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Research Article

Comparative Proximate Analysis between Two Types of Moringa (Moringa Oleifera and Moringa Ovalifolia)

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Abstract— Moringa oleifera and Moringa ovalifolia are highly valued for their nutritious seeds and are often consumed in sub-Saharan Africa. Different parts of these plants have a profile of key minerals and are high in protein, vitamins, B-carotene, and amino acids. Moringa leaves contain vitamins A, calcium, iron, C, and potassium. Moringa oleifera is well-known for its high nutritional content, which has been likened to that of Moringa ovalifolia. Moringa oleifera, also known as "Zogale" in Northern Nigeria, is one of the most widely distributed and cultivated plant species in the region. However, the prospective uses for their leaves were not adequately researched and documented. As a result, proximal examination of their leaves for possible applications is extremely important. Leaf samples were collected from Nigeria's Katsina metropolis and analyzed for proximate components using standard analytical methods. Moringa oleifera and moringa ovalifolia leaves had percentage carbohydrate, crude fiber, and moisture contents of 56.33±0.29, 63.11±0.11, 11.23±0.16, 7.09±0.11, 10.74±0.05, and 2.11±0.11, respectively. Moringa oleifera and moringa ovalifolia leaves had crude protein, lipid, and ash levels of 9.38±0.23, 17.1±0.1, 7.76±0.21, and 1.69±0.09, 10.74±0.05, and 2.11±0.11, respectively. Moringa oleifera leaves had more crude fiber, lipid, and moisture content than moringa ovalifolia leaves, whereas moringa ovalifolia leaves had much higher protein, ash, and carbohydrate content.

Keywords— Moringa oleifera, Moringa Ovalifolia, Proximate analysis, Moisture, Ash, Carbohydrate, Lipid, Fiber, Protein.

1. Introduction

Vegetables are edible portions of herbaceous plants that can be eaten whole or in pieces, raw or cooked. They are typically found in main meals and salads. These veggies can have a variety of characteristics, from fragrant and bitter to very neutral. These substances are regularly consumed in the diets of the average Nigerian and contain considerable amounts of vital minerals. Although leafy greens are mostly water, they are high in minerals, vitamins, and phytochemicals, making them a natural treasure trove [1]. Man's diet of a range of vegetables is thought to considerably improve human health in terms of disease prevention and/or cure, because plants have long acted as a valuable and sensible source of therapeutic agents [2].

Moringa oleifera and Moringa ovalifolia are drought-tolerant trees that have survived the hard climate. Although both trees thrived in severe environments, Moringa oleifera grew to greater heights than Moringa ovalifolia, which grew slowly. Moringa oleifera is part of the Moringaceae genus. Moringa oleifera, a single genus with 14 recognized species, is the best-known and most widely used of these [3]. Moringa oleifera is a fast-growing, aesthetically pleasing tree notable for its long, drumstick-shaped pods that yield seeds in their first year of growth. Moringa has been seen to grow up to 4 meters and produce fruit within the first year [4]. In different parts of the world, moringa oleifera is known by divers name: among the Igbos, it is known as "Okwe Oyibo", among the Hausas, it is called "Zogale", among the Yorubas, it is called "Ewe ile", among the Fulani, it is called "gawara", "sonjna" in Marathi, "Nuggekai" in Canada, "Murungai" in Tamil, "Mashinga Sanga" in Malayalan, "Muringa" in Konkani.

Moringa oleifera is considered as a multipurpose plant due to its many uses. This tree's leaves, fruits, blossoms, and immature pods are edible and are used into traditional cuisines in many tropical and subtropical nations. Moringa oleifera leaves contain high levels of protein, vitamins A, B, and C, as well as minerals including calcium and iron. Almost every component of the tree has been used in traditional medicine, and the oil is administered externally to treat skin conditions [5]. Moringa seed pods can be over a foot long and contain more than a dozen massive Moringa seeds. Moringa seeds are dark brown, with three papery wings emerging from the main kernel. These flaps function as wings, transporting the seed away from the mother tree and gliding across the ground with the wind until it reaches a resting place to germinate. Moringa seeds have long been used by the populace as a tasty food and a water purifier due to their coagulant properties [6]. Furthermore, it has been discovered that properly handled Moringa oleifera seed can increase soil aeration and the population of indigenous invertebrates, specialist endangered soil species, beneficial arthropods, earthworms, symbionts, and microbes [7].

