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Comparative Effect of *Curcuma longa* and *Piper nigrum* Extract and their Mixture on some Haematological Indices of Indomethacin-Induced Gastric Ulceration in Albino Rats

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ABSTRACT

Peptic ulcer disease (PUD) which includes gastric and duodenal ulcer is one of the unresolved medical problems facing numerous patients in a wide range of age of both sexes worldwide. Many medicinal plants are known to exhibit antiulcer activity and some have been confirmed scientifically to possess gastro protective and antiulcer property and also found to be useful in its treatment. Among these medicinal plants turmeric (*Curcuma longa*) and black pepper (*Piper nigrum*) have been reported to possess gastroprotective potentials. However, the effect of the combination of turmeric and black pepper on the haematological indices of ulcerated rats hasn't been considered. As a result, this study was designed to evaluate the effect of aqueous extract of *Curcuma longa* and *Piper nigrum* on some haematological parameters of indomethacin-induced gastric ulceration in albino rats. Total of sixty (60) albino rats was used for this study. After acclimatization for 14 days, the animals were randomly allocated into six groups (n=10).Group A (normal control): rats was fed on pellet and allowed free access to water, rats in Group B (Ulcerated control) were given only indomethacin at a dose of 50mg/Kg body weight. Animals in group C (Standard control) was given indomethacin after pre-treatment with omperazole (20mg/kg) body weight. Group D,E, and F comprised ulcerated rats pre-treated with turmeric (200mg/kg body weight), black pepper (100mg/kg body weight), turmeric and black pepper (200mg/Kg + 100mg/kg respectively) body weight. Treatments with the reference drug and extracts lasted for 21 days prior to ulcer induction on the twenty-third day.4 h post ulcer induction, the animals were humanely sacrificed under chloroform anaesthesia and blood samples were collected for further haematological studies. The result obtained from this study showed that there were no significant ($p > 0.05$) differences in PCV, HbC, TWBC, NEUT, MON, EOS, BAS, RBC and PLT levels across all groups, with LYM being significantly ($p < 0.05$) different in group E compared with Group F. The study found that *Curcuma longa* and *Piper nigrum* extracts, either alone or in combination, do not significantly alter haematological indices in albino rats with gastric ulcers caused by indomethacin, suggesting they may be beneficial without negative systemic impact. However, lymphocyte levels significantly decreased in the group treated with a mixture of *Curcuma longa* and *Piper nigrum*, suggesting a potential mild immunomodulatory effect.

Keywords: Haematological Indices, Indomethacin, Ulcer, *Curcuma longa* and *Piper nigrum*

INTRODUCTION

Peptic Ulcer Disease (PUD) is clinically described as a disruption of the continuity of the gastrointestinal mucosal lining which appears as sores of at least 0.5cm in diameter in endoscopic studies [1]. It is one of the commonest ailments of the alimentary system [2], and affect about 4 million of the world's population annually, with incidence of complications in approximately 10–20% [3]; [1]. It is largely classified as gastric ulcers (GU) or duodenal ulcers (DU) based on the affected section of the gastrointestinal tract (GIT) .Typically, patient with acid peptic diseases presents with mucosal disruption which is considered to be as a result of hyper secretive acidic environment, which leads to epigastric pain which may subside when food or alkali is consumed. [1].

PUD is predominantly caused by the activities of *Helicobacter Pylori* (*H. Pylori*) and/or Non-Steroidal Anti-inflammatory Drugs (NSAIDs). While the activities of H. Pylori creates imbalance in acid production and regulation through inflammation-induced increased gastric secretion and decreased somatostatin secretion, NSAIDs, which offer many benefits such as reduction of pain, fever, and inflammation, are being taken regularly by some people which makes them to be five (5) times more likely to develop PUD than people who do not take them [5]. Cyclooxygenase-1 (COX-1) and cyclooxygenase-2 (COX-2) are enzymes that produce prostaglandins, which promote pain, inflammation, and fever. NSAIDs work by inhibiting these two enzymes [6]. These medications often cause Peptic Ulcer Disease because COX-1 produces an additional type of prostaglandin that protects the stomach lining from stomach acid [7]. By inhibiting COX-1, NSAIDs increase the risk of ulcers and GI bleeding by making the mucosal cells more vulnerable to hydrochloric acid and pepsin damage [6].

