving food security and nutritional standards in Nigeria.

1.7 LIMITATIONS OF THE STUDY

This study is limited by the availability of rice samples, as only a few selected brands and batches will be analyzed, which may not fully represent all varieties in the market. Another limitation is the scope of laboratory analysis, which will be confined to basic proximate parameters due to time and resource constraints. Furthermore, environmental factors such as soil type, climate variations, and post-harvest processing methods, which could influence nutrient content, are not considered in detail.

CHAPTER TWO

LITERATURE REVIEW

Rice (*Oryza sativa*) is not only a global staple but also a critical source of energy and nutrition for more than half of the world's population (Sharif *et al*., 2014). Its role in ensuring food security, especially in developing countries like Nigeria, cannot be overstated. In addition to being a significant source of calories, rice also contains vital vitamins (thiamin, niacin, and folic acid) and minerals (such as magnesium, manganese, selenium, iron, and phosphorus). Among the bioactive phytochemicals are flavonoids, anthocyanins, and polyphenols. Compounds like g-oryzanol, tocotrienol, tocopherol, amino acids, and dietary fibers are abundant in rice (Ravichanthiran *et al*., 2018). However, the mere availability of rice is not enough; understanding its nutritional composition is essential for evaluating its dietary value and health implications. According to Fresco (2005), rice is a good source of carbohydrates, moderate amounts of protein and fat. Water, protein, fat, ash, fiber, and carbohydrate content were measured using a standard method to evaluate the proximate composition of grain samples of several aromatic and non-aromatic rice accessions (Deepak *et al*., 2017). With the increasing consumption of both local and foreign rice varieties in Nigeria, it becomes important to assess and compare their nutritional profiles to guide consumer choices and policymaking. Studying the nutritional composition of rice, including less-studied varieties like Ekpoma rice, therefore provides a scientific basis for promoting healthier diets and improving local agricultural practices.

2.1 ORIGIN AND IMPORTANCE OF RICE

Rice (*Oryza sativa*) is one of the oldest cultivated crops known to humanity and holds a vital place in the agricultural history of many civilizations. The domestication of rice (*Oryza sativa*) likely began around 9,000 years ago in parts of Asia, particularly during the Neothermal epoch (10,000–15,000 years ago), when climate changes like droughts and temperature shifts encouraged the evolution of annual plants. This process appears to have occurred independently and simultaneously across a wide area, including eastern India, northern Southeast Asia (Myanmar, Thailand, Laos, Vietnam), and parts of southern China (Whyte, 1972; Chang, 1976).

Archaeological discoveries support these origins. For instance, pottery fragments with impressions of rice husks and grains were found at Non Nok Tha in Thailand and dated to about 4000 B.C. through thermoluminescence and carbon dating (Solheim, 1972). In the Indian subcontinent, the earliest rice remains were found at Mohenjo-Daro (modern-day Pakistan) and date to around 2500 B.C. (Andrus *et al*., 1958), while carbonized rice grains from India have been traced back to 6750 B.C. (Sharma *et al*., 1980). In China, evidence of rice cultivation dates back over 7000 years, including finds from Tongxieng and Hemdu in Zhejiang Province (Chang, 1976).

Meanwhile, a different rice species, *Oryza glaberrima*, was domesticated in West Africa. It originated in the upper Niger River basin around 1500 B.C., with secondary centers developing along the Guinea coast about 500 years later (Portères, 1956). This shows that rice cultivation developed independently in both Asia and Africa, making rice one of the most historically significant staple crops in global agriculture.

Rice has emerged as a vital pillar of food security in Nigeria, where dietary habits have gradually shifted from traditional staples like cassava, maize, and yam toward rice as the dominant choice (GRiSP, 2013). As one of the most important cereals globally, rice has the capacity to supply the recommended national food security benchmark of 2,400 calories per person per day (FAO, 2000). While imported rice is often regarded as being of higher quality, many Nigerian consumers are unable to clearly distinguish between imported and local varieties. Significantly, with the application of modern processing technologies, locally produced rice can attain quality levels comparable to, and in some cases superior to, imported brands, reinforcing its importance in sustaining food security (Ogundele, 2014).

Beyond its role as a staple food, rice holds immense economic importance in Asia, particularly in Southeast Asia, where it is cultivated on millions of hectares of farmland. It serves as a major source of income and livelihood for millions of smallholder farmers and agricultural workers who depend on its production, processing, and trade (Zibaee, 2013). The rice industry also drives rural employment, contributes significantly to national GDPs, and sustains regional export markets (Maitah *et al*., 2020). Thus, rice functions not only as food security but also as a cornerstone of economic stability in these countries.

Culturally, rice is deeply embedded in the traditions, customs, and diets of people across various regions. In Asia, for example, rice is not only a food item but also a symbol of life, fertility, and prosperity (Ahuja *et al*., 2006; Widyaningrum 2022). In Nigeria, rice is widely consumed during festivals, celebrations, and daily meals. It holds a special place in social gatherings and is a central dish in many ethnic cuisines, including jollof rice, fried rice, and local rice dishes such as ofe akwu rice or tuwo shinkafa (Nwokorie *et al*., 2020).

2.2 CLASSIFICATION AND TYPES OF RICE

2.2.1 Botanical Classification of *Oryza sativa*

Oryza sativa is one of the most widely cultivated and consumed cereal crops in the world. It belongs to the Poaceae family (also known as Gramineae), which includes other economically important grasses such as maize, wheat, and barley. The classification of *Oryza sativa* reflects its evolutionary placement among flowering plants that produce grains as seeds. As a monocotyledon, rice is distinguished by its parallel-veined leaves, fibrous roots, and single embryonic leaf (cotyledon) in its seed structure (Khush, 2000).

