The Bush Candle Fruit (Canarium Schweinfurthii): Its Antioxidant Potential, Phytochemicals and Minerals Constituents

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ABSTRACT

The Bush candle fruit (Canarium schweinfurthii) is claimed to have numerous traditional therapeutic applications. Screening it for antioxidant potential, phytochemicals and minerals constituents is part of the numerous ways to scientifically ascertain these claims. Therefore, the aim of this research was to determine the antioxidant potential, phytochemicals and minerals constituents of the Bush candle fruit. Standard methods were used for the determinations. The result of antioxidant potential determination using both DPPH and FRAP methods revealed a direct relationship between increase in extract concentration and increase in antioxidant potential. An IC_{50} of 50µg/ml was obtained using the DPPH method. Results of phytochemicals analysis showed that the fruit contains flavonoids, phenolics, tannins, saponins, cardiac glycosides and alkaloids. The result of minerals analysis revealed the presence of K, Na, Ca, Mg, Fe, Cu, Zn, and Mn, all within beneficial range for human. Although, the toxic metals Pb, Cr, Li, Se, Hg and Cd were present, but were all within safety limits for human. These findings may be proofs to the therapeutic claims on Bush candle fruit that are associated with the phytochemicals and minerals it contains as revealed in this research.

Keywords: Antioxidants, Bush candle, Minerals, Phytochemicals, Therapeutic

INTRODUCTION

The emergence of Bush candle fruit (*Canarium schweinfurthii*) as the fruit with the highest superoxide dismutase (SOD) activity among thirty (30) locally available fruits in Bauchi town, North-eastern Nigeria [1] has triggered research interests to explore the fruit further. This will scientifically affirm (or otherwise) the many traditional claims on the usefulness (benefits) of the fruit.

Canarium Schweinfurth belongs to the family *Burseracea* [2], which consists of 18 genera and about 75 species [3], [4]. This plant has different names depending on the language and country where it grows: English (Purple canary tree, Incence tree, Gum resin tree, Bush candle tree, African olive, African elemi), Hausa (Atili), Yoruba (Elimi, Agbabubu), Igbo (Ube-agba) [4], [5]. Its trade names include White mahogany and African canarium [4]. The old tree is an evergreen large forest tree with its crown reaching canopy of the forest, with a long, clean, straight and cylindrical bole up to 40 to 50m high, with very slight blunt buttress and a diameter which can reach 4.5m. The bark is thick, on young trees fairly smooth, becoming increasingly scaly and fissured with age [5]. A cut on its bark exudes a heavy sticky (gum) oleoresin that colors to sulfur yellow and becomes solid. The resin is used as primitive illuminant and as incense. The resins burns readily and is used as a bush candle [6]. The fruit is a drupe, bluish-purple, in some parts brownish, glabrous, 3 – 4cm long and 1 – 2cm thick. The calyx is persistent and remain attached to the fruit. The edible fruit consist of stalk spot, pulp, core and grain (almond). The fruit could be the long or short variety [7]. In many communities, the ripe fruits are picked and first soaked in warm water to soften before consumption [7]. In fact, the soaking in warm water is believed to boost its taste. The fruit has taste similar to olive. The oily seed kernel is eaten cooked, and in Nigeria is sometimes prepared into a vegetable butter and eaten as substitute for shea butter [8]. The outer pulp of the fruit is oily and often used

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as ingredient for preparing dishes. This oily fruit pulp can also be cooked and processed into a fruity-butter. The oil can be used as vegetable oil [9].

Several parts of the tree, including the root, bark, fruit, seed, leaf, flower, gum, and resins are extensively used in traditional medicine by people of rural areas to manage health problems [10]. The stem bark is emetic and pugative and its decoction is used as treatment against hypertension and sickle cell anemia. The pounded bark is

used in the treatment and management of leprosy and ulcer [4], also as antidiabetic [5]. The leaves are used as stimulants against fever, malaria and constipation. The leaves can also be squeezed to obtain the sap that can be used alone, or combined with other herbs for treating coughs and colds [4], [5]. Ethanol extract and essential oil from the *Canarium* family were shown to be neuroprotective on some neurological disorders, including Alzheimer's disease [10]. The resin is used against round worm infection and other intestinal parasites; it is an emollient, stimulant, diuretic and affects skin affections and eczema [4], [5].

