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Evaluation of the gastroprotective activity of *Spondias purpurea* L. (Anacardiaceae) fruit juice

Avaliação da atividade gastroprotetora do sumo do fruto de *Spondias purpurea* L. (Anacardiaceae)

Evaluación de la actividad gastroprotectora del jugo de fruta de *Spondias purpurea* L. (Anacardiaceae)

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ABSTRACT

Objective: To investigate the gastroprotective activity of *S. purpurea* fruit juice (SFS). **Methods:** Aliquots of SFS were collected and analyzed using thin chromatography to study the phytochemical composition. The gastroprotective activity was achieved by the methods of acute induction of ulcers by HCl/ethanol and anti-inflammatory in mice and by absolute ethanol in rats with SFS at concentrations of 25; 50 and 100%. Stomach lesions were quantified by computerized planimetry and the results were expressed as mean ± standard error, with $p< 0.05$ and differences between groups determined by one-way analysis of variance and Tukey and Dunett T3 post-test with GraphPad software Prism®. **Results:** The phytochemical composition of SFS showed flavonoids and cinnamic derivatives. In acute ulcer induction, it was possible to observe that SFS significantly reduced the injured area in the stomach in the models: HCl/ethanol by 95, 73 and 79%; anti-inflammatory in 41, 38 and 89%; and absolute ethanol at 44, 72 and 99%, for the respective concentrations of 25, 50 and 100%. **Conclusion:** *S. purpurea* juice presented flavonoids in its composition and relevant gastroprotective properties under the tested conditions**.**
Keywords: Ulcer, Medicinal Plant, Stomach Disease.

RESUMO

Objetivo: Investigar a atividade gastroprotetora do sumo do fruto de *S. purpurea* (SFS). **Métodos:** Alíquotas do SFS foram coletadas e analisadas por meio de cromatografia delgada para estudo da composição fitoquímica. A atividade gastroprotetora foi realizada pelos métodos de indução aguda de úlceras por HCl/etanol e anti-inflamatório em camundongos e por etanol absoluto em ratos com SFS nas concentrações de 25; 50 e 100%. As lesões estomacais foram quantificadas por planimetria computadorizada e os resultados expressos em média ± erro padrão, com $p< 0,05$ e diferenças entre os grupos determinadas por análise de variância de uma via e pós-teste de *Tukey* e *Dunett T3* com o *software GraphPad Prism®.* **Resultados:** A composição fitoquímica do SFS apresentou flavonoides e derivados cinâmicos. Na indução aguda de úlcera, foi possível observar que o SFS diminuiu, de forma significativa, a área lesionada no estômago nos modelos: HCl/etanol em 95, 73 e 79%; anti-inflamatório em 41, 38 e 89%; e etanol absoluto em 44, 72 e 99%, para as respectivas concentrações de 25, 50 e 100%. **Conclusão:** O sumo de *S. purpurea* apresentou flavonoides em sua composição e relevante propriedade gastroprotetora nas condições testadas.

Palavras-chave: Úlcera, Plantas Medicinais, Gastropatias.

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RESUMEN

Objetivo: Investigar la actividad gastroprotectora del jugo de fruta de *S. purpurea* (SFS). **Métodos:** Se recogieron y analizaron alícuotas de SFS mediante cromatografía fina para estudiar la composición fitoquímica. La actividad gastroprotectora se logró mediante los métodos de inducción aguda de úlceras por HCl/etanol y antiinflamatorio en ratones y por etanol absoluto en ratas con SFS en concentraciones de 25; 50 y 100%. Las lesiones estomacales se cuantificaron mediante planimetría computarizada y los resultados se expresaron como media ± error estándar, con $p< 0,05$ y las diferencias entre grupos se determinaron mediante análisis de varianza unidireccional y postprueba Tukey y Dunett T3 con el software GraphPad Prism®. **Resultados:** La composición fitoquímica de los SFS mostró flavonoides y derivados cinámicos. En la inducción de úlcera aguda, se pudo observar que el SFS redujo significativamente el área lesionada en el estómago en los modelos: HCl/etanol en 95, 73 y 79%; antiinflamatorio en 41, 38 y 89%; y etanol absoluto al 44, 72 y 99%, para las respectivas concentraciones de 25, 50 y 100%. **Conclusión:** El jugo de *S. purpurea* presentó flavonoides en su composición y propiedades gastroprotectoras relevantes en las condiciones probadas**.**

Palabras clave: Úlcera, Plantas Medicinales, Gastropatías**.**

INTRODUCTION

Peptic ulcers are necrotizing lesions that affect the esophagus, stomach or duodenum in the presence of acid and pepsin, characterized by a dysregulation between aggressive and protective factors of the mucosa. These lesions develop through a caustic action caused by hypersecretion of acid that causes damage to gastric tissue (HSIA NY, et al., 2018).

