

Phytochemical, Antioxidant Screening, Antinociceptive, and Anti-inflammatory Activities of *Boswellia dalzielii* Hutch (*Burseraceae*) Root Ethanol Extract Using Animal Model

MacDonald Idu¹, Anthonia Omoregbee¹, Benjamin Ogunma Gabriel^{1,2,*}

¹Phytomedicine Unit, Department of Plant Biology and Biotechnology; ²Science Laboratory Technology, University of Benin, PMB 1154, Benin City, Edo State, Nigeria.

Corresponding author*

alexthemail076@gmail.com

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Abstract

This study investigated the biological activities and phytochemical screening of *Boswellia dalzielii* root ethanol extract. Standard procedures were used to evaluate the phytochemicals and antioxidant capacity, antipyretic activity in baker's yeast-induced pyrexia in mice, analgesic property (hotplate and acetic acid-induced in mice), acute anti-inflammation (carrageenan-induced in rats) and chronic arthritis (formalin-induced in rats) on *Boswellia dalzielii* root ethanol extract. The phytochemical results revealed the presence of phenol, ascorbic acid, flavonoids, alkaloids, cardiac glycoside, tannin, saponin. The extract had a significant reduction in the body temperature in graded doses and 100 mg/kg paracetamol at 60 minutes when compared with the control, but 400 mg/kg was more effective ($p < 0.01$). Morphine and plant extract showed a slight significant analgesic property at 0 and 30 minute compared to the control. The extract at 100 mg/kg elicited a significant increase at 60 and 90 minutes compared with the control, and it is comparable to 5 mg/kg morphine. The plant extract (100, 200, and 400 mg/kg) and aspirin (100mg/kg) shows significant analgesic properties compared to control ($p < 0.01$) but 200 mg/kg of extract revealed highest percentage inhibition. The extract produced no significant reduction on carrageenan induced inflammatory at all dose level compared to control ($p > 0.05$). The plant extract (100, 200, 400 mg/kg) and Indomethacin (1 mg/kg) reduced paw volume across the doses from day 4 compared to the control ($p < 0.01$). The *Boswellia dalzielii* root extract is a promising anti-inflammatory agent, it also possesses antipyretics, and analgesics effect validating the folklore claim.

Keywords: Phytochemicals, Ethanol; *Boswellia dalzielii*; pyrexia; anti-inflammatory; mice.

INTRODUCTION

Phytochemicals with medicinal properties are also known as secondary metabolism. It ranges from cell wall substances through photosynthesis pigments, terpenes and terpenoids, the alkaloids, plants phenolics to plant hormones, plant non-proteins, amino acids and cyanogenic glycosides (Harborne, 1973). Many phytochemicals have been shown to be bioactive, that is they exhibit pronounced biological activity in other living organisms (Harborne, 1973). Many of the bioactive phytochemicals have found usefulness as chemotherapeutic agents, pesticides, food additives, and other biological (Tripathi and Tripathi, 2003; Odesanmi *et al.*, 2009). Modern medicine recognizes herbal medicine as a form of alternative medicine, as the practice of herbal medicine is not strictly based on evidence gathered using the scientific method. Modern medicine, however, make use of many plant-derived compounds as the basis for evidence-tested pharmaceutical drugs, and phytotherapy works to apply modern standards of effectiveness testing to herbs and medicines that are derived from natural sources.

Boswellia dalzielii Hutch (*Burseraceae*) commonly known as the frankincense tree. The Bini called it Eban-aruokhoe, Fulani called it Januhi, while the Hausa called it Ararrabi, Basamu and Hanu. The stem bark secretes a fragrant white gum that is burnt to fumigate cloth and to drive out flies, mosquitoes, antiseptic, fever, rheumatism, gastrointestinal, antidotes for arrow poison, giddiness, palpation, cancers/fibrosis, inflammation, snake bite, arthritis, asthma, microbes, ulcer, syphilis and diarrhea (Nwinyi *et al.*, 2004; Moses *et al.*, 2005; Abubakar *et al.*, 2007; Bello *et al.*, 2013). Bello *et al.*, 2013 reported that the phytochemicals detected in ethanol and aqueous stem bark extracts include; flavonoids, terpenoids, alkaloids, tannins, saponins, quinones, and cardiac glycosides. This study investigated the phytochemical screening, antipyretic, analgesic, and anti-inflammatory activity of *Boswellia dalzielii* ethanol extract.

