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Effects of Christmas Bush (*Chromolaena Odorata*), Cathedral Bells (*Bryophyllum Pinnatum*) and Water Leaf (*Talinium Triangulare*) Leaf Extracts on Biochemical Markers, and Ulcer Parameters of Ulcer-Induced Adult Male Wistar Rats

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Abstract

Many medicinal plants are commonly used in traditional treatment of ulcer however, the dosages remain unclear. The study examined the effects of Chromolaena odorata, Bryophyllum pinnatum and Talinium triangulare leaf extracts on biochemical markers and ulcer parameters of ulcer-induced adult male wistar rats. Christmas bush and cathedral bells leaves were harvested from Nsukka town, while water leaf was bought from Ogige market at Nsukka, Enugu State. They leaves were processed into flour and marcerated in water for 48 hours to obtain extracts. Adult male Wistar rats (72) were acclimatized and randomly assigned to groups. Ulcer was induced with indomethacin solution before treatment commenced. Different doses of the extracts were administered orally for a period of 14 days. Biochemical analysis of serum prostaglandin (PG), superoxide dismutase (SOD) and catalase (CAT) levels were conducted. Thereafter, the rats were sacrificed and gastric volume, ulcer index and pH of the gastric juices determined using standard assay. Statistical analysis was performed using IBM-SPSS version 23, with significance set at $p<0.05$. The extracts reduced PG levels while increasing CAT and SOD levels. A significant difference ($p<0.05$) in PG levels was observed between baseline and end-line values in groups induced without treatment and all treated groups. Significant difference ($p<0.05$) existed between baseline and end-line values of catalase and SOD in all the treated groups. Significant ($p<0.05$) reduction occurred in ulcer index values between induced without treatment and other rat groups. The leaf extracts have the potential to ameliorate mucosal inflammation and gastric effect of indomethacin-induced ulcer.

Keywords: Christmas Bush, Cathedral Bells, Water Leaf, Ulcer Index, Serum Prostaglandin.

1. Introduction

Peptic ulcer disease (PUD) is a prevalent digestive disorder characterized by a mucosal breakdown in the digestive tract, typically greater than 3-5mm, penetrating into the submucosa [1]. This condition involves a disruption in the gastric or duodenal epithelium that extends beyond the muscularis mucosa layer. PUD occurs when the gastrointestinal mucosa's protective mechanisms, such as mucus and bicarbonate secretion, are overwhelmed by the damaging effects of gastric acid and pepsin [2]. It typically forms in the stomach and proximal duodenum, and are classified as gastric ulcers (GU) or duodenal ulcers (DU) based on their location within the gastrointestinal tract [3]. Various factors can contribute to the development of acute gastrointestinal disorders, including increased acid-pepsin secretion, decreased mucus and bicarbonate secretion, severe psychological or physical stress, smoking, imbalanced bile salt secretion, *Helicobacter pylori* infection, ethanol ingestion, hereditary factors, aspirin, and other nonsteroidal anti-inflammatory drugs [4]. Oxidative stress is a significant contributor to the development of stomach diseases and is a primary cause of stress ulcers [5].

Peptic ulcers have numerous health implications and many individuals with the disease are unaware of the symptoms and do not seek medical diagnosis. Untreated gastric ulcers can

lead to severe complications such as hemorrhages, perforation, penetration into adjacent organs, and gastrointestinal obstruction. The alarming incidence of peptic ulcer in recent time may pose a serious health and economic challenge to the nation and the entire globe if not tackled. Between1990-2019 the number of incidences of peptic ulcer disease increased from 2.82 million to more than 3.59 million, representing an increase of 27.3% in the global incident cases of peptic ulcer disease [6]. An estimated global prevalence rate of peptic ulcer of between 5-10% of the population was reported by Lanas and Chan [7]. The prevalence of peptic ulcer among under graduate students in a Nigerian university was 7.9% [8]. In spite of the changing concept of gastric ulcer management from convectional vagotomy, prostaglandin analogs, H2 receptor antagonists and antacids to proton pump inhibitors, gastrointestinal toxicity remains an impediment to their application in clinical practice [9]. The reoccurrence of peptic ulcers in treated individuals, along with the side effects of existing medications, especially with long-term use raises significant concerns.

The use of plants as alternative treatments for diseases has gained increasing attention in recent years. These plants are of particular interest due to their affordability, availability, and beneficial effects in treating various non-communicable diseases, including diabetes, cardiovascular diseases, cancer, liver disorders, ulcers, and in promoting wound healing. It is expected that the oxygen-derived free radicals involved in ulcer formation can be modulated with the use of vegetable extracts because of their antioxidants properties which provide gastro-protective effects.

Chromolaena odorata also known as Christmas bush is a tropical and sub-tropical specie of flowering shrub in the family asteracea and genus chromolaena. It is an edible vegetable used in food preparation particularly pottage yam in some part of northern Nigeria. *Chromolaena ordorata* exhibits anti-inflammatory, antipyretic, analgesic, antimicrobial, cytotoxic and numerous other relevant medicinal properties on an appreciable scale and is known in some parts of the world as a traditional medicine used in treatment of various ailments [10].

