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Research Article

Proximate and Mineral Composition Analysis of the Dried Edible Portion of Diospyros Mespiliformis (African Ebony) Fruit

I.H. Abdul[1*] M. Saidu[2], M. M. Dalhatu[3]

[1]Department of Pharmaceutical Technology, Federal Polytechnic Kabo, Kano State, Nigeria
[2]Department of Biochemistry, Kano State University of Science and Technology, Wudil, Nigeria
[3]Department of Biochemistry, Kano State University of Science and Technology, Wudil, Nigeria

**Corresponding Author:* ✉

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Abstract- This study aims to determine the proximate and mineral composition of the dried edible portion of *Diospyros Mespiliformis* (African Ebony) fruit, an underutilized wild fruit widely consume in Northern Nigeria. The nutritional value of the fruit remains largely unexplored, despite its accessibility in the region where cultivated fruits are scarce due to limited irrigational infrastructure. Proximate analysis was conducted to assess ash content, crude fiber, moisture, carbohydrates and protein levels, while also mineral contents analysis focused on calcium (Ca), phosphorus (P), magnesium (Mg), and iron (Fe) levels, among others. Findings from this research provide essential nutritional information, potentially aiding in converting malnutrition and promoting the health benefits of dried *Diospyros Mespiliformis* within local communities. This study highlight the nutritional viability of wild fruits as affordable, nutritional alternatives to cultivated varieties, especially in low resources settings.

Keywords- Diospyros Mespiliformis, Fruits, Proximate Analysis, Mineral Content, Wild Fruit, Nutrition, Health.

1. Introduction

The main source of carbons, vitamins, minerals, vital fatty acids, and usable energy for food production is plants, which engage in photosynthesis [1]. For thousands of years, plants have been essential to preserving human health and enhancing life quality [2]. They provide a major source of food and nourishment for man and animal.

Fruits are said to be the primary sources of vitamins, minerals, fiber, and carbs, all of which have nutritional value and health advantages. [3]. Many people in Nigeria's rural and urban areas rely on wild fruits for their everyday well-being. Cultivated fruits are preferred over wild fruit in many nations [4]. However, in impoverished communities, cultivated fruits are less available due to their high cost. Due to the dry climate in most of the country, cultivated fruit trees are not easily accessible in some areas of Northern Nigeria with inadequate irrigation infrastructure. On the other hand, wild fruits are readily available, but their insufficient nutritional value prevents them from being consumed with knowledge [5]. Numerous studies have demonstrated that, in comparison to cultivated fruits, some wild fruits have good or even high nutritional benefits [6]. Nevertheless, some of these fruits might have anti-nutritional elements that might be detrimental to the body if ingested in excess. The majority of wild fruit consumers are ignorant about the fruits' toxicity levels and nutritional makeup. Thus, research on wild fruits is essential to ascertain whether they have the proper proportion of anti-nutritious and nutritional components [7].

Diospyros mespiliformis (Ebenaceae) is a wild fruit consumed widely in northern parts of Nigeria. Diospyros mespiliformis is commonly known as jackal berry (English), Kanya (Hausa), Nelbi (Fulani), Jukham (Arabic). This tree can reach a height of 16 meters. When ripe, its nearly spherical fruits, which have a diameter of up to 25 mm, are fleshy yellow to purple [8]. It is extensively found throughout Africa, including Senegal, Ethiopia, Kenya, South Africa, Nigeria, and Namibia [9]. Two German scientists, Henneberg and Stohmann, developed the research of proximate analysis on foods more than a century ago. Despite the introduction of new methods, their system of proximate still serves as the foundation for the statutory declaration of food composition [10].

Hunger and starvation brought on by the intake of inadequately nutrient-dense food are some of the main issues facing emerging nations like Nigeria. Consuming nutritious food that is high in minerals, protein, carbohydrates, and other nutrients can help to resolve this issue. The significance of the native wild tree Diospyros mespiliformis has not yet been thoroughly investigated. The proximate and mineral composition of the fruit's dried edible component will be examined in this study. When this study is finished, it will significantly contribute to preserving human health and enhancing the quality of life. The proximate and elemental composition of African ebony trees will improve nutritional status and decrease malnutrition in society.

