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Original article

A comparative approach on the prophylactic impact of fermented beverages on acute ulcerative colitis in mouse model

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Abstract

Acute ulcerative colitis is an inflammatory disease of the colon that is becoming increasingly prevalent. Yet, a growing body of evidence supports the efficacy of dietary interventions in preventing acute ulcerative colitis. Fermented beverages have been the focus of research in humans and animals for several years due to their potential to influence overall health functions with an emphasis on gut health. This research comprehensively explores the preventive effect of three fermented beverages (water kefir, dairy kefir, and kombucha) on acute ulcerative colitis in a CD-1 mouse model. Histopathological evaluation of the colon samples indicated that consumption of kombucha led to increased alleviation of the gross and histopathological lesions. Oral administration of kombucha positively affected overall intestinal microecological homeostasis by decreasing the coliform counts in this group contrasting the water and milk kefir groups. Moreover, physicochemical evaluation of the fermented beverages was conducted covering key parameters such as pH, acidity, total solids, radical scavenging activity and total phenolic content. Kombucha had the highest radical scavenging activity (85.61), total phenolic content (5.04 mg GAE/ mL), and total solids (0.70%), but the lowest pH (3.1) values.

The findings from this research offer valuable insights into the distinct contribution of different fermented beverages on prevention of acute ulcerative colitis. Kombucha unravels a promising natural prevention approach for acute colitis, opening new perspectives for future research.

Keywords: acute ulcerative colitis, fermented beverages, functional foods, probiotics, histopathology

Introduction

Food harbors a suite of essential nutrients which collaborate to fuel metabolic processes in every cell of body (Chen et al. 2018). A substantial and expanding body of evidence indicates that consuming specific food categories has a beneficial impact on health and aids in the prevention of prevalent non-communicable diseases (Siddiqui et al. 2023). Food supplementation strategies have been leveraged to target development of functional products with enhanced nutritional properties (Dinçoğlu and Rugji 2021, Keyvan et al. 2021, Rugji et al. 2022, Rugji and Dinçoğlu 2022, Dinçoğlu et al. 2023). Lately, fermented foods have gained popularity due to their beneficial properties, particularly their remarkable effects on the gastrointestinal tract, both in humans and animals. Fermented feed can have several potential benefits for animal health such as improved digestibility, enhanced gut health, reduced digestive disorder, immune system support, reduction of antinutritional factors, enhanced palatability etc. (Yan et al. 2019). Several lactic acid bacteria (LAB) present in fermented dairy products have been found to have immunomodulatory effects, particularly in inflammatory bowel diseases (IBD-Crohn's disease and ulcerative colitis) (Klingberg et al. 2005, Marco et al. 2017). Increasing evidence suggests that regular consumption of fermented foods like kefir, water kefir, and kombucha may help ameliorate the proinflammatory effects associated with gut dysbiosis (Sniffen et al. 2018). Consumption of fermented products like kefir has been indicated as an approach to positively contribute to the treatment of specific diseases such as tuberculosis, cancer, and gastrointestinal disorders (Cevikbas et al. 1994).

Kombucha is a non-dairy, fermented beverage. It is typically prepared from sweetened green or black tea. A symbiotic amalgamation of bacteria and yeast, known as SCOBY, is responsible for the fermentation of the sweet tea mixture (Villarreal-Soto et al. 2018). The fermentation is typically conducted at room temperature and lasts between 7 and 21 days (Matei et al. 2018). The yeasts found in the SCOBY initially convert sucrose into ethanol, which is then metabolized by AAB into acetaldehyde and acetic acid. The presence of acetic acid leads to a decrease in pH, which has been reported to inhibit the growth of specific pathogenic bacteria like *Helicobacter pylori*, *Escherichia coli*, and Salmonella typhimurium, among others (Dimidi et al. 2019). Experimental animal studies have reported the effects of kombucha on blood glycaemia (Aloulou et al. 2012), oxidative stress (Dipti et al. 2003), diabetes (Morshedi et al. 2006), hypercholesterolemia (Yang et al. 2009), and indomethacin-induced gastric ulceration (Banerjee et al. 2010).

