Oral Grapeseed Oil and Sesame Oil in Experimental Acetic Acid-Induced Ulcerative Colitis in Rat

Fatemeh Hosseinzadeh,1,2 Nader Tanideh,3,4,7 Negar Azarpira,5 Azadeh Sayarifard,6 Masood Sepehrimanesh,7 and Moosa Salehi1,2

1Department of Clinical Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, IR Iran
2Nutrition and Food Sciences Research Center, Shiraz University of Medical Sciences, Shiraz, IR Iran
3Transgenic Technology Research Center, Shiraz University of Medical Sciences, Shiraz, IR Iran
4Transplantation Research Center, Shiraz University of Medical Sciences, Shiraz, IR Iran
5Department of Pharmacology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, IR Iran
6Center for Academic and Health Policy, Tehran University of Medical Sciences, Tehran, IR Iran
7Gastroenteropathology Research Center, Shiraz University of Medical Sciences, Shiraz, IR Iran

Corresponding author
7Gastroenterohepatology Research Center, Shiraz University of Medical Sciences, Shiraz, IR Iran, E-mail: salehi@sums.ac.ir

Abstract

Background: Ulcerative colitis (UC) is a multi-factorial disease with unknown etiology and has many clinical manifestations.

Materials and Methods: Eighty male rats were divided into eight groups as health control (HC), received normal saline; HC+, received SO; HC+, received GSO; negative control (NC), UC and normal saline; positive control (PC), UC and mesalamine; SO, UC and SO; GSO, UC and SO, and SO + GSO. The daily weight changes, serum levels of oxidative stress markers and lipid profile plus colon macroscopic and microscopic histological changes were measured at the end of the seventh day.

Results: Significant differences were detected between HC and PC on the 3rd (P = 0.002), 4th (0.013) and 6th days (0.014) and between HC and NC on the 4th day (0.027) in weight of rats. Use of GSO alone or in combination with SO decreased the extent of the changes both in macroscopic and microscopic indices and also at the inflammation level. The most significant decrease in the MDA level and the most obvious increase in the TAC belonged to the GSO group in comparison to the NC group. The lowest cholesterol (51.43 ± 5.62 mg/dL) and HDL levels (29.29 ± 6.24 mg/dL) were detected in response to SO consumption in comparison to NC group (P = 0.030 and P = 0.257, respectively).

Conclusions: GSO in combination with SO may be considered as the treatment of choice for UC based on antioxidant and histopathological evaluations.

Keywords: Grapeseed Oil, Sesame Oil, Ulcerative Colitis, Oxidative Stress, Histopathology

1. Background

Ulcerative colitis (UC) along with the Crohn disease (CD) are two types of inflammatory bowel disease (IBD) defined as relapsing, chronic and remitting inflammatory diseases of the large intestine (1). UC is a complex and multi-factorial disease with unknown etiology caused by several pathophysiological mechanisms and many clinical manifestations (2, 3) including diarrhea, abdominal or rectal pain, fever, weight loss and blood in the stool (4). There are several strategies such as medical and surgical therapies to treat UC, but surgery is indicated for the cases unresponsive to medical therapy. The extent and severity of UC and its anatomic location affects agents used to induce remission in patients with UC, including both oral and topical regimens. Sulfasalazine and its aminosalicylate analogues, corticosteroids, immunomodulators, suppressive antimetabolites, anti-tumor necrosis factor-biologics including infliximab, and in some cases antibiotics are reported as treatments of choice (5).

However, it is reported that some dietary behaviors such as animal protein and lipid intake and inadequate use of vegetable and plant based food can be the risk factors for the development of UC (6, 7). In addition, use of new treatment strategies such as using medicinal plants and their derivatives including oil, extracts and active substances are more popular. Grape seed oil (GSO) is rich in unsaturated fatty acids (more than 89% of the total oil composition) and antioxidants such as tocopherols and phytosterol (8). Sesame oil (SO) has antioxidant, anti-inflammatory, and antibacterial properties (9). This oil also contains various lignans such as sesamin and...
Hosseinzadeh F et al.

sesaminol that prevent the release of proinflammatory agents, which ultimately prevent inflammation (10).

