International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Proximate and Elemental Composition of Methanolic Extract of *Boswellia dalzielii* Hutch. (Frankincense Tree: Burseracea)

U. T. Mamza[1], O. A. Sodipo[2], F. I. Abdulrahman[3], I. Z. Khan[4]

[1, 3, 4]Department of Chemistry, University of Maiduguri, Nigeria

[2]Department of Clinical Pharmacology and Therapeutics, College of Medical Sciences, University of Maiduguri, Nigeria

Abstract: ***This study is aimed at investigating the proximate contents, concentrations of some micro/macro elements and anions of the stem bark and leaves of B. dalzielii with the view of validating its use as forage and medicinal by man in the treatment of diarrhoea, dysentery and in wound healing. The stem bark and leaves of B. dalzielii were collected from Bagale-Giere Local Government Area, Adamawa State, Nigeria. Proximate analysis was conducted following methods of Association of Official Analytical Chemists and the results showed that the stem bark had the higher dry matter (90.94 %), nitrogen free extract (54.13 %), crude fibre (30.65 %), and ash (8.34 %), while crude proteins (4.63 %), fats (21.20 %), carbohydrates (57.76 %) and moisture content (12.41 %) were estimated to be higher in the leaves of this plant. The levels of 11 elements (Ca, Mg, Na, K, Fe, Cd, Cu, Ni, Zn, Cr, Pb) were determined using atomic absorption spectrophotometer, the anions (nitrates, phosphates and sulphates) were estimated using smart spectrophotometer. The results revealed higher concentrations of macro elements and microelements in the leaves sample except for Cr concentration which was higher ($4.0 \times 10^{-5} \pm 0.00$) mg/g in the stem bark than in the leaves ($3.80 \times 10^{-5} \pm 0.01$) mg/g. In both the samples Pb was not detected.The concentrations of nitrates, phosphates and sulphates were higher in the leaves (1.52×10^{-2}, 4.0×10^{-3}, 1.33×10^{-2}) mg/g than the stem bark ($1.40 \times 10^{-2,}$ 3.0×10^{-4}, 1.24×10^{-2}) mg/g respectively.The proximate, elemental and anions concentrations for these parts of B. dalzielii were mostly found within the permissible limit set by World Health Organization.***

Keywords: Anions, *Boswellia dalzielii*, leaves, elements, proximate, stem-bark.

1. Introduction

In Africa and across the globe, herbal medicines represent the fastest growing segment of pharmacy trade, surely the cost of modern clinical medicines cannot be over looked, so most people consider other alternative form of medicines. Most herbal medicines are less expensive than prescription drugs (Sofowora *et al.*, 2013). Nature has been the source of medicine for thousands of years in the maintenance of human health since ancient time (Mamza *et al.*, 2015). Over 50 % of all modern clinical drugs are of natural product origin (Danlami *et al.*, 2015). The chemical constituents of plants, including metal ions, are particularly responsible for medicinal and nutritional properties, as well as the toxicity. The cumulative levels of these metals in both the roots and other tissues of plant above the ground can be transferred from soils into the food chain; thus causing phytotoxicity in plants and having potential harmful effects on animals and humans (Hussain Hussain *et al.*2006). WHO (1998) recommends that medicinal plants, which form the raw materials for the finished products, may be checked for the presence of heavy metals, pesticides, bacterial or fungal contamination.

Boswellia dalzielii is a tree that belongs to the family of Burseraceae, from the genus of *Boswellia* and species of *B. dalzielii*.It is about 13m high of the wooden savanna with a pale papery bark peeling and ragged characteristics. It is abundantly found in West Africa in countries such as Ghana, Niger, Ivory Coast, Upper Volta, Cameroun and Northern part of Nigeria, where the Hausa speaking people of Nigeria call it "Hano" or "Ararrabi", Margi "Mofu" and Babur-Bura "Debro" (Moses *et al.*,2005; Mahamat *et al.*, 2014a). The plant is popular in the Northern part of Nigeria due to its ethno medicinal importance.A bark-decoction is used as an antiseptic wash for sores in Ivory-Coast and is an ingredient of a complicated prescription for leprosy (Burkill, 1985). In northern Nigeria, the bark is boiled up in large quantity to make a wash for fever, rheumatism etc., and the fluid is taken internally for gastrointestinal troubles (Burkill, 1985, Danlami *et al.*, 2015). The Fulani people of northern Nigeria use a cold infusion for snake bite (Burkill, 1985). The fresh bark of the root is eaten in Adamawa State, Nigeria, to cause vomiting after a few hours and thus relieves symptoms of giddiness and palpitations as well as antidotes to arrow-poison (Burkill, 1985; Danlami *et al.*, 2015).