Bryophllum pinnatum popularly known as cathedral bells or life plant or miracle leaf is a succulent perennial plant that belongs to the crussutaceae family. It is native to Madagascar and is used in some part of the world as traditional medicinal plant [11]. Julia et al. reported the traditional use of *Bryophylum pinnatum* in the treatment of inflammation, microbial infection, pain, respiratory diseases, gastritis, ulcers, diabetes and cancer tumors. *Bryophyllum pinnatum* contains many phytochemicals including flavonoids, saponins, tannis, and alkaloids [12].

Talinium triangulare commonly known as waterleaf is an edible leafy green vegetable. It is an annual and perennial plant native to tropical and sub-tropical South America. *Talinium triangulare* leaves are beneficial in the management of cardiovascular diseases and also act as antibacterial [13,14]. The macerated leaves are applied locally to treat wound, scabies, and cuts [15].

Helicobacter pylori is a major cause of ulcers, with higher infection rates reported in developing regions such as Africa, Central America, Central Asia, and Eastern Europe [16]. Improved hygiene has contributed to reducing H. pylori infections, however complete eradication is yet to be achieved. Ongoing research is exploring alternative therapeutic drugs that suppress the effects of H. pylori and reduce gastric inflammation. The present study contributes to the growing body of knowledge on addressing these challenges. The objective of the study is to determine the effects of *Chromolaena odorata, Bryophyllum pinnatum and Talinium triangulare* leaf extracts on biochemical markers and ulcer parameters of ulcer-induced adult male wistar rats.

2. Materials and Methods

2.1 Study Design

The study adopted experimental design.

2.2 Sample Collection and Identification

One kilogram each, of fresh leaves of Christmas bush (*Chromolaena odorata*) and cathedral bells (*Bryophyllum pinnatum*) were harvested from a bush in Nsukka town while water leaf (*Talinium triangulare*) was bought from Ogige market in Nsukka, Enugu State, South East Nigeria. The leaves were taken to the herbarium unit in the Department of Plant Science and Biotechnology University of Nigeria Nsukka for proper identification.

2.3 Preparation of Extracts

The leaves of *Chromolaena odorata, Bryophyllum pinnatum and Talinium triangular*e were separately plucked, weighed, washed, cut and shade dried under room temperature for one week and then ground into powder using an electric blender. Two hundred and fifty grams (250 g) of each of the powdered dried leaves were macerated in 500 ml of distilled water for 48 hours in a flask. The mixture was decanted and then filtered through Whatman No.1 filter paper to obtain clear extracts. The extracts were stored in a refrigerator maintained at 40C for future use while the residues were discarded.

2.4 Procurement of Rats and Drugs (Indomethacin)

A total of seventy-two (72) adult male wistar rats with no prior drug treatment, weighing between 150-180g were used for the study. The rats were purchased from the Department of Veterinary Pathology, University of Nigeria Nsukka. The indomethacin that was used for the induction of ulcer and ranitidine for the treatment of ulcer were obtained from a pharmaceutical shop at Nsukka, Enugu state Nigeria.

2.5 Animal Housing and Ethics

Seventy-two (72) adult-male Wistar rats weighing between 150 - 180g were housed in the animal house of Department of Nutrition and Dietetics University of Nigeria, Nsukka. The initial weights of the rats were taken and the grouping was based on their body weights with differences not greater than ±5g. Rats were left to acclimatize for 3 days before commencement of the experiment. The experiment was carried out according to the principles in the guide for the care and use of laboratory animals described by the

National Institute of Health. The experimental protocols were made to conform to the rules for ethical conduct within the animal use and care. Ethical clearance was obtained from Animal Care and Use Committee, Faculty of Veterinary Medicine, University of Nigeria Nsukka.

2.6 Induction of Ulcer

The rats were deprived of food but had free access to water for 24 hours prior to ulcer induction. Rats in all groups were administered indomethacin, except those in group 1, which served as the normal control. A solution of indomethacin was prepared by the laboratory technician using 1% carboxymethyl cellulose (CMC) in water as a solvent. The indomethacin solution, at a dose of 30 mg/kg body weight, was administered orally to the rats using a cannula, following the method described by Sayanti et al. [17]. Two rats from each group were randomly selected and sacrificed 4 hours post-induction to confirm the presence of ulcers.

The stomachs of the sacrificed animals were dissected, and the gastric contents were collected. The stomachs were then opened along the greater curvature and gently rinsed with normal saline. Examination for ulcers was conducted using a hand lens to ensure clear visibility. The gastric ulcers were counted and evaluated based on the method of Dashputre and Niakwade as presented in Table 1. Four hours post-indomethacin administration, various degrees of ulceration were observed. The degree of ulceration (DU) was calculated using the formula: DU = total ulcer score / number of ulcerated animals [18,19].

