PROXIMATE AND MINERAL COMPOSITION OF *Ocimum gratissimum* LEAVES SUBJECTED TO DIFFERENT DRYING METHODS

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ABSTRACT

This study investigated the mineral contents and proximate analysis of scent leaves (Ocimum gratissimum) subjected to different drying methods. Fresh leaves of Ocimum gratissimum were collected from Uchi Market, Auchi, Edo State, Nigeria and identified by a qualified botanist at the biological garden in Auchi Polytechnic, Auchi. The leaves were divided into two portions. While a portion was shadow-dried, the other was sundried. The proximate analysis was examined, and the result revealed that in the sundried leaves, the moisture content, ash content, crude fat content, crude fibre content, crude protein and carbohydrate content were 7.98 ± 0.16 %, 6.22 ± 0.14 %, 11.45 ± 0.61 %, 13.54 ± 1.46 %, 23.80 ± 0.55 % and 37.01 ± 1.11 % respectively. While for the leaves subjected to shadow drying, the moisture content, ash content, crude fat content, crude fibre content, crude protein and carbohydrate content were 9.04 ± 0.02 %, 5.98 ± 0.61 %, 10.02 ± 0.42 %, 12.37 ± 0.98 %, 20.98 ± 1.31 % and 41.61 ± 1.38 % respectively. The mineral composition was also determined and the result revealed that, for sundried Ocimum gratissimum leaves; calcium, iron, potassium, magnesium and sodium were 128.42 ± 3.953 mg/g, 19.3065 ± 0.220 mg/g, 185.432 ± 1.14622 mg/g, 43.847 ± 0.446 mg/g, 58.487 ± 0.182 mg/g and 13.382 ± 1.643 mg/g respectively. Also, for shadow dried Ocimum gratissimum leaves, the mineral composition for calcium, iron, potassium, magnesium and chromium were 111.731 ± 3.411 mg/g, 12.391 ± 0.213 mg/g, 181.391 ± 1.003 mg/g, 40.617 ± 0.431 mg/g, 54.827 ± 0.178 mg/g and 16.331 ± 1.441 mg/g, respectively. The study therefore concludes that the sundried Ocimum gratissimum leaves have more nutritional and mineral composition than shadow-dried leaves. This indicates that the plant extract might also be a potential source for drug formulation, as the plant leaves are used traditionally for the treatment of many infectious diseases.

Keywords: Proximate analysis, mineral composition, shadow drying, sun drying, scent leaves

INTRODUCTION

The term vegetable refers to the edible part of a plant that is commonly or culturally consumed either fresh or cooked, typically in a savoury manner, whether spiced or salted. In Africa, numerous vegetable species are widely consumed in a boiled form. Certain others, primarily fruit and vegetables, are consumed uncooked. Various leafy vegetables have been integral to human nutrition from prehistoric times. These vegetables are generally low in calories and fat, while being high in protein relative to their caloric content. They are also rich in dietary fibre and contain significant amounts of certain minerals such as potassium, calcium, magnesium, and sodium, with others present in trace amounts. They are rich in phytochemicals with disease-fighting properties, including vitamin C, carotenoids, flavonoids, and saponins (Yilni and Naanma, 2020). Leafy vegetables, consumed by humans in processed, semi-processed, or fresh forms, and typically provided fresh to livestock, are recognised as excellent sources of carotene, ascorbic acid, riboflavin, folic acid, and minerals such as calcium, iron, and phosphorus. These nutrients confer numerous health benefits, including therapeutic applications for conditions such as scurvy, cold prevention, correction of hyperthyroidism, bone malformations, and anaemia in newborns (Abu *et al*., 2024).