B. dalzielii is a staple household medicine for dental problems, swellings, bronchitis and coughs (Ben-Yehoshua et al., 2012). The psychoactivity of *B. dalzielii* was recognized in ancient times in the near East and Europe. In India, the traditional Ayurvedic medical system refers to the use of the gum extracted from *Boswellia dalzielii*, which is recommended for arthritic and inflammatory conditions, gastric disorders, pulmonary diseases and skin ailments. It is also reported to have a strong action on the nervous system and reduces phlegm, asthmatic attack and stops vomiting (Ben-Yehoshua *et al*., 2012).*B. dalzielii* has strong antibacterial, antibiotic, antifungal and antiseptic properties, making it a valuable ingredient in natural medicine (Ben-Yehoshua *et al*., 2012). According to Mahamat *et al*. (2014a, 2014b), *B. dalzielii* has shown a potent immunological effect and immune modulatory activity both in vitro and in vivo in northern Cameroon. In the Republic of Benin, *B. dalzielii* has shown a wide spectrum of antibacterial activity (Anago *et al*., 2011). In Nigeria, antibacterial activities and gastrointestinal effects of *B. dalzielii* have been reported by different researchers (Oguakwa, 1980; Alemika and

Oluwole, 1991; Ntiejumokwu and Alemika, 1991; Nwinyi *et al*., 2004; Moses *et al*., 2005; Roseline *et al.*, 2007). Atawodi *et al*. (2011) reported that *B. dalzielii* has anti-trypanosomal activity.*B. dalzielii* has widely been reported to offer good treatment for leprosy, peptic ulcer, asthma, diarrhoea, syphilis, rabies, chickenpox, hepatitis and HIV/AIDS. In addition, it is liver protective (Burkill, 1985; Nwinyi *et al*., 2004; Anago *et al*., 2011; Ohemu *et al*., 2014).

It is therefore worthy to note that, whatever is taken as food could cause metabolic disturbance subject to the allowed upper and lower limits of trace metals (Prasad, 1976) the excesses of these essential nutrient and trace of toxic metals may cause serious effects on human health (Khan *et al.*, 2008).

There is little or no report on the proximate, elemental and anions contents of *B. dalzielii*; and thus, the aim to investigate the levels in the stem bark and leaves, with the view to validating the traditional use of this plant in Adamawa State –Nigeria, as forage and remedy against diarrhoea, dysentery, for wound healing among others.

2. Materials and Methods

Collection and Identification of plant

The plant was collected from Bagale (Long. 14^{o} 23.32' E; Lat. 11^{o} 01.22' N), Gieri Local Government Area, Adamawa State, Nigeria in November, 2015. The plant material was identified and authenticated by a plant Taxonomist, Professor S. S. Sanusi, Department of Biological Sciences, University of Maiduguri and the voucher specimen number #340 was prepared and deposited at the Post Graduate Research Laboratory, Department of Chemistry, University of Maiduguri, Nigeria.

Sample Preparation

The air-dried stem bark and leaves were manually pulverized using wooden mortar and pestle and then treated onwards. Two grams of the powdered sample were processed for various parameters according to the Association of Official Analytical Chemists methods (AOAC, 1990; AOCS, 2000).

Proximate Analysis

The proximate evaluation for the moisture, crude protein, crude fibre, ash content, crude fats, carbohydrates and nitrogen free extracts of the stem bark and leaves samples were determined using AOAC methods. The moisture and ash were determined using weight difference method. Fibre content was estimated from the loss in weight of the crucible and its content on ignition. Carbohydrate was determined when the sum of the percentages of moisture, ash, crude protein and fats were subtracted from 100. The nitrogen value, which is the precursor for protein of a substance, was determined by micro Kjeldahl method, involving digestion, distillation and finally titration of the sample (AOCS, 2000). The nitrogen value was converted to protein by multiplying with a factor of 6.25. the determination of crude lipid content of the samples was done using soxhlet type of the direct solvent extraction method. The solvent used was petroleum ether (boiling range 40 -60 ^{o}C). the nitrogen free extract (NFE) was calculated indirectly by difference as the sum of crude protein, crude fibre, ether extract and ash subtracted from 100. All the proximate values are presented in percentage (AOAC, 1990; AOCS, 2000).

Elemental Analysis of the Plant Samples

The macro and microelements were determined using Perkin-Elmer Analyst 300 single beam Atomic Absorption Spectrophotometer (AAS) and the data was obtained in parts per million (ppm) which was then converted to mg/g. Calibration curve was established using working standards for each element. Laboratory procedures for the preparation and determination of macro and microelements were used as outlined by Radojevic and Bashkin (1999) for plant samples.

Sample Digestion and Preparation for Analysis

The air-dried plant samples were pulverized manually in wooden mortar and pestle into course powder. 0.5 g of each sample was independently packed into an acid-washed porcelain crucible and then placed in a muffle furnace for four hours at 550 ^{o}C. The crucibles were removed from the furnace and cooled. Ten ml of 6 M HCl were added and then covered, this content was heated on a steam bath for 15 minutes. One ml of $HNO_3$was later added and evaporated to dryness by continuous heating for one hour so as to dehydrate silica and completely digest organic substances. Lastly, 5 ml of 6 M HCl and 10 ml of water were added and the mixture was heated on a steam bath to complete dissolution. The mixture was cooled and filtered through a Whatman No. 1 filter paper into 100 ml volumetric flask and then made up to the mark with distilled water (Radojevic and Bashkin, 1999).

