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COMPARATIVE ANALYSIS OF CHEMICAL COMPOSITION OF *BUCHHOLZIA CORIACEA* ETHANOL LEAF-EXTRACT, AQUEOUS AND ETHYLACETATE FRACTIONS

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Abstract:

The medicinal value of plants depends on their chemical constituents that provide a definite physiological action on the human body. Knowledge of chemical constituents of plant is necessary for the discovery of therapeutic agents of importance and their precursors. This work is aimed at evaluating and comparing the chemical composition of Buchholzia coriacea ethanol leaf-extract, aqueous and ethylacetate fractions of the ethanol leaf-extract. The phytochemical, mineral and vitamin constituents of the extract and fractions were analyzed using standard methods. Proximate composition of the dry leaves was also determined using standard method. Phytochemical constituents (mg/100g) in all samples were in the order of: Terpenoids>phenols>alkaloids>flavonoids>tannins>saponins>steroids>glycosides. Some phytochemicals were significantly (P<0.05) higher in the extract than fractions. The aqueous fraction contained vitamins B and C in significantly (P<0.05) higher amounts while ethylacetate fraction contained mainly vitamins A, D, E and K. The mineral compositions (mg/100g) in extract and fractions were in the order of Fe>Ca>Mg>K>P>Na>Cu while result of proximate analysis (%) of the dry leaf was in the order of carbohydrates>protein>moisture>fibre>ash>fats. The results show that Buchholzia coriacea contain some phytochemicals, vitamins and minerals in adequate concentration which could be responsible for the physiological activities of this plant. Therefore, this study provides scientific evidence for the use of this plant by rural dwellers in the management of various diseases.

Key words: *Phytochemicals, Buchholzia coriacea, Minerals and Vitamins.*

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INTRODUCTION:

Natural products from plants have played a remarkable role to cure and avert different diseases from ancient times (Kong *et al*., 2003). A study conducted by World Health Organization (WHO) has reported that about 80% of world's population relies on traditional medicine (WHO, 2002). The use of medicinal plants as an alternative form of treatment is well documented and practiced worldwide (Esimone *et al.*, 2009; Ezeja *et al*., 2011; Karem *et al*., 2010). The medicinal value of plants depends on their chemical constituents which are called phytochemicals. These phytochemicals provide a definite physiological action on the human body (Kumar *et al*., 2009). Studies have shown that plant contain numerous phytochemicals which have both medicinal and pharmacological values (Esimone *et al*., 2009; Kareem *et al*., 2010; Ajayi *et al*., 2011). Mineral elements are considered to be of great importance in the treatment and prevention of disease, and in the general well-being of individuals as they perform a critical function in the physiological and biochemical processes (Nelson, 2000).

Since 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). Also, knowledge of chemical constituents of plant is necessary for the discovery of therapeutic agents of importance and their precursors.

Buchholzia coriacea (B. coriacea) belongs to the family of *Capparidaceae*. Common names of *B. coriacea* include: Wonderful kola, Musk tree, Cola pime, and Elephant cola. It is called '*Ewi'* in Edo State, '*Okpolo'* in Igbo, '*Uwuro'* and '*Aponmu'* in Yoruba (Anowi *et al*., 2012; Koudogbo *et al*., 1972). It has multiple medicinal values. Its methanol extract has hypoglycemic, hypolipidemic and lipid peroxidation reducing effects (Chinaka *et al*., 2012; Adisa *et al.*, 2011; Olaiya *et al.*, 2013; Egwu *et al.*, 2017). It has anti-microbial, antihelmintic and antifungal properties (Ezekiel and Onyeoziri, 2009; Chika *et al.*, 2012; Nweze *et al.*, 2011). The seed extract has anti-ulcer and gastric anti-secretory activities (Enenche *et al.*, 2014). There is scarce information on the comparative analyses of phytconstituents of different fractions of *B. coriacea* leaves. This research was therefore aimed at investigating the vitamin, mineral and phytochemical constituents of ethanol leaf extract, aqueous and ethylacetate fractions of *B. coriacea* leaves. This is necessary so as to provide insight into the possible therapeutic value of the plant.

MATERIALS AND METHODS:

Materials

Equipment and Instrument: All equipment and instruments used were in good working condition.

Chemicals and Reagents: All chemicals and reagents used were of analytical grade.

Biological materials: Biological materials used for this study were *B. coriacea* leaves.

Methods

Collection and identification of Plant Materials: Leaves of *B. coriacea* were collected from Ngodo Village in Afikpo North Local Government Area of Ebonyi State, South-Eastern Nigeria. The identification of the plant was carried out by a Taxonomist in the Department of Biological Sciences, Ebonyi State University, Abakaliki.