Botanical Classification

- **Kingdom**: Plantae
- **Phylum (Division)**: Magnoliophyta (Angiosperms)
- **Class**: Liliopsida (Monocotyledons)
- **Order**: Poales
- **Family**: Poaceae (Gramineae)
- **Genus**: *Oryza*
- **Species**: *Oryza sativa* L.

2.2.2 Local and Foreign Rice Varieties

In the Nigerian context, rice can be broadly categorized into local and foreign rice. Local rice refers to rice grown and processed within Nigeria, often by smallholder farmers. According to research, many Nigerians show a stronger preference for imported rice over locally produced varieties. This trend is largely attributed to the limited access of many Nigerian rice processors to modern processing technologies, which hinders their ability to meet international quality standards (Ebuehi *et al*., 2007).

Foreign rice refers to imported varieties, mainly from Thailand, India, and China. These are usually highly polished, well-packaged, and considered superior in appearance. However, polishing removes most of the bran and germ layers, thereby reducing the rice's vitamin B content and dietary fiber (Abbas *et al*., 2018).

2.2.3 Characteristics of Ekpoma Rice

Ekpoma rice refers to varieties cultivated in Ekpoma, Edo State, a region located in the south-central part of Nigeria (Uko *et al*., 2020). Though it may not yet be widely commercialized, rice farming in Ekpoma is growing due to the region's humid tropical climate and long wet season, which are favorable for rice cultivation (Aderibigbe *et al*., 2016). Preliminary reports and anecdotal evidence suggest that Ekpoma rice, like other local varieties, retains more nutritional components such as protein, fiber, and minerals because it is less likely to undergo excessive polishing or bleaching (Olalekan *et al*., 2019). Scientific evaluation through proximate analysis is needed to confirm these assumptions and promote the variety as a viable nutritional alternative.

2.3 NUTRITIONAL COMPOSITION OF RICE

2.3.1 Macronutrients in Rice

The major macronutrients found in rice are carbohydrates, proteins, and fats, each of which plays a vital role in human health and nutrition (Sulistyowati *et al*., 2020).

Carbohydrate

Carbohydrates are the major nutritional component of rice, present mainly as starch, sucrose, and amylose. Different rice varieties show variations in these carbohydrate fractions, with some having higher starch or sucrose, while others contain more amylose. However, polishing significantly reduces these components, leading to a decrease in overall carbohydrate content and nutritional value. Despite this reduction, some varieties still retain relatively higher levels of starch or amylose after polishing. This indicates that both the type of rice and the extent of processing strongly influence its carbohydrate composition and quality (Basu *et al*., 2012)

Protein and Amino Acids

The protein content of rice grain is about 7% and is made up of a complete profile of essential amino acids. Its proteins are considered highly digestible at about 93%, with a biological value of 74%, reflecting good nutritional quality (Eggum, 1969). The protein efficiency ratio, ranging between 2.02% and 2.04%, further demonstrates its effectiveness in supporting growth and maintenance. This quality is largely attributed to the relatively high lysine concentration of about 4%, which enhances its amino acid balance (Bressani *et al.*, 1971; Juliano, 1993).

Fats

Fat content has been shown to influence the taste of cooked rice, as varieties with higher fat levels are often tastier and contain less starch (Verma *et al*., 2017). Reported crude fat content ranges from 0.72% to 1.71%, with the lowest values recorded in the Faya 14M69 variety. Similar results were observed by Oko *et al*. (2010), who reported fat levels between 0.5–3.5%, and by Oko *et al.* (2010), who recorded values from 1.5–3.5%. These variations in fat content among rice varieties are often linked to differences in milling processes. Since most fat is stored in the aleurone layer of the kernel, the degree of milling directly impacts the amount of fat retained (Kalpanadevi *et al*., 2018).

2.3.2 Micronutrients in Rice

Vitamins

Rice serves as an important source of vitamin B1, which supports energy metabolism and quick energy release in the body (Verma *et al*., 2011). In addition, it provides significant amounts of other B-complex vitamins that are essential for proper physiological and metabolic functions. These vitamins contribute to the efficient utilization of nutrients, making rice a valuable dietary staple. Alongside its energy role, the B-vitamins enhance the overall nutritional quality of rice.

Minerals

Rice grains contain essential minerals such as calcium (Ca), magnesium (Mg), and phosphorus (P), which contribute to nutritional balance. In addition to these major minerals, trace elements including iron (Fe), copper (Cu), zinc (Zn), and manganese (Mn) are also present. These micronutrients, though required in small amounts, play vital roles in human metabolism and overall health. Their presence enhances the dietary value of rice, making it not only an energy source but also a contributor to mineral nutrition (Oko *et al*., 2012).

2.4 COMPARATIVE STUDY OF LOCAL AND FOREIGN RICE AGAINST EKPOMA RICE

The African rice (*Oryza glaberrima*) traditionally grown in Nigeria has some disadvantages compared with the Asian rice (*Oryza sativa*). For example, *O. glaberrima* seeds shatter easily, the grains are brittle and difficult to mill, and yields are generally lower. However, it also offers distinct advantages such as tolerance to fluctuating water depths, iron toxicity, infertile soils, and better adaptation to African ecological conditions (Efisue, 2000). By contrast, the Asian rice introduced long ago into Nigeria is gradually displacing African rice due to its superior agronomic and quality attributes. Many Nigerian farmers have adopted *O. sativa* varieties locally, sometimes assigning local names to the same cultivar based on its quality or the person who introduced it. As a result, different local rice varieties may in reality be the same Asian cultivar.

