

Original Article

Comparative efficacy of extra virgin olive oil versus refined olive oil in the treatment of individuals suffering from constipation: A double-blind randomized clinical trial study

Farahnaz Joukar (PhD)¹
Seyedeh Narjes Mozaffari
Chenijani (MD)¹
Saman Maroufizadeh (PhD)²
Tahereh Zeinali (MSc)¹
Niloofer Faraji (MSc)¹
Narges Eslami (MSc)¹
Fariborz Mansour-Ghanaei (MD)^{1*}

1. Gastrointestinal and Liver
Diseases Research Center, Guilan
University of Medical Sciences,
Rasht, Iran

2. Department of Biostatistics,
School of Health, Guilan
University of Medical Sciences,
Rasht, Iran

* Correspondence:

Fariborz Mansour-Ghanaei,
Gastrointestinal and Liver Diseases
Research Center, Razi Hospital,
Sardar-Jangle Ave., P.O. Box:
41448-95655, Guilan University of
Medical Sciences, Rasht, Iran

E-mail:

fmansourghanaei@gmail.com

Tel: +98 1315535116

Abstract

Background: Evidence suggested that olive oil may alleviate constipation symptoms. This study compared the effectiveness of two types of extra virgin olive oil and refined olive oil on the treatment of patients experiencing constipation.

Methods: This double-blind clinical trial included 140 participants aged 18 years or older who were diagnosed with chronic constipation by a gastroenterologist using the Rome III questionnaire. Block randomization was utilized approach to divide patients into two groups of 70 individuals (Extra virgin olive oil as trial and refined olive oil as control) that consumed two tablespoons per day of olive oil for four weeks. Follow-up assessments were conducted using the Rome III and Bristol Stool Form Scale (BSFS) questionnaires.

Results: According to analysis of covariance (ANCOVA), after four weeks of the intervention, the mean score of Rome III decreased significantly from 11.37 ± 2.25 to 7.74 ± 2.53 ; and from 11.27 ± 2.73 to 3.47 ± 1.73 among refined olive oil and extra virgin olive oil consumers, respectively, (-4.22 (95% CI: 3.63-4.82), ($F_{(1,137)} = 197.67$, $p < 0.001$, $\eta^2 P = 0.591$). In week 2,3, and 4, the mean score of BSFS were significantly higher among consumers of extra virgin olive oil than to the consumers of refined olive oil 0.53 (95% CI: 0.38- 0.68), $p < 0.001$, 0.78 (95% CI: 0.60- 0.97), $p < 0.001$ and 1.14 (95% CI: 0.94-1.35), $p < 0.001$, respectively.

Conclusion: Extra virgin olive oil was more effective compared refined olive oil at alleviating constipation. These outcomes highlight the importance of extra virgin olive oil as a possible treatment for constipation.

Keywords: Constipation; Extra virgin olive oil; Rome III; Bristol stool form scale.

Citation:

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Constipation is a multifaceted condition marked by a decrease in the frequency of bowel movements and/or challenges in passing stools, which may involve exertion during defecation, stools that are hard or pellet-like, a feeling of not completely emptying the bowels, and a sensation of blockage or obstruction in the anorectal area (1, 2). According to research findings, constipation in Europe ranged from 8% to 26%, with an average prevalence of 22.3% (3). In studies conducted in Iran, the prevalence of constipation has been reported to range from 3.5% to 32.9% (4). Constipation is a heterogeneous disorder in that dysfunction in chloride channels can disrupt fluid secretion, leading to decreased stool hydration and constipation. Also, serotonin levels or receptor function imbalances can affect intestinal contractions and contribute to constipation. Inflammatory conditions in the gastrointestinal tract can disrupt normal intestinal muscle and nerve function, altering motility patterns and impairing stool passage (5, 6).

