



Research Article

Proximate and Mineral Composition of *Leptadenia hastata* (Pers.) Decne Leaves from Six Accessions Collected from Bauchi State, Nigeria

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ABSTRACT

Leptadenia hastata (Pers.) Decne is an indigenous leafy vegetable consumed in parts of northern Nigeria, but information on variation in its nutritional composition among accessions remains limited. This study evaluated the proximate and mineral composition of leaves from six *L. hastata* accessions from Bauchi State, Nigeria. The accessions were designated BHAZ, BHCH, BHFA, BHGD, BHMS and BHTR. Standard analytical procedures were used to determine moisture, dry matter, crude protein, crude fibre, crude fat, ash, nitrogen-free extract (NFE), energy content and mineral elements. Data were subjected to one-way analysis of variance, and means were separated using Duncan's Multiple Range Test at the 5% significance level. Significant differences were observed among accessions for the proximate and mineral parameters evaluated. Moisture content ranged from 64.88% to 75.57%, while dry matter ranged from 24.43% to 35.12%. Crude protein ranged from 10.61% to 14.84%, crude fibre from 7.98% to 10.06%, crude fat from 3.25% to 4.76%, ash from 15.10% to 17.04%, NFE from 54.65% to 60.25%, and energy content from 313.76 to 331.96. Mineral concentrations also varied among accessions. Calcium ranged from 1307.36 to 3503.22 mg kg⁻¹, magnesium from 1300.14 to 1401.69 mg kg⁻¹, potassium from 5450.11 to 10400.21 mg kg⁻¹, phosphorus from 1003.57 to 2036.43 mg kg⁻¹ and iron from 2802.71 to 6061.13 mg kg⁻¹. The observed variation indicates differences in nutritional composition among the evaluated accessions. The findings provide baseline information on the nutritional composition of *L. hastata* and support further investigation of its potential contribution to dietary diversification and future domestication research.

Keywords: Accessions; Bauchi State; Indigenous vegetables; *Leptadenia hastata*; Mineral composition; Nutritional value; Proximate composition

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INTRODUCTION

Increasing demand for food and rising cases of malnutrition are growing global challenges which are expected to worsen in developing nations due to the corona virus (COVID-19) pandemic and current global conflicts (Chang *et al.*, 2018; FAO *et al.*, 2021). According to the United Nations (2019), the world population reached 7.7 billion in mid-2019 and is anticipated to reach 8.5 billion by 2030. As such, ensuring food supply and security for the growing population becomes one of the key global challenges. Currently, the world is facing the double burden of

undernutrition (thinness, stunting and underweight) and overnutrition (obesity and overweight) (Thow *et al.*, 2018). Malnutrition remains a serious public health challenge in Nigeria, particularly among women and children under five years of age. According to the Food and Agriculture Organization (FAO, 2022), over 9% of Nigerians suffer from severe food insecurity due to inadequate access to nutritious foods. Green leafy vegetables (GLVs) play a vital role in addressing micronutrient deficiencies because they are rich in vitamins, minerals, fiber, and bioactive compounds that promote health (Knez *et al.*, 2024)

Traditional leafy vegetables are 'wild vegetables' usually collected by poor households from the bush or fallow fields. They are known to rural dwellers in some African communities as 'morogo' or 'imfino' (Aworh, 2018) and these indigenous leafy vegetables have formed part of day-to-day livelihood among Africans for centuries (Van Rensburg *et al.*, 2007; Mabhaudhi *et al.*, 2017). However, the displacement of indigenous crops by a few major crops has inevitably contributed, in part, to the limited success of the global food systems (Mbhenyane, 2016; CoqHuelva *et al.*, 2017; Mabhaudhi *et al.*, 2019b). With a growing shift towards healthy diets, underutilised functional food crops are now gaining popularity due to their nutritional, pharmacological, therapeutic and nutraceutical benefits (Mudau *et al.*, 2022). There are hundreds of traditional wild leafy vegetables that are of agricultural and nutritional significance in Africa and have the potential to add diversity to traditional diets by providing unique flavours, textures and other sensory attributes (Uusiku *et al.*, 2010).

