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THE QUANTITATIVE PHYTOCHEMICALS CONTENT OF THE STEM BARK OF BOSWELLIA DALZIELII HUTCH, THE ANTIOXIDANT AND CYTOTOXICACTIVITIES OF ITS EXTRACTS

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ABSTRACT

The aim of this study was to determine the quantitative phytochemical content of the stem bark of Boswellia dalzielii hutch used in folklore medicine, with the antioxidant and cytotoxic activities of its extracts (petroleum ether, ethyl acetate, acetone, methanol and water) obtained by soxhlet extraction. The quantitative phytochemical profile was determined using standard methods, cytotoxicity was determined using brine shrimp assay and the antioxidant activity was determined using 1, 1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging activity. The result showed that the total flavonoid had the highest content (1.8119%) followed by tannin (0.3258%) and Saponin (0.2362%) while alkaloid (0.0008%) had the least concentration. The cytotoxic activity showed that the ethyl acetate extract was the most potent with LC_{50} value of 115.43µg/ml followed by the water extract with LC_{50} value of 122.41 µg/ml and acetone extract (200.26 µg/ml) while petroleum ether extract was the least active (272.67 µg/ml). The ethyl acetate extract had the highest antioxidant activity in the DPPH assay with IC_{50} value of 77.06 µg/ml followed by water extract with IC_{50} value of (384.79 µg/ml) and acetone extract had the least activity (6212.50µg/ml). According to the findings of this study Boswellia dalzielii stem bark contain some active phytochemicals which had a strong natural anticancer and antioxidant activities.

Keywords: *Boswellia dalzielii, phytochemicals, antioxidant and cytotoxicity*

INTRODUCTION

Plants have been used for the treatment of diseases all over the world before the advent of modern clinical drugs, and are known to contain substances that can be used for therapeutic purposes or as precursors for the synthesis of useful drugs. According to Ayepola and Adeniyi (2008), over 50% of modern drugs are of natural product origin, and as such these natural products play important roles in drug development in pharmaceutical industries. Phytochemicals are non-nutritive plant chemicals that have protective or disease preventive properties. It is known that plants produce these to protect themselves but researchers have demonstrated that they can protect humans and animals against diseases (Kumar *et al.,* 2013; Abdul kader et al., 2022). The frequency of life threatening infections caused by pathogenic microorganisms has increased worldwide and is becoming an important cause of morbidity and mortality in immune compromised patients in developing countries. There have also been reports that a vast majority of the population, particularly those living in rural areas depend on herbal medicines (Gupta, 2005). These therefore translate to an increased need to authenticate the claim by traditional medical practitioners that the plant – *Boswellia dalzielii* has some medicinal properties.

Boswellia dalzielii Hutch (Burseraceae) commonly known as the frankincense tree grows up to 13 m high and is found mainly in the Savannah region of West Africa. The tree has a characteristic pale papery bark that is peeling and ragged. The Hausa names include “Ararrabi”, “Basamu” and Hanu. This plant is very popular among the locals as a potent source of ethnomedicine. The extract from its leaves is used for the treatment of diarrhoea in poultry. The root decoction of *B. dalzielii* and *Daniella oliveri* is used for wound healing (Etuk *et al.,* 2006). The stem bark secretes a fragrant while gum that is burnt to fumigate cloth and to drive out flies, mosquitors, etc from rooms. The fresh stem bark is eaten to induce vomiting and relieve symptoms of giddiness and palpitations. The stem bark is boiled to make a wash for fever and rheumatism while it is taken internally for gastrointestinal troubles. It is also used as a stomach ache (Dalziel, 1956; Oliver, 1960; Burkill, 1985).

Nwinyi *et al.,*(2004) has shown that the aqueous extract of the stem bark produced some anti-ulcer activity. Antispasmodic agents have smooth muscle relaxation property and are used to decrease gastrointestinal motility, inhibit gastric acid secretion and to relieve pain associated with

diarrhoea and other gastrointestinal disorders. The root decoction of the plant boiled along with *Hibiscus sabdariffa* is used for the treatment of syphilis. Oil from the leaves of *Boswellia dalzielii* was found to exhibit significant activity against *S. aureus, B. subtilis and C. albicans* (Nwinyi*et al.,* 2004). It also possesses anti-diarrhoeal effect, which may be related to anticholinergic mechanisms (Etuk*et al.,* 2006). Crude extracts of the root of this plant have been found to show antibacterial against some grampositive and gram-negative bacteria (Olukemi*et al.,* 2005). The stem bark have been found to contain phenolic compounds such as protocatechuic acid, gallic acid and ehtylgallate as well as diterpenoidincensole and triterpenoids – boswellic acid derivatives (Olukemi*et al.,* 2005). In this study, the active bioactive compounds present in the stem bark of *Boswellia dalzielii* will be isolated and characterized. Such a medicinal plant, if authenticated can be exploited as a source of new chemical substance with potential therapeutic effects.