Nigeria's local rice is largely produced under rain-fed lowland systems, which account for an estimated 25% of the country's rice cultivation area and contribute between 43 and 45% of national rice output (Imolehin *et al*., 2000; Singh *et al*., 1997). These lowland ecologies include shallow and deep Fadama areas where soils must be fully submerged at some point during the growth cycle (Moormann *et al*., 1986). While this system supports rice growth, it also poses challenges such as excessive flooding, iron toxicity, and poor water-control infrastructure. In some part of nigeria, such conditions have led farmers to adopt complex cropping systems, building large mounds for yams and groundnuts before flooding fields and transplanting rice (Efisue, 2000). This traditional system maintains soil fertility but exposes farmers to the risk of total crop failure in years of severe flooding, which in turn lowers production, affects the chemical composition and agronomic traits of rice, and reduces the grain's quality and organoleptic properties (Imolehin *et al*., 2000).

Foreign rice varieties, on the other hand, have been bred for higher yields, early maturity, disease resistance, and better milling quality. These attributes give imported or improved *O. sativa* cultivars an edge in the Nigerian market, where they are often perceived as cleaner and of higher quality. Yet, local rice, especially when produced under favourable ecological conditions and processed with modern equipment, can compete with foreign rice in taste, nutritional value, and even price. The production of rice accounts for 38.89% of total cereal output in Nigeria, and in Ebonyi State the production and marketing chain for local rice is already well developed, supplying neighbouring states and creating significant employment (Horna *et al*., 2005).

This comparative view underscores that while imported (foreign) rice dominates Nigeria's supply due to its superior physical and milling characteristics, local rice has inherent advantages such as ecological adaptability, contribution to rural livelihoods, and potential for high quality if supported by improved agronomic practices and better processing technologies.

2.5 PROXIMATE ANALYSIS OF RICE

The proximate composition of food generally covers moisture, ash, lipid, protein, and carbohydrate levels. These components are crucial in the food industry for purposes such as product formulation, quality control, and meeting regulatory standards. Depending on the need, analyses may involve quick methods suitable for routine quality control or more precise, official procedures that require more time to carry out (Thangaraj, 2015).

2.5.1 Moisture Content

Determining moisture content is a critical step in food analysis since it influences the stability of products, their shelf life, and their susceptibility to microbial activity. The most common procedure involves drying the sample at 105 °C until a constant weight is reached, which allows for the removal of free water while reducing the loss of volatile compounds (AOAC, 2016). Moisture percentage is then calculated from the weight difference before and after drying. In order to prevent microbial growth, foods should generally maintain a moisture content below 10% and a water activity level between 0.60 and 0.65, though the exact values depend on the specific food type (Mercer, 2008).

2.5.2 Ash Content

Ash refers to the inorganic residue remaining after either ignition or complete oxidation of organic matter in a food sample. Determining the ash content of a food is part of proximate analysis for nutritional evaluation, and it is an important quality attribute for some food ingredients. Also, ashing is the first step in the preparation of a sample for specific elemental analysis. This laboratory exercise uses the dry ashing technique with a muffle furnace to determine the ash content of a variety of food products (Ismail, 2015).

2.5.3 Crude Protein

The measurement of total crude protein is performed more often than analyzing individual proteins or amino acids. This assessment is typically done by determining the nitrogen content of the sample, which also accounts for small amounts of non-protein nitrogen that are generally overlooked in the final calculation (Aremu *et al*., 2017).

2.5.4 Crude Fat

Crude fat determination is typically conducted using solvent extraction methods, such as Soxhlet extraction, which isolates lipids by dissolving them in an organic solvent like petroleum ether or hexane (AOAC, 2019). The total fat content in foods is usually measured using organic solvent extraction techniques. The effectiveness of these methods largely depends on how well the chosen solvent can dissolve the lipids present. Accuracy is also influenced by the ability of the solvent to release lipids that may be bound to proteins or carbohydrates. If separation is incomplete, results may underestimate actual fat content. Thus, solvent choice and extraction efficiency are critical for reliable lipid analysis (Min *et al*., 1998).

2.5.5 Crude Fiber

Crude fiber is described as the portion of plant cell walls and structural materials that, during chemical analysis of plant foods, remains after the extraction of crude protein, crude fat, and nitrogen-free compounds (Mangold, 1934). Crude fiber represents the indigestible portion of plant-based foods, including cellulose, lignin, and hemicellulose. The analysis involves sequential acid and alkali digestion to remove digestible components, leaving behind the fibrous residue (Mertens, 2002).

2.5.6 Nitrogen-Free Extract (NFE) or Carbohydrate Content

Carbohydrates in foods are generally classified into three groups. The first are the readily available types, such as starches and soluble sugars like sucrose, glucose, and fructose, which can be easily utilized by the body. The second group includes the partly available carbohydrates, mainly hemicelluloses, which yield reducing sugars when hydrolyzed by acids but are not broken down by mammalian digestive enzymes. Examples include pentosans, hexosans, inulin, and fructosans. The third group consists of unavailable carbohydrates, chiefly dietary fiber, made up largely of cellulose (McCance *et al*., 1929).

