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Specialty Section:

This article was submitted to
Basic Science, a section of
NAPAS.

Accepted: 3rd January, 2022

Published: 20 July 2022

Citation:

Yakubu J, Maina C A,
Abdulrahman F I, Sodipo O A,
Andema K A, Dawi H A et al.,
(2022). Phytochemical
Analysis, Nutritional Content
and Evaluation of Antidiabetic
Related Elements of *Boswellia
Dalzielii*. Nig Annals of Pure
& Appl Sci. 5(1):97-108.
DOI:10.5281/zenodo.7130093

Access Code



<http://napas.org.ng>

Phytochemical Analysis, Nutritional Content and Evaluation of Antidiabetic Related Elements of *Boswellia Dalzielii*

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ABSTRACT

The present study was aimed at investigating the phytochemical constituents, proximate content and elemental levels of some mineral elements associated with antidiabetic properties. Fresh leaf, stem and root barks of *Boswellia dalzielii* were air-dried, pulverized and extracted using cold maceration method with 85% methanol. Proximate analysis was conducted following standard methods. The levels of the mineral elements were determined using Atomic Absorption Spectrometer. Result of the proximate content revealed that the increasing order of these nutrients among the plant parts is dry matter > carbohydrates > crude fibre > moisture content > ash content > crude protein > fats content. The elemental analysis revealed that Ca had the highest concentration (7.70E-01 mg/g), of all the plant parts the macro-elements analysed. Other macro-elements; K, Mg and Na in the leaf had concentrations of 4.62E-03, 3.45E-01 and 7.65E-01 mg/kg respectively, while Zn had the highest concentration (9.91E-03) when compared to all the other microelements which were Cd, Cr, Cu, Fe and Ni. The concentration of Na (7.20E-01 mg/g) was the highest in the stem bark of the plant while Cd had the lowest (4.15E-05 mg/g). Na had the highest concentration in the root with 6.55E-01 mg/g, while Fe had the lowest, 3.05E-04 mg/g. Lead was not detected in all the plant parts analysed. The phytochemical studies of the crude methanol leaf, stem and root bark extracts revealed the presence of alkaloids, flavonoids, cardiac glycosides, tannins, saponins and terpenoids. The proximate levels and elemental concentrations of the leaf of *B. dalzielii* were within the permissible limit set by WHO. Thus, *Boswellia dalzielii* contains phytochemicals and phytonutrients which might synergistically potentiate the antidiabetic activity of the plant.

Keywords: *Boswellia dalzielii*; Phytochemicals; Proximate; Elements.

INTRODUCTION

Traditional medicine is a diverse and complex system of medicine which involves the use of plants as a source of healing since time immemorial (Jamshidi-Kia *et al.* 2018). However, herbal medicines are currently trending as a substituent to synthetic medicines due to their fast-relative health negative effects. World Health Organization (WHO), has recommended the investigation into the safety, properties and effectiveness of plants used as medicines, bearing in mind that they stand the chance of discovering variety of potent and novel drugs especially anti-diabetic drugs. Plants contained chemical compounds such as saponins, tannins, oxalates, phytates, trypsin inhibitors and cyanogenic glycosides which are known as phytochemicals. These class of chemicals in plants are considered as the agents that help man in fighting against several diseases.

Boswellia dalzielii Hutch, is a medicinal plant which belongs to the family Burseraceae (Younoussa *et al.*, 2014) and it is mostly called the “Frankincense tree” (Sani and Qamar, 2015). It is popular in the Northern part of Nigeria due to its ethnomedicinal importance. The leaves are used for beverage flavouring. The stem bark secretes a fragrant white gum that is burnt to fumigate cloth and to drive out flies and mosquitoes had been reported for the treatment of diarrhoea in humans and poultry. It is also known for the treatment of many forms of cancers/fibrosis, inflammation, snakebite, arthritis, asthma, microbes, ulcer and syphilis (Burkill, 1985). The stem bark is boiled stem bark is used to treat fever, rheumatism and gastrointestinal troubles (Burkill, 1985; Bello *et al.*, 2013). In Beninese Pharmacopeia, the roots are used as a protection against syphilis. The mixture of the roots and bark is known to be a real antidote to poisons and snakebites (Ouedraogo, 1996). The decocted root bark is used traditionally by the Hausa-Fulanis in Sokoto, Nigeria to treat diabetes (Shinkafi, 2015). A cold infusion could be used 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 an antidote to arrow-poison (Burkill, 1985; Danlami *et al.*, 2015).

Pharmacologically, *Boswellia dalzielii*, is recommended for arthritic and inflammatory conditions, gastric disorders, pulmonary diseases and skin ailments (Ben-Yehoshua *et al.*, 2012). 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). In Nigeria, antibacterial activities and gastrointestinal effects of *B. dalzielii* have been reported by different researchers (Oguakwa, 1980; Alemika and Oluwole, 1991; Nwinyi *et al.*, 2004; Mamza *et al.*, 2021).