Kefir is a conventional fermented dairy product that is estimated to harbor more than 50 species of microorganisms including LAB, acetic acid bacteria (AAB) and yeasts (Kim et al. 2019). As stated in the Codex Standard for Fermented Milks, kefir is a fermented milk prepared from a unique starter culture containing a conglomerate of bacteria in an aggregate form known as kefir grain (Codex Alimentarius 2003). Some of the strains common in kefir have been identified to have probiotic properties (Bengoa et al. 2018). *Lactobacillus kefiri, Lactobacillus kefiranofaciens,* and *Lactobacillus acidophilus* cooperatively with the other LAB, AAC, and yeasts are responsible not only for the sensorial profile but also for the health benefits of kefir (Erdogan et al. 2018).

Water kefir is a non-dairy alternative to traditional kefir. The production of water kefir starts with combining a sucrose-containing fruit or extract with insoluble water kefir grains. Sucrose content plays a significant role in the production of exopolysaccharides (EPS), which are crucial for the structural integrity of kefir grains (Laureys et al. 2018). Kefir grains are a mixed aggregate of microorganisms that can ferment sucrose. The grains population is composed of LAB, AAB, *Bifidobacteria* and yeasts (Randazzo et al. 2016). These microorganisms are fixed together in a flexible, water-soluble branched galactoglucan matrix known as kefiran. Some of the bacteria in the kefir are probiotics (Fels et al. 2018).

To the best of our knowledge, no previous research has been conducted to compare the effects of milk kefir, water kefir, and kombucha on acetic acid-induced acute ulcerative colitis.

Therefore, this study provides valuable insights into how various fermented beverages distinctly contribute to preventing acute ulcerative colitis.

Materials and Methods

Beverage production

Commercial kefir grains (*Danem, Süt ve* Ürünleri *Ltd.* Şti.) were used to produce kefir. Standardized UHT milk containing 3% fat was heated to 25°C. After the addition of 3% kefir starter culture, the lids of the jars were closed and incubated at 37°C for 12 hr. The final product was put into a glass container and stored at 4°C. Water kefir was produced with water-kefir grains (*Danem, Süt ve* Ürünleri *Ltd.* Şti.). Preparation was done in accordance with the method described by Laureys and De Vuyst (2014) with few modifications. Black tea kombucha was prepared according to Ardheniati et al. (2009). A commercial starter (*SCOBY, Kombucha*) was used in this investigation.

Table 1. Mice beverage groups.

Group	Kombucha	Milk kefir	SBW	Water kefir
K	+	-	-	-
MK	-	+	-	-
C	-	-	+	-
WK	-	-	-	+

K – kombucha, MK – milk kefir, C – control, WK – water kefir, SBW – saline buffered water

Approximately 10 g of the black tea was extracted in 500 mL of boiling water for 10 min prior to filtering and sweetening (10% sugar). The sugared tea extract was put into a glass container and cooled to room temperature before adding 10% kombucha starter aseptically. The jar was then covered with a sterile cheesecloth and incubated at ambient temperature for 10 days. Beverages were prepared once over the course of study.

Proximate analysis

The pH values of the samples were determined by a digital pH meter (704 pH Meter, Metrohm) at 25°C±2°C. The acidity and total solids were evaluated according to AOAC standards (Williams 1984). The proximate composition was evaluated on the first and last day of the shelf life of the beverages (D1 and D14).

Radical scavenging activity of the beverages

The radical scavenging activity (%) of each sample was measured using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) Free Radical Test. The analysis was conducted in accordance with Kahraman et al. (2021). At first a methanolic DPPH solution with a concentration of 200 µM was prepared. After that, we added 150 µL of the DPPH solution to each well of the 96-well plate and then 50 µL of two concentrations (10% and Neat) from each fermented beverage (made in distilled water). The absorbance was measured at 517 nm after 30 minutes of incubation at room temperature in the dark using a microplate reader (Multiskan Go, Thermo Scientific). The blank was made up of pure methanol. The following formula was used to determine the relative amount of radical scavenging activity (RSA):

