

Physicochemical Properties of *Moringa Oleifera* Seeds: Promising Potential for Applications across Nutrition and Health Sector.

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DOI: <https://doi.org/10.51584/IJRIAS.2025.1010000012>

Received: 01 September 2025; Accepted: 07 September 2025; Published: 28 October 2025

ABSTRACT

The physicochemical attributes of defatted *Moringa oleifera* seeds renowned for their versatile health applications have been the focal point of substantial research. This study extensively investigated the nutritional profile of *Moringa oleifera* seeds to further inform their medicinal use. The defatted seed meal of *Moringa oleifera* was subjected to proximate, mineral, vitamin and amino acids analyses with the fatty acid composition. The results of the proximate composition show moisture content (9.81 %), ash (3.79 %), crude fibre (4.95 %), protein (23.97 %), crude fat (5.88 %) and carbohydrate (51.60 %). Mineral composition shows that the seed is rich in potassium, phosphorus, calcium and sodium with 271 mg/100g, 180 mg/100g, 118 mg/100g and 62 mg/100g respectively. The seed has vitamins A and C with 38.12 mg/100g and 45.42 mg/100g respectively. The seed also contains both essential and non-essential amino acids which are present in appreciable concentrations in the defatted seed meal. The seed oil which was extracted with n-hexane gave 34.38 %. The extracted oil revealed iodine value of 61.32 gI₂/100g, saponification value, 231 mgKOH/g and acid value of 1.15 mg/g. The oil also contains high levels of unsaturated fatty acids with oleic acids (monounsaturated) having up to 75.7 % but linolenic (polyunsaturated) with 2.12 % while the saturated fatty acids gave a total of 16.39 %. These reveal medicinal composition and emphasizing the promising potentials for application across nutrition and health sectors. This contributes to the expanding body of knowledge concerning the versatility of this medicinal plant to help in times of health challenge.

Keywords: *Moringa oleifera*; physicochemical properties; nutrition; healthcare, fatty acids and amino acids.

INTRODUCTION

Medicinal plants have been an integral part of human health and well-being for millennia, providing natural remedies for a wide range of ailments. With the resurgence of interest in natural and holistic health, these plants continue to be relevant in modern medicine. Medicinal plants have played a vital role in healthcare for centuries, offering natural remedies for a wide range of ailments. From ancient civilizations to modern medicine, these botanical treasures continue to be a source of nutrition, healing and well-being.

Moringa oleifera, commonly known as the drumstick tree, miracle tree, horseradish tree, or simply *Moringa*, is a fast-growing, mainly found in the Middle East, African and Asian countries, but, due to its adaptability, it is spreading to other areas, especially tropical and subtropical lands affected by drought (Boopathi and Abubakar, 2021; Maryam and Manzoor, 2023). It is also cultivated in tropical and subtropical regions around the world for its nutritional, medicinal, and industrial uses. It grows and reaches 15 m in height, with a diameter of 20–40 cm at chest height. The *Moringa* genus comprises 14 species belonging to the Moringaceae family (Madrigales-Reátiga et al., 2021). Among these, *M. oleifera* is most widely recognized species. *M. oleifera*, being known to thrive in extreme arid conditions, and all parts of the plant, including the leaf, seed, root, bark, flower, seedpod, gum, oil, and fruits, are utilized due to their various environmental applications and multiple health benefits both to humans and animals.

Moringa oleifera is celebrated for its remarkable nutritional and medicinal properties. Rich in vitamins, minerals, antioxidants, and protein, its leaves, pods, seeds, and flowers offer extensive health benefits. With a history deeply rooted in traditional medicine, *Moringa* is used to address a spectrum of conditions like inflammation,

diabetes, and digestive disorders (Chiş et al., 2023). Its potent antioxidant and anti-inflammatory qualities combat oxidative stress and inflammatory ailments. Moreover, Moringa shows promise in regulating blood sugar levels and managing cholesterol, potentially reducing the risk of cardiovascular diseases (Ma et al., 2020; Patil et al., 2022). Beyond its medicinal value, Moringa's eco-friendly nature, thriving in arid climates while aiding soil conservation, underscores its significance in sustainable agriculture.