CHAPTER THREE

METHODOLOGY

3.1 STUDY AREA

The samples were obtained in a market within Benin metropolitan and Ekpoma.

Location

The research was coordinated at Space-Earth Environment Research Laboratory, University of Benin of the National Space Research and Development Agency (NASRDA).

Table 3.1: Shows the names of the rice samples, their locations, assigned codes, and sample IDs used in this study.

Rice Brand	Sample ID	Code	Location
Ma’s Choice	A	A012025	Foreign
Vitalis Life rice	B	B022025	Foreign
Golden Trad. rice	C	C032025	Local
Kiara’s Red Eagle	D	D042025	Local
Ekpoma Rice	E	E052025	Local

Equipment

Oven, Grinder, Desiccator, Micro-Kjeldahl flask and distillation apparatus, Soxhlet extractor, heating mantle, porous extraction thimbles, Muffle furnace and analytical weighing balance.

Apparatus

Crucibles, Cotton wool, Muslin cloth, beaker, conical flask, volumetric flask, burettes and pipettes, distillation tubes.

Reagents

4% Copper Sulphate ($CuSO_4$) solution, Sulphuric Acid (H_2SO_4), Potassium Sulphate (K_2SO_4), 30% Sodium Hydroxide (NaOH) solution, Hydrochloric Acid (HCl), Sodium Hydroxide (NaOH), Methylene red indicator, Petroleum ether, Sulphuric Acid (H_2SO_4) and Petroleum ether.

METHODS

Sample Collection

Sample A (Foreign rice), B (Foreign rice), C (Local rice), D (Local rice) were bought from Eselu market, Egor Local Government Area, Benin city, Edo state, Nigeria. Sample E (Ekpoma rice) was sourced from Ekpoma in Esan West Local Government Area of Edo State through an authorized local supplier.

Sample Preparation

The rice samples were first cleaned to remove husks and impurities, then dried at 60 °C for 24 hours in a hot-air oven to reduce moisture without degrading nutrients. After drying, samples were cooled in a desiccator to prevent moisture reabsorption and then ground into fine powder using a grinder, with residues removed between batches to avoid contamination. The powdered samples were sieved to ensure uniform particle size for accurate analysis and then stored in clean, airtight containers, properly labeled, and kept in a cool, dry environment until proximate analysis.

3.2 PROXIMATE ANALYSIS

The standard methods of AOAC (2006) were employed in the determination of proximate analysis of the following: Moisture content, ash content, crude fibre, crude protein, crude fat and carbohydrate.

3.2.1 Determination of moisture content

The moisture content of food samples was determined using A.O.A.C (2000) method (The gravimetric method).

Principle

The moisture content is determined from the difference in weight after complete evaporation of moisture.

Procedure

One gram of food samples was weighed in crucibles and oven dried at 105^{o}C to a constant weight. The samples were cooled in a dessicator and weighed.

Moisture loss = initial weight– final weight (weight after drying)

$$\% \text{ moisture} = \frac{\text{Loss in weight}}{\text{Weight of sample}} \times 100$$

3.2.2 Determination of crude protein content

Nitrogen was be determined using the micro-Kjeldahl method (A.O.A.C 2000) and crude protein content will be subsequently calculated by multiplying the nitrogen content by a factor of 6.25

Principle

Proteins and other food components are digested with sulphuric acid in the presence of catalysts. Ammonium sulphate is produced from the total organic nitrogen in the food. Alkali is then used to neutralize the acid digest to produce ammonium which is steam distilled directly into a hydrochloric acid containing the indicator methylene red. Hydrochloric acid and ammonium react to produce ammonium chloride which is then titrated with sodium hydroxide. A blank determination is run to determine the nitrogen content of the reagents. The percentage nitrogen is calculated. The percent nitrogen multiplied by the conversion factor for that particular food produces the percent protein in a food.

Procedure

One millilitre of 4% CuSO4, H2SO4 and 0.8g of K2SO4 were placed in the micro kjeldahl flask. Varying quantity of food samples depending on nitrogen content was added to the reagents in micro Kjeldahl flask. It was digested first at low temperature until frosting ceases, then at a high temperature, until the solution was clear, pale yellow or light blue. The flask was left to cool, and 4ml of distilled water was gradually added and content were distilled using a Kjeldahl distillation apparatus. 10 mL of 30% NaOH was used to liberate during distillation ammonium. Ammonium was collected in 0.01 M HCl (a drop of methylene red was added to the HCl.). The distillate was titrated with 0.01M NaOH. Nitrogen content of samples was calculated from the volume of HCl neutralized by NaOH.

Calculations

$$\%\text{nitrogen} = \text{titre value (blank)} - \text{titre value (distillate)} \times \frac{0.14}{\text{Weight of sample}}$$

Protein = % nitrogen x 6.25

$$\%\text{ protein} = \text{protein} \times \frac{100}{\text{Initial weight}}$$

3.2.3 Determination of lipid content

Crude fat was be determined using Soxhlet extraction A.O.A.C (2000)

Principle

The free lipid content consists of neutral fats (triglycerides) and free fatty acid was determined by extracting the dried and ground material with diethyl ether in a continuous extraction apparatus (Soxhlet extractor).