MATERIALS AND METHODS

Collection of Plant Material

The fresh root of *Boswellia dalzielii* was collected from Makaya forest, Kibiya Local Government Area, Kano State in the month of May, 2015. The plant root was identified and authenticated by Dr. Timothy Odaro in the herbarium unit of the Department of Plant Biology and Biotechnology, with the voucher number UGH-K257. The roots were chopped, air dried for four weeks and ground to course powder. The dried seeds were ground to powder using a mechanical grinder.

Preparation of Plant Extract

The dried powder was weighed (100 g) and then macerated in 2.5 liters of Ethanol for 72 hours. The solution of the root was decanted into another flask. The solution was filtered and concentrated at 40°C by means of a rotary evaporator. The evaporated extract was transferred into an oven at 40°C and evaporated to dryness for 24 hours. The concentrated extract was transferred into a sample bottle of known weight. The weight of the ethanol root extract was 111.5 g giving a yield of 15 %.

Phytochemical Screening

The preliminary qualitative and quantitative phytochemical test was screening and identification of bioactive chemical constituents in the ethanol root extract of *Boswellia dazielii* under study that was carried out in extract. Specimens using follows the standard procedures as described by Sofowora (1993) and Tiwari *et al.* (2011); Naredra Devanboyina *et al.* (2013).

Experimental Animal

Adult Swiss mice and Wistar rats of male and female sexes weighed between (20 – 30 g) and (180-220 g) were obtained from the Animal House, Department of Pharmacology, Faculty of pharmacy, University of Benin, Benin City. They were acclimatization for 14 days. They were housed in a well-ventilated woody cages in a normal laboratory state (12 hours light/dark cycle: 23 ± 2°C) and fed using a standard diet. Food and water were administered at free choice (*ad libitum*) to the animals designed for experiments. The animals were properly handled using the ethics of Laboratory animals' approval from the ethical committee of the Faculty of Life Sciences with the ethical number LS21592.

Experimental Design

The animals were transferred into the laboratory 24 hours before the commencement of the experiment and were randomly grouped into five (n=5). This was done based on the design protocol of the study includes: The groups for antipyretic study, rectal temperature were taken in order to accustom handling and the environment. The animals were exposed to natural lighting conditions and a room temperature of between

22-26°C and has free access to water and laboratory diet. The animals were carefully handled and the ethical committee of the Faculty of Life Sciences issued an ethical number LS20619.

Antipyretics Activity

The animals had their rectal temperature measured, using a SFDA lubricated probe digital thermometer (KFT-04). A stock solution of 30% (w/v) of Baker's yeast in 0.9% NaCl solution was prepared. The intended doses were 10ml/kg and the doses to be administered to individual mouse were calculated with respect to their weights. The different doses were administered intraperitoneally and the time of administration was noted. The different groups were observed for 6 – 7 hours (Bafor *et al.*, 2010). At the 7th hour, the rectal temperature was taken for the different groups and a calculated dose of 0.9% NaCl solution (control), extract and paracetamol (standard). The control group received 10 ml/kg of NaCl orally while the extract groups received 100, 200, 400 mg/kg orally and the standard group received 100 mg/kg of paracetamol intraperitoneally. The different groups were observed for change and sign and their rectal temperature were recorded for 2 hours at 30 minutes hour interval (Bafor *et al.*, 2010).

Analgesic Property

Hot Plate Method

The paws of mice are very sensitive to heat at temperature which is not damaging the skin. The responses are jumping, withdrawal of the paws and licking of the paws. The hot plate (Ugo Basile Hot/Cold Plate 35100) consist of electrically heated surface, the temperature is controlled to 55.5°C. The animals were placed on the hot plate for 30 minutes before the experiment in order to accustom the environment, after which each animal was placed on the hotplate and the time until either licking or jumping is recorded (Shanmugasundaram and Venkataraman, 2005). The control group received 10 ml/kg 0.9% NaCl orally, while extract groups received 100, 200, 400 mg/kg orally and the standard group received 5 mg/kg Morphine intraperitoneally. After 30 minute the animals were placed on the hot plate and the observation were recorded and the time interval of 60, 90 and 120 minutes for all groups. The result of the hot plate method was tabulated.

