Comparative Studies of Phytochemicals, Proximate Analysis, and Mineral Compositions of the Leaves and Bark of Buchholzia Coriacea

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ABSTRACT: This study evaluated the phytochemical constituents, proximate and mineral compositions of Buchholzia coriacea leaves and bark used for medicinal purposes. Standard procedures were followed for phytochemical determination, proximate and mineral analyses of the plant parts. Preliminary phytochemical investigation showed the presence of anthraquinone, cardiac glycosides, saponins, steroids, coumerin, alkaloids, tannins, phlobatannins and terpenoids were present both in the leaves and bark of Buchholzia coriacea while flavonoids was present in the leave only whereas reducing sugar and quinone were absent in the leave and bark. The proximate analysis revealed that the moisture content and crude fat were significantly higher (p<0.0001) in the leaves compared to the bark while the crude protein, crude fibre, ash, and carbohydrate contents were significantly lower (p<0.05) in the leaves compared to bark. The mineral analysis indicates considerable amount of sodium, potassium, magnesium, copper, zinc, iron and manganese. Some of these minerals can serve as co-factors for certain enzymes and are indispensible in numerous biochemical pathways. These preliminary findings show that Buchholzia coriacea is a potential source of new pharmacological compounds.

KEYWORDS: phytochemical constituent, Buchholzia coriacea, proximate analysis, mineral composition, pharmacological compound.
INTRODUCTION

Use of plants for medicinal purposes is as old as human civilization (Mosahuzzaman, 2012) and continuous efforts are being made towards its improvement. A renewed interest in natural products as a potential source of new medicine has been observed recently both in the academia and the pharmaceutical industry. The important values of some plants have long been published but a large number of them remain unexplored. Hence, there is a need to explore their uses and to conduct pharmacognostic and pharmacological studies to ascertain their therapeutic properties (Mushtaq et al., 2009).

The World Health Organisation, WHO (2000) estimated that 80% of the planet’s inhabitants rely mainly on traditional medicine for their primary health care needs, and it may be presumed a major part of traditional healing involves the use of plant extracts or their active principles.

Medicinal plants contain some organic compounds which produce specific physiological actions on the target organs/systems. These bioactive substances include tannins, alkaloids, carbohydrates, terpenoids, steroids and flavonoids (Edoga et al., 2005) that can possess useful properties that contribute to health and improved wellbeing. Herbal medicine, an alternative form of medicine acceptable worldwide, encompasses the use of plant materials in the diagnosis, prevention and treatment of disease conditions.

Scientific validation of plants with useful medicinal properties is necessary for development of alternative therapies that can be used in place of synthetic drugs. Proximate analyses play a crucial role in assessing the medicinal significance of such plants (Pandey et al., 2006). As various medicinal plant species are also used as food along with their medicinal benefits, evaluating their nutritional significance can help to understand the worth of these plant species (Pandey et al., 2006).

The World Health Organization (WHO) emphasizes the importance of determining proximate and micronutrients composition as well as phytochemical constituents in establishing standardization of the medicinal herbal products. Such herbal formulations must pass through standardization processes (Niranjan and Kanaki, 2008). It is thus necessary to study and compare the proximate, mineral and phytochemical constituents of the leaves and bark of the plant *Buchholzia coriacea*.

*Buchholzia coriacea* is a perennial plant which grows as a tree. It belongs to the family *Capparaceae* (Ibrahim and Fagbohun, 2013). The plant *Buchholzia coriacea* is a shrub or medium-sized tree, ever green, with a dense crown, large glossy leathery leaves arranged spirally and clustered at the ends of the branches, and conspicuous cream-white flowers in racemes at the end of the branches (Akpanyung et al., 1995). The tree is found in the southern part of Nigeria, Ghana and Liberia. The leaves of *Buchholzia coriacea* can be described as follows: They are large, obovate, oblong-eovate to elliptic, shortly acuminate or acute at apex, cuneate at base, 15-30x5-11 cm, thinly coriaceous, glabrous, midrib very prominent below, about 10 lateral nerves, each running directly into the one above and forming distinct loops close to the margin, prominent below, stalk 10-15 cm long, swollen for about 1 cm at both ends, pale green while the bark of the plant is smooth, blackish-brown or dark-green and slashes of it are deep red turning dark brown (Akpanyung et al., 1995).