3. Anions Analysis in Plant Samples

Determination of nitrate

The concentration of nitrate in the leaves and stem bark was carried out by standard cadmium reduction method using Smart Spectrophotometer (La Motte, 2000). Plant samples solutions were prepared by chopping each sample into smaller sizes. About 0.5 g of the samples was transferred into 100 ml volumetric flask and soaked with 50 ml distilled water. The flask was corked and shaken for 30 minutes, then filtered into another 100 ml volumetric flask and the volume made to the mark with distilled water (Radojevic and Bashkin, 1999).

Determination of phosphate

The air-dried and powdered samples of the stem and leaves of *Boswellia dalzielii* were used. About 0.5 g was weighed into crucibles; this was then underlayed with 5 ml of (20 %) w/v magnesium acetate and thereafter evaporated to dryness. The content of the crucible was then transferred into the muffle furnace and heated to 550 ^{o}C. Furthermore, the crucible contents were ashed at 550 ^{o}C for 4 hours and then cooled in desiccators. Ten ml of 6 M HCl were then added to each off the crucible and covered and then heated on a water bath for 15 minutes. The contents of the crucible were completely transferred into different evaporating basins and 1 ml of concentrated HNO_3 was added. The heating was continued for 1 hour to dehydrate silica. One ml of 6 M HCl further added, swirled and then followed by the addition of 10 ml distilled water and again heated on the water bath for

complete dissolution. The contents of the evaporating basins were cooled and then filtered through a Whatman No. 1 filter paper into 100 ml volumetric flasks and the volumes made up to the marks with distilled water (Radojeveic and Bashkin, 1999). Phosphate was determined using batch direct reading 2000 spectrophotometer.

Determination of Sulphate

Sulphate was determined using smart spectro spectrophotometer (La Motte, 2000). The samples were prepared as follows: 5 ml of magnesium nitrate solutions were added to each of the ground samples in the crucibles which were then heated to 180 ^{o}C on a hot plate. The heating process was allowed to continue until the colour of the samples changed from brown to yellow (AOAC, 1990). The samples were then transferred to the furnace at a temperature of 500 ^{o}C for four hours. Magnesium nitrate was added to prevent loss of Sulphur. The contents of each crucible were carefully transferred to different evaporating basins; 10 ml of concentrated HCl were added to each and covered with watch glass. The content of each crucible above was boiled on a steam bath for 3 minutes. On cooling, 10 ml of distilled water were added to each of the basins and the contents filtered into 100 ml volumetric flask and the volume made up to the mark with distilled water (Radojevic and Bashkin, 1999).

4. Results and Discussion

Proximate Analysis

The result of proximate analysis shows variant proportions of nutrients and their contents. The data for the proximate contents of the stem bark and leaves are presented on Figure 1. The result revealed that the ash content of the stem bark (8.34 %) is higher than that of the leaves (4.00 %), therefore the stem bark contains more inorganic constituents than the leaves. The result also showed that the crude fats contents (21.20 %) and the crude protein (4.63 %) content of the leaves was higher than that of the stem bark (3.56 % and 3.32 %) respectively which indicated that the leaves contain more calories constituents than the stem bark. The crude fibre content of the stem bark (30.65 %) was higher than that of the leaves (28.4 %), therefore it may provide protection against gastrointestinal disease than the leaves (Danlami *et al.,* 2015). The moisture content was obtained as 9.06 % and 12.41 % in the stem bark and leaves respectively which was in agreement with the results reported by Danlami *et al.,*2015 that moisture contents for stem bark and leaves were calculated as 8.51 % and 12.24 % respectively. Our data for carbohydrate content in the stem bark and leaves were found as 45.07 % and 57.76 % respectively. Looking also at the result, it showed that carbohydrate content in the leaves which is an important source of energy is higher than that of the stem bark. The nitrogen free extract was more in the stem bark (54.13 %) than that found in the leaves (41.77 %). The highest proximate contents were presented by percentage dry matter in both parts; the stem bark had 90.94 % and the leaves had 87.59 %. The percentage dry matter observed in this study had showed a similar results reported by Danlami *et al.,* 2015 on this plant and Usman *et al.,* 2011 on *B. rufescens* Lan. From these results, the increasing order of these nutrients among the plant parts is dry matter> nitrogen free extract > carbohydrates > crude fibre > moisture content > ash content > fats content crude protein.

Elemental Analysis

The results of macro- and microelements concentrations reported in mg/g are presented in Table 1.

Macro elements

Metals play a vital role as structural and functional components of proteins and enzymes in cells. Each mineral plays a number of different functions in the body. The most important pathway of metals to transport into human is from soil to plant and from plant to human (Maghrabi, 2014).

The macro elements analysed were potassium, calcium, magnesium, and sodium. The K, Ca, Mg and Na are available in very low to moderate concentrations respectively. This is very significant, as K, Ca, Mg and Na are known to enhance the qualities of blood, bone, teeth and blood formation and also for cardiac function; these elements likewise also play a predominant role in enzyme activation, oxygen and electron transport. There are lots of disease conditions that result due to the deficiency or excess of these essential elements in the body. For instance, a reduced extracellular blood calcium increases the irritability of nerve tissue and very low levels may cause spontaneous discharge of nerve impulse, leading to tetany and convulsion (Soetan *et al.,*2010). In children, calcium deficiency causes rickets due to insufficient calcification by calcium phosphate of the bones in growing children. The bones therefore remain soft and deformed by the body weight (Vohora, 1987). In adults, Ca deficiency causes osteomalacia, a generalized demineralization of bones. Toxicity symptoms occur with excess absorption due to hypervitaminosis D or hypercalcemia due to hyperparathyroidism, or idiopathic hypercalcemia. Excess calcium depresses cardiac activity and leads to respiratory and cardiac failure; it may cause the heart to stop in systole, although, normally, calcium ions increase the strength and duration of cardiac muscle contraction (Soetan *et al.*, 2010; Maghrabi, 2013).