Acetic Acid Induced Writhing Method

The writhing model represents a chemical nociceptive test based on the induction of peritonitis like condition in animals by injecting irritant substances intraperitoneally. The control group received 10ml/kg 0.9% NaCl orally, while extract groups received 100, 200, 400 mg/kg and the standard control received 100 mg/kg of Aspirin orally and 30minute later all groups

received 10mg/ml of 1% acetic acid solution intraperitoneally (Vogel, 2002). The mice were placed individually into glass beakers and immediately were observed for a period of 20 minutes and the numbers of writhes were recorded in each animal. For scoring purpose, a writhe is indicated by stretching of the abdomen with simultaneous stretching of at least one hind limb

Percentage inhibition was calculated using the following formula:

$$\% \text{ inhibition} = \frac{\{(Wc - Wt) \times 100\}}{Wc}$$

Where,

Wc : No. of writhes in control group,

Wt : No. of writhes in test group.

Carrageenan-paw induced edema

In evaluating carrageenan- induce paw edema, 25 Wistar rats were randomly divided into 5 groups (n=5). The control group was treated with distilled water, 10 ml/kg, the test groups and graded doses (100, 200 and 400 mg/kg) of the treatment groups, while the standard group received indomethacin (10 mg/kg) orally. After one hour, 0.1 ml/kg of 1% carrageenan was injected into the subplantar tissue of the right hind paw (Vogel, 2002). Paw edema was measured using a Vernier caliper at 30, 60, 120, 180, and 240.

Formaldehyde induced arthritis

Arthritis was induced by injecting 0.1 ml of 1% of formaldehyde into the hind paw of albino rat using the model described by Fatima and Fatima (2016). Twenty-five (25) Wistar rats weighing 180-220 mg/kg were randomly divided into 5 groups (n=5). Group 1 received the vehicle (Distilled water) (1 ml/kg) without arthritis (normal control). Group 2 received the vehicle (Distilled water) with arthritis. Group 3 received the standard drug dexamethasone (2 mg/kg). Group 4, 5, 6 and 7 received the extract (100, 200, and 400 mg/kg). Before administration of the standard and test drug, the rat was induced arthritis by injecting 0.1 ml of formaldehyde into the hind paw of the animal. At the third day, formaldehyde was re-injected again into the hind paw followed by treatment with the test agent. The thickness of the paw was measured at days 2, 3, 4, 5, 6, 7, 8, 9 and 10.

Statistical Analysis

Data were expressed as the mean ± SEM. The data were analyzed using one-way analysis of variance (ANOVA) followed by Tukey's post hoc test. Statistical analysis was performed using Graph Pad Prism Version .6.01. p < 0.05 was considered significant

RESULTS AND DISCUSSION

The Qualitative and Quantitative Phytochemistry, antioxidant, identification and in vitro antioxidant property of *Boswellia dalzielii* root ethanol extract. Table 1 showed the presence of Alkaloid, Flavonoid and cardiac glycoside in abundantly while Carbohydrate, Saponin and Tannin were moderately present. The total antioxidant capacity was shown in Figure 1, which indicates that the total phenolic content was high compared to ascorbic acid that was very low. The phytochemicals screening of *Boswellia dalzielii* root ethanol extract revealed the presence of alkaloid, flavonoid, saponins, tannins, cardiac glycoside and carbohydrate. Alkaloids are naturally occurring chemical compounds with nitrogen atoms (Andreas Luch, 2009), and it is use as a starting points for drug discovery in traditional or modern medicine used for analgesic and anti-bacterial activities. The findings of Raymond *et al.* (2010); Cushnie *et al.* (2014), adhere to the analgesic and anti-inflammatory activities of this present study. Study of Raymond *et al.* (2010) showed the effect of flavonoids as a potent antioxidant, anti-inflammatory, vasculopropertor, anti-hepatotoxic, anti-allergic and antitumor properties (Singh and Gambhir, 1998). The presence of phenolic and ascorbic acid antioxidant contents of the extract may have contributed to the analgesic and anti-inflammatory properties.