Procedure

The weight of an empty flask was determined. One gram of sample was wrapped and placed in an extraction thimble. The thimble was plugged with cotton wool to avoid loss of sample. The thimble was placed in the extractor. An already weighed, clean and dry soxhlet extractor flask was attached to bottom of the extractor. Petroleum ether (500mls) was poured into dry soxhlet flask and the heating mantle switched on so that the petroleum ether boiled. Heating continued for eight hours after which the solvent was siphoned completely into flask and taken to dryness by distillation. The flask was removed dried to a constant weight. The cooled, weighed and the amount of extracted lipids was calculated from the difference between the weight before and after extraction.

Calculation:

Weight of empty porous thimble = w_o

Weight of thimble +ground sample = w1

Weight of ground sample = w1- w_o

Weight of empty extraction flask = w2

Weight of extraction flask + ether = w3

$$\%lipid = \frac{W3 - W2}{W1 - W_o} \times 100$$

3.2.4 Determination of ash content

Ash content was determined using the method of AOAC (2000).

Principle

The total ash complete is estimated by complete removal of organic material using ignition.

Procedure

One gram of samples was weighed in crucibles and ignited in a furnace at 500-600^oC for 3 hours until it ashes completely. It was then cooled in a desiccator, cooled and weighed immediately at room temperature.

Calculation:

$$\% \text{ Ash} = \frac{W_2 - W_0}{W_1 - W_0} \times 100$$

3.2.5 Determination of dietary fibre

This was determined by enzymatic-gravimetric method as described by A.O.A.C (2000)

Procedure

one gram of samples(w_0) was boiled in 200ml 0f sulphuric acid and boiled ently for thirty minutes the boiled sample were filtered through a muslin cloth which was rinsed with hot distilled water. 200ml 0f sodium hydroxide was added to the residue and allowed to boil for 30min, it was then rinse with hot distilled water. it was also rinsed with hydrochloric acid. it was finally rinsed three times with petroleum ether. it was allowed to drain, dried in the oven, allowed to cool in a dessicator and weighed(w_1). the samples were ashed at 500 ^{oC,} for 90minutes in a muffle furnace coole in a dessicator and weighed(w_2).

calculation:

$$\% \text{ crude fibre} = \frac{w_1 - w_2}{w_0} \times 100$$

3.2.6 Determination of carbohydrate content

Carbohydrate content was determined by obtaining the difference after adding up the % protein content, % fibre content and % lipid then subtracting from one hundred.

% carbohydrate = 100 - % lipid + % protein + % ash + % fibre.

CHAPTER FOUR

RESULT

The proximate composition of the rice samples, analyzed as part of a comparative nutritional assessment, is presented in Table 4.1. This study examines the nutritional profile of the selected rice varieties, with particular attention to key components such as moisture content, crude protein, crude fat, crude fibre, ash, and carbohydrate levels. The findings highlight variations in nutrient composition among the samples, offering valuable insights into their nutritional quality and potential dietary significance.

Table 4.1: Shows the proximate analysis of Selected rice found in the market in Benin City, Edo State.

SAMPLE ID	MOISTURE CONTENT %	ASH CONTEN %	CRUDE FIBRE %	CRUDE FAT %	CRUDE PROTEIN %	CARBOHYDRATE %
A	15.45	0.3	0.65	0.2	10.18	73.22
B	14.45	0.3	0.5	0.19	14.65	69.91
C	19.6	0.5	0.45	0.21	7.91	71.34
D	13.85	0.3	0.45	0.18	10.81	74.34
E	16.75	0.3	0.6	0.19	8.45	73.71

Where sample A, B, C, D, E are respectively, foreign rice, foreign rice, local rice, local rice and Ekpoma rice (Local rice)

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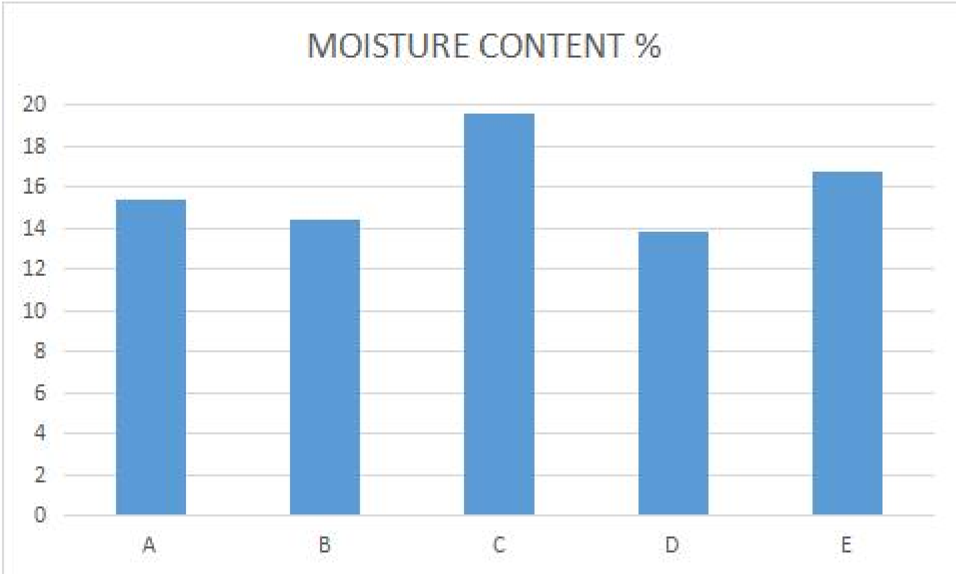