L. hastata (Pers.) Decne is an indigenous wild vegetable consumed widely in Northern Nigeria. It belongs to the family Apocynaceae and is valued for its nutritional, medicinal, and cultural importance. The plant is often cooked as a vegetable sauce or added to soups. Ethnobotanical studies have reported its medicinal uses in treating wounds, anemia, diabetes, and skin infections (Thomas, 2012). Despite these benefits, *L. hastata* remains underutilized, mainly harvested from the wild without standard agronomic or nutritional evaluation (Souratié *et al.*, 2025).

Previous studies, such as those by Fai *et al.* (2015), have reported the nutritional value of *L. hastata*, indicating that the plant could serve as a valuable dietary supplement. However, data on variations in nutritional and mineral composition across accessions remain limited. Understanding these differences is essential for promoting domestication and inclusion in food security programs.

This study therefore assessed the proximate and mineral composition of *L. hastata* leaves from Bauchi State, Nigeria, to evaluate their nutritional significance and potential contribution to food and nutrition security.

MATERIALS AND METHODS

Plant Material and Accession Collection

Leaves of six *L. hastata* accessions designated BHAZ, BHCH, BHFA, BHGD, BHMS and BHTR, were evaluated for this study. The accessions were collected from

Bauchi State, Nigeria, and subsequently established for experimental evaluation. The plant material collected (fruit) was authenticated at the Herbarium section of the Department of Plant Science and Biotechnology, Federal University Dutsin-Ma, having a voucher number FUDMA/PSB/000216

Experimental Design and Cultivation

The accessions were grown at the Botanical garden of the Department of Botany, Ahmadu Bello University, Zaria, using Randomized Complete Block Design with three replications. The leaves were harvested at 18 weeks after planting. The harvested leaves were taken to the laboratory immediately where they were oven dried, milled, sieved and stored in airtight containers prior to analysis.

Proximate analysis

The aim of proximate analysis is the estimation and determination of how much of the major food components, which are Moisture, Lipids, Crude Proteins, Ash, Crude Fiber and Energy exist in a given food. All these were determined following the procedure of Association of Analytical Chemists (AOAC 2006). The analysis was conducted on dry weight basis

Sample preparation

The harvested leaves were oven-dried and milled into powder to obtain a homogeneous sample. The milled material was sieved and stored in airtight containers prior to analysis.

Moisture content

Approximately 1.5 g of the sample was weighed into a clean and dry crucible. The crucible was kept in an oven and the temperature was set at 100 °C and allowed to heat for 12 hours until it reached a constant weight. The crucible was then cooled off on a desiccator for about 30 minutes and weighed (W2). The percent moisture was calculated using following formula:

$$\% \text{moisture} = \frac{W1 - W2}{\text{weight of sample}} \times 100$$

Where:

W₁ = Initial weight of crucible + Sample

W₂ = Final weight of crucible + Sample

Note: Moisture free samples were used for further analysis.

Crude Protein

Protein in the sample was determined by Kjeldahl method. For the determination of this component, three steps are involved, and they are Digestion, Distillation and titration.

Digestion: to begin the digestion process, 1.0 g of dried samples was accurately weighed and placed into a digestion flask. 15 ml of concentrated sulfuric

acid (H₂SO₄) was added to the sample and 8 g of a digestion mixture composed of potassium sulfate and copper sulfate (K₂SO₄ CuSO₄) in a ratio of 8:1 was also added. The flask was carefully swirled to ensure that all the contents were thoroughly and uniformly mixed together. It was then placed on a heater and left to digest until the mixture become clear blue green in color, a process that took 2 hours to complete. Once the digestion was complete, the flask was removed from the heat and allowed to cool down at room temperature. The cooled digest was transferred into a 100 ml volumetric flask and distilled water was gradually added until the total volume reached 100 ml mark

