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PHYTOCHEMICAL SCREENING, ANTIBACTERIAL AND INSECTICIDAL ACTIVITIES OF STEM BARK EXTRACTS OF *BOSWELLIA DALZIELII* HUTCHIN FROM KALTUNGO, NIGERIA

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ABSTRACT

The importance of traditional herbal medicinal system has now gained attention in developed and developing countries. *Boswellia dalzielii* is a tree grows in the wild usually in the Savannah region of West Africa. These work assessed the phytochemical constituents, antibacterial and insecticidal activities of the stem bark extracts of *Boswellia dalzielii*. The plant extracts were obtained using soxhlet method with petroleum ether, ethyl acetate, acetone, ethanol and water as solvents for 10 hours while the phytochemicals and insecticidal activities were determined using standard methods. The phytochemical screening showed significant presence of carbohydrate in the ethanol and water extracts while significant amount of tannin was detected only in the ethanol extract. The petroleum ether and ethyl acetate showed absence of carbohydrate, tannins, phlobotannin, cyanogenic glycoside, chlorogenic acid and alkaloid. Significant amount of flavonoid was seen in the water extract, while only the ethanolic extract showed significant amount of cardiac glycoside and alkaloid. The acetone extract showed significant quantity of alkaloid and terpenes and steroids. The antibacterial screening showed that ethanol extract had the highest inhibitory activity. The petroleum ether extract had the least active components with no activity on the test organisms. The insecticidal activity of the plant extracts showed that acetone extract had the highest insecticidal activity on both the test insects. Camponotus consobrinus shows the highest percentage mortality of 75% at a concentration of 500µg and LC_{50} of 1.64×10^2µg followed by the Acanthscelides obtectus with the percentage mortality of 53% at a concentration of 250µg and LC_{50} of 9.58×10^2µg. The result of the study confirmed the use of plant stem bark in ethno medicine for treatment of infectious diseases as well as an insect repellent by the folklore.

Keywords: *Boswellia dalzielii,* Phytochemical, Antibacterial, Insecticidal, *Camponotus consobrinus, Acanthscelides obtectus*

INTRODUCTION

Traditional herbal medicine is practiced in several parts of the world, especially in Africa, Asia, North and South America. History has revealed that most of the people of the world have been using plants, animals, micro-organisms and minerals for treating their illness. Traditional herbal medicine in the last one decade has gained importance in various developed countries (WHO, 2000) with 80% of the world use traditional medicine to cure some illness (WHO, 2005). It is estimated that the number of people to traditional practitioners in Tanzania is 30,000-40,000 in comparison to 600 medical doctors which gives traditional medicine in its diverse and pluralist nature (Asfaw, 1998).

The world health organization has described traditional medicine as one of the surest means to achieve total health care coverage of the world population and the desire for research, investment and design of programmes in this field in several developing countries such as Africa and elsewhere (Farnsworth,1985). It is therefore necessary for innovation in science and Agriculture for the systematic cultivation of medicinal plants to be introduced in order to protect some of the threatened species (Cunningham, 1997). As Africa's population grows, demand for traditional medicine will increase, and pressure on medicinal plant resources will become greater than ever.

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. Pytochemicals 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 against diseases (Kumar et al., 2013).

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 has 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 dalzialii* has some medicinal properties. Such a medicinal plant, if authenticated can be exploited as a source of new chemical substance with potential therapeutic and insecticidal effects.

Boswellia dalzialii 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 (Etuk et al., 2006). The root decoction of *B. dalzialli* and *Daniella oliveri* is used for wound healing (Etuk et al., 2006). The stem bark secretes a fragrant while gum is burnt to fumigate cloth and to drive out flies eg mosquitoes, 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 for stomach ache (Dalziel, 1956; Oliver, 1960; Burkill, 1985) and have shown pharmacological activity (Massei *et al., 2023).*

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 motality, inhibit gastric acid secretion and to relieve pain associated with diarrhoea and other gastrointestinal disorders (Hassan *et al.*, 2009; Etuk et al, 2006). The extracts from the plant have been used as antihyperglycemic (Ibrahim *et al.*, 2023), anti-inflammatory (Adebisi and Giaze, 2018 and antidiabetic (Yakubu *et al.*, 2020). The root decoction of the plant boiled along with *Hibiscus sabdariffa* is used for the treatment of syphilis. It also possesses anti-diarrhoeal effect, which may be related to anticholinergic mechanisms (Etuk et al., 2006). Oil and crude extracts of the root bark and leaves of this plant have been found to show antimicrobial activity (Danlami *et al.,* 2015; Olukemi et al, 2005; Nwinyi *et al.,* 2004). In this study the phytochemical screening, antibacterial and insecticidal activities of the stem bark extracts of *Boswellia dalzielii w*as investigated.