Remark	Score
Normal colored stomach	0
Red coloration	0.5
Spot ulcer	1
Hemorrhagic ulcer	1.5
Deep ulcer	2
Perforated ulcer	3

Table 1: Descriptive Remark and Ulcer Score

2.7 Feeding Trial

All rats were fed with grower's mash and had access to water ad libitum for 14 days. Group 1 (normal control) was not induced with ulcers and did not receive any leaf extract. Group 2 (negative control) was ulcer-induced but did not receive any treatment. Group 3 (positive control) was ulcer-induced and treated with 150 mg/kg body weight of ranitidine. Groups 4 and 5 received 200 mg/kg and 400 mg/kg of *Chromolaena odorata* extract, respectively. Groups 6 and 7 were given 200 mg/kg and 400 mg/kg of *Bryophyllum pinnatum* extract, respectively, while Groups 8 and 9 were administered 200 mg/kg and 400 mg/kg of *Talinium triangulare* extract, respectively (Table 2). The extracts were administered orally using a cannula for 14 days.

Group of Rats	Animal Condition	Doses of Treatment	Feeding Period
Group 1	Rats with only growers mash and water (normal control)	Freely feed and water	14
Group 2	Ulcerated rats with no drug/extracts treatment (negative control)	Freely feed and water	14
Group 3	Ulcerated rats with standard ulcer drug: Ranitidine (positive control)	150mg/kg bodyweight	14
Group 4	Ulcerated group with *C. Odorata*	200 mg/kgbodyweight	14
Group 5	Ulcerated group with *C. odorata*	400mg/kg/bodyweight	14
Group 6	Ulcerated group with *B. pinnatum*	200mg/kg/bodyweight	14
Group 7	Ulcerated group with *B. pinnatum*	400mg/kg/bodyweight	14
Group 8	Ulcerated group with *T. triangulare*	200mg/kg/bodyweight	14
Group 9	Ulcerated group with T. triangulare	400mg/kg/bodyweight	14

Table 2: Summary of the Experimental Design

2.8 Blood Sample Collection

Blood samples were collected on days 4 and 18 via the retrobulbar plexus of the eye and transferred into non-heparinized sample bottles. The samples were then carefully mixed with an anticoagulant (10% w/v EDTA in distilled water) to assess the effects of the leaf extracts on selected biochemical parameters.

2.9 Determination of Serum Prostaglandin (PG) Level

The serum prostaglandin (PG) level was determined using the method described by Teppner et al. [20]. Prostaglandins were first extracted from the serum using a negative ion online solid-phase extraction technique, followed by quantitative analysis using a biochemical assay. The levels of extracted prostaglandins were

then measured spectrophotometrically, allowing for accurate quantification based on the absorbance values obtained.

2.10 Determination of Superoxide Dismutase (SOD)

The activity of SOD was determined by the method described by Xin et al. which is based on the inhibition of epinephrine auto-oxidation to adrenochrome in an alkaline environment [21]. The sample was mixed with the reaction mixture, and the superoxide radicals generated from epinephrine oxidation were scavenged by the SOD in the sample. The inhibition of adrenochrome formation was measured by the decrease in absorbance at 480 nm using spectrophotometry. SOD activity was determined by comparing the rate of inhibition to a standard curve, providing an estimate of the enzyme activity in the sample.

2.11 Determination of Catalase Activity

The activity of catalase was determined using the method described by Aebi based on the measurement of hydrogen peroxide (H2O2) decomposition [22]. The ultraviolet absorption of hydrogen peroxide at 240 nm was recorded. As catalase decomposes H2O2, the absorption decreases over time. The rate of decrease in absorbance was used to calculate catalase activity. At the end of the feeding trial, the animals were sacrificed, and the ulcer index, volume, and pH of the gastric juices were determined.

• Ulcer Index

The ulcer index was calculated thus:

Where A = degree of ulceration and
B = percentage of group ulcerated.

2.12 Determination of pH

The pH of the gastric content from both control and treatment groups were measured using a pH meter according to the method described by Akilandeswari et al. [23]. A small amount of gastric content was collected, and the pH was directly measured by immersing the electrode of the pH meter into the sample. The pH readings were recorded once the meter stabilized.

2.13 Determination of Gastric Juice Volume

The gastric content was carefully collected from each animal and transferred into a graduated measuring cylinder. The total volume was then recorded to determine the amount of gastric juice produced, following the method outlined by Akilandeswari et al. [23].

2.14 Data Analysis

The IBM-SPSS version 23 statistical tool was used for the statistical analysis. Paired sample T-test (PSTT) was used to analyze the baseline and end-line data on biochemical markers. Duncan's multiple range tests were adopted to separate and compare for differences in ulcer parameters across the experimental groups. Statistical difference and / or significant were set at P-value <0.05.

3. Results

Table 3 shows the baseline (after ulcer induction) and final results of effects of the leaf extracts on prostaglandin level of normal and ulcer- induced rats. The serum prostaglandin (PG) level showed significant difference (P<0.05) between the mean baseline and the end-line values in the induced without treatment group and all the treated rats, while there was no significant difference (P>0.05) between the mean baseline and end-line values in the prostaglandin values of rats in normal control group.