2. Related Work

Diospyros Mespiliformis

Non-cereal plant foods in Africa and most of the developing tropical world contribute considerably to the diets of indigenous rural groups, especially during periods of grain shortages [11]. In addition to providing fuel wood and timber products, the native trees also produce non-timber goods including fruits, nuts, and honey that assist people avoid starvation during lean agricultural years. From Sudan, where its fruit pulp is used to make a fermented beverage, to South Africa, the jackal-berry tree D. mespiliformis (family Ebenaceae) grows in tropical regions of Africa [12]. The tree is typically found on anthills with moderately fertile soils and in riverine regions. The blossoms are sweet and white. When young, the fruit is often greenish and pubescent, but when ripe, it becomes yellowish to orange yellow. It is globose, meaty, and up to 3 cm in diameter. Four to six dark brown bean-shaped seeds are found inside each ripe fruit. Many wild animals and people consume the soft, sweet pulp of the tree's fruit, but giraffes and elephants mostly browse the leaves and soft twigs, which serve as wildlife food [13].

This plant grows in arid tropical soils and can be found up to 1,300 meters above sea level. Although it can withstand temperatures between 12 and 34°C, it thrives in regions with yearly daytime temperatures between 16 and 27°C. Although it can withstand 400–1,500 mm of rainfall each year, it prefers 500–1,300 mm. prefers rocky soils, heavy soils, sunny spots, and areas with seasonal waterways and swamps. It thrives on volcanic and loamy sands, as well as wet red loams. prefers a pH between 5.5 and 6.5, but will tolerate a pH between 5 and 7. Coppicing trees is possible. If fruit and seed are needed, both male and female versions of this dioecious plant must be cultivated.

Many animals love the fruit of the jackal berry tree. The fleshy fruit is yellow or yellow-green in hue, oval, nearly spherical, and about an inch in diameter. The tips of five sepals from the flower's calyx curl backwards and stay on the fruit's underside. The fruit contains two to six wrinkled seeds. The edible fruit has a lemon-sweet flavor and a chalky, floury consistency, but the skin is tough. They can be stored or consumed fresh. They are also processed into flour after being dried. Additionally, brandy and beer are made from them [14]. The jackal berry fruit turns purple when it is fully ripe, although this color is rarely seen because it is consumed by many animals before it reaches that stage. The jackal berry is a favorite food of many animals, including hornbills, baboons, warthogs, nyalas, and impalas. Its name comes from the fact that jackal berry seeds can also be found in jackal excrement. Elephants, rhinos, giraffes, buffaloes, and kudus all consume the leaves. The leaves of this tree are also consumed by the larvae of the bush veld emperor butterfly [15].

The edible fruit can be consumed fresh in fermented beverages, dried and preserved for later use, or, more frequently, combined with food to make a kind of porridge [16].

Elephants, giraffes, black rhinos, eland, and kudus consume leaves, whereas kudus, baboons, vervet monkeys, yellow-spotted rock dassies, pigeons, parrots, and hornbills consume fruits. Astringent, febrifuge, hemostatic, moderately laxative, stimulant, and vermifuge are some of the uses for leaves. The leaves' infusion is used to cure leprosy, syphilis, pneumonia, and fevers [17]. Bark and roots are used as an anthelmintic, to aid in childbirth, and to treat illnesses like syphilis, leprosy, pneumonia, malaria, and dermatomycoses. Barks and roots are used to cure tum and as psycho-pharmacological drugs [18]. The traditional use of Diospyros mespiliformis methanol extract to treat fever and discomfort was assessed. The extracts' antipyretic, analgesic, and anti-inflammatory properties were assessed in mice and rats. The formalin test, acetic acid-induced writhing in mice, yeast-induced pyrexia in rats, and egg albumin-induced anti-inflammatory action in rats were all studied. The extract (50 and 100 mg/kg i.p.) shown considerable activity ($p<0.05$) against all analgesic and anti-inflammatory models used, and at 100 mg/kg it produced a strong antipyretic effect [19]. Significant action against E. coli, S. aureus, Shigella species, and P. aeruginosa was demonstrated by the ethanol extract of Diospyros mespiliformis leaf. At different concentrations, the Diospyros mespiliformis leaf and bark extract shown strong antifungal activity against Aspergillus Niger, Aspergillus flavus, and Microsporum gypseum [20].

3. Materials and Methods

This research utilized thorough analytical methods to assess the proximate and mineral makeup of the dried edible part of *Diospyros mespiliformis* (African ebony) fruit. Presented below are the comprehensive methods utilized for sample collection, preparation, proximate analysis, and determination of mineral composition.

