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Research Article

ANTIOXIDANT EFFECTS OF METHANOLIC STEM-BARK EXTRACT OF *PTEROCARPUS ERINACEUS* ON INDOMETHACIN-INDUCED ULCER IN ALBINO RATS

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ABSTRACT

Objective: The antioxidant effects of methanolic stem-bark extract of *Pterocarpus erinaceus* on indomethacin-induced ulcer in albino rats was studied. **Methods:** Phytochemicals in the bark extract were qualitatively and quantitatively determined. Antioxidant status of the extract was determined using DPPH, FRAP and TBARS assays. The activities of glutathione reductase, superoxide dismutase and catalase effects were also determined along with total protein concentration in the stomach tissue homogenate. Thirty five (35) adult male rats were randomly divided into seven groups (Group A-G) of five rats each. The in-vitro antioxidant status of the extract was also determined. Indomethacin was orally administered as a single dose of 30 mg/kg/b.w to induce ulcer in the rats. The rats were fasted for 24 hrs, on the last day of the experiment before the animals were sacrificed. Macroscopic examinations of the stomach, quantification of gastric juice, homogenization of stomach were also carried out. The stomach homogenate of treated rats was analyzed for total protein (TP), lipid peroxidation and the antioxidant enzymes glutathione reductase (GR), superoxide dismutase (SOD) and catalase (CAT) activities. **Results:** Indomethacin treatment caused significant increases ($p< 0.05$) in ulcer index. The administration of the methanolic stem-bark extract of *Pterocarpus erinaceus*, rats previously treated with indomethacin showed significant reduction in ulcer index, volumes of gastric juice, free and total acidity, pepsin activity and lipid peroxidation in the extract treated rats compared with the group treated with indomethacin. Treatments with P. erinaceus extract showed significant dose dependent elevation ($p< 0.05$) of pH of gastric juice, total protein, GR, SOD and CAT in the treated animals. **Conclusion:** These results demonstrate that the plant extract may have antioxidant potentials suggesting that *P. erinaceus* stem bark extract at doses used have the ability to reduce gastric acid secretion and healing of the ulcer.

Keywords: Antioxidant, Effect, Albino rats, Ulcer, Stem-bark Extracts, phytochemical and Indomethacin.

INTRODUCTION

Antioxidant effects remain central to biochemical events associated with slowing aging, tissue recovery following trauma and inflammation. Beneficial effects of increased antioxidant capacity in the body may be the reduction of oxidative damage to important biomolecules. Oxidants are highly reactive molecules which are present in biological systems and may oxidize nucleic acids, proteins and lipids. They may initiate disorders such as cancer, heart diseases, inflammation, dermal disorders and aging. The consumption of plants plays an important role as a health promotion factor [23]. This beneficial effect is mainly associated with the antioxidant activity of their metabolites especially phenolic and flavonoids components which are largely present in herbs [38].

Play this role through acting as reducing agents by donating hydrogen, quenching singlet oxygen, acting as chelators and trapping free radicals. The antioxidant activity of polyphenols is even considered to be much greater than some of the essential vitamins [35]. It has also been proved that many properties of polyphenols such as anti-inflammatory, anti-diabetes, anti-cancer and prevention of capillary fragility and permeation are due to their antioxidant effects [58]. The antioxidant activity of phenolics has introduced them as dosage forms in prevention and treatment of many disorders [24].

Flavonoids are a group of polyphenolic compounds which are widely distributed throughout the plant kingdom. They occur naturally in fruit and vegetables and are, therefore, an integral part of the human diet. Phenolic and flavonoids compounds are secondary metabolites of plants which possess various activities such as anti-inflammatory, analgesic, anti-diabetes and anticancer effects. It has been established that these compounds can scavenge free radicals produced in the body. Because of this ability, not only the plants containing phenolic and flavonoids compounds but also, the pure compounds are used in medicinal products for prevention and treatment of many disorders [9].

Nowadays, there is an increasing interest to antioxidants because they have proved to prevent several diseases such as neurodegenerative, tissues damage, tumors, inflammation, cardiovascular disorders and also aging [18] and [17]. Several formulations have been prepared from antioxidant materials for healthcare. Among different secondary metabolites of the plants, phenolics and flavonoids are the main compounds with considerable antioxidant activity [37] and [36].