Preparation of the Crude Ethanol leaf Extract and Fractions of *B. coriacea*

The leaves of *B. coriacea* were washed and shade-dried and later pulverized in a grinder and sifted using 0.25 mm sieve. The powdered sample was used for the extraction. Eight hundred grammes of the sample were soaked in 2000 ml of ethanol for 48 hours with intermittent shaking. Thereafter, it was filtered using white clean cloth and the filtrate heated on a water bath at 35 ºC until the solvent was completely removed. The extract was stored in airtight container.

The dried crude ethanol leaf extract was fractionated in a glass column (150 cm x 1.5 cm) packed with 200 g of a slurry of silica gel (70-230 mesh). The column was eluted in succession with 500 ml water, 500 ml ethylacetate to obtain aqueous and ethylacetate fractions, respectively. The crude ethanol leaf extract, aqueous and ethylacetate fractions of the ethanol leaf-extract were subsequently used for various analyses.

Determination of Phytoconstituents of *B. coriacea* Leaves.

Crude protein, moisture and fibre contents were determined according to the method described by James (1995) while total fat and fibre were determined according to the method described by AOAC (1995). Vitamins A, D and K contents were evaluated according to the method described by AOAC (1990) while vitamins B_1, B_2, B_3 and C contents were investigated according to the method described by Neo and Nollet (2000). Mineral compositions were analyzed using AOAC (1995) method. Saponin and terpenoids concentrations were assessed according to the method of Sofowora

(1993), flavonoids, alkaloids and glycosides compositions were assessed according to the method of Harborne (1973) while tannins concentration were determined the method of Trease and Evans (2002).

Statistical Analysis.
All the results were expressed as Mean $\pm$ Standard deviation (SD) and data were subjected to one-way analyses of variance (ANOVA). Data were analyzed using statistical package for social sciences (SPSS), version 20. Value of $P<0.05$ was considered to be statistically significant.

RESULTS:

Chemical Composition of *B. coriacea* of Ethanol Leaf-extract and Fractions.
The result of the proximate composition of *B. coriacea* leaves is shown in Figure 1. The result revealed that leaves of *B. coriacea* have high levels of carbohydrates (70%) and protein (14%). Proximate composition is in this order: carbohydrate>protein>moisture>fibre>ash>fats.

The results of the vitamin composition of crude ethanol leaf-extract, aqueous and ethylacetate fractions of *B. coriacea* are shown in Figure 2. The results revealed that crude ethanol leaf-extract and aqueous fraction of *B. coriacea* contained vitamins B and C in significantly ($P<0.05$) higher amount while ethylacetate fraction contained mainly vitamins A, D, E and K.

The results of the mineral composition of ethanol leaf-extract, aqueous and ethylacetate fractions of *B. coriacea* are shown in Figure 3. Analysis of the result revealed that the magnitude of occurrence of the minerals was in the following order: Fe>Ca>Mg>K>P>Na>Cu>Pb. However, the level of iron was in this order: crude>ethylacetate>aqueous, while Ca and K were significantly ($P<0.05$) higher in the aqueous fraction than in the other samples.

The result of quantitative phytochemical analyses of crude ethanol leaf-extract, aqueous and ethylacetate fractions of *B. coriacea* is shown in Figure 4. The results revealed that the extract and fractions contain phytochemicals in varying amounts and occurred in the order of:
terpenoids>phenols>alkaloids>flavonoids>tannins>saponins>steroids>glycosides, in both the crude and fractions. However, phytochemicals were significantly ($P<0.05$) higher in the crude extract than the fractions.