Sodium deficiency in young chicks cause growth retardation. Egg production and hatchability in laying chickens are depressed. Increased level of sodium in the serum is called hypernatraemia and this occurs in Cushion's disease. Low level of sodium in the serum is hyponatraemia and this occurs in acute Addison's disease, vomiting, diarrhoea, nephrosis-severe (non-inflammatory degeneration of kidneys) burns and intestinal obstruction. The toxicity which occur as a result of high accumulation of sodium in the body fluid may cause hypertension in susceptible individuals (Soetan *et al.,* 2010). The health status of the digestive system and the kidneys significantly influence magnesium status. Magnesium is an active component of several enzyme systems in which thymine pyrophosphate is a cofactor. Chronic or excessive vomiting and diarrhoea may result in magnesium depletion. Deficiency diseases or symptoms is secondary to malabsorption or diarrhoea. Acute magnesium deficiency results in vasodilation, with erythemia and hyperaemia. Toxicity disease or symptoms of magnesium deficiency in humans include depressed deep tendon reflexes and respiration (Murray *et al* 2000; Soetan *et al*., 2010).

Potassium is the principal cation in intracellular fluid and functions in acid-base balance, regulation of osmotic pressure, conduction of nerve impulse, muscle contraction particularly the cardiac muscle, cell membrane function and Na^+/K^+-ATPase (Soetan et al., 2010). Excessive amount of potassium in blood (hyperkalaemia) usually causes advanced chronic renal failure, shock and dehydration while other symptoms of accumulated potassium include dilatation of the heart, cardiac arrest, small bowel ulcers. Low level of serum potassium (hypokalaemia) causes diarrhoea, metabolic alkalosis and familial periodic paralysis. Potassium deficiency affects the collecting tubules of the kidney, resulting in the inability to concentrate urine and also causes alterations of gastric secretions and intestinal motility. Deficiency diseases or symptoms occur secondary to illness, functional and structural abnormalities including impaired neuromuscular functions, skeletal, smooth and cardiac muscle, muscular weakness, paralysis, mental confusion (Soetan *et al*., 2010; Sarpong *et al.*, 2012; Maghrabi, 2014).

According to Osuji *et al.* (2013), concentrations of these elements in plants could be specifically useful as anti-infective in the treatment of diseases and disorders such as diarrhoea, dysentery, wound healing and other bacterial and fungal infections. The abundance of Ca, Mg. Na and K in the present study was also in agreements with previous studies, which indicate that these elements are the most abundant elements in many herbal drugs (Soetan *et al.*,2010; Sarpong *et al*., 2012; Maghrabi, 2014).

Micro elements

High levels of hazardous metals such as lead (Pb) in medicinal plants can have adverse effects on the blood, the central nervous system (CNS), the blood pressure, the kidneys, the reproductive system and vitamin D metabolism (Sarpong et al., 2012). Exposure to chromium (Cr) can cause lung cancer, irritation of the lung resulting in asthma, liver and kidney damage. When cadmium (Cd) enters the body, it severely irritates the stomach, leading to vomiting and diarrhoea. Cadmium can also cause severe lung damage leading to death. Acute toxicity of zinc may cause throat dryness, cough, general weakness, fever, nausea, anaemia and pancreas damage (Soetan et al., 2010; Sarpong *et al*., 2012; Kulhari *et al*., 2013; Mughrabi, 2014). Mercury (Hg) and its compounds are highly toxic, especially methylmercury- a potent neurotoxin. A few studies reflect that even minor increases in methylmercury exposure can cause harmful effects on the cardiovascular system, blisters in the upper gastrointestinal tract, vomiting, abdominal pain, constipation and gastritis (Mudgal *et al*., 2010).

According to WHO recommendation, medicinal plants which form the raw materials for the finished products may be checked for the presence of heavy metals. Further, it regulates maximum permissible limits of toxic metals like As, Cd, Hg and Pb which amounts to 1.0, 0.3, 0.5, 10.0 ppm respectively (WHO, 2007). Although, macro and micro elements are valuable for diseases and disorders control in man (Iwalewa *et al*., 2009) they could however produce harmful effects in excessive amounts (Hussain et al., 2006; Usman, 2012). According to the European Union (EU) Commision Regulation published by Kabata-Pendias and Mukherjee (2007), the maximum amount of Cd, Pb and Hg in foodstuffs and plants used for therapy have to be controlled. Thus, Provisional Tolerable Weekly Intake (PTWI) values for adults have been set as Cd,7; Hg, 5 and Pb, 25 in µg/kg body weights. The Recommended Diatary Allowance (RDA) for other elements also have been estimated for safety and adequate daily intake for adults as follows: Cr, 0.6-3; Mn, 26-60; Se, 0.9; and Zn 190 in µg/kg body weights (Iwalewa *et al*., 2009).