Apart from the activities of H. pylori and NSAIDs, studies have identified risk factors of PUD which are mostly modifiable. The modifiable risk factors include the use of corticosteroids, anticoagulants, coffee, alcohol, smoking, stress, spicy foods, use of unclean water sources and fasting; while non-modifiable risk factors include genetics, age, gender and past history of PUD. [5]; [8]; [9]; [10]. Since PUD impacts negatively on the health-related quality of life of the affected individuals hence, there have been a rapid change in the concept of gastric ulcer management, ranging from conventional vagotomy, prostaglandin analogs, H2 receptor anatagonists and antacids to proton pump inhibitors, such as cimetidine, ranitidine, misoprostol, omeprazole and esomeprazole but then gastrointestinal toxicity remains an impediment to their application in clinical practice [11]; [12]; [13]. However, there have been needs to search for non toxic, easily assessable and affordable anti ulcer medication.

Phytotherapy of some therapeutic plant extracts that are highly valued and widely used in traditional system of medicine such as *curcuma longa* and *piper nigrum* are being investigated to ascertain if they could provide efficient formulation for better management, as such discovering effective and safe drugs that also have gastro-protective activity.

Curcumin, the natural phenolic active ingredient of turmeric (*Curcuma longa*) rhizome, has been used in Asia as a herbal remedy for a variety of diseases [14] phytochemicals such as Terpenes, phytosterols several bioactive essential oils, were revealed, other bioactive compounds were also isolated from methanol extract of *curcuma longa* rhizome. [15]; [16]. The phytochemicals analysis carried out by [12] revealed the percentages of total phenolic, alkaloid and saponin (4.91± 1.0, 6.64± 1.0 and 2.30±0.0) respectively and flavonoids 6.15+ 0.03, the presence of these also confirmed the medicinal properties of turmeric rhizomes. [17]. Similar to chili, turmeric is commonly used in Asian cuisine to add a yellow color, both as a flavor and as a preservative [18]. In addition to the use of curcumin as an anti-inflammatory in ancient times, it has also been used to treat gastrointestinal (GI) diseases such as indigestion, flatulence, diarrhea, and even gastric and duodenal ulcers [19]. Great attention has been paid to the medical applications of *Curcumin* in the treatment of human diseases associated with oxidative stress and inflammation, including different cancers [19]. *Curcumin* treatment has also led to the improvement of metabolic parameters involving aging-associated diseases such as atherosclerosis, diabetes, cardiovascular disease, and chronic kidney diseases [20]; [21]. Interestingly, some promising effects of curcumin have been observed in the alleviation by this turmeric derivative of the chronic inflammatory conditions such as arthritis, uveitis, and inflammatory bowel disease [22]. In some instances, *Curcumin* has been found to aid in the prevention and treatment of various cancers [23]. Recently, the anticarcinogenic activity of *Curcumin* has been documented in the GI tract because this compound has proven to exert a therapeutic effect on different human GI cancers such as esophageal, gastric, and small and large intestinal cancer [24]; [25].

Piper nigrum (Black pepper) is one of the most commonly used spices and considered as "The King of Spices"due to its trade in the international market [26]; [27]. Black pepper is used as medicinal agent, a preservative, and in perfumery [28]. The genus Piper has more than 1000 species but the most well known species are *Piper nigrum*, *Piper longum* and *Piper betli* [29]. Black pepper can be used for many different purposes such as human dietaries, as medicine, as biocontrol agents [27]; [3]; [30]. Black Pepper is used worldwide in different types of sauces and dishes like meat dishes, as rubs, salad dressings. It contains major pungent alkaloid piperine (1-peperoyl piperidine) which is known to possess many interesting pharmacological actions [31], as well as other beneficial compounds such as tannins, saponins, terpenes, steroids, flavones, flavonoids [32]. A study conducted by [33] revealed that black pepper fruits are endowed with essential oils (1.0–2.5%) and alkaloids (5–9%) also a study showed that it contains Tannins (0.81–2.25) Saponins (1.73,) and Flavonoids 1.28. [34]; [35].