Folklore medicine and some scientific work have records of the use of the seed of *Buchholzia coriacea* in the remedy of different disease. Among such diseases are cough, chest pain, waist pain, irregular menstruation, internal piles, malaria, premature ejaculation, headache, hypertension, dysentery, premature ageing, etc. (Jayesimi et al., 2011).

In folklore medicine, the bark is made into a pulp for inhalation or into an inhalant to relieve headache, sinusitis, and nasal congestion in Ivory Coast; smallpox or skin itching in Gabon. The pulped bark is applied to the chest to treat chest pains and also boils (Chinedu, et al., 2012). The leaves and stem bark is being used in various formulations, decoctions and concoction exhibiting anti helminitic, antimicrobial and cytotoxic effects on micro-organism (Ajaiyeoba et al 2003; Ezekiel and Onyeoziri, 2009). However, there is limited information on the composition of the leaves and bark of the plant.

Contamination of traditional medicines by heavy metals is of major concern because of the toxicity, persistence and bio accumulative nature of such metals. Even though WHO has formulated guidelines for quality assurance and control of herbal medicine, traditional practitioners lacks enough knowledge that may result in medication with various types of heavy metal contamination.

This present work was aimed at ascertaining and comparing the proximate analysis, the compositions of some mineral elements and presence of phytochemical of the leaves and bark of *Buchholzia coriacea*.
MATERIALS AND METHODS

Chemicals
All organic solvents and chemicals used in this study were of analytical grade from Sigma, Poole, UK and BDH Laboratory Supplies, UK.

Plant Material
Collection and Identification
Fresh leaves and bark of *Buchholzia coriacea* were collected August 2014 from Idanre forest reserve, Ondo State, Nigeria. It was authenticated by Mr Omotayo a botanist and assigned herbarium number UHAE 2014/82(a)-(i) which was deposited at the Department of Botany, Ekiti State, University, Ado Ekiti, Ekiti State.

Preliminary Phytochemical Screening
The methanolic extracts of the plant leaves and bark were subjected to different chemical tests for the detection of different phytochemical using standard procedures with modification (Sofowora, 1993; Trease and Evans, 1989; Harborne, 1973).

Test for alkaloids
A sample of the extract (0.4 g) was stirred with 8 ml of 1% HCl and the mixture was warmed and filtered. A 2-ml sample of the filtrate was treated separately with a few drops of potassium mercuric iodide (Mayer's reagent). Turbidity or precipitation was taken as evidence for existence of alkaloids.

Test for Tannins:
A small quantity of each extract was mixed with water and heated on water bath and filtered. A few drops of ferric chloride were added. A dark green colour indicates the presence of tannins.

Test for Glycosides:
Each extract was hydrolyzed with HCl and neutralized with NaOH solution. A few drops of Fehling solution A and B were added. Red colour indicates the presence of Glycosides.

Test for Reducing Sugars:
Each extract were shaken with distilled water and filtered. The filtrate was boiled with few drops of Fehling solution A and B. An orange red precipitate indicates the presence of sugars.

Test for Saponins:
A sample of the extract (0.2 g) was shaken with 5ml of distilled water and heated to boiling. Frothing (appearance of creamy mist of small bubbles) shows presence of saponins.

Test for Flavonoids:
The plant extracted was dissolved in solvent and treated with few drops of lead acetate (10%) solution, the formation of yellow precipitate indicate the presence of flavonoids.

Test for Phlobatans: A 0.5 g sample of each extract was dissolved in distilled water and filtered. The filtrate was boiled with 2% HCl solution. Red precipitate indicates the presence of phlobatans.

Test for Steroids:
Acetic anhydride (2 ml) was added to the mixture of 0.5 g of the extract and H₂SO₄ (2 ml). The colour from violet to green in some samples indicates the presence of steroids.