Cytoprotective factors are represented by the mucus-bicarbonate barrier, mucin secretion, surface phospholipids, PGs, mucosal blood flow, cell renewal, antioxidant enzymes (such as catalase and superoxide dismutase) and growth factors (ATEUFACK G, et al., 2015).

The attacking mechanisms result from the union of endogenous factors, such as HCl, pepsin, bile reflux, lipid peroxidation and formation of free radicals; and exogenous, related to the contemporary lifestyle, which include excessive alcohol use, indiscriminate use of non-steroidal anti-inflammatory drugs (NSAIDs), stress, smoking and infection with the bacteria *Helicobacter pylori* (MEHTA D, 2016).

This dysfunction has variable prevalence around the world, with duodenal ulcers being more common in Western countries and gastric ulcers being more common in Asian countries. In Brazil, the prevalence of duodenal is higher in relation to gastric, in a 3:1 ratio, with a predominance in males (KUNA L, et al., 2019). The most common symptoms are epigastric pain, which worsens or attenuates intensity with food intake, dyspepsia, vomiting and, less frequently, loss of appetite and intolerance to foods with a high fat content. Bleeding is a frequent complication of peptic ulcers, approximately 15 to 20% of cases, largely associated with duodenal ulcers, with a mortality rate of 5 to 10% of cases. When left untreated, it can trigger perforations, a more serious complication, responsible for 2/3 of deaths from peptic ulcers (AHMED SR, et al., 2021; SVERDÉN E, et al., 2019).

Currently, medications that help treat this clinical condition include alternatives such as histamine receptor antagonists, proton pump inhibitors (PPIs), which promote a decrease in the production of gastric secretion, and antacids, which act as neutralizers of the acid produced in the stomach. Studies indicate that PPIs, such as omeprazole, are more effective in combating peptic ulcers. However, caution is needed regarding the prolonged use of these drugs due to high relapse rates, drug interactions and potential undesirable effects (BRANDÃO LB, et al., 2019; KAVITT RT, et al., 2019).

Natural products have been used since ancient civilizations in the search for symptom relief and cure of diseases, mainly through the intake of medicinal plants. In this context, it is possible to infer that these products have assets for the development of medicines. In developed countries, medicinal plants used by the population are a source of studies to discover and elucidate a range of new bioactive structures with therapeutic potential (DINAT S, et al., 2022; CERAVOLO IP, et al., 2021).

Medicinal plants are widely used due to their low cost, easy obtaining and effectiveness, especially in developing countries. However, the difficulty in accessing healthcare systems for a large portion of the population and the tradition of using these plants contribute to the widespread use of this resource to cure illnesses (JAMES PB, et al., 2018).

Furthermore, plants have a diversity of bioactive components, such as phenolic compounds, which are secondary metabolites with anti-inflammatory, anticancer, antioxidant, gastric cytoprotective and antisecretory effects. These compounds have the ability to protect the gastric mucosa from harmful agents, by reducing the production of gastric secretion and/or enhancing gastroprotective activity (MATULJA D, et al., 2022; FREITAS PHS, et al., 2021; GARAYEV E, et al., 2018).

Brazilian biodiversity is the largest in the world and is home to around 20% of the total known species on the planet. It has around 55 thousand cataloged species, in addition to the widely spread tradition of using medicinal plants linked to empirical knowledge, propagated between generations through the exchange of experience and knowledge (OZELIN SD, et al., 2021; QUEIROZ JUNIOR NF, et al., 2021; SOUSA JA, et al., 2020).

However, despite the richness of its flora, the number of information, in recent years, about medicinal plants in Brazil, grows only 8% annually and studies referring to the use of plants in alternative medicine have been increasingly highlighted due to the successive information and clarifications they provide to science (PEREIRA IA, et al., 2023).

Belonging to the Anacardiaceae family, *Spondias* is a genus with tropical characteristics. It encompasses a wide variety of species spread across the world, 14 of which are described in Brazilian territory. *Spondias purpurea* L., known by the general population as “serigueleira”, is an endemic species of the Brazilian semi-arid region, restricted to the Northeast region, and widely used by popular medicine in the treatment of gastrointestinal diseases (BRITO SA, et al., 2022; NASCIMENTO DC, et al., 2022).

Work carried out with this plant species is still scarce, despite its common use in the community. Phenolic compounds, flavonoids and carotenoids were found in its fruit (CÂMARA JAR, et al., 2019). Also, it was found that the ethanolic extract of the *S. purpurea* leaf has anti-inflammatory and gastroprotective activity (ALMEIDA CLF, et al., 2017). Furthermore, the antioxidant and photoprotective activity of the phenolic extract from the bark of *S. purpurea* was evidenced, characterized by the high capture of DPPH radicals and the high photoprotective activity (RODRIGUES FAM, et al., 2021).