Distillation: Markam Still Distillation Apparatus was used as described by Khalil and Manan, (1990). 10 ml of the prepared digest was introduced in the distillation tube, after which 10 ml of 0.5N sodium hydroxide (NaOH) was gradually added through the same inlet. Distillation was then allowed to run for 10 min, during which ammonia gas (NH₃) produced and subsequently collected in the form of ammonium hydroxide (NH₄OH) in a conical flask containing 20 ml of 4% boric acid solution, to which a few drops of modified methyl red indicator had been added. The production of collection of ammonium hydroxide is confirmed by the appearance of yellowish color in the conical flask.

Titration: upon completion of distillation, Titration: The distillate was titrated with standard 0.1N HCl to the endpoint (pink coloration). Percentage nitrogen was calculated and multiplied by a conversion factor of 6.25 to obtain crude protein. A blank was also run through all steps as above. Percentage crude protein was determined by multiplying %N (percentage nitrogen) by a correction factor of 6.25. The percentage Nitrogen content of the sample was calculated by using the following formula:

$$\% \text{ Nitrogen} = \frac{(S-B) \times N \times 0.014 \times D}{W \times V} \times 100$$

Where S = Sample titration reading, B = Blank titration reading, N = Normality of HCl, D = Dilution of sample after digestion, V = Volume taken for distillation, 0.014= milli equivalent weight of Nitrogen.

Crude Fiber

To determine crude fiber content, 2 g of finely grinded samples (W) were placed into a round bottom flask, 100 ml of sulfuric acid (H₂SO₄) was then added to the sample, and the mixture was boiled under reflux condition for a period of 30 minutes thereby allowing the acid effectively breakdown and dissolve the non-fiber components of the sample. The hot solution was promptly filtered under suction to

separate the insoluble matter from the liquid. The insoluble residue was then washed thoroughly with hot water until all traces of acid were removed. The acid-free residue was then transferred into a clean round bottom flask and 100cm² of hot 0.312M of sodium hydroxide (NaOH) solution was added. The mixture was once again boiled under reflux for another 30 minutes and quickly filtered under suction. The insoluble residue was repeatedly washed with boiling water until was completely free of any base residue. It is then dried to a constant weight in an oven at 100°C, cooled in a desiccator and weighed (C₁). The weighed residue was then incinerated in furnace at 550°C for 2 hours, cooled in a desiccator and weighed again (C₂). The % crude fiber was calculated using the equation below:

$$\% \text{ crude fiber} = \frac{C_2 - C_3}{W} \times 100$$

Where $C_2 - C_3$ = loss of weight on incineration
W= weight of the original sample

Crude fats

To carry out this analysis, soxhlet extraction apparatus was used. Crude fat. 1 g of completely dried sample was carefully wrapped in filter paper, tucked into fat-free thimble and then placed into the extraction tube. A clean, pre-weighed beaker was filled with petroleum ether and connected to the apparatus. The water supply and heater were then switched to kick initiate the extraction process. After five siphoning cycles, the ether was allowed to evaporate and beaker was disconnected just before the final siphoning. the extract was then transferred into a clean glass dish and the remaining ether was evaporated on a water bath. Then placed the dish in an oven at 105° C for two hours and then placed on a desiccator to cool off. The percent crude fat was determined by using the following formula:

$$\% \text{ crude fat} = \frac{\text{increase in mass of the flask}}{\text{weight of the sample}} \times 100$$

Ash Content

For the determination of ash, clean empty crucible was placed in a muffle furnace at 600°C for an hour, cooled in desiccator and then weight o of empty crucible was noted (W1). One gram of each of the sample was taken in crucible (W2). The sample was ignited over a burner with the help of blowpipe, until it is charred. Then the crucible was placed in muffle furnace at 550°C for 2-4 hours. The appearances of grey white ash indicate complete oxidation of all organic matter in the sample. The furnace was switched off after ashing. The crucible was cooled and

weighed (W3). Percentage ash was calculated using the following formula:

$$\text{Ash content} = \frac{\text{difference in weight of ash}}{\text{weight of sample}} \times 100$$

Difference in wt. of Ash= W3 -W1 Determination of nitrogen free extract: Nitrogen Free Extract (NFE) was calculated by difference after analysis of all the other items method in the proximate analysis.

