

Proximate, Phytochemical and Mineral Assessment of *Cymbopogon citratus* Leaf**By****MOHAMMED, Umar Manko, AKPOKIERE, Roseline Ugbede., FANIKA Suleiman, and
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Nigeria*****Correspondence email : mohammedumarmanko@yahoo.com*****Correspondence Phone Number : 07068762152****ORCID ID: [0009- 0004- 8948-8205](https://orcid.org/0009-0004-8948-8205)****DOI: <https://doi.org/10.5281/zenodo.22891654>****Abstract**

Cymbopogon citratus, commonly known as lemongrass is an aromatic perennial grass widely used as a culinary spice, herbal beverage and traditional medicinal plant. This study assessed the proximate, phytochemical and mineral composition of *C. citratus* leaves. The proximate composition showed moisture content of 10.93%, ash 18.86%, fat 9.98%, protein 10.92%, crude fibre 21.51% and carbohydrate 27.80% respectively. The phytochemical analysis indicated phenolic compounds as the most abundant quantified constituent (428.79 mg/100 g), followed by flavonoids (121.11 mg/100 g), saponins (120.80 mg/100 g) and alkaloids (11.98 mg/100 g). The mineral analysis revealed manganese (2.57 ± 0.04 mg/100 g) and calcium (2.14 ± 0.02 mg/100 g) as the most abundant minerals, followed by potassium (0.64 ± 0.01 mg/100 g), sodium (0.41 ± 0.01 mg/100 g), copper (0.39 ± 0.01 mg/100 g), iron (0.11 ± 0.02 mg/100 g) and zinc (0.03 ± 0.03 mg/100 g) respectively. The results demonstrate that *C. citratus* leaves contain appreciable nutritional components and bioactive phytochemicals, together with several essential minerals. The presence of saponins and alkaloids warrants consideration of anti-nutritional effects of *C. citratus*. Recent studies similarly confirm the presence of phenolics, flavonoids, saponins and diverse mineral elements in lemongrass. Overall, *C. citratus* leaves have potential as a proximate and phytochemical resource, although further studies on mineral bioavailability, anti-nutritional factors, toxicity and processing effects are recommended.

Keywords: *Cymbopogon citratus*, lemongrass, proximate composition, phytochemical, minerals, phenolics, flavonoids.

Introduction

Plants have historically provided humans with food, medicines, spices and materials for maintaining health. In recent years, increasing attention has been directed towards edible and medicinal plants because of their nutritional composition and their content of biologically active secondary metabolites. Among these plants, *Cymbopogon citratus* commonly called lemongrass is an important aromatic grass belonging to the family *poaceae*. It is widely cultivated and used in traditional medicine, food preparation, herbal teas and the production of essential oils. A recent review described *C. citratus* as

both a food and medicinal plant and reported a wide range of chemical constituents, including terpenoids, flavonoids and phenolic acids (Du, *et al.*, 2024).

The nutritional importance of a plant is commonly evaluated through proximate composition, which provides information about moisture, ash, protein, fat, crude fibre and carbohydrate. These parameters are important indicators of the potential contribution of plant materials to human and animal diets. Lemongrass has attracted attention as a potential source of dietary fibre and other nutrients. For example, a recent proximate study of lemongrass powder reported 16.7% crude fibre, 8.2% protein and 61.2% carbohydrate, although substantial differences can occur because of geographical origin, plant maturity, drying conditions and analytical methods (Manna, *et al.*, 2024). Apart from primary nutrients, *C. citratus* contains numerous secondary metabolites. Phenolic compounds and flavonoids are particularly important because they can contribute to antioxidant activity. Recent phytochemical investigations have identified phenolic compounds and flavonoids in *C. citratus* extracts and demonstrated antioxidant activity in different experimental systems (Benyahia, *et al.*, 2024). Another recent investigation detected flavonoids, tannins, saponins, alkaloids and phenols in lemongrass and reported the presence of several mineral elements, including calcium, iron, manganese, zinc, sodium and potassium (Sambo, *et al.*, 2024).

