

Mineral Composition, Phytochemical Profile, and Nutritional Properties of the Calyces of Two Bombax Species: *Bombax Buonopozense* and *Bombax Costatum*

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Abstract

Original Research Article

The calyces of *Bombax buonopozense* and *Bombax costatum* are widely consumed in Côte d'Ivoire, yet their nutritional composition and phytochemical properties remain insufficiently characterized. This study compared their mineral composition, phytochemical profiles, and antioxidant activities to assess their potential for nutritional and industrial valorization. Dried and ground calyces were subjected to aqueous extraction. Mineral elements were analyzed by atomic absorption spectrophotometry, primary and secondary metabolites were quantified using colorimetric methods, and antioxidant activity was evaluated using the DPPH radical scavenging assay. Both species contained calcium and iron, with higher reported concentrations in *B. buonopozense* (2.7% calcium; 0.01181% iron) than in *B. costatum* (2.5% calcium; 0.01028% iron). Carbohydrates accounted for 80% and 79% of the respective samples. Total phenolic content was higher in *B. buonopozense* (325 mg/g dry matter) than in *B. costatum* (200 mg/g dry matter). However, substantial oxalate contents were also detected, reaching 198.5 and 154.82 mg/g dry matter, respectively. Both extracts exhibited DPPH radical scavenging activity. These findings highlight differences in the nutritional and phytochemical profiles of the two species while emphasizing the need to evaluate antinutritional factors and processing methods before recommending their broader food applications.

Keywords: Bombax buonopozense; bombax costatum; mineral composition; phenolic compounds; antioxidant activity.

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1. INTRODUCTION

Wild plant resources contribute to human nutrition, traditional medicine, and household livelihoods, particularly in rural communities (Avikpo et al., 2017; Calín-Sánchez et al., 2020). Wild edible fruits and other plant-derived food resources can complement cultivated crops and contribute to food security, while their collection, processing, and marketing also support local economic activities, including women's livelihoods.

In Côte d'Ivoire, rural populations rely on various plant species available in their surrounding environments to supplement their diets and meet their nutritional needs (Vroh et al., 2014). These resources may become particularly important during periods of

drought or reduced agricultural production. Depending on the species, plant-derived foods can provide carbohydrates, proteins, lipids, vitamins, and minerals, while also containing secondary metabolites that may contribute to their biological properties. Consequently, some plants are valued for both their nutritional and traditional medicinal uses (Aké-Assi, 2011; Bruneton, 1999; Kouakou et al., 2020). The collection, preservation, and commercialization of these resources may further contribute to local food systems (Seleiman et al., 2021).

Ethnobotanical research has documented the diversity of plant resources used by local communities in Côte d'Ivoire (Béné et al., 2016). However, the nutritional and phytochemical characteristics of certain

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traditionally consumed plant parts remain insufficiently documented. In particular, the calyces of *Bombax buonopozense* P. Beauv. and *Bombax costatum* Pellegr. & Vuillet (Malvaceae), which are consumed in central and northern Côte d'Ivoire, warrant further investigation. A better understanding of their mineral composition, nutritional constituents, and phytochemical profiles could help characterize their food value and inform their potential applications.

The present study therefore aimed to characterize and compare the calyces of *B. buonopozense* and *B. costatum* consumed in Côte d'Ivoire. Specifically, it sought to determine their mineral composition, characterize their nutritional constituents, investigate their major phytochemical groups, quantify selected metabolites and antinutritional factors, and evaluate the antioxidant activity of their aqueous extracts. This comparative approach is intended to provide a more comprehensive understanding of the properties of these two plant resources and contribute to the scientific assessment of their potential for nutritional and industrial valorization.

2. MATERIALS AND METHODS

2.1 Selection of Calyces

The selection of calyces from the two *Bombax* species was based on recent studies that highlighted the lack of sufficient scientific data on the calyces of *Bombax buonopozense* and *Bombax costatum* consumed in Côte d'Ivoire, specifically in the Bélier and Poro regions, respectively.

2.2 Preparation of Aqueous Extracts

The edible calyces were manually harvested early in the morning, separated from the rest of the flower, cut into small pieces, and dried in an oven at ambient temperature. After drying, the calyces were ground into a fine powder using an electric grinder (Blender IKA-MAG RTC). The resulting powder was stored in kraft paper for subsequent preparation of total aqueous and hydroethanolic extracts (Harborne, 1998).

