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## ASSESSMENT OF PROXIMATE AND PHYTOCHEMICAL COMPOSITION OF *BOMBAX COSTATUM* PELLEGR AND VUILLET IN BENUE STATE, NIGERIA

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**ABSTRACT:** This study investigated the proximate and phytochemical composition of *Bombax costatum* calyx. The calyxes were collected from mature trees located in Kwande and Gboko Local Government Area (L.G.A) of Benue State. The calyxes were washed, cut into pieces and dried for four days. The dried sample were powdered into powdered form with mortar and pestle and put into a clean and dry rubber container. The dried powdered calyx was then taken to Chemistry Laboratory of the Federal University of Agriculture, Makurdi for proximate and phytochemical analysis. T-test was used to compared the means of the two L.G.A. The proximate composition was determined using standard methods of Association of Official Analytical Chemist. The results show no significant differences ( $p < 0.05$ ) in the moisture, carbohydrate, ash content, protein and fibre in both L.G.A. However, the proximate content from Kwande Local Government Area (11.00±1.00, 27.67±5.77, 17.67±1.53, 16.67±1.16 and 14.67±1.53) were higher than those obtained from Gboko L.G.A. (10.67±0.57, 26.33±5.51, 16.67±2.31, 15.33±1.16 and 13.00±1.73). Carbohydrate had the highest concentration of nutrients from both L.G.A. Phytochemical composition was determined using standard methods of Association of Official Analytical Chemists. The results in both Local Government Areas also indicated the presence of Phytochemicals such as Tannins++, Phlobatannins +, Glycoside ++, Saponin +, Sterols +, Flavanoid +++, Resins +++ and Alkaloids +. Flavanoid and Resins were found to exhibit strong antioxidant activity. The calyxes were found containing adequate amounts of nutrients and phytochemical quality. The high appreciable amounts of carbohydrate indicate that the calyx is energy giving food. The high presence of flavanoid and resins also indicates its contribution to medicinal value. Consumption of this calyx will increase the nutritional quality of diets and help to reduce oxidative stress and build human body. The information obtained will improve and contribute to human health and could play a major role to combat micro nutrient deficiency.

Key words: Phytochemical, proximate, *Bombax costatum*, calyx, nutrients

### 1. INTRODUCTION

Forest plants contribute in many ways to global food security, its contributions help maintain household nutrition and provide a lifeline to rural populations especially between harvests or during extreme weather conditions. These wild plants are categorized as underutilized or neglected forest plants that occurs in wild or are grown in local scale whose economic potential have been poorly addressed, confining it into

mostly traditional and local use substance (Sibangini and Malaya, 2016). Many wild plants serve as alternatives to staple foods during period of food deficit and are valuable supplements for a nutritionally balanced diet. Wild edible plants are one among primary alternative sources of income for local communities, ?? most urban dwellers and are fundamentally used for domestication purposes (Deshmukh and Waghmode, 2011). Wild plants have been part of human diets and traditional food systems throughout history, providing important nutrients, such

as carbohydrate, protein. Fats, vitamins and bioactive compounds. The medicinal value of these plants is due to the presence of a variety of phytochemicals and their elemental composition (Monica *et al.*, 2015).

*B. costatum* commonly called Red Flowered silk cotton tree is an edible plant belonging to the family malvaceae commonly found in West Africa (Maiga *et al.*, 2005). It is a deciduous tree that grows up to 25m high; its leaves are with 5 - 7 leaflets, 8 - 15 cm long, on long petioles. Its fruit is a dark brown, ellipsoidal capsule, and the calyx of its flowers is used in sauces while the young fruit has been used for preparation of meals (Adewunmi and Sofowora, 1980). *B. costatum* leaves have been reported to be rich in anti-oxidants (Atawodi *et al.*, 2004).