In addition to recent findings which revealed Bush candle fruit as the richest source of superoxide dismutase (SOD) among thirty screened locally available fruits in Bauchi town, Northeastern Nigeria [1], exploring the fruit further for antioxidant potential, phytochemicals and minerals constituent will enrich the existing literature with more revelations on scientifically affirmed benefits (or otherwise) of the fruit. This was achieved in this research.

MATERIAL AND METHODS

Plant Material

Bush candle fruit (*Canarium schweinfurthii*) was obtained from the local market in Bauchi town, Bauchi state Nigeria. It was identified and authenticated by the Botanist, Mr Musa Ibrahim of the Department of Biological Sciences, Faculty of Science, Abubakar Tafawa Balewa University, Bauchi, Nigeria.

Plant extraction

Eighty percent (80%) methanol extract was prepared as reported by [11]. Briefly: fruit was peeled, sliced and air-dried under shade. It was then pulverised into powder to size smaller than 0.5 mm. It was then soaked in the extraction solvent in the ratio of 1:5 (w/v) in a stoppered container for 3 days with frequent agitation. After the 3 days, the mixture was filtered. The filtrate was evaporated and the residue was regarded as extract.

Antioxidant Potential Determination

Antioxidant potential was determined using two different methods:

1. 2, 2 - diphenyl-1-picryl hydrazyl (DPPH) method: free radical scavenging activity was determined as reported by [12] with some modifications. In brief: a stock solution (500 µg /ml) of the fruit extract was diluted to different concentrations (31.25, 62.5, 125, 250 and 500 µg/ml). 1.0ml of 0.3mM DPPH solution (methanol was used as solvent) was added to 1.0ml of each of the different extract concentrations. The mixture was shaken vigorously and incubated at room temperature in the dark for 30 minutes. The absorbance was taken at 517nm. Methanol only was used as Blank. Ascorbic acid at different concentrations identical to that of the extract was used as standard. The radical scavenging activity was calculated using the formula:

   $$\text{Radical scavenging activity} = \frac{(\text{As}-\text{Ai})}{\text{As}} \times 100$$ (He et al., 2012).

   Where As = Absorbance of DPPH solution only

   Ai = Absorbance of DPPH solution mixed with various extracts

   A graph of % inhibition (Radical scavenging activity) vs concentration was plotted to determine the IC_{50}.

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2. Ferric ion reducing antioxidant power (FRAP) was determined as reported by [13] with some modifications. In brief: a stock solution (500 µg /ml) of the fruit extract was diluted to different concentrations (31.25, 62.5, 125, 250 and 500 µg/ml). 2.5 ml of 20mM phosphate buffer was added. 2.5ml 1% (w/v) potassium ferricyanide was then added. The mixture was incubated at 50^0C for 30 min. 2.5ml of 10% (w/v) trichloroacetic acid was added. The mixture was centrifuged at 3000 rpm for 10 min. 2.5 ml of the upper layer of the solution was mixed with 2.5ml of distilled water. 0.5ml of 0.1% (w/v) ferric chloride was then added. The mixture was incubated at room temperature for 10 min. Absorbance was taken at 700nm against blank. Ascorbic acid at different concentration identical to that of the extract was used as standard. A graph of absorbance vs concentration was plotted.

Phytochemical Analysis

Qualitative and quantitative determinations of flavonoids, phenolics, terpenoids, steroids, tannins, saponins, anthraquinones, cardiac glycosides and alkaloids in the selected sample were carried out using standard procedures [14], [15], [16], [17], [18].

Determination of Minerals and Toxic Metals

Minerals (K, Na, Ca, Mg, Fe, Cu, Zn and Mn) and some toxic metals (Pb, Cr, Li, Se, Hg and Cd) in the fruit were analysed using atomic absorption spectrophotometry as reported by [19], [20]. In brief: the sample was finely ground, then oven dried at 60 ^{0}C for 48 hours. 0.5g of the dried sample was transferred into 125ml conical digestion flask. 12ml HNO3:HCl (1:3 v/v) were added to the flask. It was then digested in cold for 3 hours followed by digestion for 2 – 3 hours on a hot plate, until the digest was clear or colourless. The content of the flask was allowed to cool and then diluted to 50ml with distilled water. It was then taken for analysis using atomic absorption spectrophotometer.