The majority of frequently consumed vegetables are the tender leaves of plants; they are utilised as additional foods, side dishes, seasonings in soups, or accompanied by other main courses (Oluwole *et al*., 2019). Leafy vegetables are common components of the diet in the typical household of many tropical African nations (Ibeabuchi *et al*., 2023). These vegetables are inexpensive yet significant sources of essential nutrients, particularly in rural regions, where they provide considerable amounts of proteins, minerals, vitamins, fibres, and oils that are often scarce in daily diets (Idris *et al*., 2019). In Nigeria, several ethnic groups consume distinct leafy vegetables, either individually or in combination, which have been documented to possess components beneficial for the construction and repair of bodily tissues (Imosemi, 2020).

Ocimum gratissimum (Scent leaf) is an aromatic shrub characterised by its lime green, fuzzy leaves. It is utilised to enhance the flavour of soups and season dishes owing to its potent fragrance (Nkoli *et al*., 2020). *Ocimum gratissimum* is cultivated for the essential oil extracted from its leaves and stems. The essential oil exhibits antimicrobial qualities and is utilised as an insect repellent; similarly, the dried leaves can be burned for this purpose. It is utilised in traditional medicine for the treatment of diarrhoea, abdominal pain, as an antipyretic, and as a component in anti-malarial medicines (Awe *et al*., 2018), as well as a general tonic and antiseptic for wound dressing, skin infections, conjunctivitis, and bronchitis. An infusion of the leaves known as "Ocimum tea" is administered as a treatment for fever and sweating. The roots serve as sedatives for children. The phytochemical analysis of *Ocimum gratissimum* (scent leaf) indicates a high concentration of alkaloids, tannins, phytates, flavonoids, and oligosaccharides.

The rise in the consumption of Western diets and the disregard for indigenous foods has led to a significant increase in health issues associated with diet-related non-communicable diseases. Nonetheless, nutrients derived from native plant-based diets present a possible answer to certain health concerns (Chinwe *et al*., 2023). In the current economic recession, characterised by rising living costs, diets rich in vegetables and herbs will support family health. Vegetables and herbs provide essential vitamins and minerals necessary for optimal human bodily function. They represent the most economical dietary source and provide the sole feasible and sustainable method to guarantee the supply of micronutrients through nutrition (Idahosa *et al*., 2020).

The drying process is the optimal way for preserving the nutrients and bioactive chemicals in medicinal herbs at their highest levels. Furthermore, it diminishes the expense of the finished product, as weight influences both transportation and storage fees. Moreover, the product's shelf life has been extended due to moisture being a critical element in microbial proliferation (Periche *et al*., 2015). The dehydration of leaves can be accomplished by several means, as outlined in the studies on peppermint leaves and *Stevia rebaudiana* leaves (Ridhima *et al*., 2024). Moreover, to the authors' knowledge, no research has been completed on the impact of different drying processes on the proximate and mineral properties of *Ocimum gratissimum*. Therefore, the current study aimed to assess how different drying methods, sun drying and shadow drying, affect the proximate and mineral composition of *Ocimum gratissimum*.

MATERIALS AND METHODS

Sample Collection and Identification

Fresh leaves of *Ocimum gratissimum* were collected from Uchi Market, Auchi, Edo State, Nigeria and identified by a qualified botanist at the biological garden in Auchi Polytechnic, Auchi.

Materials Used

Distilled water, Ferric chloride, Potassium iodide, Ammonia, Hydrochloric acid, Felin A and B, Benedict solution, Nihydrine, Chloroform and Acetic acid, iodine, H_2SO_4. All chemicals are of analytical grade. Other materials include: digital weighing balance, filter paper, test tube rack, masking tape, foil paper, filter paper, beaker, gunnel and micro pipette (20 ml – 1000 ml). All glass was first washed with detergent and rinsed with distilled water, wrapped with aluminium foil after drying and sterilised by the dry heat method zin the oven at a temperature of 160^0C for 2-3 hours. The working area was disinfected thoroughly before and after use with ethanol (75% v.). Cotton wool was soaked in ethanol and used to clean the working bench; a Bunsen burner was put on, and the flame was allowed to burn, which helped in sterilising the air in the laboratory.

