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Full Length Research Article

ANTI-INFLAMMATORY, ANALGESIC AND ANTI-PYRETIC EFFECTS OF ETHANOLIC AND AQUEOUS STEM BARK EXTRACTS OF *BOSWELLIA DALZIELII* H.

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ABSTRACT
This study evaluated the anti-inflammatory, analgesic and anti-pyretic activities of *Boswellia dalzielii* stem bark extracts, focusing on their potential as a natural alternative to conventional pain and inflammation treatments. The study involved the analgesic, antipyretic and anti-inflammatory impacts in albino rats. Antipyretic activity was assessed in pyrexia-induced rats, analgesic effects were evaluated using the hot plate test, and anti-inflammatory activity was measured through the rat paw edema model. The antipyretic assay revealed that, 300 mg/kg dose significantly reduced rectal temperature in pyrexia-induced rats, better than paracetamol. The analgesic activity of the extract was found to be dose-dependent, with 300 mg/kg showing significant and sustained analgesic effects compared to tramadol. The anti-inflammatory assessment revealed that the 300 mg/kg extract markedly inhibited edema formation, with effects to diclofenac. The results of this study showed that *Boswellia dalzielii* ethanol stem bark extract exhibited potent antipyretic, analgesic, and anti-inflammatory activities, with effects comparable to conventional medicine. Hence, suggests that it could serve as potent therapeutic agent for managing inflammation, pain and fever.

Keywords: *Boswellia dalzielii*, anti-inflammatory, analgesic and anti-pyretic activities.

INTRODUCTION

The response of the body to harmful stimuli like pathogens, damaged cells, or irritants is generally referred to as inflammation and it natural and crucial biological process. Inflammation is a complex process which occurs in order to eliminate the cause of cell injury, evacuate worn-out cells and tissues, and initiate tissue repair. Its process involves the immune system, blood vessels, and various signaling molecules (Khalua *et al*., 2019; Sherif *et al*., 2024). Non-steroidal anti-inflammatory medications (Gupta *et al.,* 2021) are medicinal pharmacological class that relieves pain, reduces inflammation, lowers fever, and prevents blood clots. But they have side effects that vary by medicine, dose, and length of usage, but most commonly include an increased risk of gastrointestinal ulcers and bleeding, heart attack, and kidney disease (Navarro *et al*., 2016). Due to these conditions, there has been continuous search for natural products especially medicinal plants for effective therapeutic drugs with possibly fewer side effects. Thus, exploring the efficacy of medicinal plants utilized in the management of pain, inflammation and fever is imperative and may unveil opportunities to ascertain non-toxic, more potent, efficacious, and safe drugs (Olorukooba *et al*., 2020).
Boswellia dalzielii Hutch. is a very promising frankincense species in Africa, however it has been inadequately researched. Frankincense is an aromatic oleogum-resin (hereinafter "resin") produced by members of the genus Boswellia Roxb. It belongs to the family Burseraceae. Boswellia consists of 24 tree species that thrive in dry to humid subtropical habitats throughout West Africa, East Africa, southern Arabia, and the Indian subcontinent (Thulin, 2020). Boswellia species are medium-sized blooming plants that grow as trees and shrubs in tropical parts of Africa and Asia. *Boswellia dalzielii* is over 13 meters tall and has fragrant white flowers. This tree has traditionally been used in African folk medicine to treat diarrhea, ulcers, hypertension, malaria, toothaches, abscesses, asthma, yellow fever, mental problems, vomiting, inflammation, diabetes, and arthritis (Owolabi *et al.,* 2020). This gum resin, also known as olibanum (Wang *et al.,* 2019), has been used in traditional Chinese medicine (TCM) to treat symptoms related with severe injuries, chest congestion, discomfort, and inflammatory disorders such as rheumatoid arthritis (Mohammed *et al.,* 2023). Previous studies explored the phytochemical and pharmacological properties of olibanum, which revealed its varied biological actions, such as anti-inflammatory effects, cytotoxic characteristics, neuroprotective qualities, suppression of alpha-glucosidase, and antioxidant activities (Parsonidis *et al.,* 2021).
However, further work is required to evaluate the anti-inflammatory, analgesic and antipyretic abilities of *Boswellia dalzielii* stem bark ethanol extracts. Hence, this present study seeks to validate and explore its traditional uses as an anti-inflammatory, analgesic, and antipyretic agent.

MATERIALS AND METHODS

Plant Collection

The plant specimen which is the fresh stem bark of *Boswellia dalzielii* was collected from Jigawa State, Nigeria in the Month of January, 2024. The plant stem was identified and authenticated in the herbarium section of the Department of Pharmacy, Faculty of Pharmaceutical Science, Kaduna State University, Kaduna. by a plant botanist Mallam Usman H.A. Specimen number was obtained (No. 00849) and the specimen was deposited at the herbarium with voucher number (KASU/PCG/HERB/291) for future reference. The stem bark was chopped into smaller pieces, air dried at room temperature (25°C) in pharmaceutical laboratory for four weeks and ground to coarse powder. The dried plants were ground to powder using a mechanical grinder.