For the preparation of total aqueous extracts, a decoction method was employed following the procedure described by Sofowora (1993). One hundred grams (100 g) of calyx powder from each species were mixed with 1 liter of distilled water and brought to a boil on a heating plate. After boiling, the decoction was successively filtered through hydrophilic cotton and then through Whatman filter paper. The extraction solvent was then removed by evaporation using an oven set at 50°C. The resulting dry residue was collected in powder form and constituted the total extracts.

2.3 Calculation of Extraction Yield

Extraction yield refers to the mass of extract obtained after solvent evaporation, expressed as a percentage relative to the initial mass of calyx powder

subjected to extraction (Bruneton, 1999). It is calculated using the following formula:

$$R(\%) = \frac{m}{M} \times 100;$$

With: R is the extraction yield (%); m is the mass of the dry extract obtained; M is the initial mass of calyx powder used for extraction.

2.4 Mineralogical Analysis of Extracts

2.4.1 Determination of Mineral Content

Elemental chemical analysis was performed using a spectrometer, which enabled the simultaneous quantification of all chemical elements present in the sample. For this procedure, the sample was first ground into a fine powder using a vibratory mill (RETSCH MM400) to ensure proper homogeneity. Subsequently, 4 g of the powder were accurately weighed and mixed with 1 g of a cellulose-based binder to facilitate pellet cohesion. The mixture was homogenized in a vial using the same vibratory mill and then transferred into a mold. Pellet formation was carried out under a pressure of 10 tons using a hydraulic press, ensuring a uniform and compact structure (Potts, 1987).

Each pellet obtained was then placed in an X-ray fluorescence (XRF) spectrometer. Prior to analysis, sample information (code, origin, mass, etc.) was entered into the control software. The spectrometer irradiates the pellet with primary X-rays and detects the emitted fluorescence X-rays. The resulting spectrum is then analyzed to determine the mass concentration of the elements present in the sample.

2.4.2 Determination of Ash Content

Ash content was determined according to the AOAC method (1990). Two point five (2.5) grams of dried samples were weighed using an electronic balance and placed in a porcelain crucible of known mass (m_0). The samples were then incinerated in a muffle furnace (CERADEL Industries) at 550°C for 12 hours. After incineration, the samples were transferred into a desiccator to cool. The crucible containing the calcined sample was then weighed (m_1).

The ash content was calculated using the following parameters:

$$\text{Cendres } (\%) = \frac{(m_1 - m_0)}{m_e} \times 100 ;$$

With m_0 : mass (g) of the empty crucible; m_e : mass (g) of the sample; m_1 : mass (g) of the crucible plus ash after incineration.

2.5 Phytochemical Analysis

Phytochemical screening was carried out to detect the presence of primary and secondary metabolites in plant extracts. The primary metabolites identified included reducing sugars, aromatic amino acids,

proteins, gums, and mucilages. The secondary metabolites detected included alkaloids, flavonoids, tannins, saponins, terpenes, and steroids.

2.5.1 Primary Metabolites

2.5.1.1 Identification of Primary Metabolites

2.5.1.1.1 Detection of Reducing Sugars

Reducing sugars were identified in crude extracts using Fehling's reagent. For this test, 5 mL of calyx extract were mixed with 5 mL of Fehling's solution. After heating at 70°C in a water bath for 2–3 minutes, the formation of a red precipitate indicated a positive reaction.

2.5.1.1.2 Detection of Aromatic Amino Acids

Aromatic amino acids were detected using the xanthoproteic reaction. To 3 mL of extract, 1 mL of concentrated nitric acid was added. The mixture was then boiled for 2 minutes. The appearance of a yellow coloration indicated a positive reaction, revealing the presence of aromatic nuclei (benzene rings), characteristic of amino acids such as tyrosine, tryptophan, and phenylalanine.

2.5.1.1.3 Detection of Proteins

Proteins were identified using the Biuret reaction. An aliquot of Bombax calyx extract dissolved in 2 mL of 20% aqueous NaOH was placed in a test tube, and 2–3 drops of 2% aqueous CuSO₄ solution were added. The appearance of a violet coloration, sometimes with a reddish tint, indicated a positive reaction.