Preparation of Sample

The sample was prepared using the method outlined by Muhammad *et al.* (2020) with slight modifications. Fresh leaves of *Ocimum gratissimum* were properly washed to remove dirt and divided into portions. One portion was dried directly under the sun, while another was air-dried in shade away from the sun. The samples were pounded into fine powder and kept at 40C in an airtight container before further analysis.

Chemical Analysis

Proximate Properties

The proximate analyses of the formulated samples were investigated using the following standard methods:

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Determination of Moisture Content

The AOAC (2006) technique was employed to determine the moisture content of the samples. Two-gram portions of each flour blend sample were measured into pre-weighed dry crucibles. The crucibles containing samples were subjected to drying in an oven at 105^0C, subsequently cooled in desiccators for ten minutes, reweighed, and then placed back in the oven until a stable weight was achieved.

$$\% \text{ Moisture content} = \frac{\text{Weight } \textbf{loss}}{\text{Weight of sample}} \text{ x } 100$$

Determination of Ash Content

The ash content was evaluated according to the AOAC (2006) method, as modified by Uzoukwu *et al*. (2020). Two grams of the samples were measured in triplicate and placed into pre-weighed silica crucibles. The samples in the crucibles were incinerated on a heater in a fume cabinet to reduce smoke production. The materials were placed in crucibles and subjected to heating in a muffle furnace for approximately four hours at a temperature of 550°C. The samples underwent cooling in a desiccator and were then weighed. The heating process was performed multiple times until the samples attained a grayish-white colour and achieved a stable weight.

$$\% \text{ Ash} = \frac{\text{Weight of ash}}{\text{Weight of sample taken}} \text{ x } 100$$

Determination of Crude Proteins

Crude protein was quantified utilising the micro-Kjeldahl apparatus in accordance with AOAC (2006) guidelines. Two grams of the sample were placed in a Kjeldahl flask, and 30 ml of concentrated H_2SO_4 was added. Ten grams of potassium sulphate and one grams of copper sulphate were subsequently added to the mixture. The mixture was gently heated until frothing ceased. The digest was permitted to cool and was subsequently diluted with distilled water (washing the digestion flask) to a final volume of 100 ml. Ten millilitres (10 ml) of the dilute digest were transferred into a distillation flask, followed by the addition of 10 ml of 40% (w/v) sodium hydroxide. The mixture underwent distillation, and the released ammonia was captured in 10 ml of 2% boric acid with an indicator present. The titration was conducted using 0.01 N hydrochloric acid until a coloured endpoint was reached. A control was also prepared without a sample and treated in the same manner. The crude protein content was calculated by multiplying the percentage of Nitrogen in the digest by the conversion factor of 6.25.

$$\% \text{ N} = \frac{(\mathbf{a-b}) \boldsymbol{x}\ \mathbf{0.01}\ \boldsymbol{x}\ \mathbf{14}\ \boldsymbol{x}\ \boldsymbol{v}}{\text{W x C}} \text{ x } 100$$

Where: a is the digested sample's titre value; b is the blank sample's titre value; V is the volume after dilution; W is the dried sample's weight (mg); C = sample's aliquot, while 14 = Atomic weight of Nitrogen.

Crude protein = 6.25 x % N

Determination of Crude Fibre

The methods outlined by AOAC (2006) were utilised. Two grams of the flour samples were measured in duplicate into a 600 ml Pyrex beaker, followed by the addition of 200 ml of a 1.25% H_2SO_4 solution. The beaker was covered with a watch glass, and the contents were gradually heated on a hot plate for a duration of 30 minutes. The acid was removed via filtration through muslin fabric with a Buchner funnel, and the sample was rinsed three times with 50 ml of boiling water to eliminate any residual acid prior to returning it to the beaker. Following this, 200 ml of 1.25% NaOH solution was added to the residue in the beaker, which was then covered with a watch glass, gently heated on a hot plate for 30 minutes, and filtered thereafter. The residue was placed into a pre-weighed No. 2 sintered glass crucible using 50 ml of hot water and then cleaned twice with 30 ml of petroleum spirit. The crucible underwent drying in an oven at 800^0C until a stable weight was attained, subsequently followed by ignition in a muffle furnace at 600^0C until a light grey ash was formed. The crucible and its contents were allowed to cool to ambient temperature in a desiccator before being weighed.