DPPH scavenging activity (%) = (Ac-As)/Ac x 100

Ac: Absorbance of control [DPPH + Methanol without sample]

As: Absorbance of sample [DPPH + Sample]

Total phenolic content of the beverages (TPC)

The Folin-Ciocalteu method was used to examine the TPC content in a 96-well microplate with certain modifications, as described by Yırtıcı et al. in (2022). First, 12.5 µL of diluted Folin-Ciocalteu reagent (1:9 dilution) was combined with 25 µL of the beverages and 187.5 µL of ultrapure water in each well of the microplate. To this mixture, 25 µL of 20% sodium carbonate solution (w/v) was added. The absorbance at 760 nm was measured using a microplate reader. The results were reported as milligrams of gallic acid equivalents per mL of beverage (mg GAE/mL).

Mice and experimental protocol

This research received approval from the Burdur Mehmet Akif Ersoy University Animal Research Local Ethics Committee on November 18, 2020, under protocol number 687. A total of 40 male CD-1 mice (ages 6-8 weeks) weighing 30-35 g were obtained from the Experimental Animal Production and Experimental Research Center of Burdur Mehmet Akif Ersoy University, Türkiye. Male mice were chosen as they are less protected against chemically induced colitis when compared to females (Bábíčková et al. 2006). After a week of acclimatization, the animals were randomly assigned into four groups (n=10 animals per group). They were housed in a room under standard conditions of humidity (50-60%) and temperature (23±2°C) with a 12-h light/dark cycle.

A diet with standard laboratory pellet and water *ad libitum* was provided. After the acclimation period, the groups were given their designated fermented beverages for seven consecutive days. The control group (C) was given saline buffered water (SBW), whereas the other groups were provided with milk kefir (MK), water kefir (WK), and kombucha (K) (Table 1). The administration of the fermented products was done in accordance with the method described by Erdogan et al. (2018) with immaterial modification. Each day, 0.2 mL of fermented beverage was given to the mice by intragastric gavage to each animal.

Acetic acid induced colitis

All groups were fasted for 12 hours after feeding on the 7th day (D7). After the 12 h fasting period, 1 mL of 5 % acetic acid (AA) solution was administered intrarectally with a soft 22 G and 1.2 mm diameter (Intechlabs, USA) feeding tube to induce acute colitis.

Table 2. Gross and histopathological scoring criterion of the mouse colon.

	0	1	2	3
Gross lesion scores of colons	No lesion	Inflammation and ulceration at 1 or 2 foci	Inflammation and ulceration more than 3 foci	Diffuse damage in colon
Histopathological scores	No lesion	Few scattered inflammatory cells and ulcerations not exceeding lamina Muscularis mucosae	Distributed inflammatory cell infiltrations and ulcerations not exceeding submucosa	Severe inflammatory cell infiltrations and ulcerations exceeding submucosa

Table 3. Proximate composition of beverages.

	Group	D1	D14
pH values	K	3.2 ± 0.01	3.1 ± 0.01
	MK	4.4 ± 0.01	4.1 ± 0.01
	WK	5.8 ± 0.01	6.7 ± 0.01
Titratable acidity (% LA)	K	0.90 ± 0.01	0.99 ± 0.01
	MK	0.76 ± 0.01	0.81± 0.01
	WK	<0.1	<0.1
Total solids (%)	K	0.63 ± 0.01	0.70 ± 0.01
	MK	0.50 ± 0.01	0.46 ± 0.01
	WK	0.08 ± 0.01	0.09 ± 0.01

D1 – day 1, D14 – day 14 (beverage shelf life), K – kombucha, MK – milk kefir, WK – water kefir

Immediately, mice were held in the supine Trendelenburg position for 30 seconds to prevent leakage (Sun et al. 2019). Then, the beverages continued to be given to the groups for 7 more days. Following 14 days (D14) of treatments, all mice were euthanized. The colons were excised and sectioned for further analysis.