Materials

The research employed various materials, such as a digital balance with 30 mg precision, measuring cylinders (with capacities of 0.1, 1.0, and 10 ml), Soxhlet extractors, conical flasks, beakers, droppers, wash bottles, platinum and silica dishes, a hot air oven, a muffle furnace, desiccators, crucibles, and Petri dishes. Reagents including concentrated sulfuric acid, 40% sodium hydroxide, 2% boric acid solution, 0.025N sulfuric acid, screened methyl red indicator, and petroleum ether were used for different analyses.

Sample collection and preparation
Representative samples of *Diospyros mespiliformis* fruits were gathered from several trees in Faragai, Albasu Local Government Area, Kano State. These samples were dried in air for two weeks to guarantee stability and lower moisture levels. They were subsequently taken to the Biochemistry Laboratory at Kano University of Science and Technology, Wudil, for examination. The recognition and verification of the plant species took place at the Department of Food Science and Technology, Faculty of Agriculture and Agricultural Technology, Kano University of Science and Technology.

Reagents
1. Concentrated sulphuric acid-nitrogen free
2. 40% solution of NaOH
3. 2% boric acid solution
4. 0.025N sulphuric acid
5. Screened methyl red indicator
6. Kjeldhal catalyst tablets
7. Kjeldahl digestion and distillation apparatus
8. Petroleum ether
9. Soxhlet extraction with ground glass joints
10. Tap off receiver with ground glass joints
11. Extraction thimbles heating mantels (six channel type)

Methods
Proximate Examination
Proximate analysis was conducted to measure essential nutritional elements, such as moisture, ash, crude protein, crude fat, crude fiber, and carbohydrates using the Micro Kjeldhal Method.

Mineral Analysis
This was determined according to the method described by [21]. 5g of the sample will be weighed in a crucible and then placed in a muffle furnace for ashing at a temperature of 500 for two hours. To the ashed sample $10cm^3$ of 6M Nitric acid (HNO_3) will be added and agitated until a uniform solution is obtained. This will then be filtered into a $50cm^3$ sample bottle. To the filtrate, distilled water will be added until it was filled up to the $50cm^3$ level.

Blank sample will be prepared involving the addition of $10cm^3$ 6M Nitric acid. Solutions will be analyzed using Atomic Absorption Spectrophotometer (AAS).

Statistical Analysis
All experiments were carried out in pairs to guarantee precision, and outcomes were reported as mean ± standard deviation. Statistical significance was established at ($p<0.05$).

Ethical Considerations
This research followed ethical principles, guaranteeing that all resources and methods were ecologically sustainable and met laboratory safety regulations.

4. Results and Discussion

Results
Description of the Tables and Figures
The tables (1 and 2) below summarizes the proximate and mineral makeup of the dried edible section of *Diospyros mespiliformis* (African ebony) fruit. It is split into two parts: proximate composition and mineral composition. The information shown in table 1 highlights the main nutritional features of the fruit, such as moisture level, ash level, protein, fat, fiber, carbohydrates, and that in Table 2 shows the vital minerals. The addition of figures (1 and 2) improves the understanding of the data, providing a clear and attractive visual depiction of the fruit's composition, while also support the use of this research in upcoming studies and real-world applications, including food security initiatives and the development of nutrient-dense food products.

Table 1: Proximate Composition of Diospyros Mespiliformis (African Ebony) Dried Fruit; Values are means of duplicate determinations ± standard deviation, expressed in %

PROXIMATE	PARAMETRES (%)
Moisture	7.96 ± 0.00
Ash	3.06 ± 0.08
Crude fiber	3.30 ± 0.30
Crude protein	6.49 ± 0.06
Crude lipid	7.28 ± 0.38
Total carbohydrate	71.92 ± 0.09

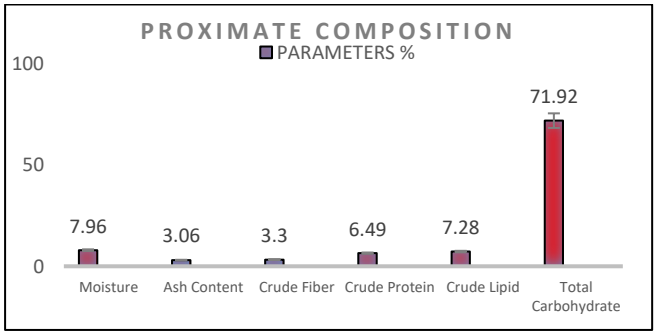

FIGURE 1: Bar Graph Showing the Proximate Composition of *Diospyros Mespiliformis* (African Ebony)

Dried Fruit: proportion of moisture, ash, crude fiber, crude protein, crude lipid, and total carbohydrates in %.