$$\% \text{ Crude fibre} = \frac{\text{Loss in weight on ignition}}{\text{Weight of sample}} \times 100$$

Determination of Fat Content

The total fat content of the samples was assessed utilising the AOAC (2006) Soxhlet fat extraction technique. Five grams of the material were measured into a pre-weighed fat-free extraction thimble securely sealed with cotton wool. The thimble was positioned in the Soxhlet extractor equipped with a reflux condenser, all linked to a boiling flask with 200 ml of petroleum ether (boiling point 60^0C) on a heating mantle. After heating the flask and petroleum ether, the solvent evaporated and condensed in the thimble, extracting oil from the sample and refluxing it back into the boiling flask with the extracted oil. This was conducted for four hours. After extraction, the solvent (petroleum ether) was evaporated by heating to 70^0C on a hot plate, resulting in the lipid extract remaining in the flask. The flask containing its contents was positioned in an oven, subjected to drying at 110^0C for one hour, then chilled in a desiccator, and reweighed.

$$\% \text{ Fat content} = \frac{\text{Weight of oil}}{Weight\ of\ sample} \times 100$$

Determination of Carbohydrates

The carbohydrate content was obtained by different means, according to Onwuka (2005).
% Carbohydrate = (100% - % Moisture - % Crude protein - % Fat - % Ash - % Crude fibre)

Mineral Composition

The minerals were determined by the method described by AOAC (2005).

RESULTS AND DISCUSSION

The proximate analysis and mineral composition of *Ocimum gratissimum* leaves (sundried and shadow dried) are presented below.

Table 1: Proximate analysis of *Ocimum gratissimum* (sun-dried and shadow-dried)

Parameters	Percentage (%)	
	Sundried	**Shadow dried**
Moisture Content	7.98 ± 0.16	9.04 ± 0.02
Crude Fat	6.22 ± 0.14	5.98 ± 0.61
Crude fibre	11.45 ± 0.61	10.02 ± 0.42
Ash content	13.54 ± 1.46	12.37 ± 0.98
Crude protein	23.80 ± 0.55	20.98 ± 1.31
Carbohydrate	37.01 ± 1.11	41.61 ± 1.38

The results are expressed as Mean ± Standard deviation of each sample analyzed in duplicate.

Table 2: Mineral composition of *Ocimum gratissimum* (sun-dried and shadow dried)

Minerals	Sundried (mg/g)	Shadow dried (mg/g)
Calcium (Ca)	128.420 ± 3.953	111.731 ± 3.411
Iron (Fe)	19.307 ± 0.220	12.391 ± 0.213
Potassium (K)	185.432 ± 1.146	181.391 ± 1.03
Magnesium (Mg)	43.847 ± 0.446	40.617 ± 0.431
Phosphorus (P)	58.487 ± 0.182	54.827 ± 0.178
Sodium (Na)	13.382 ± 1.643	16.331 ± 1.441
Chlorine (Cl)	BDL	BDL
Selenium (Se)	BDL	BDL
Molybdenum (Mo)	BDL	BDL
Chromium (Cr)	BDL	BDL
Silicon (Si)	BDL	BDL

The results are expressed as Mean ± Standard deviation of each sample analyzed in duplicate.