Statistical Analysis

Descriptive statistics was used to analyse the data. Values were expressed as Means ± Standard deviation. Tables and graphs were used to present the data.

RESULTS

Table I shows the DPPH free radical scavenging activity of Bush candle fruit and the standard (Ascorbic acid). The results show that there was a direct relationship between increase in extract concentration and increase in antioxidant activity. The antioxidant activity increased from 35.26% at 31.25 µg/ml to 68.89% at 500 µg/ml.

Table I: Dpph Free Radical Scavenging Activity Of Bush Candle Fruit

Extract Concentration (µg/ml)	Antioxidant potential of Bush candle fruit (%)	Antioxidant of potential of Ascorbic acid (%)
31.25	35.26	75.59
62.5	39.81	75.86
125	46.09	77.26
250	60.53	95.32
500	68.89	96.43

The DPPH free radical scavenging activity was further represented by the line graph (Fig 1) below. The IC_{50} of the Bush candle fruit, as well as that of the standard (Ascorbic acid), as obtained from the line graph were 150µg/ml and 20µg/ml respectively.

Fig 1: Line graph of the DPPH free radical scavenging activity of the Bush candle fruit

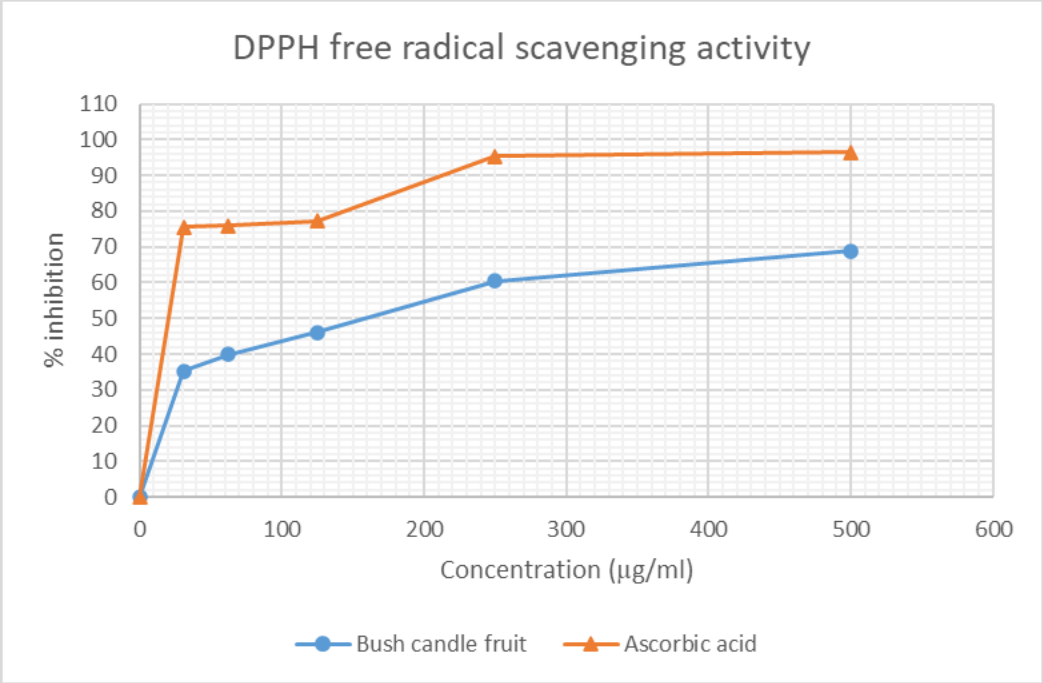

Table II shows the FRAP of the Bush candle fruit and the standard (Ascorbic acid). The results also shows that there was a direct relationship between increase in extract concentration and increase in antioxidant activity (which was represented by FRAP). The FRAP increased from 0.273 at 1.00mg/ml to 1.772 at 5.00mg/ml.

