ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug1232

Comprehensive Evaluation of the Proximate, Phytochemical, Mineral and Ascorbic Acid Composition of *Ocimum gratissimum* Leaves

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Publication Date: 2026/09/05

Abstract: The leaves of Ocimum gratissimum are used as vegetables with medicinal properties. An analysis of the nutrient, phytochemical, mineral, and ascorbic acid components of Ocimum gratissimum leaves is conducted. The fresh leaves of Ocimum gratissimum were collected, processed, and analysed for proximate analysis, preliminary qualitative phytochemical screening, quantitative phytochemical analysis, minerals, and ascorbic acid using standard methods. The results obtained from proximate analysis included carbohydrate (54.87 ± 0.02%), crude protein (12.25 ± 0.01%), crude fiber (11.20 ± 0.03%), ash (8.83 ± 0.01%), crude fat (8.30 ± 0.03%), moisture (4.55 ± 0.02%), and an energy value of 1448.10 ± 0.10 KJ/g. The phytochemical screening carried out qualitatively showed the presence of saponin, tannins, flavonoids, and cardiac glycosides, while alkaloids were absent. The quantitative phytochemicals include; flavonoids (25.03 ± 0.10%), total phenols (10.29 ± 0.01%), saponins (3.11 ± 0.02%), glycosides (10.13 ± 0.01 mg Mineral analysis revealed appreciable concentrations of calcium (186.00 ± 0.10 mg/kg), potassium (98.00 ± 0.02 mg/kg), magnesium (75.60 ± 0.03 mg/kg), sodium (65.00 ± 0.01 mg/kg), and iron (1.73 ± 0.02 mg/kg), together with trace amounts of zinc, copper, manganese, and nickel, while lead was not detected. Vitamin C concentration in the leaves was also high (188.14 ± 0.01 mg/g). The results confirmed that Ocimum gratissimum leaves are a rich source of essential nutrients, bioactive phytochemicals, minerals, and antioxidants, which could be useful in traditional medicinal uses and have potential applications in functional foods, nutraceuticals, and phytopharmaceutical products.

Keywords*: Ocimum gratissimum, African Basil, Phytochemicals, Proximate Composition, Mineral Analysis, Vitamin C, Functional Food, Medicinal Plants.*

How to Cite: Abdul Dimeji Ishola; Shola Hezekiah Awodeji; Olusegun Olafimihan Ogundiran; Usman Oladayo Afolabi; Lateefah Olanike Adebayo; Monsurat Olajide; Abdulhakeem Dapo Olasupo; Ismail Kolawole Odetayo; Oluseye Gbadebo Olasunkanmi; Bolanle Mary Olawoye; Rasidat Adenike Tairu; Oluwafunmilola Dorcas Ogundipe; Monsurat Alarape Rahimi (2026) Comprehensive Evaluation of the Proximate, Phytochemical, Mineral and Ascorbic Acid Composition of *Ocimum gratissimum* Leaves. *International Journal of Innovative Science and Research Technology*, 11(8), 2840-2846. https://doi.org/10.38124/ijisrt/26aug1232

I. INTRODUCTION

Vegetables, some of which are derived from leafy parts of edible plants, are used as supplementary foods, side dishes, seasoning for soups, or served with the main course [23]. They provide essential nutrients required for normal physiological functions and contribute substantially to health promotion and disease prevention. Regular consumption of vegetables has been associated with improved gastrointestinal health, enhanced vision, and a reduced risk of chronic diseases such as cardiovascular disorders, diabetes, hypertension, obesity, anaemia, gastric ulcers, rheumatoid arthritis, stroke, and certain forms of cancer [1, 13]. Beyond their nutritional value, vegetables are important sources of

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug1232

bioactive compounds, including flavonoids, alkaloids, tannins, saponins, phenolic compounds, and terpenoids, many of which exhibit antioxidant, antimicrobial, anti-inflammatory, antidiabetic, anticancer, and immunomodulatory activities [7, 29]. Consequently, there is increasing global interest in vegetables that possess both nutritional and therapeutic properties for use as functional foods and nutraceuticals.

Among the many medicinal vegetables grown in the tropics, *Ocimum gratissimum* L., which is often referred to as scent leaf or African basil, is among the most used. The plant is part of the *Lamiaceae* family of plants and is found abundantly in the tropics, especially in West Africa [10]. The plant is popular due to the use of its leaves in cooking, medicine making, and industry. In Nigeria and other African countries, the leaves of *O. gratissimum* are used in cooking vegetables and herbs.