This study reports the concentrations of seven microelements; Cd, Cr, Pb, Cu, Fe, Ni and Zn. The results showed the highest concentration of Cu in the leaves as ($4.22 \times 10^{-3} \pm 0.63$) mg/g than stem bark ($2.56 \times 10^{-3} \pm 0.04$) mg/g samples as shown in Table 2. On the other hand, the concentration of chromium (Cr) in both leaves and stem bark were the lowest ($3.8 \times 10^{-5} \pm 0.01$ and $4.00 \times 10^{-5} \pm 0.00$)mg/grespectively. The levels of Cd were low in both stem bark and leaves with values of $7.80 \times 10^{-4} \pm 0.01$ and $8.10 \times 10^{-4} \pm 0.40$ mg/g respectively.The concentrations of Ni in both stem bark and leaves equally showed low values of $1.25 \times 10^{-3} \pm 0.00$ and $1.33 \times 10^{-3} \pm 0.01$ mg/g respectively. The concentration of Fe in this part of plant (stem bark and leaves) was found to be$3.00 \times 10^{-4} \pm 0.01$ and $3.80 \times 10^{-4} \pm 0.33$ mg/g while the levels of Zn are$3.9 \times 10^{-4} \pm 0.02$ and $3.82 \times 10^{-3} \pm 0.01$ mg/g respectively. This is in agreement with most medicinal plants studied as reported by several workers that these metals were either very low in concentration or below the detection limit of the instruments used (Khan *et al*., 2008; Kulhari *et al*., 2013; Maghrabi, 2014). Lead (Pb) was not detected in the samples. Cadmium (Cd) which is known to be practically toxic (Khan *et al*., 2008; Kulhari *et al*., 2013), was found to be below the permissible limit of 0.3 mg/kg (WHO, 2007). The concentration of Cr for both stem bark and leaves (4.00 x 10-5±0.00 and $3.80 \times 10^{-5} \pm 0.01$ mg/g) determined falls below the permissible region in plant as reported by Adriano (1986), that most phytotoxic level of Cr in plant occurs at 10 mg/kg. The concentration of copper (Cu) was determined as $2.56 \times 10^{-3} \pm 0.04$mg/g and as reported by Suttle and Jones (1989), copper as a trace element has as inhibitory effect on edema and inflammation as well as being universally important cofactor for many hundreds of enzymes (Suttle and Jones, 1989; Tilson, 1982). It is therefore pertinent to say that there is reason for the use of this part of this plant in the management of diarrhoea and dysentery. The effect of copper on resistance to bacterial and viral infections in ruminants has been highlighted (Suttle and Jones, 1989). A Cu deficiency can result in a decrease in the tinsel strength of arterial walls, leading to aneurysm formation and skeletal maldevelopment (Tilson, 1982).

Ni concentration was lower in the sample studied (1.25 x 10-3±0.00 mg/g) and these values fall within the safety margin, since phytotoxic concentration of Ni ranges between 40 to 246 mg/l (Usman, 2012) and also lower than the Ni concentration of 0.05-5 mg/kg for most of plant foods (FAO/WHO, 1993). The concentration of Zn was less than 0.15 mg/g which falls within the normal range of 25-150 mg/kg (Jones, 1972) and was found to be far below the concentration which affects human health that ranges between 100 to 500 mg/l (Macnicol and Beckett, 1985). This

element being essential is utilized in the development of brain, bone formation and wound healing (Khan *et al*., 2008). These observations could be the possible reason for the use of this plant in wound healing in the traditional system of medicine. Therefore, it may properly be said that the anti-infective effects of this plant may be related to these elements.

According to WHO recommendation, medicinal plants which form the raw materials for the finished products may be checked for the presence of heavy metals, further it regulates maximum permissible limits of toxic metals like arsenic (As), cadmium (Cd) and lead (Pb), which amount to 1.0, 0.3 and 10 ppm, respectively (WHO,1989, 1998). Although, macro- and microelements are valuable for disease and disorders control in man (Iwalewa *et al.*,2009), they could however produce harmful effects in excessive amounts (Hussain *et al.*,2006).

Anions Analysis

The levels of anions in the leaves and stem of *B. dalzielii* are presented in Figure 2. The results revealed that the concentrations (mg/g) of nitrates were highest in stem bark (1.52×10^{-2}) mg/g compared to those in the leaves (1.40×10^{-2}) mg/g while the phosphate content in both stem and leaves were lowest (4.0×10^{-4} and 3.0×10^{-4}) mg/g respectively. The levels of sulphates in the *B. dalzielii* parts (stem bark and leaves) were $1.33 \times 10^{-2}$and 1.24×10^{-2} mg/g respectively. The levels of nitrates and sulphates are below WHO/FAO standard permissible limits while phosphates concentration were higher than the WHO/FAO limits.