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Moreover, studies indicate that an imbalance in gut microbiota can also contribute to constipation by affecting the production of metabolites necessary for regular bowel movements (7). The impact of constipation on patients' quality of life, work productivity, and social relationships is significant, making it a substantial burden on individuals and society, particularly in developing countries (8). During the past decade, various treatments, both established and novel, with diverse modes of action have demonstrated efficacy. However, their integration into the optimal therapeutic strategy remains to be fully elucidated (9). In the last ten years, a multitude of conventional and innovative therapies with diverse mechanisms and proven effectiveness have been developed and introduced to the medical field. However, none of these approaches have emerged as definitive treatment methods (10-12). Current guidelines suggest that behavior-based interventions, such as increasing fiber and fluid intake and engaging in regular exercise, should be considered the first-line treatment for constipation (2, 13).

Moreover, research findings have indicated that refined olive oil may mildly affect constipation due to its lubricating properties and potential to stimulate intestinal contractions. While it contains fewer polyphenols and beneficial compounds than extra virgin oil, it can still help soften the stool and improve gut motility. However, the effects of refined olive oil on constipation may be milder than less refined varieties. It's recommended to incorporate a balanced diet, including adequate dietary fiber, fluids, physical activity, and olive oil for optimal constipation management (14-16). Also, some studies indicated that polyphenols enhanced gut motility, modulated gut microbiota, had anti-inflammatory effects, and increased bile acid production (17-19). Although olive oil has been recognized for its potential usefulness in constipation treatment, no study has yet compared the efficacy of extra virgin olive oil, which is exceptionally high in polyphenols, with refined olive oil in this context (20, 21). Therefore, although the usefulness of oils such as olive oil has been proven, no study has compared extra virgin olive oil and refined olive oil in treating constipation. By investigating the comparative efficacy of these two types of olive oil, this study aimed to provide valuable insights into their potential use as therapeutic options for chronic constipation, addressing an unmet need in constipation management.

Methods

Study design and setting: This study is a phase three double-blind, randomized, single-center clinical trial that is

a superiority trial with a parallel study design and per-protocol analysis and an allocation concealment method using opaque sealed envelopes with a randomized sequence (SNOSE). This study was conducted on 150 participants over 18 years of age referred to the Guilan Gastroenterology clinic, Rasht, Iran, from May 2021 to November 2021. This research was approved by the Ethics Committee of Guilan University of Medical Sciences, located in Rasht, Iran, under the ethical approval code [IR.GUMS.REC.1399.600]. The project was registered on the Iran Clinical Trials Registration System (IRCT) website (<https://en.irct.ir/trial/54490?revision=173199>, <https://en.irct.ir/trial/54490?revision=181530>, first registration date: 01/03/2021, revision date: 02/05/2021) with registration number: IRCT20080901001155N33. All patients were informed about the study before participating and consented to participate.

Chronic constipation in subjects was diagnosed based on Rome III criteria (22), alongside a colonoscopy by a gastroenterologist. The determination of the sample size was conducted utilizing G*Power version 3.1.9.2 (23). The calculation was based on a two-sample t-test, with a power level set at 0.8, an alpha significance level of 0.05, and a medium effect size ($d=0.5$). This calculation indicated that a minimum of 64 patients would be necessary for the study. To account for an anticipated attrition rate of 15% due to potential dropouts and technical issues, it was established that a total of 75 patients per group, resulting in a combined sample size of 150, would be required. From both groups, in the first two to three days of the study, five people withdrew because they did not like the taste and smell of olive oil. The participants were allocated into two groups, an intervention group and a control group, each consisting of 70 individuals. The allocation was carried out using the block randomization method, with block sizes of 4 and 6 as depicted in Diagram 1. We used the randomization list from Sealed Envelope Ltd.2019 online randomization service (<https://www.sealedenvelope.com/simple-randomiser/v1/lists>).

One group was given extra-virgin olive oil rich in polyphenols produced by the Jalalat Exir Olive Oil Company (Iran) (trial group), and the other group was given refined olive oil (control group). The health license number of the Food and Drug Organization is 16/23824. The national identity card number of Jelalat Exir Olive Oil Company was 14004764735, and the number of the National Standards Organization of Iran is 6678276981. This extra virgin olive oil was of organic cold-pressed type from special varieties of olives in special regions; it had polyphenols above 500 mg+/kg with no additives. The

gastroenterologist and the patients did not know the type of olive oil, and it was explained to the participants that the difference in the flavor and taste of olive oil was because they are procured from different companies. In this study, the primary outcome was the effectiveness of olive oil based on Rome III criteria and based on the score obtained at the beginning and end of the week 4. The secondary outcome includes the assessment of stool shape based on the BSFS criteria and based on the patients' reports at the end of each week for four weeks, where the number 1 to 7 is given to the patients.