Moringa ovalifolia is a succulent-stemmed tree that grows in desert and semi-arid environments. The plant grows vertically and can reach 7 metres in height. It is deciduous with a primary branch up to 1 meter in diameter. Moringa ovalifolia, which has been classified in the Donaldsoniana part of the genus, was highly valued in antiquity [8]. The Romans, Greeks, and Egyptians extracted edible oil from moringa seeds and used it to make perfumes and skin treatments. Moringa ovalifolia leaves are edible and used throughout West Africa and portions of Asia. Moringa grows in the wilderness (Arava in Hebrew), near the Dead Sea, on mineral-rich land (mainly calcium), and contains a high concentration of vitamin E [9].

A comparative analysis of the nutritional composition of Moringa oleifera and Moringa ovalifolia leaves within a given region is significant since it is a crucial indicator of potential climatic and soil changes. The nutritional value of Moringa oleifera leaves has been established in the literature. However, the potential of Moringa ovalifolia leaves has not been fully investigated. To close this knowledge gap, the proximate compositions of Moringa oleifera and Moringa ovalifolia leaves must be determined. This will not only help us better understand the nutritional content of these leaves, but it will also aid in the development of a Moringa proximate composition database.

2. Related Work

According to the paper [10], the nutritional composition of three plants commonly used as culinary condiments: ginger (Zingiber officinale), garlic (Allium sativum), and raw and fermented locust bean (Parkia biglobosa). The proximate compositions of three common food condiments, ginger (Zingiber officinale), garlic (Allium sativum), and locust bean (Parkia biglobosa), were investigated. The composition of the locust bean was investigated before and after fermentation. The results show that fermentation increases the moisture and oil content of locust beans while decreasing protein levels. The statistics also show that ginger has the highest moisture content (76.86%), followed by garlic (66.67%) and locust bean (41.8 and 8.67% in fermented and raw beans, respectively). According to a report by [11], Telfairia occidentalis and Telfairia pedata are valued for their nutritious seeds and widely consumed in Sub-Saharan Africa. However, the potential uses for their leaves were not thoroughly investigated and documented. As a result, a close evaluation of their leaves for potential applications is critical. The leaf's proximal components were identified using established analytical procedures. Telfairia pedata and Telfairia occidentalis leaves included 49.23±0.79 percent carbohydrate, 19.50±0.31 percent crude fiber, 62.06±0.49 percent moisture, 49.44±0.55, 14.68±1.04, and 71.40±0.31, respectively. Telfairia pedata and Telfairia occidentalis showed crude protein, fat, and ash values of 16.04±0.51, 2.00±0.50, 13.33±0.31, and 22.45±0.50, 4.80±0.34, and 8.60±0.21, respectively. Telfairia pedata leaves have more crude fiber and ash than Telfairia Occidentalis leaves. There was no significant difference in carbohydrate content between the leaves. However, Telfairia Occidentalis leaves had greater crude protein, moisture, and fat. The proximate, antinutritional, and mineral contents of three vegetables consumed in Zaria, Nigeria: green amaranth (Amaranthus tricolor), bitter leaf (Vernonia amygdalina), and fluted pumpkin (Teilferia occidentalis) were investigated using the literature reviewed in [12]. The findings revealed the presence of nutritional, antinutritional, and mineral components in these vegetables. Among the vegetables investigated, bitter leaf has the maximum moisture (62%) and carbohydrates (67%). Fresh and dried vegetables have substantial nutritional differences ($p < 0.05$). Furthermore, the results showed that bitter leaf has the highest concentration of anti-nutrients. However, there is a large quantity of mineral content, with Amaranthus having the highest calcium (40 ppm) and zinc levels (1.3 ppm). Ugu leaf (Teilferia) and Amaranthus have significant iron concentrations, whereas bitter leaf (Vernonia) has low levels. As a result, this study revealed that dried versions of these vegetables contain a greater concentration of nutritional and mineral components, as well as more energy, than fresh counterparts. [13] The proximate composition of some edible green leafy vegetables was investigated, including okro leaf (Abelmoschu sesculentus), pumpkin leaf (Telfairia occidentalis), bitter leaf (Vernonia amygdalina), and water leaf (Talinum triangulare), from selected oil producing communities in River State (Umusoya, Eleme, Omagwa, Rukpokwu, and Bomu). The findings were compared to the proximate composition of edible green leafy vegetables in Imo's non-oil-producing districts (Owerri, Mgbidi, Mbano, Mbaise, and Orlu). Polluted and unpolluted areas had significantly different moisture content in vegetables ($P<0.05$), with polluted areas ranging from 4.10% to 6.07% and non-polluted areas ranging from 3.27% to 6.36%. There was no significant difference ($P > 0.05$) between polluted and unpolluted bitter leaf. The ash content in contaminated areas ranged from 9.80% to 13.09%, whereas in unpolluted areas it ranged from 11.73% to 19.39%, with significant differences ($P<0.05$). The protein concentration in polluted areas ranged from 8.15% to 16.52%, whereas it was 9.80% to 17.36% in unpolluted areas, with a significant difference ($P>0.05$). Furthermore, lipid concentration in contaminated areas ranged from 2.18% to 4.12%, whereas unpolluted areas ranged from 1.0% to 2.17%, with significant differences ($P>0.05$). The crude fiber concentration in polluted areas ranged from 9.58% to 12.28%, while in non-polluted areas it ranged from 10.70% to 13.47%. According to the study's findings, indiscriminate crude oil pollution of soil has a significant impact on plant proximate composition and quality of vegetables produced due to bioaccumulation of hydrocarbon compounds in the vegetables' aerial portions.