Although there was a report on using SO to treat UC (11), there were no previous reports on using GSO, or its combination with SO to treat UC in human or animal models.

2. Objectives

The current study aimed to evaluate the healing effects of GSO and SO as dietary dosage and compare them with mesalamin in male rats with experimentally acetic acid-induced ulcerative colitis. The study focused on the gross, macroscopic, microscopic, oxidative and biochemical changes of UC and their alterations in response to both treatments in oral dietary application. In addition the serum lipid profile was evaluated because these two oils are one of the items in male food basket. If these two plant based oils had the beneficial effects on the treatment of UC, and just after performing randomized control trial, they can advised as a part of daily food consumption in all people, especially the ones with UC in their families as an preventive dietary therapy.

3. Materials and Methods

3.1. Oil Sources

Zareentalia Grapseed oil 1 Liter (Zareentalia Co., Italy) and Samar sesame oil (Samar Co., Iran) were used in the study. These two products were prepared from the best quality raw materials and had the standard production certificates.

3.2. Animals, Housing, UC Induction and Treatments

Eighty male Sprague Dawley rats weighing 200 ± 20 g were provided from the center of experimental and comparative medicine, Shiraz University of Medical Sciences, Shiraz, Iran. The rats were randomly allocated into eight equal separated groups according to Table 1. The rats were housed in standard cages under 12/12 light-dark schedule (lights on at 7:00 pm) with an ambient temperature of 22 ± 2°C, and 55% relative humidity.

Animals were off fed for 36 hours before induction of UC to empty the colon. UC was induced according to the previously reported protocols (12). All animals were fasted overnight and their bowels were cleaned before induction of UC. A polyurethane cannula (2 mm diameter) was applied for the rectal entrance of acetic acid and 2 mL of 3% acetic acid was administered transrectally into the colon to induce UC under ketamine-zaylazine anesthesia. Treatment with normal saline, mesalamin, GSO and SO were applied to desired groups for seven days after UC induction according to Table 1. The weight changes were recorded during the seven days by using digital scale with 0.1 g precision.

3.3. Macroscopic Evaluations

At the end of the seventh days, the rats were sacrificed in the CO₂ induction box. Then, the distal 8 cm of the colon was removed and dissected by longitudinal incision. The mucosal injury was macroscopically assessed using grading scale reported previously (13) and reported as scores 0 - 5.

3.4. Microscopic Evaluations

Colon tissue was processed and stained according to the previously reported procedures (14-16). All sections were studied and photographed using a light microscope. The degree of inflammation of the colon was graded as 0 - 3 according to the previous report by Onderdonk et al. (17). Also, the crypt injury was graded as 0 - 4 based on the report by Murthy et al. (18). The means of each score in each grading system is presented in Table 2.

3.5. Oxidative Stress Evaluation

The blood sample was taken from the heart of each rat in each group. The serum was separated using centrifugation (3000 rpm, 10 minutes) and then stored in -70°C. The malondialdehyde (MDA) level, as the end-products of lipid peroxidation (LPO), was assessed via the measurement of thiobarbituric acid reactive substances (TBARS) in sera (19). The determination of total antioxidant capacity (TAC) in serum was performed by colorimetric method using commercial kit (Cayman, USA).

3.6. Inflammation Indices and Lipid Profile Measurements

The serum level of IL-6 was measured using rat specific sandwich enzyme-linked immunosorbent assay (ELISA) kit (Sigma Aldrich, USA). Serum C-reactive protein (CRP) samples were evaluated by enzyme immunoassay kit (IBL international, Germany). Cholesterol, triglyceride, high density lipoprotein (HDL) and low density lipoprotein (LDL) were measured by colorimetric method using commercial kits (ParsAzmoon Co., Iran) and biochemical Autoanalyzer (BT-1500, Italy).

