European Journal of Medicinal Plants
3(4): 577-590, 2013

SCIENCEDOMAIN *international*
www.sciencedomain.org

Antiulcerogenic Activity of *Kigelia africana, Nauclea latifolia* and *Staudtia stipitata* on Induce Ulcer in Albino Rats

R. T. Orole[1], O. O. Orole[2] and T. O. Adejumo[2*]

[1]Department of Biochemistry, Adekunle Ajasin University, P. M. B. 001, Akungba-Akoko, Nigeria.
[2]Department of Microbiology, Adekunle Ajasin University, Akungba-Akoko, Nigeria.

Authors' contributions

All the authors have cordially supported the work and preparation of the manuscript. Author RTO designed the study, performed the experiment. Author OOO managed the statistical analysis, wrote the protocol, and the first draft of the manuscript. Author TOA wrote the final draft, edited and managed the literature searches. All the authors have read and approved the final manuscript.

Research Article

Received 22nd May 2013
Accepted 12th July 2013
Published 21st August 2013

ABSTRACT

Aim: Ethanolic extracts of *Kigelia africana, Nauclea latifolia* and *Staudtia stipitata* were investigated for their phytochemical constituents and antiulcerogenic potential on aspirin induced ulcer in albino rats at 150mg/kg, 300mg/kg, and 450mg/kg body weights.
Place and Duration of Study: The study was carried out at Department of Biochemistry, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria, between June 2009 and August 2010.
Methodology: Ulcer was induced by administering aspirin (200mg/kg body weight) orally to albino rats. Phytochemical screening of leaf extracts was done using standard methods after ethanolic extraction had been concluded. Biochemical parameters showing the effects of ethanolic extracts of the different leaves used in treating ulcer were tested using standard methods.
Result: The extracts gave positive results to saponin, tannins, phylobatannins, anthraquinones and cardiac glycosides. *K. africana* at a concentration of 450 mg/kg body weight gave the best results with a significant decrease in ulcer index (0.67±0.16) on

**Corresponding author: Email: toadejumo@yahoo.com;*

aspirin-induced ulcerogenic animals compared to 3.0 for the reference drug (Cimetidine at 300mg/kg) and control with 1.67±0.27, while the leaf extracts of *S. stipitata* showed the least efficacy.
Conclusion: This study contributes to the search for potent and locally available plant materials for managing ulcer disease caused by non-steroidal antiinflammatory drugs.

Keywords: Kigelia Africana; Nauclea latifolia; Staudtia stipitata; antiulcerogenic; non-steroidal antiinflammatory.

1. INTRODUCTION

Peptic ulcer is a sore (which may be an acute or chronic inflammation) of the stomach or duodenum caused by a number of factors including bacterial infection by *Helicobacter pylori*, Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) such as starvation followed by aspirin or ibuprofen treatment, excessive drinking of alcohol, and smoking [1,2]. Patients with ulcer produce about twice as much as hydrochloric acid which bathes the lining of the mucosa, resulting in damage to the lining [2]. Aspirin, also known as acetylsalicylic acid is a corrosive agent with toxicity of LD50 of 200mg/kg in rats [3]. It induces the reactive oxygen metabolites in animal model and subsequently contributes to mucosa injury [4]. It also causes a dose-dependent reduction in mucosa prostaglandin E2 (PGE2) and PGI 2 biosynthesis with extension in the area covered with ulcerations [5,6]. Aspirin belongs to the group of NSAIDs. The gastric mucosa protects itself from gastric acid with a layer of mucus, the secretion of which is stimulated by certain prostaglandins. NSAIDs block the function of cyclooxygenase 1 (*cox-1*), which is essential for the production of these prostaglandins [7]. COX-2 selective anti-inflammatories (such as celecoxib or the since withdrawn rofecoxib) preferentially inhibit *cox-2*, which is less essential in the gastric mucosa, and roughly halve the risk of NSAID-related gastric ulceration [8]. The mechanisms of mucosal damage due to Aspirin (NSAID) could be explained as the inhibition of prostaglandin synthesis leading to vasoconstriction and low mucin content [9], damage to mucosal barrier leading to back diffusion of H+ ions causing tissue acidosis and lowering of pH, which in turn brings about uncoupling of oxidative phosphorylation in mitochondria releasing oxidative free radicals [10] and induction of inflammation and neutrophil infiltration [11,12].

Among the plants that have been reported to be useful in the treatment of ulcer include whole plant of *Diodia sarmentosa*, leaves of *Cassia nigricans*, *Ficus exasperate*, and *Synclisia scabrida* [13], roots of roots of *Zapoteca portoricensis, Morinda citrifolia* L., *Azadirachta indica* Juss. Syn. *Melia azadirachta* L., *Asparagus racemosus* Wild, *Bauh{inia variegata* Linn., *Aspilia africana*, *Kielmeyera coriacea* and *Carica papaya* L. [14,15].