Groups	Baseline	End-line	MD	Std Error	t-value	p-value	%D
Control(normal)	247.20	253.80	6.60	2.42	-2.73	0.053	2.67 ↑
Control (-)	379.20	435.40	56.20	10.97	-5.12*	0.007	14.82 ↑
Control (+)	382.40	280.60	101.80	14.40	7.07*	0.002	- 26.62 ↓
200mg/kgbw CO	373.80	289.60	84.20	4.96	16.96*	0.000	- 22.53 ↓
400mg/kgbw CO	404.20	246.60	157.60	2.69	58.49*	0.000	- 38.99 ↓
200mg/kgbw BP	381.20	282.20	99.00	13.83	7.16*	0.002	- 25.97 ↓
400mg/kgbw BP	383.80	243.80	140.00	5.51	25.43*	0.000	- 36.55 ↓
200mg/kgbw TT	395.60	241.00	154.60	5.27	29.34*	0.000	- 38.93 ↓
400mg/kgbw TT	394.00	244.80	149.20	3.57	41.80*	0.000	- 37.87 ↓

MD = mean difference; Std error = standard error; t = t-test value; %D = percentage difference;
* = significant difference (P < 0.05); baseline = after induction; end-line = after treatment.
Control (normal) = Rats without induction
Control (-) = Induced but not treated
Control (+) = Induced and treated with standard ulcer drug (ranitidine)
CO = *Chromolaenaodorata*, BP = *Bryophyllumpinnatum*,
TT = *Talinium triangulare*

Table 3: Effect of the Extracts on Prostaglandin Levels of Normal and Ulcerated Rats

Table 4 shows the baseline (after ulcer induction) and the final results of catalase level of normal and ulcer- induced rats. There was a significant (P<0.05) difference in mean base line and end-line values of catalase of all the rats in the treated groups while there

was no significant difference (P>0.05) between the mean baseline and end-line values of catalase in normal rat group and induced without treatment control group. Table 5 presents the baseline (after ulcer induction) and the final results of superoxide dismutase level of normal and ulcer- induced rats. The Superoxide dismutase (SOD) differ significantly (P > 0.05) between the baseline and end-line values of all the treated rats, while there was no significant ($p < 0.05$) difference between the mean baseline and end- line values of the SOD values in normal and induced without treatment groups. Table 6 presents the final results of ulcer parameters (ulcer index, volume of gastric juice and pH level of gastric juice) of normal and ulcer- induced rats. There was a significant difference ($p < 0.05$) in the mean volume between the control groups and group treated with 400 mg *Talinium triangulare* leaf extracts. There was a strong significant difference ($p < 0.05$) in the mean ulcer index between induced without treatment group and all other groups. Also, significant difference ($p < 0.05$) was observed in the mean pH value across the groups, specifically between induced but not treated control group, 200mg *Chromonela odorata* treated group and 400mg *Bryophyllum pinnatum* treated group.

Groups	Baseline	End-line	MD	Std Error	t-value	p-value	%D
Control(normal)	0.69	0.65	0.04	0.05	0.79	0.475	- 5.80 ↓
Control (-)	0.27	0.18	0.09	0.03	2.89	0.045	- 33.33 ↓
Control (+)	0.26	0.74	0.48	0.03	-16.17*	0.000	184.62 ↑
200mg/kgbw CO	0.28	0.67	0.39	0.03	-12.01*	0.000	139.29 ↑
400mg/kgbw CO	0.26	0.67	0.41	0.03	-13.27*	0.000	157.69 ↑
200mg/kgbw BP	0.27	0.68	0.41	0.02	-24.65*	0.000	151.85 ↑
400mg/kgbw BP	0.26	0.67	0.41	0.02	-24.65*	0.000	157.69 ↑
200mg/kgbw TT	0.24	0.73	0.49	0.03	-18.80*	0.000	204.17 ↑
400mg/kgbw TT	0.26	0.72	0.46	0.03	-14.92*	0.000	176.92 ↑

MD = mean difference; Std error = standard error; t = t-test value; %D = percentage difference;
* = significant difference (P < 0.05); baseline = after induction; end-line = after treatment.
Control (normal) = Rats without induction
Control (-) = Induced but not treated
Control (+) = Induced and treated with standard ulcer drug (ranitidine)
CO = *Chromolaenaodorata*, BP = *Bryophyllumpinnatum*,
TT = *Talinium triangulare*

Table 4: Effect of the Leaf Extracts on Catalase Levels (mg) of Normal and Ulcerated Rats

Groups	Baseline	End-line	MD	Std Error	t-value	p-value	%D
Control(normal)	8.67	8.88	0.21	0.16	-1.33	0.254	2.42 ↑
Control (-)	5.54	4.75	0.79	0.41	1.92	0.127	- 14.26 ↓
Control (+)	5.72	7.85	2.13	0.35	-6.11*	0.004	37.24 ↑
200mg/kgbw CO	5.56	7.62	2.06	0.39	-5.32*	0.006	37.05 ↑
400mg/kgbw CO	5.94	8.34	2.40	0.40	-6.01*	0.004	40.40 ↑
200mg/kgbw BP	6.12	7.92	1.80	0.19	-9.49*	0.001	29.41 ↑
400mg/kgbw BP	6.30	8.14	1.84	0.20	-9.04*	0.001	29.21 ↑
200mg/kgbw TT	6.04	7.38	1.34	0.29	-4.64*	0.010	22.19 ↑
400mg/kgbw TT	6.01	8.03	2.02	0.35	-5.83*	0.004	33.61 ↑