3. Experimental Method

3.1 Materials and Reagents
Sulphuric acid (H_2SO_4), Hydrochloric acid (HCl), Ethanol (C_2H_5OH), Methanol (CH_3OH) and Sodium hydroxide (NaOH) were acquired from JHD Shantou in China. Khjeldal catalyst was obtained from Gerhardt G.C Company in Germany. Petroleum ether was obtained from Harris Chemicals Limited in Germany. All compounds are Analytical Reagent (AR) grade. The equipment used in the study include; Electric Weighing balance (AR2140), Soxhlet extractor (Mattle PC 400), Hot air oven (QBL1861A), Muffle furnace (EME30100/CEB), Khjedal apparatus and Dessicator

3.2 Samples Collection and Prepartion
Two types of fresh moringa leaves were taken from a garden in Katsina City, Nigeria: Moringa oleifera and Moringa ovalifolia. The leaves were gently packed into a clean polyethene bag. The leaf samples were authenticated and identified at the Herbarium Unit of the Department of Biology, Umaru Musa Yar'adua University in Katsina, Nigeria. Before beginning the analysis, the leaf samples were thoroughly purified, which involved using water to remove any remaining soil particles. The leaves were properly washed with distilled water and then air dried for four days in a covered setting. The leaves were pounded into a fine powder with a mortar and pestle, and then sieved through a 20 µm filter. The resulting powder was then placed in a plastic container in preparation for the upcoming analysis.

3.3 Nutritional Analysis
Each sample's moisture, crude protein, lipid content, total ash, carbohydrate content, and crude fiber content were determined using standard protocols from the Association of Official Analytical Chemists [14], with minor modifications. Moisture content was determined by heating 3.0g of each fresh sample to a constant weight in a crucible placed in an oven at 105 EC. The dry matter was used to calculate the remaining values. The Kjeldahl method was used to determine crude protein (% total nitrogen x 6.25) from 3.0g samples; lipid content was obtained by exhaustively extracting 6.0g of each sample in a Soxhlet apparatus using petroleum ether (boiling point range 40-60°C) as the extractant. Ash was determined by burning 12.0g samples in a muffle furnace at 550°C for 5 hours. Crude fiber was created by digesting 3.0g of sample with H_2SO_4 and NaOH and incinerating the residue in a muffle furnace set to 550°C for 5 hours. Moisture content was determined by heating 3.0g of each sample to a constant weight in a crucible placed in an oven at 105°C. Each analysis was carried out in duplicate.

4. Result and Discussion

Table 1 presented the results for the proximate analysis of the two types of Moringa i.e Moringa oleifera and Moringa ovalifolia.

