



Effects of Sweetgum Oil on Experimental Chronic Gastritis in Rat Model

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ABSTRACT

Background: Sweetgum oil has been traditionally used to treat wounds, respiratory tract problems, osteoarthritis and various stomach ailments. In this study, the effects of sweetgum oil on ethanol-induced chronic gastritis in rats were investigated.

Methods: Thirty Wistar albino rats were divided into 5 groups. Group 1 served as control and received no treatment. Except for control, all animals received oral doses of 8 g/kg of 56% ethanol twice a week for 4 weeks to induce gastritis. Group 2, the ethanol group received only ethanol. Group 3 was treated with the conventional treatment of 20 mg/kg omeprazole daily for 2 weeks. Group 4 was treated with 150 mg/kg of sweetgum oil dissolved in olive oil daily for 2 weeks. Group 5 was treated orally with 0.6 ml olive oil daily for 2 weeks.

Result: Histopathological and immunohistochemical examinations were performed on the stomach samples. Ethanol caused severe erosive ulcerative lesions in the gastric mucosa and inflammatory cell infiltrations in the propria mucosa. In immunohistochemical examination, marked increases in interleukin-10 (IL-10), interleukin-1 β (IL- β) and platelet endothelial cell adhesion molecule 1 (PECAM-1) expressions were observed in this group. Omeprazole treatment significantly reduced these pathological findings. Sweetgum oil provided significant improvement in histopathological and immunohistochemical findings, but the protection was not as effective as omeprazole. Moderate healing effects were also observed with olive oil. Sweetgum oil has a curative effect on chronic gastritis, although it is not as effective as omeprazole. Moreover, olive oil has a curative effect on gastritis.

Key words: Chronic gastritis, Histopathology, Immunohistochemistry, Rat, Sweetgum oil, Traditional medicine.

INTRODUCTION

Gastrointestinal system disorders are frequently seen in many people and animals due to the nutritional preferences, processed foods, uncontrolled drug consumption, intense stress and unsuitable environmental conditions. The drugs used to treat these disorders are often not preferred because they require long-term use and have side effects. Although there has been an increase in the use of herbal remedies in recent years, undesirable results are often encountered due to inability to properly adjust the appropriate plant selection, preparation, dosage and frequency of use (Muszyński *et al.*, 2016; Kan *et al.*, 2017; Lia *et al.*, 2018; Ardalani *et al.*, 2020; Bornschein and Pritchard, 2021; Subramani and Sathiyarajeswaran, 2022; Roy *et al.*, 2023; Ansari *et al.*, 2023).

There are many studies on the harmful effects of ethanol on different systems. However, since ethanol directly contacts the gastric mucosa, it can cause significant damage, especially in the long-term consumption. Many studies have reported the effects of ethanol on the gastric mucosa of experimental animals. Indicating that the damage increases with the consumed dose (Lia *et al.*, 2018; Sistani Karampour *et al.*, 2019).

One of the potent anti-inflammatory cytokines is IL-10 which has numerous biological effects, including inhibition of many effector functions of phagocytes (Steen *et al.*, 2020). Numerous cells are capable of producing IL-10, with T-cells being the major source (Almanan *et al.*, 2020). Other important producers of IL-10 include certain granulocytes

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such as eosinophils and mast cells, human B cells, stimulated macrophages, monocytes and some subsets of dendritic cells (Ryan *et al.*, 2007; Fillatreau *et al.*, 2008). Additionally, some non-immune cell including epithelial cells, keratinocytes and certain tumor cells, have been

shown to produce IL-10 (Moore *et al.*, 2001; Williams *et al.*, 2004). IL-10 mainly regulates the production of T cells, B cells and NK cells and inhibits the transcription, expression and secretion of cytokines in various immunocompetent cells (Yang *et al.*, 2016). Increased IL-10 expressions have been reported in *Helicobacter pylori* associated gastritis (Bodger *et al.*, 2001).

The biological activities of IL-1 β are related to enhancing the host's inflammatory response against numerous exogenous and endogenous stimuli (El-Omar, 2001). Most microbes or their microbial products, as well as many non-microbial agents, stimulate the synthesis and transcription of IL-1 β in inflammatory reactions (Dinarello 1996). The main responsibility of cytokines is arranging immune responses and increased secretion of proinflammatory cytokines such as IL-1 α/β has been reported in *Helicobacter pylori* gastritis (Noach *et al.*, 1994).

