African Journal of Sciences and Traditional Medicine

ISSN : 3434-6031

Index: Harvard, Boston, Sydney University, Dimensions, Lens, ResearchGet Scilit, Semantic, Google Scholar, Base etc

https://doi.org/10.58578/AJSTM.v2i1.4535

Evaluation of the Antidiarrheal Activity of Aqueous Leaf Extract of *Senna surattensis* on Castor Oil-Induced Diarrhea in Rats

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Article Info:

Submitted:	Revised:	Accepted:	Published:
Nov 30, 2024	Dec 14, 2024	Dec 26, 2024	Jan 1, 2025

Abstract

Diarrheal disease is a major health problem in developing countries. It is the second leading cause of death among children under five globally; accounting for about 9 percent of all deaths. This study was aimed at evaluating the antidiarrheal activity of the aqueous leaf extract of *Senna surattensis*. The antidiarrheal effect of the extract was evaluated using castor oil-induced diarrhea model. Loperamide was used as the standard drug. Thirty (30) Wistar rats were divided into six (6) groups of five (5) rats each. Groups I and II served as the normal and negative controls respectively, group III as standard treatment and groups IV, V and VI as test groups. The extract was administered orally at three different doses of 100 mg/kg, 200 mg/kg and 400 mg/kg to groups IV, V and VI respectively. The extract exhibited a graded dose-dependent inhibition of castor oil-induced diarrhea. The stool inhibition was highly significant at 100 mg/kg (88.1% inhibition) and maximal at 400 mg/kg (100% inhibition). The maximal effect produced by the extract at 400 mg/kg (100% inhibition) is similar to that of the standard drug (5 mg/kg loperamide) which produced 97.6% inhibition. The extract also exhibited a modest dose-dependent reduction on the distance travelled by the charcoal meal. This extract high doses, significantly decrease the volume of the intestinal content when compared to that of the negative control. The results obtained from this study suggests that the aqueous leaf extract of *Senna surattensis* have significant antidiarrheal effect on animal models and this finding supports the

traditional use of this plant extract for treatment and or management of diarrhea.

Keywords: Diarrhea, *Senna surattensis*, Castor Oil, Antidiarrheal

INTRODUCTION

Diarrheal diseases are a major public health problem in developing countries [1,2]. It is a condition of having at least three loose, liquid, or watery bowel movements each day [3]. It often lasts for a few days and can result in dehydration due to fluid loss [3]. This occurs as a result of increased secretion of fluid and it's decreased absorption leading to increased fluidity, stool volume and frequency, excessive loss of body water and electrolytes [4]. Symptoms may range from dehydration, loss of the normal stretchiness of the skin, to decreased urination, loss of skin color, a fast heart rate, and a decrease in responsiveness as it becomes more severe [3].

Diarrheal diseases are a major problem in third world countries and are responsible for the death of millions of people each year [5]. According to the World Health Organization, diarrhea had been reported to be the major cause of morbidity and mortality in several developing nations where about three to five billion cases of diarrhea occur each year with children below 5 years of age accounting for about one billion of these cases [6,7,8].

Diarrheal diseases are usually associated with unhygienic environments, lack of safe drinking water and poverty [8,9]. Exposure of an individual to contaminated or wrong diet, could lead to infection as well as disruption in the intestinal absorptive and secretory functions [10]. Other causes include bacterial infections by agents such as *Salmonella, Vibrio cholera*, enteric parasites such as *Entamoeba histolytica*, and *Blastocystis hominis*, virus, psychological stress, anxiety, and side effect originating from some medications [11,12,13]. Diarrhea could be acute, caused by parasitic infections that may last for 1–2 days or chronic, associated with functional disorders including irritable bowel syndrome and crohn's disease which may last up to 1 month [14].

In developing nations, *Rotaviruses* and *Escherichia coli* are the two recognized causative agents that result in moderate to severe diarrhea [15]. The major transmission route for such organisms is stools, contaminated drinking-water and food, and the infection is higher in the area where there is less access to clean drinking-water, cooking and poor hygiene and

sanitation [9]. The crucial interventions to prevent diarrhea are proper hand-washing with soap, providing clean drinking water, using improved sanitation and proper individual and food cleanliness [16].