Ash Content
In the context of proximate analysis, the ash content of plant materials like Moringa ovalifolia and Moringa oleifera provides important insights into their inorganic composition. The ash content in plant materials often represents the total mineral content. The study found that moringa ovalifolia and moringa oleifera had comparatively high ash content values (7.93 ± 0.12% and 4.56 ± 0.13%, respectively). According to Figure 1 in this study, Moringa ovalifolia had larger ash content than Moringa oleifera. Higher ash content in Moringa ovalifolia suggests a higher concentration of minerals, which can be beneficial from a nutritional perspective. Minerals such as calcium, potassium, magnesium, and iron are crucial for various bodily functions, and their presence in higher amounts can enhance the nutritional value of the plant. If Moringa ovalifolia and Moringa oleifera are being considered for bioenergy production, the higher ash content in Moringa ovalifolia could impact its suitability as a fuel source. High ash content can reduce the calorific value, meaning less energy is produced per unit of biomass. This makes Moringa oleifera potentially a more efficient fuel source due to its lower ash content. The mineral-rich ash from these plants can be used as a soil amendment to improve soil health. Higher ash content in Moringa ovalifolia could mean it provides more minerals when used as a fertilizer, enhancing soil fertility. However, the specific mineral composition would need to be analyzed to understand its full benefits and any potential toxicity. Ash content can also affect the industrial processing of these plants. For example, in the production of plant-based products, high ash content might necessitate additional processing steps to remove or manage the inorganic residues. This could affect the overall cost and efficiency of production. The ash concentration of Moringa ovalifolia in this investigation was consistent with the 8.3% reported for Fluted pumpkin leaf [15] and 8.60± 0.21 for Telfairia occidentalis [16]. Moringa oleifera has a higher ash content compared to 2.57±0.04% produced by [17]. The difference in mean ash content between the two leaves is statistically significant ($P < 0.05$).

Carbohydrate contents
Carbohydrate content is a critical parameter in proximate analysis, providing insights into the energy value and nutritional profile of plant materials. Table.1 shows that all leaves had considerable carbohydrate content, with no significant difference in mean results ($P < 0.05$). In this study, Moringa ovalifolia has greater carbohydrate content than Moringa oleifera (63.11±0.11%). These values indicate that both species have high carbohydrate content, with Moringa ovalifolia having a slightly higher average value compared to Moringa oleifera. The high carbohydrate content in both Moringa ovalifolia and Moringa oleifera suggests that these plants can be significant energy sources when included in the diet. The high carbohydrate content makes these plants suitable for incorporation into food products, particularly in regions where energy-dense foods are needed, they can be used in flours, porridges, and other food items. For livestock, high carbohydrate content is beneficial as it provides the necessary energy for growth, reproduction, and lactation, both Moringa species can be valuable components in animal feed formulations. Carbohydrates are important for bioenergy production, particularly in the production of bioethanol. The high carbohydrate content of Moringa ovalifolia and Moringa

oleifera could make them good candidates for biofuel production, contributing to renewable energy sources. Carbohydrates can also be processed into various bioproducts, including bioplastics, sweeteners, and fermentation substrates. These applications could benefit from the high carbohydrate content of these Moringa species. This study's result of 56.33±0.29 for Moringa oleifera compares favorably to the (51.40%) carbohydrate content of Bitter leaf reported by [18]. However, Telfairia pedata (Oyster Nut) seeds had low carbohydrate content (4.01%), according to [19].

Crude Protein

Table 1 show that Moringa ovalifolia leaves had considerably greater mean crude protein content ($P < 0.05$), likely due to better soil fertility and environmental conditions. Moringa ovalifolia has a greater crude protein concentration of 17.1 ± 0.1%, similar to Telfairia pedata (16.04 ± 0.51) [12], but lower than the 22.97% found in [20]. Oyster nut seeds had a considerably greater crude protein value of 29.08 ± 1.43% compared to moringa oleifera (9.38 ± 0.23%) in this study [21]. With a protein content of 17.1 ± 0.1%, Moringa ovalifolia is a rich source of protein. This makes it an excellent choice for dietary inclusion, especially in regions where protein malnutrition is prevalent. It can contribute significantly to daily protein intake, supporting muscle development, immune function, and overall health, though lower in protein content at 9.38 ± 0.23%, Moringa oleifera is still a valuable source of protein. Its protein content, while less than that of Moringa ovalifolia, is comparable to many other plant-based protein sources and can still contribute positively to a balanced diet. For moringa ovalifolia, higher protein content may enhance its value as a crop, potentially offering higher economic returns for farmers. It could be marketed specifically for its high protein benefits, making it more attractive in health food markets. Despite its lower protein content, Moringa oleifera remains widely cultivated and valued for its other nutritional properties, including vitamins, minerals, and antioxidants. It also has well-established agricultural practices which might offset the lower protein content in economic terms. The high protein content in moringa ovalifolia makes it suitable for fortifying foods, creating protein supplements, and developing high-protein food products like protein bars and shakes. It could be particularly useful in vegan and vegetarian diets. The significantly higher protein content in Moringa ovalifolia (17.1 ± 0.1%) compared to Moringa oleifera (9.38 ± 0.23%) positions Moringa ovalifolia as a superior source of protein in dietary applications. Both species offer valuable nutritional benefits, but the choice between them may depend on specific dietary needs, economic considerations, and intended uses in food products. This comparison underscores the importance of proximate analysis in understanding and leveraging the nutritional properties of different food sources. According to [22], plants that consume more than 12% of their energy from protein are considered viable protein sources. As a result, the protein value discovered for moringa ovalifolia in this study suggests that it could be an easily available and inexpensive protein source for maintaining normal biological processes. The results suggest that the Moringa ovalifolia leaf contains more protein than the Moringa oleifera leaf, most likely because to higher soil fertility and improved environmental circumstances.