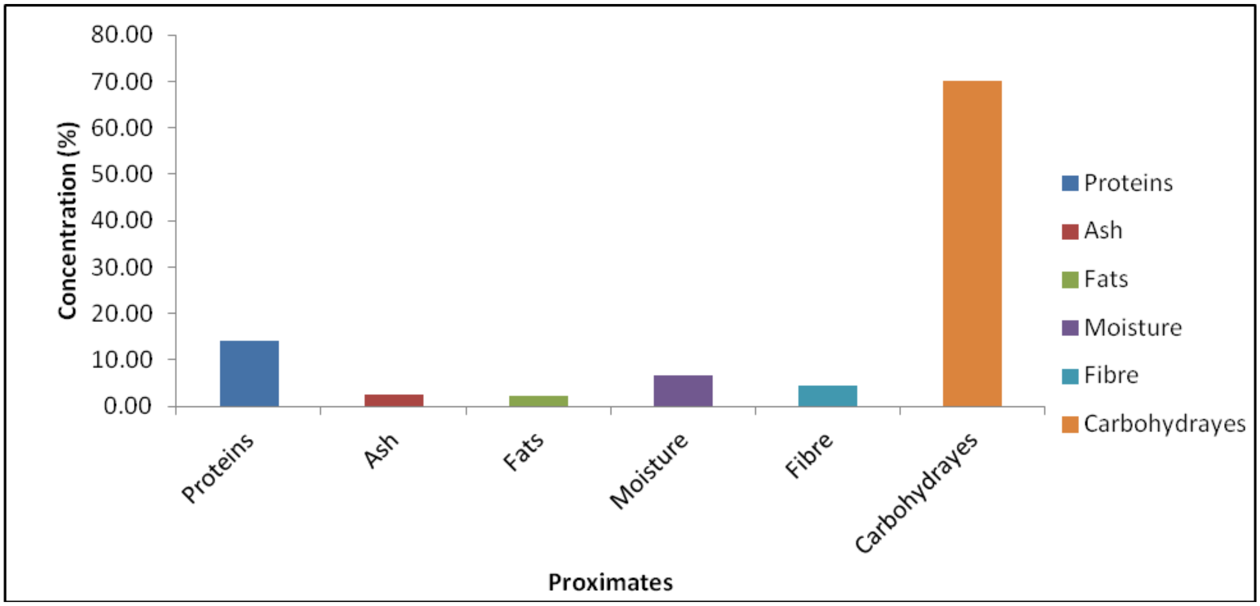

Figure 1. Percentage proximate composition of *B. coriacea* leaves.

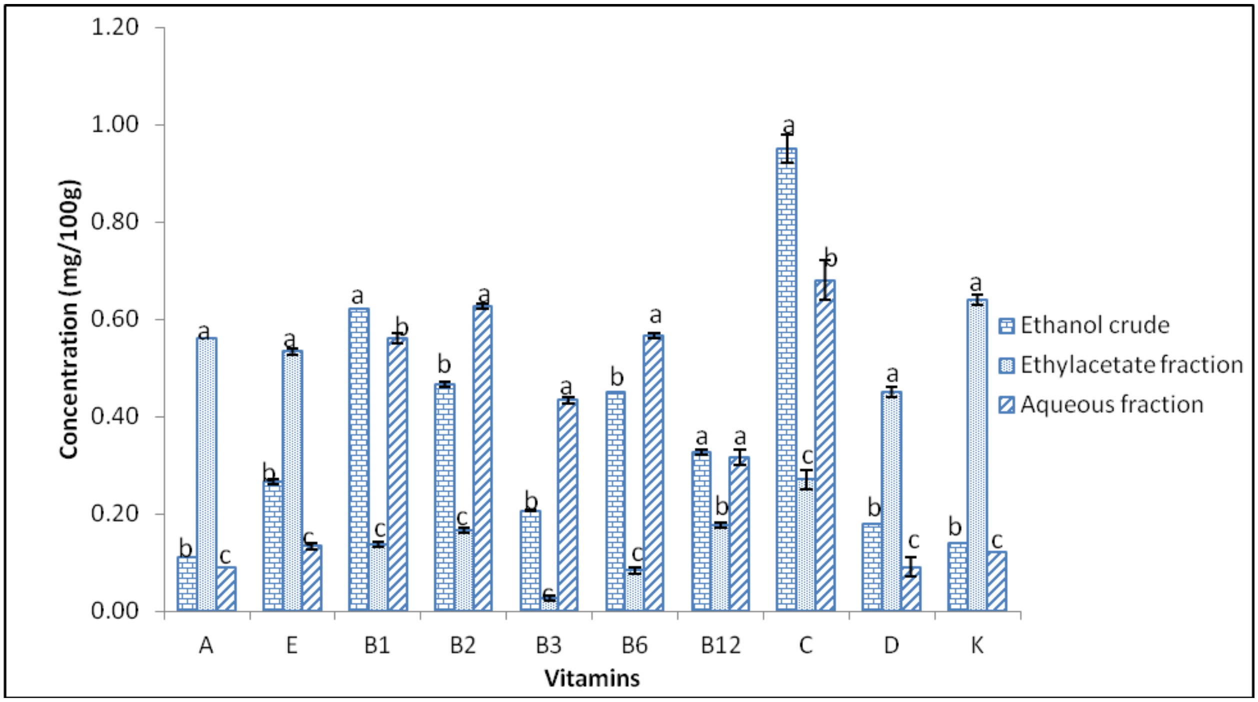

Figure 2: Vitamins composition of crude ethanol leaf-extract, aqueous and ethylacetate fractions of *B. coriacea.*
Bars with different alphabets are significantly different at P<0.05.