Therefore, the present study proposes to evaluate the gastroprotective activity of *S. purpurea* fruit juice, with a view to proposing efficient and viable therapeutic alternatives for the treatment of acid-peptic disorders.

METHODS

The botanical material, fruits of *S. purpurea*, was collected in the rural area of the municipality of Barbalha – CE at an appropriate stage of maturation. The fruits were sanitized, packaged and frozen for later use. A representative sample of the species was deposited in the Herbarium Caririense Dárdano de Andrade Lima of the Universidade Regional do Cariri under registration number 14.698. Separation of the seed, juice and peel was carried out manually, with the aid of a conventional fruit juicer.

In the study of phytochemical composition, a 10 ml aliquot of fresh juice was centrifuged for 5 minutes, and the supernatant was used to investigate different classes of secondary metabolites through thin layer chromatography, using specific chemical developers for flavonoids, cinnamic derivatives, phenylpropanoglycosides (NEU reagent and ferric chloride reagent), alkaloids (Dragendorff reagent), saponins (vanillin/sulfuric acid reagent), condensed proanthocyanidins, and leucoanthocyanidin (vanillin/HCl reagent) (ALMEIDA CLF, et al., 2017). The animals used were male Swiss mice (*Mus musculus*), with a mass between 25 – 35 g, and male Wistar rats (*Rattus norvergicus*), with a mass between 180 – 250 g. Both species came from the vivarium of the Agricultural Sciences Campus – Federal University of Vale do São Francisco (CCA/UNIVASF), under a temperature of 22 ± 2 °C and 12-hour light-dark cycles. The research project was

submitted to the UNIVASF Animal Experimentation Ethics Committee and approved under nº 0003/241121 following the Brazilian Guideline for the Care and Use of Animals for Scientific and Didactic Purposes of CONCEA.

In evaluating gastroprotective activity, three experimental tests of acute ulcer induction were used, using different damaging agents. In the HCl/ethanol model, after 8 hours of fasting, Swiss mice were divided into 5 groups (n = 6) and pretreated orally with vehicle - 0.9% NaCl solution (10 ml/kg), lansoprazole (30 mg/kg) and *S. purpurea* juice (SFS) at concentrations of 100, 50 and 25%. After 50 minutes, ulcerogenesis was induced by administration of 0.3 M HCl/60% ethanol solution (0.2 ml/animal) and, one hour later, the mice were anesthetized and euthanized by an anesthetic overdose with xylazine and ketamine. The stomachs were removed, opened by the greater curvature, and photographed. The gastric contents were discarded, the mucosa was washed with 0.9% NaCl solution and fixed on glass plates for better visualization (BRITO SA, et al., 2018). The lesions were quantified by computerized planimetry, with the aid of the ImageJ Program®, and the results were expressed in Ulcerative Lesion Area - ULA (mm^2) in relation to the total area of the gastric mucosa.

In acute ulcer induction with non-steroidal anti-inflammatory drugs (NSAID), the mice were divided into 5 groups (n = 6) and fasted for 8 hours. The groups received vehicle - 0.9% NaCl solution (10 ml/kg), ranitidine (60 mg/kg) and SFS at concentrations of 25, 50 and 100%. After 1 hour of pre-treatment, the animals received indomethacin 30 mg/kg (damaging agent) subcutaneously and, 6 hours after this administration, they were anesthetized and euthanized by an anesthetic overdose (DJAHANGURI B, et al., 1969). The stomachs were removed, opened by the greater curvature, photographed and the lesions quantified by computerized planimetry, with the aid of the ImageJ Program®. The results were expressed in ULA (mm^2) in relation to the total area of the gastric mucosa.

In the absolute ethanol ulcer induction model, after an 8-hour fast, five groups of Wistar rats (n = 6/group) were pre-treated, respectively, orally, with control (vehicle, 0.9% NaCl solution), lansoprazole (30 mg/kg) and SFS (10 ml/kg) at concentrations of 100, 50 and 25%. After one-hour, absolute ethanol was administered (1 ml/100g of body mass, p.o.) and, one hour later, the animals were anesthetized and euthanized by an anesthetic overdose with xylazine and ketamine. The stomachs were removed, opened by the greater curvature, and photographed. The gastric contents were discarded, the mucosa was washed and fixed on glass plates. The lesions were quantified by computerized planimetry with the aid of the ImageJ Program® and the results were expressed in ULA (mm^2) in relation to the total area of the gastric mucosa (MORIMOTO Y, et al., 1991).