3.7. Statistical Analysis

The data were presented as mean and standard deviation. Normal distributions of the data were assessed by Kolmogorov-Smirnov test. One-way ANOVA and Tukey post hoc test were used to compare the mean differences in all variables between the eight groups. P < 0.05 was considered statistically significant. Mann-Whitney U
test and Bonferroni correction were used to compare the histopathology scores between different groups on different days. SPSS 16.5 software was used to analyze the data.

4. Results

The changes in the mean weight of the rats before the experiment and during the seven days of experimental period are presented in Figure 1. There were no significant differences in the mean weight of the rats between different groups before the study and until the 2nd day of the study (P > 0.05). Only significant differences were detected between HC and PC on the 3rd (P = 0.002), 4th (0.013) and 6th days (0.014) and HC and NC on the 4th day (0.027).

The pathological lesions and their grades are presented in Figure 2. Also, the results of macroscopic and microscopic evaluations of the changes in the colon tissue are presented in Table 3. As demonstrated, UC caused more macroscopic and microscopic changes plus more inflammation in the colon compared with the control group. Use of GSO alone or in combination with SO decreased the extent of the changes both in macroscopic and microscopic indices and also at inflammation level. However, use of SO alone cannot significantly affect these pathological features and all indices were significantly higher than those of the health control group (P < 0.05).

The results of oxidative stress indices, inflammation markers and lipid profile measurements are presented in Figure 3. No significant differences were detected in the CRP, triglyceride and LDL level between different groups. The highest MDA level (9.81 ± 1.43 µM/L) and lowest TAC (1.29 ± 0.48 mM/L) belonged to the NC group in which the
Table 3. Macroscopic (Morris) and Microscopic (Onderdonk and Murthy) Evaluations of the Colon Tissue in Different Groups<sup>a, b</sup>

| Groups  | Morris       | Onderdonk    | Murthy       |
|---------|--------------|--------------|--------------|
| HC<sub>1</sub> | 0.00 ± 0.00<sup>a</sup> | 0.00 ± 0.00<sup>a</sup> | 0.00 ± 0.00<sup>a</sup> |
| HC<sub>2</sub> | 0.20 ± 0.45<sup>a</sup> | 0.40 ± 0.89<sup>a</sup> | 0.20 ± 0.45<sup>a</sup> |
| HC<sub>3</sub> | 0.20 ± 0.45<sup>a</sup> | 0.00 ± 0.00<sup>a</sup> | 0.00 ± 0.00<sup>a</sup> |
| NC      | 3.00 ± 1.32<sup>b</sup> | 2.67 ± 0.87<sup>b</sup> | 2.44 ± 0.53<sup>b</sup> |
| PC      | 0.67 ± 0.82<sup>a</sup> | 0.17 ± 0.41<sup>a</sup> | 0.17 ± 0.41<sup>a</sup> |
| SO      | 3.34 ± 1.07<sup>b</sup> | 2.41 ± 1.72<sup>bc</sup> | 1.85 ± 1.13<sup>bc</sup> |
| GSO     | 0.88 ± 0.99<sup>a</sup> | 0.38 ± 0.74<sup>a</sup> | 0.38 ± 0.74<sup>a</sup> |
| SO + GSO | 0.60 ± 0.55<sup>a</sup> | 0.80 ± 1.30<sup>bc</sup> | 0.80 ± 1.30<sup>bc</sup> |

Abbreviations: GSO, grape seed oil; HC, health control; NC, negative control; PC, positive control; SO, sesame oil.

<sup>a</sup>Treatment in each group was conducted according to the Table 1.

<sup>b</sup>Significant differences in each column are demonstrated by different superscript letters (P < 0.05).