*Bombax costatum* is among the most used and important wild vegetable species in northern Nigeria (Mertz *et al.*, 2001; Lykke *et al.*, 2002). The calyx of the plant is most frequently used especially for food (Ouédraogo *et al.*, 2014; Assogba *et al.*, 2017). The calyx is sold on local markets and hence constitutes an additional source of income in rural communities (Kristensen and Lykke, 2003; Belem *et al.*, 2007). Several parts of the tree are used in traditional medicine against a great variety of illnesses such as fever or to promote lactation in women and as tonic for tiredness (Orwa *et al.*, 2009). *Bombax costatum* provides ecosystems services such as erosion control, soil improvement, fencing material and intercropping attesting to its agroforestry significance (Orwa *et al.*, 2009). In Nigeria, different parts of *Bombax costatum* are employed for various purposes. The immature fruits are prepared as an emollient; decoction of young leaves used as a warm bath for febrile children (Abubakar and Barminas, 2017). *B. costatum* is a useful plant resource that could help alleviate poverty. It has many benefits for local populations and a great potential for food and medicine (Assogba *et al.*; 2017). The flowers of *B. costatum* are used as ingredients in gelatinous sauces. *B. costatum* has unstable population structures characterized by few seedlings in anthropogenized zones. *Bombax costatum* is classified as a vulnerable species and is among the species which could be highly threatened if adequate measures are not taken to ensure their conservation (Garzuglia, 2006). Forest fruits are not accorded the importance they deserve in the diet of Nigerians due to ignorance of their nutritive value, cost and difficulty in storage and distribution (Hurson *et al.*, 2005). Except very few, there is a lack of comprehensive investigation on nutritional value contained in wild edible plant (Mahapatra *et al.*, 2012). No documented data or scientific report on the proximate and phytochemical composition of *Bombax costatum* calyx in Nigeria. In order to ascertain the nutritive value of the calyx and thereby stimulate interest in its utilization and consumption, it is important to validate scientific

documentation on the calyx for the presence of proximate and phytochemical composition so as to promote its health and ethno medicinal value. This in turn will improve and provide a balanced and healthy diet to the populace.

## 2. METHODOLOGY

### 2.1. Sample Collection

*B. costatum* (calyxes) were collected from mature trees in Shangev-ya districts in Kwande and Ipav districts in Gboko Local Government Area of Benue state. A Kwande L.G.A has it's headquarter in the town of Adikpo. It lies between latitude 6°15' and 7°10'N, longitude 9° 00'' to 9°45'E. It has an area of 2,891 sq.km. The climate is tropical, with dry season spanning from November to March and a marked wet season from April to October Annual rainfalls of between 1650mm-2000mm (Ade, 2014). Gboko L.G.A lies on the geographical coordinates of latitude 7°23'47'N and longitude 3°55'0''E and 8°51'47'E. The topography of the area is mostly characterized by several plains and a few hilly areas. The town enjoys a tropical climate with two distinct seasons namely the raining season (May-October) and the dry season (November –April). The annual rainfall of about 1000mm-1300mm. Temperature ranges from 22°C and 33°C (Akpen *et al.*, 2018).

### 2.2. Sample preparation

*B. costatum* (calyxes) (plate 1) were washed with distilled water, cut into pieces and sun dried for five days and later then pounded into powder form using local Mortar and pestle. The dried samples were stored in clean rubber container and then taken to Chemistry Laboratory, Federal University of Agriculture, Makurdi for Proximate and Phytochemical analysis.



Plate 1: *Bombax costatum* calyxes

### 2.3. Data collection

#### 2.3.1. Proximate composition

The proximate analyses of the samples were carried out according to the standard procedures of Association of Official Analytical Chemist (AOAC, 1990).

##### 2.3.1.1. Determination of moisture content

A crucible was washed with distilled water then dried in an oven at 180°C for 30 minutes and cooled in desiccator and weighed (W1). Five gram (5g) of the sample was then added to the crucible and weighed (W2). After weighing, the crucible then heated at 105°C in a muffle furnace for 2 hours, cooled in desiccator and reweighed (W3). The process was repeated until a constant weight was reached.

The moisture was calculated as

$$\% \text{ moisture} = \left( \frac{w_2 - w_3}{w_2 - w_1} \right) \times 100$$

Where W1= Weight of 1<sup>st</sup> sample weigh

W2= Weight of 2<sup>nd</sup> sample weigh

W3= Weight of 3<sup>rd</sup> sample weigh

##### 2.3.1.2. Determination of protein with formol titration

Exactly five (5) grams of the dried sample was put in 50 ml of deionized water, 10 ml of the sample juice was pipette into 100 ml conical flask. 1.0 ml phenolphthalein and 0.4 ml saturated potassium oxalate solution was added into the sample juice to stay for 2 minute. (Potassium oxalate was used to remove the disturbing effect of soluble calcium salt if present). The mixture was titrated to a faint pink colour with 0.1ml sodium hydroxide solution from the burette. Then, 2 ml of 40% formaldehyde solution was added and the titration continued to a clear pink colour. Only the amount of 0.1m sodium hydroxide used for the second step titration was recorded.