In Nigeria, *Kigelia africana* (Sausage tree, uyan tree in Yoruba), *Nauclea latifolia* (Pin cushion tree and egbesi in Yoruba), and *Staudtia stipitata* Warb. commonly known as noive and oropa or Ewe Gbomorin in Yoruba belongs to the Family: Myristicaceae. They are tropical trees in Africa used for treating various ailments and remedies. The multipurpose nature of these herbal trees makes them important for everyday use in the African set up. Bark extracts of *K. africana* is reported to have anti malarial, anti cancer, anti aging potentials with additional abilities to treat venereal diseases, wounds, renal ailments, eczema, depression, body weakness and impetigo [16]. Antibacterial and antidiarrhoeal nature of the ethanolic extract of the leaves has been reported by Grace et al. [17]. *Kigelia africana* also called "sausage tree" because of the shape of its fruit is part of the family Bignoniaceae and Scrophulariaceae order. It is traditionally used for its effectiveness in

improving the firmness and elasticity of the skin. Other traditional uses include, use of the fruit for its antimicrobial properties in combating skin problems such as acne, eczema, wound dressing, and as water disinfectant [16]. *Kigelia africana* had been reported to contain antibacterial and antifungal properties, analgesic and anti-inflammatory, antidiarrhoeal, antiprotozoal, antimalarial and antineoplastic potentials [18,19,].

N. latifolia bark is used in the management of pain, fever and malaria; wounds, coughs and gonorrhoea in eastern and southern Nigeria [20]. The roots of this plant are used to induce abortion, as a purgative and for treating hypertension [21]. *N. latifolia* has been found to be useful in treating malaria caused by *Plasmodium falciparum* and against enteric bacteria: *Bacillus subtilis, Escherichia coli, Salmonella enteritidis, Pseudomonas aeruginosa* and *Klebsiella pneumonia* [22]. The extract of *Nauclea latifolia* were reported to contain strictosamide, naucleamides A, naucleamide F, quinovic acid-3-O-beta-rhamnosylpyranoside and quinovic acid 3-O-beta-fucosylpyranoside [23]. Further analysis on these compounds yielded 10-hydroxystrictosamide, 10-beta-glucosyloxyvincoside lactam and 16,17-dihydro-10-beta-glucosyloxyvincoside lactam which exhibited different levels of anti-GST and anti-fungal activities. *Nauclea latifolia* is noted to be anti-nociceptive, anti-inflammatory and anti-pyretic activities that justifies its use in malaria ethnopharmacy and subsequent development for clinical application [24]; leaves of *N. latifolia* possesses hypoglycaemic activity when used on alloxan-induced diabetic rats [24].

S. stipitata is most commonly exploited for timber [25]. The leaves are also used for catching naked-handed crustaceans and shellfish [26], and nutlets used for beads and necklaces in Ghana [27].

This study was to assess the efficacy of *Kigelia africana, Nauclea latifolia,* and *Staudtia stipitata* as antiulcerogenic plants useful in traditional medicine.

2. MATERIALS AND METHODS

2.1 Collection of Plant Materials and Animals

The leaves of *Kigelia africana*, *Staudtia stipitata*, and *Nauclea latifolia* were obtained from Iwaro-Oka in Ondo State, Nigeria. They were authenticated in the Department of Plant Science and Biotechnology, Adekunle Ajasin University, Akungba-Akoko, Ondo State. The specimen had been deposited at their herbarium under the reference number 3:157. Healthy albino rats (male and female weighing 110 g - 165 g) were used in the study. The rats were fed on Top Feed produced by Premier Feed Mills Co. Ltd., Ibadan, Nigeria. The animals were given water *ad libitum* and kept under standard environment (12 hr light, 12 hr darkness and temperature of 28±2ºC). This continued for eight (8) weeks in animal house before sacrificing them. The animals were separated and kept in individual cages, but given the same food throughout this period.

2.2 Extraction Procedure

The leaves were cleaned, air-dried in the shade, blended using warring blender. After blending, the pulverized leaves were soaked in 50v/v methanol then put on an electronic shaker for 3 days according to the methods of Nworgu et al. [22]. On the 3rd day, the filtrate was extracted using vacuum pump. The filtrate was then kept in a rotary evaporator to allow the ethanol to evaporate for further analysis.

2.3 Phytochemical Screening of Test Plants

2.3.1 Test for alkaloids

Each dried extract (0.05 g) was stirred with 5 ml of 1% aqueous hydrochloric acid (HCl) on a steam bath; 1 ml of the filtrate was treated with three drops of Mayer's reagent and a second 1 ml portion was treated with Dragendrff's reagent. Turbidity (reddish-brown) with either of the reagents was taken as preliminary evidence of the presence of alkaloid in the extract [28].

2.3.2 Test for phylobatannins

Deposits of red precipitate when an aqueous extract of the plant part was boiled with 1% aqueous hydrochloric acid indicated presence of phylobatannins [28].

2.3.3 Test for glycosides

Five millilitres of 25% H_2SO_4 was transferred into a tube and 0.5 ml of the extract was added and boiled in water bath for 15 mins. Fehling's solution (5 ml) was then added to the boiled mixture. A reddish brown colour indicated the presence of steroidal ring of glycosides.

2.3.4 Test for tannins

Five grams of each portion of the plant extract was stirred in 10 ml distilled water and filtered with Whattman's filter paper. Ferric chloride reagent was then added to the filtrate. A blue-black or blue-green precipitate indicated presence of tannins [29].