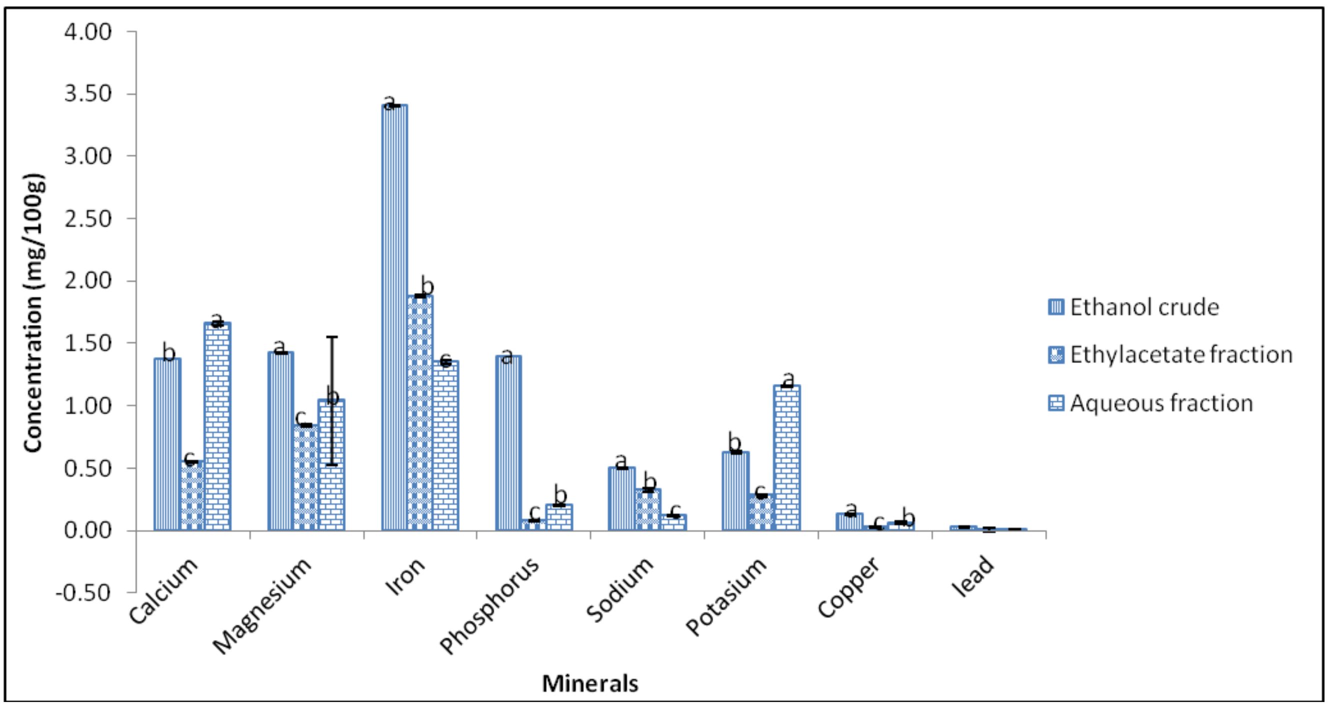

Figure 3: Mineral composition of crude ethanol leaf-extract, aqueous and ethylacetate fractions of *B. coriacea.*

Bars with different alphabets are significantly different at P<0.05.