Fecal microbial analysis

Prior to the administration of the fermented beverages (D0), stool samples were taken, and the genera of the fecal samples were analyzed (D0-before product administration). The genera of the fecal microbiota were also analyzed after 7 days of product ingestion (D7) and after 7 days of colitis induction (D14). The fecal microbial analyses were performed by media-dependent assay and the following bacterial populations were investigated: total aerobic mesophilic counts (TAMC), *Lactobacillus* spp., *Lactococcus* spp., and coliform counts. The mediums and incubation times were like those in our previous study (Rugji et al. 2022).

Colon histopathology

During the necropsy, colon specimens were collected and fixed in 10% neutral formalin solution. After fixation, tissue samples were taken with an automatic tissue processor (*Leica ASP300S, Wetzlar, Germany*) and embedded in paraffin. Paraffin blocks were prepared and cut in sections of 5 µm thickness by a rotary microtome (*Leica RM2155, Leica Microsystems, Wetzlar, Germany)*. Then, the sections were stained with hematoxylin-eosin (HE), mounted with a coverslip, and examined under a light microscope. The severity of the acute inflammatory reaction and the degree of the spread of inflammation in the gut was graded using the macroscopic and histological scoring criteria (Table 2), which were modified from a previous study (Qin et al. 2012). Five random fields were selected on each slide. Morphometric analyses and microphotography were performed using the Database Manual Cell Sens Life Science Imaging Software System (*Olympus Co., Tokyo, Japan*). The results were saved and statistically analyzed.

Statistical analysis

The statistical analysis of histopathological scores were compared between the groups. A one-way ANOVA Duncan test was used with a SPSS-22.00 package program.

Results

Proximate analysis

Fermented beverages (water kefir, milk kefir, and kombucha) were evaluated in terms of pH and total solids as seen in Table 3. Kombucha tea had the lowest pH values both on D1 and D14 ($p<0.05$). Water kefir

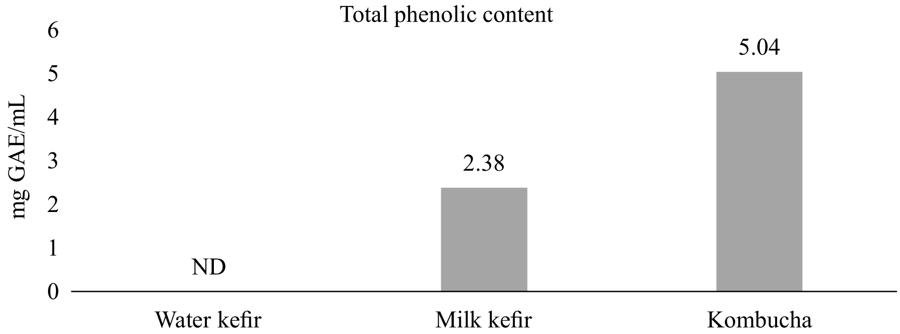

Fig. 1. Total phenolic content of the fermented beverages.

Table 4. DPPH results of the beverages.

Group	100%
K	85.61 ± 0.01
MK	57.54 ± 0.01
WK	7.58 ± 0.01

K – kombucha, MK – milk kefir, WK – water kefir, DPPH – 2,2-diphenyl-1-picrylhydrazyl

had the highest pH values on D1 and D14. The pH values of the water kefir were pH 5.8 (D1) and pH 6.7 (D14). The milk kefir showed a slight decrease in pH values from pH 4.4 on D1 to pH 4.1 on D14. The initial titratable acidity of the water kefir, milk kefir, and kombucha was <0.1, 0.76 and 0.90% respectively. The titratable acidity of the milk kefir and the kombucha gradually increased during 14 days of storage. On D14, titration acidity values for the milk kefir and kombucha were 0.81 and 0.99 respectively. Variations were seen in the total solids content of all samples on D1 and D14. The total solids (%) on D1 were 0.079 for water kefir, 0.50 for milk kefir, and 0.63 for kombucha. On D14 the values were 0.70, 0.49 and 0.09 for kombucha, milk kefir and water kefir, respectively.