Test for Terpenoids:
A 0.2 g sample of each extract was mixed with 2 ml of chloroform and concentrated (3ml) H₂SO₄ was carefully added to form a layer. The formation of reddish brown coloration at the interface indicates the presence of terpenoids.

Test for Cardiac Glycoside:
To 2 ml of plant extract, 1 ml of glacial acetic acid and 5% ferric chloride was added. Then few drops of concentrated H₂SO₄ were added. Presence of greenish blue colour indicates the presence of cardiac glycosides.

Test for Anthraquinones:
A 0.5 g of each extract was boiled with 10% HCl for few min. The reaction mixture were filtered and allowed to cool. Equal volume of chloroform was added to each filtrate. Few drops of 10% ammonia was added to each mixture and heated. Rose-pink colour indicates the presence of anthraquinones.

Test for Coumarin:
A solution of 10 % NaOH was added to the extract and chloroform was added for observation of yellow colour, which shows the presence of coumerin.

Test for Quinones:
Dilute NaOH was added to 1 ml of the extract. Blue green or red coloration indicates the presence of quinones.

Proximate Analysis:
After bringing the samples to uniform size, they were analyzed for moisture, protein, crude fat, ash, crude fiber and nitrogen free extract by the methods of AOAC (2003) and Ibitoye (2002) as described below.

Moisture Determination
Moisture was determined by the loss in weight that occurs when a sample is dried to a constant weight in an oven. 2g of leave and bark sample are weighed into a silica dish previously dried and weighed. The samples are then dried in an oven for 65°C for 36 hours, cool in a desiccator and weigh. The drying and weighing continues until a constant weight is achieved.
% Moisture = \( \frac{W_b - W_a}{W_s} \times 100 \)

where \( W_b \) = weight of sample + dish before drying, \( W_a \) = weight of sample + dish after drying; \( W_s \) = weight of sample taken.

Ether Extract

The ether extract represents the fat and oil in the leave and bark. Determination of ether extract was carried out using a Soxhlet apparatus. A 150 ml portion of anhydrous diethyl ether (petroleum ether) (boiling point of 40 – 60 °C) was placed in a flask. A 2-5 g sample was weighed into a thimble and the thimble was plugged with cotton wool. The thimble with content was placed into the extractor; the ether in the flask was then heated. As the ether vapour reaches the condenser through the side arm of the extractor, it condenses to liquid form and drop back into the sample in the thimble. The ether soluble substances were dissolved and were carried into solution through the siphon tube back into the flask. The extraction was carried out for at least 4 hours. The thimble was removed and most of the solvent was distilled from the flask into the extractor. The flask was then disconnected and placed in an oven at 65 °C for 4 hours, cool in desiccator and weighed.

\% Ether extract = \( \frac{W_f - W_t}{W_s} \times 100 \)

where \( W_f \) = weight of flask; \( W_t \) = tare weight of flask; and \( W_s \) = weight of sample taken.

Crude Fibre

The organic residue left after sequential extraction of plant with ether was used to determine the crude fibre, however if a fresh sample is used, the fat in it could be extracted by adding petroleum ether, stir, allow it to settle and decant. This will be done three times. The fat-free material was then transferred into a flask/beaker and 200 ml of pre-heated 1.25% \( \text{H}_2\text{SO}_4 \) was added and the solution is gently boiled for about 30 minutes, maintaining constant volume of acid by the addition of hot water. The buckner flask funnel fitted with whatman filter was pre-heated by pouring hot water into the funnel. The boiled acid sample mixture was then filtered hot through the funnel under sufficient suction. The residue was then washed several times with boiling water (until the residue is neutral to litmus paper) and transferred back into the beaker. Then 200 ml of pre-heated 1.25% \( \text{Na}_2\text{SO}_4 \) was added and boiled for another 30 minutes. It was filtered under suction and washed thoroughly with hot water and twice with ethanol. The residue was dried at 65 °C for about 24 hours and weighed. The residue is transferred into a crucible and placed in muffle furnace (400-600 °C) and ashed for 4 hours, then cooled in desiccator and weighed.