[36] reported that this plant and its active components piperine can stimulate the digestive enzymes of pancreas and intestine and also increases billiary bile acid secretion when orally administered. Black pepper is important for its medicinal values [37]. Medicinally black pepper can be used digestive disorder like large intestine toxins, different gastric problems, diarrohea and indigestion and also can be used against respiratory disorder including cold, fever and asthma [38]; [39]; [40]. Piperine exhibits diverse pharmacological activities like antihypertensive

and anti-platelet [41], antioxidant, antitumor [42] antipyretic, analgesic, anti-inflammatory, anti-diarrheal, anti-spamodic, hepato-protective [5], antibacterial, antifungal, anti-thyroids, anti-apoptotic, anti-spermatogenic, insecticidal and larvicidal activities. Piperine has been found to enhance the therapeutic efficacy of many drugs, vaccines and nutrients by increasing oral bioavailability [43].Research supports that combining the piperine in black pepper with the curcumin in turmeric enhances curcumin absorption by up to 2,000%, [44]; [45], thus in one study Shoba and colleagues reported that adding 20 mg of piperine to 2 grams of curcumin increased its absorption significantly by slowing down the breakdown of curcumin by the liver, thereby increasing its blood levels [45

MATERIALS AND METHODS

Materials

Equipment and Instruments

The equipment and instruments used was of good analytical grade.

Chemicals and Reagents

Indomethacin and esomeprazole was respectively procured from Kapit Pharmaceutical Limited, Nigeria and Ranbaxy Laboratories, India. Trichloroacetic acid (TCA), dimethylaminobenzaldehyde, epinephrine, acetyl acetone, bovine serum albumin (BSA), gallic acid, aluminum chloride, quercetin and thiobarbituric acid (TBA) were products of Sigma Chemical Co. (St. Louis, MO, USA). Assay kits from Randox Laboratories limited, United Kingdom was used. Other chemicals used was of analytical grade from reputable companies in the world.

Plant collection and authetication

Curcuma longa rhizomes and piper nigrum peppercorns were collected locally and were botanically identified by a Botanist in the department of Botany, Ebonyi state university, Nigeria.

Preparation of extracts

Curcuma longa rhizomes and black pepper was air-dried at room temperature for 10 days to constant weight. The dried samples were then be pulverized with an electric blender (model: Bajaj Stormix: 410501), weighed and kept airtight prior to extraction. Powdered samples of turmeric (180g) and black pepper (250g) was separately extracted in 1.8 litres and 2.5 litres of 70% alcohol respectively. For 120 hours using a rotary evaporator kept at a temperature of 40℃. The solutions obtained was filtered with Whatman No. 1 filter paper and yielded 25.56% and 17.60% for turmeric and black pepper respectively.

METHODS

Experimental animals

Wister albino rats was purchased from Animal Unit of Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Enugu, Nigeria. All animals received humane care in accordance with the National Institute of Health guidelines for the care and use of laboratory animals. The animals were left to acclimatize for one week before the start of the experiment and housed in standard clean cages under a controlled room temperature of 21–25 °C and a 12 h light/dark cycle. The animals were given free access to clean water and standard chow diet *ad libitum.*

Ulcer Induction

After a 24 hour fasting period, gastric ulceration was induced in the animals according to the procedure described by [46]. Briefly the rats was administered orally at a dose of (50mg/kg body weight) of indomethacin; this dosage used was based on previous findings that rats administered 50mg/kg body weight of indomethacin presented a very high degree of weakness, behavioral changes, reduced physical activity and very high ulcer index. [47].

Experimental designs

Total of sixty (60) albino rats was randomly allocated into six groups (n=10). Doses of (200mg/kg body weight) turmeric was administered, selecting this dose of curcumin, was informed by previous findings that at dose of 200mg/kg an effective protection against hyperacidity was observed [48]. Doses of (100mg/kg body weight) black pepper was administered; a study showed that *Piper nigrum* offered a prophylactic treatment at a dose of 100 and 200/kg body weight [49]. Group A (normal control): rats was fed on pellet and allowed free access to water, rats Group B (Ulcerated control) were given only indomethacin at a dose of 50mg/Kg body weight. Animals in group C (Standard control) will be given indomethacin after pre-treatment with omperazole (20mg/kg) body weight; it was selected as a standard treatment and dose based on a present study carried out by [50]. Group D,E, and F comprised ulcerated rats pre-treated with turmeric (200mg/kg body weight), black pepper (100mg/kg body weight), turmeric and black pepper (200mg/Kg + 100mg/kg respectively) body weight. Treatments with the reference drug and extracts lasted for 21 days prior to indomethacin administration. These were orally administered once daily using oral intubator with *ad libitum* provision of food and water throughout the experimental period. On the twenty-second day prior to ulcer imduction, the animals were fasted for 24 hours and animals in groups B – F were thereafter indomethacin at a dose of 50mg/Kg body weight.