MATERIALS AND METHOD

Collection of Plant Materials

The stem bark of Boswellia dalzielii was collected in Tula Wange Kaltungo local Government Area of Gombe State in March when the leaves were green. The fresh stem bark were removed, air dried under shade in the laboratory and pulverized using motorized miller.

Extraction of plant material

One hundred (100 gram) of the powdered stem bark of Boswellia dalzielii were serially extracted with hexane, ethyl acetate, acetone, ethanol and distilled water using soxhlet extractor apparatus for 10 hours each (Vogel, 1979). The extracts were evaporated to dryness on rotary evaporator and the percentage yield of the extracts were then determined.

Quantitative Phytochemical Determination the stem bark of Boswellia dalzielii

The quantitative phytochemical determination of the stem bark of Boswellia dalzielii was done in triplicate and the average value determined.

Determination of Alkaloids content

This was done by the alkaline precipitation gravimetric method described by Harborne, (1973). A measured weight of the sample was dispersed in 10% acetic acid solution in ethanol to form a ratio of 1:10 (10%). The

mixture was allowed to stand for 4hours at 28°C. It was later filtered via whatman paper No. 42 grade of filter paper. The filtrate was concentrated to one quarter of its original volume by evaporation and treated with drop wise addition of conc. aqueous NH_4OH until the alkaloid was precipitated. The alkaloid precipitated was received in a weighed filter paper, washed with 1% ammonia solution dried in the oven at 80°C. Alkaloid content was calculated and expressed as a percentage of the weight of sample analyzed.

Determination of Flavonoids content

This was determined according to the method of Harborne (1973), the sample (5g) was boiled in 50$cm^3$of 2M HCl solution for 30minutes under reflux. It was allowed to cool and then filtered through whatmanNo. 42 filter paper. A measured volume of the extract was treated with equal volume of ethyl acetate starting with drop. The flavonoid precipitated was recovered by filtration using weighed filter paper. The resulting weight difference gave the weight of flavonoid in the sample and the percentage determined.

Determination of Tannin content

Tannin content was determined by the Folis-Denis colorimetric method described by Kirk and Sawyer (1998). 5g sample was dispersed in 50$cm^3$of distilled water and shaken. The mixture was allowed to stand for 30minutes at 28°C before it was filtered through whatman No. 42 grade of filter paper. 2cm^3 of the extract was dispersed into a 50cm^3 volumetric flask. Similarly 2cm^3standard tannin solutions (tannic acid) and 2cm^3 of distilled water were put in separate volumetric flasks to serve as standard and reagent was added to each of the flask and the 2.5cm^3 of saturated Na_2C0_3 solution added. The content of each flask was made up to 50cm^3 with distilled water and allowed to incubate at 28°C for 90 minutes. Their respective absorbance was measured in a spectrophotometer at 260nm using the reagent blank to calibrate the instrument at zero then the percentage determined.

Saponin determination content

The method used was that of Obadoni and Ochuko (2001). The samples were ground and 2.0 g of each were put into a conical flask and 100 cm^3 of 20% aqueous ethanol were added. The samples were heated over a hot water bath for 4 hours with continuous stirring at about 55°C. The mixture was filtered and the residue re-extracted with another 200 cm^3

20% ethanol. The combined extracts were reduced to 40 cm^3 over water bath at about 90°C. The concentrate was transferred into a 250 cm^3separator funnel and 20 cm^3 of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated. 60 cm^3 of n-butanol was added. The combined n-butanol extracts were washed twice with 10 cm^3 of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation the samples were dried in the oven to a constant weight; the saponin content was calculated as percentage.

Determination of Anthraquinone contents

The method described by Soladoye &Chukwuma, (2012) is used for the determination of the anthraquinone. 50 mg of the fine powder sample was soaked in 50 $cm^3$of distilled water for 16 hours. This suspension was heated in water bath at 70°C for one hour. After the suspension was cooled, 50cm^3 of 50% methanol was added to it and then filtered. The clear solution was measured by spectrophotometer at a wavelength of 450nm and compared with a standard solution containing 1mg/100cm^3 alizarin with the absorption-maximum 450nm

Determination of Cardiac glycosides content

Cardiac glycoside content in the sample was evaluated using Buljet's reagent as described by El-Olemy*et al.,* (1994). The fine powder of the stem bark of Boswellia dalzielii *(*1g) was soaked in 10cm^3 of 70% alcohol for 2hours and then filtered. The extract obtained was then purified using lead acetate and Na_2HPO_4 solution before the addition of freshly prepared Buljet's reagent (containing 9cm^3 aqueous picric acid + 5cm^3 10% aqueous NaOH). The difference between the intensity of colours of the experimental and blank (distilled water and Buljet's reagent) samples gives the absorbance and is proportional to the concentration of the glycosides.