The results were expressed as mean ± standard error of the mean (S.E.M.). The normality of the data was investigated using the Shapiro-Wilk and Kolmogorov-Smirnov tests and the homogeneity of variances using the Brown-Forsythe test. Differences between groups were determined by one-way analysis of variance (ANOVA), followed by Tukey's post-test, in the models of peptic ulcer induction by acidified ethanol and peptic ulcer induction by anti-inflammatory and by ANOVA of Welch, to correct non-homogeneous variances, followed by the Dunett T3 post-test, in the peptic ulcer induction model by absolute ethanol, using the GraphPad Prism® software version 9.0 (San Diego, CA, USA). The minimum significance level was $p < 0.05$. The effect size was determined by calculating Cohen's d (SERDAR CC, et al., 2021).

RESULTS AND DISCUSSION

Phytochemical studies with *Spondias purpurea* are scarce and, although the species is widely used in traditional medicine, this work is pioneering in the investigation of the gastroprotective activity of the fruit of *S. purpurea.*

In a study carried out with the fruits of the “seriguela”, phenolic compounds such as quercetin, kampferol, gallic acid and rutin were identified. Another analysis carried out with the fruits of *S. purpurea* revealed a significant content of phenolic compounds (ENGELS C, et al., 2012; OMENA CMB, et al., 2012).

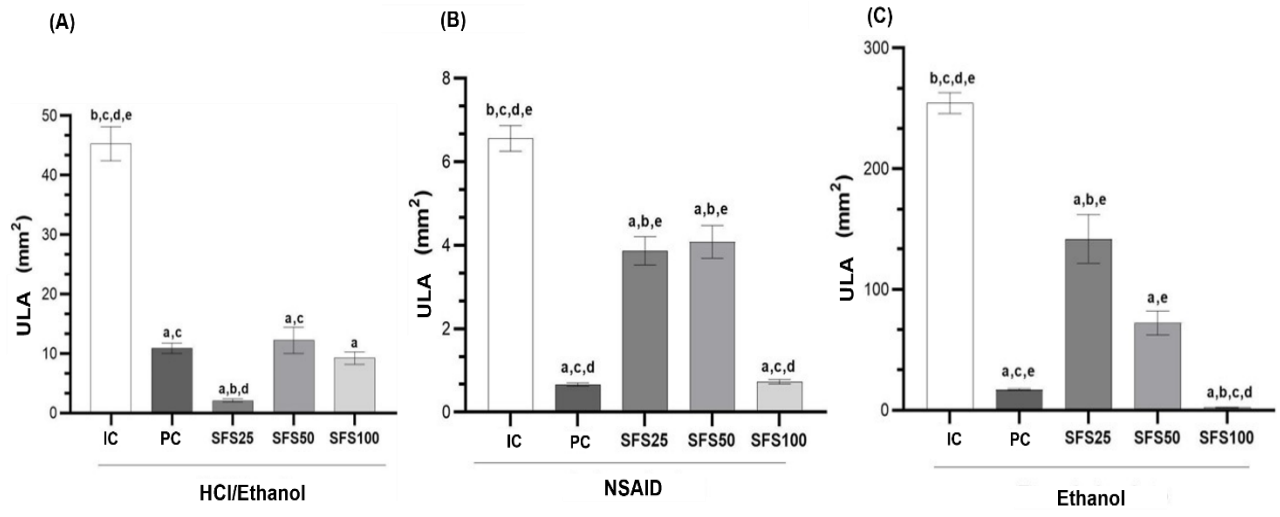
Studies with the hexane extract of *S. purpurea* leaves also revealed the presence of caffeic acid and epigallocatechin. These compounds are recognized for their antioxidant and antiulcerogenic capacity in ulcers induced by ethanol, stress and acetic acid in rats (KOLGAZI M, et al., 2021; HAMAISHI K, et al., 2006).

In the phytochemical prospecting study, it was possible to identify flavonoids and cinnamic derivatives in SFS. Flavonoids, also found in *S. purpurea* leaf extracts, stand out for their antioxidant effect by preventing lipid peroxidation and the formation of reactive oxygen species, which constitutes an important mechanism in the treatment and prevention of inflammatory diseases, such as peptic ulcers (ALI SS, et al., 2020).

To investigate the possible gastroprotection promoted by SFS, a pharmacological screening was carried out in mice with HCl/ethanol, being considered a suitable model to evaluate the antiulcerogenic, cytoprotective and/or antioxidant potential of samples due to the non-specific mechanism of action exerted by the harmful agents. Hydrochloric acid is responsible for causing serious damage to the gastric mucosa and enhancing the effect of ethanol. This, in turn, produces necrotic lesions as a result of direct action on the mucosa, in addition to causing a reduction in defensive factors, such as bicarbonate secretion and mucus production (PRAZERES LDKT, et al., 2019).