The most common therapy used in the management of diarrhea is oral rehydration therapy. Treatment with oral rehydration therapy reduces dehydration caused by diarrhea, It works as glucose increases the uptake of sodium and thus water by the intestines, and the potassium chloride and sodium citrate help prevent hypokalemia and acidosis, respectively. [17,18,19].

Treatment with oral rehydration therapy however, only serves to manage or minimize dehydration resulting from diarrhea, it does not treat or cure diarrhea. In addition, synthetic chemicals such as diphenoxylate, loperamide and antibiotics used in the treatment of diarrheal diseases have harmful side effects for the body including but not limited to nausea, dry mouth and constipation [20]. This give rise to the need to develop antidiarrheal drugs or agents that are safe, effective and having significantly reduced or no side effects.

The continuous search for new approaches in the management of diarrhea and the development of new specific drugs for its treatment is of utmost importance, and medicinal plants are reported as effective means of treating and managing the symptoms of diarrhea especially among rural dwellers, traditional medical practitioners and livestock farmers [21]. WHO therefore suggested that herbal formulations could be effective in the treatment of diarrhea and some other disease conditions [3]

Senna surattensis, also called glossy shower, scrambled egg tree or glossy shower, is a plant species of the legume family (*Fabaceae*) in the subfamily *Caesalpinioideae* that is native to southeast Asia, and possibly northern and eastern Australia.[22,23,24]. It grows as a shrub or small tree to 11 m high. The roots have been used to treat gonorrhea, its leaves for dysentery, and flowers as a laxative [25]. It can also be used to treat constipation, It works by increasing activity of the intestines to cause a bowel movement.

MATERIALS AND METHODS

Collection and preparation of plant

Fresh leaves of *Senna surattensis* were collected in Mubi, Mubi North local government area, Adamawa State, The leaves were identified by a taxonomist in the department of Botany

Adamawa State University, Mubi. The leaves were washed with tap water, shed-dried and crushed into powder using mortar and pestle. The powder (300 g) was macerated in distilled water for 72 h with occasional shaking using an orbital shaker. After maceration, this was then filtered twice with Whatman No. 1 filter paper. Excess water was removed from the filtrate and evaporated to dryness in water bath at 50°C. The dried extract was stored in airtight containers at room temperature until the need arises.

Preliminary phytochemical screening

The aqueous *Senna surattensis* leaf extract was subjected to qualitative phytochemical screening according to the standard methods [26].

Experimental Animals

The experimental animals were wistar rats of both sexes (males and females) obtained from the animal house, Department of Zoology Adamawa State University, Mubi, weighing between 130 g – 200 g. The experimental animals were housed in well ventilated cages. The animals were handled with strong adherence to the guidelines established by the European Animal Research Association (E.A.R.A) [27]. Before the commencement of the experiment, the experimental animals were acclimated to the Zoology laboratory, Department of Zoology, Adamawa State University, Mubi, for two weeks in the laboratory environmental conditions (28°C - 30°C and 12 hr light / 12 hr darkness) with free access to feed and tap water.

Castor oil-induced diarrhea test in rats

The method of Shoba and Thomas [5] was adopted for this experiment with slight modifications. Thirty (30) wistar rats of both sexes weighing between 130 g – 200 g were fasted overnight (for 12 h). The rats were randomly grouped into six (6) groups (normal and negative controls, standard treatment and three test groups) of five (n = 5) animals each. Diarrhea was induced in groups II, III, IV, V and VI by administering castor oil (1ml/rat) orally to rats. Thirty minutes after the administration of castor oil, the rats in group I received normal saline (10 ml/kg b. wt.) and served as normal control, group II received normal saline (10 ml/kg b. wt.) and served as negative control, group III received the standard drug loperamide (5 mg/kg b. wt.) and served as standard and groups IV, V, and VI, received the aqueous leaf extract of *Senna surattensis* orally (100 mg/kg, 200 mg/kg and 400 mg/kg b. wt. respectively) and served as test groups. After treatment, the rats were placed in separate metabolic cages, the floor of which was lined with blotting paper, which

was replaced after every hour. The number of diarrheal stools excreted by each rat was observed and recorded for a period of four hours. The mean of the diarrheal stools excreted by the treated groups were compared with that of the negative control group. The percentage curative index of the aqueous leaf extract of *Senna surattensis* was determined using the formula:

$$\% \text{ Curative Index} = \frac{DSC - DST}{DSC} \times 100$$

Where DSC is the diarrheal stools in control and DST is the diarrheal stools in treatment