Cell adhesion molecules play a pivotal role in the pathogenesis of inflammatory processes. These molecules are expressed in response to various pro-inflammatory cytokines. Platelet endothelial cell adhesion molecule 1 (PECAM-1) is one of the most important cell adhesion molecules involved in adhesion, expressed on the lateral surfaces of endothelial cells and on blood platelets (O'Brien *et al.*, 2003). Recently, new functions of PECAM-1 have been reported, such as inhibition of apoptotic pathway in pathological conditions and physiological functions (Gao *et al.*, 2003; Bergom *et al.*, 2005). Additionally, PECAM-1 regulates adhesion to endothelium and rolling. It also regulates mast cell accumulation in chronic inflammation areas (Dudeck *et al.*, 2010). Furthermore, the PECAM-1 adhesion molecule regulates the transendothelial migration of neutrophil leukocytes. IL-1 β induces PECAM-1-dependent transmigration (O'Brien *et al.*, 2003). Decreased PECAM-1 expression has been reported in patient with primary non-Hodgkin's gastric lymphoma (Darom *et al.*, 2006).

Sweetgum oil is a dark gray, honey-like substance with a pleasant-smell and a bitter-taste. It contains essential oil and cinnamic acid. It is believed to have antiseptic (Akram, 2021), anti-mycobacterial (Askun *et al.*, 2021), wound-healing, antiparasitic, pain-relieving, expectorant, antioxidant (Sengun *et al.*, 2023) and anticancer (Cetinkaya *et al.*, 2022) effects. In traditional medicine, it is used for respiratory diseases such as asthma and bronchitis and for treating fungus and scabies as an ointment or plaster. It has been known since ancient times that it was used for mummification and wound cleaning in ancient Egypt (Gunal, 1994). Sweetgum oil is still used by the local people in Türkiye for stomach diseases and is believed to have a therapeutic effect (Arslan and Sahin, 2016; Baloglu *et al.*, 2023).

It is popularly believed that sweetgum oil has curative effects on chronic gastritis in southwestern Türkiye. In the literature, the anti-ulcer effects of *Liquidambar orientalis* oil on ethanol-induced acute gastric ulcers (Gurbuz *et al.*,

2013) were investigated, but the effects on ethanol-induced chronic gastritis were not studied. This study aimed to determine the protective effect of sweetgum oil (*Liquidambar orientalis*, *Styrax*) locally grown in Muğla, Denizli, Aydın, Burdur and Antalya provinces on chronic gastritis in rats.

MATERIALS AND METHODS

Drugs

Sweetgum oil (*Styrax liquidus*) balm was obtained by purchasing a ministry-approved product from a commercial company and was stored at +4°C until the experimental stage. 1800 mg sweetgum oil balm (raw styrax) was dissolved in 30 mL of olive oil. After mixing the solution, it was administered orally to the rats in the sweetgum group at a dose of 150 mg/kg. Gurbuz *et al.* (2013) determined the effects of various doses of sweetgum oil in rats with acute gastritis. They have demonstrated that a dose of 150 mg/kg had best therapeutic effect compared to 300 mg/kg used in rats. Therefore, in the present study, a dose of 150 mg/kg was selected for all the rats with chronic gastritis.

Animals and groups

Thirty 2 month old female Wistar albino rats weighing 200 to 280 g were used in the study. The rats were obtained from the Experimental Animal Production and Experimental Research Center of Burdur Mehmet Akif Ersoy University (Türkiye). All experiments were performed in accordance with the ARRIVE (Animal Research: Reporting in Vivo Experiments) guidelines in 2.0 and study was approved by the Local Ethical Committee on Animal Research of Burdur Mehmet Akif Ersoy University, Türkiye (No: 491).

All animals were fed a standard commercial chow diet (Korkuteli Yem, Antalya, Türkiye) and had free access to food pellets and water. The rats were kept under standard laboratory conditions (humidity 60 $\pm$ 5%; temperature 21 $\pm$ 2°C, 12/12 h light dark cycle).

The rats were randomly separated into five groups of six rats each. All the rats, except control group, received a dose of 8 g/kg of 56% ethanol twice a week for 4 weeks by oral gavage. The groups were as follows:

Group I (Control group)

No drug administered, only 0.6 ml of drinking water was given twice a week for 4 weeks by oral gavage to create oral gavage stress during the study.

Group II (Ethanol group)

A dose of 8 g/kg ethanol (56%) was administered to the rats twice a week for 4 weeks by oral gavage and then they were left to spontaneous healing for two weeks.

Group III (Omeprazole group)

After administration of ethanol (56%), each rat was received a dose of 20 mg/kg omeprazole daily for two weeks by oral gavage.

Group IV (Sweetgum oil group)

Following ethanol administration, a 150 mg/kg dose of sweetgum oil dissolved in olive oil were given to the all the rats in this group daily for two weeks by oral gavage.

Group V (Olive oil group)

All the animals in this group were treated with 0.6 ml olive oil daily for two weeks by oral gavage.