The effect of SFS in the acidified ethanol model demonstrated significant results according to the ANOVA test ($F(4, 21) = 87.57$, $p < 0.0001$, $\eta = 0.94$) (**Figure 1A**). When analyzing Tukey's multiple comparison test, it was observed that SFS concentrations (25, 50, and 100%) were able to reduce ULA by 95, 73, and 80%, respectively, when compared to the injured control - IC (SF25 - $\Delta M = 43.17$; IC95 = 35.39, 50.94; $p < 0.0001$; Cohen's d = 8.97. SFS50 - $\Delta M = 33.06$; IC95 = 25.29, 40.84; $p < 0.0001$; Cohen's d = 5.86. SFS100 - $\Delta M = 36.01$; IC95 = 28.24, 43.79; $p < 0.0001$; Cohen's d = 7.19) (**Table 1**).

Figure 1 - Effect of oral administration of SFS on ulcers induced by acidified ethanol (A), NSAID (B), and ethanol (C) in animal models.



Subtitle: Values were expressed as mean ± standard error of the mean (n = 6 animals per group). ULA = Ulcerative Lesion Area, IC – injured control, PC – positive control, SFS25 – 25% *S. purpurea* juice, SFS50 – 50% *S. purpurea* juice, SFS100 – 100% *S. purpurea* juice, a – significant when compared to IC, b – significant when compared to PC, c – significant when compared to SFS25, d – significant when compared to SFS50, e – significant when compared to SFS100.

Source: Junior GRC, et al., 2024.

Table 1 - Effect of SFS on gastric ulcers induced by HCl/ethanol, NSAID and ethanol in animal models.

Treatment (v.o.)	Ulcerative lesion area (mm²)	Area of injury (%)	Inhibition (%)
HCl/ethanol			
NaCl 0.9% (10 ml/kg)	45.28 ± 2.90 [b,c,d,e]	11.10 ± 0.71 [b,c,d,e]	-
Lansoprazole (30 mg/kg)	10.90 ± 0.87 [a,c]	2.96 ± 0.25 [a,c]	76
SFS (25%)	2.12 ± 0.28 [a,b,d]	0.72 ± 0.11 [a,b,d]	95
SFS (50%)	12.22 ± 2.21 [a,c]	4.00 ± 0.73 [a,c]	73
SFS (100%)	9.27 ± 1.06 [a]	2.60 ± 0.30 [a]	80
NSAID			
NaCl 0.9% (10 ml/kg)	6.57 ± 0.31 [b,c,d,e]	2.24 ± 0.10 [b,c,d,e]	-
Ranitidine (60 mg/kg)	0.66 ± 0.04 [a,c,d]	0.24 ± 0.01 [a,c,d]	90
SFS (25%)	3.87 ± 0.34 [a,b,e]	1.25 ± 0.11 [a,b,e]	41
SFS (50%)	4.08 ± 0.39 [a,b,e]	1.29 ± 0.12 [a,b,e]	38
SFS (100%)	0.73 ± 0.05 [a,c,d]	0.24 ± 0.02 [a,c,d]	89
Ethanol			
NaCl 0.9% (10 ml/kg)	254.50 ± 8.57 [b,c,d,e]	21.00 ± 0.71 [b,c,d,e]	-
Lansoprazole (30 mg/kg)	17.22 ± 0.81 [a,c,e]	1.48 ± 0.06 [a,c,e]	93
SFS (25%)	142.00 ± 20.16 [a,b,e]	13.75 ± 1.89 [a,b,e]	44
SFS (50%)	72.35 ± 9.86 [a,e]	6.75 ± 1.03 [a,e]	72
SFS (100%)	2.15 ± 0.32 [a,b,c,d]	0.25 ± 0.03 [a,b,c,d]	99

Subtitle: Results expressed as mean ± S.E.M. ANOVA followed by Tukey's test in the HCl/ethanol and NSAID tests in mice. Welch's ANOVA followed by Dunett's T3 test in the rat ethanol model. a – Significant when compared to NaCl 0.9%, b – significant when compared to CP, c – significant when compared to SFS25, d – significant when compared to SFS50, and significant when compared to SFS100.