This present work aims to explore the various physicochemical properties such as their proximate, vitamin, mineral and fatty acid compositions of Moringa oleifera seeds to highlight their potential applications in addressing nutritional deficiencies, promoting health, and combating diseases.

Experimental

Materials collection and treatment

Fresh Moringa oleifera seeds were obtained from different farms in Ado-Ekiti, Ekiti State, Nigeria and transported to the Research Laboratory, Federal polytechnic, Ado-Ekiti, Nigeria. The fresh seeds were washed thoroughly, sun dried for 10 days, crushed to powder, sieved and stored in a plastic container for further use. All chemicals are of analytical grades and were used with no prior treatments.

Sample analysis and characterization

Proximate, mineral and vitamins analyses of defatted Morigea oleifera were carried out using standard analytical method. The proximate analysis was carried out by a method reported by Sodamade et al 2017. Mineral analysis of the seed was carried out using Atomic Absorption Spectroscopic (AAS) method while the vitamins in the seed were quantified by High-Performance Liquid Chromatography (HPLC) A.O,A.C (1990). The amino acid analysis was determined according to Adeyeye et al. (2022); Adeyeye and Olaleye (2012). The physicochemical parameters of the seed oil were determined using the methods obtained by Cervera-Chiner et al., 2024; Anwar and Rashid, 2007 while the fatty acid profile was carried out according to Cervera-Chiner et al., 2024; International olive council, 2017.

RESULTS AND DISCUSSION

Table 1: Proximate Composition Of Defatted Moringa Olafera Seed

Parameters	Composition (%)
Moisture	9.81
Ash	3.79
Crude fat	5.88
Crude fibre	4.49
Protein	23.97
Carbohydrate	51.60

The results of the proximate composition of defatted Moringa oleifera seed are present in Table1. The results show the seed contains 9.81 % moisture content, 3.79 % ash content, 4.49 % crude fibre content, 23.97 % protein content, 5.88 % fat content, and 51.60 % carbohydrate content. This nutritional profile indicates the seeds' significant potential contributions to both dietary nutrition and health care.

The protein content (23.97%) M. oleifera seed shows the seed has potential for growth, repair, and maintenance of body tissues, serving as building blocks for muscles, enzymes, hormones, and immune molecules (Islam et al., 2023). The high protein content of the seeds positions them as an excellent source of plant-based protein.

Adequate protein intake supports muscle development, enhances immune function, and contributes to overall physiological maintenance (Shao et al., 2021). Carbohydrates are the primary source of energy for the body, vital for brain function, physical activity and metabolic processes. The substantial carbohydrate content of 51.60 % obtained from the defatted seeds is an indicative that seeds can provide both immediate and sustained energy. This is beneficial for individuals requiring energy replenishment, such as athletes or those engaged in strenuous physical activities.

Fats are crucial for the absorption of fat-soluble vitamins (A, D, E, and K), providing essential fatty acids and serving as a significant energy source. The defatted seed shows a moderate fat content of 5.88 %. The moderate fat content of Moringa seeds includes beneficial fatty acids that support cardiovascular health, improve lipid profiles, and contribute to cellular function, ensuring a balanced dietary intake (Mehwish et al., 2022). Lower calorie consumption supports weight management, reducing the risk of obesity-related conditions such as type 2 diabetes, hypertension, and cardiovascular diseases (Jiang et al., 2022). A diet low in fat, particularly saturated and trans fats, can lower blood cholesterol levels. Reduced cholesterol levels can decrease the risk of developing atherosclerosis, heart attacks, and strokes. Seeds low in fat but high in fibre can enhance digestive health by promoting regular bowel movements and preventing constipation. A fibre-rich diet can reduce the risk of developing digestive disorders, such as diverticulitis and irritable bowel syndrome. Consuming low-fat seeds can provide a balanced intake of nutrients necessary for overall health and well-being (Jiang et al. 2022).