However, phytochemicals may have both beneficial and potentially adverse nutritional effects. Some compounds, particularly tannins, saponins and certain alkaloids, are commonly discussed as anti-nutritional factors because at sufficiently high concentrations they may interfere with nutrient digestion, absorption or utilisation. The distinction between bioactive phytochemicals and anti-nutrients is therefore important. For example, phenolics and flavonoids are generally regarded as beneficial bioactive compounds, whereas tannins and saponins may exert anti-nutritional effects depending on their concentration and the amount consumed. Earlier work specifically examining *C. citratus* identified

phytochemicals including alkaloids, phenols, saponins, flavonoids and tannins and discussed their possible anti-nutritional effects (Uraku, *et al.*, 2015). Mineral elements are also essential components of plant foods. Calcium is required for skeletal development and several physiological processes, manganese contributes to enzyme function and metabolism, while iron, zinc and copper participate in processes including oxygen transport, enzymatic reactions and immune function. The mineral profile of a plant can therefore contribute to its nutritional value, although the actual nutritional contribution depends on concentration, bioavailability and dietary intake. The present paper therefore evaluates the nutritional, anti-nutritional and mineral composition of *C. citratus* leaves.

Materials and Methods

Plant Sampling

The *Cymbopogon citratus* was obtained in a compound in kwangwara Kontagora. The sample was identified by a Botanist in the Biology Department F.U.E. Kontagora, only healthy leaves were used. The leaves were dried, ground using a machine, and kept for further analysis.

Proximate assessment

Procedure for determination of Moisture Content

2.0g of the powder was weighed into weighed crucible and was put into a Gallenkamp drying oven set at 105°C for 3 h, cooled in desiccators and weighed. Further weighing was repeated until a constant weight was obtained (AOAC, 2000).

$$\% \text{ Moisture} = \frac{(\text{weight of wet sample} - \text{weight of dry sample})}{\text{sample weight}} \dots\dots\dots (1)$$

Procedure for Ash Content

1.0 g of the powder was weighed into a clean crucible and was incinerated in a furnace set at 550 to 600 °C for 3 h. It was removed, cools in a desiccator and reweighed (Onwuka, 2005).

$$\text{Ash content} = \frac{\text{wt of ash (g)}}{\text{wt of original sample (g)}} \times 100 \dots\dots\dots (2)$$

Procedure for crude protein content determination

2.0 g of the powder was weighed into a digestion flask containing 0.5g of selenium catalyst. 25cm³ of concentrated H₂SO₄ was added and the contents thoroughly mixed. The flask was then heated on a digestion burner for 8 h until the solution was green and clear. The solution was transferred into a 100cm³ volumetric flask and made up to the mark with distilled water. 25cm³ of 2 % boric acid was pipette into a 250cm³ conical flask and 2 drops of mixed indicator (20cm³ of bromocresol green and 4cm³ of methyl red) solutions were added. 10cm³ of the digested sample solution was then introduced into a Kjeldahl flask. The condenser tip of the distillation apparatus containing 15cm³ of 40 % NaOH was dipped into the boric acid contained in the conical flask. The ammonia in the sample solution was then distilled into the boric acid until it became bluish green. The distillate was titrated with 0.1M HCl solution until colourless end point was obtained (AOAC, 2000).

$$\% \text{ Total nitrogen} = \frac{(100 \times (VA - VB) \times M \times 0.01401) \times 100}{10W} \dots\dots\dots (3)$$

Where:

VA= volume (cm³) of HCl used in the sample titration

VB = volume (cm³) of HCl used in the blank titration

M = Molarity of HCl

W = weight of sample (g)