2.5.1.1.4 Detection of Gums and Mucilages

For the detection of gums and mucilages, 10 mL of aqueous calyx extract were slowly mixed with 25 mL of absolute ethanol under constant stirring. The formation of a flocculent precipitate indicated the presence of gums and mucilages.

2.5.1.2 Determination of Protein Content

Crude protein content was determined using the Kjeldahl method (AOAC, 1990). A quantity of 0.5 g of each sample powder was digested at 400°C for 120 minutes in the presence of a catalyst mixture (selenium + potassium sulfate, K₂SO₄) and 20 mL of concentrated sulfuric acid (H₂SO₄, 95–97%) using a digestion unit (BUCHI, France). The resulting digest was diluted to 60 mL with distilled water. Subsequently, 50 mL of sodium hydroxide solution (40%, w/v) were added, and the mixture was subjected to distillation using a LEGALLAIS-type distillation apparatus.

The released ammonia was trapped in a receiving flask containing 10 mL of an acid-base mixture (4%, w/v) with a mixed indicator (methyl red + bromocresol green) at pH 4.4–5.8. Protein content was calculated using the following formula:

$$\text{Protein} = \frac{(V_0 - V_1) \times 14 \times 6.25 \times N}{m_e};$$

With V₀: volume (mL) of sulfuric acid used for the blank; V₁: volume (mL) of sulfuric acid used for the sample; N: normality of sulfuric acid (0.1 N); m_e: mass (g) of the sample; 14: atomic mass of nitrogen; 6.25: nitrogen-to-protein conversion factor.

2.5.1.3 Determination of Lipid Content

Total lipids were extracted using hexane (organic solvent) following the AOAC (1990) Soxhlet method. Five (5) grams of dried and ground sample were placed in a pre-weighed Whatman extraction thimble. Then, 200 mL of hexane were added into a pre-weighed extraction flask (m₀). The flask was heated under reflux at 110°C for 8 hours.

After extraction, the flask was removed from the Soxhlet apparatus and placed in an oven at 130°C for 1 hour to ensure complete solvent evaporation using a rotary evaporator. The flask was then weighed (m₁). Lipid content was calculated using the following parameters:

$$\text{Lipid} = \frac{(m_0 - m_1)}{m_e} \times 100;$$

With m₀: mass (g) of the empty flask; m_e: mass (g) of the sample; m₁: mass (g) of the flask plus lipids after evaporation.

2.5.2 Secondary Metabolites

2.5.2.1 Identification of Secondary Metabolites

2.5.2.1.1 Detection of Saponins

Ten (10) mL of each aqueous extract were introduced into a test tube. After 15 seconds of shaking followed by 15 minutes of standing, the formation of a persistent foam layer higher than 1 cm indicated the presence of saponins (Mahmoud et al., 2025).

2.5.2.1.2 Detection of Polyphenols

Polyphenols were detected using the ferric chloride (FeCl₃) test. One drop of 2% alcoholic ferric chloride solution was added to 2 mL of each extract. The appearance of a dark blue or green coloration indicated the presence of polyphenols (Meda et al., 2005).

2.5.2.1.3 Detection of Flavonoids

Flavonoids were identified using the sodium hydroxide test. To 1 mL of extract, 2–3 drops of 10% NaOH solution were added. The appearance of a red coloration indicated a positive reaction Meda *et al.*, (2005).

2.5.2.1.4 Detection of Quinones

Quinones were detected using the Bornträger reaction. An aliquot of residue dissolved in 5 mL of diluted HCl (1/5) was heated in a boiling water bath for 30 minutes, then extracted with 20 mL of chloroform (CHCl₃) after cooling. To the organic phase, 0.5 mL of 50% diluted NH₄OH were added. A color change from

red to violet indicated the presence of quinones (Mahmoud *et al.*, 2025).

2.5.2.1.5 Detection of Sterols and Polyterpenes

Sterols and polyterpenes were identified using the Liebermann reaction. A fraction of the residue was dissolved in 1 mL of acetic anhydride, then transferred into a test tube containing 0.5 mL of concentrated H₂SO₄. The appearance of a violet coloration turning to blue and then green indicated a positive reaction (Razgonova *et al.*, 2021).