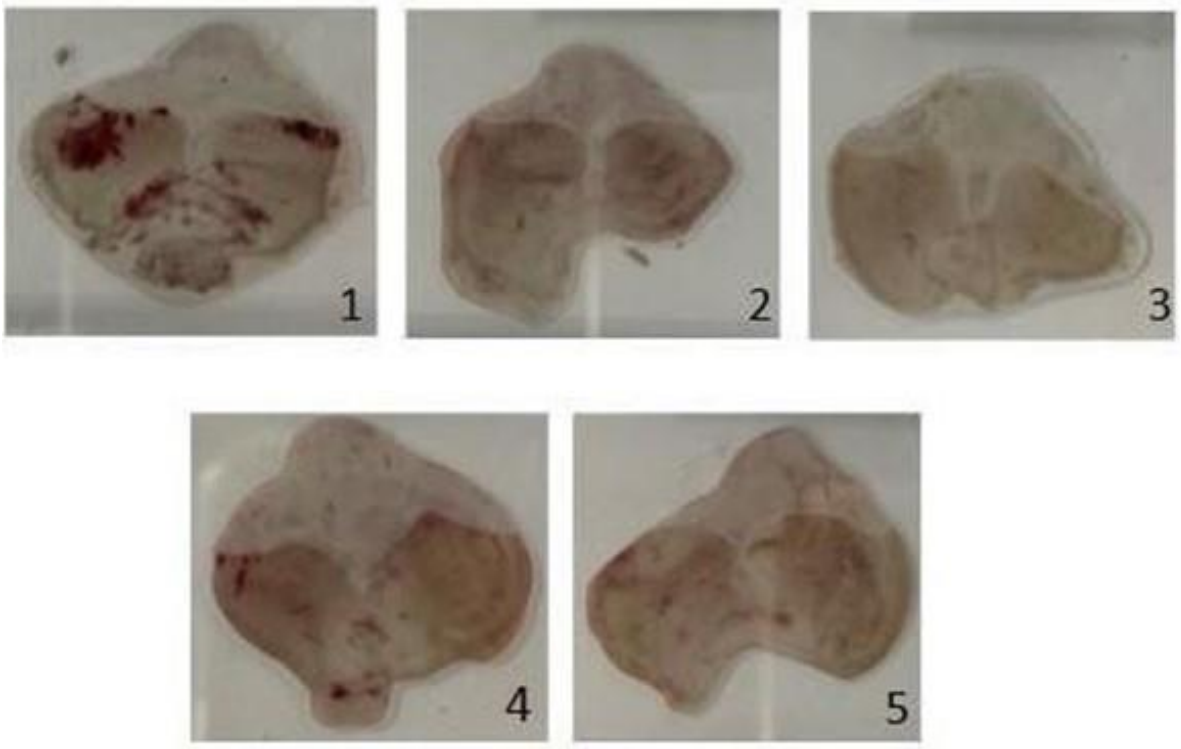
Source: Junior GRC, et al., 2024.

The injuries generated in this experiment involve damage to the vascular endothelium and stagnation of gastric blood flow, with the consequent appearance of hemorrhage, necrosis, and tissue injury, in addition to causing erosion of the protective mucus membrane, formation of edema and cellular exfoliation. It was possible to observe that in mice that received vehicle and then acidified ethanol, the mucous membranes showed damaged regions in the mucosa with intense hemorrhage and necrosis. For the groups pretreated with lansoprazole and with different concentrations of SFS, the mucous membranes remained better preserved and with discrete areas of inflammation (**Figure 2**).

NSAIDs are drugs widely prescribed for the treatment and relief of pain, inflammation, rheumatic diseases and migraines, also due to their analgesic and antipyretic effects. However, they are considered one of the main factors responsible for the development of peptic ulcers and delays in the healing process.

The indiscriminate use of NSAIDs, such as indomethacin, causes local and systemic damage to the gastric mucosa (when inhibiting the COX enzyme), in addition to partially interfering with COX-independent mechanisms. In local cytotoxic action, NSAIDs, particularly those of an acidic nature, chemically associate with the phospholipid layer and cause the disruption of the barrier that covers the surface of the mucosa, which impairs the integrity of the membrane (ATEUFACK G, et al., 2015).

Figure 2 - Stomachs of Swiss mice pretreated orally with 0.9% NaCl solution - injured control (1), lansoprazole 30 mg/kg (2), SFS (25%) (3), SFS (50%) (4), SFS (100%) (5) in the acidified ethanol model.



Source: Junior GRC, et al., 2024.

In the systemic mechanism, NSAIDs are capable of inhibiting cyclooxygenase enzymes (COX-1 and COX-2) and, consequently, suppressing the synthesis of cytoprotective prostaglandins, in addition to causing impairment of mucus and bicarbonate production, decreased blood flow, changes in microvascular structures and platelet aggregation, reduced angiogenesis and increased leukocyte adhesion. Regarding COX-independent mechanisms, the decrease in the levels of nitric oxide, hydrogen sulfide, and polyamines play an important role in the formation of ulcers induced by NSAIDs (MUSUMBA C, et al., 2009).