% Crude protein = % nitrogen x 6.25

Procedure for crude fibre content determination

2.0g of the defatted powder from crude fat determination was transferred into a 250 cm³ Erlenmeyer flask and 2.5 cm³ of 1.25 % H₂SO₄ was added. The content of the flask was boiled under reflux and digested for 30 min. At the end of the 30min, the content was filtered and subsequently washed with boiling water until the washings were no longer acidic using blue litmus paper. The sample was washed back into the flask with 200 cm³ boiling 1.25 % NaOH solution and boiled for 30 min. It was then filtered and thoroughly washed with boiling water until the washings was no longer alkaline using red litmus paper. The crucible with its content was then dried in an oven at 105 °C overnight and cooled in desiccators and reweighed. The crucible with its content was then ignited in a furnace at 600 °C for 30 min, cooled and weighed. The loss in weight was expressed as a percentage of the initial weight of the sample (AOAC, 2000).

% Crude fibre

$$= \frac{(\text{wt. of crucible} + \text{sample before ignition}) - (\text{wt of crucible} + \text{ash}) \times 100}{\text{weight of fresh sample}} \dots \dots (4)$$

Procedure for Carbohydrate content determination

Total percentage carbohydrate (Nitrogen Free Extract) was determined by the difference method as reported by Amadi *et al*, (2004). This method involves adding the total values of crude protein, crude fat, crude fibre, moisture and ash constituents of the sample and subtracting it from 100. The value obtained is the percentage carbohydrate.

$$\% \text{ Carbohydrate} = 100 - (\% \text{ moisture} + \% \text{ ash} + \% \text{ protein} + \% \text{ fat} + \% \text{ fibre}). \dots \dots (5)$$

Procedure for determination of Crude Lipid Content

5.0g of the powder was weighed into the extraction thimble, and about 50 cm³ of petroleum ether (40 - 60 °C) range was added to the extraction flask. A condenser was fixed at the top of the extractor. The flask was fitted into the extraction unit and refluxed to about 60 ° C for 6 h. The ether extract was evaporated on an evaporating bath until the lipid was solvent free. This was dried in an oven at 100 °C for 1 h, cooled in a desiccator and weighed

$$\% \text{ Lipid} = \frac{(\text{weight of beaker} + \text{lipid}) - (\text{weight of beaker}) \times 100}{\text{Sample weight}} \dots \dots (6)$$

Phytochemical Screening

The phytochemical analysis of methanol extracts of *C. citratus* for phenol, flavonoid, saponin and alkaloid contents (Mosses, *et al* 2006 and Harborn ,1998). These compounds were considered in relation to both their potential biological benefits and possible anti-nutritional effects.

Determination of Total Alkaloids (Harborne, 1976)

0.5g of the sample was dissolved in 96% ethanol -20% H_2SO_4 (1:1), 1ml of the filtrate was added to 5cm^3 of 60% tetraoxosulphate (VI), and allowed to stand for 5min. Then; 5cm^3 of 0.5% formaldehyde was added and allowed to stand for 3h. The reading was taken at absorbance of 565nm. The extinction coefficient (E_{296} , ethanol {EIOH} = $15136\text{M}^{-1}\text{cm}^{-1}$) of vincristine was used as reference alkaloid.

Determination of Saponins (Oloyed, 2005)

0.5g of the sample was added to 20 cm^3 of 1NHCl and was boiled for 4h. After cooling it was filtered and 50 cm^3 of petroleum ether was added to the filtrate and ether layer evaporated to dryness. 5cm^3 of acetone ethanol was added to the residue. 0.4 cm^3 of each was taken into 3 different test tubes. 6 cm^3 of ferrous sulphate reagent was added into them followed by 2cm^3 of concentrated H_2SO_4 . It was thoroughly mixed after 10min and the absorbance was taken at 490nm.