2.3.5 Test for anthraquionones

To 5 g of the extract of the leaves was added 5 ml benzene and shaken properly until it dissolved. Five millilitres of 10% ammonia solution (NH_3) was then added to the filtrate and the mixture shaken. Pink, red, or violet colour in the ammoniacal (lower) phase indicated the presence of free hydroxyl anthraquionones [30].

2.3.6 Test for saponins

Each plant extract (0.5 g) was shaken with water in a test tube. Frothing which persisted on warming was taken as preliminary evidence of the presence of saponins. In order to remove 'false-positive' result, the blood haemolysis' test was performed on those extracts that frothed in water. Half gram of each extract was boiled briefly with 50 ml phosphate buffer of pH 7.4, and allowed to cool, then filtered. Five millilitres of the filtrate was passed for 3 hr through an asbestos disc (1.5 mm thick and 7 mm in diameter), which had been previously soaked with 2-3 drops of 1% cholesterol in ether and dried. After filtration, the disc was washed with 0.5 ml of distilled water, dried and boiled in 20 ml xylol or 2 hr to decompose the complex formed between cholesterol and any saponin in the extract. The disc was then washed in ether, dried and placed on a 7% Blood Nutrient Agar. Complete haemolysis of red blood cells around the disc after 6 hr indicated the presence of saponins [30].

2.3.7 Other tests

Other tests performed on the dried extract include the presence and absence of steroidal ring, steroidal nucleus, cardenolides and deoxyribose sugar using standard procedures [29,31,32,33].

2.4 Induction of Ulcer

A modified methods of Sivaraman and Muralidharan [34] was employed. Ulcer was induced by administering aspirin at 200 mg/kg orally, based on body weight of the individual rat in a suspension prepared in 1% CMC with distilled water. Later, the animals were denied feeding for 2 days according to the methods of Zeeyauddin et al. [35] and Borikar et al. [36].

2.5 Treatment with Extracts

The animals were treated after the induction of ulcers. They were divided into 12 groups of 5 animals each and fasted for 2 days to allow free access to water only. The first 3 groups were differently administered with 150 mg/kg concentration of the leaves extract each. The next three groups were treated each to 300mg/kg doses of the 3 ethanolic extracts respectively, while the 450 mg/kg concentrations of *K. africana*, *N. latifolia* and *S. stipitata* were orally administered differently to a group of five animals each. One group of 5 albino rats were given aspirin (200 mg/kg) and water only; another group was administered with standard drug: Cimetidine at concentration of 300mg/kg. The control group was administered with water only. The test drugs (aspirin, cimetidine and the ethanolic extracts) were orally administered twice daily for a period of two days.

2.5.1 Estimation of ulcer index

The ulcer index (UI) was calculated by the following equation:

UI = UN + US + UP × 10-1
Where,
UN = Average number of ulcers/animal,
US = Average severity scores,
UP = Percentage of animals with ulcers.
Ulcer index is the mean of total number of ulcers in particular group.
UN= total no of ulcers per animal in a group÷no of animals in the group
US= average severity score= total animals with ulcers of 3mm size above to perforated ulcers÷total animals

Ulcer index and acidity of the gastric content of the treated animals were compared with the control.

2.6 Collection of Gastric Juice

A modified method of Devaraj et al. [37] was used. The albino rats were anaesthetized in a desiccator before sacrificing. They were then dissected and the stomach carefully removed and incised along the greater curvature to expose the mucosa layer of the lumen. Color Atlas of the Rats Olds, [38] was used to examine for the presence of ulcers. They were subsequently confirmed by examining the tissues under magnification with obliquely

reflected light (magnified light). The GI was observed for ulceration >1 mm to <5 mm in diameter and up to 5 intestinal perforations. The glandular lining of the stomach was then scrapped and suspended in normal saline before being homogenized. The homogenate was then centrifuged at 3500 rpm for 10 minutes. The volume of the centrifuged gastric juice and the pH were measured and stored for further analysis.

2.7 Biochemical Tests

2.7.1 Determination of free acidity

The gastric content was centrifuged at 1000 × g for 10 minutes. One millilitre was pipetted out of the supernatant liquid and diluted to 10 ml with distilled water. Then total acidity of gastric juice was estimated by titration with 0.01 N sodium hydroxide using phenolphthalein as an indicator. The result was expressed as the free acid output, expressed as mEq/liter of body weight [39].

2.7.2 Determination of protein content

Protein estimation was carried out using the methods described by Lowry et al. [40]. One millilitre of gastric juice and 9 ml of 95% alcohol was mixed, shaken, and then the mixture was centrifuged at 3000 × g for 15 minutes to obtain the precipitation. The precipitate was dissolved in 1 ml of 0.1 N NaOH. Then 0.9 ml of distilled water was added to 0.1 ml of the above-mentioned solution. Out of this solution, 0.4 ml was taken in another test tube. Four milliliters of alkaline reagent was added to the test tube and kept for 10 minutes. Then 0.4 ml of phenol reagent was added to this test tube and kept for 10 minutes for color development. The readings were taken against the blank prepared with distilled water. Protein content was obtained by calculating with the use of standard curve prepared with bovine albumin. The concentrations of proteins were expressed in terms of micrograms per millilitre of gastric juice ± SEM.