NFE = 100 - (% crude protein + % crude fat + % crude fiber + % ash)

Nitrogen Free Extract (NFE) would be determined by subtracting

Nitrogen Free Extract

Nitrogen Free Extract (NFE) was calculated by difference method after analysis of all the other items in the proximate analysis.

Nitrogen Free Extract (NFE) was be obtained by adding up the proportions of all the other components that had been determined already and then subtracting the total from 100. The value obtained represents the fraction of food sample that is made up of soluble carbohydrates and other easily digestible and utilizable non-nitrogenous substances. NFE = 100- (% crude protein + % crude fat + % crude fiber + % ash)

Energy content

The energy content of the individual accessions was estimated (Osborne and Voogt, 1978) using the equation below:

$$\text{food energy (KCal/g)} = (CP \times 4) + (O \times 9) + (NFE \times 4)$$

Where CP= Crude Protein, O= Oil content and NFE= Nitrogen Free Extract

Mineral Content

Sample preparation:

1 g of finely powdered sample was weighed and placed into a digesting glass tube. 12ml of nitric acid (HNO₃) was then added to the sample, the mixture was left to stay overnight at room temperature, allowing the acid to begin breaking down the organic materials gradually. The following day 4.0 ml perchloric acid (HClO₄) was then added to this mixture and was placed on a hot plate to begin the digestion process. The digestion was considered complete after in 85 minutes which was confirmed by the appearance of white fumes, serving as a visual indicator that the organic matter had been fully broken down. The mixture was then to cool down after which the contents were transferred into 100 ml volumetric flasks, and distilled water was added to bring the total volume to 100 ml, ensuring accurate

and consistent concentration across all samples. The prepared solutions were then poured into clean plastic bottles, which were clearly labeled after which they were stored and used for mineral determination.

Mineral analysis

Samples were digested overnight in concentrated nitric acid followed by perchloric acid on a hot plate until clear. Calcium, magnesium and iron were determined by atomic absorption spectrophotometry (Buck Scientific Model 2010 VGP); phosphorus was determined colorimetrically at 470 nm (UV/Visible Spectrophotometer, Model 91743 Cecil); and potassium was determined by flame photometry (Jenway Digital Flame Photometer, Model PFP7/6108).

Statistical analysis

One-way analysis of variance (ANOVA) was used to test for difference among the accessions. Where the data differ significantly, means were separated using Duncan's Multiple Range Test (DMRT) at P≤0.05. Results are presented as mean ± standard error. Pearson's correlation coefficients were computed among proximate parameters and, separately, among mineral parameters. All analyses were conducted in SPSS version 21.

RESULTS

Proximate composition

Accessions differed significantly (P≤0.05) in all proximate parameters measured. Moisture content ranged from 64.88% (BHAZ) to 75.57% (BHFA), with dry matter inversely following the same pattern (35.12% in BHAZ to 24.43% in BHFA). Crude protein ranged from 10.61% (BHMS) to 14.84% (BHTR); crude fibre from 7.98% (BHFA) to 10.06% (BHMS); crude fat from 3.25% (BHGD) to 4.76% (BHFA); ash from 15.10% (BHFA) to 17.04% (BHTR); NFE from 54.65% (BHTR) to 60.25% (BHFA); and energy content from 313.76 (BHGD) to 331.96 (BHFA) (Table 1).