Determination of total flavonoids concentration

Aluminum chloride colorimetric method was used for flavonoids determination (Chang *et al.*, 2002). The extract (0.5 ml) was mixed with 1.5 ml of methanol, 0.1 ml of 10% aluminum chloride, 0.1 ml of 1 M sodium acetate and 2.8 ml of distilled water. it remained at room temperature for 30 min; the absorbance of the reaction mixture was measured at 415 nm with a double beam spectrophotometer (USA). The calibration curve was prepared by preparing quercetin solutions at concentrations 12.5 to 100mg ml⁻¹ in methanol.

Determination of Phenol concentration

2.0 g of the sample was heated to boiling in 50ml of diethyl ether. 5ml boiled mixture were pipetted and 10ml of distilled water, 2ml of ammonium hydroxide solution and 5ml of concentrated any alcohol

were added. The mixtures were allowed to stand for 30minute for color development and the absorbance is measured at 505 nm.

Mineral assessment

0.5 g of homogeneous sample was weighed into a digestion vessel and concentrated HNO₃. acid was added. The vessel was heated, cooled and the solution was filtered and diluted to a known volume with deionized water. The Atomic Absorption Spectroscopy (AAS) was used for determining the elements Fe, Zn, Mn, Cu, Na, K, and Ca respectively. The digested sample was aspirated into a flame, and the absorption of element-specific radiation was measured.

RESULTS

Proximate composition

The proximate composition of *C. citratus* leaves is presented in Table 1.

Table 1: Proximate composition of *Cymbopogon citratus* leaves

Nutritional parameter	Composition (%)
Moisture	10.93
Ash	18.86
Fat	9.98
Protein	10.92
Crude fibre	21.51
Carbohydrate	27.80
Total	100.00

The results show that carbohydrate was the major proximate nutrient, accounting for 27.80%, followed by crude fibre at 21.51%. Ash accounted for 18.86%, while protein and fat accounted for 10.92% and 9.98%, respectively. Moisture content was 10.93%.

Phytochemical composition

Table 2: Phytochemical constituents of *Cymbopogon citratus* leaves

Phytochemical	Content (mg/100 g)
Phenol	428.79
Flavonoid	121.11
Saponin	120.80
Alkaloid	11.98

Phenolic compounds had the highest concentration (428.79 mg/100 g), whereas alkaloids had the lowest concentration (11.98 mg/100 g). Flavonoids and saponins were present at relatively high concentrations of 121.11 and 120.80 mg/100 g, respectively.

Mineral composition

Table 3: Mineral composition of *Cymbopogon citratus* leaves

Mineral	Concentration (mg/100 g)
Iron	0.11 ± 0.02
Zinc	0.03 ± 0.03
Manganese	2.57 ± 0.04
Copper	0.39 ± 0.01
Sodium	0.41 ± 0.01
Potassium	0.64 ± 0.01
Calcium	2.14 ± 0.02

Manganese was the most abundant mineral (2.57 ± 0.04 mg/100 g), followed by calcium (2.14 ± 0.02 mg/100 g). Zinc had the lowest concentration (0.03 ± 0.03 mg/100 g).

DISCUSSION OF RESULTS

Proximate composition

The proximate analysis demonstrates that *C. citratus* leaves contain a mixture of macronutrients and mineral-bearing components. The carbohydrate concentration of 27.80% indicates that the leaves can contribute carbohydrate to the diet. Carbohydrates are important sources of metabolic energy, although the nutritional significance of carbohydrate in leafy herbs depends on the form in which it occurs and its digestibility. The crude fibre content of 21.51% is particularly noteworthy. Dietary fibre is important for

normal gastrointestinal function and may contribute to satiety and healthy bowel movements. The relatively high fibre concentration also suggests that *C. citratus* leaf material could be considered as a source of structural plant polysaccharides. A 2024 study similarly characterised lemongrass as a potential functional-food ingredient because of its fibre content, although the reported values differed considerably from those in the present study. Such differences emphasise that cultivar, growing conditions, maturity, processing and analytical procedures can strongly influence proximate composition (Manna, *et al.*, 2024).