The amount of olive oil for each individual was two tablespoons in raw form without adding to any other food for four weeks. All the participants were asked not to change their eating habits during the period determined for the study and not to use any other vegetable oil. Also, dietary habits, including fruits, vegetables, meat, dairy, bread, cereals, and legumes, were recorded both before and after the intervention. It was also said that they can have daily life activities but should not do heavy physical activity or sports, and physical activity should be for 20-30 minutes, at maximum, three times a week. None of the participants received any drugs for constipation. Moreover, for each individual, a checklist including demographic information, clinical characteristics, eating and behavioral habits including age, gender, marital status, education level, occupational status, body mass index (BMI), history of underlying diseases, history of surgery, physical activity, hours of sleeping, cigarette smoking, hookah use, consumption of opium and alcohol, amount of water consumption per day, amount of tea consumption per day and consumption of coffee were recorded.

The excretory habits measured by the Bristol Stool Form Scale (BSFS) (24) are linked to Type 1 consisted of distinct, hard lumps (severe constipation); Type 2 was lumpy and sausage-like (mild constipation); Type 3 was a sausage shape with surface cracks (normal); Type 4 was like a smooth, soft sausage or snake (normal); Type 5 consisted of soft blobs with distinct edges (lack of fiber); Type 6 consisted of mushy consistency with ragged edges (mild diarrhea); Type 7 consisted of liquid consistency with no solid pieces (severe diarrhea) (25, 26). During the study, the participants' constipation status was checked every week based on BSFS, and after four weeks, it was checked according to the Rome III Magda criteria (fewer than three bowel movements per week, hard stool, straining during defecation, feeling of incomplete evacuation, anorectal obstruction, defecation by hand).

Inclusion and exclusion criteria: Inclusion criteria consisted of the existence of constipation. Individuals with

secondary causes of constipation related to organic diseases, systemic diseases, or medications were excluded. Also, patients with organic constipation, hypothyroidism, intestinal pseudo-obstruction, cystic fibrosis, neurological anomalies, obstruction intestine, opium use, and laxatives such as MOM were excluded from the study.

Data analysis: The average Rome III scores were compared between the refined and extra virgin olive oil groups separately before and after the intervention using a paired t-test. Also, the average scores of BSFS at different time points were compared for the groups of refined olive oil and extra virgin olive oil using repeated measures of variance analysis. The average Rome III scores following the intervention and the BSFS scores at various intervals following the intervention between the two groups of refined and extra virgin olive oil were compared using analysis of covariance (ANCOVA). In addition, Cohen's d effect size was reported for paired t-test and partial η -squared (η^2p) for ANCOVA and repeated measures analysis of variance. η^2p values equal to 0.01-0.06, 0.06-0.14, and <0.14 indicate small, medium, and large effect sizes, respectively. Values of 0.2-0.5, 0.5-0.8, and <0.8 for Cohen's d denote small, medium, and large impact sizes, in that order. Software from SPSS version 16 was used to analyze the data, and a significance threshold of 0.05 was taken into account. Graphs were also designed using GraphPad Prism Version 8.0.1.

Results

Out of 140 participants (figure1), 86 were females, and the average age and BMI of the individuals were 45.88 ± 15.67 years and 25.58 ± 1.91 kg/m², respectively. About 79.3% and 40.0% of the patients drank 2-3 and 1-2 glasses of water and tea daily, respectively (table1). There was no significant difference in the frequency of dietary habits before and after the intervention, either among consumers of refined olive oil and extra virgin olive oil or between the two groups ($p > 0.05$) (table 2). The frequency distribution of the Rome III criteria including "fewer than three bowel movements per week for "hard stools," "straining during bowel movements," and "feeling of incomplete emptying" before and after the intervention were significantly different among refined olive oil and extra virgin olive oil consumers, as well as between the two groups ($p < 0.001$). Moreover, table 3 shows that there were significant differences in the frequency distribution of manual evacuation before and after the intervention between consumers of refined and extra virgin olive oil respectively, ($P = 0.043$, and $p < 0.001$).