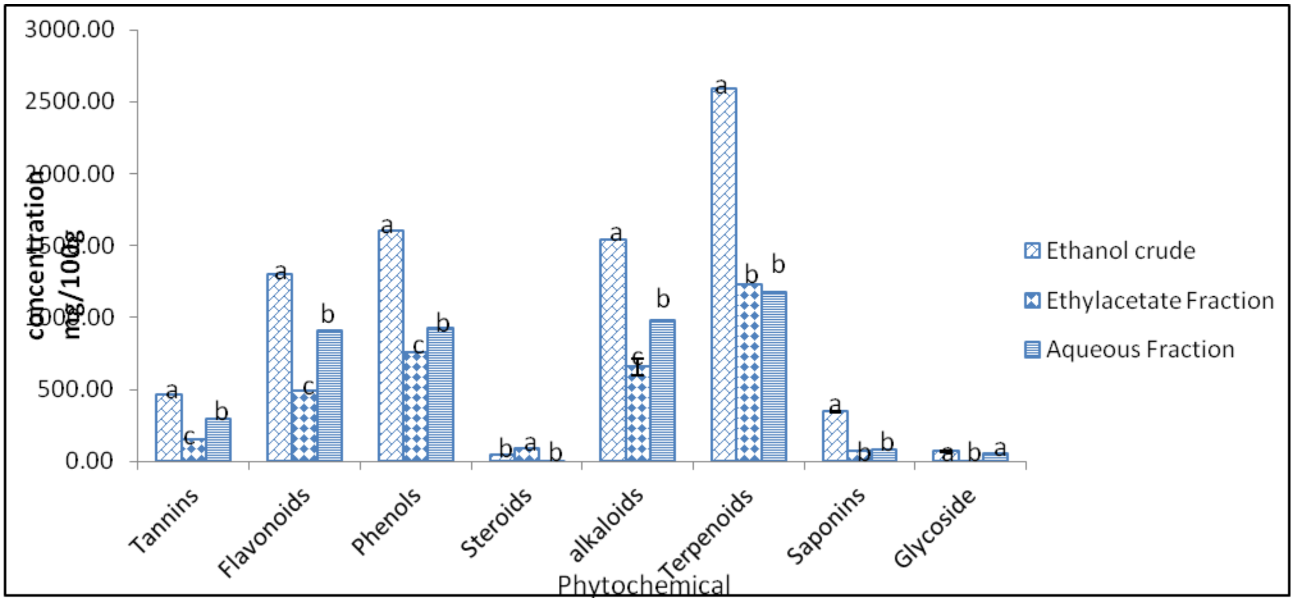

Figure 4: Phytochemical composition of crude ethanol leaf-extract, aqueous and ethylacetate fractions of *B. coriacea* mg/100g.
Bars with different alphabets are significantly different at P<0.05.

DISCUSSION:

Proximate analysis provides information on moisture content, ash content, carbohydrates, protein, fat/oil and crude fibre (Lee, 2005). Since 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 result of the proximate composition of *B. coriacea* leaves is shown in Figure 1. The result revealed that leaves of *B. coriacea* have high levels of carbohydrates (70%) and protein (14%). The result showed the proximate composition in this order: carbohydrate>protein>moisture>fibre>ash>fats.

The proximate analysis showed the moisture content of *B. coriacea* to be 6.75 ± 0.01 %. This result indicates low shelf life of the fresh plant hence long storage would lead to spoilage due to its susceptibility to microbial attack. This supports the practice of storage in dry form by users. Moisture content is among the most vital and mostly used measurement in the processing, preservation and storage of food (Onwuka, 2005). Ash content of 2.65 ± 0.01 % was obtained. Ash content is generally taken to be a measure of the mineral content of the sample (Onwuka, 2005). Crude fibre in food or plant is an indication of the level of non-digestible carbohydrate and lignin. In other words, it is the remnants of plant components that are resistant to hydrolysis by the digestive enzymes. The crude fibre obtained for *B. coriacea* was 4.37 ± 0.01 %. This low level is considered appropriate, because high level can cause intestinal irritation, lower digestibility and decreased nutrient usage (Oladiji *et al.,* 2005). Fibre also reduces the levels of plasma cholesterol and prevents colon cancer and cardiovascular diseases (Ishida *et al*., 2000). Earlier studies have found an inverse relationship between intake of dietary fibre and inflammatory biomarkers such as plasma fibrinogen, C- reactive protein (CRP), tumor necrosis factor-alpha and interleukin-6 (TNF-α, IL-6) levels which are indicators of rheumatoid arthritis (Ma *et al*., 2006). However, contradictory reports have been published (Hu *et al*., 2015). The crude lipid content obtained was 2.14 ± 0.01%. Lipid provides very good sources of energy and aids in transport of fat soluble vitamins, insulates and protects internal tissues and contributes to important cell processes (Pamela *et al.*, 2005). Dietary fat increases the palatability of foods by absorbing and retaining flavours. A diet providing 1-2% of its caloric energy as fat is said to be sufficient for human beings as excess fat consumption is implicated in certain cardiovascular disorders (Anita *et al*., 2006).

The crude protein of *B. coriacea* was 14.10 ± 0.01%. showing that the plant is a moderate source of protein. According to Pamela *et al.* (2005), plant proteins have lower quality but their combination with other sources of protein such as animal protein may result in adequate nutritional value. The carbohydrate content was 70 ± 0.01%. The caloric value of 355.26 Kcal was a little bit lower than that obtained by Ibrahim and Fagbohun (2012) (375.75 Kcal) and Umeokoli *et al*. (2016) (384.33Kcal) for *B. coriacea* seed. Thus, *B. coriacea* is a good source of energy and can contribute to the caloric requirement of the body.