Acute gastric ulcer induced by an anti-inflammatory used indomethacin as the damaging agent, which allows us to investigate the cytoprotective potential more specifically and antisecretory capacity of a sample via the systemic route, since the pathophysiology of this injury involves the gastric acid secretion and the synthesis of prostaglandins (PALLE S, et al., 2018).

When observing the effect of SFS in this model using the ANOVA test, significant results were found ($F(4, 24) = 82.01$, $p < 0.0001$, $\eta = 0.93$) (**Figure 1B**). When analyzing Tukey's multiple comparison tests, it was observed that SFS concentrations (25, 50, and 100%) were able to reduce ULA by 41, 38, and 89%, respectively, when compared to the injured control - IC (SF25 - $\Delta M = 2.70$; IC95 = 1.54, 3.89; $p < 0.0001$; Cohen's d = 3.87. SFS50 - $\Delta M = 2.48$; IC95 = 1.32, 3.64; $p < 0.0001$; Cohen's d = 3.22. SFS100 - $\Delta M = 5.83$; IC95 = 4.67, 6.99; $p < 0.0001$; Cohen's d = 13.81) (**Table 1**).

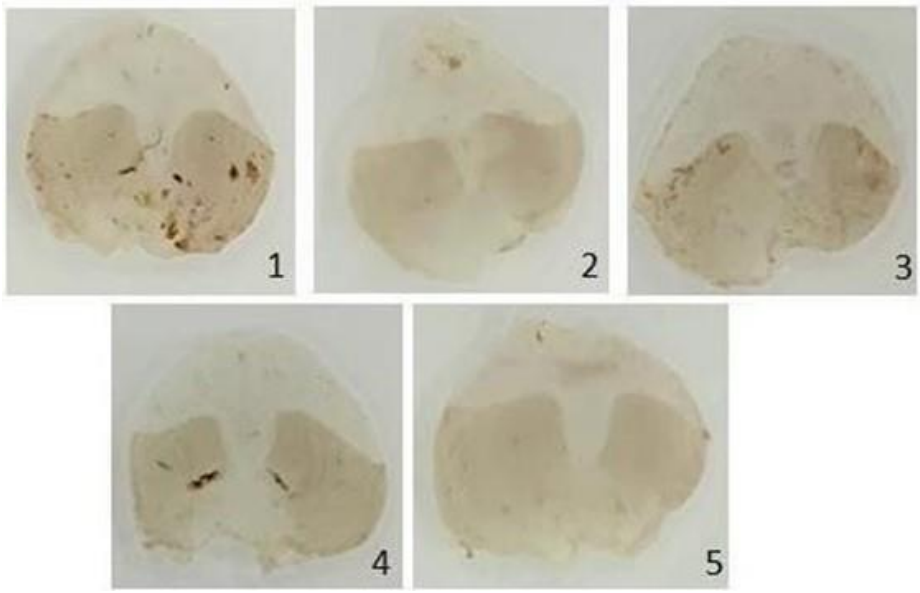
Macroscopic analysis of the mucous membranes allows us to infer that the mice that received the damaging agent presented injured regions with points of necrosis and hemorrhage of moderate intensity. For the groups pre-treated with ranitidine and with different concentrations of SFS, the mucous membranes remained preserved and with subtle points of inflammation (**Figure 3**).

Ethanol and its metabolite, acetaldehyde, are responsible for causing most gastric injuries in humans and generate hemorrhagic lesions, edema, exfoliation and infiltration of inflammatory cells (WANG XY, et al., 2018). The induction of ulcers by ethanol in rats is a common model and widely used in studies related to the

pathogenesis and therapy of ulcerative diseases, especially to help choose doses to be used in subsequent mechanisms.

Ethanol reaches the mucosa after breaking the mucus and bicarbonate barrier, producing hemorrhagic lesions, hyperemia, acute edema, degranulation of mast cells with release of histamine, infiltration of inflammatory cells and epithelial exfoliation, causing vasoconstriction and stasis of blood flow in the microcirculation, arteriolar dilation, and plasma leakage (LIANG J, et al., 2018).

Figure 3 - Stomachs of Swiss mice pretreated orally with 0.9% NaCl solution - injured control (1), ranitidine 60 mg/kg - positive control (2), SFS (25%) (3), SFS (50%) (4), SFS (100%) (5) in non-steroidal anti-inflammatory model.



Source: Junior GRC, et al., 2024.