Percentage (%) crude protein was calculated as:  
Aldehyde value x 0.17

Where aldehyde value is equivalent to volume of 0.1m sodium hydroxide solution required to reduce acidity produced by formaldehyde.

##### 2.3.1.3. Determination of Ash content (AC)

A crucible was washed with distilled water then dried in an oven at 180°C for 30 minutes and cooled in desiccator and weighed (W1). Five gram (5g) of the sample was then added to the crucible and weighed (W2). After weighing, the crucible then heated at 600°C in a muffle

furnace for 3 hours to obtain a white or light gray ash, (Where it was still black in colour after 3 hours, it was moisten, dry in the oven and the ashing repeated) it was cooled in desiccator and reweighed (W3).

Calculation

$$AC\% = \frac{(W_3 - W_1)}{(W_2 - W_1)} \times 100$$

Where W1= Weight of 1<sup>st</sup> sample weigh

W2= Weight of 2<sup>nd</sup> sample weigh

W3= Weight of 3<sup>rd</sup> sample weigh

##### 2.3.1.4. Determination of crude fiber (CF)

Crude fibre was determined by digesting about 2 g of the sample into a 200 ml solution containing 1.25ml of 9 m sulphuric acid per 100 ml of the solution and boiled under reflux for 30 minutes and filtered with linen cloth on a fluted funnel. Washed with boiled water until no more acidic on litmus paper test, transfer the residues to a beaker and boiled for 30 minutes with 200 ml of a solution containing 1.25g carbon free sodium hydroxide per 100 ml. The final filtered residue through a thin weighed filter pad in a Gooch crucible was dried in the oven and reweighed, incinerated, cooled and weighed. Finally, the loss in weight after incineration x 100 was the percentage weight of crude fibre.

##### 2.3.1.5. Determination of Carbohydrate

The percentage Carbohydrate was determined by calculating the difference between the sum of all proximate compositions from 100%." i.e. by deducting the sum of all other constituents from the total weight  
% Available carbohydrate = 100 – (% moisture + % Ash + % protein + % fibre)

### 2.3.2. Phytochemical composition

The phytochemical analyses of the samples were carried out according to the standard procedures of Association of Official Analytical Chemist (AOAC, 1990).

#### 2.3.2.1. Percentage aqueous extract

Exactly 50g of the dried sample was measured into clean glass beaker of 100 ml covered and allow to stay for a day. The extract was collected from the solution through a wool filtered of 0.005mm in another clean beaker of known weight. The aqueous extract was allowed to dry at ambient temperature till it was totally dried in a water bath and 40°C given the yield as 50g in 1000 ml of H<sub>2</sub>O produced 23g extract.

The percentage extract is  $\frac{23g}{50g} \times 100\% = 46\%$

#### 2.3.2.2. *Test for tannins*

A 10% of ferric chloride solution was added to water extract that was diluted with distilled water in the ratio of 1:4 if blue colour was observed, there is presence of tannin.

#### 2.3.2.3. *Test for phlobatannins*

1 ml of the water extract was boiled with an equal volume of 1% aqueous hydrochloric acid (1ml of HCL in 99 mls of distilled water). The deposition of a red precipitate indicated the presence of phlobatannins.

#### 2.3.2.4. *Test for Glycoside*

2.5mls of dilute H<sub>2</sub>SO<sub>4</sub> was added to 5mls of the water extract in a boiling tube and boiled for 15 minutes, cooled and neutralized with 100% NaOH. 5mls of Fehling's solution A and B was added. If a brick red precipitate was observed, it indicates the presence of glycosides.

#### 2.3.2.5. *Test for Anthraquinones*

0.5g of the powdered sample was placed in separate test tube and 20 mls of chloroform was added to the test tubes and shaken for 5 minutes. The extract was filtered and equal volume of ammonia added and shaken. If the upper aqueous layer turned bright pink, it indicates the presence of anthraquinones.