\% Crude fibre = \( \frac{W_b - W_a}{W_s} \times 100 \)

where \( W_b \) = dry weight of residue before ashing; \( W_a \) = weight of residue after ashing; \( W_s \) = weight of sample taken.

Crude Protein

Crude protein was determined by measuring the nitrogen content of the leave and bark and multiplying it by a factor of 6.25. This factor is based on the fact that most protein contains 16% nitrogen. Crude protein was determined by Kjeldahl method. The method involves digestion, distillation and titration.

**Table 1: Phytochemical constituents of leave and bark of Buchholzia coriacea**

<table>
<thead>
<tr>
<th>Phytochemical</th>
<th>Leaves</th>
<th>Bark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthraquinone</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Cardiac glycosides</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Saponins</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Steroids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>coumerin</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Quinone</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tannins</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Phlobatannins</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Terpenoids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Reducing sugar</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: positive (+), negative (-).
Digestion: A 2 g sample of the leaf and bark were weighed into kjeldahl flasks and 25 ml of concentrated sulphuric acid, 0.5 g of copper sulphate, 5 g of sodium sulphate and a speck of selenium tablet were added. Heat was applied in a fume cupboard slowly at first to prevent undue frothing, and digestion was continued for 45 minutes till the sample became clear pale green. It was left to cool and 100 ml of distilled water was rapidly added. The digestion flask was rinsed 2-3 times and added to the bulk.

Distillation: Markham distillation apparatus was used for distillation. The distillation apparatus was steamed up after which 10 ml of the digest was added into the apparatus via a funnel and was allowed to boil. Sodium hydroxide (10 ml) was added and the sample was distilled into 50 ml of 2% boric acid containing screened methyl red indicator.

Titration: The alkaline ammonium borate formed was titrated directly with 0.1N HCl. The titre value which was the volume of acid used is recorded. The volume of acid used was fitted into the formula which becomes:

\[
\% N = \left\{ 14 \times VA \times 0.1 \times w \right\} \times 100 \\
1000 \times 100
\]

\[
VA = \text{volume of acid used, } \quad w = \text{weight of sample}
\]

\[
\% \text{ crude protein} = \% N \times 6.25
\]

Carbohydrate or Nitrogen Free Extract (NFE)

NFE is determined by mathematical calculation. It is obtained by subtracting the sum of percentages of all the nutrients already determined from 100.

\[
\% \text{NFE} = 100 - (\% \text{ moisture} + \% \text{ CF} + \% \text{ CP} + \% \text{ EE} + \% \text{ Ash})
\]

NFE represents soluble carbohydrates and other digestible and easily utilizable non-nitrogenous substances in plant.

Mineral Analysis

The mineral analysis was carried out in accordance with the method of Pearson (1976). The ashed sample (0.05 g) was digested with 1 M HCl (10 ml) after which it was filtered through filter paper and glass wool, and the filtrate was made up to 50 ml with deionised water. Standardization of atomic absorption spectrophotometer was done such that the standard of each element to be determined were prepared from the AAS standard as 2 ppm, 4 ppm, 6 ppm, 8 ppm and 10 ppm respectively. The filtrate was then analysed using atomic absorption spectrophotometer model AA-700 Schimadzu model.

Statistical Analysis

SPSS statistical packages version 15.0 was used and data obtained were expressed as percentage and mean ± standard deviation with levels of significant.

RESULTS AND DISCUSSION

The results of the phytochemical analysis, proximate composition analysis, and analysis of mineral elements of the leaves and stem bark of Buchholzia coriacea are summarized in Tables 1, 2 and 3 respectively.

There was no significant difference (p>0.05) in the amounts of sodium, calcium, zinc, and manganese between the leaves and the bark of the plant. However, potassium, magnesium, copper, lead and cadmium levels were significantly higher (p<0.01) in the leaves compared to the bark while iron level is significantly higher (p=0.001) in the leaves compared to the bark.