Gastrointestinal motility test in rats

The method described by Chitme *et al.* [28] was adopted for this experiment. Thirty rats weighing between 130 g – 200 g were fasted for 12h. The rats were randomly divided into six groups (normal and negative controls, standard and three test groups) of five (n=5) animals each. Castor oil (1 ml/rat) was administered to groups II, III, IV, V and VI. 1 hour after the administration of castor oil, the standard drug loperamide (5 mg/kg b. wt.) was administered to rats in group III, the animals in the test groups (groups IV, V and VI) were administered orally the aqueous leaf extract of *Senna surattensis* at 100 mg/kg, 200 mg/kg and 400 mg/kg b. wt. respectively. To each animal, 1 ml of charcoal meal (10% charcoal suspension in 5% gum acacia) was administered orally as marker. Thirty minutes later, the rats were sacrificed by cervical dislocation and the abdomen was opened and the intestines were removed. The distance travelled by the charcoal meal from the pylorus was measured and expressed as percentage of the total length of the intestine from pylorus to the cecum. The peristaltic index, was calculated using the formula:

$$\text{P.I} = \frac{DTCM}{TLSI} \times 100$$

Where DTCM is the distance travelled by the charcoal meal and TLSI is the total length of small intestine

Castor oil-induced enteropooling test in rats

Thirty (30) rats fasted overnight (12 hours) were divided into six (6) groups (normal and negative controls, standard and three test groups) of five (n = 5) animals each. Castor oil (1 ml/rat) was administered to groups II, III, IV, V and VI. 1 hour after the administration of castor oil, standard drug loperamide (5 mg/kg b. wt.) was administered orally to group III, the aqueous leaf extract of *Senna surattensis* at 100 mg/kg, 200 mg/kg and 400 mg/kg b. wt.

was administered orally to groups IV, V, and VI respectively. One hour later, the animals were sacrificed by cervical dislocation, the abdomen was opened. The edges of the intestines (from pylorus to cecum) were tied with thread and the intestines were carefully removed. The contents of the intestines were collected by milking into a graduated tube and their volume measured [29].

Statistical analysis

Values were expressed as mean ± S.E.M (n=5). Statistical significance was determined by the one-way analysis of varance (ANOVA), followed by Duncan test, using the SPSS version 25, at $p < 0.05$ level of significance.

RESULTS

Phytochemical screening

Table 1 shows the results obtained from the qualitative phytochemical screening of the aqueous leaf extract of *Senna surattensis*. This revealed the presence of alkaloids, flavonoids, saponins, carbohydrates, steroids, tannins and glycosides.

Table 1: **Qualitative phytochemical screening of the aqueous leaf extract of *Senna surattensis***

Phytochemicals	Inference
Alkaloids	+
Flavonoids	+
Tannins	+
Steroids	+
Terpenoids	+

Key: + = present

Table 2 shows the effect of the aqueous leaf extract of *Senna surattensis* on stool inhibition of castor oil-induced diarrhea in rats. A significant reduction (at $p<0.05$) in the number of diarrheal stools was observed across the three test groups over the four hours of observation in a dose dependent manner.

Table 2: **Effects of the aqueous leaf extract of *Senna surattensis* on stool inhibition in castor oil-induced diarrhea in rats**

Groups	No. of diarrheal stools	%inhibition
Group I (NS)	0.00 ± 0.00^{a}	-
Group II (NC)	14.00 ± 1.52^{c}	-
Group III (Lop5)	$0.33 \pm 0.0.57^{a}$	97.6
Group IV (SE100)	1.67 ± 0.66^{b}	88.1
Group V (SE200)	1.00 ± 0.01^{b}	92.9
Group VI (SE400)	0.00 ± 0.00^{a}	100.0

Values are expressed as Mean ± SEM.(n=5) Values with different superscript down the column indicates significant difference at $p<0.05$. NS: normal saline; NC: negative control; Lop5: loperamide 5mg/kg; SE100: *S.surattenis* extract 100 mg/kg; SE200: *S.surattenis* extract 200 mg/kg; SE400: *S.surattenis* extract 400 mg/kg.