#### 2.3.2.6. *Test for Saponins*

Three (3g) grams of each of the powdered sample was added to 95% ethanol and boiled for 5 minutes. The mixture was filtered and 2.5mls of the filtrate was added to 10 mls of distilled water in a test tube. The test tube was stoppered and shaken thoroughly for about 30 seconds and allowed to stand for over 10 minutes. The appearance of honey comb froth indicated the presence of saponins.

#### 2.3.2.7. *Test for Terpenes and Sterols*

Five grams of each of the powdered sample was extracted by macerations with 50 mls of 95% ethanol, filtered and the filtrate evaporated to dryness. The residue was dissolved in 10 mls of anhydrous chloroform and then filtered. The filtrate was divided into two equal portions for the following tests: - Liebermann-Buchard Test was used to test the first option. The chloroform solution was

mixed with 1ml of acetic anhydride solution, followed by the addition of 1ml concentrated sulphuric acid down the wall of test tube to form a layer underneath. The formation of a reddish violet colour, indicated the presence of terpenes. Salkowski's Test was used for the second portion. The chloroform solution was mixed with 2mls of concentrated sulphuric acid carefully poured down side of the test tube as earlier described so that the sulphuric acid formed a lower layer. A reddish brown precipitate indicated the presence of sterols.

#### 2.3.2.8. *Test for flavonoids*

Five grams of each of the powdered sample was completely detanned with acetone. The residue was extracted in water after evaporating the acetone on a water bath. The mixture was filtered and 5mls of sodium hydroxide added to an equal volume of the detanned water extract. The yellow colour observed indicated the presence of flavonoids.

#### 2.3.2.9. *Test for Phenols- Ferric chloride test*

2 mls of the detanned extract was diluted with distilled water in a ratio of 1:4 and a few drops of 10% ferric chloride solution was added. Phenol was confirmed by the presence of green or blue colour.

#### 2.3.2.10. *Test for Resins*

0.5g of the powdered sample was dissolved in 5mls of acetic anhydride solution and a drop of concentrated sulphuric acid was added. The purple or violet colour obtained indicated the presence of Resin.

#### 2.3.2.11. *Test for Balsams*

Two drops of alcoholic ferric chloride were added to 5mls of 90% ethanol extract of the powdered samples. The dark colour indicated the presence of balsam.

#### 2.3.2.12. *Test for Alkaloids*

Few drops of 10% of sodium carbonate was added to the mixture of water extract and distilled water in the ratio of 1:4 The purple, violet or black colour observed indicated the presence of Alkaloid.

### 2.4. Data analysis

Data were analyzed using Statistical Package for Social Science (SPSS) Version 20.0. Significant differences between the two Local Government Area from means of three replicates were compared using T-test.

### 3. RESULTS

#### 3.1. Proximate analysis of *Bombax costatum* calyx

The result revealed that *B.costatum* calyx contained appreciable amount of nutrients such that the

carbohydrate, protein, ash, fibre and moisture from Kwande L.G.A (27.67±5.77, 17.67±1.53, 16.67±1.16, 14.67±1.53 and 11.00±1.00) were higher than those obtained from Gboko L.G.A (26.33±5.51, 16.67±2.31, 15.33 ±1.16, 13.00±1.73, and 10.67±0.57 (Table 1).

**Table 1: Proximate composition of *Bombax costatum* calyx**

Proximate Composition	Kwande	Gboko	F	P-value (Sig.)
	Mean±Std.	Mean±Std.		
Moisture	11.00±1.00	10.67±0.57	0.25	0.64
Protein	17.67±1.53	16.67±2.31	0.39	0.57
Ash	16.67±1.16	15.33±1.16	2.00	0.23
Fibre	14.67±1.53	13.00±1.73	1.56	0.28
Carbohydrates	27.67±5.77	26.33±5.51	0.08	0.79

Values were expressed as means of 3 replicates ± standard deviation

#### 3.2. Phytochemical Composition of *B. costatum* calyx

The phytochemical screening revealed the presence of Tannin, Phlobatannins, Glycoside, saponin, sterols, flavonoid, resins and alkaloids in various concentrations. Flavanoids and resins have the highest concentration (+++) followed by moderate concentrations such as Tannins, Glycoside (++), Phlobatannins, Saponin, sterols and alkaloids + while Anthraquinones, Terpense, phenol and balsams have negative result (Table 2).