Lipid Content

Lipid content is an essential parameter in proximate analysis, indicating the amount of fats present in a food sample. Lipids are a crucial part of the diet, providing energy, essential fatty acids, and aiding in the absorption of fat-soluble vitamins (A, D, E, and K). The amount and type of lipid content can influence the nutritional and culinary properties of the food. The lipid content of the leaves varied between Moringa ovalifolia and Moringa oleifera. With a lipid content of 1.69 ± 0.09%, Moringa ovalifolia is low in fats, this makes it suitable for low-fat diets and for individuals who need to manage their fat intake due to health conditions like cardiovascular diseases. The lower fat content also means it can be consumed in larger quantities without significantly increasing caloric intake from fats. At 7.76 ± 0.21%, Moringa oleifera provides a higher fat content, which contributes to its energy density. The fats in Moringa oleifera can provide essential fatty acids and support the absorption of fat-soluble vitamins, making it a valuable addition to diets where these nutrients are needed. However, higher fat content may not be suitable for all dietary needs, particularly for those requiring low-fat options. Moringa ovalifolia, its low lipid content aligns with dietary recommendations for reducing the risk of chronic diseases associated with high-fat intake, such as heart disease and obesity. It can be beneficial for those looking to reduce overall fat intake while still obtaining essential nutrients. The higher lipid content in Moringa oleifera can offer additional health benefits by providing essential fatty acids like omega-3 and omega-6, which are important for brain function, reducing inflammation, and supporting heart health. The presence of healthy fats can also enhance satiety and help in maintaining a balanced diet. With lower fat content, Moringa ovalifolia can be used in recipes where minimal fat is desired. It can be included in salads, smoothies, and soups without altering the fat profile significantly. Its low fat makes it a versatile ingredient in health-conscious and weight management diets. The higher fat content makes Moringa oleifera suitable for richer culinary applications. It can add a nutty flavor and smooth texture to dishes. It is ideal for use in oils, sauces, and as a fat source in vegetarian and vegan recipes. The higher fat content can enhance the mouthfeel and palatability of various dishes. Moringa oleifera, with its higher lipid content of 7.76 ± 0.21%, offers substantial nutritional benefits by providing essential fats and supporting the absorption of fat-soluble vitamins. This makes it suitable for energy-dense dietary needs and culinary applications requiring richer textures and flavors. On the other hand, Moringa ovalifolia, with a lower lipid content of 1.69 ± 0.09%, is ideal for low-fat dietary requirements and applications where minimal fat is desired. Both species provide unique advantages depending on dietary goals, health considerations, and culinary applications, highlighting the importance of lipid content in their overall nutritional profiles. [23] obtained a very same result (3.46%) for the lipid content of Telfairia occidentalis leaves. According to [13], Telfairia Pedata seeds have substantially higher lipid content (61.20±1.20%) than leaves in the current study. The findings suggest that the examined leaves have health benefits, as their use does not appear to contribute to obesity.