MATERIALS AND METHOD

Plant Materials

The stem-bark specimens of *Pterocarpus erinaceus* were collected from Vunoklang Village, Girei Local Government Area of Adamawa State, Nigeria in the month of June that falls with the rainy season. The rainy season starts from May and ends in October. The plant was taxonomically identified and authenticated in the Department of Plant Science of Modibbo Adama University of Technology, Yola, Nigeria.

Stem bark Extraction

Stem-bark samples were cleaned before being sundried over a thirty day period. It was then reduce to powdered form by grinding in mortar and pestle [31]. One hundred and eighty grams (180g) of the powdered stem bark were cold macerated in 100ml of methanol solution for a minimum of 24 hours with constant shaking and filtered using Whatman's filter paper No. 1. The extract was then concentrated to dryness on a water bath at 40 ºC. The extract was further dried in vacuum oven. The dried methanol extract was dissolved in water to get clear solution, which was used for the analysis.

Animals

Thirty five (35) male albino rats weighing (100±20 g) were purchased from Animal House Unit, Department of Biochemistry, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria. The animals were housed in polypropylene cages and were given Broiler finisher feed and water ad libitum before any work was carried out using them. All the laboratory conditions were maintained

Experimental Design

Thirty five (35) male albino rats weighing (100±20g) used in the study were randomized into seven (7) groups of five (5) rats each. Ulcer was induced in the animals with a single dose of indomethacin (30 mg/kg/b.w) on the first day of the experiment. Ulcer induction method of [60] was adopted. The animals were group as follows:

Group A. animals received only broiler finisher feed with water. Group B animals were administered 900 mg/kg/b.w of methanolic extract. Group C were given cimetidine 100 mg/kg/b.w orally once daily as a reference drug. Animals in Group D were given indomethacin 30 mg/kg/b.w single doses as a negative control (ulcer control). Group E, F and G animals are ulcerated animals administered 300, 600 and 900 mg/kg/b.w of the extract. The experiment lasted for seven days (a week).

RESULTS

Table 1: DPPH Radical Scavenging Activity of Methanolic Stem-bark Extract of *Pterocarpus erinaceus* and Ascorbic Acid in Percentage (%)

Concentration	Methanolic Extract	IC_{50}	Ascorbic Acid	IC_{50}
20	26.36 ± 2.69		46.78 ± 0.49	
40	30.51 ± 0.78		60.42 ± 0.39	
60	41.10 ± 2.49	41.83	75.25 ± 0.17	44.3
80	50.00 ± 1.07		82.03 ± 0.20	
100	68.19 ± 0.44		91.08 ± 0.25	

Values are expressed as Mean ± SEM (n = 3)

Table 2: Ferric Reducing Antioxidant Power (FRAP Assay) of Methanolic Stem-bark Extracts of *Pterocarpus erinaceus* and Ascorbic Acid mg/ml

Concentration	Methanolic Extract	IC_{50}	Ascorbic Acid	IC_{50}
20	50.00 ± 0.18		67.50 ± 0.13	
40	62.50 ± 0.16		74.50 ± 0.18	
60	67.50 ± 0.14	50.93	81.50 ± 0.17	42.87
80	75.00 ± 0.12		85.50 ± 0.71	
100	80.50 ± 0.37		96.00 ± 0.14	

Values are expressed as Mean ± SEM (n = 3)

Table 3: Activities by Thiobarbituric Acid Reducing Species (TBARS) of Methanolic Stem-bark Extract of *Pterocarpus erinaceus* and Ascorbic Acid in Percentage (%)

Concentration	Methanolic Extract	IC_{50}	Ascorbic Acid	IC_{50}
20	14.10 ± 0.40		36.62 ±0.71	
40	26.75 ±0.70		42.72 ±0.74	
60	34.66 ± 0.34	54.2	57.10 ±0.55	43.63
80	59.36 ±0.55		69.18 ±0.68	
100	68.73 ± 1.24		80.25 ±1.24	

Values are expressed as Mean ± SEM (n = 3)

Table 4: Effects of Methanolic Stem-bark Extract of *Pterocarpus erinaceous* on Ulcer Index (mm^2)

Groups	Treatments	DAY 7
1	Normal control	0.00± 0.00
2	Methanol extract Treated	0.00±0.00
3	Ulcerated rats treated with Cimetidine 100 mg/kg/b.w	3.29±0.09[a]
4	Indomethacin 30 mg/kg/b.w Induced ulcer rats	8.28± 1.11[b]
5	Ulcerated rats treated with ME 300 mg/kg/b.w	6.64±0.44
6	Ulcerated rats treated with ME 600 mg/kg/b.w	6.00±1.83
7	Ulcerated rats treated with ME 900 mg/kg/b.w	5.17±1.33[a]