Atawodi *et al.* (2011) reported that *B. dalzielii* has antitrypanosomal activity. *B. dalzielii* is widely reported to offer good treatment for leprosy, peptic ulcer, asthma, diarrhoea, syphilis, rabies, chickenpox, hepatitis and Human Immuno-Deficiency Virus/ Acquired Immuno-Deficiency Syndrome (HIV/AIDS). The anti-hyperglycemic effect of the plant was previously reported by Bobboi and Olusegun (2005), Balogun *et al.*, 2014 and Yakubu *et al.* (2020)

Diabetes mellitus (DM) is a metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion and or action (Amos *et al.*, 2010). Diabetes is considered the third leading cause of death, after cancer and cardiovascular disease, because of its high prevalence, morbidity and mortality (Li *et al.*, 2004). In 2015, the

International Diabetes Federation (IDF) estimated that 415 million people are living with diabetes worldwide (IDF, 2015). DM is known to be associated with increased risk of many devastating complications such as cardio vascular disease, peripheral vascular disease complications such as coronary artery disease, stroke, neuropathy, renal failure, retinopathy amputations and blindness (IDF, 2015). Conventional drugs which include insulin and various types of hypoglycemic agents such as biguanides and sulfonylureas are available for the treatment of diabetes. However, these drugs are to be taken for lifetime and are characterized with side effects (Halim, 2003). Interestingly, many traditional treatments have been recommended in the complementary and alternative system of medicine for the treatment of diabetes. Based on the WHO recommendation hypoglycemic agents of plant origin used in traditional medicine are of more importance because. plant drugs and herbal formulation are frequently considered to be less toxic and free from side effects than synthetic ones (WHO, 1985).

Human nutrition deals with the provision of essential nutrients in food necessary to support human life and health. They include four major classes namely: macro elements, trace or micro elements, vitamins and organic acids. Micronutrients are essential nutrients that are required by the body in trace amounts or tiny quantities on a day-to-day basis in order to function properly. Macro elements include chloride, calcium, phosphorous, magnesium, sodium, potassium, and iron. The microelements include cobalt, boron, chromium, copper, sulphur, iodine, fluoride, selenium, manganese, zinc, and molybdenum. Micro elements have multiple roles within the body. Trace elements interact with vitamins and macro elements to enhance their effects on the body. They are accepted as essential for human health and have diverse metabolic characteristics and functions (Matsumura *et al.*,

2000). Direct associations of macro and trace elements with diabetes mellitus (DM) have been observed in many research studies (Nourmohammadi *et al.*, 2000). Insulin action on reducing blood glucose was reported to be potentiated by some trace elements such as chromium, magnesium, vanadium zinc, manganese, molybdenum and selenium (Candilish, 2000). Macro elements are the natural elements of which the body needs more amount and are more important than any other minerals. Macro minerals such as sodium and potassium are electrolytes which the body use to maintain acid-base balance and fluid balance (homeostasis) and for normal neurological, myocardial, nerve, and muscle function. Neurons and muscles are activated by electrolyte activity occurring between the extracellular (or interstitial fluid) and intracellular fluid (Candilish, 2000).

MATERIALS AND METHODS

Sample Collection and Identification

Fresh leaves, stem and root barks of *Boswellia dalzielii* were collected from Gulantabar village of Song Local Government Area, Adamawa State. The plant specimens were transported to the University of Maiduguri, where it was identified and authenticated by a Plant Taxonomist in the Department of Biological Sciences, University of Maiduguri, Maiduguri, to be from *Boswellia dalzielii*. A voucher specimen number UM/DC/04/348 was given and specimen of the samples were deposited at the Postgraduate Research Laboratory of Chemistry Department, University of Maiduguri, Maiduguri, Borno State. The fresh samples were cleaned and air-dried under shade at room temperature for ten (10) days and were rendered free of foreign material through manual picking. The air-dried plant materials were pulverized using a wooden mortar and pestle and then stored until required for use.

Proximate Content Analysis of *Boswellia dalzielii* Leaf, Stem Bark and Root Barks

The air-dried samples were manually screened and crushed using a wooden mortar and pestle and stored in a dessicator. Two grammes (2 g) each of the crushed samples were processed for analysis of various parameters which include, moisture content, ash, crude fibre, crude fat, crude protein and carbohydrate content following the methods described by the Association of Official Analytical Chemists (AOAC, 1990; AOCS, 2000).

Sample Digestion and Elemental Content Analysis of *Boswellia dalzielii* Leaf, Stem Bark and Root Barks

The air-dried plant samples were pulverized manually in a wooden mortar and pestle into a coarse powder. 0.5 g of each sample was independently packed into an acid-washed porcelain crucible and then placed in a muffled furnace for 4 hr at 550°C. The crucibles were removed from the furnace and cooled. Ten (10) ml of 6 M HCl were added and then covered, and the content was heated on a steam bath for 15 minutes. One ml of HNO₃ 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). The macro and microelements were determined using Perkin-Elmer Analyst 300 single beam Atomic Absorption Spectrophotometer (AAS) and the data were obtained in parts per million (ppm) which were 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.