2.7.3 Determination of total carbohydrate

One milliliter of 5% phenol was pipetted into test tubes containing 0.15 m gastric juice and a blank containing 0.15 ml of distilled water, it was mixed thoroughly. Five milliliters of 96% $H2SO_4$ was added and mixed slowly. After 10 minutes, the test tubes were shaken and placed in water kept at 20ºC for 20 minutes. The optical density of the developed yellow orange chromophore was read in a UV spectrophotometer at 482 nm. Several concentrations of glucose standard solutions were run to prepare a standard curve. Total carbohydrates were expressed in terms of micrograms per millilitre liberated in gastric juice [41].

The hexose, hexosamine, fucose and sialic acid content were also determined [41,42].

2.8 Statistical Analysis

The results were expressed as means and Standard Error of Means (SEM). Analysis of Variance was obtained and the means were separated using Tukey's Kramer post hoc test at $p \leq 0.05$.

3. RESULTS

3.1 Phytochemical Screening of Leaf Extracts

The analysis of the three plants showed that the three plants (*Kigelia africana*, *Nauclea latifolia*, and *Staudtia stipitata*) contained saponin, tannins, phylobatannins, cardiac glycosides, and cardenolides in their leaves (Table 1). Other constituents were deoxyribose sugars and anthraquinones. *K. africana* lacks steroidal ring while steroidal nucleus was absent in *N. latifolia* and *S. stipitata.* The result is shown in Table 1 below.

Table 1. Phytochemical constituents of leaf extracts

Phytochemicals	*Kigelia africana*	*Nauclea latifolia*	*Staudtia stipitata*
Saponin	+	+	+
Tanins	+	+	+
Phylobatannins	+	+	+
Cardiac Glycosides	+	+	+
Steroids	-	+	+
Anthraquinones	+	+	+
Cardenolides	+	+	+
Deoxyribose Sugars	+	+	+

Keys: + = Present; - = Absent

3.2 Percentage Yield of Extracts

The percentage yield of each plant extract from the sample using ethanol and water as solvent resulted in *Kigelia africana 25%*, *Nauclea latifolia* 15%, and *Staudtia stipitata* 10%.

3.3 Biochemical Analysis

The group of 5 animals treated with only aspirin (200mg/kg) and water had the highest pH 3.2±0.09 and highest ulcer index of 5 was also observed showing its ability to induce ulcer in rats. Table 2 shows the effects of administering varying doses of the plant extracts on the rats. Extracts from *K. africana* and *N. latifolia* significantly (P=0.05) reduced the ulcer index (Figure 1), from 4.33±0.27 to 0.67±0.16 and 2.67±0.27 to 1.0 respectively while *S. latifolia* showed best effects of 2.6±0.27 at 450mg/kg body weight (Table 2).

Table 2. Biochemical Parameters of gastric juice of rats treated with the plant extracts

Group	Gatric Volume (ml)	pH	Free acidity (Meq/l)	Total acidity (Meq/l)	Hexose (µg/ml)	He hexosamine (µg/ml)	fucose (µg/ml)	Sialic acid (µg/ml)	Protein (µg/ml)
Control	6.0±0.47^{a}	2.8±0.16^{a}	25±0.47^{a}	30±1.41^{a}	198±12.70^{a}	108±9.24^{a}	23±1.15^{a}	19±0.58^{a}	240±0.27^{a}
Aspirin	5.0±0.47^{b}	3.2±0.09^{b}	27±1.7^{a}	40±1.89^{b}	200±11.55^{a}	115±1.15^{a}	31±1.15^{b}	30±1.15^{b}	270±17.32^{b}
Cimetidine	6.0±0.47^{a}	2.0±0.08^{c}	25±0.94^{a}	30±2.36^{at}	250±17.32^{b}	130±10.00^{b}	20±1.15^{ce}	22±1.00^{c}	225±8.66^{c}
K. africana									
150 mg/kg	6.0±0.19^{a}	2.0±0.09^{c}	5.0±0.47^{b}	20±0.94^{d}	280±11.55^{c}	270±11.55^{c}	18±1.15^{c}	17±0.58^{d}	165±8.66^{e}
300 mg/kg	5.0±0.21^{b}	1.0±0.00^{d}	5.0±0.24^{b}	20±2.05^{d}	295±10.41^{c}	320±5.77^{d}	16±0.58^{d}	18±1.15^{d}	145±25.98^{e}
450 mg/kg	4.0±0.47^{c}	1.1±0.07^{e}	5.0±0.94^{b}	5.0±0.47^{e}	300±36.06^{c}	350±10.00^{e}	15±0.58^{d}	23±1.15^{c}	125±20.21^{c}
N. latifolia									
150 mg/kg	4.0±0.47^{c}	2.0±0.05^{c}	10±0.47^{d}	25±1.89^{g}	245±8.66^{b}	210±5.77^{h}	26±0.58^{f}	11±0.58^{g}	210±11.55^{e}
300 mg/kg	5.0±0.47^{b}	1.8±0.05^{g}	5.0±0.94^{b}	20±3.74^{dh}	258±9.24^{b}	225±5.00^{i}	25±.58^{fg}	14±1.15^{h}	250±11.55^{ab}
450 mg/kg	6.0±0.47^{a}	1.4±0.09^{h}	14±0.47^{e}	25±0.47^{g}	275±14.47^{b}	214±5.77^{h}	19±0.58^{h}	15±0.58^{h}	290±11.55^{bf}
S. stipitata									
150 mg/kg	4.0±0.47^{c}	1.5±0.09^{f}	15±0.47^{c}	30±3.00^{a}	255±10.41^{b}	160±5.77^{f}	22±1.00^{e}	6.0±1.00^{e}	200±11.55^{f}
300 mg/kg	4.0±0.47^{c}	1.0±0.07^{de}	5.0±0.94^{b}	25±2.75^{fgh}	260±17.32^{b}	170±10.0^{f}	21±1.00^{c}	8.0±0.58^{f}	162±6.13^{d}
450 mg/kg	6.0±0.24^{a}	1.1±0.05^{e}	15±2.16^{ce}	20±0.94^{d}	263±21.36^{b}	190±5.77^{g}	24±.58a^{g}	9.0±1.53^{f}	155±4.49^{d}