**Table 2: Phytochemical composition of *Bombax costatum* calyx**

S/N	Phytochemicals	Kwande	Gboko
1.	Tannins	++	++
2.	Phlobatannins	+	+
3.	Glycoside	++	++
4.	Anthraquinones	-	-
5.	Saponin	+	+
6.	Terpense	-	-
7.	Sterols	+	+
8.	Flavanoid	+++	+++
9.	Phenols	-	-
10.	Resins	+++	+++
11.	Balsams	-	-
12.	Alkaloids	+	+

- = negative result, + = low concentration, ++ = moderate concentration, +++ = high concentration

### 4. DISCUSSION

#### 4.1. Proximate Composition

The moisture content obtained from *Bombax costatum* calyx from Kwande and Gboko L.G.A were (11.00 ±1.00) and (10.67±0.57). These values were however lower than the value obtained by Achi *et al.*, (2017) in the

leaves of *Ficus capensis* (104.53%) and the value (35.03) obtained in *P. thonningii* as reported by Ene Obong and Carnovale, (1992). However, the values obtained by Abiodun *et al.*, (2017) on *Occium gratissimum* (80.80%) leaves and *Veronia amygdalina* leaves (79.20%) were higher than *B.costatum* calyx values. However, the values obtained were higher than the value (4.23 and 7.36) reported by Benhanu and Amare, (2014) on *Millettia ferruginea* and Franklin *et al.*, (2017) respectively. The values obtained are within the range of 5-11% observed by Aremu *et al.*, (2006) and 9-13.33% obtained by Habtamu *et al.*, (2015) on *Abelmoschus esculentus*.

The ash content values from Kwande and Gboko L.G.A were (16.67±1.16) and (15.33±1.16). Each of the value was lower than those reported in leaves of *B.costatum* (66.4%) (Atawodi *et al.*, 2004). However, the values were higher than the value obtained by Achi *et al.*, (2017) in the leaves of *Ficus capensis* (6.65%) and *Z. vulgaris*. with 2.84 (Hussain *et al.*, 2009). The values were similar with the work observed by Ayeni *et al.*, (2018) in *A. altilis* leaves. The values were compared favorably with the value obtained in *Xylophia aethiopia* (16.04) by Abolaji *et al.*, (2007) and *A. altilis* (15.92) (Ayeni *et al.*, 2018). It is an indication that the *B.costatum* calyx is a potential good source of minerals required by the body. The ash content is a reflection of the amount of mineral elements preserved in any food materials (Iniaghe *et al.*, 2009).

The fibre content value from Kwande and Gboko L.G.A were (14.67±1.53) and (13.00±1.73) respectively. These values were higher than the value (4.77%) reported by Ngozi *et al.*, (2017), (9.96) by Ayeni *et al.*, (2018) and (11.91) observed by Iniaghe *et al.*, (2009) in *Acalypha*

*hispidia*. The values however were lower than the value obtained in *Parquetin nigrescen* leaves (22.05). The values were similar with the work obtained on *Oscium gratissimum* (14.30) by (Abiodun et al., (2017). The finding agrees with the value (13.04) obtained on *C.ambrosioides* by Abiodun et al., (2017). Though crude fiber does not contribute nutrients or energy, it is a source of dietary fiber which is essential for good bowel movement and helps in preventing obesity, diabetes, cancer of the colon and other ailments of the gastrointestinal tract of man. The plants are good source of crude fibre when consumed because adequate intake of dietary fibre can lower the serumcholesterol level, heart disease, hypertension, constipation, diabetes and breast cancer (Ishida et al., 2000). Generally dietary fibre helps in digestion and functions the body to slow down the rate of glucose absorption into the blood stream thereby reducing the risk of hyperglycemia,

The protein content of *B.costatum* calyx reported from Kwande and Gboko L.G.A were (17.67±1.53) and (16.67±2.31) respectively. Each of the value was lower than either the 20.08 or 23.68% crude protein values reported for Sabz Pari and Punjab-8 varieties of Okra by Farooq et al., (2011) or 29.7 reported by Berhanu and Amare, (2014). When compared with other plant species, the values were lower than the value of protein (22.16-22.57 %) found in *Tamarindus indica* seed (Akajiaku et al., 2014) and value (24.85%) obtained by Antia et al., (2006) who work on the leaves of *Ipomea batata*. However, these values were higher than 6.31% reported for *Ficus capensis* by Achia et al., (2017) and 2.84% obtained by Ayeni et al., (2018) on *B. vulgaris*. The protein values obtained were also higher than the value 8.39 by Olayinka et al., (2019) on *Carpolobia lutea* leaves. The values were within the same range with the value reported for *A. viridus* (16.41). The values reported agree with the work of Akubugwo et al., (2007) who found protein to have 17.92 in the leaves of *Amaranthus hybridus*. The plant with more than 12 of calorific value from protein can be considered as good source of protein. Protein is vital for various body functions such as body development, maintainance of fluid balance, formation of hormones, enzymes and sustaining strong immune function. The calyxes are considered as a good source of protein because it gives us more than 12% of caloritic value from protein (Abiodun et al., 2017). The high protein value suggests that the calyx can be ranked as a potential source of plant protein and therefore could be used as protein supplement.