Extraction of the Leaf, Stem and Root Barks of *B. dalzielii*

Extraction of plant material can involve different methods, such as percolation, decoction, soxhlet extraction, refluxing, maceration etc. but for the purpose of this study, maceration method was chosen. The powdered plant material (2 kg) each of the leaf, stem and root barks were macerated using 22.5 L of 85 % methanol for 72 hrs with periodic shaking and allowing to stand at room temperature for a proper dissolution of soluble plant chemicals. The liquid mixture of the extract was filtered using a clean muslin followed by filtration using 200 mm diameter of Whatmann No. 1 filter paper. The crude extracts were concentrated to dryness at room temperature. The crude methanol extracts were weighed, coded BDMLE, BDMSE and BDMRE- *Boswellia dalzielii* methanol leaf, stem and root bark extracts respectively.

Preliminary Phytochemical Screening

The extract fractions of the leaf, stem and root barks were screened qualitatively for phytochemical constituents which includes: carbohydrates, alkaloids, cardenolides, flavonoids, saponins, tannins, phlobatannins, steroids and terpenoids, using standard procedures as described by Evans (2009).

RESULTS

Proximate Analysis of Leaf, Stem and Root Barks of *Boswellia dalzielii*

The result of proximate analysis of the leaf, stem and root barks showed variation of percentage (%) compositions of nutrients. The % proximate contents of the leaf, stem bark and root barks of *B. dalzielii* are presented in Figure 1. The highest proximate contents were the % dry matter in all the parts; leaf, stem and root barks had 90.08 %, 90.71 and 91.08 % respectively, while the least % proximate composition was crude fat of which all

the plant parts had 1.00 % each. From these results, the increasing order of these nutrients among the plant parts is dry matter > carbohydrates > crude fibre > moisture content > ash content > crude protein > fats content

Elemental Analysis of Leaf Stem and Root Barks of *Boswellia dalzielii*

The results of macro and microelements concentrations reported in mg/g are presented in Table 1. for the he concentration levels of macro elements (Ca, K, Mg and Na) micro-elements (Cr, Cu, Fe, Ni, and Zn) and toxic elements (Cd and Pb). The result revealed that Ca in the leaf of *B. dalzielii* had the highest concentration ($7.70\text{E-}01$ mg/g), of all the macro-elements analysed. Other macro elements; K, Mg and Na had concentrations of $4.62\text{E-}03$, $3.45\text{E-}01$ and $7.65\text{E-}01$ mg/kg respectively, while Zn had the highest concentration ($9.91\text{E-}03$ mg/g) when compared to all other microelements which were Cd, Cr, Cu, Fe and Ni which had concentrations of $5.15\text{E-}4$, $3.45\text{E-}03$, $4.79\text{E-}03$, $5.85\text{E-}04$ and $1.41\text{E-}03$ respectively. The concentration of Na ($7.20\text{E-}01$ mg/g) was the highest in the stem bark of the plant while Cd had the lowest concentration ($4.15\text{E-}05$ mg/g). The concentrations of other elements; Ca, Cr, Cu, Fe, K,

Mg, Ni and Z were $4.45\text{E-}01$ mg/g, $3.80\text{E-}03$ mg/g, $3.59\text{E}03$ mg/g, $5.15\text{E-}04$ mg/g, $3.40\text{E-}03$ mg/g, $2.91\text{E-}01$ mg/g, $1.36\text{E-}03$ mg/g and $2.0\text{E-}02$ mg/g respectively. Na had the highest concentration in the root with $6.55\text{E-}01$ mg/g, while Fe had the lowest $3.05\text{E-}04$ mg/g. The concentrations of other elements analysed were $3.90\text{E-}01$ mg/g (Ca), $4.05\text{E-}04$ mg/g (Cd), $4.05\text{E-}03$ mg/g (Cr), $2.88\text{E-}03$ mg/g (Cu), $3.05\text{E-}04$ mg/g (Fe), $3.00\text{E-}3$ mg/g (K), $2.05\text{E-}01$ mg/g (Mg), $1.23\text{E-}03$ mg/g (Ni) and $1.46\text{E-}02$ mg/g (Zn). Lead was not detected in all the plant parts analysed. The results were compared with WHO (2007) maximum permissible limits and are shown on Table 1 below.

Phytochemical Constituents of Methanol Leaf, Stem and Root Barks of *B. dalzielii*

The preliminary phytochemical screening of the leaf, stem and root barks extracts of *B. dalzielii* using 85 % methanol solvent revealed the presence of flavonoids, terpenoids, cardiac glycosides, saponins and tannins; while phlobatannins, soluble starch and alkaloids were not present in all the plant parts analysed. The result of the phytochemical screening of the extracts is shown in Table 2.