MD = mean difference; Std error = standard error; t = t-test value; %D = percentage difference; * =significant difference (P < 0.05); baseline = after induction; end-line = after treatment
Control (normal) = Rats without induction
Control (-) = Induced but not treated
Control (+) = Induced and treated with standard ulcer drug (ranitidine)
CO = *Chromolaena odorata*,
BP = *Bryophyllum pinnatum*,
TT = *Talinium triangulare*

Table 5: Effect of the Leaf Extracts on Superoxide Dismutase Levels (mg) of Normal and Ulcerated Rats

Groups	Gastric Juice (mls)	Ulcer Index	pH
Control (normal)	1.20[a]	0.00[c]	6.30[b]
Control (-)	1.22[a]	14.00[a]	4.12[d]
Control (+)	1.14[a]	0.60[bc]	6.90[ab]
200mg/kgbw CO	1.00[ab]	2.00[b]	5.50[c]
400mg/kgbw CO	1.10[ab]	0.20[bc]	6.94[ab]
200mg/kgbw BP	0.82[ab]	1.00[bc]	6.76[ab]
400mg/kgbw BP	1.24[a]	0.00[c]	7.24[a]
200mg/kgbw TT	0.90[ab]	0.00[c]	7.16[a]
400mg/kgbw TT	0.62[b]	0.00[c]	7.10[a]

Column with different superscript shows significant difference (P< 0.05).

Control (normal) = Rats without induction
Control (-) = Induced but not treated
Control (+) = Induced and treated with standard ulcer drug (ranitidine)
CO = *Chromolaena odorata*,
BP = *Bryophyllum pinnatum*,
TT = *Talinium triangulare*

Table 6: Effects of the Leaf Extracts on Volume of Gastric Juice, Ulcer Index, and pH of Gastric Juice Contents of Normal and Ulcer- Induced Rats

4. Discussion

Prostaglandins are group of lipids with hormone-like actions that the body makes primarily at the sites of tissue damage or infection. There are four principal bioactive prostaglandins generated *in vivo*: prostaglandin E_2 (PGE_2), prostacyclin (PGI_2), prostaglandin D_2 (PGD_2) and prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) [24]. Biosynthesis of prostaglandin is significantly increased in inflamed tissue and they contribute to the development of the cardinal signs of acute inflammation [24]. The PGE_2 is of particular interest because it is involved in all processes leading to the classic signs of inflammation: redness, swelling and pain [25]. The significant ($p< 0.05$) reduction in the prostaglandin level between the base line and the end line implies that the inflammatory action of the inducing agent can be reduced by the administration of the leaf extracts. The higher reduction of 400 mg *Chromolaena odorata,* 400 mg *Bryophyllum pinnatum*, and *Talinum triangulare* treated groups showed that they will be more effective in the treatment of ulcer. The observed decrease in the prostaglandin levels of the rats on administration of the leaf extracts is in line with the work done by Ayertey et al. who reported that, ethanolic leaf extract of *Morinda lucida* Benth inhibited the production of prostaglandinE2 (PGE_2) without necessarily inhibiting COX-2 protein expression [26]. The decrease in the prostaglandin activity levels in the present study may be due to the phytochemical composition of the leaf extracts or probably due to the anti-oxidant vitamins present in the extracts.

Catalase exists as tetramer with each subunit containing a haem group in the active site [27]. As an enzymatic antioxidant, catalase has a key role in preventing cellular oxidative damage by degrading hydrogen peroxide (H_2O^2) into water and oxygen with high efficiency [28]. The significant ($p< 0.05$) increase in the catalase values of the treated rats are of interest. This is because low level of catalase leads to oxidative damage. The increase therefore, suggests that the leaf extracts have the therapeutic potential to reduce the oxidative damage associated with low level of catalase as a result of the inducing agent. The higher incremental level of 200mg *Talinum triangulare* treated groups implies that it will be more effective in treatment of ulcer and its associated complications. The significant ($p<0.05$) increase in catalase levels of rats among the treated groups in the study is comparable with the observation of Awhin et al. [29] who reported that methanol leaf extract of *Dryopteris filix-mas* caused a dose dependent increase in catalase activity when compared to the control group although this was statistically insignificant. The increase may be due to the presence of bioactive compounds contained in the leaf extracts. However, the present result is contrary with Nahdi et al. findings that there was a decrease of antioxidant enzyme activities (CAT and SOD) in liver tissues of rats treated with *Hypericum humifusum* aqueous and methanolic leaf extracts [30].