Determination of total phenols content by spectrophotometric method

The fat free sample was boiled with 50 $cm^3$of ether for the extraction of the phenolic component for 15 minutes. The extract 5$cm^3$was pipette into a 50 cm^3 flask, and then 10 $cm^3$of distilled water was added. Ammonium hydroxide solution (2cm^3) and 5 cm^3 of concentrated amyl alcohol were also added. The samples were made up to mark and left to react for 30 minutes for colour development. This was measured at 505 nm.

Determination of total terpenoids content

The plant powder (2 g) was weighed and soaked in 50 cm^3 of 95% ethanol for 24 hours in a conical flask. The extract was filtered and the filtrate extracted with petroleum ether (60-80^{0}C) and concentrated to dryness. The dried ether extract was treated as total terpenoid (Ladan*et al.,* 2014; Kwaji*et al*., 2015).

Brine Shrimp Lethality Assay

Brine shrimp eggs were commercially available. For this experiment, brine shrimp egg without shells "*Artemia Revolution*" 120g were obtained from NT labs (fry care) laboratories LTD UK, Serial No. 7//3380900038///3. The eggs were stored in a refrigerator at 5^{0}C. (NT Laboratory, 2015)

Hatching of Brine Shrimp

Artificial sea water was prepared by dissolving 35g of sea salt in1000 $cm^3$of distilled water at 24^{o}C to obtain a solution of specific gravity of 1.022 for hatching the brine shrimp eggs (NT Laboratory, 2015).The seawater prepared was added to the brine shrimp Hatcher in a heated aquarium aerate from bottom of the unit so that all eggs are kept in suspension and moving. The brine shrimp bottle was shaken and three drops were dispensed into the aquarium (each drop gives about 1500 to 2000 nauplii, three drops (5000 nauplii) and are hatched in approximately 250ml sea water (NT Laboratory, 2015).The Hatcher is illuminated very well for a minimum of three hours preferably for 12hours. The hatching time depend on temperature at 24^{0}C (which is average tropical aquarium temperature) hatching take place between 24-48 hours (maximum hatch 44-48hours) (NT Laboratory, 2015). The Nauplii is then used directly for the cytotoxicity test.

Brine Shrimp Cytotoxicity

Two (2cm^3) of brine shrimps stock solution (containing about 15-20 shrimps), five (5 cm^3) sea salt water and two (2 cm^3) extracts in concentrations 10, 100, 200, 500 and 1000 ppm were added to a vial (Adoum, 2009). An incubation period of 24 hours was given at room temperature. The test tubes were maintained under illumination and survivors were counted, with the aid of the 3 X magnifying glass after 24 hours and the percentage death for each dose and control were determined. The LC_{50} for each extract were then determined.

Statistical Analysis

The percentage of deaths and (LC_{50}) were determined using statistical analysis. Percentage mortality (M %) was calculated by dividing the number of dead nauplii by the total number, and then multiply by 100 as shown in equation below

Percentage of Death (%M) = $\frac{Initial\ no.\ of nauplii - no.of\ living\ nauplii}{initial\ no.\ of\ nauplii}\ X\ 100$.

The LC_{50} values were obtained from the best-fit line, plotted of concentration against Percentage mortality (Adoum *et al.,* 1997).

Quantitative determination of Antioxidant content of Boswellia dalzielii Extracts

Antioxidant activity (DPPH free radical scavenging activity) of the extract was carried out on the extracts. The antioxidant activity of the plant extracts and the standard was assessed on the basis of the free radical scavenging effect of the stable 1, 1-diphenyl-2-picrylhydrazyl (DPPH)-free radical activity as described by Marwah*et al.,* 2007. The diluted working solutions of the test extracts andascorbic acid as standard were prepared in methanol with the concentrations of 100, 125, 250, 500 and 1000μg/ml solutions. The 0.002% of DPPH was also prepared in methanol and $1cm^3$ of this solution was mixed with 1 cm^3 of sample solution and standard solution separately. These solution mixtures were kept in dark for 30 minutes and optical density was measured at 517 nm using UV-Vis – Spectrophotometer model –LT-290 (Labtronics). Methanol (1 cm^3) with DPPH solution (1 cm^3) was mixed and used as blank. The optical density was recorded and percentage (%) inhibition was calculated using the formula given below

Percentage (%) inhibition of DPPH activity = ($\frac{A-B}{A}$) x100

Where A = optical density of the blank and B = optical density of the sample.