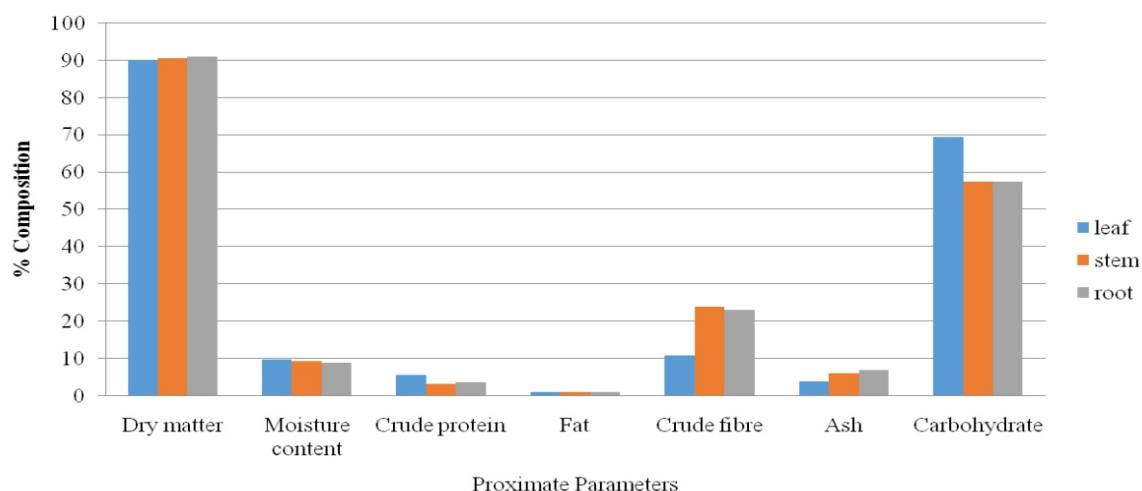


Figure 1: Proximate levels of leaf, stem and root barks of *B. Dalzielii*

Table 1: Elemental concentration analysis of the leaf, stem and root barks of *Boswellia dalzielii*

s/n	Elements	Leaf	Conc. (mg/g) Stem	Root	WHO Maximum Permissible Limit (mg/g)
1	Ca*	7.70E-01 ^{ab} ±1.00E-02	4.45E-01 ^b ±1.00E-02	3.90E-01 ^a ±0.000	8.00E-01
2	Cd	5.15E-04 ^{ab} ±7.07E-06	4.15E-04 ^b ±2.12E-05	4.05E-04 ^a ±7.07E-06	3.00E-03
3	Cr	3.45E-03 ^a ±7.07E-05	3.80E-03 ^a ±1.40E-04	4.05E-03 ^a ±7.10E-05	1.30E-03
4	Cu	4.79E-03 ^a ±1.41E-06	3.59E-03 ^a ±4.24E-05	2.88E-03 ^a ±2.80E-05	1.00E-02
5	Fe	5.85E-04 ^a ±7.07E-06	5.15E-04 ^b ±2.12E-05	3.05E-04 ^{ab} ±2.12E-05	2.61E-01
6	K*	4.62E-03 ^a ±0.000	3.40E-03 ^a ±1.00E-03	3.00E-03 ^a ±7.01E-05	1.00E-01
7	Mg*	3.45E-01 ^a ±7.00E-03	2.91E-01 ^a ±7.00E-01	2.05E-01 ^a ±7.00E-01	4.00
8	Na*	7.65E-01 ^a ±3.60E-02	7.20E-01 ^a ±1.40E-02	6.55E-01 ^a ±7.00E-02	5.00E-01
9	Ni	1.41E-03 ^a ±1.41E-05	1.36E-03 ^b ±1.41E-05	1.23E-03 ^{ab} ±3.50E-05	1.00E-02
10	Pb	ND	ND	ND	1.0 0E-02
11	Zn	9.91E-03 ^a ±1.27E-04	2.0E-02 ^a ±7.07E-05	1.46E-02 ^a ±4.2E-05	2.74E-02

Key: data are expressed in mean±SD, n=3, ND= not detected

DISCUSSION

Table 2: Phytochemical constituents of methanol leaf, stem and root barks of *B. dalzielii*

S/N	Phytochemical Test	BMLE	BMSE	BMRE
1	Carbohydrates			4
i	General test-Molisch	+	+	+
ii	reducing sugar-Fehling	+	+	+
iii	Combined reducing sugar	+	+	+
v	Ketoses	+	+	-
vi	Pentoses	+	+	-
2	Tannins			
i	Ferric chloride	+	+	+
ii	Lead acetate	+	+	+
3	Phlobatannins	-	-	-
4	Steroids/Triterpenes			
i	Salkowski	+	+	+
ii	Liebermann-Burchard	+	+	+
5	Flavonoids			
i	Shinoda	+	+	+
ii	Ferric chloride	+	+	+
iii	Lead acetate	+	+	+
iv	Sodium hydroxide	+	-	-
6	Saponins			
i	Frothing	+	+	+
7	Soluble Starch	-	-	-
8	Alkaloids			
i	Dragendroff's reagent	-	-	-
ii	Meyer's reagent	-	-	-
9	Steroidal Nucleus/cardenolides			
i	Keller-killiani	+	+	+
10	Terpenoids	+	+	+

Keys: BMLE = *Boswellia dalzielii* methanol leaf extract;

BMSE = *Boswellia dalzielii* stem bark extract;

