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Does the African garden egg offer protection against experimentally induced ulcers?

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ABSTRACT

Objective: To evaluate the possible antiulcer effect of the African garden egg, *Solanum aethiopicum (S. aethiopicum)* (a domestic vegetable) experimentally in rats. **Methods:** A methanol extract of the plant fruit was prepared by maceration. Twenty five overnight fasted rats for each model were divided randomly into five groups of five rats. Groups 1, 2, 3, 4 and 5 received normal saline, extract dose levels of 100, 200 and 400 mg/kg and 100 mg/kg of ranitidine respectively. All administrations were given orally. For the indomethacin and aspirin models, ulcerogenic agents (indomethacin, 50 mg/kg and aspirin 200 mg/kg) were given thirty minutes after extract treatments and animals sacrificed 8 h later. The acidified ethanol model (ethanol 60% + 0.1 mol/L HCl) was given 1hr after extract treatment and animals sacrificed 1 h later. Ulcer index was checked and analysed with appropriate statistical tools. **Results:** Extract of *S. aethiopicum* showed positive effect on all the models used. It produced higher ulcer inhibition than ranitidine in the indomethacin and acid-ethanol models. All the anti-ulcer effects of the extract at different doses were dose dependent but only in indomethacin model did it produce statistically significant ($P<0.05$) ulcer reduction in all doses compared to control. **Conclusions:** Garden egg, a readily cultivated crop vegetable possesses ulcer protective properties against ulcers induced experimentally making it a cheap source of natural anti-ulcer remedy.

1. Introduction

Solanum aethiopicum (S. aethiopicum) Gilo, "Garden egg" or "scarlet egg plant" is an edible vegetable crop belonging to the family Solanaceae. The family is one of the largest and most important families of vegetable which are essentially tropical in origin[1]. Most species are wild but some species bear edible fruits; they include *S. aethiopiculum*, *S. macrocarpon*, and *S. muricatum*, which are of West African origin[2]. *S. aethiopicum* is also being cultivated in smaller quantities in Brazil and Europe[3]. Its fruits may be consumed freshly raw, dried, cooked or in salad form. It is one of the most important vegetable crops in West Africa as it is consumed daily and remains a source of income for many rural dwellers[3,4]. Phytochemical analysis on this plant though scarce, has been recorded by Nagaoka *et al*[5]. Reports on the pharmacological activity of this plant has been scanty with only tests on its purgative[6], sedative and antidiabetic effects[7] reported in literature. This plant has been regarded as an underutilized crop possibly because (among other reasons) there is scanty knowledge and scientific information about it[8].

Peptic ulcer, a gastrointestinal disease affecting mainly the stomach and duodenum is thought to arise from the necrotising effect of "ulcerogenic agents", such as non steriodal anti-inflammatory agents (NSAIDs), alcohol *etc*[9]. These agents may cause an increase in the volume of acid production or disrupt the integrity of the mucosal wall of the stomach/intestine thus exposing it to acid attack[10]. This disease continues to be of interest to researchers in herbal medicine probably because of the unavailability of a cure, high costs and noxious side effects of available synthetic drugs[11]. Herbs in the tropics have been the toast of researchers in gastroenterology with majority of plants under investigation for treatment in ulcer originating from Africa, Asian and Latin America. Native doctors "Dibia" of the Ibo tribe, Nigeria, believe a boiled concoction mix, which includes garden egg is a comfortable remedy for "stomachic pains". This study however, was aimed at evaluating the possible antiulcer effect of this common plant in rats experimentally induced with various ulcers.

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2. Materials and methods

2.1. Chemicals

All chemicals (Methanol, hydrochloric acid and ethanol) used in this study were of analytical grade and were products of Sigma Aldrich, Germany.

2.2. Plant material

Fruits of *S. aethiopicum* were obtained from the Agric Farm of the Faculty of Agricultural sciences, University of Nigeria, Nsukka, and were identified by Mr. Ugwuozor, a taxonomist of Botany Department, University of Nigeria, Nsukka. A voucher specimen was deposited in the herbarium unit of the Department of Botany, University of Nigeria, Nsukka.

The plant was chopped into tiny bits, shade-dried for 2 weeks and milled with a mechanical grinder. The ground plant (500 g) was macerated in methanol for 24 h, filtered with a white cloth and the filtrate concentrated using a rotary evaporator (IKA, Germany) at an optimum temperature of 40 ℃-50 ℃. The yield of the dried extract was 5 g and designated methanol extract of *S. aethiopicum* (MESA).

2.3. Phytochemical analysis

The qualitative tests on the phytochemistry of the freshly prepared methanol extract of *S. aethiopicum* fruits were carried out according to methods described by Habourne[12].

2.4. Animals used

Adult wistar albino rats (weighing 120-200 g) of both sexes obtained from the animal house of the Faculty of Biological Sciences, University of Nigeria, Nsukka were used for the studies. They were housed in metal steel cages with sufficient space to ease their movement. They were allowed to acclimatize in the laboratory for seven days before the experiment and were given free access to water. The animals were fed with growers mash (Niger Feeds, Nigeria) purchased from the local market.