DISCUSSION

This study examines the proximate analysis and mineral composition of *Ocimum gratissimum* leaves dried using different methods. The moisture content of the *Ocimum gratissimum* leaves was measured at 7.98 ± 0.16 % for sundried and 9.04 ± 0.02 % for shadow dried, indicating a favourable preservative capacity and enhanced resistance to deterioration. The determination of moisture content is a crucial factor in food quality, preservation, and resistance to deterioration. The moisture content of foods can be assessed using various methods (Ojewumi, 2016). Fats consist of various glycerides of fatty acids, exhibiting limited solubility in water and specific organic solvents such as ethyl ether, petroleum ether, acetone, ethanol, methanol, and benzene (Ojewumi, 2016). Extraction is performed using a Soxhlet apparatus with either ether or petroleum ether. The crude fat content values obtained for the samples were 6.22 ± 0.14 % for sundried leaves and 5.98 ± 0.61 % for shadow-dried leaves. This indicates a low-fat composition in the samples; however, sundried *Ocimum gratissimum* leaves contained a higher fat content compared to the shadow-dried leaves.

Crude fibre refers to the component of plant material that remains after the ash content has been removed. Initially, fibre was perceived as detrimental and considered the indigestible component of food. Research has revealed the advantages of a diet rich in fibre. High-fiber foods can absorb cholesterol and toxic substances present in food. It additionally increases the excretion of bile and sterols. Fibre is composed of cellulose, which can be digested to a significant degree by both ruminants and non-ruminants (Nkolu and Amako, 2020). Interest in dietary fibre in food and feed has risen due to the observed correlation between low fibre intake and serious health issues. The crude fibre content of *Ocimum gratissimum* leaves was measured at 11.45 ± 0.61 % for sundry drying and 10.02 ± 0.42 % for shadow drying. The high fibre content is advantageous for individuals seeking to increase dietary fibre intake (Etukudo and Ukpe, 2021). The ash content percentage for *Ocimum gratissimum* leaves was 13.54 ± 1.46% for sundried samples and 12.37 ± 0.98% for shadow-dried samples. Ash constitutes the inorganic residue remaining after the removal of water and organic matter from a substance through heating in the presence of specific oxidising agents. Ash content is significant as it indicates the quantity of mineral elements and the level of organic matter in the sample (Oludosu-Ajahi *et al.*, 2017). Organic matter comprises quantitative constituents such as proteins, lipids, carbohydrates, and nucleic acids. The ash content measurement indicates the total mineral content present in a food item (Nkolu and Amako, 2020).

The protein content of *Ocimum gratissimum* leaves was measured at 23.80 ± 0.55 % for sundried samples and 20.98 ± 1.31 % for shadow-dried samples. The protein content indicates that it serves as a significant energy source and facilitates growth and the repair of damaged tissues. Proteins play a crucial role in the body by facilitating the production of hormones, enzymes, and blood plasma. They function as immune boosters and facilitate cell division and growth. The consumption of *Ocimum gratissimum* leaves is recommended due to their high protein content (Idahosa *et al.*, 2020). The carbohydrate content was measured at 37.01 ± 1.11% for sundried *Ocimum gratissimum* leaves and 41.61 ± 1.38% for shadow-dried leaves. The carbohydrate content of the samples was determined by calculating the difference between the total percentages of moisture, fat, fibre, protein, and ash (Ebun-oluwa *et al.*, 2007). *Ocimum gratissimum* is a significant source of starch and energy (Idahosa *et al.*, 2020).

The mineral composition of the leaves is presented in Table 2. Calcium (Ca) concentrations were measured at 128.42 mg/g 3.953 for sundried samples and 111.731 mg/g 3.411 for shadow dried samples, both of which fall below the WHO recommended range of 24 – 28 mg/g. It is essential for the development and preservation of robust bones and teeth, as well as a significant component of human blood and extracellular fluids. About 99 percent of calcium in the body is stored in the bones and teeth (Udo *et al.*, 2021). The research indicates that *Ocimum gratissimum* leaves play a crucial role in enhancing calcium levels in the body (Idahosa *et al.*, 2020). It is important to recognise that the selection of calcium-rich foods should be approached cautiously, as approximately 85% of kidney stones are primarily composed of calcium compounds (Sodamade *et al.*, 2017).