MATERIALS AND METHODS

Collection of plant materials

The stem bark of *Boswellia dalzielii* was collected in Tula Wange Kaltungo local Government Area of Gombe State in March 2019 when the leaves were green. The fresh stem barks were removed, air dried under shade in the laboratory for 28 days and pulverized using motorized miller.

Extraction of plant material

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

Phytochemical screening of the extracts

The phytochemical screening was carried out on the extracts of the stem bark of *Boswellia dalzielii* obtained by soxhlet extraction method using standard procedures to identify the phytochemical constituents as described by (Harborne, 1973; Trease and Evans, 1989; Sofowora, 1993; Mshelia et al., 2007; Victor and Chidi, 2009).

Source and Maintenance of Organisms

Both gram negative and gram positive bacteria (*Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumonia, Klebsiella specie, Staphylococcus aureus, Salmonella typii, Shigella dysentriae, Bacillus subtillis and Nissera gonorrieae)* were obtained and confirmed at the microbiology laboratory of the Department of microbiology Federal Teaching Hospital, Gombe. They were maintained on Muller-Hinton agar (MHA) (Oxford, UK) before the experiment.

Disc-Agar Diffusion Method

Plant extracts were tested for antibacterial activity by the disc diffusion method. A single colony was aseptically transferred with an inoculating loop to about 20 ml of the prepared nutrient agar.

Filter papers were cut out with a diameter of 10mm. The filter paper is then transferred to the oven and sterilized for one hour. Using sterilized forceps, the filter papers were then transferred to the various extracts at a concentration of 250µg/ml. The filter papers were left in the extracts for about 30 minutes so as to soak very well. The filter papers were then transferred to a cultured agar plates, the plates were then incubated at 37ºC for 24 hours in the incubator. Standard ampiclox at a concentration of 250µg/ml as positive control and negative control with acetone were also use

Insecticidal activity

Sources of Insects

The insects used for the experiment were collected with some modifications according to Irfan et al., 2020; Ayalew, 2020; Mweshi *et al.,* 2022. The *Acanthscelides obtectus w*as obtained from infested beans in Biu grain market. The heavily infested beans were brought to the laboratory in a sack and kept in a dark place for four week for the insects to multiply. The *Camponotus consobrinus* (sugar ant) were also collected directly from their hole behind investment quarters Tunfure Gombe, Gombe State. The sugar ant were kept in a plastic bottle and fed with sugar and honey sucked on a cotton wool for three days before the experiment.

Mortality test

The mortality test was carried out as described by Mweshi et al., 2022; Ileke and Olabimi, 2019; Men et al., 2022; Adeniyi, 2010 with some modifications. Petri dishes was used for the mortality test. In each of the Petri dish, five (5) grams of bean powder and five (5) grams of cotton wool were placed in the petri dishes test for adult mortality of *Acanthscelides obtectus*. Five (5) grams of sugar with five (5) grams of cotton wool in petri dishes were also used for mortality test of *Camponotus consobrinus*. The extracts at concentrations of 10, 100, 250 and 500µg were put into the petri dishes far away from the cotton wool and ten of the test insects were introduced into each of the petri dish and allowed to stay for 24 hours in a dark place. A control test was carried out with standards insecticide (permethrin 0.60%) generally referred to as Rambo insect powder (Gongoni Co. Ltd), Kano Nigeria as a positive test. Ten (10) µg of bean powder for *Acanthscelides obtectus* and 10 µg of sugar for *Camponotus consobrinus* as negative control respectively.

The mortality was recorded after 24 hours and the numbers of death insects were counted in each of Petri dish and the percentage of mortality was calculated using the formula.

Percentage of mortality (%M) $=\frac{Number\ of\ dead\ insects}{initial\ no.of\ insects} X\ 100$

The LC50 was determined by probit analysis from the percentage mortality.

