



Nigerian Journal of Pharmaceutical Sciences
Vol. 8, No. 1, March, 2009, ISSN: 0189-823X
All Rights Reserved

PHYTOCHEMICAL AND ANTIDIARRHOEAL STUDIES OF THE STEM BARK OF *CEIBA PENTANDRA* (BOMBACACEAE)

*Sule, M. I.¹ Njinga, N. S.¹ Musa, A. M.¹, Magaji, M. G.², Abdullahi, A.³

¹Department of Pharmaceutical and Medicinal Chemistry, Ahmadu Bello University, Zaria, Nigeria

²Department of Pharmacology and therapeutics, Ahmadu Bello University, Zaria, Nigeria

³ Faculty of Pharmaceutical sciences, Ahmadu Bello University, Zaria, Nigeria

***Author for Correspondence:** ibrasule@gmail.com

ABSTRACT

Ceiba pentandra is a plant commonly used traditionally to treat ailments including diarrhea in Nigeria. The methanolic extract of the stem bark of *Ceiba pentandra* was studied for its phytochemical constituents and antidiarrhoeal activity using castor oil-induced diarrhea and intestinal transit time models in mice. The phytochemical studies of the methanolic extract revealed the presence of saponins, flavonoids, tannins, terpenes, resins and carbohydrates. The extract showed significant ($p < 0.05$) protection against castor oil-induced diarrhea at (1000mg/kg) but no significant delay in intestinal transit time was observed. The median lethal dose (LD₅₀) of the methanolic extract was found to be greater than 5000mg/kg which suggested that the extract was non toxic at the antidiarrhoeal dose of 1000mg/kg. The results indicate that the methanolic extract contains compounds with antidiarrhoeal activity

INTRODUCTION

Diarrhoea remains one of the commonest illnesses of children, and one of the major causes of infant and childhood mortality in developing countries. It is estimated that 3.3 million deaths occur each year among children under 5 year old (Bern *et al.*, 1992). In Nigeria, diarrhoea infection remains the number one killer disease among children under 5 years, while 7 – 12 months old babies remain the most susceptible (Audu *et al.*, 2000). Nigeria, the fourth largest economy in Africa with an estimated per capita income of \$350 has over half of its population living in poverty (WHO, 2007). This implies that very few people can afford orthodox medicine in curing diseases. Thus, there is need to study plants with antidiarrhoea activity that can be used traditionally to curb

the death rate caused by diarrhoea. *Ceiba pentandra* is a tropical tree of the order Malvales and the family Bombacaceae, native to Mexico, Central America and the Caribbean, northern South America and to tropical West Africa. It is a tree that grows to 60-70 m tall and has a very substantial trunk up to 3 m in diameter with buttresses. The following compounds have been isolated from the bark of this plant; vavain 3'-O-B-D-glucoside, and its aglycone, vavain; flavan-3-ol, (+)-catechin (Ylva *et al.*, 1998), pentandrin and pentandrin glucoside and beta-sistosterol and 3-beta-D-glucopyranoside (Ngounou *et al.*, 2000). *Ceiba pentandra* bark decoction has been used as a diuretic, aphrodisiac, and to treat headache, as well as type II diabetes (Burkill, 1999). In this study, we report the phytochemical and antidiarrhoea

activity of the stem bark of *Ceiba pentandra*.

MATERIALS AND METHODS

Plant material

The plant sample was collected in Zaria city, Kaduna state-Nigeria in October, 2008. The plant was authenticated in the Herbarium of the Department of Biological sciences, A.B.U. Zaria Nigeria, where a voucher specimen (7059) has been deposited. The stem bark was removed, air-dried and size reduced using mortar and pestle.

Extraction procedure

The powdered stem bark (140g) was extracted with methanol after defatting with petroleum ether in a soxhlet extraction apparatus for 24 hours. The methanolic extract (ME) was concentrated *in vacuo* to give a residue (Brain and Tuner, 1975; Sofowora, 1993) which was used for the experiments.

Phytochemical screening

Various phytochemical tests were carried out on the extract (ME) to detect the presence of bioactive constituents (flavonoids, saponins, tannins, alkaloids etc) of the plant material (Trease and Evans, 2004; Sofowora, 1993).