Histopathological examination

All the rats were weighed and then anesthetized by intraperitoneal injection of 90 mg/kg ketamine (Ketasol, Richter Pharma AG) and 10 mg/kg xylazine HCl (Xylasinbio %2, Bioveta, Czech Republic). The animals were sacrificed by exsanguination, following the standardized ethical rules. During the necropsy, stomach samples were harvested and examined grossly for findings related to gastritis. The samples were then fixed in 10% neutral-buffered formaldehyde solution. After two days of fixation, the samples were placed into tissue processing cassettes and routinely processed using an automatic tissue processor (Leica ASP300S, Wetzlar, Germany) and embedded in paraffin. Serial sections of 5 μ m serial sections were taken from each sample using a rotary microtome (Leica RM 2155; Leica Microsystems, Wetzlar, Germany). All sections were then stained with hematoxylin and eosin (HE) and examined under a light microscope. Semiquantitative analysis and scoring were performed for the histopathological sections. The evaluation criteria were mucosal damage, inflammation, granulation tissue, re-epithelialization, neovascularization, regeneration of gastric gland epithelium. These criteria were scored as "0" absent, "1" mild, "2" moderate and "3" severe. The histopathological scoring criteria are shown in Table 1.

Immunohistochemical analysis

Selected sections were stained to demonstrate the presence of PECAM-1 (CD-31) [CD31 (anti-CD31 antibody, HEC7, ab119339)]; IL-1 β [interleukin-1 β (IL-1 β) [Anti-IL1 beta antibody (ab2105)] and IL-10 [Anti-IL-10 antibody [JES5-2A5] (ab33471)] using the streptavidin-biotin peroxidase technique, according to the manufacturer's instructions. All primary antibodies were purchased from the Abcam, (Cambridge, UK) and used at a 1/100 dilution. The Mouse and Rabbit Specific HRP/DAB Detection Kit-

Micropolymer (ab236466) was used as the secondary antibody and 3,3'-diaminobenzidine was used as the chromogen. The primary antibody was omitted in negative controls. All examinations were performed by a specialized pathologist blinded to the sample treatments. Three serial sections were prepared and examined for each rat and two areas of each stomach were examined. All the slides were analyzed for immunopositivity and a semiquantitative analysis was carried out as detailed below. Samples were analyzed by examining five different sections in each sample, which were then scored from 0 to 3 according to the intensity of staining (0, absence of staining; 1, slight; 2, medium and 3, marked). The Database Manual CellSens Life Science Imaging Software System (Olympus Corporation) was used for evaluation of lesioned area. Immunohistochemical score analyses were carried out using ImageJ version 1.48 (National Institutes of Health, Bethesda MD).

Statistical analysis

A one-way analysis of variance test was used to determine significant differences between the groups. To determine differences between groups in the histopathological and immunohistochemical analyses, the Duncan multiple comparison test was used. Calculations were made using the SPSS 22.00 program. A $p < 0.05$ was set as the level of significance.

RESULTS AND DISCUSSION**Gross examination**

During the study, a noticeable softening of the feces was clinically observed in the groups where olive oil and sweetgum oil dissolved in olive oil were administered. This change in stool consistency was consistently seen across these groups and suggests that olive oil may be the underlying cause. Olive oil is known for its laxative properties, which can lead to softer stools. This effect was not observed in the control or other treatment groups, indicating a specific response related to the administration of olive oil and its combination with sweetgum oil. The clinical observation highlights the need to consider the gastrointestinal effects of olive oil when used as a vehicle for administering other substances.

Table 1: Histopathological scoring criteria.

Score	0	1	2	3
Mucosal damage	None	Desquamation of epithelial lamina	Erosion of mucosae	Ulcer of mucosae
Inflammation	None	Scant	Moderate	Abundant
Granulation tissue	None	Mild and immature	Moderate partially mature	Marked and mature
Re-epithelialization	None	Partial	Complete but immature	Complete and mature
Neovascularization	None	Up to 5 vessels/HMF	6-10 vessels /HMF	>10 vessels/HMF
Regeneration of gastric gland epithelium	None	Slight irregular	Moderate regular	Total healing

HPF: High power field.

During the necropsy, all stomachs were dissected along the greater curvature and the mucosae were carefully examined for pathological findings. In the Group I; no pathological findings were observed. The stomach mucosa appeared normal with no signs of erosion, ulceration, hyperemia, or edema. In the Group II, significant erosive and ulcerative lesions were observed in the gastric mucosa. Moderate to marked hyperemia and edema were present. These findings indicate severe damage to the gastric mucosa as a result of ethanol administration. In the Group III, marked improvement in gastric mucosal health was observed compared to the Group II. Erosive and ulcerative lesions were significantly reduced and many lesions were completely healed. Hyperemia and edema were also considerably lessened, suggesting that omeprazole effectively mitigated the damaging effects of ethanol on the gastric mucosa. In the Group IV, sweetgum oil demonstrated a significant healing effect on the erosive and ulcerative lesions caused by ethanol. A noticeable reduction in hyperemia and edema was observed, indicating that sweetgum oil has protective and restorative properties for the gastric mucosa. The healing was significant, though not as complete as seen in the Group III. In the Group V, olive oil also contributed to the healing process, albeit to a lesser extent than sweetgum oil and omeprazole. Lesions were diminished compared to the Group II, with reductions in both erosive and ulcerative lesions. Hyperemia and edema were less pronounced, indicating some protective effect, though not as robust as the therapeutic agents.