Crude Fibre Content

The leaves of Moringa oleifera and Moringa ovalifolia had mean crude fiber levels of 11.23±0.16 and 7.09±0.11, respectively. The crude fiber value of Moringa oleifera leaf is consistent with the result (13.40±0.37) obtained by [20]. This study found that the crude fiber content of Moringa ovalifolia leaves was much greater than that of Oyster Nut (1.00±0.13%) reported by [13]. With a fiber content of 7.09 ± 0.11%, Moringa ovalifolia provides a moderate amount of dietary fiber. It contributes to overall fiber intake, supporting digestive health, though not as substantially as Moringa oleifera. at 11.23 ± 0.16%, Moringa oleifera is a rich source of dietary fiber. This high fiber content enhances its role in promoting digestive health, helping in the management of blood sugar levels, and reducing cholesterol. It can be particularly beneficial in diets requiring high fiber intake for managing conditions like diabetes and heart disease. The moderate fiber content in moringa ovalifolia could aids in maintaining regular bowel movements, preventing constipation, and contributing to overall gut health. Its fiber can also aid in the slow release of sugars into the bloodstream, thus helping to maintain stable blood sugar levels. The higher fiber content in moringa oleifera provides more substantial health benefits, including improved digestion, increased satiety (which can aid in weight management), and enhanced cholesterol management. The higher fiber content also means it can better help in maintaining healthy blood sugar levels. Moringa oleifera, with its higher fiber content of 11.23 ± 0.16%, is superior to Moringa ovalifolia (7.09 ± 0.11%) in terms of providing dietary fiber. This higher fiber content enhances its health benefits, particularly for digestive health, cholesterol management, and blood sugar regulation. While Moringa ovalifolia offers moderate fiber benefits, it is particularly notable for its higher protein content, which can cater to different nutritional needs and markets. Both species offer valuable health benefits and can be used complementarily depending on dietary requirements and product development goals. This highlights how seeds are frequently poor providers of crude fiber. Dietary fiber consumption has been related to lower serum cholesterol levels and a lower risk of a variety of health conditions, including coronary heart disease, hypertension, diabetes, colon cancer, and breast cancer [24]. According to the findings of this study, Moringa oleifera leaves had more fiber than Moringa ovalifolia leaves. The crude fiber content of the leaves varied significantly ($P < 0.05$) and was often higher.

Moisture Content

Moisture content is a critical parameter in proximate analysis, indicating the amount of water present in a food sample. It influences the shelf life, storage conditions, and overall quality of food products. High moisture content can promote microbial growth, leading to spoilage, while low moisture content can enhance preservation and stability. These values show that Moringa ovalifolia has significantly lower moisture content compared to Moringa oleifera. With a moisture content of 2.11 ± 0.11%, Moringa ovalifolia has a very low water content, which is advantageous for shelf life and storage. Lower moisture content reduces the risk of microbial growth and spoilage, making it easier to store for extended periods without significant loss of quality. This characteristic is particularly beneficial for regions with limited access to preservation technologies. At 10.74 ± 0.05%, Moringa oleifera has a higher moisture content, which may require more careful storage conditions to prevent spoilage. Higher moisture levels can lead to faster microbial growth, necessitating the use of proper drying techniques, airtight packaging, and possibly refrigeration to extend its shelf life. The low moisture content means that the other nutrients are more concentrated. This can be advantageous for nutritional density, providing more nutrients per unit weight. For instance, the higher protein content observed in Moringa ovalifolia can be attributed, in part, to its lower moisture content, concentrating its nutrient profile. Higher moisture content dilutes the concentration of nutrients per unit weight. Although Moringa oleifera is rich in fiber and other nutrients, the higher moisture content means these nutrients are less concentrated compared to Moringa ovalifolia. For moringa ovalifolia, its low moisture content makes it suitable for powdered supplements and dried food products. It can be easily ground into a fine powder, which can then be used in teas, smoothies, or as a dietary supplement. Its stability at low moisture levels makes it an excellent ingredient for long-term storage products. With higher moisture content, Moringa oleifera might be better suited for fresh or minimally processed products. It can be used in soups, stews, or as a fresh vegetable, where its higher moisture content can contribute to the texture and moisture of the final dish. For dried products, additional processing to reduce moisture content may be required. Moringa ovalifolia, with its lower moisture content of 2.11 ± 0.11%, offers advantages in terms of longer shelf life, better storage stability, and more concentrated nutrients. These factors make it highly suitable for dried and powdered products. On the other hand, Moringa oleifera, with a moisture content of 10.74 ± 0.05%, may require more careful handling and storage but is well-suited for fresh and minimally processed products, offering different culinary and nutritional benefits. The choice between these two species can depend on specific needs, such as shelf life requirements, nutritional concentration, and the intended use of the food products. A higher moisture level helps to preserve the cell's protoplasmic material [25]. It also stimulates the activity of hydrophilic enzymes and coenzymes, which are necessary for the metabolic activities of leafy green vegetables [26]. Nonetheless, the higher moisture content may result in a quality issue because the samples are more prone to bacterial degradation during storage [27].]. Comparatively, from the present analysis, Moringa oleifera leaf is more sensitive to deterioration by bacteria on storage and easier digestible on intake than the Moringa ovalifolia leaf because it has higher moisture content. This may be attributed to the plant’s geographical location and the research’s analytical precision. The findings demonstrate that the leaves significantly varied in percentage moisture content at ($P < 0.05$).