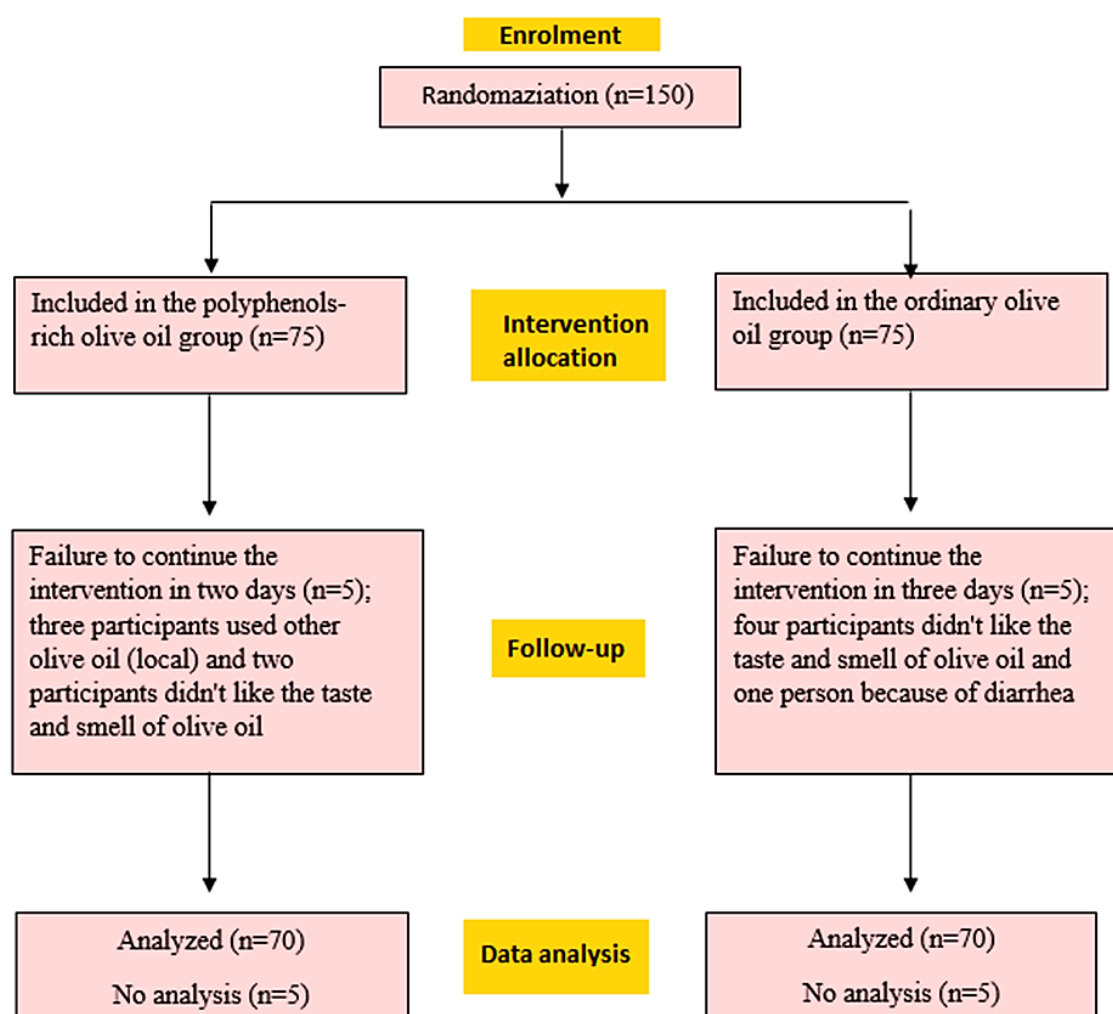


Figure 1. Flow diagram for study participants

According to the results of paired sample t-test, after four weeks of the intervention, the mean score of Rome III decreased significantly by 3.63 (95% CI: 3.18-4.07), ($d=1.944$, $P<0.001$, $t_{(69)}=16.27$); and 7.80 (95% CI: 7.22-8.38), ($d=3.203$, $p<0.001$, $t_{(69)}=26.80$), among refined olive oil and extra virgin olive oil consumers respectively. Also, according to the results of ANCOVA, after four weeks of the intervention, the mean score of Rome III decreased significantly from 11.37 ± 2.25 to 7.74 ± 2.53 ; and from 11.27 ± 2.73 to 3.47 ± 1.73 among refined olive oil and extra virgin olive oil consumers, respectively, (-4.22 (95% CI: 3.63-4.82), ($F_{(1,137)}=197.67$, $P<0.001$, $\eta^2P=0.591$). According to table 4 and figure 3, the frequency of the BSFS scale including types 3 and 4 was significantly higher in extra virgin olive oil consumers than in refined olive oil consumers at weeks 2, 3, and 4 ($P=0.002$, $p<0.001$, and $p<0.001$, respectively).

According to the results of repeated measures ANOVA, after the intervention at different time points, the mean score of BSFS increased significantly among refined olive oil and extra virgin olive oil consumers, respectively ($F_{(4 \text{ and } 276)}=46.35$, $p<0.001$, $\eta^2=0.402$); and ($F_{(4 \text{ and } 276)}=242.99$, $P<0.001$, $\eta^2=0.779$). According to the results of ANCOVA, in week 1, the mean score of BSFS after adjusting for baseline scores was significantly higher among users of extra virgin olive oil than those of refined olive oil. However, these differences were not statistically significant 0.70 (95% CI: -0.01- 0.21), $P=0.056$, table 5 and figure 4. In week 2,3 and 4, the mean score of BSFS were significantly higher among consumers of extra virgin olive oil compared to the consumers of refined olive oil 0.53 (95% CI: 0.38- 0.68), $p<0.001$, 0.78 (95% CI: 0.60- 0.97), $p<0.001$ and 1.14 (95% CI: 0.94-1.35), $p<0.001$, respectively, table 5 and figure 4.