These results highlight the comparative effectiveness of the different treatments, with omeprazole showing the

most significant therapeutic benefit, followed by sweetgum oil and then olive oil. The findings suggest that while sweetgum oil and olive oil can aid in healing gastric lesions, omeprazole remains the most effective treatment in this experimental model (Fig 1).

Histopathological findings

Results of histopathological examination were parallel with gross findings. Normal tissue architecture was observed in Group I rats' stomachs. The glandular part of the stomachs of these rats was lined with simple columnar epithelium. The gastric glands were observed to occupy the entire lamina propria. Mucus-secreting cells, parietal cells and chief cells, which showed a distinctly regular arrangement, covered the entire mucosa. However, marked epithelial loss and inflammatory reactions were noticed in Group II. The mucosae were much thinner compared to the Group I. Inflammatory reaction included severe hyperemia, edema and marked diffuse mononuclear cell composed lymphocyte, monocyte and macrophages and slight neutrophil leukocyte infiltrations were diagnosed in this group rats. The Group II exhibited unique lesions that thoroughly penetrated the stomach mucosa, whereas there was no gastric injury seen in the Group I. Significantly decreased inflammatory reaction was noticed in Group III group. Marked healing was observed in pathological findings in Group IV. Olive oil also diminished histopathological lesions in Group V (Fig 2). While mucosal damage and inflammation increase in Group II, granulation tissue, re-epithelialization, neovascularization and regeneration of gastric gland epithelium were increased in Group III, Group IV and Group V respectively. Statistical

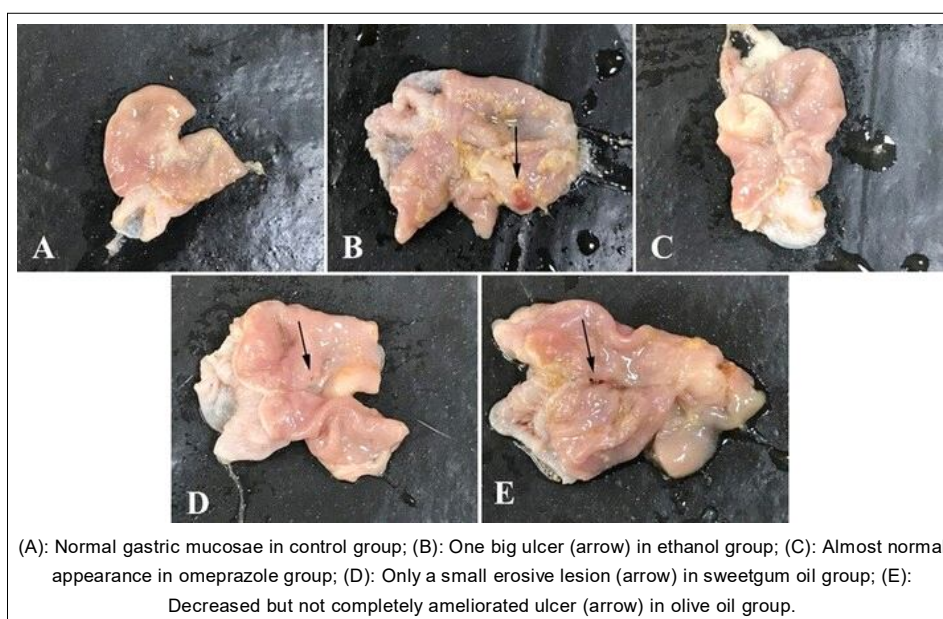


Fig 1: Gross findings of stomachs between the groups.

analysis results of histopathological findings were shown in Table 2.

Immunohistochemical findings

While negative or slight expressions were observed in Group I for IL-1 β , IL-10 and PECAM expressions. All markers increased in Group II. Omeprazole markedly decreased all markers in Group III. Sweetgum oil also decreased all markers both expressed cells and severity of the expressions were decreased in Group IV. Olive oil also decreased the expressions in Group V compared the Group II. IL-1 β and PECAM expressions were observed in markedly epithelial cells. IL-10 expressed cells were inflammatory cells (Fig 3-5). Table 2 displayed the statistical analysis results of the immunohistochemistry findings.