Fibre is important for maintaining digestive health, aiding in bowel regularity, controlling blood glucose levels, and reducing cholesterol. The levels of fibre content available in defatted Moringa seeds (4.49 %) can help to prevent constipation, supports a healthy gut microbiome, and reduces the risk of chronic diseases such as diabetes and cardiovascular disease. Additionally, dietary fibre promotes satiety, assisting in weight management.

Ash content is indicative of the total mineral content in the seeds. Minerals are essential for various bodily functions, including bone health, nerve function, and enzymatic activity. The mineral contents in ash provide good supply of essential minerals such as calcium, magnesium, and potassium, which are crucial for maintaining bone density, muscle function, and metabolic health (Godswill et al., 2020).

Moderate moisture content (9.81 %) of the seed elongates the shelf life and preservation. Low or moderate moisture content is advantageous for storage stability. This could also reduce the risk of microbial growth, ensuring the seeds remain safe for consumption over extended periods.

Table 2 presents the results of mineral composition of defatted Moringa oleifera seeds. The analysis reveals significant levels of Potassium, Phosphorus, Calcium with 271.90, 180.32 and 118.55 mg/100g, respectively.

Potassium is vital for many physiological processes, including maintaining proper fluid balance in cells and tissues, regulating heartbeat and blood pressure to reduce the risk of hypertension and cardiovascular diseases, supporting muscle contractions to prevent weakness, and aiding in nerve signal transmission for overall nervous system health (Fenn 1940).

Table 2: Mineral Composition Of Defatted Moringa Olaifera Seeds

Mineral	Composition (mg/100g)
Sodium	62.65
Magnesium	30.66
Calcium	118.55
Potassium	271.90
Iron	10.23

Zinc	0.15
Phosphorus	180.32
Copper	0.05
Mangarese	0.08
Cobalt	N.D

N.D = Not Detected

Phosphorus is an important minerals in the body which helps in many functions. It helps in the maintenance and building strong bones and teeth. It is not left out in energy production especially in the production of adenosine triphosphate which acts as energy currency of the cell, cell repairs in building block of DNA and RNA and proper kidney function by helping filter waste product from the blood (Olagbemide and Alikwe, 2014).

Calcium is crucial for several bodily functions, including maintaining bone density and preventing osteoporosis, facilitate muscle contraction to prevent cramps and spasms, transmit nerve impulses for effective brain-body communication, and support the blood clotting process to prevent excessive bleeding (Godswill et al., 2022).

Sodium plays important roles in maintaining fluid balance in and around cells, ensuring proper nerve impulse transmission and muscle contraction, and regulating blood pressure (Bernal et al., 2023), where an appropriate amount is necessary for maintaining normal levels.

Defatted Moringa oleifera seeds, based on the results of the present work, offer a balanced source of essential nutrients that support overall health by contributing to strong bones and teeth through calcium, maintaining heart health and reducing hypertension risk with potassium, ensuring proper muscle function and nerve transmission with a mixture of calcium, potassium, and sodium, and maintaining proper hydration and electrolyte balance (Olagbemide and Alikwe, 2014).

Magnesium is present in appreciable amount in defatted Moringa oleifera seeds with 30.66 mg/100g. Its importance in the human body cannot be overemphasized in the maintenance of nerve and body function and helps in immune system by keeping the heartbeat steady.

Table 3 presents the results of vitamins in Moringa oleifera seeds. The analysis of M. oleifera seeds revealed the presence of Vitamin A and C with 38.12 and 45.42 mg/100g respectively.

Vitamin A is essential for several critical for maintaining good vision by aiding in the formation of rhodopsin for low-light and colour vision, support a healthy immune system by promoting white blood cell function, contribute to cell growth and differentiation for healthy skin and mucous membranes, and play a vital role in reproductive health and embryonic development (Murkey et al., 2023).