BMRE = *Boswellia dalzielii* root bark extract; + = present; - = absent

The proximate analysis of the leaf, stem and root barks of *B. dalzielii* revealed that the plant parts generally could be said to be good sources of nutrition to both man and animals. It also showed that the relatively low moisture content suggests that the plant parts have a long shelf life (Oyenuga *et al.*, 1968). The low moisture content could prevent microbial spoilage and pest attack during storage for medicinal purpose. Ash content of the leaf, stem and root barks which were 4.05 % 6.00 % and 7.00 % respectively. This shows that the plant could have an appreciable quantity of mineral elements (Gadanya *et al.*, 2014). The low crude fat (1.0 %) indicates that the plant is not a good source of fat for energy. The high amount of crude fiber in the plant parts (11.01 %, 24.01 % and 23.02 %) of the leaf, stem and rootbarks respectively) means that it is a good source of dietary fiber, which could aid bowel movement and help in preventing obesity, diabetes, cancer of the colon and other ailments of the gastrointestinal tract (Gadanya *et al.*, 2014). The crude carbohydrate 65.80 % could be a good source of energy and thus a useful supplement in animal feed formulation and human diet (Gadanya *et al.*, 2014). The percentage proximate

content recorded in the plant parts supports the findings of Mamza *et al.* (2017) who reported the proximate composition of the stem and leaf of the same plant and this is also in agreement with the study and report of Danlami *et al.* (2015).

The macro and micro elements studied i.e calcium, magnesium, potassium sodium, chromium, iron, nickel, copper and zinc all had concentrations that are all within the permissible limits of FAO/WHO (1991).

Several scientific studies have found that supplementation of a single element like calcium, zinc, potassium, manganese or selenium could efficiently alter blood glucose levels in human body. Similarly, the combined effect of the mixture of all these elements present in this antidiabetic plant could probably produce a much greater effect than supplementation by a single trace element. Trace elements present in the antidiabetic plants might be in the various organic forms. Thus, elements in different parts of the plant are more readily bioavailable than through different inorganic forms of supplementation of these elements. The trace elements individually may not produce hypoglycaemia in diabetic patients, but their consumption with several metals-containing compounds and through different chemical forms present in various herbal products might play a major and vital role.

The proposed mechanism of trace elements of enhancing insulin action includes activation of insulin receptor sites, serving as cofactors for enzyme systems involved in glucose metabolism (Vincent, 2000), enhancing insulin sensitivity and acting as antioxidants, thus preventing tissue peroxidation. Some of the trace elements, such as zinc, chromium, copper, manganese, vanadium and selenium are found to play a major role in protecting the insulin secreting pancreatic β -cells which are very much sensitive to free radical damage (Srinivasu *et al.*, 2016). Sodium (Na) is involved in the transport of glucose into the

body cells. Potassium supplementation is reported to improve insulin sensitivity, responsiveness and secretion (Pittas *et al.*, 2007). Recent studies have shown that the low potassium concentration may be a possible risk factor for diabetes (Chatterjee *et al.*, 2010). Potassium depletion may result in reduced glucose tolerance (Rajendra *et al.*, 2007). In the human body, K and Cl act as electrolytes. Potassium is essential, mainly in the intercellular fluid as the primary ion. Sodium together with potassium helps to regulate the water balance within the body. It regulates the transfer of nutrients to the cell, transmits electrochemical impulses and is necessary for the normal growth and most of the enzymatic reactions (Rajendra *et al.*, 2007)). The recommended daily intake of sodium and potassium for an adult person is 2.4 g and 3.5 g respectively (WHO, 2007).

Zinc is required for proper glucose metabolism. It is used as a cofactor for the function of intracellular enzymes that may be involved in lipid, protein and glucose metabolism (Isbir *et al.*, 1994). Zinc plays an important role in the biosynthesis, storage, utilization and secretion of insulin (Diwan *et al.*, 2006). The recommended daily intake of zinc for an adult person is 15 mg (WHO, 2007). The upper level of zinc intake for an adult man is set at 45 mg/day (WHO, 2007). Copper is considered as a powerful enzyme catalyst. It possesses an insulin-like activity and promotes lipogenesis (Siddiqui *et al.*, 2014). Abnormal copper metabolism can lead to several chronic pathogenesis, such as diabetes or diabetic complications (Zheng *et al.*, 2008). Chromium is necessary for optimum carbohydrate metabolism. Cr may potentiate insulin, and is usually lost in processed foods (Sarma and Goswami, 2017). Calcium and cyclic adenosine monophosphate are important in the stimulation of insulin release (Rajendra *et al.*, 2007). Iron influences glucose metabolism and insulin action. Iron interferes

with insulin inhibition of glucose production by the liver (Wilson *et al.*, 2003). It facilitates insulin binding and subsequent uptake of glucose molecules into the body cell and therefore decreases fasting glucose levels, enhances glucose tolerance and decreases total cholesterol in type II diabetic patients (Mooradian and Morley, 1987). It has been found that chromium administration decreases fasting and postprandial glucose concentration. It has been reported that trace amount of Cd and Pb can be detected in all plants and food materials (Piscator, 1985). However, lead was not detected in all the plant parts analysed in this study, indicating the plant is probably not toxic.