The study demonstrated the therapeutic effects of sweetgum oil on experimental chronic gastritis in a rat model. Histopathological analysis revealed a significant reduction in inflammation and mucosal damage in rats treated with sweetgum oil compared to the control group. The treated group showed a marked improvement in gastric mucosal integrity, with fewer signs of erosion, ulceration and inflammatory cell infiltration. These findings suggest that sweetgum oil possesses potent anti-inflammatory and mucosa-protective properties, which contribute to the healing process of chronic gastritis. The results indicate that sweetgum oil could be a promising natural remedy for managing chronic gastritis, offering a potential alternative to conventional treatments. The findings of this study showed that sweetgum oil has a curative effect according

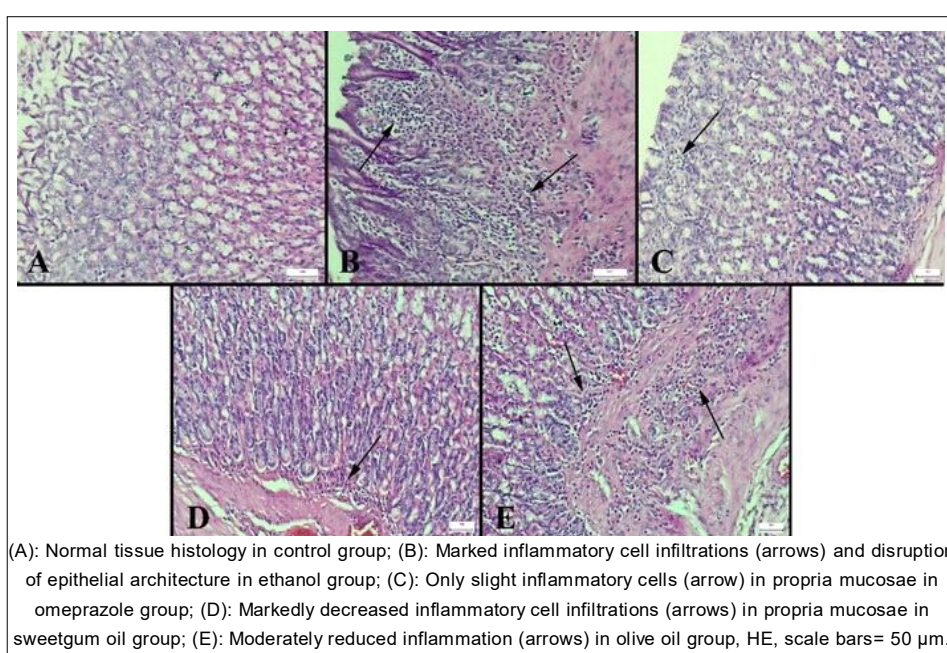


Fig 2: Representative histopathological figures among the groups.

Table 2: Histopathological and immunohistochemical scores in the groups.

Groups	Group I	Group II	Group III	Group IV	Group V	P value
Mucosal damage	0.00 $\pm$ 0.00 ^a	2.66 $\pm$ 0.51 ^b	0.33 $\pm$ 0.51 ^a	1.61 $\pm$ 0.40 ^c	2.00 $\pm$ 0.63 ^d	<0.001
Inflammation	0.33 $\pm$ 0.51 ^a	2.66 $\pm$ 0.51 ^b	1.00 $\pm$ 0.63 ^a	2.00 $\pm$ 0.63 ^b	2.00 $\pm$ 0.89 ^b	<0.001
Granulation tissue	0.00 $\pm$ 0.00 ^a	0.33 $\pm$ 0.51 ^{ab}	1.83 $\pm$ 0.51 ^c	1.33 $\pm$ 0.51 ^{de}	0.83 $\pm$ 0.75 ^{be}	<0.001
Re-epithelialization	0.16 $\pm$ 0.40 ^a	0.50 $\pm$ 0.54 ^b	2.66 $\pm$ 0.51 ^c	1.83 $\pm$ 0.40 ^d	1.33 $\pm$ 0.51 ^d	<0.001
Neovascularization	0.33 $\pm$ 0.51 ^a	1.50 $\pm$ 0.54 ^b	2.50 $\pm$ 0.54 ^c	1.66 $\pm$ 0.51 ^b	1.33 $\pm$ 0.51 ^b	<0.001
Regeneration of gastric gland epithelium	0.33 $\pm$ 0.51 ^a	0.50 $\pm$ 0.54 ^b	2.83 $\pm$ 0.40 ^c	2.00 $\pm$ 0.00 ^d	1.50 $\pm$ 0.54 ^d	<0.001
IL-1 β IHC Scores	0.33 $\pm$ 0.51 ^{ab}	2.33 $\pm$ 1.21 ^c	0.16 $\pm$ 0.40 ^a	1.16 $\pm$ 0.40 ^{bc}	0.33 $\pm$ 0.51 ^{ab}	<0.001
IL-10 IHC Scores	0.50 $\pm$ 0.54 ^a	2.66 $\pm$ 0.51 ^c	1.50 $\pm$ 0.54 ^b	0.50 $\pm$ 0.54 ^b	0.83 $\pm$ 0.75 ^b	<0.001
PECAM IHC Scores	0.16 $\pm$ 0.40 ^a	1.50 $\pm$ 0.54 ^b	0.50 $\pm$ 0.54 ^a	0.83 $\pm$ 0.75 ^{ab}	0.83 $\pm$ 0.75 ^{ab}	<0.05