Figure 4.1: Shows Moisture content of the various Rice

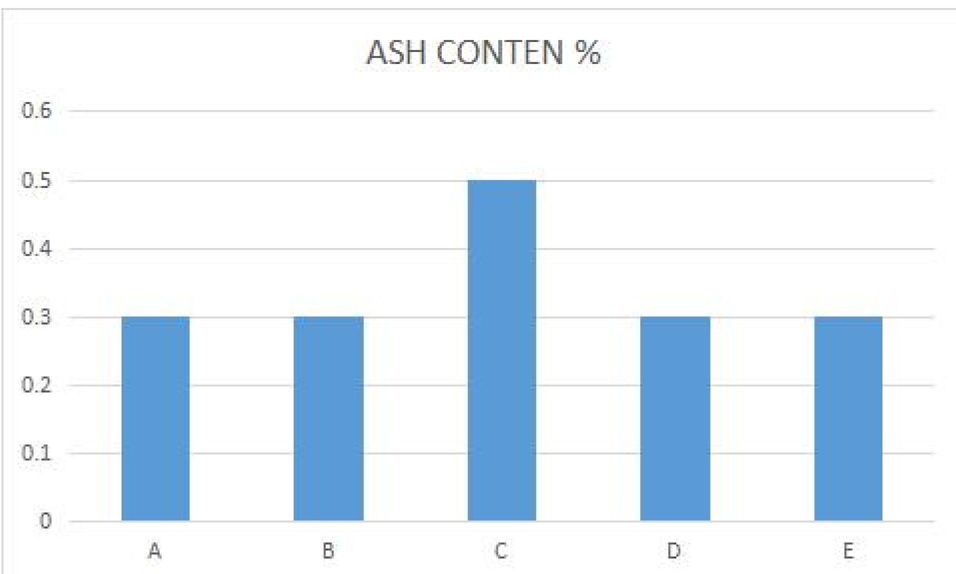

Figure 4.2: Shows Moisture content of the various Rice

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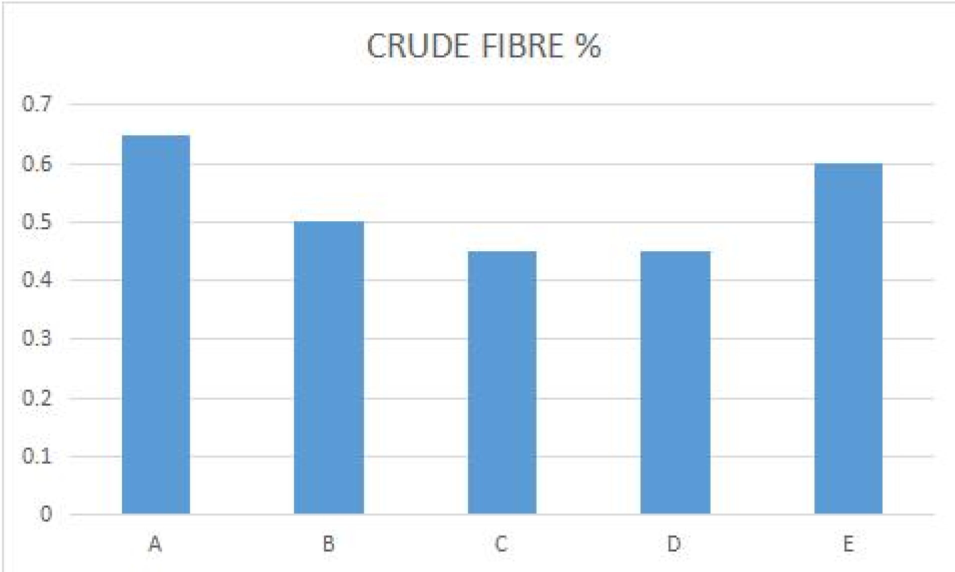

Figure 4.3: Shows Crude fibre of the various Rice.

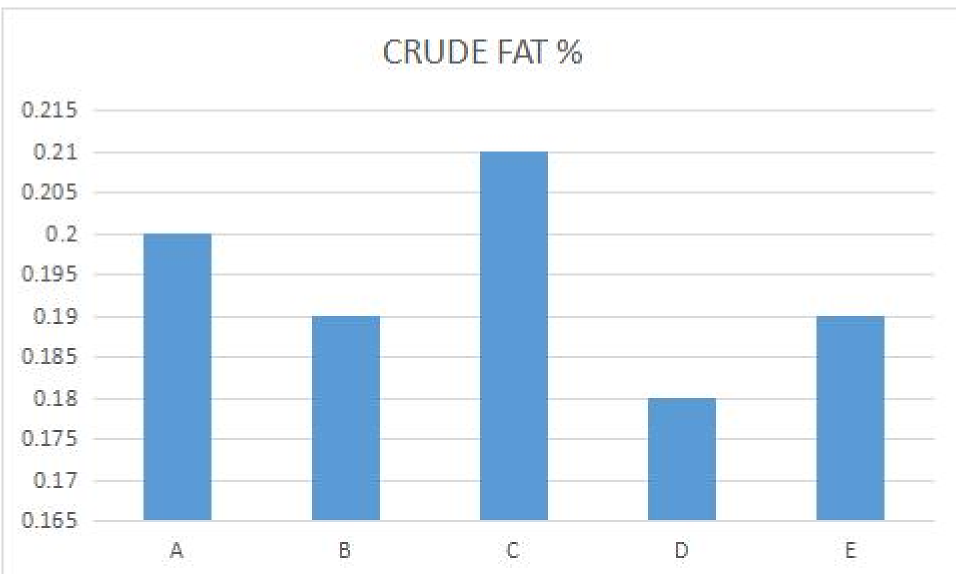

Figure 4.4: Shows Crude fat of the various Rice.