Anthraquinone, cardiac glycosides, saponins, steroids, coumerin, alkaloids, tannins, phlobatannins and terpenoids were present both in the leaves and bark of Buchholzia coriacea while flavonoids were found to be present in the leaves only. No detectable amounts of reducing sugar and quinine were found both in the leaves and bark (Table 1). Proximate analysis revealed that moisture content and crude fat were significantly higher (p<0.0001) in the leaves compared to the bark while crude protein, crude fibre, ash, and carbohydrate were significantly lower (p<0.05) in the leaves compared to the bark (Table 2).

The moisture content of the fresh leaf and bark of Buchholzia coriacea were moderate (leaf 48.15% and bark 45.14%) whereas the ash, crude protein, crude fibre, crude fat and carbohydrate content of Buchholzia coriacea were (leaves 1.16% and bark 3.30%), (0.13% leaves and 0.15% bark), (1.03% leaves and bark 2.99%), (1.73% leaves and 0.06% bark) and (47.80% leaves and 48.44% bark) respectively.

The literature search revealed that elements such as sodium, potassium, magnesium, calcium, manganese, copper, zinc and iodine could reduce individual risk factors, including those related to cardiovascular disease for both human beings and animals (Sanchez-Castillo et al., 1998). The leaves and bark of Buchholzia coriacea are good source of some of these major and trace element. We evaluated the amount of the heavy metals lead and cadmium because they are micropollutants and are of special interest as they both have health and environmental significance due to their...
persistence, high toxicity and bio-accumulation characteristics in living organisms. Lead has no biochemical or physiological importance and is considered a toxic pollutant. It causes a rise in blood pressure, kidney damage, miscarriages and subtle abortion, brain damage, decline fertility of men through sperm damage, diminishing abilities of children and disruption of nervous systems (Kiran Yasmin Khan et al., 2011).

**Table 2: proximate composition of leave and bark of Buchholzia coriacea**

<table>
<thead>
<tr>
<th></th>
<th>Leaves</th>
<th>Bark</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>48.15 ± 0.002</td>
<td>45.14 ± 0.071</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Crude Protein</td>
<td>0.13 ± 0.001</td>
<td>0.15 ± 0.005</td>
<td>0.001</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>1.03 ± 0.062</td>
<td>2.99 ± 0.006</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Crude fat</td>
<td>1.73 ± 0.059</td>
<td>0.06 ± 0.001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Ash</td>
<td>1.16 ± 0.001</td>
<td>3.30 ± 0.052</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>47.80 ± 0.057</td>
<td>48.44 ± 0.281</td>
<td>0.018</td>
</tr>
</tbody>
</table>

Moisture content and crude fat were significantly higher (p<0.0001) in the leaves compared to bark while the crude protein, crude fibre, Ash, and Carbohydrate were significantly lower (p<0.05) in the leaves compared to bark. n = 3 in each group.

Table 3 shows that the leaves and bark of *Buchholzia coriacea* contain 0.0003± 0.00002 ppm and 0.0004± 0.00003 ppm lead respectively. These values are below the permissible limit with reference to WHO (1992). The permissible limit for lead set in edible plants is 0.43 ppm (WHO, 1992). However, for medicinal plants, the limit is 10 ppm set by China, Malaysia, Thailand and WHO (Jabeen et al., 2010). These references indicate that the plant under study may be safe as far as these parameters are concerned.

Cadmium is toxic metal having functions in neither human body nor plants. Cadmium accumulates in human body and damages mainly the kidneys and liver. The accumulation of Cadmium in kidney leads to high blood pressure and renal diseases. Cadmium intoxication also leads to damaging the nerve cells, inhibition of release of acetylcholine and activation of choline esterase enzyme, resulting in a tendency for hyperactivity of the nervous system (Asparna and Aruna, 2013). Table 2 indicates that the leaves and bark of *Buchholzia coriacea* contain 0.079± 0.0002 ppm and 0.009 ± 0.0001 ppm cadmium respectively. The permissible limit set by FAO/WHO (1984) in edible plant was 0.21 ppm. However, for medicinal plants the permissible limit for Cd set by WHO is, China and Thailand was 0.3 ppm. The low concentration of Cd in the plant studied indicates safety.