2.5.2.1.6 Detection of Tannins

Catechic tannins (condensed tannins) were detected using the Stiasny reaction. To 2 mL of plant extract, 6 mL of Stiasny reagent (30% formaldehyde / concentrated HCl) were added. The mixture was heated at 80°C for 30 minutes and then cooled. The formation of large light-brown flocs indicated the presence of condensed tannins (Mahmoud *et al.*, 2025).

2.5.2.1.7 Detection of Alkaloids

Alkaloids were detected using the Dragendorff/Kraut test. Two (2) mL of calyx extract filtrate were mixed with 1 mL of Dragendorff reagent. The formation of a reddish-brown precipitate indicated a positive reaction (Carolina *et al.*, 2016).

2.5.2.2 Quantification of Phenolic Compounds

2.5.2.2.1 Extraction of Phenolic Compounds

Phenolic compounds were extracted using 70% (v/v) methanol. One (1) gram of dried and ground sample was mixed with 10 mL of 70% methanol. The mixture was centrifuged at 1000 rpm for 10 minutes. The residue was re-extracted with another 10 mL of 70% methanol. The supernatants were pooled in a 50 mL volumetric flask and adjusted to volume with distilled water. The resulting solution constituted the phenolic extract.

2.5.2.2.2 Quantification of Polyphenols

Total polyphenols were determined using the Folin–Ciocalteu method (Singleton *et al.*, 1999). One (1) mL of methanolic extract was mixed with 1 mL of Folin–Ciocalteu reagent. After homogenization, 1 mL of 20% sodium carbonate solution was added after 3 minutes, and the volume was adjusted to 10 mL with distilled water. The mixture was incubated in the dark for 30 minutes, and absorbance was measured at 725 nm using a spectrophotometer (PG Instruments, England). A calibration curve was established using gallic acid (0–1 mg/mL), and results were expressed as mg gallic acid equivalents (GAE)/100 g dry matter (DM).

$$\text{Polyphénols (mg/100g)} = \frac{DO_{725} \times 5 \times 10^3}{5,04 \times m_e}$$

Calibration curve: DO₇₂₅ = 5.04; Mass (mg): gallic acid equivalent; m_e: mass (g) of the sample.

2.5.2.2.3 Determination of Total Flavonoids

Total flavonoid content was determined according to Meda *et al.*, (2005). To 0.5 mL of methanolic extract were added: 0.5 mL distilled water, 0.5 mL aluminum chloride (10%, w/v), 0.5 mL sodium acetate (1 M), and 2 mL distilled water. The mixture was incubated in the dark for 20 minutes, and absorbance was measured at 415 nm. A calibration curve was prepared using quercetin (0–0.1 mg/mL), and results were expressed as mg quercetin equivalents (QE)/100 g dry matter.

$$\text{Flavonoids(mg/100g)} = \frac{DO_{415} \times 2 \times 10^3}{18,12 \times m_e}$$

Calibration curve: DO₄₁₅ = 18,12; m_e: mass (g) of the sample.

2.5.2.2.4 Determination of Tannins

Tannin content was determined using the method described by Bainbridge *et al.*, (1996). One (1) mL of methanolic extract was mixed with 5 mL of vanillin reagent (50 g vanillin + 4 mL HCl in 100 mL distilled water). The mixture was incubated in the dark for 20 minutes, and absorbance was measured at 500 nm. A calibration curve was prepared using tannic acid (0–2 mg/mL), and results were expressed as mg tannic acid equivalents (TAE)/100 g dry matter.

$$\text{Tannins} = \frac{DO_{500} \times 10^3}{3,11 \times m_e}$$

Calibration curve: DO₅₀₀ = 3,11 ; m_e : mass (g) of the sample.

2.6 Analysis of Nutritional and Antinutritional Characteristics

2.6.1 Nutritional Characteristics

2.6.1.1 Determination of Dry Matter and Moisture Content

Moisture content was determined according to AOAC (1990). Five (5) grams of sample (PE) were weighed into a pre-weighed porcelain crucible. The crucible and sample (M₁) were dried in an oven at 105°C until constant weight (24 h). After drying, the sample was cooled in a desiccator and weighed (M₂). Dry matter (DM) and moisture content (MC) were calculated using standard formulas:

$$MC (\%) = \frac{(m_1 - m_2)}{PE} \times 100 ; DM (\%) = 100 - MC (\%)$$

With M₁: mass of the crucible plus sample before drying; M₂: mass of the crucible plus sample after drying; DM: dry matter content (%); MC: moisture content (%); PE: test portion (sample weight);

2.6.1.2 Determination of pH

The pH was measured according to AFNOR (1991). A 2.5 g sample was homogenized in 12.5 mL distilled water and centrifuged at 6000 rpm for 15

minutes. The supernatant was collected, and pH was measured using a calibrated digital pH meter (calibration range: pH 3–11).