Values are expressed as Mean ± SEM (n = 5)
[a] significantly lower (p< 0.05) compared to values of indomethacin group in each column
[b] significantly higher (p< 0.05) compared to values in each column; ME = methanolic extract; b.w = body weight

Table 5: Percentage (%) Preventive Curative Index

Groups	Treatments	DAY 7
1	Normal control	0.00± 0.00
2	Methanol extract Treated	0.00±0.00
3	Ulcerated rats treated with Cimetidine 100 mg/kg/b.w	52.89±1.65
4	Indomethacin 30 mg/kg/b.w Induced ulcer rats	0.00±0.00
5	Ulcerated rats treated with ME 300 mg/kg/b.w	15.58±1.05[a]
6	Ulcerated rats treated with ME 600 mg/kg/b.w	25.73±0.73
7	Ulcerated rats treated with ME 900 mg/kg/b.w	49.75±3.39[b]

Values are expressed as Mean ± SEM (n = 5).[a] significantly lower (p< 0.05) compared to values of indomethacin group in each column.[b] significantly higher (p< 0.05) compared to values in each column.ME = methanolic extract; b.w = body weight

Table 6: Effects of Methanolic Stem-bark Extracts of *Pterocarpus erinaceus* on Volume of Gastric Juice (ml/4hr)

Groups	Treatments	DAY 7
1	Normal control	1.13± 0.06[a]
2	Methanol extract Treated	1.28±0.08[a]
3	Ulcerated rats treated with Cimetidine 100 mg/kg/b.w	2.57±0.12
4	Indomethacin 30 mg/kg/b.w Induced ulcer rats	3.00± 0.98b [b]
5	Ulcerated rats treated with ME 300 mg/kg/b.w	2.98±1.21
6	Ulcerated rats treated with ME 600 mg/kg/b.w	2.85±0.87
7	Ulcerated rats treated with ME 900 mg/kg/b.w	2.80±0.64

Values are expressed as Mean ± SEM (n = 5).[a] significantly lower (p< 0.05) compared to values of indomethacin group in each column.[b] significantly higher (p< 0.05) compared to values in each column.ME = methanolic extract; b.w = body weight

Table 7: Effects of Methanolic Stem-bark Extracts of *Pterocarpus erinaceus* on Free Acidity (FA) mEq/l

Groups	Treatments	DAY 7
1	Normal control	3.16± 0.19[a]
2	Methanolic Extract Treated	3.69±0.08[a]
3	Ulcerated rats treated with Cimetidine 100 mg/kg/b.w	5.77±0.12[a]
4	Indomethacin 30 mg/kg/b.w Induced ulcer rats	16.93± 0.63[b]
5	Ulcerated rats treated with ME 300 mg/kg/b.w	14.03±0.15
6	Ulcerated rats treated with ME 600 mg/kg/b.w	10.33±0.19
7	Ulcerated rats treated with ME 900 mg/kg/b.w	8.65±0.31[a]

Values are expressed as Mean ± SEM (n = 5).[a]significantly lower (p< 0.05) compared to values of indomethacin group in each column.[b]significantly higher (p< 0.05) compared to values in each column.ME = methanolic extract; b.w = body weight

Table 8: Effects of Methanolic Stem-bark Extracts of *Pterocarpus erinaceus* on Total Acidity (TA) mEq/l

Groups	Treatments	DAY 7
1	Normal control	16.70± 2.00[a]
2	Methanol extract Treated	18.50±0.70[a]
3	Ulcerated rats treated with Cimetidine 100 mg/kg/b.w	25.48±1.65[a]
4	Indomethacin 30 mg/kg/b.w Induced ulcer rats	57.47± 1.80[b]
5	Ulcerated rats treated with ME 300 mg/kg/b.w	45.38±1.20
6	Ulcerated rats treated with ME 600 mg/kg/b.w	38.59±1.52
7	Ulcerated rats treated with ME 900 mg/kg/b.w	33.81±1.21[a]