The results of the vitamin composition of crude ethanol leaf-extract, aqueous and ethylacetate fractions of *B. coriacea* are shown in Figures 2. The results revealed that ethanol leaf-extract and aqueous fraction of *B. coriacea* contained vitamins B and C in significantly (P<0.05) higher amount while ethylacetate fraction contained mainly vitamins A, D, E and K. The reason for the variability in vitamin concentration may not be far-fetched. Water-soluble vitamins (B and C) are most likely to be extracted by polar solvents (likes dissolve likes) while the fat-soluble vitamins (A, D, E and K) will be extracted by the non-polar solvent.

Vitamins are organic compounds required in trace amounts in diet because they cannot be made in sufficient quantities by an organism (Rosenberg, 2007). They are minor, but essential for an organism's normal health and growth. Humans need to obtain them from food or supplements (Moreno and Salvado, 2000). These nutrients facilitate the metabolism of proteins, carbohydrates, and fats. They are reported to reduce damage from free radicals, and insufficient levels may result in deficiency diseases (Jacab and Sotoudeh, 2002; Blake, 2007).

Vitamin A is required by human for normal growth of body cells, skin, and for proper vision. Deficiency of vitamin A can result in night blindness and reduced resistance to diseases (Tanumihardjo, 2011). Retinoic acid enhances cytotoxicity and T-cell proliferation (Ertesvag *et al*., 2002). Vitamin C aids wound healing and also help in resisting infection. Its deficiency can cause scurvy which is characterized by weakening of collagenous structures, resulting in poor healing of wound and impaired immunity. Vitamin C can also act as a cofactor to hydroxylase, an enzyme implicated in the synthesis of collagen. It also prevents oxidative stress in humans and rats (Pleiner *et al*., 2008; Ozcan *et al*., 2007; Pozzer *et al*., 2012).

Vitamin E occurs in many different forms (α, β, γ and δ-tocopherols and α, β, γ and δ-tocotrienols) and has many health benefits; it is mostly used for treating and preventing heart diseases (Pyka and Sliwiok, 2001; Zhao *et al*., 2014). It is a well-known antioxidant, preventing different types of cancer, such as lung and oral cancer and others. It is also believed to help patients with Alzheimer's disease and other types of diseases related to the nervous system. Vitamin E contributes to the protection of cells from oxidative stress. Vitamin E decreases the release of reactive oxygen species (ROS) by monocytes (Jialal *et al*., 2001). It also blocks the release of pro-inflammatory cytokines like IL-1, IL-6, TNF-α, by monocytes and macrophages (Munteanu *et al*., 2007). Vitamin E also plays a role in preventing atherosclerosis (Terasawa *et al*., 2000). Therefore, the anti-inflammatory and antioxidant potential of the *B. coriacea* could be explained, in part, by their capacity to decrease ROS generation, atherosclerosis and production of pro-inflammatory cytokines. In the Collagen-induced arthritis (CIA) model in rodents, vitamin D supplementation prevents initiation and progression of inflammatory arthritis (Arnson *et al.* 2007). Patients with rheumatoid arthritis (RA) are at an increased risk of osteoporosis and associated fractures (Bella *et al*., 2015). Vitamin D has long been known to be crucial to bone health by regulating bone metabolism but has also been shown to play other crucial physiologic roles, including regulating the immune system (Urruticoechea-Arana *et al*., 2015; Wöbke *et al*., 2014). Hence, it can play an important role in the development of autoimmune diseases like RA.

The concentration of thiamine in the extract and fractions is higher than the result obtained by Offor *et al*. (2014) from the leaves of *Blighia unijugata*. Thiamine functions as coenzyme in the metabolism of carbohydrate (Anita *et al*., 2006). The antioxidant and/or anti-atherogenic role of other vitamins, such as B_6 and K, are also documented (Endo *et al*., 2006; Thomson *et al*., 2007).

The results of the mineral composition of ethanol leaf-extract, aqueous and ethylacetate fractions of *B. coriacea* are shown in Figure 3. Analysis of the result revealed that the magnitude of occurrence of the minerals in all samples were in the following order: Fe>Ca>Mg>K>P>Na>Cu>Pb. The level of iron was in this order: crude>ethylacetate>aqueous, while Ca and K were significantly (P<0.05) higher in the aqueous fraction relative to other samples. The result of the mineral constituents of *B. coriacea* ethanol leaf-extract, aqueous and ethylacetate fractions varied significantly (P<0.05) from each other. Our result is similar to that of Ibrahim and Fagbohun (2014) who reported the presence of sodium, potassium, phosphorus, calcium, magnesium, zinc and iron in *B. coriacea* seed.