Superoxide dismutase (SOD) is an enzyme with several functions including antioxidant defense mechanism, neutralizing superoxide radicals and protecting against oxidative stress. Superoxide dismutase activity may be double and opposite. It is an antioxidant enzyme when its activity is coordinated with either the CAT, GPx or Prx/Trx enzymes, which avoid hydrogen peroxide(H2O2) accumulation by neutralizing it into water (H2O); secondly, SOD may act as a pro-oxidant as H2O2 can over accumulate, leading to reactive oxygen species (ROS) molecules overproduction and cell toxicity [31]. The significant ($p< 0.05$) increase in SOD levels among the extract treated groups suggest that the extracts have the antioxidant enzyme potential to neutralize hydrogen peroxide (H2O2) to water thereby preventing its accumulation and the resultant oxidative damage to the tissue especially in disease conditions like ulcer. The higher increase in the 400mg treated *Chromolaena odorata* implies that the dose will be more effective in the treatment of ulcer. The increase in the superoxide

dismutase activity levels of the treated rats is in line with the findings of Siregar et al. who reported that Gambier extract has a role in increasing the SOD activity in proteinuric model Wistar rats, with the best increase seen in 80 mg/200gBW [32]. However, the increase is contrary with the findings of Colak et al. who reported an unexpected decrease in SOD activity in the *Cynara scolymus* leaf extract treated group of rats without carbon tetrachloride (CCl_4)-induced oxidative stress application [33].

Peptic ulcer is usually due to deterioration of the stomach and mucosal lining that can result in gastrointestinal tissue while gastric ulcers in particular, are mostly caused by hyper-secretion of gastric juice of humoral or gastrin origin caused by states of food in the stomach. The significant ($p< 0.05$) reduction in the ulcer index between the induced without treatment group and other groups is of great interest. This is because the severity of ulcer is dependent on the ulcer index. Higher level of ulcer index means more ulcer scores and severity of ulcer. The reduced ulcer index suggests that the leaf extracts have the potential to ameliorate the severity of ulcer. The higher reduction in the 400 mg *Bryophyllum pinnatum*, and *Talinum triangulare* treated groups implies that the extracts at these doses are more effective in ulcer treatment. The reduction in the ulcer index in the groups treated with 200mg and 400mg/kgbw of the leaf extracts as well as standard ulcer drug (ranitidine 30 mg/kg) when compared with the untreated control group is in line with the observation of Abebaw et al. who reported a significant ($p<0.001$) reduction in ulcer index on administration of 200 and 400mg/kg extract of quadripartite and standard ulcer drug (ranitidine 50 mg/ kg) to ulcer- induced rats. The reduction in the ulcer index among the treated groups may be attributable to the antioxidant activity of the phytochemical constituents of the leaf extracts [34].

Gastric acid or gastric juice by lowering pH, kills ingested microorganisms, limits bacterial growth in the stomach and prevents intestinal infections such as *Clostridioides difficile* [35]. Though the gastric juice has its important functions, the significant ($p<0.05$) reduction in the volume of gastric juice in the study is desirable. This is because increase in gastric juice increases ulcer complications and low level of gastric juice helps to reduce the severity of ulcer. The higher reduction in volume of gastric juice in the groups treated with 400mg *Talinum triangulare* treated groups suggest that the dose level is more effective in the treatment of ulcer diseases. The gastric juice reduction in the study can be compared to the report in dose study of 200mg/kgbw *Osyris quadripartite* which exhibited significant ($p < 0.001$) reduction in volume of gastric secretion in comparison with the negative control group and standard drug treated group [34].

The pH meter is used to determine the condition of a substance or solution and it ranges from 0-14. The pH at 7 is said to be neutral, less than 7 acidic and basic when it is greater than 7. The more acidic the stomach gastric juices are the severity of crisis to a gastric ulcer patient. The significant ($P<0.05$) increases between induced without treatment (negative control) group and the treated groups are desirable. This is because, reduction in pH results in acidity and acidic conditions of the stomach contents aggravates ulcer. The rise in pH of the gastric juice of the treated groups in relation to induced without treatment group depicts the ability of the leaf extracts to act as an anti-acid source. It also implies that the increased pH value (alkalinity) lowers the acidity of the stomach, hence reducing the severity of ulcer and its complications. The higher increase in the 400mg *Bryophyllumpinnatum*, and *Tallnium triangulare* treated groups suggest that the doses is more effective in the treatment of ulcer and its complications.

The rise in the pH of the gastric juice secretion of rats in the study is in line with the observation of Ahmed et al. in pylorus ligation induced gastric ulcer model in which both aqueous and 80% methanol extracts of *Urtica simensis* at doses of 200 and 400 mg/kg demonstrated substantial significant ($P<0.05$) rise in pH of the gastric juice secretion [36]. The study is also in line with an increase in pH observed by Henneh et al. who reported that the mean pH of the ulcerated group (negative control group) was 1.95 ± 0.31 whereas the mean pH of the highest dose (300 mg/kg) of *Manihot esculenta* increased significantly ($p < 0.05$) to 3.12 ± 0.40, which was higher than (2.63 ± 0.10) value obtained by the 10 mg/kg standard drug (omeprazole) [37].