Mineral composition

All five minerals assessed varied significantly (P≤0.05) among accessions (Table 2). Potassium was the most abundant mineral overall, ranging from 5450.11 mg kg⁻¹ (BHAZ) to 10,400.21 mg kg⁻¹ (BHTR), followed by iron (2802.71 mg kg⁻¹ in BHMS to 6061.13 mg kg⁻¹ in BHFA), calcium (1307.36 mg kg⁻¹ in BHTR to 2552.88 mg kg⁻¹ in BHCH), phosphorus (1003.57 mg kg⁻¹ in BHFA to 2036.43 mg kg⁻¹ in BHAZ) and magnesium (1300.14 mg kg⁻¹ in BHGD to 1401.69 mg kg⁻¹ in BHMS).

Table 1. Proximate composition of leaves of six *Leptadenia hastata* accessions collected from Bauchi State, Nigeria

ACCESSION	MC (%)	DM (%)	CP (%)	CF (%)	OIL (%)	ASH (%)	NFE (%)	Energy content
BHAZ	64.88±0.75 ^c	35.12±0.75 ^a	11.16±0.56 ^{bc}	9.40±0.66 ^{ab}	4.45±0.27 ^{ab}	15.34±0.92 ^{bc}	59.65±0.03 ^a	323.90±0.18 ^b
BHCH	70.57±0.81 ^b	29.43±0.81 ^b	11.16±0.33 ^{bc}	9.14±0.55 ^b	4.61±0.23 ^a	17.00±0.68 ^a	58.09±0.03 ^b	318.49±0.36 ^c
BHFA	75.57±0.87 ^a	24.43±0.87 ^c	11.91±0.83 ^{bc}	7.98±0.24 ^c	4.76±0.24 ^a	15.10±0.76 ^c	60.25±0.40 ^a	331.96±1.61 ^a
BHGB	73.80±0.86 ^a	26.20±0.86 ^c	12.64±0.88 ^b	9.27±0.19 ^{ab}	3.25±0.16 ^d	16.35±0.49 ^{ab}	58.48±0.42 ^b	313.76±0.24 ^d
BHMS	75.33±0.87 ^a	24.67±0.87 ^c	10.61±0.85 ^c	10.06±0.30 ^a	3.70±0.24 ^c	15.60±0.47 ^{bc}	60.03±0.32 ^a	315.84±2.47 ^{cd}
BHTR	73.97±0.86 ^a	26.03±0.86 ^c	14.84±1.04 ^a	9.31±0.46 ^{ab}	4.16±0.08 ^b	17.04±0.35 ^a	54.65±1.38 ^c	315.40±1.48 ^{cd}

Results are presented as mean ± standard error; means sharing a common superscript down the column are not significantly different

Table 2. Mineral composition of leaves of six *Leptadenia hastata* accessions collected from Bauchi State, Nigeria

Accession	Ca (mgkg ⁻¹)	Mg (mgkg ⁻¹)	K (mgkg ⁻¹)	P (mgkg ⁻¹)	Fe (mgkg ⁻¹)
BHAZ	3503.22±72.26 ^a	1320.69±53.84 ^a	5450.11±188.80 ^e	2036.43±70.55 ^a	3222.90±57.70 ^c
BHCH	2552.88±44.22 ^{ab}	1359.36±47.09 ^a	10350.21±298.79 ^a	1716.32±60.71 ^b	5183.74±67.32 ^b
BHFA	1983.37±80.16 ^c	1374.53±23.81 ^a	9016.85±312.35 ^b	1003.57±37.62 ^d	6061.13±227.20 ^a
BHGD	2294.05±79.47 ^b	1300.14±30.84 ^a	7800.14±225.16 ^c	1752.76±17.89 ^b	3375.85±34.45 ^c
BHMS	2425.05±112.01 ^{ab}	1401.69±24.28 ^a	6733.47±233.26 ^d	1540.12±26.67 ^c	2802.71±67.89 ^d
BHTR	1307.36±52.84 ^d	1348.19±62.27 ^a	10400.21±120.09 ^a	1987.25±22.95 ^a	5194.77±59.78 ^b

Results are presented as mean ± standard error; means sharing a common superscript down the column are not significantly different.