2.6.1.3 Determination of Crude Fiber Content

Crude fiber content was determined according to AOAC (1990). Two (2) grams of dried sample were treated with 50 mL of 0.25 N sulfuric acid and boiled under reflux for 30 minutes. Then, 50 mL of 0.31 N NaOH were added, and the mixture was boiled again for 30 minutes. The residue was filtered (Whatman No. 4), washed with boiling water, dried at 105°C for 8 hours, cooled, and weighed (m_1). It was then incinerated at 550°C for 3 hours, cooled, and weighed again (m_2). Fiber content was calculated based on:

$$\text{Crude Fiber (\%)} = \frac{(m_1 - m_2)}{m_e} \times 100;$$

With m_1 : mass of dried residue; m_2 : mass of ash; m_e : sample mass.

2.6.2 Antinutritional Factors

2.6.2.1 Determination of Oxalate Content

Oxalates were determined according to Day and Underwood (1986). Two (2) grams of sample were mixed with 75 mL of 3 M H_2SO_4 and stirred for 1 hour at room temperature. After filtration, 25 mL of filtrate were titrated hot with 0.05 M $KMnO_4$ until a persistent pink endpoint. Results were calculated using:

$$\text{Oxalate Content (mg / 100g)} = \frac{2,2 \times V_{eq} \times 100}{m_e};$$

V_{eq} : volume of $KMnO_4$ at equivalence; m_e : sample mass.

2.6.2.2 Determination of Phytate Content

Phytates were determined using the Wade reagent method (Latta and Eskin, 1980). One (1) gram of sample was extracted with 20 mL of 0.65 N HCl and stirred for 12 hours. After centrifugation (3000 rpm, 40 min), 0.5 mL of supernatant were mixed with 3 mL of Wade reagent. After 20 minutes in the dark, absorbance was measured at 490 nm. A calibration curve was prepared using phytic acid (0–10 mg/mL), and results were expressed as mg phytic acid equivalents (PAE)/100 g dry matter.

$$\text{Phytate Content (mg / 100g)} = \frac{DO_{490} \times 4}{0,033 \times m_e};$$

Calibration curve: $DO_{490} = 0.033$; Mass (μ g): sodium phytate equivalent; m_e : mass (g) of the sample.

2.6.3 In Vitro Antioxidant Activity (DPPH Assay)

Antioxidant activity was evaluated using the DPPH radical scavenging method (Choi et al., 2002). One (1) gram of sample was extracted with 20 mL of 70% methanol. Two (2) mL of extract at different concentrations were mixed with 1 mL of freshly prepared DPPH solution (3 mM). After incubation in the dark for

30 minutes, absorbance was measured at 517 nm using a spectrophotometer (MS-A 5100, Spain). A control (1 mL DPPH + 2 mL methanol) was prepared under the same conditions. Trolox was used as a reference standard.

$$AA (\%) = \frac{[DO_c - DO_e] \times 100}{DO_c}$$

With AA (%): Antioxidant Activity; DO_c : absorbance of the control; DO_e : absorbance of the sample.

3. Results

The results related to the objective of this study are presented in three parts: The first addresses the mineral constituents present in the calyces from a nutritional perspective; The second focuses on the qualitative and quantitative phytochemical composition of priority groups; The third concerns the determination of nutritional value.

3.1 Mineral composition of *B. buonopozense* and *B. costatum*

3.1.1 Major Minerals

Analysis of the calyx extracts revealed the presence of 2.7% calcium, 0.8% phosphorus, 1.8% potassium, and 0.8% magnesium in the calyx extract of *B. buonopozense*, compared to 2.5% calcium, 0.09% phosphorus, 1.7% potassium, and 0.09% magnesium in the calyx extract of *B. costatum*.