5. Conclusion

The leaf extracts of *Chromolaena odorata, Bryophyllum pinnatum*, and *Talinum triangulare* possess anti-inflammatory and antiulcerogenic properties. The extracts also exhibited antioxidant activity through the significant increase in catalase and superoxide dismutase (SOD) levels, which are important for mitigating oxidative stress and cellular damage. The potential of these plants to ameliorate ulcer severity, suggests that these extracts may offer therapeutic benefits in the treatment of ulcers and associated complications. However, further studies are necessary to fully elucidate their mechanisms of action and establish optimal therapeutic dosages.

References

1. Sverdén, E., Agréus, L., Dunn, J. M., & Lagergren, J. (2019). Peptic ulcer disease. BMJ. 367: l5495.
2. Debruyne, L. K., Pinna, K., & Whitney, E. (2016). Nutrition and diet therapy. 9th edition pp 480. Cengage learning, Boston USA.
3. Eniojukan, J. F., Okonkwo, O. C., & Adje, U. D. (2017). Risk Factors, management and other correlates of peptic ulcer disease in a university community in south-south Nigeria. Pharmaceutical and Biosciences Journal, 07-15.
4. Mirshral, V., Pandey, R., Misra, S., & Dwivedi, M. (2013). Helicobacter Pylori and gastric cancer. *Indian Enigma World Journal of Gastroentrology, 20* (6), 1503-1509.
5. Sukuki H., Nisizawa T, Tsugawa H, Mogami S, Hibi T. (2012). Roles of antioxidive stress in stomach disorders. *Journal of Clinical Biochemistry and Nutrition. 50*(1), 35-39.
6. Xin, X., Kaijie, Z., Zhangjian, Z., Chengxue, D., & Hao, Z. (2022). The global regional and national burden of peptic ulcer disease from 1990-2019: a population-based study: *Gastroenterology* 22:58.