Table 3 shows the effect of *Senna surattensis* on intestinal motility in rats. From the result obtained, peristaltic index increased upon the administration of castor oil (57.26%). This effect was reduced in each of the three test groups upon treatment with different doses of the extract (36.72%, 33.7% and 33.82% at 100mg/kg, 200mg/kg and 400mg/kg b. wt. respectively).

Table 3**: Effect of the leaf extract of *Senna surattensis* on intestinal motility in rats**

Groups	TLSI	DTCM	PI(%)
Group I	89.67 ± 1.20	42.00 ± 0.57	48.84
Group II	85.00 ± 0.57	48.67 ± 0.33	57.26
Group III	80.67 ± 0.88	21.33 ± 1.20	25.00
Group IV	85.33 ± 0.88	31.33 ± 3.28	36.72
Group V	90.00 ± 0.57	30.33 ± 0.88	33.70
Group VI	91.67 ± 0.88	31.00 ± 1.52	33.82

TLC: total length of small intestine; DTCM: distance travelled by charcoal meal; PI: peristaltic index

Table 4 shows the effect of the aqueous leaf extract of *Senna surattensis* on castor oil-induced enteropooling in rats. Castor oil caused the accumulation of water and electrolytes in the intestinal loop. This is evident from the increased intestinal volume content observed in the negative control group (group II), to which castor oil was administered without treatment. However, upon treatment with the extract, a significant decrease was observed

across the three test groups (IV, V, VI), as the dosage increases, the volume of the intestinal content decreases. A similar reduction was observed in the group (III) treated with the standard drug (5 mg/kg loperamide).

Table 4**: Effect of the leaf extract of *Senna surattensis* on castor oil-induced enteropooling in diarrheal rats**

Group	I.F volume (ml)	%inhibition
Group I	1.33 ± 0.57^{a}	-
Group II	3.33 ± 0.57^{c}	-
Group III	1.33 ± 0.05^{a}	60.0
Group IV	2.00 ± 0.01^{b}	39.9
Group V	1.33 ± 0.57^{a}	60.1
Group VI	1.00 ± 0.01^{a}	70.0

Values are expressed as Mean ± SEM. Values with different superscript down the column indicates significant difference at $p<0.05$. I.F volume: volume of intestinal fluid

DISCUSSION

This study aims to evaluate the antidiarrheal activity of the aqueous leaf extract of *Senna surattensis* on castor oil-induced diarrhea in rats. Castor oil was used in this study to induce diarrhea. It is well documented that castor oil produces diarrhea due to its most active metabolite, ricinoleic acid, by hypersecretory response, which stimulates peristaltic activity in small intestine, leading to changes in the electrolytes permeability of the intestinal mucosa [30].

From the results obtained in this study, all tested doses (100 mg/kg, 200 mg/kg and 400 mg/kg) of the extract significantly reduced the total diarrheal stools when compared with the negative control group. Increase in doses of the extract resulted in a dose-dependent increase in the percentage inhibition of diarrheal stools (88.1%, 92.9% and 100% at 100mg/kg, 200mg/kg and 400mg/kg b. wt. respectively).

Treatment with this extract also resulted in a modest dose-dependent reduction on intestinal transit in rats and a significant dose-dependent reduction in the volume of intestinal content when compared with the negative control group. However the extract appears to be more effective at higher doses (200mg/kg and 400mg/kg).

The qualitative phytochemical screening of the aqueous leaf extract of *Senna surattensis* revealed the presence of alkaloids, tannins, flavonoids, steroids, carbohydrates, saponins and glycosides. The antidiarrheal activity of many plants have been found to be due to the presence of these phytochemicals [31]. These phytochemicals exert their antidiarrheal effect through various mechanisms. Tannins and flavonoids for example increase caloric water and electrolytes reabsorption [32].

These effects may be justified by the presence of compounds such as flavonoids, alkaloids and tannins [2, 3].

CONCLUSION

This study revealed that aqueous leaf extract of *Senna surattensis* has a significant dose-dependent antidiarrheal effect. This finding will help to support the claim by traditional healers who use this plant in the treatment of diarrhea.

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