3.1.2 Trace Elements

The following nutrient proportions were identified in the powder of *B. buonopozense*: 0.01181% iron, 0.00332% zinc, 0.00220% copper, and 0.00005% selenium. In comparison, the calyx powder of *Bombax costatum* contained 0.01028% iron, 0.00364% zinc, 0.00252% copper, and 0.00005% selenium.

3.2 Qualitative and Quantitative Analysis of Metabolites

3.2.1 Primary Metabolites

Carbohydrate content was predominant, with proportions of 80% and 79% in the aqueous extracts of the calyces of *B. buonopozense* and *B. costatum*, respectively. Other primary metabolites were present in the following proportions: 7% proteins and 4% lipids in the aqueous extract of *B. buonopozense*. In the aqueous extract of *B. costatum*, protein and lipid contents were 11% and 4%, respectively. The ash content in the calyx powder was 8.68% for *B. buonopozense* and 6.76% for *Bombax costatum*. The energy value of the aqueous extracts of *B. buonopozense* calyces was 8.69%, compared to 6.76% for *B. costatum*, which also contained 6.76% ash.

3.2.2 Secondary Metabolites

3.2.2.1 Screening of Secondary Metabolites

The results of the phytochemical tests performed on the aqueous extracts of the calyces of *B. buonopozense* and *B. costatum* are presented in Table 1.

Table 1. Phytochemical compounds identified in the extracts of *B. buonopozense* and *B. costatum*

Compounds Plants	Saponins	Polyphénols	Flavonoïds	Quinones	Stérols	Poly Terpènes	Tanins	Alcaloïds
<i>B. buonopozense</i>	+	+	+	+	+	+	+	-
<i>B. costatum</i>	+	+	+	+	+	+	+	-

+ : Positive reaction ; - : Negative reaction.

3.2.2.2 Quantitative Analysis of Phenolic Compounds

The results show that the phenolic compound content in the calyx extracts of *B. buonopozense* is higher than that of *B. costatum*. This content is approximately 650 mg, corresponding to 325 mg/g of dry matter (DM) for *B. buonopozense*, and 400 mg, corresponding to 200 mg/g of dry matter for *B. costatum* in terms of total polyphenols.

The flavonoid and tannin contents are distributed as follows:

- Flavonoids: 95 mg (47.5 mg/g DM) for *B. buonopozense* and 45 mg (22.5 mg/g DM) for *B. costatum*;
- Tannins: 95 mg (47.5 mg/g DM) for *B. buonopozense* and 50 mg (25 mg/g DM) for *B. costatum* in the aqueous extracts.

3.3 Nutritional and Anti-nutritional Characteristics

3.3.1 Nutritional Characteristics

The results of the nutritional characteristics of the extracts of *B. costatum* and *B. buonopozense* are presented in Table 2.

Table 2. The nutritional characteristics of the extracts of *B. costatum* and *B. buonopozense*

Characteristics	<i>B. costatum</i>	<i>B. buonopozense</i>
Dry matter (%)	85,03	87,14
Moisture content (%)	14,09	12,86
pH (hydrogen potential) (%)	4,8	5,77
Crude fiber (mg/g of extract)	18,42	20,09

3.3.2 Anti-nutritional Characteristics

The results related to the anti-nutritional characteristics of the calyx extracts of *B. buonopozense* and *B. costatum* show that both contain high levels of oxalates. This content varies between the two species: approximately 397 mg (198.5 mg/g) of oxalates for *B. buonopozense* compared to 309.65 mg (154.82 mg/g) in the extract of *B. costatum*. However, the phytate content in both *Bombax* extracts is statistically similar.

3.4 Antioxidant Activity

The antioxidant activity of the aqueous extracts of both *Bombax* species, assessed using the DPPH assay, shows that the antioxidant activity of *B. buonopozense* (70.01%) is higher than that of *B. costatum* (52.58%).

4. DISCUSSION

4.1. Mineral composition of the calyces

The mineral analysis revealed the presence of several nutritionally important elements in the calyces of *Bombax buonopozense* and *Bombax costatum*, particularly calcium, potassium, iron, and zinc. Calcium was the most abundant element reported, followed by potassium, whereas iron and zinc occurred at lower concentrations. The reported calcium and iron contents were higher in *B. buonopozense* (2.7% and 0.01181%, respectively) than in *B. costatum* (2.5% and 0.01028%). These differences suggest variation in mineral composition between the two species. However, their nutritional significance depends on the analytical basis, mineral bioavailability, and quantities consumed.