Table 1. Demographical data and clinical characteristics of the participants

Variables	Total (140)	Extra virgin olive oil (70)	Refined olive oil (70)
Age (years) (Mean±SD)	45.88±15.67	45.01±15.14	46.74±16.24
Gender			
Male	54 (38.6)	28 (40.0)	26 (37.1)
Female	86 (61.4)	42 (60.0)	44 (62.9)
Marital status			
Not married	40 (28.6)	22 (31.4)	18 (25.7)
Married	96 (68.6)	45 (64.3)	51 (72.9)
Widow/Widower	4 (2.9)	3 (4.3)	1 (1.4)
Educational status			
Illiterate	2 (1.4)	0 (0.0)	2 (2.9)
Under diploma	17 (12.1)	7 (10.0)	10 (14.3)
Diploma	68 (48.6)	35 (50.0)	33 (47.1)
University degree	53 (37.9)	28 (40.0)	25 (25.7)
Occupational status			
Farmer	17 (12.1)	7 (10.0)	10 (14.3)
Employee	25 (17.9)	13 (18.6)	12 (17.1)
Worker	13 (9.3)	7 (10.0)	6 (8.6)
University student	36 (25.7)	19 (27.1)	17 (24.3)
Housewife	41 (29.3)	20 (28.6)	21 (30.0)
Other	8 (5.7)	4 (5.7)	4 (5.7)
Body mass index (kg/m²) (Mean±SD)	25.58±1.91	25.26±1.74	25.91±2.03
Comorbidity	9 (6.4)	4 (5.7)	5 (7.1)
History of surgery	7 (5.0)	7 (10.0)	0 (0.0)
Cigarette smoking	8 (5.7)	4 (5.7)	4 (5.7)
Hookah smoking	5 (3.6)	4 (5.7)	1 (1.4)
Alcohol consumption	1 (0.7)	1 (1.4)	0 (0.0)
Amount of water consumption per day			
2-3 glasses	111 (79.3)	58 (82.9)	53 (75.7)
4-5 glasses	29 (20.7)	12 (17.1)	17 (24.3)
Amount of tea consumption per day			
1-2 glasses	56 (40.0)	36 (51.4)	20 (28.6)
3-4 glasses	84 (60.0)	34 (48.6)	50 (71.4)
Consumption of coffee	8 (5.7)	7 (10.0)	1 (1.4)

Continuous variables were presented as mean ± standard deviation (SD), while categorical variables were expressed as the frequency (percentage) of occurrence.

