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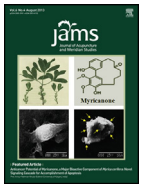

RESEARCH ARTICLE

Assessment of the Antiulcer Potential of *Moringa oleifera* Root-Bark Extract in Rats

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Abstract
In the present study, an ethanolic root-bark extract of *Moringa oleifera* (MO) was examined for its antiulcer potential in albino Wistar rats using two experimental models: ethanol-induced and pylorus ligation-induced gastric ulceration. The extract was orally administered at three different doses (150, 350, and 500 mg/kg) for 15 consecutive days. The antiulcer effects in rats treated with different doses of the extract and omeprazole (30 mg/kg, p.o.) were determined and compared statistically with the antiulcer effects in the control rats treated with saline (NaCl, 0.9%). The MO at doses of 350 and 500 mg/kg decreased the ulcer index significantly as compared to the control group ($p < 0.01$). The percentage protections against gastric ulcers were 82.58%, 85.13%, and 86.15% for MO doses of 150, 350, and 500 mg/kg, respectively, in the pylorus-ligated ulcer model and 55.75%, 59.33%, and 78.51%, respectively, in the ethanol-induced ulcer model. The MO significantly reduced the free acidity, total acidity, and ulcer index ($p < 0.01$) and increased the pH of gastric content compared with the control group. This study suggests that MO possesses valuable antiulcer, antisecretory, and cytoprotective activity. Thus, an ethanolic root-bark extract of *Moringa oleifera* can be used as source for an antiulcer drug.

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1. Introduction

Peptic ulcer disease is the most common gastrointestinal tract disorder and includes gastric and duodenal ulcers, which are usually acidic and, thus, extremely painful [1]. The pathophysiology of peptic ulcer disease involves an imbalance between offensive (acid, pepsin, and *Helicobacter pylori*) and defensive factors (mucin, prostaglandin, bicarbonate, nitric oxide, and growth factors) [2]. Several factors—such as improper digestion, metabolism, and elimination of food, and mental and physical stress—enhance the development of peptic ulcers. A number of drugs are available for the treatment of peptic ulcers, but the clinical evaluation of these drugs indicates high incidences of side effects and drug interactions. These negative effects are the rationale for the development of new antiulcer drugs and the search for novel molecules in plants, such as *Ocimum sanctum*, *Azadirachta indica*, *Asparagus racemosus*, *Musa sapientum*, *Centella asiatica*, *Bacopa monnieri*, and *Bidens pilosa*, that could offer better protection and decreased relapse [3]. In the present study, the antiulcer potential of an ethanolic extract of *Moringa oleifera* root bark (MO) was studied using ethanol- and pylorus ligation-induced gastric lesions in experimental rats.

M. oleifera Lamm (Family: Moringaceae), also known as the drumstick tree and horseradish tree, is indigenous to Northwest India, Pakistan, Bangladesh, and Afghanistan [4]. This tree is the most widely cultivated species of the genus *Moringa*. Leaves of *M. oleifera* are highly nutritious, being a significant source of β-carotene, vitamin C, protein, iron, and potassium [5]. Almost all parts of this plant—root, leaves, fruit, bark, seeds, and flowers—are reported to have important medicinal values as cardiac and circulatory stimulants and to have antitumor, antipyretic, anti-inflammatory, antihypertensive, diuretic, cholesterol-lowering, antidiabetic, antioxidant, antispasmodic, antibacterial, and antifungal activities [6—11]. Moreover, the ethanolic extract of leaves of *M. oleifera* is reported to have antiulcer activity [12]. In view of the above, this study was performed to investigate the antiulcer potential of an ethanolic root-bark extract of *M. oleifera* by using ethanol-induced gastric ulcers and pylorus ligation-induced ulcers.

2. Material and methods

2.1. Animals

Male albino rats of the Wistar strain weighing about 200—250 g were procured from the Indian Institute of Chemical Biology, Kolkata, India. The rats were housed in solid-bottomed polypropylene cages and kept under standard husbandry conditions. The rats were fed with standard diet and water *ad libitum*. The experiments were designed and conducted in accordance with the ethical norms approved by the CPCSEA (Committee for the Purpose of Control and Supervision of Experiments on Animals) and the Institutional Animal Ethics Committee of the SLT (Sulochna Lakhanlal Trivedi) Institute of Pharmaceutical Sciences, Guru Ghasidas Central University, Bilaspur (994/a/GO/06/CPCSEA, IACE/Pharmacy/2012/42).

2.2. Materials

The root barks of *M. oleifera* were collected from the local area of Chhattisgarh, India. The plant was taxonomically identified and authenticated by Dr. H.B. Singh (head of the Raw Materials and Herbarium Museum, National Institute of Science Communication and Information Resources, New Delhi, India). The specimens were deposited in the Pharmacology Department of the SLT Institute of Pharmaceutical Sciences, Guru Ghasidas Central University, Bilaspur (C.G.), India. The powdered plant material was packed in soxhlet extractor and heated under reflux using 70% ethanol as a solvent. The percentage yield of the ethanolic extract from the root bark of *M. oleifera* was found to be 11.8%. The extract was filtered, concentrated under reduced pressure, dried, and stored in a tightly closed container at 4 °C for future use. The following chemicals and reagents were procured: ethanol (Jiangsu Huaxi International, China), diethyl ether (Fischer Scientific, Mumbai, India), and omeprazole (Cipla Ltd, India). All chemicals used were of analytical grade.

2.3. Phytochemical analysis

The MO was subjected to the following test for the phytochemical screening methods [13,14]: carbohydrates were identified by using Molisch's test (Molish's reagent, Organo Biotech Laboratories Pvt. Ltd., New Delhi, India), alkaloids by using Mayer's test (Mayer's reagent, Oxford Laboratory, Maharashtra, India), and Hager's test (Hager's reagent, Alpha Chemika, Mumbai, India), phenols by using a ferric chloride test (Ferric chloride, Alpha Chemika, Mumbai, India), tannins by using a gelatin test (Gelatin, Triveni Chemicals, Vapi, India) and a ferric chloride test, flavonoids by using an alkaline reagent test (Sodium hydroxide, Alpha Chemica, Mumbai, India), proteins and amino acids by using a xanthoproteic test (Nitric acid, Vats International, Delhi, India) and ninhydrin test (Ninhydrin reagent, Shinton Chemicals Pvt. Ltd., Indore, India), cardiac glycosides by using Legal's test (Sodium nitropruside, Brisben Chemicals, Mumbai, India), and saponins by using a foam test.

The acute oral toxicity study was performed as per the OECD (Organisation for Economic Co-operation and Development)-425 guidelines. The extract was suspended using Tween-80 (0.1%) and was administered orally at doses in the range of 50—2000 mg/kg. The concentration was adjusted in such a way that it did not exceed 1 mL/kg body weight of the rats. LD_{50} was calculated, and three different doses of MO (150, 350, and 500 mg/kg) were selected for the evaluation of the antiulcer activity.

2.4. Evaluation of the antiulcer activity using the pylorus ligation-induced ulcer model

Thirty male Wistar rats were divided into five different groups with six rats in each group ($n = 6$) [1,15]. Pylorus ligation was performed in all groups of rats for the induction of gastric ulcers, which was followed by the respective treatments. Group 1 (control) received normal saline (0.9%), Group 2 was treated with a standard drug (omeprazole, 30 mg/kg), and Groups 3, 4, and 5 were treated with