Animals

Swiss albino mice weighing 18 to 25g maintained at the animal house of the Department of Pharmacology and Therapeutics, Ahmadu Bello University, Zaria-Nigeria were used for the experiment. The animals were

fed with standard laboratory feeds and water *ad libitum*. This research was carried out in accordance with the rules governing the use of laboratory animals as accepted internationally.

Acute toxicity study

Thirteen mice were used for this experiment. In the first phase, three doses (10, 100, 1000 mg/Kg) of the methanolic extract were administered intraperitonally to three groups each containing three mice. In the second phase, more specific doses were administered to four groups each containing one mouse. The median lethal dose (LD₅₀) value was determined as the geometric mean of the highest non lethal dose and the lowest lethal dose of which there is 1/1 and 0/1 survival (Lorke, 1983).

Effects of methanol extract on castor oil-induced diarrhea in mice

The mice were fasted for 18 hours prior to the commencement of the experiment and were randomly divided into five groups of five mice each. The first group was administered normal saline, while group two, three and four were administered 250, 500, and 1000mg/kg respectively of the methanolic extract orally. The fifth group was administered loperamide (5mg/kg). An hour later, 0.2 ml castor oil was administered to each mouse orally. The animals were placed in individual cages over clean filter papers. Three hours after the administration of the castor oil, the cages were inspected for the presence of characteristic diarrhoea droppings. The absence of which was considered as protection from diarrhoea (Diurno *et al.*, 1996) and the percentage protection calculated (Akah and Offiah, 1996).

Small intestine transit Time

Mice were fasted for 18 hours, divided into five groups of five mice each. The first group was administered normal saline, (2ml) orally. The second, third and fourth groups were administered 250, 500 and 1000mg/kg of methanolic extract respectively using same route. Group five was administered atropine (0.1mg/kg). After 30 mins of administration, 0.2ml of marker (10% charcoal suspended in 5g gum acacia) was administered orally. The mice were sacrificed after 30min and the distance traveled by charcoal meal from the pylorus was measured and expressed as percentage of the total length of the intestine from the pylorus to caecum (Mascolo *et al.*, 1994).

Statistical analysis

The results were analyzed for statistical significance using student t-test (castor oil induce diarrhea) and Chi-square test (intestinal transit time). P values less than 0.05 were considered significant.

RESULTS

The median lethal dose value for the ME was found to be greater than 5000mg/kg.

The results of phytochemical screening revealed the presence of saponins, flavonoids, tannins, triterpenes and steroids (Table 1).

Effect of Methanol stem bark of *Ceiba pentandra* extract on Castor oil-induced diarrhoea

The ME (500, 1000mg/kg) and loperamide (5mg/kg) significantly ($P < 0.05$) and d protected mice against castor oil-induced diarrhoea when compared with the control. The protection was dose dependent (Table 2).

Effect of methanolic stem bark extract of *Ceiba pentandra* on intestinal transit time in mice

The extract showed no significant delay in the intestinal transit time when compared with normal saline but atropine produced a significant increase in intestinal transit time (Table3).

Table 1: Phytochemical constituents of the methanolic stem-bark extract of *Ceiba pentandra*

Constituents	Inference
Saponins	+
Flavonoids	+
Tannins	+
Alkaloids	-
Carbohydrates	+
Anthraquinones	-
Terpenes	+
Resins	+
Steroids	+

- = Absent; + = present.

Table 2: Effect of methanolic stem-bark extract of *Ceiba pentandra* on castor oil-induced diarrhoea in mice

GROUPS	TREATMENT	DOSE	Number with diarrhoea	% Protection
I	Normal saline	10 ml/kg	5	0
II	ME	250 mg/kg	3	40
III	ME	500 mg/kg	2	60
IV	ME	1000 mg/kg	1	80
V	Loperamide	5 mg/kg	1	80

*Results were analyzed by Chi-square (X^2). Values are significant at $P < 0.05$. $n = 5$ in each group

Table 3: Effect of methanolic stem bark extract of *Ceiba pentandra* on intestinal transit time in mice

Group	Treatment/ Dose	Mean percentage distance traveled (%) ± SEM
I	Normal saline (10ml/kg)	61.96 ± 5.36
II	Extract (250mg/kg)	60.64 ± 6.52
III	Extract (500mg/kg)	59.98 ± 7.46
IV	Extract (1000mg/kg)	54.28 ± 4.46
V	*Atropine (0.1mg/kg)	29.25 ± 2.00