Mineral Composition Analysis
The mineral assessment concentrated on calcium (Ca), phosphorus (P), magnesium (Mg), and iron (Fe). The levels of these minerals are shown in Table 2.

TABLE 2: Mineral Analysis of *Diospyros Mespiliformis* (African Ebony) Dried Fruit; Values are means of duplicate determinations ± standard deviation, expressed in mg/kg

MINERALS	COMPOSITION (mg/Mg)
Fe	55.32 ± 0.52
P	2512.5 ± 0.5
Ca	328.28 ± 0.53
Mg	40.76 ± 0.56

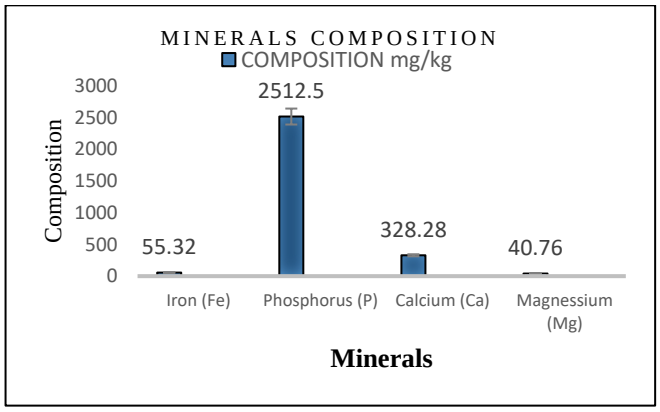

FIGURE 2: Bar Graph Showing the Mineral Composition of *Diospyros Mespiliformis* (African Ebony) Dried Fruit; Concentrations of Iron, Phosphorus, Calcium, and Magnesium in mg/kg.

Discussion

Proximate Composition Analysis

The proximate analysis of Diospyros mespiliformis (African ebony) dried fruit showed notable nutritional characteristics. The assessed parameters consisted of moisture level, ash level, crude fiber, crude protein, crude fat, and total carbohydrates. The findings are encapsulated in Table 1, where values are displayed as mean ± standard deviation of duplicate measurements.

Moisture Content

The moisture level of the dried fruit was approximated at 7.96 ± 0.00%. This fairly low moisture level suggests that the fruit is appropriate for long-term storage, since reduced moisture decreases microbial activity and lessens spoilage. In comparison to the seed of the same fruit mentioned by [22] and that of the pulp and peel of the same fruit reported by [23]. According to [24], the moisture content plays a vital role in determining the shelf life and stability of food items. The low moisture level noted here corresponds with results from similar studies on dried fruits, reinforcing the idea that *Diospyros mespiliformis* dried pulp is a suitable option for preservation and transport.

Ash Content

The ash content measured 3.06 ± 0.08%, which indicates the mineral composition of the fruit. The value found in this study surpasses those recorded for several other wild fruits, indicating the abundance of essential minerals in *Diospyros mespiliformis*. Minerals are essential for numerous physiological processes, such as enzyme activation, muscle contraction, and bone development. Consequently, the fruit possesses promise as a nutritional supplement, especially in areas susceptible to mineral shortages.

Crude Lipid Content

The crude fat obtained in this investigation is 7.28 ± 0.38 %, which is higher than that of the same fruit reported by [25], and that of the seed reported by [26], but less than that of the fruit reported by [27]. The value is also higher than that reported by [28] for the same fruit, this variation could be due to the climatic factor. Lipids play a crucial role in energy storage, cellular composition, and the absorption of fat-soluble vitamins including A, D, E, and K. The crude fat value reported in this work indicated that the fruit pulp is a good source of oil-soluble vitamins [29]. The lipid levels in this research also indicated that *Diospyros mespiliformis* could function as an energy-rich food, especially important during times of food shortages.

Crude Fiber Content

The crude fiber content of the fruit pulp in this work was found to be 3.30 ± 0.30 %, the value is very close to that of the seed reported by [30] 2.67 ± 0.76 %, and that of [31] 3.37 ± 0.26 %. Fiber is essential for supporting digestive health, facilitating bowel movements, and avoiding issues like constipation. Moreover, dietary fiber is recognized for its ability to reduce cholesterol levels and decrease the likelihood of cardiovascular diseases [32].