Blood sample collection

Blood samples were collected from the abdominal aorta into Ethylenediamine tetraacetic acid (EDTA) and Lithium heparin sample bottles and kept in the refrigerator for further haematological studies.

Determination of Haematological Parameters (PCV, HB, RBC, Platelets and WBC)

Haematological parameters (packed cell volume, haemoglobin concentration, red blood cell count, red cell indices, total white blood cell count and differential and platelets were determined using Mindray automated haematology analyser (BC-2800VET, Indiamart Inter MESH Ltd, Uttar Pradesh, India).

Statistical Analysis

The data was analysed using the statistical package for social science (SPSS Inc., Chicago, IL, USA) version 21.0. One-way analysis of variance (One-way ANOVA) was used to determine significant difference among groupd. Results were expressed as mean±standard error of mean (SEM). The results were considered statistically significant different at *p* values less than 0.05

RESULTS

Comparative Effect of Turmeric, Black Pepper and their Mixture on Haematological Parameters of Indomethacin-Induced Ulceration in Rats

The result obtained from this study as presented in table 1showed that there was no significant ($P > 0.05$) in PCV, HbC, TWBC, NEUT, MON, EOS, BAS, RBC, and PLT across the groups. LYM was significantly ($P < 0.05$) decreased in group E when compared with group F.

Table 1: Comparative effect of turmeric, black pepper and their mixture on haematological parameters of imdomethacin-induced ulceration in rats.

Parameters	Experimental Groups					
	A	B	C	D	E	F
PCV (%)	45.02 ± 0.95	44.32 ± 1.08	45.00 ± 1.48	41.66 ± 0.83	42.34 ± 0.83	42.93 ± 2.00
HbC (g/dL)	14.68 ± 0.37	15.00 ± 0.26	15.20 ± 0.36	14.32 ± 0.38	14.74 ± 0.16	14.08 ± 0.69
TWBC (10^9/L)	13.99 ± 1.66	14.12 ± 1.36	16.82 ± 2.60	14.83 ± 1.36	12.90 ± 0.49	15.86 ± 4.15
NEUT (%)	10.62 ± 2.96	14.93 ± 2.56	14.60 ± 4.83	13.54 ± 2.78	20.94 ± 2.00	7.65 ± 1.24
LYM (%)	81.94 ± 5.32	78.28 ± 4.43	78.88 ± 4.51	79.96 ± 4.66	66.32 ± 2.19^{e}	90.05 ± 1.01^{d}
MON (%)	7.40 ± 2.40	6.77 ± 2.08	6.48 ± 2.36	6.28 ± 2.76	10.82 ± 2.36	2.00 ± 0.46
EOS (%)	0.04 ± 0.02	0.02 ± 0.02	0.04 ± 0.02	0.04 ± 0.02	0.12 ± 0.10	0.15 ± 0.09
BAS (%)	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
RBC (10^12/L)	7.92 ± 0.26	8.27 ± 0.15	8.01 ± 0.16	7.52 ± 0.15	8.02 ± 0.13	7.56 ± 0.50
PLT (10^9/L)	865.20 ± 58.79	846.33 ± 65.75	891.00 ± 86.47	812.60 ± 83.81	869.40 ± 53.97	869.25 ± 223.95

Values are expressed as mean ± SEM, n = 10. Values with different supersripts are statistically significant (p<0.05). PCV: Packed cell volume; LYM: Lymphocytes; PLT: Platelets; NEUT: Neutrophils; MON: Monocytes; EOS: Eosinophils; BAS: Basophils.

* = significantly different from group A at p<0.05; a = significantly different from group B at p<0.05; b = significantly different from group C at p<0.05; c = significantly different from group D at p<0.05; d = significantly different from group E at p<0.05; e = significantly different from group F at p<0.05.