Table 1. The qualitative and quantitative phytochemical screening of *Boswellia dalzielii* root methanol extract.

Phytochemicals Constituents	Observations	Concentration(mg/kg) Mean ± SEM
Alkaloid	+++	127 ± 0.01
Flavonoid	+++	77.84 ±0.00
Carbohydrate	++	–
Cardiac glycoside	+++	–
Saponin	++	124 ± 0.00
Tannin	++	145 ± 032

Key: +++ = Abundantly present, ++ = Moderately present

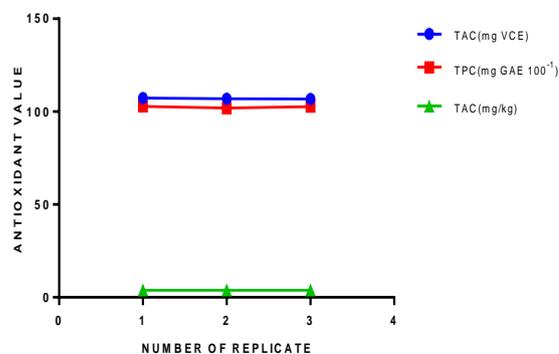


Figure 1. Total antioxidant capacity, phenolic content and ascorbic content of the ethanolic extract of *Boswellia dalzielii* root.

The extract produced significant reduction ($p < 0.05$) in body temperature at all dose level and standard (100 mg/kg paracetamol) when compared with control. The antipyretic activities of the extract was in dose dependent and also comparable to the standard. The results also show that the antipyretic effect of the extract increase with time, in Table 2. The root extract of *Boswellia dalzielii* displayed a significant decrease in baker's yeast-induced pyrexia with an increase in grade time, starting from 60 minutes and progresses a through the study when compared with the control, but at highest dose of 400 mg/kg, the extract showed more effect. Antipyretic effect of the extract was comparable to that of the standard drug (paracetamol), with an underlying mechanism of action unknown. Yeast is known to be an exogenic pyrogen responsible for an increased in the body temperature via the formation and synthesis of cytokines called as endogenic pyrogens, hence this endogenic pyrogen centrally promote thermosensitive neurons in the preoptic area of the hypothalamus,

increasing heat and decreasing heat loss. The body temperature increases to a set point that leads to fever (Kelly *et al.*, 2003). Certain phytochemicals including tannins, flavonoids, and cardiac glycosides of the root extract as a potent antipyretic action observed. Flavonoids have been reported in previous study carried out by Germain *et al.* (2011) to inhibit prostaglandins and arachidonic acid peroxidation, which surmount to the lowering of the prostaglandin thus causes a reduction in fever occurrence (Houghton and Raman, 1998; Germain *et al.*, 2011). The main mechanism of action through which acetaminophen act is by the inhibition of cyclooxygenase (COX), or highly selective COX-2 receptors (Hendrickson *et al.*, 2006). Paracetamol reduces the oxidized form of the COX enzyme, thereby reducing the release of prostaglandin E2 in the central nervous system to lower its binding from the hypothalamus set point of thermoregulatory center (Hendrickson *et al.*, 2006) which may be consider also as mechanism of action of the extract.

Table 2. The effect of *Boswellia dalzielii* root ethanol extract on baker's yeast-induced pyrexia in mice.