7. Lanas, A., & Chan, F. K. L. (2017). Peptic ulcer disease. *The Lancet*. 390: 613–624.
8. Anaemene, D. I., & Ochugu, E. U. (2022). Prevalence, symptoms and lifestyle aspect of peptic ulcer. Disease among undergraduate students of a Nigerian university. *African Journal of Biomedical Research*. 25; 129-133.
9. Saheed, S., Oharewaju, A. S., Tao, F. G., Olatunde, S. T., & Alanamu, A. A. (2015). Combined administration of spondias mombin and Ficus Exasperata leaf extracts stall indomethacin-mediated gastric mucosal onslaught in rats. *African Journal of Traditional, Complementary and Alternative Medicines, 12*(1): 45-51.
10. Vijayaraghavan, K., Rajkumar, J., Nasir, S., Bukhari, A., Badr A., & Ali M. S. (2017). Chromolaena odorata: A neglected weed with a wide spectrum of pharmacological activities (Review). *Molecular Medicine Reports, 15*(3):1007-1016.
11. Julia, M. F., Lorena, M. C., Eduardo, P. A., Estela, M. G. L., Matheus, F. F., Silvaria, M. (2019). Kalanchoe laciniata and Bryophyllum pinnatum, an updated review about ethropharmacology, phytochemistry, pharmacology and toxicology. *Revista Brasileira de Farmacognosis, 29* (24) 529-558.
12. Kanika, P. (2011). Pharmacognistic and Phytochemical evaluations of Bryophyllum pinnatum leaves. *Journal of Advance Science and Research, 2*(1); 42-49.
13. Aja, P. M., Okaka, A. N. C., Ibiam U. A., & Uraku, A. J. (2010). Proximate Analysis of Talinum triangulare (waterleaf) leaves and its softening principle. *Pakistan Journal of Nutrition*, (6) 524-526.
14. Erinoso, S. M., & Aworinde, D. (2012). Ethnobotanical survey of some medicinal plants used in Traditional health care in Abeokuta Areas of Ogun state, Nigeria. *African Journal of Pharmacy and Pharmacology, 6*, 1352-1362.
15. Egharevba, R. K. A., & Ikhatua, M. I. (2008). Ethno-medical uses of plants in the treatment of various skin diseases in Ovia North East, Edo state, Nigeria. *Research Journal of Agriculture and Biological Sciences, 4*(1) 58-64.
16. Hooi, J. K.Y., Lai, W.Y., Wee, K., Ng, S., M. M. Y., Underwood, F. E., Graham, D. Y., & Wong, V.W.S. (2017). Global prevalence of Helicobacter Pylori infection: Systematic review and meta-analysis. *Gastroenterology.* 153 (2):420-429.
17. Sayanti, B., Susri, R. C., Subrata C., & Sandip K. B. (2007). Healing properties of some Indian medicinal plants against indomethacin-induced gastric ulceration of rats. *Journal of Clinical Biochemistry and Nutrition, 41*(2):106–114.
18. Dashputre, N. L., & Naikwade, N. S. (2011). Evaluation of anti-ulcer activity of methanolic extract of Abutilon indicum Linn leaves in experimental rats. *International Journal of Pharmaceutical Sciences and Drug Research*. 3(2):97–100.
19. Ezikel, A. C, Akah, P. A., Okoli, C. O., Ezeuchenne, N. A. & Ezeugwu, S. (2009). Carica papaya (paw paw) unripe fruit may be beneficial in ulcer. *Journal of Medicinal Food*, 12 (6), 1268-1273.
20. Teppner, M., Zell, M., Husser, C., Ernst, B., & Pähler, A. (2016). Quantitative profiling of prostaglandins as oxidative stress biomarkers in vitro and in vivo by negative ion online solid phase extraction - Liquid chromatography-tandem mass spectrometry. *Annals of Biochemistry,* 498, 68–77.
21. Xin, J. S., Guo, J. C., Zhu, H. Q., & Song, X. X. (1991). An assay for superoxide dismutase in mammalian tissue homogenates. *Annals of Biochemistry*, 179: 8–18.
22. Aebi, H. (1984). Catalase in vitro. *Methods Enzymology*, 105, 121-126.
23. Akilandeswari, S., Senthamarai, R., Valarmarthi, R., Shanthi, S., & Prema, S. (2010). Screening of gastric antiulcer activity of side acute burn. *International Journal of Pharmaceutical Technology Research*, 2(2), 1644-1648.
24. Ricciotti, E., Garret, A., & FitzGerald, M.D. (2011). Prostaglandins and Inflammation. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 31(5), 986–1000.
25. Funk, C. D. (2001). Prostaglandins and leukotrienes. advances in eicosanoid biology. *Science*, 294:1871–1875.
26. Ayertey, F., Ofori-Attah, E., Antwi, S., Amoa-Bosompem, M., Djameh, G., Nathaniel L., Ohashi, M., Kusi, K. A., Appiah, A. A., Appiah-Opong, R., & Okine, L. K. (2021). Anti-inflammatory activity and mechanism of action of ethanolic leaf extract of Morinda lucida Benth. *Journal of Traditional and Complementary Medicine*, 11, 3; 249-258.
27. SridharRao, P. N. (2017). Catalase test.
28. Ahmad, P., Nabi, G., Jeleel, C. A., & Umar, S. (2011). Free radical production, oxidative damage and antioxidant defense mechanisms in plants under abiotic stress. In Ahmad, P. Umar, S. (Eds). Oxidative stress: Role of antioxidants in plants. PVT Ltd. New Delhi, India, 19-53.
29. Awhin, P. E., Ajoh, A., Erutere, B., & Dennis-Eboh, U. (2023). Effects of methanol leaf extract of Dryopteris filix-mas on catalase activity and malondialdehyde levels in the brain of adult male Wistar rats. *Sokoto Journal of Medical Laboratory Science, 8*(1)56-59.
30. Nahdi, A., Hammami, I., Ali, R. B., Kallech-Ziri, O., El May, A., & El May, M. V. (2018). Effect of Hypericum humifusum aqueous and methanolic leaf extracts on biochemical and histological parameters in adult rats. *Biomedicine & Pharmacotherapy = Biomedecine & pharmacotherapie, 108*, 144–152.
31. Singh, N., Gupta, V. K., Kumar, A., & Sharma, B. (2017). Synergistic Effects of Heavy Metals and Pesticides in Living Systems. Frontiers in chemistry, 5, 70.
32. Siregar, R. S., Lelo, A., Haris, D., Ramayani, O.R., & Ichwan M. (2021). Effect of Uncaria gambir Roxb. extract on superoxide dismutase activity in proteinuric wistar rats model. *Macedonian Journal of medical Sciences,* 10(B):1505-1509.
33. Colak, M., Ustuner, M.C, Tekin, N., Colak, E., Burukoglu, D., Degirmenci, I., & Gunes, H. V. (2016). The hepatocurative effects of Cynara scolymus L. leaf extract on carbon tetrachloride-induced oxidative stress and hepatic injury in rats. *Springer Plus*, 5, 216.
34. Abebaw, M., Mishra, B., & Gelayee, D. A. (2017). Evaluation of anti-ulcer activity of the leaf extract of Osyris quadripartita Decne. (Santalaceae) in rats. Journal of experimental pharmacology, 9, 1–11.
35. Vakil N. (2024). Developments in Gastroesophageal Reflux

Disease over the Last 40 Years. Digestive diseases (Basel, Switzerland), 42(2), 127–136.

36. Ahmed, O., Nedi, T., & Yimer, E. M. (2022). Evaluation of anti-gastric ulcer activity of aqueous and 80% methanol leaf extracts of Urtica simensis in rats. *Metabolism Open*, 14, 100172.

37. Henneh, I. T., Ahlidja, W., Alake, J., Mohammed, H., Boapeah, S.O., Kwabil, A., Malcolm, F., & Armah, F. A. (2022). Acute toxicity profile and gastroprotective potential of ethanolic leaf extract of Manihot esculenta *Crantz*. *Scientific African*, 17; e01284.