Iron is essential for haemoglobin synthesis, and its deficiency results in anaemia. The daily recommended intake of iron for adults and children is 10 mg and 15 mg, respectively (Sodamade *et al.*, 2017). Iron plays a role in the oxidation of biomolecules, influencing obesity, which is a risk factor for multiple diseases. The iron concentration in the leaves of *Ocimum gratissimum* is 19.3065 mg/g ± 0.220 for sundried samples and 12.391 mg/g ± 0.213 for shadow-dried samples. The World Health Organisation recommends an iron level of 20 mg/kg in medicinal plants, while dietary intake ranges from 10 to 28 mg/day. Therefore, the leaves selected in this study may be recommended for inclusion in diets aimed at reducing anaemia, which affects over one billion individuals globally (Idahosa *et al*., 2020). The presence of iron indicates that the plant is crucial for red blood cell production and oxygen transport in the body, as evidenced by the research of Bahl and Bahl (2006).

The potassium concentration in the analysed *Ocimum gratissimum* leaves is 185.432 mg/g ± 1.14622 (sundried) and 181.391 mg/g ± 1.003 (shadow dried). Potassium plays a role in carbohydrate metabolism and protein synthesis. It sustains fluid balance, regulates blood pressure, modulates heartbeat, and decreases the risk of stroke (Oselebe *et al*., 2013).

Magnesium concentrations were measured at 43.847 mg/g ± 0.446 for sundried samples and 40.617 mg/g ± 0.431 for shadow-dried samples. Magnesium plays a crucial role in sustaining a normal heart rhythm and is occasionally administered intravenously to mitigate the risk of atrial fibrillation and cardiac arrhythmia (Ugwuona *et al*., 2021). Magnesium plays a role in the regulation of blood pressure and the release of insulin. Magnesium has been shown to effectively alleviate coronary heart disease and stroke, as well as assist in cellular repairs (Agunbiade *et al*., 2015). The recommended daily allowance of magnesium for adults is 350 mg per 100 g (Sodamade *et al*., 2017). In humans, its deficiency is associated with severe diarrhoea, persistent migraines, and neuromuscular hyperirritability in chickens (Philip *et al*., 2014).

The phosphorus content in *Ocimum gratissimum* leaves was measured at 58.487 mg/g 0.182 for sundried samples and 54.827 mg/g 0.178 for shadow dried samples, both of which fall within the WHO recommended range of 52-100 mg/g. Phosphorus is an essential constituent of bones and teeth, primarily in the form of calcium phosphate. It is also an essential component of ATP (adenosine triphosphate), which serves as the body's energy currency and contributes to the maintenance of pH balance. The sodium concentration in *Ocimum gratissimum* leaves is 13.382 mg/g 1.643 for sundried samples and 16.331 mg/g 1.441 for shadow dried samples, both of which fall within the WHO recommended range of 4.8 – 55.6 mg/g. Sodium plays a crucial role in maintaining cellular water balance and is essential for the functioning of nerve impulses and muscles (Shrimanker & Bhattarai, 2019). Sodium contributes to the maintenance of normal acid-base balance (Chinwe *et al*., 2023). Chlorine, selenium, molybdenum, and silicon were not detected.

CONCLUSION

The sundried leaves of *Ocimum gratissimum* exhibit higher levels of crude fibre, crude fat, ash content, and crude protein in comparison to the shadow-dried leaves. Sun-dried *Ocimum gratissimum* leaves serve as a superior source of protein, whereas shadow-dried *Ocimum gratissimum* leaves provide a more effective source of starch and energy. Sundried *Ocimum gratissimum* leaves exhibit a higher mineral composition of calcium, iron, potassium, magnesium, and phosphorus, whereas shadow-dried *Ocimum gratissimum* leaves contain a greater sodium composition. The study concludes that sundried *Ocimum gratissimum* leaves possess a superior nutritional and mineral composition compared to shadow-dried leaves. This suggests that the plant extract may serve as a potential source for drug formulation, as the leaves of the plant are traditionally utilised for the treatment of various infectious diseases. This study demonstrated that the leaves of *Ocimum gratissimum* possess significant nutritive values, which include essential nutrients. The plant leaf is suitable for consumption.

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