DISCUSSION

Peptic ulcer disease (PUD) which includes gastric and duodenal ulcer is one of the unresolved medical problems facing numerous patients in a wide range of age of both sexes worldwide[51], with a global prevalence of 5-10% [52], Nigeria ranked #31 in the world with PUD total deaths of 0.39% according to the World Health Organisation and an unexpected rise in gastric ulcer has also been reported in the South-East [53]; [54].Many medicinal plants are known to exhibit antiulcer activity [55] and some have been confirmed scientifically to possess gastro protective and antiulcer property and also found to be useful in its treatment [56]; [57]. Some

studies have been conducted on the use of turmeric and black pepper respectively and also its combination to achieve therapeutic effects on various diseases including gastro intestinal diseases. [58] [59]; [60].However, the effect of the combination of turmeric and black pepper on the haematological indices of ulcerated rats hasn't been considered. As a result, this study was designed to evaluate the effect of ethanolic extract of *Curcuma longa* and *Piper nigrum* on some haematological parameters of indomethacin induced gastric ulceration in albino rats. Haematological parameters are those parameters that are related to the blood and blood-forming organs [61]. These parameters change in relation to the physiological status of an animal. Thus, haematological examination is one of the methods employed in the detection of some changes in health and physiological status, which may not be apparent during physical examination but which affect the fitness of the animal [61]. Blood serves as a pathological indicator of the health of animals that have been exposed to toxicants and other circumstances [62]. The existence of various metabolites and other constituents in the body of the organism can be clinically investigated using a blood examination. During normal clinical evaluation, haematological markers are useful diagnostic tools. It is important for an organism's physiological, nutritional, and pathological condition. It also provides useful information about the animal's immunological condition [62]. The majority of blood illnesses reduce or impair the number of cells, proteins, platelets, or nutrients in the blood. Red and white blood cells, as well as haemoglobin concentration, are the most common clinical indications of illness condition. In healthy people, these indicators are under control [63]. A number of research studies have documented a correlation between PUD and haematologic disorders, such as thrombocytopenia [64]. A good recovery from PUD has been associated with an increase in platelet counts [65]. Additionally, the relationship between red blood cell parameters and digestive diseases has been assessed. It has been demonstrated that PUD brought on by H pylori lowers haematocrit (Hct), haemoglobin (Hgb), and erythrocyte count values [66]. In a number of diseases, including gastritis, novel inflammatory biomarkers, including as NLR, MLR, and PLR, have been employed as non-invasive indicators of systemic inflammation [67]. The role of PLR has only been documented in adults, and those characteristics have only been evaluated in relation to gastritis thus far. Consequently, a rise in thrombocyte count and a decrease in lymphocyte count have been linked to a greater PLR [67]. In the present study, there was no significant ($P > 0.05$) difference in PCV, HbC, TWBC, NEUT, MON, EOS, BAS, RBC, and PLT across the groups. LYM was significantly ($P < 0.05$) decreased in group E when compared with group F. In an observational study exploring the impact of ucomplicated peptic ulcer disease (PUD) on haematological parameters, Ahmed et al. (2024) reported that the mean values of Hgb, RBC, Hct, MCV, MCH, MCHC were observed to be significantly lower in uncomplicated PUD when compared to control group. However, the mean values of neutrophil count, monocyte count, neutrophil-to-lymphocyte ratio (NLR) and monocyteto-lymphocyte ratio (MLR) were significantly higher in uncomplicated PUD patients than that of the control group. On the other hand, mean values of platelet count and (platelet-to-lymphocyte ratio) PLR were lower in uncomplicated PUD patients in comparison to control group which were statistically non-significant. In contrast to the report of [64] and consistent with the result obtained in this study, [68] reported that there was no significant change in PCV and Hb in PUD patients when compared with the non-peptic ulcer patients. Omeprazole, a proton pump inhibitor, is not a new drug in medical and pharmaceutical circles. Its use for the management of gastric ulcer and gastroesophageal reflux disease (GERD) since its discovery and launch in the 1980's is well documented [69]; [70]. Today, omeprazole (OME) has become one of the most frequently prescribed and widely used medications [71]; [72]. It may also have become a form of standard especially in terms of cost-efficient and clinically effective therapy for gastric ulcer and GERD [73]; [74]. Furthermore, OME (and other proton pump inhibitors) is considered a mainstay in the control of disease manifestations and improvement of quality of life of patients with GERD [75]. This is because it is very effective in suppressing acid secretion (its basic mechanism of action) and has a wide margin of safety [76]; [77]. The safety profile of OME has been well established and documented through several clinical trials and over 30 years of post-market exposure and surveillance [75]. Despite the indications of omeprazole in the management of peptic ulcer disease, it is not devoid of side effects particularly when it regards haematological parameters. On this note, [78] reported that long-term use of omeprazole resulted in a significant ($p<0.001$) reduction in RBCs and its indices comprising of HGB, MCV, MCH and MCHC with no significant effect on other blood parameters evaluated when compared with the control. Their findings was in contrast with the result obtained from this study which showed no significant ($p>0.005$) difference in all haematological parameters evaluated in the omeprazole administered group when compared with the control and other groups. This discrepancy in this results maybe due to the difference in the duration of administration. Turmeric and black pepper are two culinary spices that have gained popularity due to their therapeutic potential. Piperine obtained from black pepper has been employed to increase the bioavailability of curcumin gotten from the rhizomes of the turmeric palnt. In this study, LYM was significantly ($P < 0.05$) decreased in the group pre-treated with black pepper extract (group E) when compared with the group pre-treated with a combination of turmeric and black pepper extracts (group F), while there was no significant change in the levels of other haematological