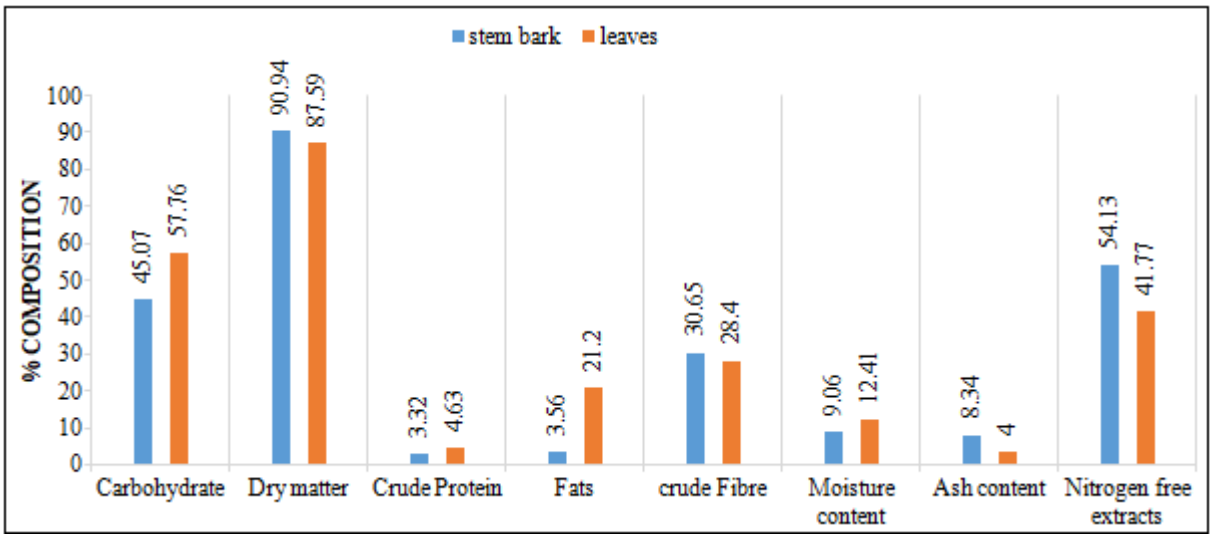

Figure 1: Proximate levels of the stem bark and leaves of *B. dalzielii*

Table 1: Macro- and microelements contents of the stem bark and leaves of *B. dalzielii*

S/No	Elements	Concentration(mg/g)		WHO/FAO Maximum Permissible Limit (mg/g)
		Stem bark	Leaves	
1	Ca	$2.50 \times 10^{-1} \pm 0.33$	$5.20 \times 10^{-1} \pm 0.01$	-
2	K	$3.33 \times 10^{-3} \pm 0.14$	$4.62 \times 10^{-3} \pm 0.03$	-
3	Mg	$2.71 \times 10^{-1} \pm 0.63$	$3.13 \times 10^{-1} \pm 0.33$	-
4	Na	$8.10 \times 10^{-1} \pm 0.01$	$8.65 \times 10^{-1} \pm 0.31$	-
5	Cd	$7.80 \times 10^{-4} \pm 0.01$	$8.10 \times 10^{-4} \pm 0.04$	3.0×10^{-3}
6	Pb	ND	ND	$1.0 \times 10_{-2}$
7	Cu	$2.56 \times 10^{-3} \pm 0.04$	$4.22 \times 10^{-4} \pm 0.63$	1.0×10^{-2}
8	Ni	$1.25 \times 10^{-3} \pm 0.00$	$1.33 \times 10^{-3} \pm 0.01$	1.0×10^{-2}
9	Fe	$3.00 \times 10^{-4} \pm 0.0.1$	$3.80 \times 10^{-4} \pm 0.33$	2.61×10^{-1}
10	Cr	$4.00 \times 10^{-5} \pm 0.00$	$3.80 \times 10^{-5} \pm 0.01$	1.30×10^{-3}
11	Zn	$3.90 \times 10^{-4} \pm 0.02$	$3.82 \times 10^{-3} \pm 0.01$	2.74×10^{-2}

Key: ND = no detected

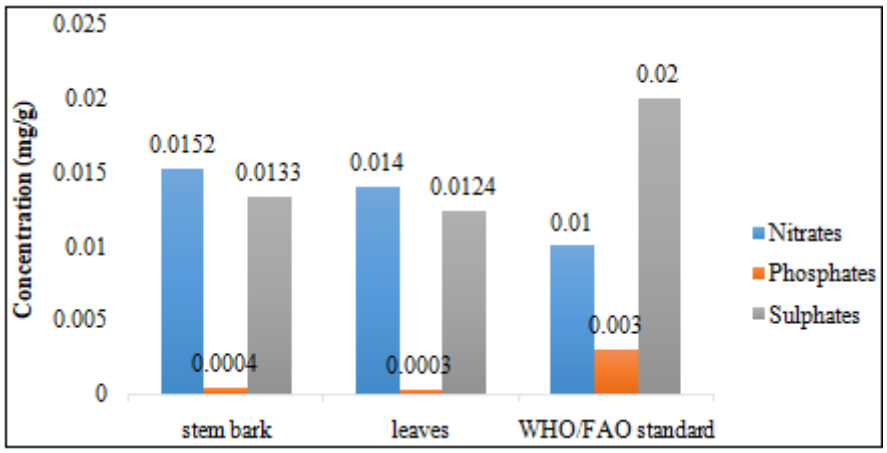

Figure 2: Concentrations of nitrates, phosphates and sulphates in stem bark and leaves of *B. dalzielii*compared with WHO/FAO Standard

5. Conclusion

In conclusion, both the proximate, elemental and anions concentrations for these parts of *B. dalzielii* were mostly found within or below the permissible limits set by WHO/FAO.This results further corroborates the use of this plant in some parts of Adamawa State, Nigeria, in the treatment of diarrhoea, dysentery and wound healing among others.