Table 2. Daily nutritional habits before and after the intervention between the patients of the two study groups

	Refined olive oil		P [†]	Extra virgin olive oil		P [†]	Between-group differences (P [‡])	
	Before	After		Before	After		Before	After
Milk and dairy products			0.125			1.000	0.209	1
None	1 (1.4)	5 (7.1)		5 (7.1)	5 (7.1)			
1-3 times	69 (98.6)	65 (92.9)		65 (92.9)	65 (92.9)			
Meat and legumes			0.125			-	-	0.120
None	0 (0)	4 (5.7)		0 (0)	0 (0)			
1-2 times	70 (100)	66 (94.3)		70 (100)	70 (100)			
Bread and cereals			1			-	0.120	0.245
Less than six times	66 (94.3)	67 (95.7)		70 (100)	70 (100)			
6-11 times	4 (5.7)	3 (4.3)		0 (0)	0 (0)			
Vegetables			0.125			1	1	0.366
None	0 (0)	4 (5.7)		1 (1.4)	1 (1.4)			
less than three times a day	70 (100)	66 (94.3)		69 (98.6)	69 (98.6)			
Fruit			0.500			1	1	1
Less than two times	65 (92.9)	67 (95.7)		66 (94.3)	67 (95.7)			
2-4 times	5 (7.1)	3 (4.3)		4 (5.7)	3 (4.3)			

Values are frequency (Percentage); [†] McNemar test; [‡] Chi-squared test.

Table 3. Comparison of the frequency distribution of Rome III criteria before and after intervention between patients with chronic constipation receiving refined olive oil and extra virgin olive oil

Rome III criteria	Refined olive oil		P	Extra virgin olive oil		P	Between group differences (P)	
	Before	After		Before	After		Before	After
Fewer than three bowel movements per week			<0.001			<0.001	0.303	<0.001
Never or rarely (0)	0 (0)	0 (0)		0 (0)	0 (0)			
Sometimes (1)	1 (1.4)	7 (10.0)		1 (1.4)	41 (58.6)			
Often (2)	7 (10.0)	30 (42.9)		15 (21.4)	26 (37.1)			
Most of the time (3)	39 (55.7)	32 (45.7)		36 (51.4)	3 (4.3)			
Always (4)	23 (32.9)	1 (1.4)		18 (25.7)	0 (0.0)			
Hard stool			<0.001			<0.001	0.060	<0.001
Never or rarely (0)	0 (0)	1 (1.4)		0 (0.0)	6 (8.6)			
Sometimes (1)	0 (0)	17 (24.3)		0 (0.0)	56 (80.0)			
Often (2)	4 (5.7)	31 (44.3)		12 (17.1)	7 (10.0)			
Most of the time (3)	49 (70.0)	20 (28.6)		38 (54.3)	1 (1.4)			
Always (4)	17 (24.3)	1 (1.4)		20 (28.6)	0 (0)			