Groups	Dose mg/kg	Base line °C	6 hrs	7 hrs
Control (NaCl)	10 ml/kg	39.43±0.10 ^a	39.65±0.17 ^a	39.95±0.15 ^a
<i>Boswellia dalzielii</i>	100	39.90±0.18 ^a	37.15±0.16 ^b	37.05±0.17 ^b
<i>Boswellia dalzielii</i>	200	39.00±0.09 ^a	37.28±0.16 ^a	37.13±0.13 ^b
<i>Boswellia dalzielii</i>	400	39.88±0.79 ^a	37.30±0.15 ^b	37.18±0.18 ^b
Aspirin	100	39.08±0.14 ^a	37.22±0.14 ^b	37.20±0.19 ^b

The values were expressed in Mean ± SEM and the significant difference was spotted as p -value < 0.05

Boswellia dalzielii root ethanol extract exhibited a significant decrease in hot plate-induced analgesia when compared to the control. The analgesic effect of the extract was comparable to the Morphine standard analgesic, at the lowest concentration. The presence of certain phytochemicals like alkaloids displayed a major role in the analgesic action observed from the extract. This agreed with Sinatra *et al.* (2010) study on analgesic. The significant increase in pain threshold synthesized by hot plate model suggested the connection with the central pain pathways. Pain is centrally modulated via series of multifaceted processes on the opiate, dopaminergic descending noradrenergic and serotonergic systems (Headley and Shaughnessy, 1985; Wigdor and Wilcox, 1987; Yekkirala *et al.*, 2012). The analgesic potential of the treatment groups act with central mechanisms of action connecting the receptor and the inhibitory effect of prostaglandins, leukotrenes, and other endogenous neurotransmitters that triggered

pain. Morphine being a phenanthrene opioid receptor agonist elicited its main effect is an requisite and activation of μ -opioid receptors in the central nervous system. The μ - δ -opioid receptor heteromer (Yekkirala *et al.*, 2010). The μ -binding sites are discretely spread across human brain, with a high densities in the posterior amygdala, hypothalamus, thalamus, nucleus caudatus, putamen, and certain cortical areas. They are also present in the terminal axons of the primary afferents within the laminae I and II (substantia gelatinosa) of the spinal cord and in the spinal nucleus of the trigeminal nerve. Morphine exerts its main action on the central nervous system and gastrointestinal tract to excite possible analgesic action. It also serve as an κ -opioid and δ -opioid receptor agonist, associated with spinal analgesia, meiosis (pinpoint pupils) and psychotomimetic effects. δ -Opioid is thought to play a role in analgesia (Chien and Pasternak, 1995).

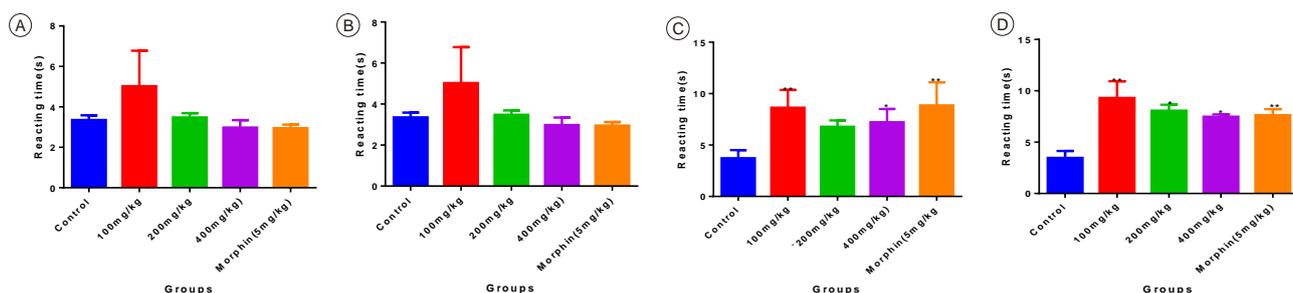


Figure 2. (A, B, C, and D) Effect of *Boswellia dalzielii* root ethanol extract on hotplate-induced pain. Plant extract at 100mg/kg, 400mg/kg and Morphine increase the reaction time to pain induced by hotplate at 0, 30, 60 and 90 minutes exposure compared to control (**p < 0.01, *p < 0.05).