RESULTS

Table 1: Phytochemical Screening of the Stem Bark extracts of *Boswellia dalzielii* Hutch

S.N	TEST	Extracts Petroleum ether	Ethyl ether	Acetone	Ethanol	Water
1	Carbohydrate					
	Mollish's test	-	-	+	+++	+++
	Barfoed test	-	-	++	+++	+++
2	Tannins					
	Bromine water	-	-	++	+++	+
	Ferric chloride test	-	-	+	+	-
	formaldehyde test	-	-	+	+	-
3	Phlobatanin					
	HCl test	-	-	-	+	-
	Lime water tset	-	-	+	+	-
4	Flavonoid					
	Lead acetate test	-	-	+	++	+++
	Sodium hydroxide	-	-	-	-	-
	Pew test	+	++	++	++	+
5	Cardiac glycoside	++	++	-	+++	+
6	Cyanogenic glycoside					
	sodium picrate paper test	-	-	-	+	-
7	Chlorogenic acid	-	-	-	-	-
8	Saponin-froth test	+	++	-	+	-
9	Haemolysis	-	+	-	-	-
10	Alkaloid General test					
	Dragendorff's	-	-	+++	+++	-
	Mayer's test	-	-	++	++	-
	wagner	-	-	-	++	-
	Quinoline alkaloid	-	-	+	+++	-
	Indole alkaloid	-	-	-	+	-
11	Anthraquinone					
	(Borntrager test free)	-	-	+	++	-
	Free or combined	-	+	-	-	-
12	Terpenes and steroids					
	Lieberman Burchard	-	++	+++	-	+
	Salkowski test	++	++	++	++	++

(+++): Significant quantity, (++): Moderate quantity, (+): Traces, (-): Negative test.

Table 2: Antibacterial activity of stem bark extracts from *Boswellia dalzielii* Hutch at 250µg/ml showing zone of inhibition

Bacterial strain	Extracts zone of inhibition in millimeters (mm) Petroleum ether	Ethyl ether	Acetone	Ethanol	Water	Ampiclox	Acetone solvent
E. coli	0	18	20	23	0	24	0
Klebsiella spp	0	18	20	28	22	30	0
K. pneumonia	0	0	0	14	20	16	0
S. aureus	0	0	0	24	26	28	0
P. aeruginosa	0	15	0	20	16	17	0
Salmonella typii	0	4	0	8	2	15	0
Shigella dysentriae	0	0	2	0	0	26	0
Bacillus subtilis	0	3	2	10	2	23	0
Nissera gonorrieae	0	0	3	5	3	8	0

Key: E.coli=Escherichiacoli, P.aeruginosa = Pseudomonas aeruginosa, K.pneumonia = Klebsiella pneumonia, Klebsiella spp = Klebsiella specie, S. aureus = Staphylococcus aureus

Table 3: Insecticidal activity of stem bark extracts of *Boswellia dalzielii* Hutch at different Concentrations against *Camponotus consobrinus (*Sugar ants)

Extracts	Conc. (µg)	Number of mortality after 24 hours						Mean mortality 24 hrs	% mortality after 24 hrs	LC_{50}(µg)
		1st		2nd		3rd				
		0	24	0	24	0	24			
Petroleum ether	10	10	1	10	1	10	0	0.7	7.0	$1.04x10^{7}$
	100	10	2	10	3	10	2	2.3	23	
	250	10	2	10	2	10	2	2.0	20	
	500	10	0	10	2	10	1	1.0	10	
Ethyl acetate	10	10	0	10	1	10	0	0.3	3	$3.28x10^{7}$
	100	10	1	10	0	10	1	0.3	3	
	250	10	0	10	0	10	1	0.3	3	
	500	10	1	10	2	10	1	1.3	13	
Acetone	10	10	3	10	2	10	2	2.3	23	$1.64x10^{2}$
	100	10	4	10	4	10	3	3.7	37	
	250	10	4	10	5	10	5	4.7	47	
	500	10	7	10	7	10	8	7.3	73	
Ethanol	10	10	1	10	0	10	0	0.3	3	$1.69x10^{3}$
	100	10	3	10	2	10	2	2.3	23	
	250	10	1	10	3	10	2	2.0	20	
	500	10	4	10	3	10	3	3.3	33	
Water	10	10	1	10	0	10	0	0.3	3	$7.59x10^{12}$
	100	10	1	10	0	10	0	0.3	3	
	250	10	1	10	0	10	0	0.3	3	
	500	10	1	10	0	10	1	0.7	7	
Permethrin (0.60%)	10	10	8	10	9	10	10	9.0	90	$1.77x10^{-2}$
	100	10	8	10	7	10	9	8.0	80	
	250	10	10	10	10	10	9	9.7	97	
	500	10	10	10	9	10	10	9.7	97	
Sugar	10	10	0	10	0	10	0	0	0	