In humans, Magnesium is required in the plasma and extra cellular fluid, where it helps in maintaining osmotic equilibrium. It is required in many enzyme–catalysed reactions, especially those in which nucleotide participate where the reactive species is the magnesium salt, e.g., Mg-ATP². Intracellular Magnesium deficiency is correlated with the impaired function of many enzymes utilizing high energy phosphate bonds, as in the case of glucose metabolism (Asparna and Aruna, 2013). Lack of magnesium is associated with abnormal irritability of muscle and convulsions and excess magnesium with depression of the central nervous system. Table 3 indicates that the magnesium content of the studied plant *Buchholzia coriacea*, leave and bark is 0.108 ± 0.001 ppm and 0.152 ± 0.003 ppm respectively.

Iron is an essential element for human beings and animals and is an essential component of haemoglobin. Iron is necessary for the formation of haemoglobin and also plays an important role in oxygen and electron transfer in human body (Ullah et al., 2012) Low iron content causes gastrointestinal infection, nose bleeding and myocardial infection (Ullah et al., 2012). Table 3 indicates that the leaves and bark of *Buchholzia coriacea* contain 0.087 ± 0.001 ppm and 0.079 ±0.002 ppm iron respectively, with leave having higher content than the bark.

Calcium is an essential structural and functional element in living cells. Calcium plays an important role in bones, teeth, muscular system and heart functions. It participates in cell division and the regulation of cell proliferation and differentiation (Whitfield et al., 1979). It is required for absorption of dietary Vitamin B, for synthesis of neurotransmitter acetylcholine and is also required for activation of enzyme pancreatic lipase (lokhande, 2010). Calcium is necessary for the coagulation of blood, the proper functioning of the heart and nervous system and the normal contraction of muscles (Asparna and Aruna, 2013) heart, nervous system and muscles. Calcium deficiency can lead to rickets, osteomalacia and tooth decay (Michael, 2007). The calcium content of the studied plant *Buchholzia coriacea*, leave and bark is 0.023±0.003 ppm and 0.027± 0.001 ppm respectively as indicate in Table 3 which shows that the bark Ca content is slightly higher than that of the leave.

Manganese (Mn) is an essential trace element. It plays a pivotal role in the normal growth, skeleton formation and
normal reproductive function. For medicinal plants the WHO (2005) limits not yet been established for manganese. Deficiency of Manganese in human causes myocardial infection and cardiovascular diseases, also disorder of bony cartilaginous growth in infants and children and may lead to immunodeficiency disorder and rheumatic arthritis in adults (Khan et al., 2008). Its deficiency also causes reproductive failure in both male and female (Lokhande, 2010). Table 2 shows that the manganese content of leaves and bark *Buchholzia coriacea* 0.038 ±0.003 ppm and 0.04 ±0.001 ppm respectively with the manganese content of the bark slightly higher than the leaves. The permissible limit set by FAO/WHO (1984) for manganese was 2 ppm in edible plants. However, the permissible WHO (2005) limits for manganese in medicinal plants have been set.

Table 3: Mineral composition of leave and bark of *Buchholzia coriacea*

<table>
<thead>
<tr>
<th></th>
<th>Leaves</th>
<th>Bark</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td>0.524 ± 0.001</td>
<td>0.516 ± 0.002</td>
<td>0.001</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.709 ± 0.001</td>
<td>0.715 ± 0.004</td>
<td>0.055</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.023 ± 0.003</td>
<td>0.027 ± 0.001</td>
<td>0.079</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.108 ± 0.001</td>
<td>0.152 ± 0.003</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Copper</td>
<td>0.013± 0.003</td>
<td>0.029 ± 0.001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.00088± 0.00015</td>
<td>0.00086 ± 0.00004</td>
<td>0.399</td>
</tr>
<tr>
<td>Iron</td>
<td>0.087 ± 0.001</td>
<td>0.079 ±0.002</td>
<td>0.001</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.038 ± 0.003</td>
<td>0.04 ± 0.001</td>
<td>0.210</td>
</tr>
<tr>
<td>Lead</td>
<td>0.0003 ± 0.0002</td>
<td>0.0004 ± 0.00003</td>
<td>0.001</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.079 ± 0.0002</td>
<td>0.009 ± 0.0001</td>
<td>0.002</td>
</tr>
</tbody>
</table>

It was reported by Jabeen et al., (2010) that the permissible limit set by FOA/WHO in edible plant was 27.4 ppm. The maximum tolerable zinc level has been set at 500 ppm for cattle and 300 ppm for sheep (National Research Council, 1994).