Rome III criteria	Refined olive oil		P	Extra virgin olive oil		P	Between group differences (P)	
	Before	After		Before	After		Before	After
Straining during defecation			<0.001			<0.001	0.856	<0.001
Never or rarely (0)	0 (0)	1 (1.4)		0 (0)	22 (31.4)			
Sometimes (1)	3 (4.3)	20 (28.6)		3 (4.3)	42 (60.0)			
Often (2)	20 (28.6)	33 (47.1)		20 (28.6)	5 (7.1)			
Most of the time (3)	41 (58.6)	16 (22.9)		39 (55.7)	1 (1.4)			
Always (4)	6 (8.6)	0 (0)		8 (11.4)	0 (0)			
The feeling of incomplete evacuation			<0.001			<0.001	0.870	<0.001
Never or rarely (0)	5 (7.1)	14 (20.0)		5 (7.1)	58 (82.9)			
Sometimes (1)	7 (1.0)	21 (30.0)		10 (14.3)	11 (15.7)			
Often (2)	36 (51.4)	29 (41.4)		31 (44.3)	1 (1.4)			
Most of the time (3)	16 (22.9)	6 (8.6)		19 (27.1)	0 (0)			
Always (4)	6 (8.6)	0 (0)		5 (7.1)	0 (0)			
Anorectal obstruction			0.317			0.081	0.312	-
Never or rarely (0)	69 (98.6)	70 (100)		67 (95.7)	70 (100)			
Sometimes (1)	1 (1.4)	0 (0)		3 (4.3)	0 (0)			
Often (2)	0 (0)	0 (0)		0 (0)	0 (0)			
Most of the time (3)	0 (0)	0 (0)		0 (0)	0 (0)			
Always (4)	0 (0)	0 (0)		0 (0)	0 (0)			
Manual Evacuation			0.043			<0.001	0.001	-
Never or rarely (0)	66 (94.3)	70 (100)		52 (74.3)	70 (100)			
Sometimes (1)	4 (5.7)	0 (0)		18 (25.7)	0 (0)			
Often (2)	0 (0)	0 (0)		0 (0)	0 (0)			
Most of the time (3)	0 (0)	0 (0)		0 (0)	0 (0)			
Always (4)	0 (0)	0 (0)		0 (0)	0 (0)			

Values are frequency (Percentage); The P-values reported were based on the results of the chi-squared statistical test.

Table 4. Comparison of the BSFS score at different time points after the intervention between patients with chronic constipation receiving refined olive oil and extra virgin olive oil.

BSFS Score	Group		χ^2	P
	Refined olive oil (n=70)	Extra virgin olive oil (n=70)		
Baseline			-	-
Type 1	29 (41.4)	39 (55.7)		
Type 2	41 (58.6)	31 (44.3)		
Week 1			$\chi^2_{(2)}=0.56$	0.755
Type 1	27 (38.6)	30 (42.9)		
Type 2	41 (58.6)	37 (52.9)		
Type 3	2 (2.9)	3 (4.3)		
Week 2			$\chi^2_{(3)}=14.99$	0.002
Type 1	19 (27.1)	5 (7.1)		
Type 2	43 (61.4)	43 (61.4)		
Type 3	8 (11.4)	21 (30.0)		
Type 4	0 (0.0)	1 (1.4)		

BSFS Score	Group		χ^2	P
	Refined olive oil (n=70)	Extra virgin olive oil (n=70)		
Week 3			$\chi^2_{(4)}=32.52$	<0.001
Type 1	11 (15.7)	1 (1.4)		
Type 2	45 (64.3)	24 (34.3)		
Type 3	14 (20.0)	39 (55.7)		
Type 4	0 (0.0)	5 (7.1)		
Type 5	0 (0.0)	1 (1.4)		
Week 4			$\chi^2_{(4)}=62.70$	<0.001
Type 1	3 (4.3)	0 (0.0)		
Type 2	50 (71.4)	8 (11.4)		
Type 3	15 (21.4)	36(51.4)		
Type 4	2 (2.9)	23 (32.9)		
Type 5	0 (0.0)	3 (4.3)		

BSFS: Bristol stool form scale; Type 1: separate hard lumps (severe constipation); type 2: lumpy and sausage-like (mild constipation); type 3: a sausage shape with cracks in the surface (normal); type 4: like a smooth, soft sausage or snake (normal); type 5: soft blobs with clear-cut edges (lacking fiber), type 6: mushy consistency with ragged edges (mild diarrhea), and type 7: liquid consistency with no solid pieces (severe diarrhea).