The carbohydrate contents of *Bombax costatum* calyx from kwande and Gboko L.G. A were (27.67±5.77) and (26.33±5.51). These values were lower than 73.77% reported for *ficus capensis* by Ngozi et al., (2017) and 48.5 of the leaves of *B.costatum*(Atawodi et al., (2004).

The results were also lower than the values reported for *A. sativum* (57.28) and for *P. fistulosus* (62.39) (Hussain et al., 2009) and but were higher than that of *Senna obtusifolia* (23.70) (Faruq et al., 2002). The carbohydrate contents were higher in the calyx when compared to other nutrients found. The results correspond with the finding of Olayinka et al., (2019) who reported high appreciable amount of carbonhydrate in *Carpolobia lutea* leaves.

This is also in agreement with Gnansounou et al., (2014) who stated that very high carbohydrate content was found in *Dialium guineense* fruits. This means, *B. costatum* calyx is a potential good source of energy. The carbohydrates are essential nutrient required for adequate diet and supplies energy to cell such as brain, muscles and blood. Carbohydrate constitutes a major class of naturally occurring organic compounds that are essential for the maintenance and sustenance of life in plants and animals and also provide raw materials for many industries (Egun and Alade, 2007). The calyx is a good source of carbohydrate when consumed because it meets the Recommended Dietary Allowance (RDA) values (Food and Nutrition Board, 2002).

#### 4.2. Phytochemical Composition

There is no significant difference ( $p < 0.05$ ) between the two L.G.A in their phytochemical contents. This could be as result of the same ecological zone. The result revealed that calyx of *Bombax costatum* from both L.G.A have high Flavonoid and Resin properties. The findings were similar to the work of Abiodun et al., (2017) who reported the high presence of flavonoid in *Chenopodium ambrosioides*, *Morinda lucida* and *Magnifera indica*. The results were also similar with the work of Olayinka et al., (2019) and Ajayi et al., (2020) who observed high presence of flavonoid in *Carpolobia lutea* leaves and *Centella asiatica*. The results supported the finding of (Olumide et al., 2019) who reported high presence of flavonoid in *V. amygdalina*, *O.gratissium* and *M. oleifera*. The result disagrees with the report of Nkoli and Ngozi, (2020) who had saponin and terpenoids in high concentration. Some of these phytochemicals most importantly alkaloids, saponins, steroids, flavonoids have been established to be of high medicinal values (Oloyede, 2005). Similarly, anti-microbial and anti-inflammatory activities of the plant could be attributed to the presence of flavonoids and terpenoids (Doughari, 2012). This implies that the calyx exhibited strong antioxidant activities and has great potential for pharmaceutical industry. The presence of these secondary metabolites inferred that the species have the therapeutic effect and has contributed to its medicinal value as well as physiological activity (Asquith and Butter, 1986) Flavonoid which was detected has a wide

range of pharmacological effects including antioxidant, anti- inflammation, antiplatelet, anti-allergic, cytotoxicity and reduce risk for heart disease (Awoyinka *et al.*, 2007). The identified phytoactive compounds in the plant are well known for their pharmacological activities ranging from antibacterial and antifungal (Adodo, 2002).

## 5. CONCLUSION

1. The study has shown that *B.costatum* calyx contained appreciable amount of nutrients and phytochemical content. The calyx is rich in carbohydrate, protein, moisture which can contribute to nutrient' uptake.
2. The phytochemical profile of the species investigated contained active secondary metabolites which support their therapeutic potentials.
3. Therefore, the calyx of *B.costatum* could be recommended as constituent and supplement to the human diet and health.

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