The nutritional and medicinal value of *O. gratissimum* has been contributed by the essential oils, nutrients, and bioactive compounds it contains. The leaves are comprised of essential oils like eugenol and thymol and phenols, which play an important role in their antimicrobial, antioxidative, anti-inflammatory, and antidiabetic properties [17, 28]. There are proteins, dietary fibre, minerals, vitamins, and many phytochemicals such as flavonoids, alkaloids, tannins, and saponins in *O. gratissimum* leaves. Traditionally, the leaves have been utilised for treating and managing gastrointestinal and respiratory infections, fever, skin diseases, diarrhoea, malaria, diabetes, and inflammation [2, 27].

Vitamin C (ascorbic acid) is also a vital natural antioxidant found in numerous leafy vegetables, and is crucial to immune function, collagen synthesis, and wound healing, as well as protection from oxidative stress [5]. Vitamin C is present in significant amounts in a few plant-based foods and medicines, and has the potential to greatly improve the nutritional and functional properties of these foods and medicines. This widespread use in ethnomedicine has triggered great interest in the plant's chemical composition, particularly in the field of functional foods and nutraceuticals.

Thus, this study was undertaken to assess the nutritional and phytochemical composition of *Ocimum gratissimum* leaves in terms of proximate, mineral, and vitamin C content, for scientific evidence of the nutritional and medicinal applications, and to highlight the potential applications of the plant in functional foods, nutraceutical formulation, and phytopharmaceutical development.

II. MATERIALS AND METHODS

➢ *Sample Collection and Preparation*

Mature fresh leaves of *Ocimum gratissimum* were collected from a farmland in Ikirun, Osun State, Nigeria. The samples were harvested around 16:00, in the evening, authenticated, washed, air-dried at an ambient temperature of 27 °C for two weeks, and pulverized into fine powder using a mill and sieved through a 0.05 mm pore sieve to obtain a fine powder. The sieved powdered sample was stored in a dry, clean, and airtight container until further analysis.

➢ *Proximate Analysis*

Moisture content was determined by oven drying at 105 °C to constant weight. Ash content was determined by incineration in a muffle furnace at around 450-550 °C. The crude protein by the Kjeldahl method, crude fat by Soxhlet extraction, and crude fiber by acid–alkali digestion. Carbohydrate content was calculated by the difference between the sums of all the proximate compositions from 100%. All these methods were conducted using the method according to [6]. Energy values were obtained by multiplying the carbohydrate, protein, and fat by the Atwater conversion factors of 17, and 37, respectively [30].

➢ *Mineral Determination*

Mineral composition was carried out according to [22]. The sample was digested with a mixture of concentrated nitric acid (HNO_3) and perchloric acid ($HClO_4$) at 115 °C for about 1 h until a clear solution was obtained. The resulting digest was allowed to cool, filtered, and diluted appropriately for atomic absorption spectrophotometry (AAS) analysis to determine the concentrations of potassium, sodium, calcium, magnesium, iron, zinc, copper, manganese, nickel, and lead.

➢ *Phytochemical Analysis*

The qualitative phytochemical screening of the powdered leaves of *Ocimum gratissimum* was carried out to determine the presence of phytochemicals. Those detected were quantified using standard methods. Qualitative and quantitative phytochemical analyses were conducted using standard procedures as described by [24].

➢ *Vitamin C Determination*

Vitamin C (Ascorbic acid) content was determined using the standard analytical method described by [9].

➢ *Statistical Analysis*

All analyses were carried out in triplicate, and results were expressed as mean ± standard deviation.

III. RESULTS AND DISCUSSION

The proximate composition of *Ocimum gratissimum* leaves demonstrated that the plant possesses an appreciable nutritional profile that supports its use as both a dietary vegetable and a medicinal plant. The carbohydrate content (54.87 ± 0.02%) was the most abundant component, followed by crude protein (12.25 ± 0.01%), crude fibre (11.20 ± 0.03%), ash (8.83 ± 0.01%), and crude fat (8.30 ± 0.03%). The calculated energy value of 1448.10 ± 0.10 kJ/g further highlights the nutritional contribution of the leaves as a potential source of dietary energy.

The moisture content of 4.55 ± 0.02% observed in this study was lower than the values reported for sun-dried (7.98 ± 0.16%) and shade-dried (9.04 ± 0.02%) *O. gratissimum* leaves, as well as the 13.60% reported by [7, 30]. The level of moisture content is one of the important parameters of stability and shelf-life of plant materials. The reduction in

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug1232

moisture content prevents the growth of microorganisms and enzymatic reactions to minimize decay and increase stability [20]. The low level of moisture content in the current experiment indicates the high storage stability and preservability of the leaves.