Radical scavenging activity

Results of the DPPH assessment of the fermented beverages is presented in Table 4. DPPH radical scavenging activity for all samples was 85.61, 57.54 and 7.58%, for kombucha, milk kefir and water kefir, respectively.

TPC of the beverages

Figure 1 displays the TPC of all samples. The results were reported as gallic acid equivalents (mg GAE) per mL of material. The results highlighted that the kombucha exhibited the highest total phenolic content, followed by milk kefir. In contrast, the total phenolic content in water kefir was below the detectable level. The total phenolic content in kombucha was 5.04 while the milk kefir was 2.38 mg GAE/ mL.

Fecal microbial analysis

The data presented in Table 5 reveals the results of the bacterial populations present in the feces from all experimental groups throughout the study. The assessed bacterial populations demonstrated consistent variation in magnitude. TAMC were found to be at the level of 7 $\log_{10}$CFU for all groups in the initial evaluation (D0). The highest counts were found on D14 in group MK (8.27 $\log_{10}$CFU). At the end of the study, the population of *Lactobacillus* spp. increased in all groups compared to the initial levels and was determined to be at the level of 8 $\log_{10}$CFU. The *Lactococcus* spp. population was at the level of 7 $\log_{10}$CFU for all groups in the initial evaluation, but changes were noted on D7 and D14. The *Lactococcus* spp. counts increased to 8 $\log_{10}$CFU in all groups on the D14. The coliform count varied across all groups throughout the study. The highest counts were found in the MK group (6.64 $\log_{10}$CFU), while the lowest counts were found in the K group (2.16 $\log_{10}$CFU). The groups that received kombucha exhibited the lowest coliform counts overall on the last day of the experiment.

Colon histopathology

During the study, 6/10 mice from the milk kefir, 5/10 mice from the control group, and 4/10 mice from the water kefir group died. No death was observed in the kombucha group. During necropsy, an inflammatory reaction was observed in all mice, with varied severity. Some of the mice had marked and diffuse inflammation while some of them had only slight reactions. The most severe lesions were noticed in group C. In the kombucha group, lesions were slight compared

Table 5. Fecal microbial analysis.

	Group	D0	D7	D14
TAMC	K	7.20 ± 0.36	7.49 ± 0.06	6.70 ± 0.03
	MK	7.15 ± 0.22	6.95 ± 0.16	8.27 ± 0.01
	WK	7.25 ± 0.07	7.02 ± 0.36	7.90 ± 0.56
	C	7.84 ± 0.14	7.67 ± 0.04	8.16 ± 0.12
Lactobacillus spp.	K	8.00 ± 0.20	8.05 ± 0.07	8.69 ± 0.11
	MK	7.70 ± 0.01	7.38 ± 0.09	8.59 ± 0.06
	WK	8.05 ± 0.19	7.64 ± 0.20	8.86 ± 0.20
	C	8.13 ± 0.16	8.17 ± 0.23	8.47 ± 0.06
Lactococcus spp.	K	7.21 ± 0.28	7.49 ± 0.11	8.40 ± 0.08
	MK	7.13 ± 0.29	6.97 ± 0.19	8.54 ± 0.30
	WK	7.19 ± 0.07	7.22 ± 0.44	8.31 ± 0.07
	C	7.74 ± 0.19	7.56 ± 0.11	8.27 ± 0.04
Coliform	K	4.61 ± 0.65	4.93 ± 0.20	2.16 ± 0.12
	MK	4.85 ± 0.40	4.83 ± 0.29	6.64 ± 0.10
	WK	3.88 ± 0.14	4.26 ± 0.31	4.72 ± 0.05
	C	4.89 ± 0.01	5.35 ± 0.07	4.47 ± 0.45

D0 – day 0, D7 – day 7, D14 – day 14 (feces sampling intervals), K – kombucha, MK – milk kefir, WK – water kefir, TAMC – total aerobic mesophilic counts

to the other groups. Microscopical evaluation of the colons revealed parallel findings with gross lesions. In the control group, severe infiltrations extended the tunica muscularis. Most mice had severe necrosis in the mucosa. The number and severity of lesions in the mice that were dosed with any of the fermented beverages were lower than those in the control group. In the water kefir, milk kefir, and kombucha groups relatively normal areas were also noticed (Fig. 2). Statistical analysis results of the gross and histopathological findings are illustrated in Fig. 3. Acetic acid induced colitis is a confirmed experimental model like human ulcerative colitis. AA (5%) increases the intestinal permeability by altering the epithelium structure and loss of crypts. This is followed by the entrance of luminal bacteria into the mucosa and induction of intestinal inflammation mediated by the local proinflammatory cytokines.