Crude Protein Content

The crude protein obtained in this investigation is 6.49 ± 0.06 %. The value obtained is higher than that of the seeds of the same fruit reported by [33], and is very close to the fruit pulp of the same fruit reported by [34] 6.01 ± 0.37 %. According to [35], Proteins are vital macromolecules that function as the foundational components for bodily tissues and enzymes. The fruit's protein content indicates its potential as an additional protein source, particularly in areas where protein deficiency is common. Protein is also essential for growth, repair, and enzymatic activities.

Carbohydrate Contents

The overall carbohydrate content was 71.92 ± 0.09 %. The value is lower than that the seed of the same fruit reported by [36], and greater than that of the fruit pulp reported by [37]. Carbohydrates serve as the main energy source for human metabolism, and the high carbohydrate levels highlight the fruit’s potential as a crucial energy source and offers easily accessible calories to fulfill energy needs.

Mineral Composition Analysis

The mineral assessment concentrated on calcium (Ca), phosphorus (P), magnesium (Mg), and iron (Fe). The levels of these minerals are shown in Table 2, where, Phosphorus (P) 2512.50 ± 0.5mg/kg, followed by Calcium (Ca) 328.28 ± 0.53 mg/Kg, Magnesium (Mg) 40.76 ± 0.56 mg/kg and Iron (Fe) 55.32 ± 0.52 mg/Kg.

Phosphorus

Phosphorus was the prevalent mineral, present at a concentration of 2512.5 pm 0.5 mg/kg. This elevated level is significant, as phosphorus is crucial for bone and tooth formation, energy generation, and nucleic acid synthesis. The notable presence of phosphorus in such large amounts emphasizes the fruit's ability to address phosphorus deficiency, a widespread nutritional problem in developing nations.

Calcium

The calcium concentration was recorded as 328.28 ± 0.53 mg/kg. Calcium is essential for supporting bone health, enabling muscle contraction, and facilitating blood clotting. Its sufficient consumption is important for averting osteoporosis and various calcium-deficiency conditions. Serve as

constituent of teeth and bone, it also serves as second messengers in signal transduction pathway and control muscle contraction. Calcium is needed by many enzymes for their activity [38].

Magnesium

The concentration of Magnesium in this investigation is 40.76 ± 0.56 mg/kg. According to the [39], the daily requirement of Magnesium for adult is 15 mg, the amount of Magnesium in the fruit pulp of Diospyros mespiliformis is more than the daily requirement of adult, indicating that consuming it might aid in preventing magnesium-related deficiencies. This mineral is essential for energy metabolism, protein creation, and nerve function. Magnesium acts as a cofactor for enzymes and also helps to support the health of bones and teeth as well.

Iron

Iron was found at a concentration of 55.32 ± 0.52 mg/kg, Iron is an important micronutrient in the formation of hemoglobin, it also plays vital role in the normal functioning of central nervous system and oxidation of carbohydrate, protein and fat. In order to prevent anemia and other related disorders, Iron is very important in the diet of pregnant woman, nursing mothers, infants, convulsing patients and elderly people [40]. The noted iron levels in this research highlight the capability of *Diospyros Mespiliformis* in tackling such disorders.

Comparison with Other Studies

The proximate and mineral compositions observed in this study align with, and in some cases surpass, values reported for other wild fruits. Variations in the results may be attributed to factors such as geographical location, climatic conditions, and differences in processing methods. For instance, the higher lipid content observed in this study compared to others may result from environmental conditions that favor oil accumulation in the fruit.

Nutritional and Health Implications

The findings of this research indicate that *Diospyros mespiliformis* is a nutrient-rich fruit offering notable health advantages. The mix of macronutrients and micronutrients makes it a functional food capable of tackling malnutrition and deficiencies in micronutrients. Its elevated carbohydrate levels offer a readily accessible energy source, while its significant mineral content promotes overall health and wellness. The possible applications of the fruit go beyond just eating it. It can act as a base ingredient for making jam, juice, or other food items, increasing its nutritional and economic worth. Furthermore, the minimal moisture level and sun-drying method enable the fruit to be easily stored and transported, aiding its incorporation into food supply chains.

Challenges and Limitations

Although the results are encouraging, it is essential to consider the possible limitations of the research. This study did not assess the anti-nutritional factors in *Diospyros mespiliformis*, which may affect its bioavailability and safety. Subsequent studies ought to explore the amounts of phytates, oxalates, and various other anti-nutrients to create a more thorough nutritional profile.