6. Acknowledgements

The Authors wish to acknowledge the technical support rendered by Messrs Fine Akawu of Department of Chemistry University of Maiduguri, Nigeria.

References

[1] Alemika, T.O. E. and Oluwole, F. S. (1991). An investigation of the potentials of *Boswellia dalzielii* and *Commiphora kerstinggii* in the treatment of peptic ulcer. *W. Afr. J. Pharmacol. Drug Res.* **9**(10), 91-94.

[2] Anago, E., Lagnika, L., Gbenou, J. Loko, F., Moudachirou, M. and Sanni, A. (2011). Antibacterial activity and phytochemical study of six medicinal plants used in Benin. *Pakistan J.Bio.Sci.***14**(7), 449-455.

[3] AOAC (1990): *Association of Official Analytical Chemists.* Official Methods of Analysis 15th Ed. Washington, DC. USA. pp. 12-43.

[4] AOCS (2000). *American Oil Chemist Society*. Official methods of analysis 5th Ed. Association of Official analytical chemist Washington DC. U.S.A.

[5] Atawodi, S, E., Joseph-Idris, J., Ndidi, U. S. and Yusufu, L, M.D. (2011). Phytochemical and antitrypasonomal studies of different solvents extracts of *Boswellia dalzielii. Int. J. Bio.***3**(2), 179-185.

[6] Ben-Yehoshua, S., Borowitz, C. and Hanus, L. O. (2012). Frankincense, myrrh and balm of Gilead: Ancient spices of southern Arabia and Judea. Horticultural Reviews, Vol. 39 1st Ed. Willy-Blackwell publisher. Isreal. 76 pp.

[7] Burkill, H. M. (1985). *The Useful Plants of West Tropical Africa.* (Vol.1). Families A-D. 2nd Ed. Royal Botanic Gardens Kew, London, pp. 300-301.

[8] Danlami, U., Daniel, G. J., David, B. M. and Galadanchi, K. M. (2015). Phytochemical, nutritional and antimicrobial screening of hexane, ethyl acetate and ethanolic extracts of *Boswellia Dalzielii* leaves and bark. *Am. J. Biosci. Bioengnr.* **3**(5), 76-79.

[9] FAO/WHO: (1993). Evaluation of certain food additives and contaminants. WHO Technical Report series 837. Geneva: FAO/WHO.

[10] Hussain, I., Khan, F., Khan, I., Khan, L. and Ullah, W. (2006). Determination of heavy metals in medicinal plants. *J. Chem. Soc. Pak.* **28**(4), 347-351.

[11] Iwalewa, E. O., Omisore, N. O., Daniyan, O. M., Adewunmi, C. O., Taiwo, B. J., Fatokun, O. A., Oluborode, I. O. (2009). Elemental composition and anti-anemic property of *Harungana madagascariensis* stem bark. *Bangl. J. Pharmacol.* **4**:115-121.

[12] Jones, J. B. (1972). Plant tissue analysis for micronutrients. In: *Micronutrients in Agriculture* (Mortvedt, J. J., Giorando, P. M. and Lindsay, W. L. (Eds. J), *Soil Sci. Am.* Madison, West Indes. pp. 21-46.

[13] Kabata-Pendias, A. and Mukherjee, A. B. (2007). *Trace Elements from Soils to Human* Spring-Verlag, Heidelberg, Germany. pp. 283-293.

[14] Khan, S. L., Khan, L., Hussain, I., Marwat, K. B. and Akhtar, N. (2008). Profile of heavy metals in selected medicinal plants. *Pak. J. Weed Sci. Res.***14**(1-2), 101-110.

[15] Kulhari, A., Sheorayan, A., Bajar, S., Sarkar, S., Chaudhury, A. and Kalia, R. (2013). Investigation of heavy metals in frequently utilized medicinal plants collected from environmentally diverse locations of north western India. *Springer Plus J.* India. p. 1-9.

[16] La Motte Company (2000). Smart Spectro Test procedures 3/05 Chester Town

[17] Macnicol, R. D. and Beckett, P. H. T. (1985). Critical tissue concentrations of potentially toxic elements. *Plt. Soil.* **85**:107-110.

[18] Maghrabi, I. A. (2014). Determination of some mineral and heavy metals in Saudi Arabia popular herbal drugs using modern techniques. *Afr. J. Pharm. Pharmacol.***8**(39), 1000-1005.

[19] Mahamat, O., Christopher, T., Odette, K. M. and Albert, K. (2014a). *In vitro* effect of aqueous extract, Hexane and Methanol fractions of *Boswellia dalzielii* Hutch (Family: Burseraceae) in immunomodulatory activities

of human monocytes/ macrophages. *Int. J. Bio. Pharm. Res.***5**(2), 201-209.