Data expressed mean $\pm$ standard deviation (SD). Different superscript letters in same row indicate statistically significant differences between the groups.

to gross, histopathological and immunohistochemical evaluation in ethanol-induced chronic gastritis model, although its degree of protection is not as pronounced as that of omeprazole. Additionally, olive oil was found to have some healing effects compared to the ethanol group. These healing effects are considered to be due to a protective layer provided by the oil on the gastric mucosa.

Ulcer is a condition characterized by inflammation, irritation, or erosion in the mucosal lining of the stomach.

10% of the world's population is affected by chronic ulcers. The formation of ulcers depends on the pH of gastric juice and the decrease in mucosal defenses. Nonsteroidal anti-inflammatory drugs (NSAIDs) and *Helicobacter pylori* (*H. pylori*) infection are two significant factors that weaken mucosal resistance to injury. In recent years, as with all diseases, herbal and natural medicines have attracted attention in ulcer treatments. It has been reported that ulcer treatment with herbal medicines can accelerate healing,

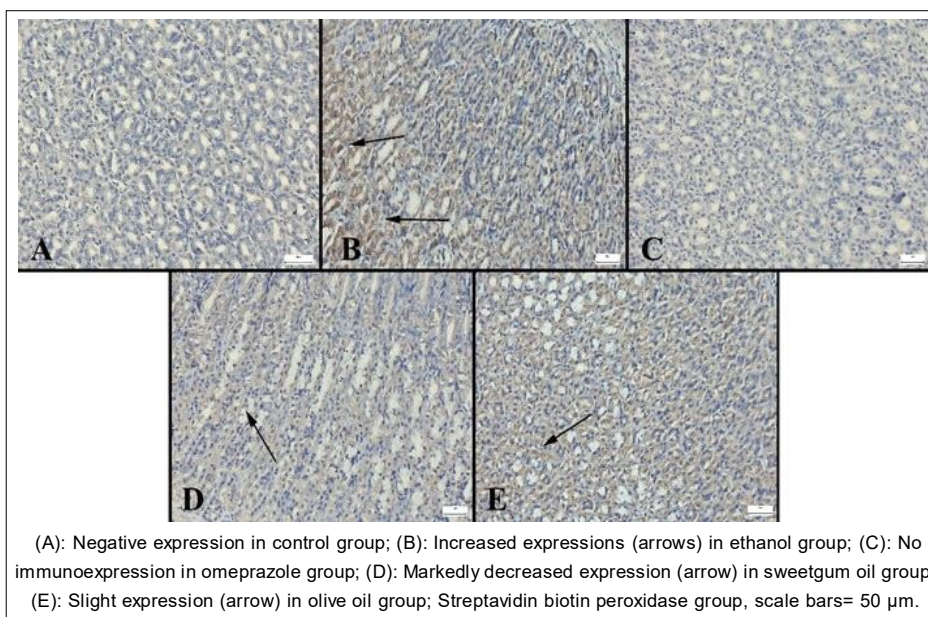


Fig 3: IL-1 β expression among the groups.