Discussion

During fermentation, the acidity of the kombucha beverage intensified due to organic acid production (Watawana et al. 2015). The reduction in pH and increase in acidity observed in milk kefir is caused by the key products of fermentation: lactic acid, ethanol, and CO_2. These components contribute to the characteristic viscosity, acidity, and low alcohol content of milk kefir. In addition, minor constituents such as diacetyl, acetaldehyde, ethyl, and amino acids are in part responsible for the flavor profile associated with milk kefir (de Oliveira Leite et al. 2013). By contrast, the elevated pH levels in water kefir are attributed to the presence of low initial nutrient concentrations, which can cause sluggish fermentation and thus reduced metabolite concentrations which ultimately result in higher pH values (Lynch et al. 2021).

The DPPH evaluation is widely recognized as a reliable method for measuring antioxidant properties due to the capacity of the components to scavenge free radicals and donate hydrogen or electrons (Baliyan et al. 2022). The kombucha beverage exhibited higher DPPH radical scavenging activity compared to milk and water kefir. During the fermentation of kombucha, numerous compounds with radical scavenging abilities are released from the tea leaves themselves (Malbaša et al. 2011). The main group of these compounds found in tea, belonging to the flavanol group, are polyphenols and catechins. Polyphenols possess significant broad-spectrum antioxidant properties due to their capacity to neutralize free radicals and reactive oxygen species (ROS). Polyphenols make up around 30% of the total dry weight of fresh tea leaves, with epigallocatechin, epigallocatechin-3-gallate, epicatechin-3-gallate, and epicatechin being the most prominent types of polyphenols present in tea leaves (Watawana et al. 2015).

Kombucha exhibited the highest TPC, followed by milk kefir. In contrast, the total phenolic content in water kefir was below the detectable level. The TPC in kombucha was 5.04 while the milk kefir was 2.38 mg GAE/ mL. The findings of this study align with