The plant extract 100, 200, 400mg/kg and aspirin (100mg/kg) reduced the number of writhing compared to control (P<0.01), in Table 2. The root ethanol extract of *Boswellia dalzielii* exhibit a significant decrease in acetic acid induced analgesia when compared with the control. The analgesic effect of this present study was comparable to the standard analgesic, aspirin. Abdominal constriction reaction induced by acetic acid serves as a sensitive procedure for the evaluation of peripherally pain acting analgesics (Gene *et al.*, 1989). Acetic acid is a peripheral pain triggering factor capable of liberating the endogenous substances (histamine, prostaglandins (PGs), bradykinins and substance P, endings). The local peritoneal receptors are proposed to be complicated in the abdominal with a constrictive response (Bentley *et al.*, 1983). Prostanoids is a general stimulatory factor that increases the levels of PGE2 and PGF2 α in the peritoneal fluids as well as lipoxygenase

products (Derardt *et al.*, 1980). The analgesic effect instigated by the treatment via peripheral mechanisms could be involved in prostaglandins, leukotrenes, and other endogenous substances with inhibitory effect. The presence of certain phytochemicals (alkaloids) in the facilitated analgesic action observed from this study (Sinatra *et al.*, 2010). Aspirin as a pure compound suppresses the production of prostaglandins and thromboxanes to trigger irretrievable inactivation of the cyclooxygenase (COX; known as prostaglandin–endoperoxide synthase, PTGS) enzyme needed for prostaglandin and thromboxane production. It also acts via acetylating agent where acetyl group is covalently bond to serine residue in the active site of PTGS enzyme. This makes aspirin different from other NSAIDs, which are reversible inhibitors (Burke *et al.*, 2006).

Table 3. The effect of *Boswellia dalzielii* root ethanol extract on acetic acid-induced writhing in mice.

Group	Doses mg/kg	Numbers of Writhing	% inhibition
Control (NaCl)	10 ml/kg	91.75±10.48 ^a	-
<i>Boswellia dalzielii</i>	100	45.00±10.34 ^b	50.95
<i>Boswellia dalzielii</i>	200	34.00±7.22 ^b	62.94
<i>Boswellia dalzielii</i>	400	36.50±5.33 ^b	60.22
Aspirin	100	42.00±5.95 ^b	54.22

The values were expressed in Mean ± SEM and the significant difference was spotted as *p*-value < a 0.05.

The ethanol root extract of *Boswellia dalzielii* exhibit a significant decrease in carrageenan-induced inflammatory when compared with inflammatory control. The report of Cushnie *et al.* (2014) concurred to this present ant-inflammatory potential. Various components leads to inflammatory response stimulating edema formation, leukocyte infiltration and granuloma formation inked with the components of inflammation (Mitchell and Cotron, 2010). Edema formation in the paw is as a result of the synergistic action between inflammatory mediators that triggered an increase in the vascular permeability of blood flow (Lalenti *et al.*, 1995). The inhibitory effect of carrageenan-induced

inflammation in rats was an established model for the evaluation of anti-inflammatory ingredient, with the frequency to evaluate the anti-inflammatory potential on natural remedies. The development of carrageenan-induced edema is consist of two phase system such as first phase (within one hour of carrageenan inflammation) and is usually intermediate with the release of cytoplasmic enzymes serotonin, discharged from mast cells. The second phase is (mediated release of prostaglandins) in most inflammatory area and linger between the two phases provided by kinins (Goel *et al.*, 2001).

Table 4. The effect of *Boswellia dalzielii* root ethanol extract on Carrageenan induced inflammation in rats.

Treatment	Doses mg/kg	Paw volume (mm)				
		T _{30 min}	T _{60min}	T _{120min}	T _{180min}	T _{240min}
Control (NaCl)	10 ml/kg	1.28±0.51 ^a	1.46±0.55 ^a	1.62±0.59 ^a	1.08 ±0.29 ^a	0.74±0.25 ^a
<i>Boswellia dalzielii</i>	100	0.83±0.114 ^b	1.08 ±0.16 ^b	2.06±0.27 ^a	1.56±0.44 ^a	1.12±0.47 ^a
<i>Boswellia dalzielii</i>	200	0.69±0.62 ^b	0.63±0.35 ^b	0.72±0.37 ^b	0.77±0.39 ^b	0.49±0.37 ^b
<i>Boswellia dalzielii</i>	400	0.99±0.80 ^b	0.91±0.17 ^b	1.70±0.44 ^a	0.73±0.25 ^b	0.56±0.20 ^b
Indomethacin	10	0.79±0.34 ^b	0.78±0.35 ^b	0.18±0.17 ^b	0.32±0.21 ^b	0.09±0.05 ^b

The values were expressed in Mean ± SEM and the significant difference was spotted as *p*-value < a 0.05.