Tabulated results are means of five determinations ± SEM. Values with different letters superscripts are significantly different ($p \leq 05$).

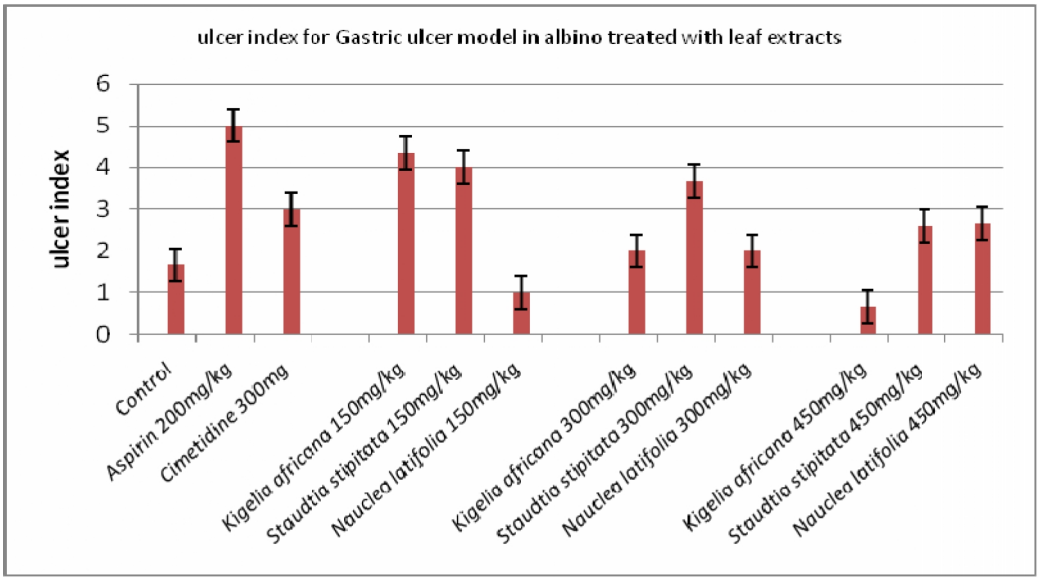

Figure 1. Ulcer Index for gastric ulcer model in albino treated with leaf extracts

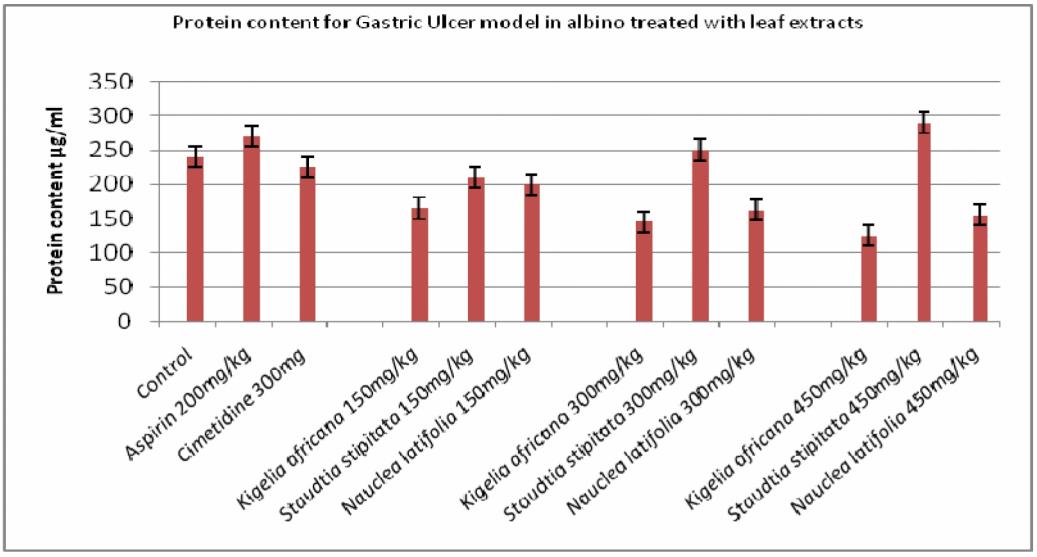

Figure 2. Protein content for gastric ulcer model in albino rats treated with leaf extracts

A dose of 450 mg/kg of *K. africana* showed the best protection of 0.67±0.16 ulcer index followed by *N. latifolia* at a dosage of 150mg/kg body weight and ulcer index of 1. Free acidity, pH, and total acidity content decreased in all three tested concentrations of the three extracts, except for *S. stipitata* when administered at a dose of 150 and 300mg/kg (Figure 2).