Table 3: Vitamin Composition Of Defatted Moringa Oleifera Seeds

Vitamins	Composition (mg/100g)
Vitamin C	45.42
Vitamin A	38.12
Vitamin B ₁₂	0.35
Vitamin B ₁	0.05

Vitamin B ₂	0.01
Vitamin B ₃	0.10

Vitamin C, also known as ascorbic acid, is a crucial nutrient with multiple benefits. It acts as a powerful antioxidant to protect cells from free radical damage and reduce the risk of chronic diseases, enhances the immune system by promoting white blood cell function, improves skin defense, and aids antibody production (Pehlivan, 2017). It is essential for collagen synthesis, which supports the health and repair of skin, cartilage, bones, and blood vessels, and it improves the absorption of non-heme iron, helping to prevent iron deficiency anemia.

Moringa oleifera seeds contribute to overall health in several ways, including enhanced vision and skin health supported by vitamin A, boosted immune system function due to the presence of both vitamins, antioxidant protection against oxidative stress and chronic diseases provided by vitamin C, and improved iron absorption and collagen formation, supporting tissue health and repair (Pehlivan, 2017).

Vitamins B₁₂, B₁, B₂ and B₃ are present in small quantities. Their importance in the body is not left out as they are important for various bodily functions, including energy production, nerve function and cell growth.

Table 4: Essential Amino Acid Profile of Defatted Moringa Olaifera

Essential amino	Composition (%)
Leucine	1.05
Lysine	0.92
Threonine	5.21
Valine	2.57
Histidine	1.09
Isoleucine	0.95
Methionine	0.85
Phenylalanine	1.32

Total essentials amino acids 13.96 %

Table 5: Non-Essential Amino Acids of Defatted Moringa Oleifera Seed

Non-essential A.A	Composition (%)
Glutamic acid	11.80
Arginine	4.95
Tyrosine	5.21
Cystine	2.11
Alanine	6.28

Aspartic acid	2.98
Serine	3.22

The results of essentials and non essentials amino acids composition (%) of defatted *Moringa oleifera* seeds are presented in Tables 4 and 5 respectively. Among the essentials amino acid profiles, Threonine has the highest concentration with 5.21 %, followed by valine and phenylalanine with 2.57% and 1.32% respectively. However, methionine has the least value in the defatted seeds. The Total Essential Amino Acids in this study is 13.96%. They are called essential amino acids because the human body cannot synthesize them and they must be made available through diet. They have been reported to be vital for various bodily functions which includes protein synthesis, tissue repair and overall maintenance of health (Fuglie, 2005). A deficiency in essentials amino acids can lead to series of health issues which include decreased immunity, digestive challenges and slow growth in children.

Out of all the non-essentials amino acid determined, glutamic acid had the highest concentration in the defatted sample. This was followed by alanine, tyrosine arginine and serine with 6.28 %, 5.21 %, 4.95 % and 3.22 % respectively. Non-essential amino acids are very important for bodily functions despite the ability of the body to produce them. They play a very important roles in protein synthesis, digestion and production of some essential molecules (Fuglie, 2005). Though the body can synthesize them, it is still very important that adequate intake of non-essential amino acids through diet for maintaining overall health and proper bodily functions.

Table 6: Physico Chemical Parameters of *Moringa Oleifera* Seed Oil

Physiochemical parameter	Composition
Moisture content	2.05 %
pH	6.01
Conductivity	988
Saponification value	231 (mg KOH/g)
Unsaponifiable matter	0.93 %
Iodine value	61.32 (gI ₂ /100g)
Peroxide value	9.40 meq/kg
Acid value (as oleic acid %)	1.15 %
Specific gravity	0.855

Table 6 depicts the physicochemical parameters of *Moringa oleifera* seed oil. The oil which was extracted with n-hexane was found to be 34.38 %. The percentage oil content detected was not so different from those reported by Anwar and Rashid, (2007), 34.80%; Tsaknis et al., (1999), 35.7 %; Lalas and Tsaknis, (2002), 38.3%. The result of the present study however is lower than the one obtained by Anhwange et al, (2004) with 41.58% as obtained in Nigeria. Though the present result was similarly obtained in Nigeria, the difference could probably be as a result of different geographical locations.