Table 4: Insecticidal activity of stem bark extracts of *Boswellia dalzielii* Hutch at different concentrations against *Acanthscelides obtectus* (Beans weevil)

Extracts	Conc. (µg)	Number of mortality after 24 hours						Mean mortality 24 hrs	% mortality after 24 hrs	LC $_{50}$(µg)
		1st		2nd		3rd				
		0	24	0	24	0	24			
Petroleum ether	10	10	0	10	1	10	0	0.3	3	$1.97x10^{7}$
	100	10	2	10	0	10	0	0.7	7	
	250	10	0	10	0	10	1	0.3	3	
	500	10	1	10	1	10	2	1.3	13	
Ethyl acetate	10	10	2	10	1	10	0	1.0	10	$1.50x10^{7}$
	100	10	1	10	1	10	1	1.0	10	
	250	10	0	10	2	10	1	1.0	10	
	500	10	2	10	2	10	3	2.3	23	
Acetone	10	10	2	10	3	10	3	2.7	27	$9.58x10^{2}$
	100	10	1	10	2	10	3	2.0	20	
	250	10	4	10	8	10	4	5.3	53	
	500	10	6	10	3	10	5	4.7	47	
Ethanol	10	10	0	10	2	10	3	1.7	17	$5.69x10^{22}$
	100	10	2	10	1	10	2	1.7	17	
	250	10	1	10	1	10	2	1.3	13	
	500	10	3	10	3	10	1	2.3	23	
Water	10	10	0	10	0	10	1	0.3	3	$4.55x10^{12}$
	100	10	2	10	0	10	0	0.7	7	
	250	10	0	10	0	10	1	0.3	3	
	500	10	0	10	0	10	2	0.7	7	
Permethrin (0.60%)	10	10	10	10	9	10	9	9.3	93	$2.7x10^{2}$
	100	10	10	10	9	10	9	9.3	93	
	250	10	10	10	9	10	10	9.7	97	
	500	10	9	10	10	10	10	9.7	97	
Beans powder	10	10	0	10	0	10	0	0	0	

RESULTS AND DISCUSSION

In studies previously conducted on plant extracts, it has, shown that the phytochemicals present in solvent extracts was known to have wide range of biological activates including antibacterial, antifungal, antiviral, antioxidant, cytotoxic, and insecticides properties (Ahmed et al.,2022; Ricardo *et al.,* 2022; Ashish *et al.,* 2022; Adeniyi *et al.,* 2021; Mshelia *et al.,* 2008). This study was carried out in the same line in order to find out the phytochemicals present in the extracts obtained with different solvents and their biological activities such as antibacterial and insecticidal properties.

The percentage recovery of the extracts showed that water had the highest (13.20%), followed by ethanol (10.15%), acetone (7.41%), ethyl acetate (7.25%) and petroleum ether (9.03%). The result for the percentage recovery as obtained may be due to the polarity of the phytochemicals present in the stem bark of the *Boswellia dalzielii.*

Water extract contains significant amount of carbohydrate while acetone extract contains moderate quantity of the carbohydrate. The presence of the carbohydrate in the ethanol and water extracts shows that carbohydrates are soluble in the polar solvents. The presence of significant amount of tannins in the ethanol extract and moderately in the acetone extract also showed that the tannins present in the plant is moderately polar. Traces of phlobotannins were only detected in the ethanol and acetone extracts which may the same reason as above as in the case of tannin because of its solubility in polar solvent. According to Table 1 the flavonoid was detected with significant quantity in the water extract whereas ethanol, acetone and ethyl acetate showed moderate quantities with at least one of the methods used with only traces detected in petroleum ether.The cardiac glycoside was detected in significant amount in the ethanol extract, petroleum ether and ethyl acetate which showed moderate amount while water showed only traces whereas acetone extract showed total absence.