5. Conclusion

The analysis of the dried edible part of *Diospyros mespiliformis* (African ebony) fruit showed its important nutritional and mineral content, highlighting its promise as a valuable food source. This research offered in-depth information about the proximate and mineral composition of the fruit, enhancing the knowledge of its nutritional benefits and its possible function in combating malnutrition, especially in areas with restricted access to conventional farm products.

The proximate analysis indicated that *Diospyros mespiliformis* is a fruit rich in nutrients, featuring a high carbohydrate level of 71.92 pm 0.09%, positioning it as a major source of dietary energy. This aspect is especially crucial in addressing energy shortages in areas with limited resources, particularly during times of famine or drought. The carbohydrate levels make the fruit a sustainable and cost-effective energy source for at-risk groups, especially in rural and semi-arid areas.

The mineral assessment of the fruit revealed its abundance in vital nutrients like phosphorus, calcium, magnesium, and iron. These minerals are essential for sustaining overall health and avoiding nutrient shortages. The elevated phosphorus levels underscore the fruit's importance in enhancing bone health and aiding metabolic processes, especially among groups with restricted availability of phosphorus-dense foods. The measured magnesium levels surpass daily recommended intake, indicating that the fruit may help prevent magnesium-related deficiencies and health problems like muscle cramps, fatigue, and metabolic disorders.

Dried fruit from *Diospyros mespiliformis* is a nutrient-dense food that holds considerable promise for tackling nutritional deficiencies and improving food security. Encouraging its use and consumption could significantly influence health and nutrition in areas with limited resources, underscoring the need for additional research and development to optimize its capabilities.

Recommendation

The results of this study emphasize the nutritional importance of *Diospyros mespiliformis* dried fruit, showcasing its ability to mitigate food insecurity, malnutrition, and nutrient shortages in low-resource environments. Its elevated levels of carbohydrates and fats result in a food rich in energy, whereas its minerals contribute to general health and wellness. The fruit's extended shelf life and simple transportation boost its attractiveness as a sustainable food option.

The nutritional characteristics of *Diospyros Mespiliformis* indicate its potential role in food systems as a functional component or dietary supplement. Employing it in the making of food items like jams, juices, or energy bars could increase its usefulness and financial worth. Moreover, encouraging the growth and eating of this fruit may aid local economies while meeting dietary requirements.

Future Directions

Although the study offers important insights, additional research is necessary to investigate the bioavailability of

nutrients and the existence of anti-nutritional factors that may influence the fruit's overall usefulness. Exploring the antioxidant characteristics and bioactive substances in the fruit may uncover further health advantages. Moreover, research into the fruit's longevity under various storage environments would offer valuable information for its marketability and wider acceptance.

Data Availability

The datasets created and examined during this research can be obtained from the corresponding author upon a reasonable request.

Conflict of Interest

The authors has no conflict of interest concerning the publication of this paper.

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Contributions of Authors

Mukhtar Sa'idu: A student with a bachelor's degree in the Biochemistry from Kano State University of Science and Technology, Wudil. Mukhtar was involved in every phase of the research, from the initial idea and data gathering to analysis and preparing the manuscript, acting as the research assistant.

Dr. Maimuna M. Dalhatu: A Senior Lecturer within the Biochemistry Department at Kano State University of Science and Technology. Dr. Dalhatu offered oversight, technical support, and important evaluation of the research project and paper.

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AUTHOR'S PROFILE

I am Ibrahim Hamisu Abdul, a biochemist and researcher currently pursuing my MSc in Biochemistry with a specialization in Toxicology. My research expertise spans genetic markers for metabolic disorders, heavy metals accumulation in cereals, and antioxidant activities in plants I am passionate about advancing my research in Cell Biology, Neurodegenerative Diseases and Sustainable Drug Discovery in health and science. I am the corresponding Author of this research.

Mukhtar Sa'idu obtain his BSc in Biochemistry from Kano State University of Scuence and Technology, Wudil in 2022. Graduated among the 1% of his cohort with a stunning grades in biochemistry courses and related discipline. His research experience rooted back to his commitment and resilience during his undergraduate years.

Dr. Maimuna M. Dalhatu is a Senior Lecturer at the Department of Biochemistry with a decade of experiences in research and supervision. With myriad expertise in both Clinical and Medical Biochemistry discipline, She is one of the Senior Lecturers in the Biochemistry Department with diversify knowledge of modern day Biochemistry.