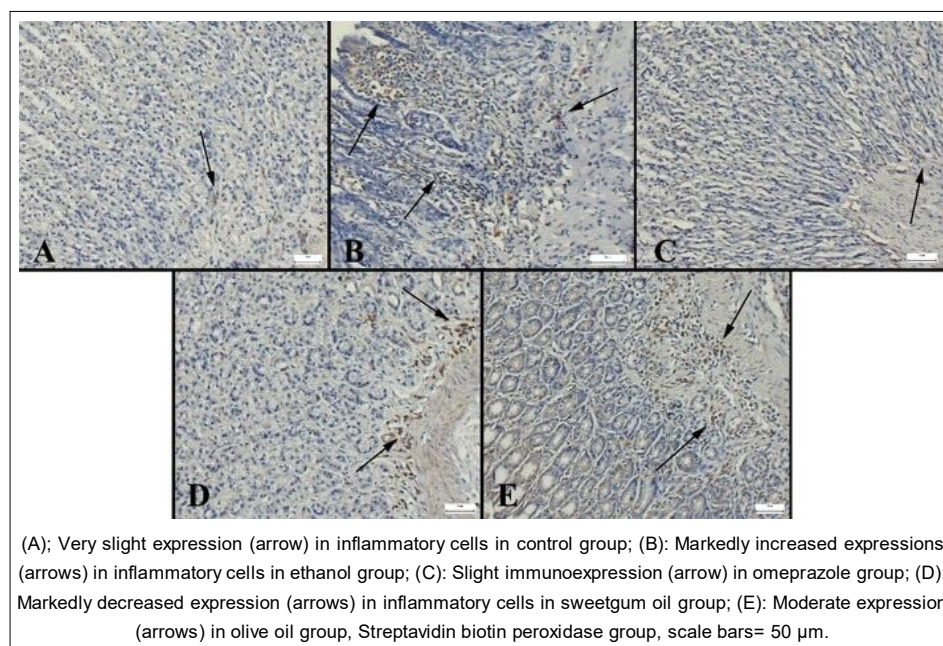


Fig 4: IL-10 expression between the groups.

reduce pain and prevent recurrences (Ardalani *et al.*, 2020; Bornschein and Pritchard, 2021; Subramani and Sathiyarajeswaran, 2022; Roy *et al.*, 2023; Ansari *et al.*, 2023).

Evaluation of gastric ulcer healing is usually based on a visual examination of patients by endoscopy or the assessment of ulcer size in experimental studies. This approach has led to the assumption that the mucosa of largely 'healed' gastric and/or duodenal ulcers returns to normal either spontaneously or following treatment. However, the re-epithelialized mucosa of a largely 'healed' experimental gastric ulcer has recently been found to undergo villi atrophy, marked dilatation of the gastric glands, poor attachment and/or degenerative changes, dilatation changes in glandular cells, prominent immune system activity and histological and ultrastructural abnormalities. It has been hypothesized that these residual abnormalities may interfere with mucosal defenses and cause to ulcer recurrence. Healing of an ulcer is accomplished by restructuring the mucosal structure by filling it with epithelial cells and connective tissue (Singer and Clark, 1999; Clark, 1996). Under the influence of reconstruction factors (predominantly epidermal growth factor (EGF), Angiogenin, fibronectin), the extracellular matrix provides cells for the restructuring of glandular structures with the formation of granulation tissue and re-epithelialization of the scar at the mucosal surface (To and Midwood, 2011; Kishimoto *et al.*, 2005; Calabro *et al.*, 1995; Sheng and Xu, 2016). Granulation tissue at the base of the ulcer supplies lamina propria and endothelial cells and connective tissue cells and aiding in the reconstruction of mucosal microvessels. The final outcome of healing reflects the dynamic interaction between an "epithelial" component from the ulcer margin and a connective tissue component including microvessels originating from the

granulation tissue. The formation of new microvessels in angiogenesis-granulation tissue plays a critical role in the ulcer healing process (Calabro *et al.*, 1995; Tarnawski *et al.*, 1992; Clark, 1996). In this study healing was microscopically evaluated and results supported immunohistochemical examination. Due to the marked amelioration, the degree of PECAM expression was decreased in omeprazole, sweetgum oil and olive oil groups respectively after two weeks of gastritis induction.

The incidence of chronic gastritis increases due to various reasons such as stress, lifestyle changes and eating habits. It is a progressive, multistage and lifelong inflammatory process. Due to the multiple and sometimes unknown etiology, current treatments for this disease remain inadequate. Increased levels of inflammation with the release of large amounts of cytokines are the main features of gastritis (Bi *et al.*, 2014; Muszyński *et al.*, 2016; Kan *et al.*, 2017; Lia *et al.*, 2018). Recent studies have shown that alcohol causes chronic gastritis and the severity of the mucosal lesion is directly related to the duration of excessive drinking (Ibrahim *et al.*, 2016; Kan *et al.*, 2017; Lia *et al.*, 2018). Here, we showed that sweetgum oil had a curative effect on ethanol induced-chronic gastritis model in rats. Sweetgum oil reduced pathological and immunohistochemical findings after two weeks of oral treatment of ethanol-induced chronic gastritis.

Numerous methods have been developed to evaluate the antiulcer effects of drugs or plant extracts and the most commonly used ulcer models being induced by indomethacin, ethanol, acetic acid or forced immobility (Matsuda *et al.*, 1998; Alvarez *et al.*, 1999; Pandit *et al.*, 2000; Tan *et al.*, 2000; Pandian *et al.*, 2002; Tan *et al.*, 2002; Muniapappan and Sundararaj, 2003; Aydinli *et al.*, 2007; Tureyen and Ince, 2021). Aydinli *et al.* (2007).