parameters evaluated when the groups were compared with each other. The reason for this is not fully understood but previous studies have evaluated the effect of turmeric and black pepper alone on the haematological indices of ulcerated animal models but none have evaluated the effect of their combination on haematological parameters of ulcerated animal models. [79], reported that oral administration of curcumin to piroxicam-induced ulcerated rats significantly increased RBCs count, Hb concentration and PCV value and significantly decreased platelets, WBCs, neutrophils, eosinophils, monocytes counts in comparison with the piroxicam treated group. Also, [80], evaluated the effect of aqueous extract of piper nigrum on some physiological parameters and histopathology in female rabbits induced gastric ulceration by aspirin and reported that treatment of rabbits for 30 days with 400mg/kg B.W. of aspirin caused significant decrease in RBC, WBC, PCV, Hb, DWBC relative to the control. And treatment with piper nigrum extract resulted in significant increase in RBC, WBC, PCV and Hb.

CONCLUSION

This study looked at how *Curcuma longa*, *Piper nigrum*, and their combination affected several haematological indicators in albino rats that had stomach ulcers caused by indomethacin. Analysing these haematological markers sheds light on the possible medical advantages of the plant extracts as well as the systemic consequences of stomach ulcers brought on by indomethacin. The majority of the haematological parameters examined, such as packed cell volume (PCV), haemoglobin concentration (HbC), total white blood cell count (TWBC), neutrophils (NEUT), monocytes (MON), eosinophils (EOS), basophils (BAS), red blood cell count (RBC), and platelet count (PLT), did not show significant differences ($P > 0.05$) between the experimental groups, according to the results. This indicates that these particular haematological indicators were not significantly affected by either the indomethacin-induced stomach ulcer or the *Curcuma longa*, *Piper nigrum*, and their combination therapies. The fact that these parameters did not significantly alter suggests that, when used to treat gastric ulcers, the extracts might not have any harmful effects on the haematological system or cause systemic toxicity. However, compared to group F (combinationation therapy), lymphocyte (LYM) levels in group E (black pepper alone) shown a substantial drop ($P < 0.05$). Given the combined extracts' potential to impact the immune response in the context of stomach ulceration, the drop in lymphocyte count observed in group E may indicate a minor immunomodulatory effect. This finding suggests that the dosage and combination of these extracts may be involved in immune system modulation; however, more research is needed to determine the therapeutic significance of this alteration. With the exception of lymphocyte count, which demonstrated a significant decrease in one of the treatment groups, the study's findings suggest that *Curcuma longa* and *Piper nigrum* extracts, either alone or in combination, do not significantly alter most haematological indices in albino rats with gastric ulcers caused by indomethacin. According to the findings, the extracts may be beneficial in treating stomach ulcers without having a negative systemic impact and are generally safe in terms of haematological markers. The underlying processes and possible therapeutic uses of these extracts should be investigated further, especially in light of their immunomodulatory properties.

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