Values are expressed as Mean ± SEM (n = 5).[a]significantly lower (p< 0.05) compared to values of indomethacin group in each column.[b]significantly higher (p< 0.05) compared to values in each column.ME = methanolic extract; b.w = body weight

Table 9: Effects of Methanolic Stem-bark Extracts of *Pterocarpus erinaceus* on Pepsin activity Units/mg of protein

Groups	Treatments	DAY 7
1	Normal control	1.00± 0.75[a]
2	Methanol extract Treated	1.08±0.02[a]
3	Ulcerated rats treated with Cimetidine 100 mg/kg/b.w	1.26±0.57[a]
4	Indomethacin 30 mg/kg/b.w Induced ulcer rats	4.35± 0.33[b]
5	Ulcerated rats treated with ME 300 mg/kg/b.w	3.60±0.33[b]
6	Ulcerated rats treated with ME 600 mg/kg/b.w	2.73±0.86
7	Ulcerated rats treated with ME 900 mg/kg/b.w	2.18±0.89[a]

Values are expressed as Mean ± SEM (n = 5).[a]significantly lower (p< 0.05) compared to values of indomethacin group in each column.[b]significantly higher (p< 0.05) compared to values in each column.ME = methanolic extract. b.w = body weight

Table 10: Effects of Methanolic Stem-bark Extracts of *Pterocarpus erinaceus* on Total Protein of Stomach Tissue Homogenate (g/l)

Groups	Treatments	DAY 7
1	Normal control	139.57± 2.07[a]
2	Methanol extract Treated	120.60±1.50[a]
3	Ulcerated rats treated with Cimetidine 100 mg/kg/b.w	105.37±4.16[a]
4	Indomethacin 30 mg/kg/b.w Induced ulcer rats	29.56± 1.84[b]
5	Ulcerated rats treated with ME 300 mg/kg/b.w	39.23±1.79[b]
6	Ulcerated rats treated with ME 600 mg/kg/b.w	54.83±4.81
7	Ulcerated rats treated with ME 900 mg/kg/b.w	64.50±3.15

Values are expressed as Mean ± SEM (n = 5). [a]significantly higher (p< 0.05) compared to values of indomethacin group in each column.[b]significantly lower (p< 0.05) compared to values in each column. ME = methanolic extract. b.w = body weight

Table 11: Effects of Methanolic Stem-bark Extracts of *Pterocarpus erinaceus* on Lipid Peroxidation (MDA level) of Stomach Tissue Homogenate in nmoles of MDA formed/mg protein

Groups	Treatments	DAY 7
1	Normal control	9.87±1.45[a]
2	Methanol extract Treated	8.95±1.39[a]
3	Ulcerated rats treated with Cimetidine 100 mg/kg/b.w	14.73±1.53[a]
4	Indomethacin 30 mg/kg/b.w Induced ulcer rats	36.04± 1.83[b]
5	Ulcerated rats treated with ME 300 mg/kg/b.w	30.43±0.87
6	Ulcerated rats treated with ME 600 mg/kg/b.w	26.54±0.75
7	Ulcerated rats treated with ME 900 mg/kg/b.w	18.29±0.33[a]

Values are expressed as Mean ± SEM (n = 5).[a] significantly lower (p< 0.05) compared to values of indomethacin group in each column.[b]significantly higher (p< 0.05) compared to values in each column.ME = methanolic extract, b.w = body weight

Table 12: Effect of Methanolic Stem-bark Extracts of *Pterocarpus erinaceous* on Superoxide Dismutase, Glutathione Reductase and Catalase Activity of Stomach Tissue Homogenate in (U/mg protein)

Groups	Treatment	SOD	GR	CAT
1	Normal Control	59.52 ± 0.89	82.97 ± 0.21	102.82 ± 1.57
2	ME Treated 900 mg/kg/b.w	60.42 ± 0.74	71.33 ± 0.03	118.00 ± 1.96
3	Ulcerated rats treated with Cimetidine 100 mg/kg/b.w	41.33 ± 0.30	57.44 ± 1.14	100.64 ± 1.87
4	Indomethacin 30 mg/kg/b.w induced Ulcer rats	8.57 ± 0.50[a]	15.75 ± 0.59[a]	23.78 ± 0.08[a]
5	Ulcerated rats treated with ME 300 mg/kg/b.w	14.73 ± 0.16[b]	28.57 ± 0.92[b]	43.00 ± 0.23[b]
6	Ulcerated rats treated with ME 600 mg/kg/b.w	22.34 ± 0.31[b]	39.90 ± 2.83[b]	59.23 ± 1.07[b]
7	Ulcerated rats treated with ME 900 mg/kg/b.w	38.47 ± 0.44[bc]	54.10 ± 1.20[b]	87.16 ± 1.88[b]