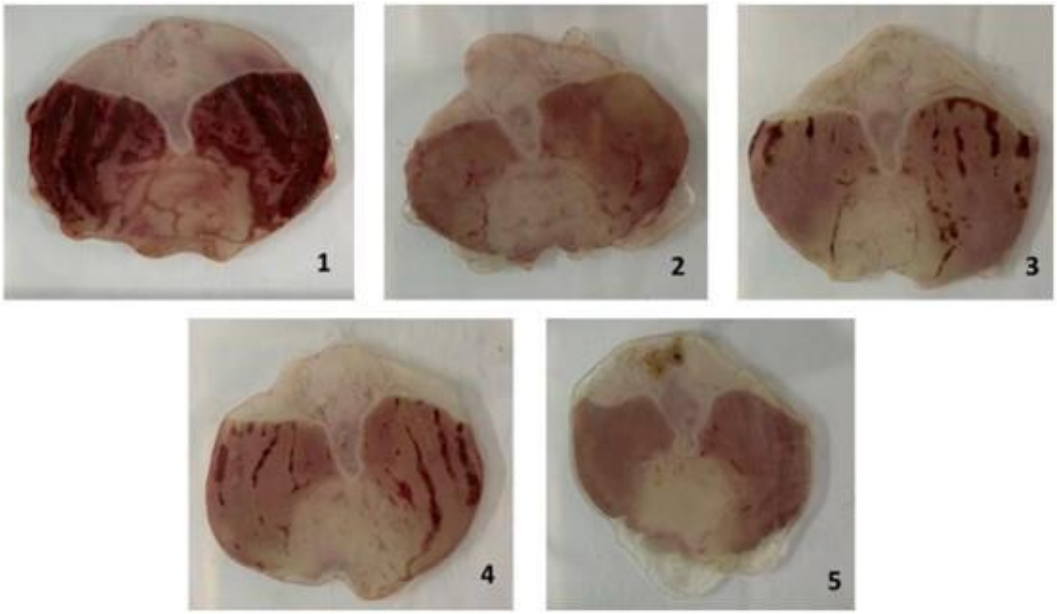
The effect of SFS in the absolute ethanol model was observed and Welch's ANOVA test found statistically significant results (W (4.00, 6.71) = 239.9, p <0.0001, η = 0.93) (**Figure 1C**). When analyzing the Dunett T3 multiple comparison tests, it was observed that SFS concentrations (25, 50, and 100%) were able to reduce ULA by 44, 72, and 99%, respectively, when compared to the injured control - IC (SF25 - ΔM = 112.50; IC95 = 6.98, 218; p = 0.0402; Cohen's d = 4.19. SFS50 - ΔM = 182.2; IC95 = 129.8, 234.5; p <0.0001; Cohen's d = 11.38. SFS100 - ΔM = 252.4; IC95 = 202.5, 302.2; p = 0.0004; Cohen's d = 24.03) (**Table 1**).

Furthermore, when comparing the different concentrations of SFS, a significant difference was observed between SFS25 and SFS100 (ΔM = 139.9; IC95 = 22.68, 257.10; p = 0.0307; Cohen's d = 5.66) and between SFS 50 and SFS 100 (ΔM = 70.20; IC95 = 12.87, 127.5; p = 0.0286; Cohen's d = 5.81). Through data analysis, it was possible to infer that the SFS concentration of 100% was the one that presented the best result.

By macroscopic analysis of the stomachs, the rats that received vehicle and then acidified ethanol presented damaged mucous membranes with intense hemorrhage and necrosis. For the groups pretreated with lansoprazole and with different concentrations of SFS, the mucous membranes remained better preserved (**Figure 4**).

During this work, one difficulty faced was waiting for the appropriate collection time for *S. purpurea* L., which occurs from November onwards in some regions, culminating in the harvesting of its fruits taking place between December and January. Furthermore, we aim to continue this work by carrying out studies to elucidate the mechanisms of action involved in the gastroprotective activity and healing activity of this species as perspectives.

Figure 4 - Stomachs of rats pretreated orally with 0.9% NaCl solution - injured control (1), lansoprazole 30 mg/kg - positive control (2), SFS (25%) (3), SFS (50%) (4), SFS (100%) (5) in the absolute ethanol model.



Source: Junior GRC, et al., 2024.

CONCLUSION

Research into medicinal plants is growing considerably, providing useful information for the development of new drugs. It is essential to research and develop new therapeutic alternatives that demonstrate good efficacy with fewer undesirable effects, as well as promoting the healing of ulcers and preventing the recurrence of the disease. According to the results obtained in the present study, it was possible to conclude that SFS contains flavonoids and cinnamic derivatives in its composition. Furthermore, SFS, at concentrations of 25, 50 and 100%, showed gastroprotective activity in models of acute gastric ulcer induced by acidified ethanol and non-steroidal anti-inflammatory drugs in mice and by absolute ethanol in rats. Thus, these data indicate that SFS has gastroprotective properties possibly related to the presence of flavonoids, recognized antioxidants. However, additional studies are necessary to elucidate the mechanisms of action involved in the activity.

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