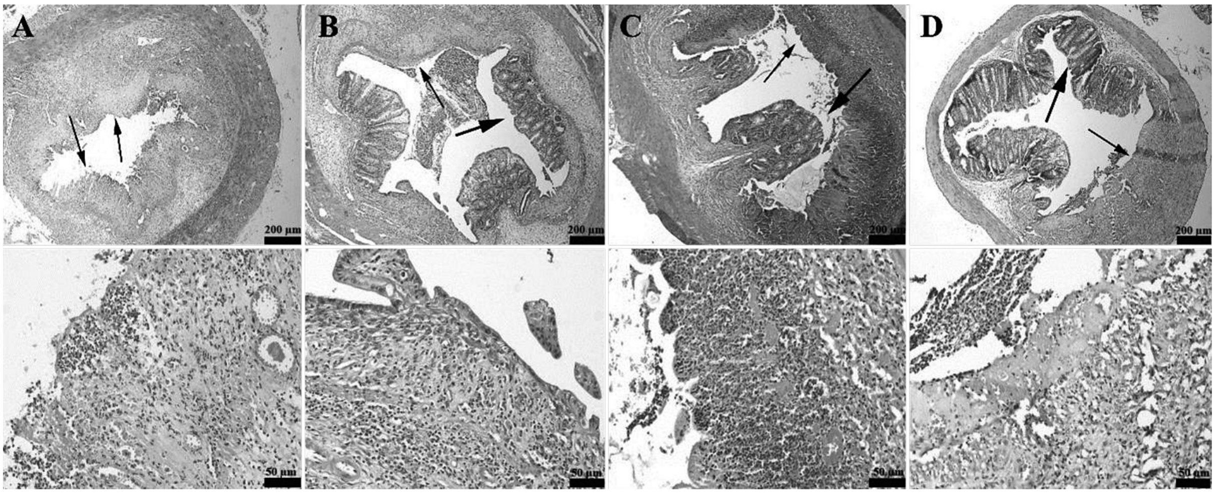

Fig. 2. Histopathological appearance between the mice groups. (A) Severe inflammatory reaction and ulcers (thin arrows) in a mouse from the control group. (B) Mild inflammation and ulcers (thin arrow and relatively normal gut mucosa (thick arrow) in water kefir group. (C) Ulcers (thin arrow) and gut mucosa (thick arrow) in milk kefir group. (D) Relatively slight ulcers (thin arrow) and gut mucosa (thick arrow) in kombucha group. Higher magnification of the lesions (below row). Scale bars=200 µm for upper row and 50 µm for below row.

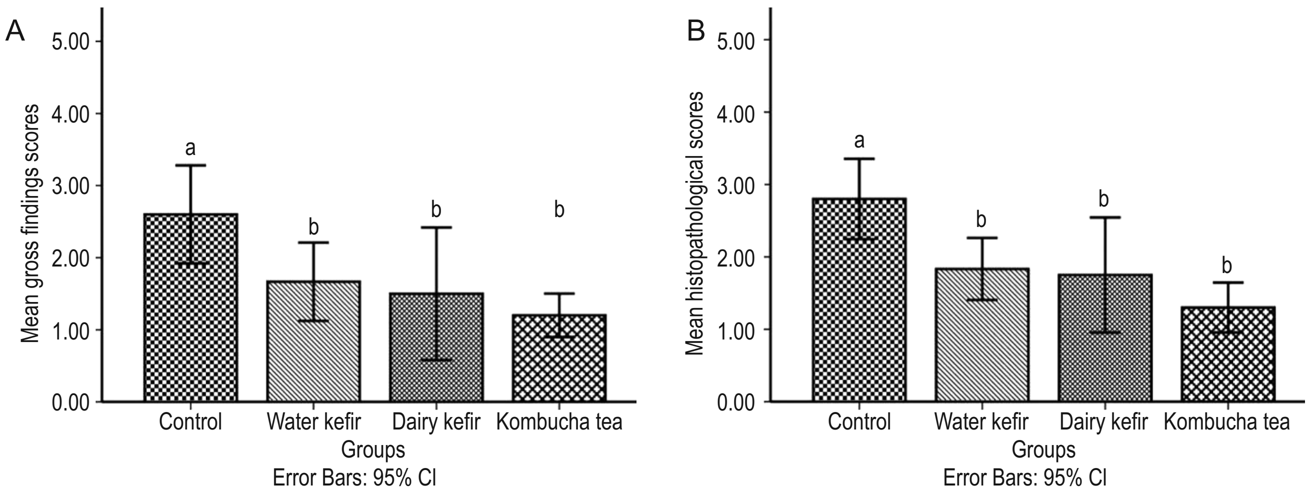

Fig. 3. Statistical analysis results of gross and histopathological scores between the mice groups. The differences between the means of groups carrying different letters are statistically significant. $p<0.001$. Data standard deviation (SD). One-Way Anova Duncan test.

previous reports (Jayabalan et al. 2007, Chakravorty et al. 2016, Özyurt et al. 2020). De Filippis et al. (2018) also investigated the TPC of kombucha, focusing on the fermentation process using either ceylon black or bancha green tea. The process of microbial fermentation in kombucha leads to the metabolic transformation of tea components through enzymatic activity, which potentially contributes to the enhanced antioxidant activity of kombucha compared to unfermented tea. Moreover, the numerous health benefits associated with kombucha, including alleviating inflammation and arthritis, cancer prevention, and immune system enhancement, may be attributed to its antioxidant properties. These properties may be explained by the presence of polyphenols as well as certain organic acids that are produced during the fermentation process (Ahmed et al. 2020).