The administration of *K. africana* and *N. latifolia* extracts and the reference drug Cimetidine showed reduction (P=0.05) in the protein content, unlike *S. stipitata* that showed increased protein content (Table 2). The sugars: hexose and hexosamine increased from 280-300µg/ml and 270-350µg/ml on the administration of *K. africana*, 255-265µg/ml and 160-190µg/ml for *S. stipitata*, and *N. latifolia* (240-275µg/ml, 210-214µg/ml) respectively, while fucose concentration (31±1.15µg/ml) was highest on administration of aspirin. It was observed that, the higher the concentration of the administered extracts, the lower the hexose, hexosamine, and fucose values. The Sialic acid content of the gastric juice was highest on aspirin administered rats (30±1.15µg/ml) and lowest for *K. africana* administered albino rats at concentration of 450mg/kg (6.0±1µg/ml).

4. DISCUSSION

Aspirin at 200mg/kg concentration caused the highest ulcer index of five. Mc Cord [43] reported the ability of aspirin to generate Reactive Oxygen Species (ROS), which plays a role in inducing gastric mucosa lesions. Aspirin decreases the carbohydrate concentration, carbohydrate/protein ratio of the gastric juice resulting into ulceration of the mucosa wall [35]. Non-Steroidal Anti-Inflamatory Drugs (NSAIDs) causes ulceration by interfering with prostaglandins, which helps the gut linings to resist corrosive acid damage in the stomach.

The presence of sugars, saponins, flavonoid, alkaloids, glycosides in *Kigelia africana* and *Nauclea latifolia* agreed with the reports of [16,22,44]. The authors reported the lack of recent and sufficient scientific information on the use of *K. africana* as a veritable medicinal plant; the same can be said of *Staudtia stipitata*. *K. africana* at 450mg/kg showed the lowest ulcer index, followed by *N. latifolia* at 150mg/kg. The efficacy of *K. africana* and *N. latifolia* may be due to the presence of saponin, tannins, phylobatannins and other secondary metabolites present in them. Atolani and Olatunji [45] and de Sousa Falcão et al. [50] reported that flavonoids and alkaloids have anti-ulcer properties. Alkaloids accelerate the ulcer healing process and subsequently increases gastric mucus production after the lesion had been formed [46]. Alkaloids protect the stomach from hemorrhages and increase the pH gradient/gastric fluid volume from damages induced by aspirin [47]. These alkaloids function by increasing free mucus and prostaglandin in the mucosal gastric, and subsequently causing reduction of exfoliation of superficial cells, haemorrhages and blood cell infiltration that can be mediated by increase in gastrin secretion and mRNA expression of epidermal growth factors [48].

Tannins have been reported by Thirunavukkarasu and Ramanathan, [1] to have anti-ulcer properties by precipitating microprotein at the site of wounds, thereby creating a vasoconstricting effect. These may be responsible for the low ulcer index observed. Abu-Darwish and Ateyyat, [49] highlighted that some anthraquinones decreased the production of hydrochloric acid (HCl acid) and pepsin, while increasing the production of mucosa. It acts on arylamine N-acetyltransferase enzyme which help the development of *Helicobacter pylori*. The action of anthraquinone may also be responsible for anti ulcerogenic activities observed in the leaf extracts.

The ulcer indexes in animals treated with different concentrations of *S. Stipitata* were mostly higher than those treated with *K. africana* and *N. latifolia*. This implied that the plant contains possibly low or ineffective alkaloids since the extract tested positive to their presence. Generally, *K. africana* and *S. Stipitata* extracts demonstrated dose-dependent anti-ulcer properties, while *N. latifolia* did not. The protein content of gastric juice decreased with increasing concentration of *K. Africana,* but increased with increasing concentration of *N.*

Latifolia, while no regular pattern was followed by *S. stipitata.* Colfer [25] reported *S. Stipitata* as a plant that is most commonly exploited for timber, as well as yielding medicinal products, which is in agreement with the results obtained in this study. It may be inferred that the 450mg/kg body weight dosage of *K. africana* may be proteolytic, while the 150mg/kg concentration may be toxicologically safer. Increases observed in the resistance factor like pH, hexose, hexosamine, fucose, and sialic acid of the extracts may be due to presence of saponins and glycosides. Further studies on these plants may provide more insight on etiopathogenesis of ulceration and ulcer managing activity of these plants.

5. CONCLUSION

This study contributes to the determination of potent compounds like alkaloids, phylobatannins, cardiac glycosides, saponins and steroids in the locally available plant materials. *Kigelia africana, Nauclea latifolia and Staudtia stipitata* extracts showed different efficacy, and therefore could be employed in the management of ulcer disease caused by non-steroidal antiinflammatory drugs.

CONSENT

Not applicable.

ETHICAL APPROVAL

All the authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable.

COMPETING INTERESTS

All the authors have declared that no competing interests exist.