The ash content of 8.83 ± 0.01% shows the availability of considerable quantities of minerals in the leaves. Even though lower than the ash content of 13.54 ± 1.46% and 12.37 ± 0.98% for sun-dried and shade-dried samples, respectively, the ash content is considerable enough to suggest the presence of nutritionally significant inorganic substances [7]. Ash content is usually an indicator of mineral content in the plant materials and can indicate the contribution of minerals to perform physiological processes like enzyme activation, electrolyte balance, bone formation, and metabolism [14]. The crude protein content of 12.25 ± 0.01% was lower than the values reported by [7] for sun-dried (23.80 ± 0.55%) and shade-dried (20.98 ± 1.31%) leaves and slightly lower than the 14.35% reported by [30]. Variations in protein content among studies may be attributed to differences in geographical location, environmental conditions, soil fertility, plant maturity, processing methods, and analytical procedures. Nevertheless, the protein content obtained in this study indicates that *O. gratissimum* leaves can contribute to dietary protein intake. The leaves of this plant serve as a valuable source of additional protein for plant growth and development, tissue repair, enzyme production, hormone synthesis, and many metabolic processes [3].

The crude fat content of 8.30 ± 0.03% was higher than the values reported by [7] for both sun-dried (6.22 ± 0.14%) and shade-dried (5.98 ± 0.61%) samples, as well as the 4.60% reported by [30]. Lipids provide a concentrated source of energy and help to absorb fat soluble vitamins (A, D, E, and K). Furthermore, plant lipids can also be rich in essential fatty acids, which are beneficial for the health of the cardiovascular system and the functions of cells [15]. Such higher fat levels in this study could thus improve the nutritional value and energy contribution from the leaves.

Dietary fibre was known for its positive effect on gastrointestinal health and the prevention of chronic diseases. The crude fibre content of 11.20 ± 0.03% obtained in this study was in good agreement with what was reported by [7] as 11.45 ± 0.61% crude fibre content for sun-dried leaves, but higher than the 7.60% reported [30]. Dietary fibre has been linked to higher stool bulk, lower serum cholesterol levels, improved glycaemic control, and decreased risk of cardiovascular diseases, obesity, and colorectal cancer. Taking this into account, the relatively high fibre content of *O. gratissimum* leaves would also render them suitable for application in functional food formulations that aim to promote digestive and metabolic health [4].

The carbohydrate content of 54.87 ± 0.02% was considerably higher than the values reported by [7] for sun-dried (37.01 ± 1.11%) and shade-dried (41.61 ± 1.38%) leaves. The high carbohydrate content indicates that the leaves could be a substantial source of energy in the diet. Carbohydrates are the main source of metabolic energy and have important functions in normal physiological activities. The elevated carbohydrate content observed in this study is consistent with the high energy value recorded for the leaves and further enhances their nutritional importance [11].

From the results obtained from the qualitative and quantitative phytochemical analyses, it is clear that the leaves of *Ocimum gratissimum* possess various biologically active secondary metabolites, including saponins, phenols, tannins, flavonoids, and cardiac glycosides, but lack alkaloids (see Tables 2 and 3). In quantitative phytochemical analysis, it was observed that flavonoids were the highest phytochemical constituents (25.03 ± 0.10%) in concentration, followed by total phenols (10.29 ± 0.01%), saponins (3.11 ± 0.02%), glycosides (10.13 ± 0.01 mg/kg), and tannins (0.98 ± 0.03 mg/kg).

In qualitative phytochemical analysis, it was found that flavonoids were the main phytochemicals in the leaf sample.

The flavonoid content was 25.03 ± 0.10%, which is equal to the 25.30% value obtained by [30] for *O. gratissimum* leaves. It is worth mentioning that flavonoids exhibit many biologically active effects. The main characteristics of this group of compounds include antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and cardioprotective properties. They neutralize reactive oxygen species and act as protectors of the body from oxidative stress, which is responsible for the development of many chronic diseases, including heart diseases, diabetes, cancers, and neurodegenerative disorders. Obo Phenolic compounds were also present in appreciable quantities (10.29 ± 0.01%). Phenolics constitute one of the most important classes of plant antioxidants and have been associated with the prevention of oxidative stress-related diseases. Their ability to donate hydrogen atoms or electrons enables them to scavenge free radicals and inhibit lipid peroxidation [19]. The high phenolic levels found in the present study also contribute to the antioxidant activity of *O. gratissimum* and its potential application in functional foods, nutraceutics, and natural health products. The amount of phenol obtained was significantly higher than that reported by [25], which could be attributed to variation in environmental conditions, geographical location, maturity of the plants, and analytical techniques.