Various clinical and experimental studies utilizing diverse models have emphasized the importance of understanding the composition of the intestinal microbiota to gain deeper insights into the origins of colitis. While various fermented foods have been associated with enhanced human health, the effects of these foods on the composition of the gut microbiome have not been adequately characterized (Rettedal et al. 2019). Bedani et al. (2010) reported that mice who were fed a soy product fermented with *E. faecium* CRL 183 and *L. helveticus* 416, or a pure culture of *E. faecium* CRL 183, exhibited an elevation in the *Enterococcus* spp. population. Kombucha is renowned for its notable antimicrobial properties, effectively targeting a wide spectrum of microorganisms, including both Gram-positive and Gram-negative types. The antimicrobial effect exhibited by the broth is primarily attributed to its low pH, with acetic acid playing a significant role alongside various other organic acids and catechins present in the beverage (Watawana et al. 2015). Similarly, Erdogan et al. (2018) in their study on the effect of kefir produced from natural kefir grains on the intestinal microbial populations and antioxidant capacities of CD-1 mice found an increase in *Lactobacillus* spp. and yeast counts in the fecal microbiota. Unlike the present study, no significant changes were observed in the *Enterobacteriaceae* counts.

The kombucha group had the most dramatic lesion reduction when compared to all other groups. According to the histological results of previous studies, fermented beverages have been shown to be effective on IBD. Filtered kombucha tea showed a beneficial effect in healing colitis in mice by reducing neutrophil infiltration, epithelial defect, mucosal disruption, edema, and other pathological manifestations such as apoptosis (Pakravan et al. 2019). In a study investigating the healing activity of black tea and black tea fermented separately with *Candida parapsilosis* and kombucha culture in mice, it was observed that black tea fermented with kombucha culture was histologically effectively healed compared to the other two products (Banerjee et al. 2010). Another study investigated the effect of kefir treatment on dextran sulfate sodium-induced colitis in rats and revealed that kefir was able to significantly reduce the histologic colitis scores (Senol et al. 2015). Similarly, Celiberto et al. (2017) outlined those mice fed with fermented soy beverages exhibited a lower degree of inflammation and ulceration in their colon. The greater healing effect of kombucha tea compared to other fermented beverages may be due to its increased total phenol compound (Banerjee et al. 2010). The beneficial impact of kombucha on ulcerative colitis may result from several mechanisms. Recently it has been reported that kombucha polysaccharides can decrease intestinal permeability, enhance the expression of tight junction proteins, support the maintenance of goblet cell numbers, and stimulate mucus secretion. Moreover, adding kombucha polysaccharides to the diet boosts the diversity of the gut microbiota and alters its composition (Ji et al. 2024). Veterinary medicine is crucial in medical research, particularly in developing treatments and functional foods for both animals and humans. This cross-species research strengthens the understanding of diseases and enhances medical innovations for both fields. In this sense, the current study has provided important findings by helping to compare different fermented products in preventing acute colitis in experimental animals.

Conclusion

A growing body of clinical trials have reported the therapeutic effect of fermented beverages on gut health. Nevertheless, the current study aims to contribute to the comprehension of the prophylactic effect of fermented beverages on acute ulcerative colitis. Obtained data from the oral administration of the beverages demonstrates that intake of kombucha possesses greater preventive capacity of acetic acid induced acute colitis in mice compared to milk and water kefir. These findings suggest that incorporating kombucha into a daily regimen presents a promising natural preventative measure for acute colitis, paving the way for further exploration in future research endeavors. This study provides useful information on the impact of different fermented beverages on various health metrics. However, it has some limitations, such as mouse mortality and a restricted number of fecal samples because of induced colitis. Integrating research on animal studies, fermented foods, and veterinary public health fosters a comprehensive approach to health, benefiting animals, people, and the environment. This approach ensures that practices are based on solid evidence, resulting in better health outcomes and more effective policies. Howbeit, to enhance our understanding, future research should explore the measurement of bacterial metabolites and evaluate microbial gene functions using techniques like RNA-sequencing.

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