REFERENCES

1. Thirunavukkarasu LR, Ramanathan T. Anti-ulcer activity of *excoecaria agallocha* bark on NSAID-induced gastric ulcer in albino rats. Global Journal of Pharmacology. 2009;3(3):123-126.
2. National Institute of Health (NIH). National Digestive Disease Information Clearing Home (NNDIC). 2004;05:4225.
3. Boyd EM. The Safety and Toxicity of Aspirin. The American J. Nursing. 1971;71(5):964-966.
4. Mc Allindon ME, Muller AF, Fillipowicz B, Hawkey C. Effect of allopurinol and sulphasalazine and vitamin C on aspirin-induced gastroduodenal injury in human volunteers gut. Annual Journal of Medicine. 1996;38:518-524.
5. Komoto J, Yamada T, Watanabe K, Woodward D, Takusagawa F. Prostaglandin F2 alpha formation from prostaglandin H2 by prostaglandin F synthase (PGFS): crystal structure of PGFS containing bimatoprost. Biochem. 2006;45(7):1987–96.
6. Komoto J, Yamada T, Watanabe K, Takusagawa F. Crystal structure of human prostaglandin F synthase (AKR1C3). Biochem. 2004;43(8):2188–98.
7. Jouzeau JY, Terlain B, Abid A, Nedelec E, Netter P. Cyclooxygeanse isoenzymes. How recent findings affect thinking about nonsteroidal anti-inflammatory drugs. Drugs, 1997;53:563-582.

8. Kent TH, Cardinelli RM, Stamler FW. Small intestinal ulcers and intestinal flora in rats given indomethacin. Am. J. Pathol. 1969;54:237-249.
9. Brunton L, Chebner B, Knollman B, editors. Goodman & Gilmans manual of pharmacol-ogy and therapeutics. 12th ed. New York: McGraw Hill companies; 2011.
10. Gana TJ, Huholewych R, Koo J. Focal gastric mucosal blood flow in aspirin induced ulceration. Ann Surg. 1987;205:399-403.
11. Yoshikawa T, Naito Y, Kishi A, Tomii T, Linuma S, Yasuda M. Role of active oxygen, lipid peroxidation and antioxidants in the pathogenesis of gastric mucosal injury induced by indomethacin in rats. Gut. 1993;34:732-7.
12. Kitahora T, Guth PH. Effect of aspirin plus hydrochloric acid on gastric mucosal micro-circulation. Gastroenterology. 1987;93:810.
13. Akah PA, Orisakwe OE, Gamaniel KS, Shittu A J. Evaluation of Nigerian traditional medicines: II. Effects of some Nigerian folk remedies on peptic ulcer. Ethnopharmacol. 1998;62(2):123-127.
14. Sravani P, Jayasri P, Samiulla, Ershad KP, Nishad KP. Review on natural antiulcer agents, Ind. J. Pharm & Ind. Res. 2011;01:67-70.
15. Ubaka MC and Ukwe VC. Investigation in to the anti ulcer activity of the aqueous leaf extract of *Aspilia africana*. Asian Journal of Medical Sciences. 2010;2(2):40-43.
16. Olatunji AG and Atolani O. Comprehensive scientific demystification of *Kigelia africana*: A review. Afr. J. Pure and Appl. Chem. 2009;3(9):158-164.
17. Grace OM, Light ME, Lindsey KL, Moholland DA, Staden JV, Jager AK. Antibacterial activity and isolation of antibacterial compounds from the fruit of the traditional african medicinal plant *Kigelia africana*. South African Journal of Botany. 2002;68:220-222.
18. Agyare C, Dwobeng AS, Agyepong N, Boakye YD, Mensah KB, Ayande PG, Adarkwa-Yiadom M. Antimicrobial, Antioxidant, and Wound Healing Properties of *Kigelia africana* (Lam.) Beneth. and *Strophanthus hispidus* DC. Advances in Pharmacological Sciences. 2013; Article ID 692613, 10 pages
19. Sangita S, Harmet K, Bharat V, Rupudaman and Singh SK. Kigelia Africana (Lam.) Benth. An Overview – Natural Product Radiance, 2009;8(2):190-197
20. Gidado A, Ameh DA, Atawodi SE. Effect of *Nauclea latifolia* leaves aqueous extracts on blood glucose levels of normal and alloxan-induced diabetic rats. African Journal of Biotechnol. 2005;4(1):91-93.
21. Akubue PI, Mittal GC. Clinical evaluation of a traditional herbal practice in Nigeria: preliminary report. J. Ethnopharmacol. 1982;6(3):355-359.
22. Nworgu ZA, Onwukaeme DN, Afolayan AJ, Ameachina FC, Ayinde BA. Preliminary studies of blood pressure lowering effect of *Nauclea latifolia* in rats. Afr. J. Pharm. Pharmacol. 2008;2(2):037-041.
23. Ata A, Udenigwe CC, Matochko W, Holloway P, Eze MO, Uzoegwu PN. Chemical constituents of Nauclea latifolia and their anti-GST and anti-fungal activities. Nat Prod Commun. 2009;4(9):1185-8.
24. Abbah J, Amos S, Chindo B, Ngazal I, Vongtau HO, Adzu B, Farida T, Odutola AA, Wambebe C, Gamaniel KS. Pharmacological evidence favouring the use of *Nauclea latifolia* in malaria ethnopharmacy: effects against nociception, inflammation, and pyrexia in rats and mice. J Ethnopharmacol. 2010;127(1):85-90.
25. Colfer CJP ed. The complex forest: Uncertainty, and Adaptive, Collaborative Management. Resource for the Future (RFF) Publishers. 2005;352.
26. Burkill HM. The Useful Plants of West Tropical Africa 1 (2). Royal Botanic Gardens, Kew; 1985.
27. Abbiw DK. Useful Plants of Ghana. Royal Botanic Gardens, Kew; 1990.