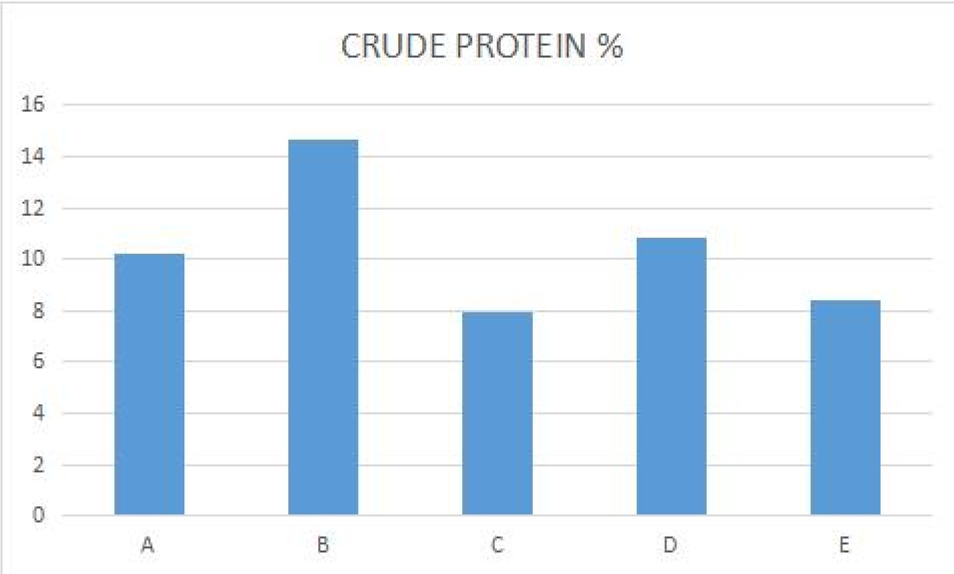

Figure 4.5: Shows Crude protein of the various Rice.

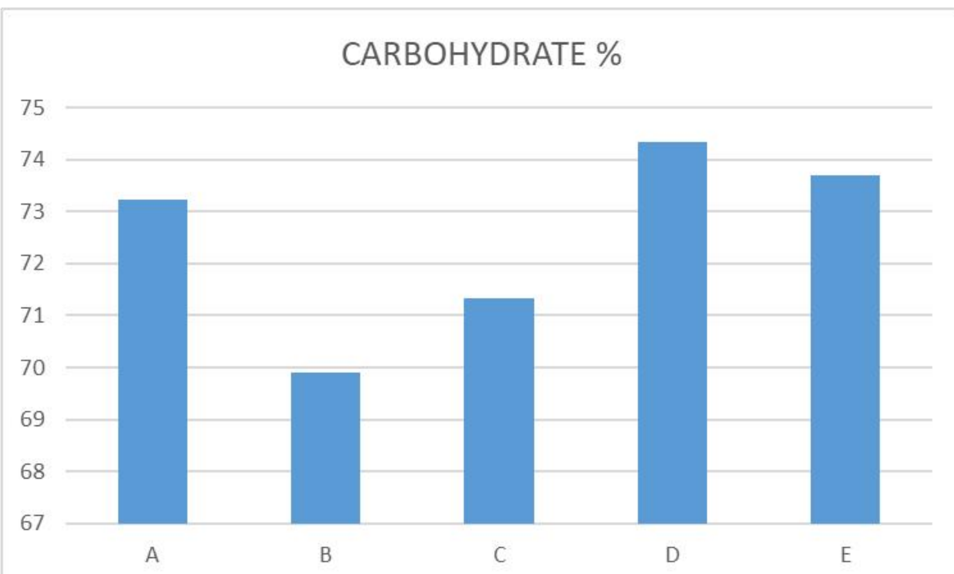

Figure 4. 6: Shows carbohydrate of the various Rice.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 DISCUSSION ON PROXIMATE ANALYSIS

5.1.1 Moisture Content

The moisture content graph shows variations among the samples, with C having the highest (19.60%) and D the lowest (13.84%). High moisture, as in Sample C, increases the risk of microbial growth and spoilage. Conversely, very low moisture, as in Sample D, improves storage but may cause kernel brittleness during milling. Sample E (Ekpoma rice) at 16.75% represents an ideal intermediate level. This value reduces susceptibility to fungal growth compared to Sample C while maintaining enough moisture to prevent grain breakage. Unlike A (15.45%) and B (14.45%), Sample E's slightly higher moisture enhances texture and cooking quality. It supports better milling yield and consumer acceptability. Its moderate moisture also reduces immediate insect infestation risk. However, proper storage remains essential to maintain quality.

5.1.2 ASH Content

The graph of ash content across the five rice samples indicates generally low mineral content, with values ranging between 0.3% and 0.5%. Samples A, B, D, and E all recorded 0.3%, while Sample C stood out with a slightly higher value of 0.5%. Ash content is a measure of total mineral composition, which contributes to the nutritional value of rice. Although Sample E (Ekpoma rice) shares the same ash content value as most other samples, its advantage lies in presenting a balanced nutritional profile without excess mineral accumulation that might affect taste or storage stability. The consistency of 0.3% ash in Sample E suggests a standard mineral load that ensures digestibility and consumer acceptability. Moreover, rice with moderate ash values is less prone to producing off-flavors during prolonged storage, thereby enhancing shelf-life. This gives Sample E an edge in terms of marketability, especially where consumer preference is tied to sensory quality. Sample E demonstrates a nutritional and practical advantage that supports its suitability for both domestic consumption and potential industrial applications.