Preparation of Plant Extract

The dried powder was weighed (200g) into two portions separately

and then dissolved into 1.5 liters of distilled water and ethanol respectively for 48 hours with intermitted shaking. Each solvent extract was filtered and concentrated at 40°C by means of a rotary evaporator. The evaporated extract was transferred into a water bath at 40°C and evaporated to dryness for 48 hours. The concentrated extract was transferred into a sample bottle of known weight and labeled properly (Oikeh *et al*., 2020). The weight of the ethanol was 24.5g giving a yield of 12.25% and for the aqueous it was 24.9g giving a yield of 12.45%

Experimental Animals

Adult male and female wistar mice (17-24 g) and Wistar rats (150-200 g) were obtained from the Animal House of the Department of Pharmacology, Faculty of Pharmacy, Kaduna State University, Kaduna. They were acclimatized for 14 days before use for the study. The animals were housed in well-ventilated woody cages in a normal laboratory state (12 hours light/dark cycle: 23±2°C) and fed with standard diet and water. The experimental protocols were approved by the University Animal Ethics Committee. The animals were handled in accordance with the criteria outlined in the Guide for the Care and Use of Laboratory Animal by the National Institutes of Health (Publications 80-23, revised 1996).

Experimental Design

The animals were transferred into the laboratory 24 hours before the commencement of the experiments, and they were randomly grouped into five (n=5). This was done based on the design protocol of the study which included; the groups for antipyretic study rectal temperature were taken in order to accustom handling of the environment, the groups for analgesic study hot plate method were applied and the groups for anti-inflammatory study carrageenen-paw induced edema was applied.

Anti-inflammatory activity

Carrageen induced paw edema method

The method of Tabassum *et al.* (2023) was adopted for the anti-inflammatory activity on albino rat of both sexes (150-200g). Animals were randomly divided into five groups each of six animals. Group I was treated with normal saline (10mg/kg), Group II with diclofenac sodium (10mg/kg), Group III, IV and V were treated with 100, 200 and 300mg/kg ethanol extract respectively. After 30 minutes of the above intraperitoneal administration, carrageenan (1%, 0.05ml) was injected subcutaneously into the sub plantar tissue of the right hind paw of each mouse. The inflammation was measured using plethysmometer immediately after injection of carrageenan and then at an interval of 1, 2, 3, 4 and 5 hours. The average foot swelling in drug treated animals as well as the standard diclofenac sodium was compared with that of control and the percent inhibition (anti-inflammatory activity) of edema was determined using the formula below;

Percent inhibition = A – B / A × 100, where A represent edema volume of control and B as paw edema of tested group.

Analgesic activity

Hot Plate Test

Albino mice of both sexes (n=6) weighing (18 – 24g) were acclimatized to laboratory conditions one hour before the start of experiment with food and water available. Animals were subjected to pre-testing on hot plate (Havard apparatus) maintained at 55 ± 0.1°C. Animals having latency time greater than 15 seconds on hot plate during pre-testing were rejected (latency time) (Tabassum *et al.,* 2023). All animals were divided into five groups each of six mice. Group I was treated with normal saline (10ml/kg). Group II was treated with Tramadol^{R} (30mg/kg), Group III, IV and V were treated with 100, 200 and 300mg/kg ethanol extract respectively. After 30mins of the treatment animals were placed on hot plate and the latency time (time for which mouse remains on the hot plate (55 ± 0.1°C) without licking or flicking of hind limb or jumping) was measured in seconds. In order to prevent the tissue damage, a cut-off time of 30 seconds were imposed for all animals. To find out the opioid-mediated mechanism in the analgesic activity of the ethanol extract. The latency time for all groups was recorded at 0, 30, 60, 90 and 120 mins. The percent of analgesia was calculated using the following formula:

% Analgesia = (Test latency – control latency) / (cut-off time – control latency) × 100.

Antipyretic Assay

The antipyretic activity was evaluated for *Boswellia dalzielii* stem bark extract using wistar mice (20-30g) of both sexes following the method of Dutta *et al*. (2020) with slight modification. The selected animals were healthy and were acclimatized to laboratory conditions before the start of experiment. The animals were divided into five groups each with six mice. The normal body temperature of each animal was recorded using digital thermometer and then pyrexia was induced in all mice by injecting 20% aqueous suspension of brewer's yeast (10ml/kg). All groups were fasted overnight but allowed accesses to drinking water after 24 hours rectal temperature of each mouse was recorded. The induction of pyrexia was confirmed by rise in temperature more than 0.5°C. Animals that showed rise in temperature less than 0.5°C were excluded from experiment (Kang *et al.,* 2008). Group I received normal saline (10ml/kg) as a negative control, Group II received paracetamol (150mg/kg) as a standard drug while the remaining groups III, IV and V received 100, 200 and 300mg/kg of the ethanol extract respectively. After drugs administration, rectal temperature was taken and recorded periodically at 1, 2, 3, 4 and 5 hours of drugs administration. The percent reduction in pyrexia was calculated by the following formula.