*Results were analyzed using student t test. Values are significant at $P < 0.05$ $n = 5$

DISCUSSION AND CONCLUSION

Diarrhoea results from an imbalance between the absorptive and secretory mechanisms in the intestinal tract, accompanied by hurry, resulting in an excess loss of fluid in the faeces. In some diarrhoeas, the secretory component predominates while other diarrhoeas are characterized by hypermotility. The use of castor oil induced diarrhoea model in this study is because the autocoids and prostaglandins are involved and these have been implicated in the causation of diarrhoea in man (Horton *et al.*, 1968; Greenbargena *et al.*, 1978). The liberation of ricinolieic acid from castor oil results in irritation and inflammation of the intestinal mucosa, leading to release of prostaglandins, which stimulate motility and secretion (Pierce *et al.*, 1971). The results of this study revealed that the methanolic stem bark extract of *Ceiba pentandra*

produced statistically significant protection against diarrhoea and was found to be comparable to loperamide; a drug widely employed against diarrhea disorders which effectively antagonizes diarrhoea induced by castor oil, prostaglandin and cholera toxin (Niemegeers *et al.*, 1974; Karim and Adeikam, 1977; Facack *et al.*, 1981). The pharmacological effect of loperamide is due to its antimotility and antisecretory properties (Couper, 1987). Extracts of plants that contain flavonoid (Irvine, 1961; Adesina, 1982, Ladeji *et al.*, 1997) are known to modify the production of cyclo-oxygenase 1 and 2 and lipo-oxygenase (Christopher *et al.*, 1996; Haruna *et al.*, 1997) thereby inhibiting prostaglandin production. The methanol extract may elicit its effect through similar mechanism. The extract showed no significant delay in the intestinal transit time compared with normal saline

suggesting that it does not delay gastric emptying, so its action may be mainly antisecretory. In this study, atropine produced a significant increase in intestinal transit time probably due to its anti-cholinergic effect (Brown and Taylor, 2000). The phytochemical analysis of the ME revealed the presence of sugars, flavonoids, saponins, tannins, steroids, terpenes and resins. Antidiarrhoeal properties of medicinal plants were found to be due to tannins, alkaloids, saponins, flavonoids, sterols and/or triterpenes and reducing sugars (Longanga *et al.*, 2000). These constituents may mediate the antidiarrhoeal property of the methanolic extract of *Ceiba pentandra*. The observed activity of methanol extract on castor oil-induced diarrhoea in mice justifies its use in the treatment of diarrhoea by traditional practitioners. Further studies are needed to completely understand the mechanism of the antidiarrhoeal action of *Ceiba pentandra* and also to isolate the compound(s) responsible for this activity.