The qualitative detection and quantitative determination of saponins were found to be 3.11 ± 0.02%, which exceeded the results of [30], who reported 1.10%. Saponins have been recognized for their cholesterol-lowering, antimicrobial, anti-inflammatory, immunomodulatory, and anticancer effects. They have also been reported to increase nutrient assimilation and boost the functional properties of foods [21]. Hence, the relatively high saponin content of leaves of *O. gratissimum* makes it useful not only for nutritional purposes but also in the production of health-promoting dietary formulations and could explain its medicinal value.

Tannins were present in the leaves, and the concentration of tannins was 0.98 ± 0.03 mg/kg, which have astringent, antimicrobial, antioxidant, and anti-inflammatory

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug1232

properties, and are correlated to wound healing and protection against microbial infections. Tannins in *O. gratissimum* might play a role in the traditional application of the plant in gastrointestinal diseases and infectious diseases. Further, tannins have been found to have antibacterial activity against some pathogenic microorganisms and might be useful in maintaining food quality [12].

The qualitative screening revealed the presence of cardiac glycosides, and total glycoside content was quantified as 10.13 ± 0.01 mg/kg, indicating that they are important bioactive compounds with various pharmacological activities, such as cardiotonic, antimicrobial, and anti-inflammatory properties [16]. Cardiac glycosides were detected in the plant, indicating its possible therapeutic use, especially in the formulation of medicines derived from plants.

The mineral composition and Vitamin C content of *Ocimum gratissimum* leaves (Table 4) indicated the presence of macro and micro-elements with a noteworthy concentration of ascorbic acid. Among the minerals analyzed, calcium (186.00 ± 0.10 mg/g) was the most abundant, followed by potassium (98.00 ± 0.02 mg/g), magnesium (75.60 ± 0.03 mg/g), sodium (65.00 ± 0.01 mg/g), and iron (1.73 ± 0.02 mg/g). Small quantities of zinc, copper, manganese and nickel were also found. The presence of these minerals indicates their nutritional value and this aligns with their traditional usage as a medicinal vegetable.

The mineral present in the highest quantity in the present study was calcium. This is also higher than the concentration reported by [7] for sun-dried (128.42 ± 3.95 mg/g) and shade-dried (111.73 ± 3.41 mg/g) *O. gratissimum* leaves. Calcium is a critical mineral for bone and tooth formation and maintenance, for neuromuscular function, for blood clotting, and for intracellular signalling [26]. The calcium content detected was high, indicating that *O. gratissimum* leaves have potential in providing a good source of calcium that can be included in the diet to improve skeletal health. The same has been reported by [30] who noted that the beneficial effect of *O. gratissimum* on the availability of calcium in the ration.

The second most abundant mineral was potassium (98.00 ± 0.02 mg/g). These potassium levels are lower than those reported by [7] for sun-dried (185.43 ± 1.15 mg/g) and shade-dried (181.39 ± 1.00 mg/g) samples but demonstrate their great potential as a source of potassium, an essential electrolyte for plants. Potassium is important for protein synthesis, carbohydrate metabolism, maintaining fluid balance, regulating blood pressure, and normal heart function. The plant has also been found to have nutritional significance with regard to reduced risk of hypertension and stroke due to adequate potassium intake. Magnesium was present at 75.60 ± 0.03 mg/g, a value higher than those reported by [7] for both sun-dried (43.85 ± 0.45 mg/g) and shade-dried (40.62 ± 0.43 mg/g) samples. Magnesium is a cofactor for many enzymes and plays a role in energy production, glucose metabolism, maintenance of normal heart rhythm, and blood pressure [8]. The high amount of magnesium found in this study indicates that *O. gratissimum* leaves could help to meet the dietary requirements for magnesium and have a beneficial effect on cardiovascular and metabolic health. Sodium was detected at 65.00 ± 0.01 mg/g, while [7] reported lower values of 13.38 ± 1.64 mg/g and 16.33 ± 1.44 mg/g for sun-dried and shade-dried samples, respectively. Sodium is important for fluid balance, nerve impulse transmission, muscle contraction, and acid-base homeostasis. Sodium is a necessary nutrient in small amounts, but too much can lead to high blood pressure. In conclusion, the moderate sodium content in this study indicates that *O. gratissimum* can be a part of the diet without being a significant source of sodium.