The importance of mineral-rich plant materials in traditional food preparation has been discussed in studies of plant-derived ashes and alkaline food additives (Malan et al., 2015; Obouayeba et al., 2019; Yao et al., 2015). In some West African culinary practices, ash-derived alkaline preparations are used to soften plant tissues and modify the consistency of sauces. Such uses provide a relevant cultural context for investigating the mineral constituents of traditionally consumed plant resources. Nevertheless, the mineral composition of calyx ash should not automatically be interpreted as equivalent to the mineral content of the edible calyces themselves, because ashing changes the chemical form and concentration of inorganic constituents.

Calcium is essential for bone structure, muscle function, and cellular signaling, while potassium contributes to fluid balance, nerve transmission, and normal muscle function. Iron is required for hemoglobin synthesis, and zinc contributes to immune function and tissue repair. The presence of these elements therefore supports further investigation of the nutritional properties of the calyces. However, their contribution to human mineral requirements cannot be established from elemental concentrations alone. The quantities consumed, mineral bioavailability, and possible interactions with antinutritional compounds must also be considered.

Although calcium and potassium are important plant nutrients, their detection in the calyces does not establish that the resulting ash can protect crops or improve soil fertility under field conditions. Such applications would require additional characterization of the ash, including its alkalinity, mineral availability, and potential contaminant content, followed by controlled soil and plant experiments. Consequently, the agricultural applications discussed in previous studies (Boli *et al.*, 2023; Neina *et al.*, 2020; Ortel *et al.*, 2024) should be regarded as avenues for future investigation rather than demonstrated outcomes of the present work.

4.2. Phytochemical composition

Qualitative phytochemical screening identified several groups of secondary metabolites in the calyces of both species, including saponins, polyphenols, flavonoids, sterols, tannins, polyterpenes, and quinones. These findings indicate that the calyces contain a diversity of phytochemical constituents that may contribute to their biological properties. They are broadly consistent with reports describing the occurrence of phenolic compounds, flavonoids, tannins, and saponins in plant materials used in traditional food and medicinal preparations (Taher *et al.*, 2024).

Among these constituents, phenolic compounds and flavonoids have attracted considerable interest because of their capacity to participate in reactions involving free radicals. However, qualitative detection establishes only the presence of particular compound classes under the conditions of the assays used; it does not identify individual molecules or establish their biological efficacy. Further chemical characterization would therefore be necessary to determine the principal compounds responsible for the observed properties.

The quantitative results showed a higher total phenolic content in *B. buonopozense* (325 mg/g dry matter) than in *B. costatum* (200 mg/g dry matter). This difference suggests that the two species may differ in their potential contribution to the antioxidant activity of aqueous extracts. Nevertheless, the interpretation of these values requires specification of the analytical standard, the expression of results, and whether the measurements refer to the original plant material or the extracts. These details are essential for meaningful comparison with other studies.

Although previous investigations have reported antioxidant or antimicrobial properties in plant extracts, such effects depend on the extraction procedure, the chemical composition of the material, and the experimental model employed (Efosa *et al.*, 2023; Komati *et al.*, 2022; Zahra *et al.*, 2024). The presence of phytochemical groups in the present study therefore supports further investigation of their biological properties but does not, by itself, demonstrate therapeutic efficacy or justify specific medicinal applications.

4.3. Nutritional composition and antinutritional factors

The nutritional analysis indicated that carbohydrates represented approximately 80% of the analyzed material for *B. buonopozense* and 79% for *B. costatum*. The calyces also contained measurable amounts of crude fiber and antinutritional compounds, including oxalates and phytates. These findings highlight the need to assess nutritional constituents and potentially limiting factors together rather than considering the carbohydrate content or mineral composition in isolation.

Oxalates can reduce calcium availability through the formation of poorly soluble complexes, while phytates can bind certain minerals, including iron and zinc, and potentially reduce their absorption. The nutritional implications of these compounds depend on their concentrations, the composition of the overall diet, and food preparation practices. The reported oxalate contents were 198.5 mg/g dry matter in *B. buonopozense* and 154.82 mg/g dry matter in *B. costatum*. These relatively high reported values warrant particular attention and should be confirmed using the analytical units and procedures specified in the methods section.