The phytochemical studies of the methanol leaf, stem and root barks of *B. dalzielii* revealed chemical constituents such as flavonoids, cardiac glycosides, tannins, saponins, terpenoids and alkaloids. The presence of these phytochemicals in the plant parts are in agreement with the reports of Mamza *et al.* (2017); Ohemu *et al.* (2018). The reported hypoglycaemic activity by Bobboi and Olusegun (2005); Balogun *et al.* (2013); Yakubu *et al.* (2020), could be associated with these phytochemicals and phytonutrients present. Moreover, during the past few years many phytochemicals responsible for antidiabetic effects have been isolated from plants. Several phytoconstituents such as alkaloids, glycosides, flavonoids, saponins, dietary fibres, polysaccharides, glycolipids, peptidoglycans, amino acids and others obtained from various plant sources have been reported as potent hypoglycaemic agents. A number of plants have been used traditionally in the treatment of diabetes and some have been proven scientifically to have hypoglycaemic activity. These plant extracts contain compounds like polysaccharides (Bhavapriya and Govidasamy, 2000), flavonoids (Tomada *et al.*, 1985), terpenoids and tannins (Schimizu *et al.*, 1984), steroids (Recher *et al.*, 1991), polypeptides (Ivorra *et al.*, 1989) and alkaloids (Karawya and Wahab, 1984) which are

responsible for antidiabetic activity. Flavonoids have been noted as one of the most numerous and widespread groups of phenolic compounds in higher plants (Carini *et al.*, 2001). Some of them, due to their phenolic structure, are known to be involved in the healing process of free-radical mediated diseases including diabetes (Czinner *et al.*, 2000). 1-Ephedrine is the major alkaloid component that is known to suppress hyperglycaemia through facilitation of regeneration of pancreatic islet cells, restoring the secretion of insulin (Middleton *et al.*, 2000). Tannins have been shown to have hypoglycaemic activity (Broadhurst *et al.*, 1997). Graded doses of saponins extract (10, 15, and 20 mg/kg) caused a marked hypoglycaemic effect in alloxan-induced diabetic rabbits (Abdel-Hassan *et al.*, 2000).

CONCLUSION

On the basis of the results from these investigations, the following conclusions could be drawn. Both the proximate and elemental concentrations of *B. dalzielii* leaf were found within the permissible limits set by FAO/WHO. The presence of the mineral elements in the leaf, stem and root of *Boswellia dalzielii* might have synergistically potentiate the reported antidiabetic activity of the plant. The phytochemical screening of the methanol leaf stem and root bark extracts of *B. dalzielii* revealed the presence of some phytochemicals such as flavonoids, saponins, tannins, terpenoids and cardiac glycosides, which probably are responsible for its effect against diabetes mellitus by decreasing blood glucose level.

REFERENCES

- Abdel-Hassan, I.A., Abdel-Bary, J.A. and Mohammeda, T.S. (2000). The hypoglycemic and anti-hyperglycaemic effect of