Table II: Ferric Ion Reducing Antioxidant Power (Frap) Of The Bush Candle Fruit

Concentration (mg/ml)	FRAP of Bush candle fruit	FRAP of Ascorbic acid
1.00	0.273	0.395
2.00	0.510	0.678
3.00	0.936	1.226
4.00	1.617	1.724
5.00	1.772	1.923

Table III shows the result of qualitative and quantitative analysis of phytochemicals in Bush candle fruit. The qualitative analysis shows the presence of flavonoids, phenolics, tannins, saponins, cardiac glycosides and alkaloids in Bush candle fruit. While terpenoids, steroids and anthraquinones were absent.

Quantitative analysis of the phytochemicals (confirmed to be present by qualitative analysis) shows that the Bush candle fruit contains flavonoids (174.67 ± 10.29 mg/g extract), phenolics (100.51 ± 0.68 mg/g extract), tannins (103.94 ± 2.09 mg/g extract), saponins (64.50 ± 2.82 mg/g extract), cardiac glycosides (5.96 ± 0.14 mg/g extract) and alkaloids (115.25 ± 3.88 mg/g extract).

Table Iii: Phytochemical Constituents Of Bush Candle Fruit

Phytochemical	Qualitative	Quantitative (mg/g extract)
Flavonoids	+	174.67 ± 10.29
Phenolics	+	100.51 ± 0.68
Terpenoids	-	-

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Steroids	-	-
Tannins	+	103.94 ± 2.09
Saponins	+	64.50 ± 2.82
Anhraquinones	-	-
Cardiac glycoside	+	5.96 ± 0.14
Alkaloids	+	115.25 ± 3.88

Values are presented as Mean ± Standard deviation, + = Present, - = Absent.

Table IV shows the results of Minerals analysis in the Bush candle fruit. The results shows that Bush candle fruit contains K, Na, Ca, Mg, Fe, Cu, Zn, Mn, Pb, Cr, Li, Se, Hg and Cd within beneficial range (for micro and macro elements) and safety limits (for toxic metals).

Table Iv: Minerals Content And Their Concentrations In Bush Candle Fruit

Mineral	Concentration (ppm)
K	107.310 ± 0.000
Na	14.080 ± 0.060
Ca	5.651 ± 0.173
Mg	16.580 ± 0.080
Fe	0.359 ± 0.326
Cu	0.044 ± 0.125
Zn	0.050 ± 0.001
Mn	0.015 ± 0.02
Pb	0.002 ± 0.00
Cr	0.001 ± 0.000
Li	0.001 ± 0.000
Se	0.016 ± 0.005
Hg	0.005 ± 0.003
Cd	0.001 ± 0.006

Values are expressed as Mean ± Standard deviation

DISCUSSION

The return to plants as source of drugs has almost become an acceptable norm in the scientific world. However, systematic methodologies are always applied by Scientists in order to ascertain hypothesized or traditional claims on the therapeutic effect(s) of plant(s) of interest. Of recent, thirty (30) locally available fruits in Bauchi town were screened for superoxide dismutase activity [1], and the result turnout with Bush candle fruit as the fruit with the highest activity. In this research, the fruit is further explored for its antioxidant potential, phytochemicals and minerals constituents with a view of providing more information that will support (or discredit) the traditionally acclaimed therapeutic applications of the fruit.

The fruit was first screened for phytochemicals. The results of the screening shows that the fruit contains flavonoids, phenolics, tannins, saponins, cardiac glycosides and alkaloids. It was also reported by [5] that the

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fruit contains some of the aforementioned phytochemicals. These phytochemicals are secondary metabolites which are generated by plants to defend themselves or promote their growth under unfavourable conditions [21]. They are equally used by humans to enhance health. For example, Saponins were reported to have antioxidant, immunostimulant and antimicrobial activity [22]. Flavonoids partake in the reduction of ischemia-reperfusion injury. This implies that all the health benefits associated with these phytochemicals may be availed to whoever use the fruit.