5. Discussion

In the present study, the healing effects of GSO alone or in combination with SO were evaluated in the experimental induced UC in rats. Also, the oxidative stress indices, inflammation markers and lipid profile changes were measured in response to different treatments. It was found that oral combination of GSO and SO had better healing effects in comparison to each treatment alone, based on macroscopic and microscopic indices and also inflammation level. However, administration of oral GSO and oral SO, each in therapeutic or dietary applications alone, was most applicable and had more efficacies in antioxidant and lipid profile changes, respectively. In addition, their beneficial effects on the lipid profile suggested that GSO and SO can be considered as a dietary regimen in patients with UC.

UC, as a form of IBD, is a major health problem and a persistent UC can increase the risk of colorectal cancer development by ~10 folds (20). Therefore, effective treatments in appropriate time are necessary to prevent and/or treat the disease. Several therapeutic agents are reported to treat UC including sulfasalazine and its aminosalicylate analogues, corticosteroids, immunomodulators, suppres-
Figure 3. Oxidative Stress Indices, Inflammation Markers and Lipid Profile Changes in Different Groups After Seven Days of Treatment

GSO, grape seed oil; HC, health control; NC, negative control; PC, positive control; SO, sesame oil; treatment in each group was conducted according to the Table 1. Significant differences between groups in each variable are demonstrated by different superscript letters (P < 0.05).

5.1. Conclusion

The study showed that daily oral consumption of grapeseed oil and sesame oil can relieve the ulcerative colitis induced by acetic acid in rat colon. Results of serum oxidative markers, inflammatory indices and lipid profile and also histopathological evaluations indicated a reduction in inflammation. The healing and anti-inflammatory properties of both oils can make them as appropriate dietary regimen and/or drug choice to treat ulcerative colitis. Further studies are required to confirm the clinical effectiveness in humans.

Acknowledgments

The present article was extracted from the Ph.D. thesis (ID: 7167) of Fatemeh Hosseinzadeh and was financially
supported by the Shiraz University of Medical Sciences, Shiraz, Iran.

**Footnote**

**Authors’ Contribution:** Moosa Salehi and Nader Tanideh played the same role in this article and both were corresponding author; Fatemeh Hosseinzadeh, acquisition of data, drafting of the manuscript and critical revision of the manuscript for important intellectual content; Nader Tanideh, study concept and design, drafting of the manuscript, critical revision of the manuscript for important intellectual content, and statistical analysis; Moosa Salehi and Azadeh Sayarifard, acquisition of data, analysis and interpretation of data, drafting of the manuscript and critical revision of the manuscript for important intellectual content; Masood Sepehrimanesh, acquisition of data, analysis and interpretation of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, and statistical analysis; Moosa Salehi, study concept and design, drafting of the manuscript, critical revision of the manuscript for important intellectual content, administrative, technical and material support and study supervision; Negar Azarpira supported by the Shiraz University of Medical Sciences, Shiraz, Iran.

**References**

1. Tanideh N, Nematollahi SL, Hosseini SV, Hosseinzadeh M, Mehrabani D, Safarpour A, et al. The healing effect of Hypericum perforatum extract on acetic acid-induced ulcerative colitis in rat. ACR. 2014;2(4).

2. Safarpour AR, Hosseini SV, Mehrabani D. Epidemiology of inflammatory bowel diseases in Iran and Asia: a mini review. Iran J Med Sci. 2013;38(2 Suppl):340-9. [PubMed: 24031093].

3. Taghavi SA, Safarpour A, Hosseini SV, Noroozi H, Safarpour M, Rahimikazerouni S. Epidemiology of inflammatory bowel diseases (IBD) in Iran: a review of 740 patients in Fars Province, Southern Iran. ACR. 2013;2(1):37-22.

4. Joshi SV, Vyas BA, Shah PD, Shah DR, Shah SA, Gandhi TR. Protective effect of aqueous extract of Oroxylum indicum Linn. (root bark) against DNBS-induced colitis in rats. Indian J Pharmacol. 2011;43(6):656-61. doi:10.4103/0253-7613.89821. [PubMed: 22147699].