[20] Mahamat, O., Christopher, T. and Albert, K. (2014b). Modulation of mitogen-response and phagocytic activities of human lymphocytes and macrophages by aqueous, hexane and methanol extracts of stem bark of *Boswellia dalzielii* Hutch. (Family-Burseraceae). *Int. J. Adv. Res. Sci. Technol.* **3**(2), 119-125.

[21] Mamza, U. T., Sodipo, O. A., Khan, I. Z. and Gulani, I. A. (2015). Phytochemical, antimicrobial and toxicity studies of ethanolic leaf extract of *Phyllanthus amarus* Thonn and Schum (Euphorbiacea). *Int. J. Green. Herb.Chem.***4**(1), 21-30.

[22] Moses, A. O., Yvonne., T. K. O. and John, D. M. (2005). Antibacterial activity of the stem bark of *Boswellia dalzielii*. *J. Pharm. Biore***. 2**(2), 131-136.

[23] Mudgal, V., Madaan, N., Mudgal, A., Singh, R. B. and Mishra, S. (2010). Effects of toxic metals on human health. *The Open Nutraceut. J.* **3**:94-99.

[24] Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (2000). *Harper's Biochemistry*, 25th Ed. McGraw-Hill, Health profession Division, U.S.A.

[25] Ntiejumokwu, S. and Alemika, T. O. E. (1991). Antimicrobial and phtyochemical investigation of the stem bark of *Boswellia dalzielii. W. Afr.J. Pharmacol Drug Res.* **9**(10), 100-104.

[26] Nwinyi, F. C., Binda, L., Ajoku, G. A., Aniagu, S.O., Enwerem, N. M., Orisadipo, A., Kubmarawa, D. and Gamaniel, K.S. (2004). Evaluation of the aqueous extract of *B. dalzielii* stem bark for antimicrobial activities and gastrointestinal effects. *Afr. J. Biotech.* **3**(5), 284-288.

[27] Oguakwa, J. U. (1980). Plants used in traditional medicine in West Africa. *J. Ethnopharmacol.* **2**(1), 29-31.

[28] Ohemu, T. L., Agunu, A., Olotu, P. N., Ajima, U., Danfam, D.G. and Azila, J. J. (2014). Ethnobotanical survey of medicinal plants used in the traditional treatment of viral infection in Jos, Plateau state-Nigeria. *Int. J. Med. Arom. Plants*. **4**(2), 74-81.

[29] Osuji, O. U., Abdulrahman, F. I., Khan, I. Z., Gambo, M. A. and Awana, A. U. (2013). Proximate content and elemental evaluations of *Allium cepa* Linn. *Bullet. Pure Appl. Sci.* **32C-Chemistry** (1), 1-9.

[30] Prasad, A. S. (1976). Trace elements in human health and diseases vols 1 and 2. Academic *Press.*New York, USA.

[31] Radojevic, M. and Bashkin, V. N. (1999). *Practical Environmental Analysis*. The Royal Society of Chemistry 2nd Ed., Cambridge, United Kingdom. pp. 378-408.

[32] Roseline, A., Donatien, G. and Kiri, H. J. (2007). The effects of *Boswellia dalzielii* (Burseraceae) aqueous bark extract on rat liver function. *Asian J. Biochem.***2**(5), 359-33.

[33] Sarpong, K., Dartey, E., Boateng, G. O. and Dapaah, H. (2012). Profile of hazardous metals in twenty selected medicinal plant samples sold at Kumasi central market, Ashanti region, Ghana. *Glob. Adv. Res. J. Educ, Res. Rev.* **1**(1), 4-9.

[34] Soetan, K. O., Olaiya, C. O. and Oyewole, O. E. (2010). The importance of mineral elements for humans, domestic animals and plants: A review. *Afr. J, Food Sci.* **4**(5), 220-222.

[35] Sofowora, A., Ogunbodede, E. and Onanyade, A. (2013). The role and place of medicinal plants in the strategies for disease prevention. *Afr.J. Trad. Comp. Altern. Med*. **10** (5), 210-229.

[36] Suttle, N. F. and Jones, (1989). Recent development of trace element metabolism and function: Trace elements, disease resistance and immune responsiveness in ruminants. *J. Nutr.* **119**:1055-1061.

[37] Tilson, M. D. (1982). Decreased hepatic copper level. A possible chemical marker for the pathogenesis of aortic aneurysms in man. *Arch. Surg.* **117**(9),1212-1213.

[38] Usman, H. (2012). Studies on the phytochemical contents and antimicrobial activities of the stem bark of *Bauhinia rufescens* Lam (*Leguminosae-caesalphinoideae*). Ph.D. Thesis, University of Maiduguri, Maiduguri, Nigeria. 249 pp.

[39] Vohora, S. B. (1987). *Element in Human Health and Diseases*. In: Earth, element and man, supplement No.1. Institute of History of Medicine and Medical Research, New Delhi. pp.1-111.

[40] WHO: (1989). Evaluation of certain food additives and contaminants. WHO Technical Report Series 776. Geneva, Switzerland.

[41] WHO: World Health Organization (1998). Quality control methods for medicinal plant materials. WHO Geneva, Switzerland.

[42] WHO: World Health Organization (2007). Guidelines for assessing quality of herbal medicines with reference to contaminants and residues. *World Health Organization*, Geneva. pp. 1-105.