Percent reduction = B - C_n/B – A ×100

Where B represents temperature after pyrexia induction, C_n temperature after 1, 2, 3, 4 and 5 hours and A, normal body temperature.

Statistical Analysis

Data were expressed as Mean±SEM. Statistical evaluation of the data was done by one-way Analysis of Variance (ANOVA) (between-control and drug treatment) followed by Dunneff's test for multiple comparison and two-way ANOVA followed by Bonterroni's multiple comparison test with the level of significance chosen at $p<0.05$. The statistical product used was 1BM SPSS software version 23.

RESULTS

Anti-inflammatory Effects of ethanol stem bark extract of *Boswellia dalzielii*

The ethanol stem bark extract of *Boswellia dalzielii* exhibited significant anti-inflammatory activity in a dose-dependent manner in the fresh egg albumin-induced rat paw edema model (Table 1). The extract, at doses of 100 mg/kg, 200 mg/kg, and 300 mg/kg,

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demonstrated varying degrees of efficacy across the 5-hour observation period. Notably, the 300 mg/kg dose produced the most substantial inhibition of edema, with significant reductions in paw swelling observed from the 3rd hour onwards, culminating in a marked inhibition of edema at the 5th hour (3.5 ± 0.22) compared to the control ($p < 0.05$). The standard drug diclofenac also significantly inhibited edema formation, with its effects being evident as early as the 1st hour and continuing throughout the assessment period. Overall, the extract at 300mg/kg showed anti-inflammatory activity comparable to Diclofenac.

Table 1: Anti-inflammatory activity of *Boswellia dalzielii* stem bark extract with better phytochemical composition in albino rats

Experimental Group	Anti-inflammatory Activity (hour)						
	Baseline	0	1	2	3	4	5
Normal saline	4.5±0.09	5.0±0.30	5.2±0.28	5.1±0.27	5.4±0.23	5.5±0.23	5.7±0.20
Diclofenac	4.8±0.06	4.6±0.26	4.5±0.23	4.5±0.22	4.3±0.22*	4.0±0.20*	3.7±0.14*
Extract (100mg/kg)	4.8±0.03	4.9±0.21	4.8±0.19	4.6±0.18	4.8±0.20	4.4±0.18*	4.1±0.15*
Extract (200mg/kg)	4.7±0.10	4.7±0.42	5.0±0.33	4.8±0.25	4.4±0.20*	4.3±0.17*	4.0±0.16*
Extract (300mg/kg)	4.9±0.05	4.8±0.44	4.8±0.44	4.6±0.36	4.2±0.19*	4.1±0.12*	3.5±0.22*

Note: Result is presented as mean ± SEM of triplicate determination. * Indicate statistically significant difference ($p<0.05$) compared to control (normal saline) within a column.

Analgesic Activity

The analgesic activity of *Boswellia dalzielii* ethanol extract, as assessed by the hot plate test, is presented in Table 2. The extract demonstrated a dose-dependent effect, with the 100 mg/kg and 200 mg/kg doses producing a moderate, statistically insignificant ($p > 0.05$) increase in latency time within the first 90 minutes post-treatment. However, a significant increase in latency time was observed at the 120-minute mark for both doses, indicating delayed analgesic activity. In contrast, the 300 mg/kg dose and the standard drug, tramadol (50 mg/kg), resulted in a significant increase in latency time ($p < 0.05$) from 30 minutes to 120 minutes post-treatment.

Table 2: Analgesic activity of *Boswellia dalzielii* stem bark extract with better phytochemical composition in albino rats

Experimental Group	Analgesic Activity (minute)					
	Baseline	0	30	60	90	120
Normal saline	5.3±0.62	6.9±0.58	5.8±0.60	6.1±0.80	8.8±1.10	5.6±1.07
Tramadol (50mg/kg)	5.8±0.55	11.2±1.82	14.8±1.37*	16.5±0.72*	17.3±0.75*	17.1±0.94*
Extract (100mg/kg)	6.1±0.79	8.3±1.15	10.5±2.51	9.9±0.71	12.2±0.88	15.8±1.36*
Extract (200mg/kg)	5.7±0.72	9.1±1.20	10.6±2.37	10.5±2.07	11.5±1.03	17.1±0.50*
Extract (300mg/kg)	6.6±0.92	11.1±1.72	12.2±0.93*	13.9±1.74*	13.2±1.13*	17.0±0.98*

Note: Result is presented as mean ± SEM of triplicate determination. * Indicate statistically significant difference ($p<0.05$) compared to control (normal saline) within a column.