5. Mehrabani D, Bahrami F, Hosseini SV, Ashraf MJ, Tanideh N, Rezaee M, et al. The Healing Effect of Teucrium polium in Acetic Acid-Induced Ulcerative Colitis in the Dog as an Animal Model. Middle East J Sci Res. 2012;13(4):40-7. [PubMed: 24829634].

6. Jantchou P, Morois S, Clavel-Chapelon F, Bourtoul-Ruault MC, Carbonnel F. Animal protein intake and risk of inflammatory bowel disease: The E3N prospective study. Am J Gastroenterol. 2005;100(10):2095-201. doi:10.1038/jag.2010.192. [PubMed: 20461067].

7. Geering BJ, Dagnelle PC, Badart-Smook A, Russel MG, Stockbrugger RW, Brummer RJ. Diet as a risk factor for the development of ulcerative colitis. Am J Gastroenterol. 2000;95(4):1008-13. doi:10.1111/j.1572-0241.2000.00942.x. [PubMed: 10783951].

8. Davidov-Pardo G, McClements DJ. Nutraceutical delivery systems: resveratrol encapsulation in grape seed oil nanoemulsions formed by spontaneous emulsification. Food Chem. 2015;167:205-12. doi:10.1016/j.foodchem.2014.06.082. [PubMed: 25434890].

9. Bagheri-Nesami M, Shorofi SA, Hashemi-Karouso NZ, Khalilian A. The effects of sesame oil on the prevention of amidodarone-induced phlebitis. Iran J Nurs Midwifery Res. 2015;20(3):365-70. [PubMed: 26120318].

10. Sharifipour F, Malekahmadi M, Zamani M, Panahi Bazaz M, Ranjbari N. Topical sesame oil for severe corneal alkali burn in rabbits. IJP. 2012;24(4):52-6.

11. Periasamy S, Hsu DZ, Chandrasekaran VR, Liu MY. Sesame oil accelerates healing of 2,4,6-trinitrobenzenesulfonic acid-induced acute colitis by attenuating inflammation and fibrosis. JPEN J Parenter Enteral Nutr. 2013;37(5):674-82. doi:10.1177/0148607112486788. [PubMed: 23243492].

12. Safarpour A, Kaviyani F, Sepehrimanesh M, Ahmadi M, Hosseinibadi O, Tanideh N, et al. Antioxidant and anti-inflammatory effects of gel and aqueous extract of mелиций officinalis L. in induced ulcerative colitis: A rattus norvegicus model. ACR. 2013;2(2).

13. Morris GP, Beck PL, Herridge MS, Depew WT, Szwczuk MR, Wallace JL. Hatpen-induced model of chronic inflammation and ulceration in the rat colon. Gastroenterology. 1989;96(3):795-803.

14. Tafit A, Nazifi S, Rajaiat H, Sepehrimanesh M, Poorbaghi S, Mohtrami S. Pathological changes associated with experimental salinomycin toxicity in sheep. Comp Clin Path. 2008;27(4):255-6.

15. Koohi-Hosseinzadeh O, Moini M, Safarpour A, Deraakhshanfar A, Sepehrimanesh M. Effects of dietary Thymus vulgaris extract alone or with atorvastatin on the liver, kidney, heart, and brain histopathological features in diabetic and hyperlipidemic male rats. Comp Clin Path. 2015;24(6):1315-1.

16. Sepehrimanesh M, Azarpina N, Saeb M, Nazifi S, Kazemipour N, Koohi O. Pathological changes associated with experimental 900-MHz electromagnetic wave exposure in rats. Comp Clin Path. 2014;23(5):3629-31.

17. Ondendorn AB, Cisneros RL, Bronson RT. Enhancement of experimental ulcerative colitis by immunization with Bacteroides vulgatus. Infect Immun. 1983;42(2):783-8. [PubMed: 6642651].

18. Murthy SN, Cooper HS, Shim H, Shah RS, Ibrahim SA, Sedergran DJ. Treatment of dextran sulfate sodium-induced murine colitis by intracolonic cyclosporin. Dig Dis Sci. 1993;38(9):2722-34. [PubMed: 8359087].