RESULTS AND DISCUSSION

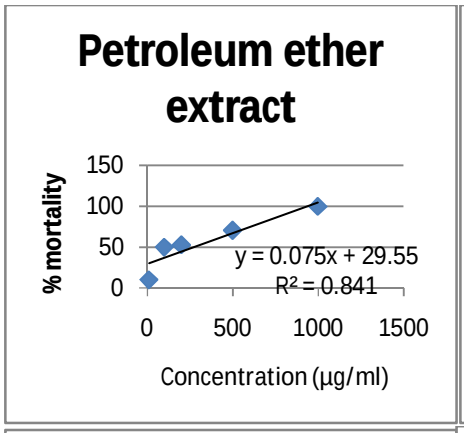
TABLE 1: Quantitative phytochemical content of stem bark of *Boswellia dalzielii* Hutch

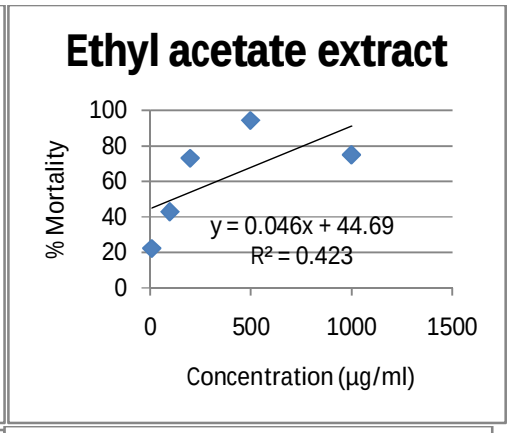
	Phytochemical content (%)			
Phytochemicals	1	2	3	Mean (%)
Tannin	0.3310	0.3341	0.3123	0.3258
Saponin	0.2721	0.2233	0.2132	0.2362
Alkaloid	0.0011	0.0006	0.0007	0.0008
Anthraquinone	0.0345	0.0302	0.0305	0.0317
Flavonoid	1.9020	1.7813	1.7523	1.8119
Cardiac glycoside	0.0295	0.0393	0.0363	0.0350
Phenol	0.0024	0.0028	0.0029	0.0027
Terpenoid	0.0085	0.0102	0.0083	0.0090

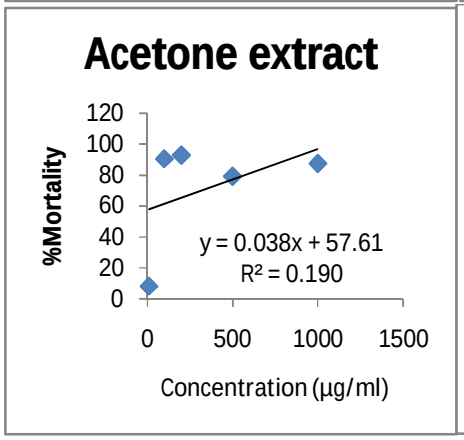
Table 2:Brine shrimp lethality test of the stem bark extract of *Boswellia dalzielii Hutch*

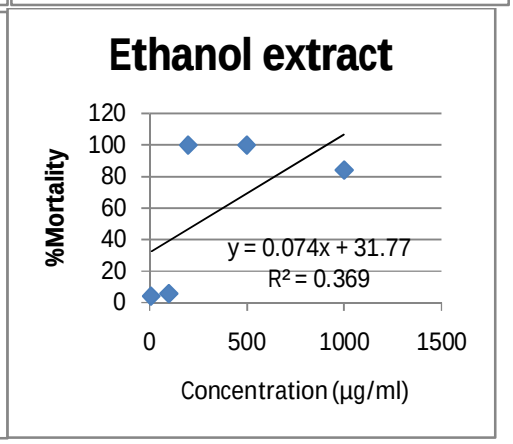
	Conc. In µg/ml	Number of surviving nauplii after 24 hours 1st 0	24	2nd 0	24	3rd 0	24	Mean survivor 24 hrs	% mortality after 24 hrs	LC_{50} µg/ml
Petroleum ether	10	20	18	20	20	20	16	18.0	10.0	272.67
	100	16	8	16	8	16	8	8.0	50.0	
	200	17	8	17	8	17	8	8.0	52.9	
	500	17	5	19	5	17	5	5.0	70.6	
	1000	18	0	18	0	18	0	0.0	100.0	
Ethyl acetate	10	12	10	12	10	12	8	9.3	22.2	115.43
	100	14	8	14	8	14	8	8.0	42.9	
	200	26	7	26	7	26	7	7.0	73.1	
	500	18	1	18	1	18	1	1.0	94.4	
	1000	20	5	20	4	20	6	5.0	75.0	
Acetone	10	12	12	12	10	12	11	11.0	8.33	200.26
	100	21	2	21	2	21	2	2.0	90.5	
	200	14	1	14	1	14	1	1.0	92.9	
	500	16	4	16	4	16	2	3.3	79.2	
	1000	16	2	16	2	16	2	2.0	87.5	
Ethanol	10	18	0	18	0	18	0	0.0	0.0	246.35
	100	17	16	17	16	17	16	16.0	5.9	
	200	13	0	13	0	13	0	0.0	100.0	
	500	14	0	12	0	14	0	0.0	100.0	
	1000	17	2	17	3	17	3	2.7	84.3	