- Citrullus colocynthis* fruit aqueous extract in normal and alloxan diabetic rabbits. *J. Ethnopharmacol.*, 71:325-330.
- Alemika, T. O. E. and Oluwole, F. S. (1991). An investigation of the potentials of *Boswellia dalzielii* and *Commiphora kerstingii* in the treatment of peptic ulcer. *W. Afr. J. Pharmacol. Drug Res.*, 9(10): 91-94.
- Amos, A.F., Mc Carty, D. and Zimmet, P. (1997). The rising global burden of diabetes and its complications: Estimates and projections to the year 2010. *Diabet. Med*, 14,81-85.
- AOAC (1990): *Association of Official Analytical Chemists*. Official Methods of Analysis 15th Ed. Washington, DC. USA. pp. 12-43.
- AOCS (2000): *American Oil Chemist Society*. Official Methods of Analysis 5th Ed. Association of Official Analytical Chemists Washington DC. U.S.A.
- Atawodi, S, E., Joseph-Idris, J., Ndidi, U. S. and Yusufu, L, M. D. (2011). Phytochemical and antitrypsinolytic studies of different solvents extracts of *Boswellia dalzielii*. *Int. J. Bio.*, 3(2): 179-185.
- Balogun, O., Ojerinde, S.O. and Alemika, T.E. (2013). Hypoglycemic effect of the aqueous stem bark extract of *Boswellia dalzielii* Hutch. *Cont. J. Pharmaceut. Sci.* 7(1):36 -41.
- Bello, M. I., Ishidi, S. B. and Sudi, I. Y. (2013). Phytochemical screening and antimicrobial activity of ethanolic and aqueous stem bark extracts of *Boswellia dalzielii* (Hutch). *Asian J. Biochem. Pharm. Res.*, 1(3): 194 - 198.
- 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.
- Bhavapriya, V. and Govidasamy, S. (2000). Biochemical studies on the hypoglycemic effect *Aegle marmelos* (Linn). Correa Ex. RoxB. In streptozotocin induced diabetic rats, *Indian Drugs*. 37(10): 474-477.
- Bobboi, A.A. and Olusegun, R. (2005). Hypoglycaemic effect of *Boswellia dalzielii* stem bark in normoglycaemic and alloxan diabetes rats. *J. Biotech.*, 16(1): 89-99.
- Broadhurst, C.L., Polansky, M.M. and Anderson, R.A. (1997). Insulin-like biological activity of culinary and medicinal plant aqueous extracts *in vitro*. *J. Agric. Food Chem.*, 48:849-852.
- Burkill, H. M. (1985). *Useful Plants of West Tropical Africa*. Volume one, Royal Botanical Gardens Kew. 300p.
- Candlish, D. J. (2000). Minerals, *J. Am. Col. Nut.*, 17: 286310.
- Carini, M., Adlini, G., Furlanetto, S., Stefani, R. and Facino, R.M. (2001). LC coupled to ion- trap MS for the rapid screening and detection of polyphenol antioxidants from *Helichrysum stoechas*. *J. Pharm. Biomed.*, 24:517-526.
- Chatterjee, R., Yeh, H.C., Shafi, T., Selvin, E., Anderson, C., Miller, E. and Brancati, F. (2010). Serum and dietary potassium and risk of incident type 2 diabetes mellitus: The atherosclerosis risk in communities (ARIC) study, *Arch. Int. Med.*, 170(19): 1745-1751.
- Czinner, E., Hagymasi, K., Blazovics, A., Kery, A., Szoke, E., Lemverkovics, E. (2000). *In vitro* antioxidant properties of *Helichrysum arenarium* (L) Moench. *J. Ethnopharmacol.*, 73: 437-443.
- 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. *A. J. Biosci. Bioengr.* 3(5): 76-79.
- 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. *A. J. Biosci. Bioengr.* 3(5): 76-79.
- Diwan A.G., Pradhan A.B., Lingojwar D., Krishna K.K. and Singh, P. (2006). Zinc, chromium and magnesium levels in type-2 diabetes, *Int. J. Diabet. Dev. Count.*, 26(3): 122-123.
- Evans, W. C. (2009). *Trease and Evans Pharmacognosy*. 16th Edition. Saunders Publishers, London. pp. 42229.
- FAO/WHO (1991). Joint FAO/WHO Food Standard Programme, Codex Alimentarius Commission, XII, Supplement 4. Rome: FAO/WHO.
- Gadanya, A.M., Atiku, M.K. and Otaigbe, B.O. (2014). Proximate and elemental analysis of Baobab (*Adansonia digitata*) seed. *Int. J. Anal. Biochem. Res.*, 1(1): 1-4.
- Halim, E.M. (2003). Effect of *Coccinia indica* and *Abroma augusta* on glycemia, lipid profile and on indicators of end organ damage in streptozotocin induced diabetic rats, *Indian. J. Clin. Biochemistry.*, 18: 54-63. IDF, (2015). Diabetes Atlas, 7th ed. International Diabetes Federation, Brussels, Belgium.
- Isbir, T., Tamer, L., Taylor, A. and Isbir, M. (1994). Zinc, copper and magnesium status in insulin-dependent diabetes, *Diabet. Res.*, 26(1): 4145.
- Ivorra, M.D., Paya, M. and Villar, A. (1989). A Review of natural products and plants as potential antidiabetic drugs. *J. Ethnopharmacol.* 27: 243-275.
- Jamshidi-Kia F, Lorigooini Z, Amini-Khoei H. (2018). Medicinal plants: Past history and future perspective. *J. Herbmed. Pharmacol.* 7(1):1-7.
- Karawya, M.S., And Wahab, S.A. (1984). Diphenylamine an antihyperglycemic agent from onion and tea, *J. Nat. Product.*, 47: 775-780.
- Li, W.L., Zheng, H.C., Bukuru, J. and De kimpe, N. (2004). Natural medicine used in the traditional Chinese medical system for the therapy of diabetes," *J. Ethnopharmacol.* 92: 1-21.
- Mamza, U. T., Sodipo, O. A., Abdulrahman, F. I. and Khan, I. Z. (2017). Proximate and elemental composition of methanolic extract of *Boswellia dalzielii* Hutch. (Frankincense Tree: Burseraceae). *Int. J. Sci. Res.*, 6(10): 751-757.
- Mamza, U.T., Yakubu, J., Chiroma, M., Balami, V.M., Moses, S., Sodipo, O.A., Abdulrahman, F.I., Taiwo E. Alemika, T.E., Irfan Z. Khan, I.Z. (2021). Phytochemical evaluation and *in-vitro* antibacterial properties of the methanolic leaf extract of *Boswellia dalzielii* Hutch. (Burseraceae). *Bull. Pure Applied Sci-Chem.*, 40C (2): 48-56.
- Matsumura, M., Nakashima, A. and Tofuku, Y. (2000). Electrolyte disorders following massive insulin overdose in a patient with type 2 diabetes, *Int. Med.*, 39(1): 5557.
- Middleton, E. Jr, Kandaswami, C. and Theoharis, C.T. (2000). The effects of plant flavanoids on mammalian cells: implications for inflammation, heart disease and cancer. *Pharmacol. Rev.*, 52: 673-751.
- Mooradian, A.D. and Morley, J.E. (1987). Micronutrient status in diabetes mellitus, *Am. J. Clin. Nut.*, 45(5): 877-895.
- Nourmohammadi, I., Shalmani, I. K., Shaabani, M. and Gohari, L. (2000). Zinc, copper, chromium, manganese and magnesium levels in serum and hair of insulin-dependent diabetics. *Arch. Iran. Med.*, 3(3): 88100.
- Nwinyi, F. C., Binda, L., Ajoku, G. A., Anaigu, S.O., and Gamaniel, K. S. (2004). Evaluation of aqueous extract of *Boswellia dalzielii* stem bark for antimicrobial activities and gastrointestinal effects. *Afr. J.*