19. Zal F, Mostafavi-Pour Z, Vessel M. Comparison of the effects of vitamin E and/or quercetin in attenuating chronic cyclosporine A-induced nephrotoxicity in male rats. Clin Exp Pharmacol Physiol. 2007;34(8):720-4. doi:10.1111/j.1440-1681.2007.04623.x. [PubMed: 17600547].

20. Mehrabani D, Almasi-Hashiomi A, Moshfeghi K, Khedmati E. Survival rate and its predictors in colorectal cancer patients, Southern Iran. Middle East J Sci Res. 2012;2(1):1072-7.

21. Mehrabani D, Ziaei M, Hosseini SV, Ghahramani L, Bananzadeh AM, Ashraf MJ, et al. The effect of calendula officinalis in therapy of acetic acid induced ulcerative colitis in dog as an animal model. Middle East J Dig Dis. 2012;4(1):40-7. [PubMed: 24829634].

22. Alizadeh-Naeini NT, Zargari-Samadnejad A, Mehrvarz S. Healing effect of licorice extract in acetic acid-induced ulcerative colitis in rat. Res Pharm Sci. 2012;7(5):5837.

23. Tanideh N, Akbari Baseri F, Jamshidizadeh A, Ashraf MJ, Kuhl O, Mehrabani D. The healing effect of strawberry extract on acetic acid-induced ulcerative colitis in rat. World Appl Sci J. 2014;31(3):281-8.

24. Tanideh N, Masoumi S, Hosseinibad M, Safarpour AR, Erjaye H, Koohi-Hosseinibadi O, et al. Healing effect of pistacia atlantica fruit oil extract in acetic acid-induced colitis in rats. Iran J Med Sci. 2014;39(6):522-8. [PubMed: 25429744].

25. Tanideh N, Aftari E, Mehrabani D, Azarpina N, Hosseinibad M, Amini M, et al. The healing effect of berberis vulgaris in acetic acid-induced ulcerative colitis in rat. Middle East J Sci Res. 2014;21(8):2889-94.

26. Nash DT. Cardiovascular risk beyond LDL-C levels. Other lipids are per- formers in cholesterol story. Postgrad Med. 2004;110(3):11-5. [PubMed: 15400086].

Ann Colorectal Res. 2016; 4(2):e37285.
27. Hsu DZ, Su S, Chien S, Chiang P, Li Y, Lo Y, et al. Effect of sesame oil on oxidative-stress-associated renal injury in endotoxemic rats: involvement of nitric oxide and proinflammatory cytokines. Shock. 2005;24(1):276–80.

28. Hsu DZ, Liu MY. Sesame oil protects against lipopolysaccharide-stimulated oxidative stress in rats. Crit Care Med. 2004;32(1):227–31. doi: 10.1097/01.CCM.0000104947.16669.29. [PubMed: 14707583].

29. Hsu DZ, Liu MY. Effects of sesame oil on oxidative stress after the onset of sepsis in rats. Shock. 2004;22(6):582–5. [PubMed: 15545812].

30. Hsu DZ, Li YH, Chien SP, Liu MY. Effects of sesame oil on oxidative stress and hepatic injury after cecal ligation and puncture in rats. Shock. 2004;21(5):466–9. [PubMed: 15087824].

31. Hsu DZ, Chiang PJ, Chien SP, Huang BM, Liu MY. Parenteral sesame oil attenuates oxidative stress after endotoxin intoxication in rats. Toxicology. 2004;196(1-2):147–53. doi: 10.1016/j.tox.2003.12.001. [PubMed: 15036764].

32. Alves N, Valdes S, Silveira C, Duarte-Martino H, Milagro FI, Moreno-Aliaga M, et al. Studies on mechanistic role of natural bioactive compounds in the management of obesity an overview. 2012

33. Nakamura Y, Tsuji S, Tonogai Y. Analysis of proanthocyanidins in grape seed extracts, health foods and grape seed oils. Journal of health science. 2003;49(1):45–54.