Values are expressed as Mean ± SEM (n = 5); [a] significantly lower (p<0.05) compared ME group in each column; [b] significantly higher (p<0.05) compared to values of indomethacin group in each column.1 unit of CAT = µmol H_2O_2 consumed/min/mg protein, 1 unit of GPx = µg GSH utilized/min/mg protein, 1 unit of GR = nmol NADH oxidized/min/mg protein, CAT = catalase, GR = glutathione reductase, SOD = superoxide dismutase, ME = methanolic extract, b.w = body weight

DISCUSSION

Antioxidants such as flavonoids and phenols, amongst other secondary metabolites (Table 1) may have individual or collectively been responsible for effects observed following treatments with the methanolic extract. Flavonoids are believed to exert their anti-ulcerogenic effects by promoting mucus formation, directly activating gastric membrane protective factors, or stimulating inherent protective mechanism via irritation of the gastric mucosa [14]. Phenols as complex compounds have haemolytic, expectorative, anti-inflammatory and immune-stimulating activities. Tannins are used in medicine primary because of their astringent properties, since they react with proteins in tissues. Tannins precipitate micro proteins at the site of peptic ulcer, forming a protective pellicle that prevents absorption of toxic substances, and promote resistance to the action of proteolytic enzymes, an associated activity against H. pylori [47].

Most anti-ulcer compounds or extracts are known for their free radical scavenging activities that promote of ulcer healing. Scavenging the free radicals and reactive oxygen species in a dose dependent manner seen with DPPH, FRAPS and TBARS (Table 1, 2 and 3) for methanolic stem bark extract of P. erinaceus

demonstrated antioxidant activities. The radical scavenging activity of DPPH was recorded in terms of percentage inhibition and the IC_{50} of methanolic and ascorbic acid where found to be, 41.83 and 44.30 mg/ml), while FRAPS (50.93 and 42.87) and TBARS also in terms of percentage inhibition with the IC_{50} of 54.20 and 43.64.

Indomethacin caused significant increase in the ulcer index (Table 4) suggesting that indomethacin induced gastric ulcer model was useful in inducing severe ulceration in experimental animals [52]. It has been suggested that indomethacin induces gastric damage via inhibiting the release of protective factors like cyclooxygenase-1, prostaglandins E_2, bicarbonate and mucus; increasing the aggressive factors like gastric acid; and increasing oxidant parameters while decreasing antioxidant parameters[57]. The significant decreases observed in the ulcer index on treatment with both aqueous and methanolic stem bark extract of P. erinaceus at different doses, suggest reduced severity of indomethacin induced ulcer following recovery through increased protective factors; alongside other natural recovery mechanisms.

Antioxidant may have been responsible for the decrease as earlier suggested by [27] and [4] who reported decreases in ulcer index on treatments with medicinal plants. The methanolic extracts of P. erinaceus remarkably inhibited ulcer index at 900 mg/kg/b.w extract by the seven day of treatment, signifying the effects of treatments and duration of treatment on ulcer index. The methanolic extract at 900 mg/kg body weight and cimetidine at 100 mg/kg seemed to confer more protection than the other concentration of the extract in this study.

Significantly decreased free and total acidity, pepsin activity (Table 6, 7 and 8) and volume of gastric juice (Table 9), on administration of 300, 600 and 900 mg/kg body weight of methanolic stem bark extracts of P. erinaceus and cimetidine at 100 mg/kg could have resulted from phenols and saponins contained in the plant extract [8]; [7] and [6]. Our results clearly suggest that ulcer induced by oral exposure of rats to indomethacin as demonstrated by significant increases in volume of gastric juice, pepsin activity, free and total acidity as previously reported by [16] and [19] who noted the relationship between acid production, pH, volume of gastric juice and pepsin activity, could be reversed by the plant extracts when administered to rats.

Treatment with methanolic stem bark extract at different doses produced significant increases in pH of gastric juice possibly following antioxidant, anti-secretory and acidity neutralizing effects exerted by the extract. This increase in pH in the methanolic extract treated groups may also be associated with the re-creation of mucin content, creation of antioxidant defence mechanism and the modulations of other indices that contribute to conferring gastro-intestinal protection on the animals. Similar findings by [41] reported a decrease in free and total acidity, and increase in pH of the gastric juice on treatment with fixed oil of Ocimum basilicum linn in ulcer induced rats.