REFERENCES

- Adesina, S.K. (1982). Studies on Nigerian herbal anti-convulsant recipe. *International journal of Crude Research* **20**: 431-434.
- Akah, P.A., Offiah, V.N. (1996). Gastrointestinal effects of *Allamanda cathorica* leaf extracts. *International Journal of Pharmacognosy*. **30**, 213-212
- Audu, R. Umilabug, S.A., Renner, J.K., Awodiji, J.A. (2000). Diarrhea management. *Journal of Nigerian Infection Control Association*. **3**, 15.
- Bern C, Martinez J, de Zoysa I, Glass RI. (1992). The magnitude of the global problem of diarrhoeal disease: A ten-year update. *Bulletin of World Health Organization*; **70**: 705-14 pmid: 1486666.
- Brain, D.R. and Tuner, T.D. (1975). Extraction procedures. In *The practical Evaluation of Phytopharmaceuticals*. Wright Scentechical, Bristol. UK. P. 98.
- Brown J.A. and Taylor, p. (2000). Muscarinic receptor agonists and antagonist. In: Hardman, J.G., Limbird, L.E., (Eds), Goodman and Gilman's The pharmacological Basis of Therapeutics. 10th Edition, MacGraw Hil, New York, pp 115-158.
- Burkill H.M. (1985). The useful plants of west tropical Africa. Vol 1. Pp 278-283.
- Christopher, S., William, A., Dubios, R.N. (1996). Prostaglandin endoperoxide synthesis, Why two isomers? *American journal of physiology* **270**, G392 - G400.
- Couper, I.M. (1987). Inhibition of intestinal motility and the secretion by flavonoids in mice and in rats: structural activity relationship. *Journal of Pharmacy and Pharmacology*. **45**: 1054-1059.
- Diurno, M.V., Izzo, A.A., Mazzoni, R., Bolognese, A., Capasso, F. (1996). Antidiarrhoea activity of new thiazolidinones related to loperamide. *Journal of Pharmacy and Pharmacology*. **48**, 760-762
- Facack, U.M., Kantz, U., Loeseke, K. (1981). Loperamide reduces the intestinal secretion but not the mucosa CMP accumulation induced by cholera toxin. Naungn Schmiedebergws *Archive of Pharmacology*, **317**, 178-179.
- Greenbargena, N.J., Arwanitakis, C. and Hurwitz, A. (1978). Drug development of gastrointestinal disorders. Churchill livingstone, New-York, pp 155-156.
- Haruna, A.K., Ilyas M., Ilyas, N. (1995). Plant constituents with antidiarrhoeal properties, *Bulletin of Science Association of Nigeria*. **10**, 5-12.
- Horton, E.W., Main, I.H.M., Thompson, C.J. and Wright, P.M. (1968). Effects of orally administered, PGE on gastric secretion and gastrointestinal motility in man, *Gut*, **9**: 655-658.
- Irvine, F.R. (1961). Key to useful plants. In: Analysis of certain Plants. Woody Plants of Ghana. London, Oxford University press, pp. XVII-LXXVI.
- Karim, S.M.M., Adeikan, P.G. (1977). The effects of loperamide on prostaglandin-induced diarrhoeal in rats and man. *Prostaglandins*, **13**: 321-331.
- Ladeji, O., Zebulon, S.C., Okoye, E.U. (1997). Effects of vitex doniana stem-bark on blood pressure. *Nigerian journal of natural products and medicine*, **1**: 18-20.

- Lorke, D. (1983). A new approach to acute toxicity testing. *Archives of toxicology*, **54** : 275-287.
- Longanga_Oushudi, A., Vercruysse, A., and Foriers A. (2000). Contribution to the Ethnobotanical, Phytochemical and Pharmacological studies of traditionally used medicinal plants in the treatment of dysentery and diarrhea in Lomela area, Democratic Republic of Congo (DRC), *Journal of Ethnopharmacology*, 71, 3, 411-23.
- Mascolo, N., Izzo, A.A., Avtore, G., Barboto, F., Capasso, F. (1994). Nitric oxide and castor oil induced diarrhea, *Journal of pharmacology and experimental therapeutics*, **268**: 291-295.
- Ngounou, F.N., Meli A.L, Lontsi, D., Sonndengam, B.L., Atta-Ur-Rahman, Choudhary, M.I., Malik, S., Akhtar, F. (2000). New isoflavones from *ceiba pentandra*. *Phytochemistry* **54 (1)**: 107-110.
- Niemegeers, C.I.L., Lenaerts, F.M., Janseen, P.A.J. (1974). Loperamide (R-18553) A novel type of antidiarrhoeal agent. Part 1. In: *VitroDrab pharmacology and acute toxicity comparing with morphine, codeine and difenoxine*. *Atzneimittelforsch* **24**, **1633-1636**.
- Pierce, N.F., Carpenter, C.C.J., Elliot, H.Z. and Greenough, W.B. (1971). Effects of prostablandins, theophylline and Cholera exotoxin upon transmucosal water and electrolyte movement in canine jejunum, *Gastroenterology*, **60**: 22-32
- Sofowora, T. (1993). Standardization of herbal medicine. In: *Medicinal plants and Traditional medicine in Africa*. Spectrum Book Limited. Lagos, Nigeria, pp 56-61.
- Trease, E. and Evans, W.C. (2004). *Pharmacognosy*. Williams Charles Evans as edited in 15th edition. Saunders publisher London pp. 137-440.
- W.H.O. (2007). Summary report-visit to Nigeria country support working group. partnership for maternal, newborn and child health summary Report September 16-22, 2007.
- Ylva, N., Hersham, E., Premila, P., Lars, B. (1998). Two new isoflavones from *ceiba pentandra* and their effects on cyclooxygenase-Catalyzed Prostaglandin Biosynthesis. *Journal of Natural Product*, **61(1)**: 8-12.