The amount of iron found was 1.73 ± 0.02 mg/g, which is significantly lower than the value reported by [7]. Iron is an essential constituent of haemoglobin and is involved in important functions such as oxygen transport, cellular respiration, and energy metabolism. Iron Deficiency is one of the most common nutritional deficiencies globally and is a major contributor to anaemia. The amount of iron recovered in this study was fairly low, but it is clear that iron makes a contribution to the nutritional value of the leaves and that the leaves can be used as a source of dietary iron. Low levels of the trace elements zinc, copper, manganese, and nickel were found. Although these micronutrients are not abundant, they play a role in various physiological functions such as the immune system and antioxidant mechanisms, enzyme activation, and metabolic regulation. They also enhance the plant's nutritional value and potential health benefits. No lead was found in any of the leaf samples. The lack of this toxic heavy metal is a good indicator of safety and indicates that the plant material was not greatly contaminated by the environment. This is important as heavy metal accumulation in medicinal plants and herbal preparations for human consumption is still a problem of great concern. Among the most important results of this research was the ascorbic acid content in the leaves of *O. gratissimum*, which was 188.14 ± 0.01 mg/g. Vitamin C or ascorbic acid is an essential component of the antioxidant system; it protects cells from oxidation, enhances immune function, promotes collagen synthesis, aids healing of wounds, and boosts the absorption of non-haem iron from plant foods [5]. Therefore, *O. gratissimum* leaves are a good source of antioxidants and could be used to prevent oxidative stress diseases because of its extremely high ascorbic acid content.

Table 1 Proximate Composition of *Ocimum gratissimum* Leaves

Parameter	**Value (%)**
Moisture	4.55 ± 0.02
Ash	8.83 ± 0.01
Crude Fat	8.30 ± 0.03
Crude Fibre	11.20 ± 0.03

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug1232

Crude Protein	12.25 ± 0.01
Carbohydrate	54.87 ± 0.02
Energy (kJ/g)	1448.10 ± 0.10

Table 2 Qualitative Phytochemical Composition of *Ocimum gratissimum* Leaves

Compound	**Presence**
Saponins	+
Tannins	+
Flavonoids	+
Alkaloids	–
Cardiac Glycosides	+
Phenol	+

Table 3 Quantitative Phytochemical Composition of *Ocimum gratissimum* Leaves

Compound	**Value**
Glycosides (mg/kg)	10.13 ± 0.01
Flavonoids (%)	25.03 ± 0.10
Saponins (%)	3.11 ± 0.02
Tannins (mg/kg)	0.98 ± 0.03
Total Phenols (%)	10.29 ± 0.01

Table 4 Mineral Composition (mg/g) and Vitamin C Content (mg/g) of *Ocimum gratissimum* Leaves

Parameter	**Value**
Sodium (mg/*g*)	65.00 ± 0.01
Potassium (mg/*g*)	98.00 ± 0.02
Calcium (mg/*g*)	186.00 ± 0.10
Magnesium (mg/*g*)	75.60 ± 0.03
Iron (mg/*g*)	1.73 ± 0.02
Zinc (mg/*g*)	0.21 ± 0.02
Copper (mg/*g*)	0.02 ± 0.01
Manganese (mg/*g*)	0.17 ± 0.02
Nickel (mg/*g*)	0.18 ± 0.01
Lead (mg/*g*)	ND
Vitamin C (Ascorbic Acid) (mg/g)	188.14 ± 0.01

IV. CONCLUSION

The study reveals the complete assessment of nutritive values and phytochemical composition of *Ocimum gratissimum* leaves and reaffirms the use of Ocimum gratissimum leaves as a functional food and medicinal plant. The nutritional value of the leaves has been established to contain carbohydrates, proteins, dietary fiber, minerals, and phytochemicals. Flavonoids, phenolics, saponins, tannins, and glycosides were identified in the leaves. The phytochemicals are known to have antioxidant, antimicrobial, and anti-inflammatory properties, and other health-promoting properties. The presence of numerous active phytochemicals is a scientific confirmation of the use of *O. gratissimum* in ethnomedicine. The mineral analysis revealed that calcium, potassium, and magnesium are some of the macro and micro elements that are required by a plant, but no heavy metals, such as lead, were detected in the leaves. Moreover, an unusually high amount of vitamin C is proof of the nutritional importance of the leaves and adds to their antioxidant properties. Therefore, the findings of this research confirmed that *Ocimum gratissimum* leaves are rich in nutrients, phytochemicals, minerals, and antioxidants.

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