The cyanogenic glycosides were absent in all the extracts with exception of the ethanol extract with only traces. Chlorogenic acid was absent in all the extracts. Saponin was detected in traces in the ethanol and petroleum ether while significant amount was detected in the ethyl acetate extract and the remaining extract showed total absence. Alkaloid was detected in both ethanol and acetone extracts in significant quantities. The presence may be due to the polar nature of alkaloids. The anthraquinone was detected in moderate quantities in the ethanol extract and traces in ethyl acetate and acetone extracts while petroleum ether and water extracts showed total absence. Terpenes and steroids were observed in significant quantity in the acetone extract, while all the remaining extracts showed moderate quantities. Mapfumari et al., (2022) reported that phytochemicals observed in plant extracts are capable of mitigating against chronic health conditions such as cancer, stroke and stress-related and infectious diseases. Ajuru et al., (2017) also reported that plants are usually used in ethno medicine due to the presence of the phytochemicals.

Table 2 shows the result for the antibacterial activities of the different plant extracts. Ethanol extract was the most active extract because it was active against the eight test organisms. Antimicrobial activity exhibited by the plant extracts could be ascribed to the presence of phytochemicals such as alkaloids, organic acids, flavonoids, phenols and tannins (Juliana *et al.,* 2022; Mshelia *et al.,* 2008; Akiyama *et al.,* 2001) likewise the extraction methods also affect the types of phytochemicals to be extracted as well as their antimicrobial activity (Nortjie *et al.,* 2022; Mshelia *et al.,* 2008; Funatogawa et al., 2094). The water extract is the second most active extract inhibiting seven of the test organisms. The activities of the ethanol and the water extracts may be due to the presence of the flavonoids (Yamamoto and Gaynor, 2009; Cushnie and lamb, 2005; Mikhlin *et al.,* 1983) which was present in significant and moderate quantities. The activities of the acetone and the ethyl acetate that inhibited five of the test organisms each may also be due to the presence of the flavonoids which was also present in moderate amount in both the extracts (Zaria et al, 1995). Adeniyi et al., 2021; Khalid et al., 2018 reported that phytochemicals possesses antimicrobial and antioxidant properties. The presence of alkaloids and anthraquinones in the ethanol extract can also be a contributory factor for its high activity on the test organisms. The inactivity of the petroleum ether extract on the test organisms may be due to the absence of phytochemical compounds in the extract.

The results of this study was similar to those reported by Mapfumari *et al.,* (2022) who reported that extracts of *Viscum continuum* had antimicrobial activity and also that of Shafodino *et al.,* (2022) reported that *Nigella sativa* seed extracts had varying antimicrobial activities. Antimicrobial activity of *Ocimum sactum* methanol leaf extract inhibited the growth of *staphylococcus aureus* and *Pseudomonas aeroginosa* (Ashish *et al.,* 2022). Bioactive compounds responsible for pharmacological activity were reported to be tannins, flavonoid, phenols, alkaloid, steroid and triterpenoid (Dheba *et al.,* 2022). Phytochemicals with antimicrobial and antioxidant properties have tremendous potential in suppressing both plant and human diseases (Mansoori *et al.,* 2020).

According to Oloya *et al.,* (2022) who investigated the phytochemicals, ant mycobacterial activity and acute toxicity of some crude extracts of selected medicinal plant species used locally in treatment of tuberculosis in Uganda, showed that most of the plants were potent on the M. tuberculosis. Generally alkaloids, tannins, saponins, flavonoids, steroids, terpenoids, resins, cardiac glycosides, phenolic compounds and coumarin possesses this antimicrobial activity (Oloya et al., 2022; Mapfumari et al., 2022; Ajuru et al., 2017). The results also revealed that *Boswellia dalzielii stem bark does not contain* any volatile or non polar compound that are active but most of the active constituents may be polar or semi-polar in nature.

The harmful effects caused by the use of toxic substances in agriculture have led to the development of alternative solutions and researches have focused on understanding the effectiveness and potentials of plants in agriculture (Ricardo *et al.,* 2022). Botanical insecticide is considered a potential method to manage diverse insect pest (Irfan *et al.,* 2022; Paternina *et al.,* 2022). The application of synthetic insecticides triggered pest resistance; environmental degradation and health concerned (Ayalew, 2020). The researchers look at an alternative to synthetic insecticide which is more environmental friendly, such as botanical sources.