The protein content of 10.92% indicates that the leaves contain a moderate amount of nitrogenous material. Protein is required for growth, tissue repair, enzymes, hormones and other physiological functions. However, *C. citratus* should not necessarily be considered a major protein source because its use as an herb generally involves relatively small quantities. Rather, its nutritional significance may arise from its combined contribution of fibre, minerals and phytochemicals. The fat content was 9.98%. Although this is not extremely high, it indicates that the leaves contain extractable lipid components. Plant lipids may contain biologically active compounds and contribute to energy intake. The ash value of 18.86% was relatively high and may reflect the substantial mineral content of the sample. However, ash is only an indirect measure of total inorganic matter and should not be interpreted as equivalent to the concentration of any single mineral. The moisture content of 10.93% was relatively moderate. Low-to-moderate moisture in a dried plant material is generally advantageous for storage because reduced water availability can limit microbial growth and some deteriorative reactions.

Phenolic and flavonoid composition

The phenolic compounds were the most with a concentration of 428.79 mg/100 g. This is important because phenolic compounds are recognised as major contributors to the antioxidant properties of many medicinal and food plants. According to recent research supports the importance of phenolics in *C. citratus*. Benyahia, *et al.* (2024) reported substantial total phenolic and flavonoid contents in a

methanolic *C. citratus* extract and demonstrated antioxidant activity using DPPH, ABTS and β -carotene-related assays. Du *et al.* (2024) also reported that the chemical composition of lemongrass includes phenolic acids and flavonoids among its numerous identified compounds.

The flavonoid content of 121.11 mg/100 g further supports the phytochemical importance of this plant. Flavonoids constitute an important class of plant secondary metabolites and are frequently associated with antioxidant and other biological activities. Nevertheless, the presence of a high total flavonoid value should not be interpreted as evidence that consumption of the leaves will automatically prevent or treat disease. Biological effects depend on the specific compounds present, their bioavailability, dose and metabolic transformation. Recent phytochemical studies have identified a variety of compounds in *C. citratus*, including phenolic and flavonoid compounds such as catechin, chlorogenic acid, rutin and quercetin, demonstrating the chemical complexity of the species (Benyahia, *et al.*, 2024).

Anti-nutritional implications of phytochemicals

The saponin content of 120.80 mg/100 g deserves attention because saponins can have both desirable biological activities and anti-nutritional effects. At appropriate concentrations, saponins may contribute to biological activities associated with medicinal plants. At high concentrations, however, they may interfere with nutrient utilisation, which can affect taste and interact with cell membranes. The alkaloid content was considerably lower than the phenolic, flavonoid and saponin contents, at 11.98 mg/100 g. Alkaloids represent a chemically diverse group of compounds. Some alkaloids possess pharmacological properties, while others can be toxic at sufficiently high doses. Therefore, their presence alone does not establish either nutritional benefit or toxicity. Previous research specifically examining the nutritional and anti-nutritional composition of *C. citratus* reported the presence of phytochemicals, including tannins, saponins, alkaloids, phenols, and flavonoids. That study noted that tannins can interact with

proteins, polysaccharides and minerals and those excessive saponins may interfere with nutrient utilisation (Uraku, *et al.*, 2015).

Mineral composition

The mineral profile indicates that manganese was the predominant mineral, with a concentration of 2.57 ± 0.04 mg/100 g, followed by calcium at 2.14 ± 0.02 mg/100 g. Manganese is involved in several enzyme systems and metabolic processes, whereas calcium is important for bones, teeth, muscle contraction and cellular signalling. Potassium was present at 0.64 ± 0.01 mg/100 g, while sodium was 0.41 ± 0.01 mg/100 g. The potassium-to-sodium relationship is nutritionally relevant because dietary potassium and sodium have important roles in fluid balance, nerve function and cardiovascular physiology. Nevertheless, the values in this particular dataset are relatively small, so the contribution of lemongrass to total daily mineral requirements would depend strongly on the quantity consumed.