Water	10	15	12	15	10	15	8	10.0	33.3	122.41
	100	17	10	17	7	17	7	8.0	52.9	
	200	17	0	17	0	17	0	0.0	100.0	
	500	16	1	16	1	16	0	0.7	95.8	
	1000	18	0	18	0	18	0	0.0	100.0	
Control		15	15	15	15	15	14	14.7	2.2	









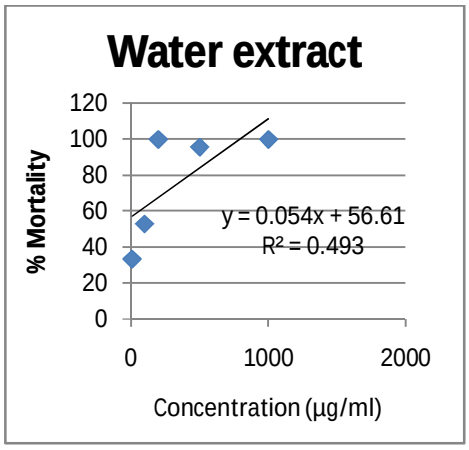
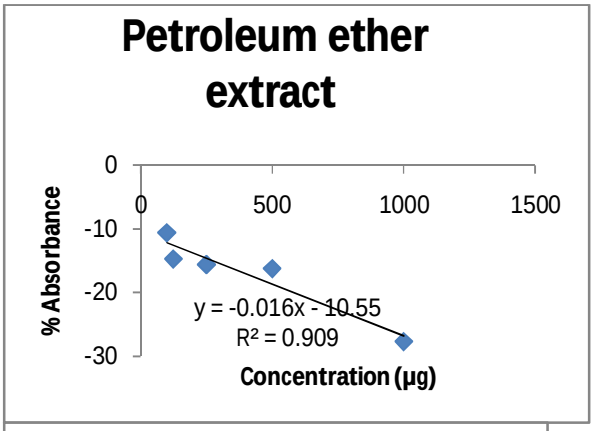
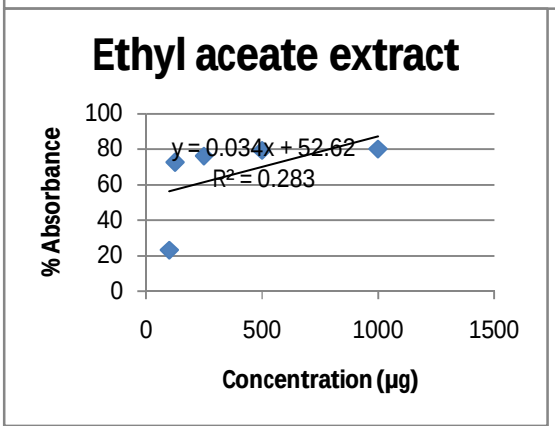


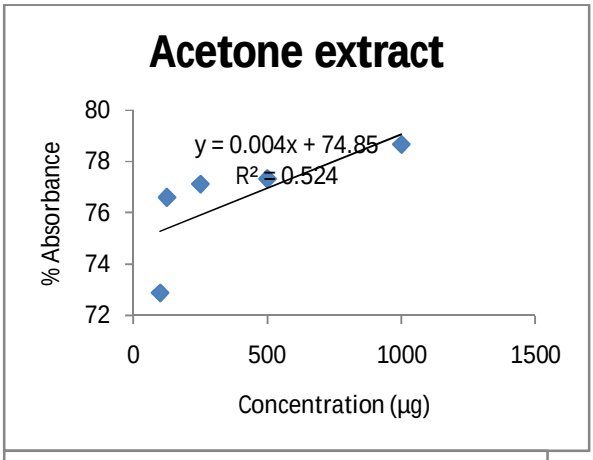
Figure 1: Plot of concentration against Percentage mortality Brine shrimp lethality test of the stem bark extract of *Boswellia dalzielii Hutch*

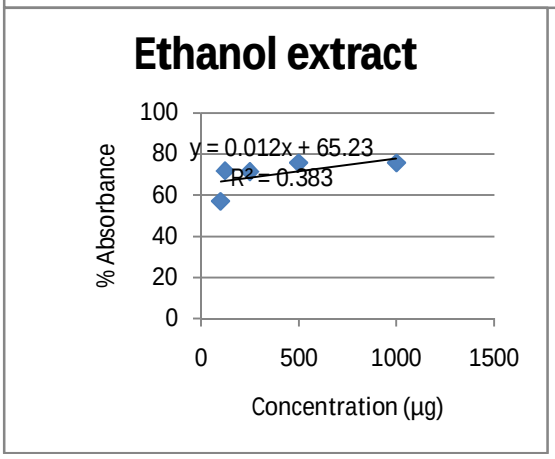
Table 3: Antioxidant activities of theStem bark Extracts *of Boswellia dalzielii* and Ascorbic acid.