All the animals were carefully monitored and maintained in accordance with the ethical recommendations of the University of Nigeria committee on care and use of laboratory animals and the revised National Institute of Health Guide for Care and Use of Laboratory Animal (Pub No. 85-23, revised 1985).

2.5. Antiulcer activity

Three experimentally proven models of inducing experimental gastric ulcers in rats were used to assess the antiulcer activity of garden egg extract. Twenty five rats were used for each model. Rats in each model were divided randomly into five groups of five rats each. The rats were Group 1 served as the control group and was administered per oral with normal saline. Groups 2, 3, and 4 received extracts at varied dose levels, 100, 200 and 400 mg/kg of MESA. The fifth group received the standard drug treatment of 100 mg/kg of ranitidine (Zantac®).

2.6. Indomethacin induced ulcer

This assay was carried out using the method of Urushidani *et al*[13].The animals were deprived of food for 18 h (but allowed free access to water) and treated per orally with normal saline and varying doses of the garden egg extract as mentioned above. The extract and drugs used were freshly prepared as a suspension in normal saline and administered per oral (p. o.) to the animals in 5 mL/kg doses. Thirty minutes later, 50 mg/kg of indomethacin (generics, India) was administered p. o. to the rats. After 8 h, each animal in the groups was sacrificed by chloroform anaesthesia. The stomach was removed, washed gently and opened along the greater curvature, pinned flat on a board, examined with a hand lens (×10) and scored for ulcer. Erosions formed on the glandular portions of the stomach were counted and the ulcer index calculated as described in a study by Aguwa and Ukwe[14].

The ulcer was counted and scored as 0 = no ulcer; 1 = superficial ulcer; 2 = deep ulcer and 3 = perforations. The sum of all the lesions/ulcer in all the animals for each group (total ulcer score) was used to calculate the ulcer index. Percent ulcer inhibition was calculated relative to control (normal saline).

2.7. Ethanol-acid induced model

Lesions of gastric mucosa membrane were induced according to the method of Robert *et al*[15]. The rats were fasted for 18 h, but water was allowed. The vehicle, extracts and reference drug were administered orally as stated above. Thirty minutes later, each of the rats received ethanol - acid mixture (as 60% ethanol and 0.1 mol/L HCl) orally. One hour later, the animals were sacrificed with chloroform and the stomachs were removed. The total ulcer scores and ulcer indices for the groups were calculated.

2.8. Aspirin induced ulcer

Ulcer was induced according to the method of Williamson *et al*[16] also used in an earlier study[17]. The animals were fasted for 24 h but had access to water. The extract, drug and vehicle were administered orally as stated above and one hr later, aqueous suspension of aspirin (generic, Nigeria) was given orally at a dose of 200 mg/kg. After 4 h, the animals were killed and the stomach removed and opened along the greater curvature. The stomach was rinsed in water, pinned flat on a board, examined with a hand lens (×10) and scored for ulcer. The total ulcer scores and ulcer indices for the groups were calculated as above.

2.9. Statistical analysis

This was done using SPSS version 14.0 (SPSS Inc. Chicago, IL, USA). All values are expressed as mean ± SEM. Data were analysed by one-way ANOVA and difference between means was assessed by a two-tailed Student's *t*-test. $P<0.05$ was considered statistically significant.

3. Results

3.1. Phytochemical analysis

Results of phytochemistry of the extract showed abundance of flavonoids, alkaloids, glycosides and terpenoids. Saponins and micronutrients such as proteins were seen in trace amounts. However, tannins and fats and oils were absent.

3.2. Effect of MESA on indomethacin induced ulcers

Ulcers produced in this model appeared as large black

sores which were mainly in streaks. Also indomethacin produced ulcer in nearly (24 of 25) all the rats in the group. Table 1 displays the effect of the methanolic extract of *S. aethiopicum* on ulcer index. Potent ulcer reduction was produced by all doses of the extract and the effect was significant ($P<0.05$) compared to control. Ulcer reduction by the extract was greater than those produced by ranitidine.

3.3. Effect of MESA on acidified ethanol induced ulcers

Ulcers produced in this model were seen as reddish sores on the gastric epithelial walls. All the rats in this model were successfully induced with ulcers. The extract produced potent and significant ($P<0.05$) ulcer reduction compared to control (Table 2). The effects were also dose dependent with the higher doses of the extract producing the greater ulcer reduction (63%, 75%, 80%) higher than those produced by ranitidine (72%).

3.4. Effect of MESA on aspirin induced ulcers

The ulcer craters produced in this model were seen as dark red sores which looked like small deep cuts. Ulcer production with the drug produced ulceration in nearly all the animals. Ulcer reduction by the extract was good but not potent (41%, 62%, 67%). Though all reductions were dose-dependent, only the effect of the extract dose of 400 mg/kg was significant ($P<0.05$). Results are displayed in Table 3.