The decreased total protein (Table 10) suggests further damage to the stomach following indomethacin treatment. However, significant improvement in protein concentrations in the groups treated with extract would be an indication of protein synthesis that includes those of antibodies and enzymes. At high dose over a long period of treatments better effects were observed.

Indomethacin intoxication also increased malonaldehyde (MDA) levels in animals (Table 11) indicating the generation of reactive oxygen species (ROS), hydroxyl radicals that caused lipid peroxidation especially in membranes. The reasons for lipid peroxidation after exposure to indomethacin are not completely known, but it is believed that disturbance in glutathione and metallothionine levels may allow free radicals such as $HO\cdot$ and $O_2\cdot$ radicals to attack double bonds in membrane lipids [62].

Treatment with methanolic stem bark extracts of P. erinaceus at different doses and cimetidine for seven days significantly reduced the adverse effects of indomethacin with regards to lipid peroxidation, especially in animals treated with high dose. It is likely that the anti-ulceration mechanism of P. erinaceus stem bark extracts involved antioxidant effects [63]. The ability of the stem bark extracts to reduce lipid peroxidation could also be due to the presence of iso flavonoids in the extracts [50].

The significant decreases in superoxide dismutase (SOD) activity observed in indomethacin control group resulted from effects on superoxide radicals. Superoxide radicals inactivate SOD and so reduce its activity since this important defense enzyme catalyzes the dismutation of superoxide anions into O_2 and H_2O_2 [25]. This has to be so since the administration of P. erinaceus extracts and cimetidine elevated the enzyme activity possibly due to the presence of flavonoids. Flavonoids and other polyphenols have well documented health benefits of rich antioxidant; one of which is their gastroprotective properties which has been attributed to their free radical scavenging and antioxidant activities. Superoxide dismutase is usually the first line of cellular defense against oxidative damage, disposing O_2 and hydrogen peroxide before their interaction forms the more harmful hydroxyl radicals [10]. Our results corroborate earlier reports by [53] who reported decreased in SOD activity in ulcer induced rats following treatment.

Significant decrease in catalase (CAT) activity following indomethacin (a hemeprotein that catalyzes the reduction of H_2O_2 to $2H_2O$ and O_2) suggest a reduction in tissue-protection against highly reactive oxygen free radicals and hydroxyl radicals. The significant increase in the activities of the H_2O_2 scavenging enzyme (catalase) following administration of the stem bark extract of P. erinaceus and standard drug cimetidine is in consonance with the expected increase in the protective capacity of the enzymes.

The stem bark extract significantly increased the activity of GR, suggesting that they possess the ability to reverse the effects of indomethacin in the rat possibly based on antioxidant potential. This result is in accord with the earlier reports by [34] who suggested that flavonoids can alter GSH metabolism and scavenge free radicals. Our results could be interpreted to mean that methanolic stem bark extracts of P. erinaceus possess antioxidant potentials base on their flavonoids content. Several researches have reported the antioxidant potential of flavonoids [63] which are among the cytoprotective phytochemicals for which anti-ulcerogenic efficiency has been extensively attributed [61]. It is suggested that these active compounds are able to stimulate mucin-bicarbonate and the prostaglandins secretions and counteract the deteriorating effects of reactive oxidant species in gastrointestinal lumen [56]. These indicate its antioxidant potential. These results demonstrated that the plants extract exerted cytoprotective effects in a dose dependent manner.

CONCLUTION

The present study showed that treatment with the stem bark extract of *Pterocarpus erinaceus* caused a beneficial effect on indomethacin-induced ulcers in rats as evidenced by the reduction in the ulcer index. The gastroprotective effects of the methanolic stem bark extracts was dose and duration dependent and this may justify its trial as an anti-ulcerogenic agent. The result of this study demonstrated that the treatment with methanolic stem bark extract of *P. erinaceus* has anti-ulcer activity. Based on the result of this research, we recommend that the isolation and characterization of the active component responsible for the anti-ulcer property should be carried out. The mechanism of action of the active compound should also be studied.

CONFLICT OF INTEREST STATEMENT

The authors declared there was no conflict of interest.

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