The result of the pH of the oil was 6.01 which shows that the oil was slightly acidic and a little bit below the neutral level. The moisture content obtained was with 2.01% was very low. The acid value of the oil was 1.15 % was generally very low. Acid value in fats and oils is very important as it measures free fatty acids which comes as a result of triglyceride hydrolysis and this indicates the quality of the oil, freshness and its stability. High values of acid values in oil could lead to rancidity, oil degradation and potentially making the oil unfit for

consumption. It has been reported that oils with lower values of acidity can be more useful for edible applications (Anwar and Rashid, 2007).

The saponification value of the seed oil of the present study gave 231 (mg KOH/g) and this is higher than the one obtained by Anwar and Rashid, (2007). The saponification value helps in assessing the oil components that make up a nutritional sample or a product within the body. It helps to quantify the amount of fatty acids in a substance by determining the amount of alkali needed to break down one gram of oil or fat. High values of saponification value suggests easy breaking down to short chain fatty acids (Anwar and Rashid, 2007).

The Iodine value of the present study gave 61.32 (gI₂/100g) and this relates the level of degree of unsaturation. The value obtained was in close agreement with Anwar et al., (2007). This reveals its nutritional benefits which may be essential for the body but must be consumed through diet. Oils with high iodine values have been reported to contain more essential fatty acids which are helpful to body function such as cellular processes and overall health but are more prone to oxidation which could lead to rancidity (Anwar et al., 2007) .

Table 7: Fatty acids composition of *Moringa oleifera* seed oil

Fatty acid	Composition (%)
Myristic	0.11
Palmitic	7.01
Stearic	6.44
Capric	2.64
Oleic	75.7
Palmitoleic	2.05
Linoleic	0.36
Linolenic	2.12
Arachidic	0.19

The fatty acid profiles of the *Moringa oleifera* seed oil extracted, expressed as percentage value of each fatty acid with respect to total fat content are presented in Table 7. Nine fatty acids were detected and identified with the carbons and number of bonds as shown below: Myristic (C14:0), Palmitic (C16:0), Stearic (C18:0) Capric (C10:0), Oleic (C18:1), Palmitoleic (C16:1), Linoleic (C18:2), Linolenic (C18:3) and Arachidic (C20:0). The results obtained suggest that the total monounsaturated fatty acid which contains both oleic and palmitoleic gave 75.7 % and 2.05 % respectively. The importance of oleic acid in the body cannot be overemphasized as it has favourable nutritional implications and may substantially contribute to the prevention of both cardiovascular disease and cancer (Oomah et al., 2000). It further helps in regulating cholesterol levels in the body, enhancing the immune response, promoting satiety for weight management and supporting the health of the brain (Pravst, 2014).

The main polyunsaturated fatty acid which contained linoleic and linolenic gave 0.36 % and 2.12 % respectively. Their presence in the body contribute to the maintenance of normal blood cholesterol levels (Cervera-Chiner et al., 2024 and Moreira et al., 2017). It helps in reducing cardiovascular disease risk and supporting bone integrity.

With regard to total saturated fatty acids which include myristic (0.11 %), palmitic (7.01 %), stearic (6.44 %), capric (2.64 %) and arachidic (0.19 %). All the saturated fatty acids detected constituted about 16.39 % in which palmitic acid has the highest concentration value. Generally saturated fatty acids from plant based ones have

been reported to be vital for structural integrity of cell membranes, hormone system and energy storage. When consumed on daily needs, the body stores saturated fatty acids as triglycerides and provide an essential energy reserves during high energy demand (Pravst, 2014 and Arishima et al., 2009).

CONCLUSION

Moringa oleifera seeds offer a rich nutritional profile, containing proteins, fats, carbohydrates, vitamins (such as A and C), minerals (including calcium, potassium, and sodium), presence of both essentials and non-essentials amino acids and fatty acids. These nutrients confer various health benefits, supporting vision, skin health, immune function, bone strength, muscle function, and cardiovascular health. Incorporating these seeds into the diet can provide a convenient way to access essential nutrients and promote overall well-being.

ACKNOWLEDGEMENT

The authors wish to appreciate Tertiary Education Trust Fund (tetfund) for providing financial assistance for making this paper a reality.

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