Table 1
Effect of the Methanol extract of *S. aethiopicum* (MESA) on indomethacin induced ulcer in experimental rats.

Treatment	Dose (mg/kg)	Quantal ulcer incidence	Mean ulcer index	UI (%)
Normal saline (Control)	5 mL/kg	5/5	3.30 ± 0.49	–
MESA	100	5/5	0.95 ± 0.40*	71.21
MESA	200	5/5	1.03 ± 0.60*	68.78
MESA	400	4/5	0.86 ± 0.59*	73.93
Ranitidine	100	5/5	1.26 ± 0.73*	61.82

Values shown are mean ± SEM ($n=5$). *Significantly different from control at $P<0.05$.

Table 2
Effect of the MESA on acidified ethanol induced ulcer in experimental rats.

Treatment	Dose (mg/kg)	Quantal ulcer incidence	Mean ulcer index	UI (%)
Normal saline (Control)	3 mL/kg	4/4[c]	2.50 ± 0.43[a]	–
MESA	100	5/5	1.20 ± 0.63[a]	63.63
MESA	200	5/5	0.80 ± 0.17[b]	75.75
MESA	400	5/5	0.65 ± 0.13[b]	80.30
Ranitidine	100	5/5	0.90 ± 0.25[b]	72.27

Values shown are mean ± SEM ($n=5$). [a]No statistical differences in mean, [b]Significantly different from control at $P<0.05$. [c]one animal death during experiment.

Table 3
Effect of MESA on aspirin induced ulcer in rats.

Treatment	Dose (mg/kg)	Quantal ulcer incidence	Mean ulcer index	UI (%)
Normal saline (Control)	3 mL/kg	5/5	2.16 ± 0.37[a]	–
MESA	100	5/5	1.92 ± 0.39[a]	41.82
MESA	200	4/5	1.25 ± 0.24[a]	62.12
MESA	400	4/5	1.08 ± 0.21[b]	67.27
Ranitidine	100	4/5	1.08 ± 0.19[b]	67.27

Values shown are mean ± SEM ($n=5$). [a]No statistical differences in mean, [b]Significantly different from control at $P<0.05$.

4. Discussion

This present study evaluated the antiulcer activity of *S. aethiopicum* on experimentally induced ulcers in rats and showed its effectiveness in reducing ulcerations in indomethacin, acidified-ethanol and aspirin models.

The extract of *S. aethiopicum* produced very potent ulcer protection against indomethacin and aspirin mucosal attack. Indomethacin at doses higher than the toxic dose (20 mg/kg) produced visible ulcerations in rats. These drugs are non steroidal anti-inflammatory agents, capable of inhibiting prostaglandin synthesis, an action needed for ameliorating pain and fever[18].However, prostaglandins have protective actions on the gastric mucosa as it has the ability to stimulate mucus and bicarbonate output[19] and increase mucosal blood flow[20] and stimulation of cellular growth[21]. Accumulated evidence have also shown that NSAIDs and aspirin-like drugs also have the ability to chemically decrease the hydrophobicity of the mucus gel layer that protects the surrounding tissue from the acidic contents of the gut[22,23]. *S. aethiopicum* protected the stomach from ulcers induced by indomethacin and aspirin in this study at comparable rates as ranitidine, a standard drug. We however, can not give specific mechanisms underlying reasons why the intermediate dose of MESA produced a lower ulcer reduction than the lowest dose given in the indomethacin model. Though specific tests were not conducted, this cytoprotection may have resulted from an increase of prostaglandin release.

The protective effect of MESA against ethanol-acid induced ulcers may be due to an inhibition of a direct effect of the

necrotizing agent on the gastric epithelium or via an indirect inhibition of the release of vasoactive products, such as histamine from mast cells which may damage the mucosa[24]. Ethanol has also been thought to cause ulceration by the production of reactive oxygen species via lipid peroxidation and production of leukotrienes which play are implicated in the mechanism of acute and chronic ulceration[25,26].This could suggest a possible anti-oxidative and antisecretory effect of the extract on ethanol-acid model.

Phytochemical study of this plant showed abundance of flavonoids, saponins and alkaloids, metabolites reported to possess gastroprotective properties in some studies[27,28]. The most important plant constituents associated with antiulcer activity are the flavonoids[29] of which *S. aethiopicum* is richly endowed with[30]. Alkaloids, however are multivariate in action with only a few showing antiulcer and gastric acid suppressive activity[31]. To effectively propose an exact mechanism of the mucosal protection by *S. aethiopicum* from direct and acute attack from necrotizing agents, specific tests for cytoprotection and anti-secretory tests should be conducted. Also a fractionation of this active extract should be done, to possibly isolate constituents responsible for this ulcer protective effect.

We conclude that this study has shown that fruits of *S. aethiopicum*, the African garden egg have an ulcer protective effect as claimed by folkloric medicine.

Conflict of interest statement

We declare that we have no conflict of interest.

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