The result for the insecticidal activities of the different extracts of *Boswellia dalzielii* against *Camponotus consobrinus* (sugar ants) is shown in Table 3, while those against *Acanthscelides obtectus* (Beans weevil) was shown in Table 4. Acetone extract had highest insecticidal activity against *Camponotus consobrinus* with a percentage mortality of 75% at a concentration of 500µg and LC_{50} of 1.64×10^2 µg when compared with the other extracts. This followed by methanol extract with the percentage mortality of 33% at a concentration of 500µg and LC_{50} of 1.69×10^3 µg. The water extract had the least insecticidal effect with LC_{50} value of 7.59×10^{12}µg, followed by the petroleum ether extract with LC_{50} value of 1.04×10^7µg. The permethine standard insecticide used recorded the LC_{50} value of 0.0177µg this shows that is very active compared to all the test extracts used. There was no mortality when sugar was used as a control test (table 3).

The insecticidal activity of different extracts of *Boswellia dalzielii at various* concentrations against *Acanthscelides obtectus* reveals that the acetone extract had the highest efficacy against the insect *Acanthscelides obtectus* with the percentage mortality of 53% at a concentration of 250µg and LC_{50} of 9.58 x 10^2 µg, this is followed by the petroleum ether with the percentage mortality of 13% at 500 µg and LC_{50} value of 1.97 x 10^7 µg, then followed by the ethyl ether extract with the LC_{50} value of 1.50 x 10^7µg. The standard insecticide permethin showed the percentage mortality of 97% at the concentration of 250µg and LC_{50} value of 2.7 x10^2µg. The ethanol extract was the least efficay with the LC_{50} value of 5.69 x 10^{22} µg, followed by the water extract with the LC_{50} value of 4.55 x 10^{12}µg concentrations. Similar results were observed in previous studies conducted using different plant extracts. For example Deolall *et al.,* (2022) demonstrated that extracts from three different plants showed insecticidal and repellent activity on *Oebalus poecilus*. In a work conducted by Irfan *et al.,* (2022), showed the effect of methanol extract of *Parthenium hysterophoras* and *Moringa oleifera* leaf extracts on Spodoptera litura insect and the methanol extract was greater than the ethanol and acetone extracts. The extracts of medicinal plant species Solanum genus showed very good insecticidal activities on some species of insects which he attributed due to some of it active phytoconstituents (Chidambaram *et al.,* 20 22).

There was no documented work cited on the insecticidal activities of *Boswellia dalzielii extracts,* except for other plants. For instance It have been reported that the average mortalities rates of extracts after 72 hours for Momordica charantia (98.62%), Cordia curassavica (90.25%) and Calotropis gigantea (100%) (Deolall *et al,* 2022; Rasib *et al.*, 2022) which was greater than our result. Irfan *et al*., (2022) also reported the methanol extract of P. hysterophorus at 50 mg concentration had 12.3% mortality rate on S. litura larvae which was lower than our findings with *Boswellia dalzielii* at higher concentration. Ayalew, (2020), reported that Lantana camara leaf powder and extract from methanol had percentage mortality of (74%) and the lowest mortality rate was observed in ethyl acetate extract (26%) which agrees with our result which showed that the ethanol extract was more active than the ethyl acetate extracts.

yalew, 2020 observed that the repellency and mortality activities of plants may be due to the presence of bioactive and phytochemical molecules such as phytol, pyrroline, paromomycin, pyrrolicin and 1-Eicosono. Gonzalez *et al*., (2022) showed that the presence of ryanoids from some plant species were responsible for their insecticidal activities. The hexane and acetone leaf extracts of *Calotropis procera* showed a good activity against termites at a very low concentration (Khalid, 2022). The aqueous leaf extracts of some plants have shown some potentials in controlling the spread of armyworm, *Spodoptera frugiperda* (Mweshi *et al.*, 2022). The extracts of *Chromolaena odorata* and Vernonia amygdalina were toxic to malaria vector with *V.amygdalina* being more potent (Ileke and Olabimi, 2019). Alsaedi and Aljeddani, (2022) showed that medicinal plants contain phytochemicals that have antimicrobial and insecticidal activities. The insecticidal activities of plant extracts act through various effects on the target insects, including repellency, growth inhibitions and structural and physiological changes (Men *et al.*, 2022).

CONCLUSION

The present phytochemical analysis showed that the stem bark of *Boswellia dalzielii* contains phytochemicals which may responsible for the antibacterial and insecticidal potency as observed in this study.

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