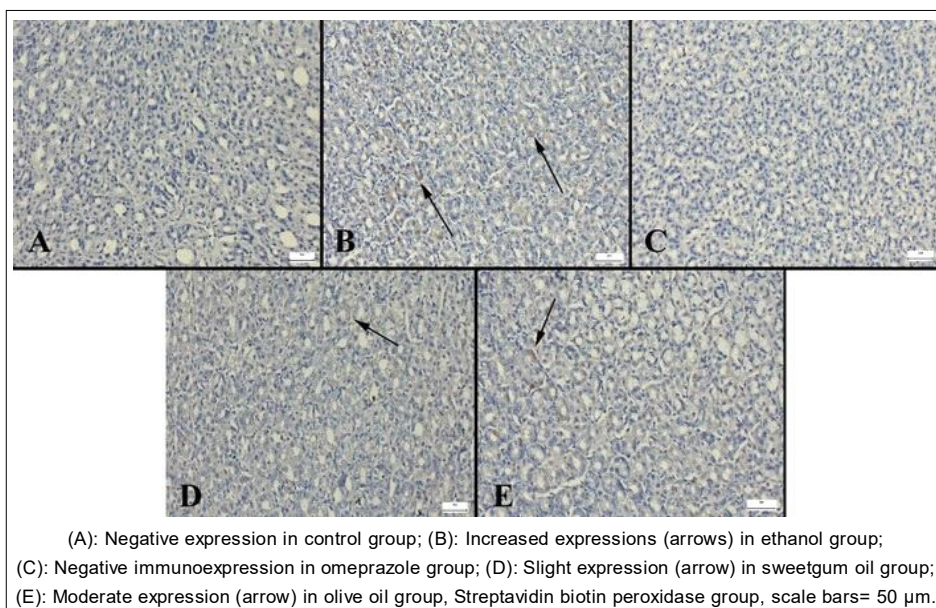


Fig 5: PECAM immunoreactions of the groups.

investigated the protective effect of sildenafil on the gastric mucosa with respect to the nitric oxide level in the stomach. Pandian *et al.* (2002) investigated the effects of fenugreek seeds on the gastric mucosa of ethanol-induced gastric ulcers in rats and found that the seeds were more effective than omeprazole. Matsuda *et al.* (1998) reported that some fractions of oleonic acid oligoglycosides obtained from plants prevented gastric ulcers caused by indomethacin and ethanol. In this study, the ameliorative effect of sweetgum oil in an experimental ethanol-induced chronic gastritis model in rats. However, the curative effect of sweetgum was less than omeprazole.

Proton pump inhibitors such as omeprazole have been widely used for years in patient with stomach problems. This group of drugs is used for an extended period, sometimes for life. In addition to the therapeutic effect of proton pump inhibitors, undesirable side effects may also occur with long-term use. These side effects include various disorders such as malabsorptions (hypocalcemia, vitamin B₁₂ deficiency), predisposition to *Clostridium difficile* and pneumonic infections, hypergastrinemia, gastric carcinoid, gastric cancer and fundic polyp development (Ozdemir and Okuroglu, 2015).

Tan *et al.* (2002) determined that *Ocimum suave* plant exhibited dose-dependent prevention of gastric lesions induced by ethanol and indomethacin. Muniappan and Sundararaj (2003) reported the antiulcer effect of *Bambusa arundinacea* plant, which is used in various inflammatory conditions in India. Lee *et al.* (2009) demonstrated the therapeutic-protective effect *Gardenia jasminoides* plant in gastritis in rats. Hamauzu *et al.* (2007) showed the antiulcer effect of *Pyrus communis* in ethanol-induced gastric lesions in rats. Tan *et al.* (2000) showed the protective effect of different formulations of *Bidens pilosa* on the gastric mucosa in various gastric ulcer models created in rats. Roldao *et al.* (2008) evaluated the antiulcer effect of *Cordia verbenacea* plant and reported its potential in treating ulcers. A large number of herbal medicinal agents are used for the treatment and prevention of gastritis. This study adds sweetgum oil as a new herbal medicine to this list. Sweetgum oil can serve as an alternative herbal remedy in chronic gastritis. Further studies are needed to understand the detailed mechanisms underlying the protective effect of sweetgum oil.

CONCLUSION

Sweetgum oil is an herbal ingredient used in the treatment of stomach ailments in humans in certain regions of Türkiye. This study demonstrates the therapeutic effect sweetgum oil in chronic gastritis in rats. More detailed studies are needed to elucidate the pathogenesis underlying of the therapeutic efficacy of sweetgum oil in gastritis.

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Conflict of interest

The authors report there are no competing interests to declare.

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