28. Sofowora A. Medicinal Plants and Traditional Medicine in Africa. 2nd Ed., Spectrum Books Ltd., Ibadan, Nigeria. 2006;151-153:209-214.
29. Harborne JB. Bioactive constituents of plant. In: Phytochemical methods. A guide to modern techniques of plant analysis (2nd ed.). Chapman and Hall Publ. Co. London. 1992;46-288.
30. Edeoga HO, Okwu DE, Mbaebie BO. Phytochemical constituents of some Nigerian medicinal plants. Afr. J. Biotechnol. 2005;4(7):685-688.
31. Evans WC. Trease and Evans Pharmacognosy. WB Saunders Ltd. London. 14th Ed. 1996;119-159.
32. Ciulei I. Methodology for analysis of vegetable drugs. United Nations Industrial Development Organisation. Romania. 1981;17-25.
33. Brain KR, Turner TD. Practical evaluation of phytopharmaceuticals. Wright – Scientechnica, Bristol. 1st Ed. 1975;144.
34. Sivaraman D, Muralidharan P. Anti-ulcerogenic evaluation of root extract of *Ficus hispida* Linn. in aspirin ulcerated rats. Afr. J. Pharm. Pharmacol. 2010;4(2):079-082.
35. Zeeyauddin K, Narsu ML, Abid M, Ibrahim M. Evaluation of antiulcer activity of *Boswellia serrata* bark extracts using aspirin induced ulcer model in albino rats. J. Med & Allied Science. 2011;1(1):14-20.
36. Borikar VI, Jangde CR, Philip P, Rekhe DS. Study of Antiulcer Activity of *Bauhinia racemosa* Lam in rats. Veterinary World. 2009;2(6):215-216.
37. Devaraj VC, Mohammed A, Prasad S. Effect of Leaves and Fruits of *Moringa oleifera* on Gastric and Duodenal Ulcers. Pharm. Biol. 2007;4(4):332–338.
38. Olds RJ. A Color Atlas of the Rat: Dissection Guide. John Wiley & Sons, New York; 1979.
39. Prino G, Paglialunga S, Nardi G, Lietti A. Inhibition of experimentally-induced gastric ulcers in the rat by a new sulfated glycopeptide. Eur J. Pharmacol. 1971;15:119-126.
40. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. Protein measurement with the folin-phenol reagent. J. Biol. Chem. 1951;193:265-75.
41. Sanyal AK, Mitra PK, Goel RK. A modified method to estimate dissolved mucosubstances in gastric juice. Indian J. Exp. Biol. 1983;21:78–80.
42. Goel RK, Das DG, Sanyal AK. Effect of vegetable banana powder on changes induced by ulcerogenic agents in dissolved mucosubstances of gastric juice. Indian J. Gastroenterol. 1985;4:249–251.
43. Mc Cord JM. The evolution of free radicals and oxidative stress. Ann. J. Med. 2000;108:652.
44. Owolabi OJ, Omogbai EK. Analgesic and anti-inflammatory activities of ethanolic stem bark extract of *Kigelia africana* (Bignoniacea). Afr. J. Biotechnol. 2007;6(5):582-585.
45. Atolani O, Olatunji AG. Epicuticular Wax and Volatiles of *Kigelia pinnata* Leaf Extract. Ethnobotanical Leaflets. 2010;14:797-806.
46. De Sousa Falcão H, Leite JA, Barbosa-Filho JM, Athayde-Filho PF, de Oliveira Chaveves MC, Dantas Moura M, Ferreira AL, de Almeida ABA, , Souza-Brito ARM, de Fátima Formiga Melo Diniz M, Batista LM. Gastric and Duodenal Antiulcer Activity of Alkaloids. Molecules. 2008;13:3198-3223.
47. Fallone CA, Morris GP. Topical nicotine protects rat gastric mucosa against ASA-induced damage. A role for mucosal fluid secretion in cytoprotection. Digest. Dis. Sci. 1995;40:936-942.
48. Toma W, Trigo JR, BensuaskI de Paula AC, Souza Brito ARM. Preventive activity of pyrrolizidine alkaloids from *Senecio brasiliensis* (Asteraceae) on gastric and duodenal induced ulcer on mice and rats. J. Ethnopharmacol. 2004;95:345-351.

49. Abu-Darwish SM, Ateyyat AM. The Pharmacological and Pesticidal Actions of Naturally Occurring 1, 8-dihydroxyanthraquinones Derivatives. World J. Agric. Sc. 2008;4(4):495-505.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=253&id=13&aid=1898