5.1.3 Crude Fibre Content

The crude fibre content of the rice samples analyzed showed variation across the different sources, as illustrated in the graph. Sample A recorded the highest fibre level at 0.65%, closely followed by Sample E with 0.60%, while Samples B, C, and D ranged lower between 0.45–0.50%. Although Sample A exhibited a marginally higher fibre content, it is important to note that excessively high fibre levels in rice are not always advantageous, as they may reduce digestibility and affect consumer preference. In contrast, the fibre level observed in Sample E is both substantial and balanced, contributing to digestive health without compromising palatability. Dietary fibre plays a crucial role in preventing constipation, improving gut motility, and lowering the risk of metabolic disorders such as diabetes and cardiovascular disease. The near-optimal fibre concentration in Sample E suggests it can deliver these benefits while still maintaining the soft texture and cooking quality desired by consumers.

5,1.4 Crude Fat Content

The crude fat content of the rice samples analyzed shows a generally low lipid level across all varieties, ranging narrowly between 0.18% and 0.21%. Among them, Sample D recorded the lowest value (0.18%), while Sample C had the highest (0.21%), with Samples A, B, and E clustered around 0.19 – 0.20%. Such low crude fat levels are typical of rice grains and are considered desirable for storage stability, as minimal fat content reduces the risk of rancidity during prolonged storage. Notably, Sample E presented a crude fat value of 0.19%, which lies within the ideal range for balancing energy contribution and shelf life. Although modest, this lipid fraction contributes essential fatty acids and facilitates the absorption of fat-soluble vitamins such as A, D, E, and K. From a nutritional perspective, the lipid profile of Sample E complements its overall carbohydrate rich matrix, offering sustained energy release without excess fat burden. This makes it suitable for individuals managing cardiovascular health or seeking weight conscious diets.

5.1.5 Crude Protein Content

The crude protein content of the rice samples shows marked variation, ranging from 7.91% to 14.65%. Sample B had the highest protein content (14.65%), followed by Sample D (10.89%) and Sample A (10.18%), while Sample C recorded the lowest value (7.91%). Sample E contained 8.45% crude protein, placing it above Sample C but slightly below the other samples. Although the protein level of Sample E is moderate, this value is nutritionally relevant, as it still contributes to daily protein intake, especially in staple-based diets where rice serves as a major energy source. Importantly, moderate protein rice varieties like Sample E may be advantageous for individuals who require balanced diets without excessive protein load, such as those managing kidney health. Protein in rice also aids in enzyme production, hormone regulation, and immune system support. Thus, while not the highest in protein, Sample E remains a valuable nutritional resource with potential health benefits, especially when consumed as part of a diversified diet

5.1.6 Carbohydrate Content

The carbohydrate content of the rice samples analyzed shows noticeable variation, with values ranging from 69.91% in sample B to 74.34% in sample D. Carbohydrate levels are critical since they represent the primary source of energy derived from rice consumption. Among the samples, sample E recorded a carbohydrate content of 73.71%, which is competitively high and only slightly below the peak value observed in sample D. For individuals managing diabetes, moderate and balanced carbohydrate intake is recommended, and sample E presents an advantage as it offers sustained energy release without the extremes seen in lower or higher carbohydrate varieties. Compared with sample B, which showed the lowest value (69.91%), sample E supplies more consistent energy while still maintaining digestibility. Its nutritional balance makes it a desirable choice not only for the general population but also for health-conscious consumers.

CONCLUSION

The proximate analysis of the selected rice samples highlights the nutritional diversity present among varieties commonly sold in benin city, with particular emphasis on the promising profile of sample e (ekpoma rice). Its moderate moisture content (16.75%) represents an ideal balance that supports good storage stability while maintaining kernel integrity and desirable cooking qualities. Although its ash content (0.3%) is similar to most other samples, this moderate mineral load enhances digestibility and prevents the development of off-flavors, thereby ensuring consumer acceptability and extended shelf life. With a crude fibre content of 0.60%, ekpoma rice contributes significantly to digestive health and the management of metabolic disorders such as diabetes, by improving gut motility and moderating blood sugar release. Its low crude fat content (0.19%) offers advantages for storage and weight management diets, while still contributing essential fatty acids necessary for nutrient absorption. Although its crude protein content (8.45%) is moderate, it remains sufficient to support basic physiological needs, particularly when rice is consumed alongside protein-rich foods. Most importantly, its carbohydrate concentration (73.71%) provides reliable energy without reaching excessive levels that predispose to metabolic disorders, making it suitable for both the general population and individuals requiring controlled carbohydrate intake.

From an industrial perspective, the balanced proximate composition of ekpoma rice ensures suitability for processing, packaging, and long-distance marketing, while its consumer-friendly nutritional profile supports market competitiveness. These combined health and industrial benefits highlight the potential of ekpoma rice not only as a staple food for household consumption but also as a variety with strong commercial prospects. Consequently, promoting the cultivation and wider distribution of ekpoma rice would support nutritional security, consumer health, and economic development within and beyond the local region.

RECOMMENDATIONS

There is need to do detailed information of rice cutivated in Nigeria and those important as the era of GMOs is on the alarming side

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