- Biotechnol.*, 3: 284-288.
- Oguakwa, J. U. (1980). Plants used in traditional medicine in West Africa. *J. Ethnopharmacol.*, 2(1): 29-31.
- 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.
- Ouedraogo, N. O. G. (1996). Plantes medicinales et pratiques medicinales traditionnelles au Burkina Faso, cas du plateau central. Ph.D Theses, Universited'Ouagadougou (Burkina Faso).
- Oyenuga, V. A. (1968). Nigeria's Food and Feeding stuffs Ibadan University Press, Reprint, pp 1-90.
- Piscator, M. (1985). Dietary exposure to Cd and health effects: Impact of environmental changes. *Environ. Health Perspect.*, 63: 127-132.
- Pittas, A. G., Lau, J., Hu, F. B. and Dawson-Hughes, B. (2007). The role of vitamin D and calcium in type 2 diabetes. A systematic review and meta-analysis, *J. Clin. Endocrinol. Metabol.*, 92(6) 2017-2029.
- Radojevic, M. and Bashkin, V. N. (1999). *Practical Environmental Analysis*. The Royal Society of Chemistry 2nd Ed., Cambridge, United Kingdom. pp. 378-408.
- Rajendra, A., Narayan, V. and Granavel, I. (2007). Study on the analysis of trace elements in *Aloe vera* and its biological importance. *J. App. Sci. Res.*, 3:1476-1478.
- Recher, G., Slijepcevic, M. and Krans, L. (1991). Hypoglycemia activity triterpenes and tannis from *Sarcopoterium spinosum* and two sanguisorba species, *Planta. Med.*, 57: A57-A58.
- Sani, Z. and Qamar, M. (2015). Comparative effects of *Boswellia dalzielii* parts on survival of adult *Callosobruchus maculatus* (Fabricius) [coleoptera: chrysomelidae] reared on cowpea seeds. *Annal Bio. Sci.*, 3(2): 1-4.
- Sarma, B. and Goswami, B.C. (2017). Study on element content of some antidiabetic medicinal plants grown in North East India by atomic absorption spectroscopy (AAS) and flame photometry, *Int. J. ChemTech Res.* 10(6):644-652.
- Schimizu, M.I., Shima, T.R. and Hasimatoy, S. (1984). Inhibition of lens aldose reductase by flavonoids. *Phytochem.* 23: 1885-1888.
- Shinkafi, T. S. Bello, L., Hassan, S. W. and Ali, S. (2015). An ethnobotanical survey of antidiabetic plants used by HausaFulani tribes in Sokoto, Northwest Nigeria. *J. Ethnopharmacol.*, 172: 9199.
- Siddiqui, K., Bawazeer, N. and Joy, S.S. (2014). Variation in macro and trace elements in progression of type 2 diabetes. *Sci. World J.*, 22: 159-171.
- Srinivasu, C.C., Babu, N.G., Raju, T.P., Narayana, P.V.L., Ram, S.S., Sudershan, M. and Das N.L. (2016). Concentration of trace elements in selected Indian antidiabetic medicinal plants by using Edxrf technique, *Int. J. Rec. Sci. Res.*, 7(2): 9104-9108.
- Tomada, M., Shimada, K., Konno, C. and Hikin, H.J. (1985). Structure of Panaxan B. J. A. Hypoglycaemic glycan of panaxginesg roots. *Phytochem.* 24: 2431- 2433.
- Vincent, J. B. (2000). Quest for the molecular mechanism of chromium action and its relationship to diabetes, *Nut. Rev.*, 58(3-1): 6772.
- WHO (2007): World Health Organization. Guideline for assessing quality of herbal medicines with reference to contaminants and residues. World Health Organization, Geneva, pp 1-105.
- WHO, (1985). Study Report. Diabetes mellitus,

- WHO *Tech. Rep. Ser.* 727: 1-113.
- Wilson, J.G., Lindquist, J.H., Grambow, S.C., Crook, E.D. and Maher, J.F. (2003). Potential role of increased iron stores in diabetes. *Am. J. Med. Sci.*, 325(6): 332-339.
- Yakubu, J., Abdulrahman, F.I. and Sodipo, O.A. (2020). Evaluation of the toxicity profile and antidiabetic potentials of the methanol extracts of *Boswellia dalzielii* (Frankincense Tree) in alloxan-induced diabetic rats. *Trop. J. Nat. Prod. Res.*, 4(5):190 - 194.
- Younoussa, L. Elias, N.N., Danga, Y.S.P. and Okechukwu, E. (2014). Larvicidal activity of *Annona senegalensis* and *Boswellia dalzielii* leaf extract against *Aedes aegypti* (Diptera: colicidac). *Intl. J. Mosq. Res.*, 1(4): 25-29.
- Zheng, Y., Wang, Y. and Cai, L. (2008). The role of zinc, copper and iron in the pathogenesis of diabetes and diabetic complications: therapeutic effects by chelators. *Hemoglobin*, 32: 135-145.