DISCUSSION

The mean crude protein content of 12% recorded across the accessions. Foods deriving at least 12% of caloric value from protein (Aruah *et al.*, 2011), confirming that *L. hastata* leaves can serve as an accessible source of plant-based protein for nutritionally vulnerable populations. The protein range obtained (10.61–14.84%) exceeded values (8.4% - 10.6 %) previously reported by Hassan *et al.* (2007) and Inuwa (2012) for the same species and was broadly comparable to the 10.40–15.30% range reported by Yakubu and Wafar (2014); such variation across studies and accessions has been attributed to differences in harvest age, climate, soil type and analytical methodology (Yakubu and Wafar, 2014). The significant, negative correlation between crude protein and NFE is consistent with the compositional constraint that an increase in one proximate fraction is necessarily offset by a decrease in another when the fractions are calculated by difference.

The crude fibre content recorded (7.98–10.06%) substantially exceeds earlier reports for *L. hastata* (0.18–4.70%; Hassan *et al.*, 2017). The relatively high fiber content observed suggests that consuming *L. hastata* may promote improved digestive efficiency, bowel regularity, and prevention of constipation (Ogungbenle and Omosola, 2015), although excessive fibre intake can also reduce the bioavailability of trace minerals such as iron and zinc (Ekwumemgbo *et al.*, 2014). Crude fat values (3.25–4.76%) place the species within the generally low-fat profile typical of leafy vegetables, a nutritionally favourable characteristic for individuals managing obesity-related conditions (Aruah *et al.*, 2011), while the negative correlation between fibre and energy content is explained by fibre's non-digestibility and its consequent depression of NFE and hence overall caloric value.

Ash content (15.10–17.04%), The results showed that the sample contains fairly high ash content which indicates that the leaves of the accession would provide essential valuable and useful minerals needed for body development (Ogungbenle and Omosola 2015) it was markedly higher than the 8.73% previously reported for the species (Hassan *et al.*, 2017), consistent with the substantial mineral concentrations measured directly in this study. Potassium, the most abundant mineral recorded, exceeded values reported by Hassan *et al.* (2017) by nearly an order of magnitude and plays established roles in cell membrane transport, nerve impulse transmission and improved iron utilization (Elinge *et*

al., 2012). The strong positive correlation between iron and potassium suggests these two minerals may be co-regulated in accumulation by the plant or by shared soil availability at the collection sites. Iron values recorded (2802.71–6061.13 mg kg⁻¹) were likewise far higher than earlier reports and are nutritionally significant given the importance of iron for haemoglobin synthesis and the particular vulnerability of pregnant women, infants and the elderly to iron-deficiency anaemia (Hassan *et al.*, 2017). The calcium-to-phosphorus ratios implied by the ranges recorded here support the suitability of *L. hastata* leaves for consumption by children and lactating women for bone and muscle health maintenance (Sodamade *et al.*, 2013).

CONCLUSION

The study demonstrated significant variation in the proximate and mineral composition of leaves from the six *Leptadenia hastata* accessions collected from Bauchi State, Nigeria. The accessions differed in moisture, dry matter, crude protein, crude fibre, crude fat, ash, nitrogen-free extract and energy content, as well as in the concentrations of calcium, magnesium, potassium, phosphorus and iron.

BHTR recorded the highest crude protein and ash contents, while BHMS recorded the highest crude fibre and magnesium concentrations. BHAZ had the highest calcium and phosphorus concentrations, BHTR had the highest potassium concentration, and BHFA recorded the highest iron concentration.

Leaves of *L. hastata* are a nutrient-dense food resource, rich in protein, fibre and minerals, particularly potassium and iron at levels that in several cases substantially exceed previous reports for the species. Significant variation among wild accessions in both proximate and mineral composition confirms considerable genetic diversity and provides a practical basis for selecting nutritionally superior accessions for domestication and breeding.

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