Antipyretic Activity

The antipyretic activity of *Boswellia dalzielii* ethanol extract in pyrexia-induced rats is shown in Table 3. Subcutaneous administration of a 15% w/v yeast suspension (10 ml/kg) significantly elevated the rectal temperature of the rats, confirming the induction of pyrexia. Treatment with *B. dalzielii* stem bark extract at doses of 100, 200, and 300 mg/kg led to a significant ($p < 0.05$) reduction in rectal temperature. The 100 mg/kg and 200 mg/kg doses showed effectiveness in lowering the rectal temperature 2 hours post-treatment, while the 300 mg/kg dose exhibited a faster response, significantly reducing the temperature as early as 1 hour post-treatment. The antipyretic effect of the 300 mg/kg extract was particularly notable, as it was more effective than the standard drug, paracetamol, throughout the observation period.

Table 3: Antipyretic activity of *Boswellia dalzielii* stem bark using ethanol extract rats.

Experimental Group	Antipyretic Activity (hour)						
	Baseline	Pyrexia temp.	1	2	3	4	5
Normal saline	37.6±0.19	38.8±0.11	38.7±0.19	38.5±0.24	38.6±0.28	38.9±0.39	38.5±0.24
Paracetamol	37.6±0.30	39.4±0.18	37.6±0.16*	37.5±0.21*	37.3±0.18*	37.0±0.14*	37.0±0.16*
Extract (100mg/kg)	37.2±0.34	39.2±0.25	38.3±0.10	37.6±0.04*	37.5±0.13*	37.2±1.13*	38.8±8.09
Extract (200mg/kg)	37.2±0.21	38.7±0.09	38.0±0.22	37.8±0.10*	37.1±0.13*	37.3±0.22*	37.0±0.20*
Extract (300mg/kg)	37.4±0.09	38.8±0.08	37.7±0.17*	37.4±0.11*	37.0±0.08*	37.0±0.12*	36.9±0.05*

Note: Result is presented as mean ± SEM of triplicate determination. * Indicate statistically significant difference ($p<0.05$) compared to control (normal saline) within a column.

DISCUSSION

The anti-inflammatory activity of the ethanol extract of *B. dalzielii* was prominent, particularly at the 300 mg/kg dose, which significantly inhibited paw edema in the egg albumin-induced inflammation model. This result is in agreement with previous research by (Idu *et al*., 2023) on *Boswellia* species, where anti-inflammatory effects had been attributed to the inhibition of key pro-inflammatory enzymes such as COX-2 and 5-LOX.

The analgesic activity exhibited by the ethanol extract of *B. dalzielii* was dose-dependent, with significant results observed particularly at the 300 mg/kg dose. This dose showed an analgesic effect comparable to that of the standard drug, tramadol. The delayed but

sustained analgesic response suggest that *B. dalzielii* might modulate pain perception through central mechanisms, possibly involving the modulation of endogenous opioid pathways, as suggested by other studies on related Boswellia species. These findings are consistent with the analgesic properties reported by (Abubakar *et al*., 2024; Hamadjida *et al*., 2024; Mbiantcha *et. al.,* 2018) in traditional medicine, where Boswellia extracts have been used to manage pain and inflammation. *Boswellia dalzielii possess* strong and sustained analgesic effects and it exhibits time- and dose-dependent analgesic properties, with the highest dose demonstrating comparable efficacy to tramadol.

Similarly, the antipyretic activity was observed in the ethanol extract-treated rats, where significant reductions in rectal temperature were noted, particularly at higher doses, showed the potential of *B. dalzielii* as an alternative to conventional antipyretics. This finding is consistent with the research, such as the works of (Idu *et. al.,* 2023) which had documented the antipyretic properties of Boswellia species, which were attributed to the inhibition of prostaglandin synthesis, a key mediator in the pathogenesis of fever. The fact that the highest dose of the extract (300 mg/kg) demonstrated superior efficacy compared to Paracetamol further highlights the potential, particularly for patients seeking natural remedies. This suggests that *Boswellia dalzielii* possesses potent antipyretic properties, particularly at higher doses, and may serve as a promising alternative to conventional antipyretics.

Conclusion

The study demonstrated that the ethanol extract of *Boswellia dalzielii* Hutch stem bark possesses and exhibits significant anti-inflammatory, analgesic, and antipyretic activities. Therefore, suggest that *B. dalzielii* could be a potent natural alternative to conventional therapeutic agents in managing inflammation, pain, and fever.

Conflict of interest

The authors declare that there is no conflict of interest that exist among them.

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