EXTRACTS	Conc. (µg/ml)	Absorbance 1st	2nd	3rd	Mean Absorbance	Percentage Absorbance	IC_{50}(µg/ml)
Petroleum ether	100	0.855	0.895	0.812	0.854	-10.62	6055.00
	125	0.937	0.859	0.861	0.886	-14.72	
	250	0.829	0.941	0.907	0.892	-15.59	
	500	0.854	0.894	0.944	0.897	-16.23	
	1000	1.043	0.889	1.024	0.985	-27.63	
Ethyl acetate	100	0.573	0.656	0.551	0.593	23.14	77.06
	125	0.208	0.211	0.214	0.211	72.67	
	250	0.177	0.200	0.175	0.184	76.17	
	500	0.162	0.149	0.166	0.159	79.40	
	1000	0.152	0.155	0.153	0.153	80.14	
Acetone	100	0.211	0.211	0.206	0.209	72.88	6212.50
	125	0.191	0.170	0.181	0.181	76.60	
	250	0.181	0.190	0.159	0.177	77.12	
	500	0.176	0.176	0.173	0.175	77.33	
	1000	0.180	0.148	0.166	0.165	78.67	
Ethanol	100	0.571	0.220	0.206	0.332	56.95	1269.17
	125	0.206	0.223	0.224	0.218	71.80	
	250	0.210	0.196	0.256	0.221	71.42	
	500	0.186	0.188	0.190	0.188	75.65	
	1000	0.184	0.195	0.186	0.188	75.60	
Water	100	0.525	0.606	0.541	0.557	27.81	384.79
	125	0.524	0.527	0.521	0.524	32.12	
	250	0.346	0.357	0.351	0.351	54.49	
	500	0.285	0.263	0.262	0.270	65.03	
	1000	0.182	0.192	0.211	0.195	74.74	
Ascorbic acid	100	0.514	0.515	0.514	0.514	33.34	177.74
	125	0.369	0.370	0.369	0.369	52.21	
	250	0.329	0.329	0.329	0.329	57.67	
	500	0.193	0.186	0.188	0.189	75.55	
	1000	0.081	0.081	0.084	0.082	89.43	
BLANK		0.772					


Petroleum ether extract
% Absorbance
0
-10
-20
-30
0
500
1000
1500
y = -0.016x - 10.55
R² = 0.909
Concentration (µg)


Ethyl aceate extract
% Absorbance
100
80
60
40
20
0
0
500
1000
1500
y = 0.034x + 52.62
R² = 0.283
Concentration (µg)


Acetone extract
% Absorbance
80
78
76
74
72
y = 0.004x + 74.85
R² = 0.524
0
500
1000
1500
Concentration (µg)


Ethanol extract
% Absorbance
100
80
60
40
20
0
y = 0.012x + 65.23
R² = 0.383
0
500
1000
1500
Concentration (µg)