Figure 1. Moringa Ovalifolia leaf

Figure 2. Moringa Oleifera leaf

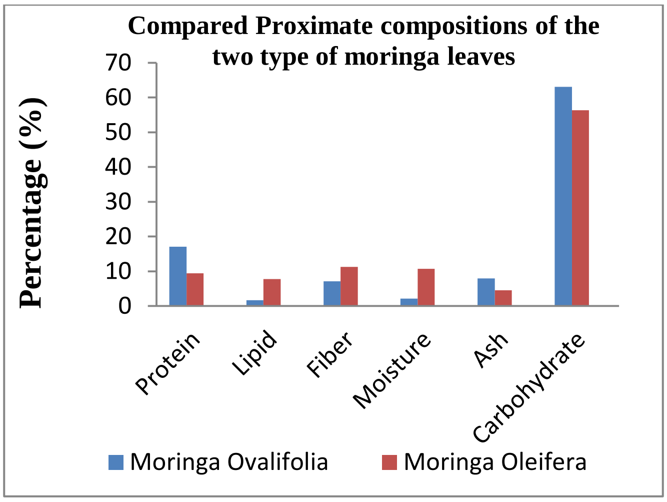

Figure 3. Comparative Proximate values of Moringa Oleifera and Moringa Ovalifolia

Table 1. Proximate compositions of Moringa Ovalifolia and Moringa Oleifera leaves

Parameters	Moringa ovalifolia	Moringa oleifera
Protein	17.1 ± 0.1	9.38 ± 0.23
Lipid	1.69 ± 0.09	7.76 ± 0.21
Fiber	7.09 ± 0.11	11.23 ± 0.16
Moisture	2.11 ± 0.11	10.74 ± 0.05
Ash	7.93 ± 0.12	4.56 ± 0.29
Carbohydrate	63.11 ± 0.11	56.33 ± 0.29

5. Conclusion and Future Scope

In this comparative investigation, the proximate composition of Moringa oleifera and Moringa ovalifolia leaves acquired from Katsina city, Nigeria, was carried out, and the results revealed fascinating findings. The high moisture content for moringa oleifera leaves, indicating that it may not be suited for lengthy storage because of high water activity, which will be more sensitive to bacterial spoiling during storage than moringa ovalifolia leaves having lower moisture content. Contrarily, moringa ovalifolia leaves reveal higher ash content, indicating a potentially greater quantity of minerals than morimga oleifera leaves. Regarding protein content, moringa ovalifolia leaves exhibited significantly greater amounts, thus a valuable source of protein adequate for bodily functions. Although the lipid content of the leaves was very low, moringa oleifera contained larger quantities than moringa ovalifolia. This shows that the leaves healthwise are not likely to contribute to obesity when consumed. Furthermore, the crude fibre was substantially higher in moringa oleifera leaves than in moringa ovalifolia leaves. The leaves are therefore regarded good sources of dietary fiber, which may be linked to their greater carbohydrate content. The carbohydrate content of the leaves was often high, indicating a significant energy source. The research findings provide vital insights for understanding these leaves' nutritional worth and prospective applications, so contributing to the larger knowledge of these valuable plant resources.

Further research is necessary to discover the anti-nutrients, minerals and amino acids, and phytochemicals of the leaves for possible nutritional and medicinal purposes. Further investigation should also be done by compounding processed diets from the two leaves i.e. moringa oleifera and moringa ovalifolia, and fed to experimental animals to assess the effects on nutritional parameters.

Data Availability

Because of the technical and time limitations, the raw data required as part of an ongoing study cannot be shared.

Conflict of Interest

The authors have no any potential conflicts of interest to declare.

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Authors' Contributions

Both authors Ibrahim Usman Gafai[1]* and Maryam Lawal Darma[2] carried out the research and the author Ibrahim Usman Gafai[1]* drafted the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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