Copper is an essential nutrient, required for a wide range of biological functions such as enzymatic and redox reactions (McLaughlin et al., 1999), whereas intoxication of copper may cause metal fumes fever with flu like symptoms, hair and skin decolouration, dermatitis, irritation of the upper respiratory tract, metallic taste in the mouth and nausea, as well as anaemia, acne, adrenal hyperactivity and insufficient, allergies, hair loss, arthritis, autism, cancer, depression, elevated cholesterol, depression, diabetes, dyslexia, failure to thrive, fatigue, fears, fractures of the bones, headaches, heart attacks, hyperactivity, hypertension, infections, inflammation, kidney and liver dysfunction, panic attacks, strokes, tooth decay and vitamin C and other vitamin deficiencies (Kibata and Pendas, 1993). Copper deficiency results in anaemia and congenital inability (Ullah et al., 2010). Table 3 shows that the copper content of leaves and bark *Buchholzia coriacea* 0.013 ±0.003 ppm and 0.027 ± 0.001 ppm respectively with the copper content of the bark much higher than the leaves. The permissible limits for copper set by China and Singapore for medicinal plant were 20 and 150 ppm, respectively (WHO, 2005). The WHO is yet to establish the limit for copper in medicinal plants.

Potassium is a multi-functional nutrient, major extracellular cation widely present in body fluids and tissues which is an essential part of many important enzymes. Both sodium and potassium are required to maintain osmotic balance of the body fluids, the pH of the body, to regulate muscle and nerve irritability, control glucose absorption, and enhance normal retention of protein during growth (NRC, 1989). The ratio of sodium: potassium (Na⁺:K⁺) in the body is of great concern for the prevention of high blood pressure. A Na⁺:K⁺ ratio of 1 is recommended (NRC, 1989).

Table 2 indicates that the K content of leaves and bark *Buchholzia coriacea* is 0.524 ± 0.001 ppm and 0.516 ± 0.002 ppm respectively indicating that there is no clear difference in potassium content. Literature search indicates that the permissible limit of potassium for both edible and medicinal plant has not been established.

Sodium is found in extracellular body fluids. Its major role is in maintaining electrolyte balance (Erdman et al., 2012). Sodium is also needed in high amount by the human body (RDA 1300-1500 mg daily). Table 2 indicates that the sodium content of leaves and bark of *Buchholzia coriacea* is 0.708 ppm respectively with the sodium content of the bark slightly higher than the leaves.
±0.001 ppm and 0.715 ± 0.004 ppm respectively which clearly suggest that there is no much difference in sodium content of the leaves and bark.

In conclusion, there was no significant difference (p>0.05) in sodium, calcium, zinc, and manganese between the leaves and bark. The potassium, magnesium, copper, lead and cadmium levels were significantly higher (p<0.01) in the bark compared to the leaves while iron level is significantly higher (p=0.001) in the leaves compared to the bark and this suggest that the variations in amount of important mineral elements in both the leaves and bark of *Buchholzia coriacea* could mean that both the leaves and bark can be exploited in drug discovery.

**Conclusion**

The phytochemicals, proximate and mineral compositions of medicinal plant, *Buchholzia coriacea* leaves and bark were studied in this work. The phytochemicals, proximate and mineral composition could be a source of biologically important elements, and they may play a part in the observed therapeutic use of this plant.

The study of the mineral elements also revealed the accumulation of the metals in the plant, which is highly relevant for the quality assessment of its safe use as a potential herbal drug. There are variations in the presence of phytochemicals and amount of important mineral elements in both the leaves and bark of *Buchholzia coriacea* which could mean that both the leaves and bark are useful which can be exploited in drug discovery.

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