Some minerals possess antioxidant potentials (e.g., copper, ferritin, zinc, manganese, and selenium). Therefore, the anti-oxidant property of *B. coriacea* reported by different authors could be as a result of the presence of these minerals in appreciable amounts. Ca is essential for blood clotting, heart rhythm, nerve impulse, muscle contraction and cell membrane function. Ca, Mg and P are also necessary for bone and teeth formation (Mann, 2002). Naturally occurring minerals such as Mg, Cu, Mn, Zn, and Se have shown anti-inflammatory effects in both animal and human studies. In a rat model of arthritis, a deficiency of dietary Mg was demonstrated to enhance the amount of cartilage damage (Shakibaei *et al*., 1996). Increased Mg in diet may influence inflammation through reducing the serum level of pro-inflammatory C-reactive protein. Cu is an essential cofactor for collagen synthesis enzymes. Cu, Zn and Mn are cofactors of anti-oxidant enzyme-superoxide dismutase. Selenium is also an important cofactor of glutathione peroxidase (Kurz *et al*., 2002; Sasaki *et al*., 1994).

In this study, the phytochemical compositions of the samples were determined and the results are presented in Figure 4. The results revealed that the extract and fractions contain phytochemicals in varying amounts and occurred in the order of: terpenoids>phenols>alkaloids>flavonoids>tannins>saponins>steroids>glycosides, in both the crude and fractions. The concentration of phytochemicals was in the order of: crude>aqueous fraction>ethylacetate fraction. It was observed that crude ethanol leaf-extract had the highest alkaloid content followed by the aqueous fraction. The crude extract had significantly the highest flavonoid content, while the ethylacetate fraction had the least flavonoid content. For phenol, the extract and fractions were significantly ($P<0.05$) different from each other, with ethylacetate fraction having the least value, while the crude ethanol extract had the highest value. The terpenoid content of crude ethanol extract was significantly higher ($P<0.05$) than the aqueous and ethylacetate fractions which had similar terpenoid content. The saponin content of the crude ethanol extract was significantly higher ($P<0.05$) than those found in the other fractions. The tannin content of crude ethanol leaf-extract of *B. coriacea* was highest while the ethylacetate fraction was lowest. The phenolic contents of the three samples were significantly different ($P<0.05$) from each other. The presence of these phytochemicals in appreciable concentrations indicates that *B. coriacea* ethanol extract and fractions have pharmacological values (Esimone *et al*., 2009; Kareem *et al*., 2011; Ajayi *et al*., 2011). The roles of these phytochemicals to well-being of plants and health of animals cannot be over emphasized. Our findings are in agreement with other reports that showed the presence of tannins, saponins, alkaloids, terpenoids, and flavonoids as phytochemicals present in ‘wonderful kola’ leaves as well as in other medicinal plants (Ugwu *et al*., 2017; Ejikeugwu *et al*., 2014; Olayemi *et al*., 2011; Mbata *et al*., 2009; Ajayi *et al*., 2011; Nweze, 2011).

Phytochemicals play active antioxidative, antiproliferative, anti-inflammatory, and antiangiogenesis roles for prevention of chronic diseases (Upadhyay and Dixit, 2015). High consumption of fruits and vegetables (which are rich in phytochemicals) not only is inversely correlated with disease progression but also exerts some protective effects against autoimmune diseases (Pattison *et al*., 2004; Cerhan *et al*., 2003).
Phytochemicals are some of the most potential natural sources for developing novel drugs with improved efficiency and safety.

In this study, flavonoid contents were in good concentration in the extract and fractions. The presence of flavonoids shows that the plant has antioxidant properties; this could enhance the body’s defense systems against free-radical (Al-Humaid *et al*., 2010). Flavonoids have been demonstrated to have a wide range of biological and pharmacological functions in *in-vitro* studies. These include anti-inflammatory, antioxidant (Cazarolli *et al*., 2008; Ishikawa *et al*., 1999), antiallergic, antiviral, anti-thrombic and vasodilatory activity (Wurochekke *et al*., 2008) anti-microbial (Cushnie *et al*., 2011; Manner *et al*., 2013; Fried, 2007), anti-cancer (Cazarolli *et al*., 2008; Ruela *et al*., 2007) and anti-diarrheal activities (Schuier *et al*., 2005). Epidemiological studies have reported a reduced risk of coronary heart disease in subjects with high flavonoids intake (Hertog *et al*., 1993).