The effect of ethanolic extract of *Boswellia dalzielii* root on formalin-induced inflammation (arthritis) in rats (Table 4). The plant extract 100, 200, 400 mg/kg and Indomethacin (1mg/kg) reduced paw volume starting from day 4 and progresses through the study compared to control (*p* < 0.01). *Boswellia dalzielii* root ethanol extract exhibit a significant decrease in formalin-induced arthritis across the graded doses when compared

with the arthritic control. The anti-arthritic effect of the extract had a significant reduction when compared with Indomethacin. The possible underlying mechanism of the extract has not be established rather it triggered an inhibitory effect of edema induced by formalin in rats, which is a most suitable test procedures to screen for anti-arthritic and anti-inflammatory agents (Mitchell and Cotron, 2010).

Table 5. The effect of *Boswellia dalzielii* root ethanol extract on formalin-induced Arthritis in rats.

Treatment	Doses mg/kg	Day 2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day10
Control (NaCl)	10 ml/kg	3.18±0.49 ^a	1.54±0.38 ^a	2.69±0.04 ^a	2.36±0.64 ^a	2.45±0.20 ^a	2.40±0.26 ^a	2.54±0.10 ^a	3.28±0.20 ^a	3.79±0.38 ^a
<i>Boswellia dalzielii</i>	100	3.15±0.16 ^a	1.06±0.23 ^b	1.36±0.13 ^b	0.72±0.19 ^b	0.78±0.19 ^b	0.66±0.19 ^b	0.46±0.15 ^b	0.56±0.15 ^b	0.77±0.12 ^b
<i>Boswellia dalzielii</i>	200	2.10±0.294 ^b	0.79±0.10 ^b	0.99±0.12 ^b	0.79±0.09 ^b	0.37±0.10 ^b	0.51±0.16 ^b	0.38±0.12 ^b	0.56±0.15 ^b	0.32±0.16 ^b
<i>Boswellia dalzielii</i>	400	2.20±22.63 ^b	0.55±0.18 ^b	1.60±0.38 ^b	0.99±0.33 ^b	0.67±0.37 ^b	0.49±0.27 ^b	0.40±0.60 ^b	0.39±0.14 ^b	0.44±0.12 ^b
Indomethacin	1	2.18±0.22 ^b	0.80±0.61 ^b	0.80±0.30 ^b	0.90±0.20 ^b	1.10±1.00 ^b	0.11±0.90 ^b	1.13±0.10 ^b	1.12±1.15 ^b	0.64±.10 ^b

The results gotten from the formalin-induced tests is associated with cell and tissue damages instigated arthritic conditions. This is as a result of the changes in connective tissue metabolism, which is one of the major biochemical cascade events leading to inflammation. These changes occurred in the alteration of relative composition of the various constituents in the connective tissue incudes; mucopolysaccharides, glycoprotein, hexosamine and hydroxy proline, sialic acid (Houck and Jacob, 1969). Hence the concentration of hexosamine and hydroxyproline had a significant increase in formalin-induced rats. *Boswellia dalzielii* extract pretreatment elicited an inhibitory effect with the accumulation of hydroxyl proline and hexosamine in the edematous tissue of the formalin-induced rats. Indomethacin is a nonselective inhibitor of cyclooxygenase (COX) I and II, enzymes that triggered prostaglandin synthesis from arachidonic acid. Prostaglandins are hormone-like molecules present in the body, with wide variety of effects, some of which it excite pain, fever, and inflammation (Brayfield, 2014)

CONCLUSION

The result from this investigation shows that the ethanolic extract of *Boswellia dalzielii* root is a potent

antipyretic analgesic and anti-inflammatory agent, as further study should be done to improve on it.

Conflict of interest: The authors declare that there is no conflict of interest.

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