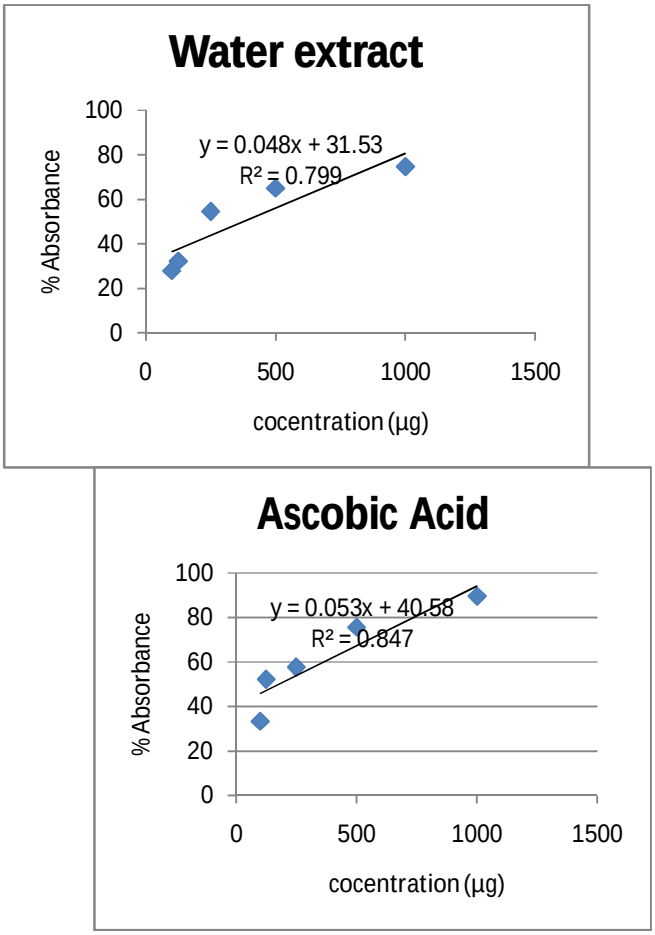


Figure 2: DPPH free radical scavenging activity of Boswellia dalzielii stem bark extracts

RESULTS AND DISCUSSION

The secondary metabolites of plants are compounds that exhibit specific biological and pharmacological activities. The secondary metabolite are usually referred to as phytochemicals and are non-dietary compounds usually derived from plant sources and shows various properties which includes antimicrobial, antioxidant, antiviral etc. (Mshelia,*et al.*, 2016;Muhongo*et al.*, 2021). There are two major methods in determining the Phytochemicals present in a plant sample, the qualitative phytochemical screening and the quantitative phytochemical determination. The quantitative determination is a major way of evaluating the standard of a plant while the effectiveness of a solvent in extracting phytochemicals gives a preliminary fact on the quality of the phytochemicals (Muhongo*et al.*, 2021). The phytochemicals that shows

diverse physiological actions in animals and human bodies include flavonoid, alkaloid, tannins, Saponin, polyphenols, steroids, terpenoid and anthraquinone.

Table 1 show the quantitative phytochemical content of the stem bark of Boswellia dalzielii and the result revealed that flavonoid (1.8119%) was the phytochemical with the highest concentration followed by tannin(0.3258%) and Saponin (0.2362%). Alkaloid (0.0008) was the least abundant Phytochemical followed by phenol (0.0027%), terpenoid (0.0090), anthraquinone (0.0317) and cardiac glycoside (0.0350%). The presences of the Phytochemicals in the stem bark may attribute some physiological activities and exhibit specific biological and pharmacological activities in animals. The physiological, biological and pharmacological activities that can be observed due to the presence of some Phytochemicals were determine on the plant extracts.

The percentage yield of the extracts of Boswellia dalzielii obtained from serial extraction of the stem bark using soxhlet extractor were petroleum ether (4.32%), ethyl acetate (6.89%), acetone (7.04%) ethanol (9.32) and water (11.21%). The brine shrimp lethality bioassay were performed on the different extracts to determine the cytotoxicity and the antioxidant activities of the stem bark extracts. The brine shrimp lethality bioassay is a rapid, cheap and simple test to evaluate the lethality of medicinal plant extracts which acts as a preliminary indicator to the cytotoxic and antitumor potential (Mshelia et al., 2016; Ghosh and Chatterjee, 2013). The in vivo lethality bioassay in a simple zoological organisms can be used as a marker for screening in the discovery of new bioactive natural products used as an antitumor agent according to Ghosh and Chatterjee, 2013.

The result in table 2 indicate that the ethyl acetate extract was the most potent extract with LC_{50} value of 115.43µg/ml, followed by water extract with LC_{50}value of122.41 µg/ml while the least potent extract was the petroleum ether with LC_{50}value of 272.67 µg/ml, ethanol extract LC_{50}value of 246.35 µg/ml and acetone with LC_{50}value of 200.26 µg/ml. The toxicity of herbal extracts expressed as LC_{50} values is commonly valorized by comparison to Meyer's or to Clarkson's toxicity index. According to Meyer's toxicity index, extracts with LC_{50}< 1000 µg/ml are considered as toxic, while extracts with LC_{50}> 1000 µg/ml are considered as non-toxic (Meyer et al., 1982). Clarkson's toxicity criterion for the toxicity

assessment of plant extracts classifies extracts in the following order: extracts with LC_{50} above 1000 µg/ml are non-toxic, LC_{50}value of 500 - 1000 µg/ml are low toxic, extracts with LC_{50} of 100 - 500 µg/ml are medium toxic, while extracts with LC_{50} of 0 - 100 µg/ml are highly toxic (Clarkson *et al*., 2004).