Steroids reduce inflammation by inhibiting phospholipase A_2 which is responsible for the hydroxylation of arachidonic acid from the membrane phospholipids leading to the formation of prostanoids and leukotrienes (Mencarelli *et al*., 2009). Plant steroids are one of the most naturally occurring plant phytoconstituents that have found therapeutic applications as cardiac drugs (Firn, 2010). They promote nitrogen retention in osteoporosis and in animals with wasting illness (Madziga *et al*., 2010).

Saponins can either induce competitive inhibition of the adsorption of dietary cholesterol in the intestine of animal or stimulate biliary excretion of bile acid or cholesterol in feaces (Durrington, 2003). This is due to the fact that saponins are glucosides of steroids and steroid alkaloid which bear chemical similarity with cholesterol and may either block the absorption of cholesterol by the intestinal lumen or enhance its excretion. Thus, the ethanol leaf- extract, aqueous and ethylacetate fractions of *B. coriacea* that had moderate amount of saponins indicate the possibility of using these samples in the management of cardiovascular diseases.
Although saponins are mostly non-toxic in nature but they are known to produce cytotoxic and growth inhibition against a variety of cell hence making then to have anti-inflammatory and anticancer properties (Majesty *et al*., 2012).

Moderate concentration of alkaloids in *B. coriacea* extracts and fractions indicate that it may be used as sedative, pain-relieving drug, anaesthetic, and analgesic (Osadebe and Uzochukwu, 2006*;* Malu *et al*., 2009). Alkaloids have a wide range of pharmacological activities including antimalarial (e.g. quinine), anticancer (e.g. homoharringtonine), antiasthma (e.g. ephedrine) (Kittakoop *et al*., 2014), cholinomimetic (e.g. galantamine) (Russo *et al.*, 2013), antiarrhythmic (e.g. quinidine), vasodilatory (e.g. vincamine), analgesic (e.g. morphine) (Sintra *et al*., 2010), antibacterial (e.g. chelerythrine) (Cushnie *et al*., 2014) and antihyperglycemic (e.g. piperine) (Shi *et al*., 2014). Other alkaloids possess psychotropic (e.g. psilocin) and stimulant activities (e.g. theobromine, cocaine, nicotine, caffeine) and have been used as recreational drugs (Wink, 2015).

Tannins are known for astringency (Chatterjea and Shinde, 2000). The sharp pungent taste with hot spicy flavour of *B. coriacea* seed and leaf could be traceable to its tannin content.
Tannins have good antimicrobial and anti-inflammatory activities (Redondo *et al.*, 2014). However, excess tannins may be toxic because tannins as metal ion chelators can decrease the bioavailability of iron which often leads to anaemia (Ukoha *et al*., 2011). Therefore, the presence of tannin in the samples show that the samples especially the ethanol extracts that had higher amount may play a very important therapeutic role in the field of medicine.

Terpenoids and phenols have antioxidant properties and protect cells from oxidative damage (Kasote *et al*., 2015). Therefore, the presence of both terpenoids and phenols in all the samples especially the aqueous fraction shows that *B. coriacea* leaf-extract and fractions could be used as an antioxidant in the management of oxidative damage. Similarly, terpenoids can reduce the incidence of heart attack. Epidemiological studies have shown that the oral supplementation of tomato extract (rich in carotenoid, lycopene) can be used to control the risk of hyperlipidemia, cardiovascular disease, metabolic syndrome by regulating several physiological phenonmenon like reduction of blood pressure, low density lipoprotein oxidation, hypertension (Hirai *et al*., 2010).

Cardiac glycosides are used in the treatment of congestive heart failure and cardiac arrhythmia. It is pertinent to note that, several cardiac glycosides such as peruvoside have been used in cancer control, especially ovarian cancer and leukemia (Patel, 2016). Ethanol leaf-extract, aqueous and ethylacetate fractions of *B. coriacea* contain trace amount of cardiac glycoside. Thus, the plant could be used in the management of heart failure, cancer and leukemia.

CONCLUSION:

This study has confirmed that *B. coriacea* ethanol leaf-extract, aqueous and ethylacetate fractions of the ethanol leaf-extract contain varying amount of vitamins, minerals and phytochemicals. However, the ethanol leaf-extract had higher concentration of these phytonutrients than other samples. Some vitamins and minerals possess antioxidant potentials and hence could be of importance in the treatment and prevention of diseases. Phytochemical constituents have pharmacological effects that are beneficial to human health. The use of *B. coriacea* by rural dwellers for the management of various diseases could be attributed to the presence of these phytoconstituents in appreciable amount.

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