The fruit was also analysed for the presence of Minerals. Plants are among the major sources of minerals for human. The supplementation of minerals may help in preventing or curing a disease condition that may arise due deficiency of the mineral in question. In this research, the results of minerals analysis shows that Bush candle fruit contains K, Na, Ca, Mg, Fe, Cu, Zn, Mn, Pb, Cr, Li, Se, Hg and Cd. The presence of Na, K and Mg in the fruit was earlier reported [5]. The presence of P, N, Mg, I and K in the fruit was also reported [3]. In this work,

we have gone further to check for the presence of more minerals. These minerals (with the exception of toxic elements) are beneficial to the general wellbeing of humans in many ways. Potassium helps in neuromuscular activities and in the maintenance of acid-base balance [23]. Calcium strengthen bones and helps in blood clotting. Magnesium on the other hand is required by enzymes of glycolysis associated with ATP and ADP [24]. Iron is a component of haemoglobin and is involved in metabolism of lipids, carbohydrates and proteins. It is also a cofactor of superoxide dismutase. Copper is essential for incorporation of iron into haemoglobin. It is also a cofactor of superoxide dismutase. Zinc is needed for normal secretion of insulin and wound healing, normal growth development and behavioural development. Manganese serves as a cofactor of the oxidoreductases, lyases and ligases class of enzymes [25]. Lead is a heavy metal and is reported to be carcinogenic. It is linked with disorders of the central nervous system. Cadmium and Mercury are also toxic metals and have negative effect on both urinary and respiratory systems. The permissible limits (in food) for Cadmium, Mercury and Lead ranges from 0.05 – 3.00 ppm, 0.01 – 1.00 ppm and 0.01 – 3.00 ppm respectively. The levels of these toxic metals in Bush candle fruit are within the permissible safe limits. Trivalent chromium is required for maintaining normal glucose metabolism in laboratory animals; it acts as cofactor for insulin. Selenium plays role in preventing liver necrosis, and it is a cofactor of glutathione peroxidase [26]. Our work on Bush candle fruit shows that it contains all the aforementioned beneficial elements within the required range. Thus, it can be used as their dietary source so as to reap their benefits.

Finally, the antioxidant potential of the fruit was determined. Antioxidants are defined as molecules which have the property of inhibiting or slowing oxidation reactions and which act to maintain a reducing environment. Plants and animals have both enzymatic and non-enzymatic antioxidants. In the context of health, a plant-based antioxidant is any plant-derived compound that either directly or indirectly contribute to *in vivo* redox balance. The antioxidant potential of a fruit (which is a measure of how effective the fruit constituents can maintain redox balance) can be assessed using different methods including 2, 2 - diphenyl-1-picryl hydrazyl (DPPH) and Ferric ion reducing antioxidant power (FRAP) methods; which are the methods used in this research. The results from both methods shows that there is a direct relationship between extract concentration and antioxidant activity. From the results using DPPH method, the antioxidant activity increased from 35.26% at 31.25 µg/ml to 68.89% at 500 µg/ml. The IC_{50} obtained from the graph was 150µg/ml. The antioxidant potential of the Bush candle fruit was earlier reported [5]. The presence of microelements – such as Se (a cofactor of glutathione peroxidase), Cu and Zn (both cofactors of SOD) - as revealed from the results of minerals analysis, might have contributed to the overall antioxidant activity of the fruit. The presence of phytochemicals (in the fruit) such as flavonoids, which is a non-enzymatic antioxidant [27] may also not be unconnected with the overall antioxidant potential of the fruit.

CONCLUSION

The present research revealed that bush candle fruit is a rich source for the phytochemicals flavonoids, phenolics, tannins, saponins, cardiac glycosides and alkaloids. It also shows that it is a rich source for the minerals K, Na, Ca, Mg, Fe, Cu, Zn and Mn. It further revealed that it may also be used as a source of antioxidants. This research has added to the existing literature on the verification of the numerous traditional and unconfirmed therapeutic claims on the fruit. Thus, more scientific exploration on the fruit is highly recommended so as to get a comprehensive report on the possible therapeutic applications of the fruit.

Authors Contribution

All authors have contributed equally during the research.

Conflict Of Interest

There is no conflict of interest among the authors.

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