Recent studies carried out showed that plant extracts had high ant cytotoxic activities (Isaac *et al.,* 2018; Uddin *et al.,* 2022; Ahmed *et al.,* 2023; Idowu*et al.,* 2022), which were similar to our findings. Based on the Clarkson's toxicity index all the plant extracts were moderately toxic which might be due to the presence of high content of flavonoid compounds determine in the plant as seen in table 1. The high cytotoxic activity of the ethyl acetate extract of the stem bark extracts was in agreement with the results obtained by Al-Douri*et al.,* 2022, who showed that the ethyl acetate extract had highest cytotoxic activity compared to other extracts. The dichloodmethne and ethyl acetate extracts if the root of Barringtoniaracemose showed good cytotoxic activity which was dependent on the concentration (Isaac *et al.,* 2018). The high activity of the ethyl acetate extracts may be due to the moderate polarity, thereby extracting semi polar active component (Udddin*et al.,* 2022).

The moderate cytotoxic activity of water extract with LC_{50} value of 122.41 µg/ml and ethanol extract LC_{50} value of 246.35 µg/ml may be due to the high content of tannin which were extracted by the polar solvent such as methanol and water. According to Md. Abdul *et al.,* 2022, the cytotoxic studies of Syzygiumsamarangense extracts revealed significant lethality of the methanol extract with LC_{50} of 30.03 µg/ml (Md. Abdul *et al.,* 2022) which was similar to that reported by Sultana *et al.,* (2022) that the ethanolic leaf and bark extract of selected mangrove plants showed cytotoxic activity.According to Al-Douri*et al.*, (2022), ethanolic extracts showed mild cytotoxic activity when compared to the ethyl acetate and hexane extracts. Manal*et al.*, (2022) showed that the n-butanol extract of Pittosporimeuganioides showed good cytotoxic effect with LC50 of 34 µg/ml and methanol extract LC50 of 45 µg/ml. The cytotoxicactivities might be due to the presence of the active compounds present (Al-Rabai*et al.,* 2022).

Table3 showed the antioxidant activity of stem bark extracts of Boswelliadalzielii obtained from serial extraction with solvents of increase

polarity. The result showed that ethyl acetate extract was the most active extract with IC_{50} value of 77.06 µg/ml, followed by the water extract with IC_{50}value of 384.79 µg/ml while the least active extract was the acetone extract with IC_{50}valueof 6212.50 µg/ml, followed by hexane extract with IC_{50}value of 6055.00 µg/ml and ethanol extract with IC_{50}value of 1269.17 µg/ml while the IC_{50} of the standard (Ascorbic acid) was 122.41 µg/ml. The result showed that the antioxidant activity of the ethyl acetate was even greater than that of the standard ascorbic acid. The antioxidant activities of the extracts were compared to that of ascorbic acid it showed that the antioxidant activity of ethyl acetate were higher than that of the standard ascorbic acid while that of water extract were closer to that of the ascorbic acid.

The result from previous studies revealed that some plant extracts showed antioxidant activities (Yoda *et al.,* 2020; Mololee*t al.,* 2022; Chen*etal.,* 2022). For instance Yoda *etal*., 2020, showed that the five different plants extracts had good antioxidant activity due to the presence of phenolic compounds while, Dela Cruz *etal.,* 2022 also reported extracts from seven different plants showed antioxidant and cytotoxic activities. Baliyan*etal*., 2022 showed that Ficusreligionsa had antioxidant activities and said it may be useful in treatment of disorders causes by free radicals. The high antioxidant activity of the ethyl acetate in our work was similar to the study carried out by Vu, 2022, who report that the spent coffee ground fraction showed that the ethyl acetate fraction has the highest amount of phenolic content (227.17mg GAL-(g) compared to the methanol extract and also exhibited higher antioxidant activity. The high antioxidant activity of the ethyl acetate is an indication that the active compounds were extracted by the ethyl acetate may be semi polar in nature like the flavonoid which has the highest concentration in the bark of the plant (Al-Rimawi, *et al.,* 2022; Vu, 2022; Dennis et al., 2022; Nguyen *et al.,* 2022).

The antioxidant activity of the water extract may be due to the presence of high concentration of tannin and saponin which were polar in nature and have been documented for their antioxidant activity (Dennis *et al*.,2022; Mololee*t al.,* 2022; Dela Cruz *et al*., 2022). In general the cytotoxic and antioxidant activities of the bark extracts of Boswellia dalzielii may be due to the presence of flavonoid, tannin and saponin as stated by Al-Robai*et al*., 2022 Total polyphenol and total flavonoid content is directly proportional to the antioxidant and cytotoxic activity while, Ahmed *et al.,*

2023 showed there were strong correlation between antioxidant and antifungal activities with flavonoid content.

CONCLUSION

The stem bark of Boswellia dalzielii contain high percentage of total flavonoid, tannin and saponin which might be responsible for the bioactivities of the ethyl acetate and water extracts. The findings of this study suggest that the stem bark of Boswellia dalzielii contain some potent natural anticancer and antioxidant potentials and its use by the folklore in traditional medicine is justified.

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