Copper occurred at 0.39 ± 0.01 mg/100 g. Copper is required in small quantities for enzymatic reactions, connective-tissue formation and iron metabolism. Iron and zinc were present at 0.11 ± 0.02 and 0.03 ± 0.03 mg/100 g, respectively. These values indicate that, although both minerals are detectable, *C. citratus* leaves may not represent a particularly concentrated source of iron and zinc in the sample analysed. The mineral pattern agrees qualitatively with recent studies. Sambo *et al.* (2024) reported that lemongrass contains several mineral elements, including iron, zinc, manganese, copper, calcium, sodium and potassium. Their analysis also examined other elements, demonstrating that mineral composition can be broader than the seven elements quantified in the present dataset. The variation between studies is expected. Soil composition, fertiliser application, geographical location, plant age, season, environmental contamination, drying and analytical methodology can all influence mineral accumulation in plants. Therefore, mineral values should preferably be interpreted in relation to the geographical origin and analytical conditions of the sample

overall nutritional significance

The combination of carbohydrate, fibre, protein, ash, phenolic compounds, flavonoids and essential minerals indicates that *C. citratus* leaves have considerable nutritional and functional potential. The high phenolic concentration is particularly significant because recent studies have associated *C. citratus* extracts with antioxidant activity. The species also has a broad chemical profile. A recent review documented 158 compounds reported from lemongrass, including terpenoids, flavonoids and phenolic acids, and summarised evidence for several biological activities (Du, *et al.*, 2024). Nevertheless, nutritional value should not be equated directly with therapeutic efficacy. The present analysis is primarily a compositional assessment. Additional studies involving digestibility, mineral bioavailability, toxicity, dose-response relationships and controlled biological experiments are required before specific health claims can be established.

Conclusion

The present assessment demonstrates that *Cymbopogon citratus* leaves possess considerable proximate, phytochemical and mineral characteristics. The proximate analysis showed 27.80% carbohydrate, 21.51% crude fibre, 18.86% ash, 10.92% protein, 9.98% fat and 10.93% moisture. The phytochemical analysis revealed particularly high phenolic content (428.79 mg/100 g), together with flavonoids (121.11 mg/100 g), saponins (120.80 mg/100 g) and alkaloids (11.98 mg/100 g). Mineral analysis showed that manganese and calcium were the predominant minerals among those investigated.

These results support the nutritional and functional importance of *C. citratus* and are broadly consistent with recent literature reporting phenolic compounds, flavonoids, saponins, alkaloids and several essential minerals in lemongrass. The overall, *C. citratus* represents a promising source of dietary fibre, selected nutrients, minerals and biologically active phytochemicals. Its potential applications in food,

nutraceutical and traditional medicine should, however, be supported by additional studies addressing bioavailability, toxicity, anti-nutritional factors, processing effects and standardised dosage

Recommendations

1. Further phytochemical analysis should be conducted to be able to quantify phytate, oxalate, tannins, cyanogenic compounds, trypsin inhibitors and other recognised anti-nutritional factors.
2. Mineral bioavailability should be investigated. The detection of calcium, manganese, potassium, iron, zinc and copper does not necessarily indicate that all these minerals are readily absorbed by the human body. Further studies should be done to determine their bioavailability.
3. Processing effects should be evaluated because Boiling, steaming, drying and fermentation may alter phytochemical and anti-nutritional composition. Recent research has demonstrated that drying conditions can significantly influence phytochemical and phenolic-acid profiles in different tissues of *C. citratus*.
4. Toxicological studies are recommended, because saponins and alkaloids were detected, dose-dependent toxicity and safe consumption levels should be established, particularly if concentrated extracts are intended for nutraceutical or medicinal applications.
5. Geographical variation of the grass should be investigated. Samples from different parts of Nigeria should be analysed because soil characteristics, climate and agricultural practices can affect nutrient and mineral accumulation.

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