Processing methods such as soaking, heating, and fermentation can reduce certain antinutritional factors in some plant foods. However, the magnitude of reduction depends on the plant matrix and the processing conditions. Consequently, the effectiveness of these treatments for the two *Bombax* species should be experimentally assessed rather than assumed from findings in other plant materials (Taher *et al.*, 2024).

The moisture contents were 13% in *B. buonopozense* and 15% in *B. costatum*, corresponding to dry matter contents of 87% and 85%, respectively. These results indicate that the analyzed samples had relatively low moisture contents. Reduced moisture can limit microbial growth under appropriate storage conditions, although it does not independently establish microbiological safety or long-term stability. Further studies of drying conditions, water activity, packaging, and storage duration would be needed to identify suitable preservation procedures.

Taken together, the nutritional and antinutritional results suggest that the calyces merit further evaluation as food resources. However, a reliable assessment of their dietary value requires confirmation of the analytical measurements, determination of the bioavailability of relevant nutrients, and investigation of processing methods capable of reducing antinutritional compounds while preserving desirable constituents.

4.4. Antioxidant activity

The DPPH radical scavenging assay showed a higher reported antioxidant activity for the aqueous extract of *B. buonopozense* (70.01%) than for that of *B.*

costatum (52.58%). This difference is consistent with the higher total phenolic content reported for *B. buonopozense*. Phenolic compounds and flavonoids can contribute to radical scavenging through several chemical mechanisms, making them plausible contributors to the observed difference.

Nevertheless, the relationship between total phenolic content and antioxidant activity cannot be established from these measurements alone. Other extract constituents, interactions among compounds, and assay conditions may also influence the results. In addition, percentage inhibition in a DPPH assay depends on the extract concentration, reaction time, and experimental conditions. The two percentages should therefore be interpreted comparatively only if the extracts were tested under equivalent conditions. Reporting concentration-dependent results and, where available, IC₅₀ values would facilitate comparisons with other studies (Kouakou *et al.*, 2025; Obouayeba *et al.*, 2019; Rudrapal *et al.*, 2022).

The results demonstrate *in vitro* radical scavenging activity under the conditions of the assay. They do not establish that consumption of the calyces prevents oxidative stress-related diseases or produces therapeutic effects in humans. Such conclusions would require additional evidence, including studies of compound identification, bioavailability, biological activity in relevant experimental models, and safety. The antioxidant findings nevertheless provide a basis for further investigation of the extracts as potential sources of naturally occurring antioxidant compounds.

Overall, the comparative findings indicate that *B. buonopozense* and *B. costatum* differ in several measured characteristics, including mineral content, total phenolic content, antinutritional factors, and DPPH radical scavenging activity. The higher phenolic content and DPPH inhibition reported for *B. buonopozense* make it a candidate for more detailed chemical and biological characterization. However, the nutritional implications of the observed differences and the practical applications of both species remain to be established through further experimental work.

5. CONCLUSION

This study compared the mineral composition, phytochemical constituents, nutritional characteristics, antinutritional factors, and *in vitro* antioxidant activity of the calyces of *Bombax buonopozense* and *Bombax costatum*. The results revealed differences between the two species, with *B. buonopozense* exhibiting higher reported calcium and iron contents, a greater total phenolic content (325 mg/g dry matter), and higher DPPH radical scavenging activity (70.01%) than *B. costatum* (52.58%). Both species also showed high reported carbohydrate contents, approximately 79–80%, and contained antinutritional compounds, particularly oxalates.

These findings provide comparative information on the nutritional and phytochemical characteristics of the two species and support further investigation of their potential as food resources and sources of naturally occurring antioxidant compounds. However, the presence of oxalates and phytates highlights the importance of evaluating mineral bioavailability and determining whether appropriate processing methods can improve their nutritional quality.

Further research should focus on validating the reported compositional values, identifying individual phytochemical constituents, assessing nutrient bioavailability, and evaluating the effects of processing and storage on nutritional quality and safety. Additional biological studies would also be necessary to establish the relevance of the observed *in vitro* antioxidant activity to potential applications. Such investigations could provide a stronger scientific basis for assessing the nutritional and technological value of these traditionally consumed plant resources.

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