Table 5. Comparison of the mean score of BSFS during the intervention between patients with chronic constipation receiving refined olive oil and extra virgin olive oil

BSFS Score	Group		Adjusted mean difference (95% CI)	$F_{(1,137)}$	P	η^2_p
	Refined olive oil Mean (SD)	Extra virgin olive oil Mean (SD)				
Baseline	1.59 (0.50)	1.44 (0.50)	-	-	-	-
Week one	1.64 (0.54)	1.61 (0.57)	0.70 (-0.01- 0.21)	3.70	0.056	0.026
Week two	1.84 (0.61)	2.26 (0.61)	0.53 (0.38- 0.68)	49.96	<0.001	0.265
Week three	2.04 (0.60)	2.73 (0.68)	0.78 (0.60- 0.97)	71.57	<0.001	0.343
Week four	2.23 (0.57)	3.30 (0.73)	1.14 (0.94-1.35)	122.20	<0.001	0.471

BSFS: Bristol Stool Form Scale; SD: Standard Deviation; CI: Confidence Interval; Data are mean $\pm$ SD, unless otherwise specified; Between-group differences were examined using ANCOVA (after adjusting for baseline scores); η^2_p values of 0.01-0.06, 0.06-0.14, and >0.14 were considered as small, medium, and large effect size, respectively.

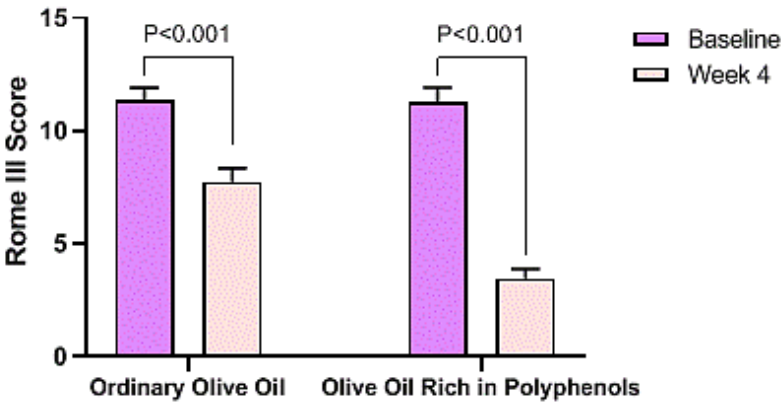


Figure 2. Comparison of the mean score of Rome III before and after the intervention in patients with chronic constipation, according to the groups receiving refined olive oil and extra virgin olive oil.

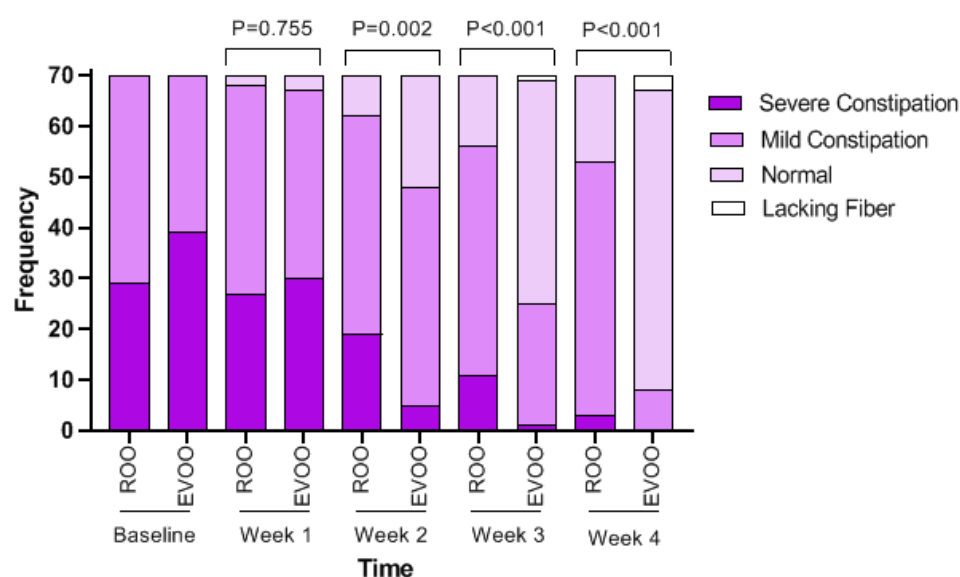


Figure 3. Comparison of BSFS scale during intervention between patients with chronic constipation receiving refined olive oil and extra virgin olive oil. ROO: Refined Olive Oil; EVOO: Extra Virgin Olive Oil; P-Values is based on the Cochran-Armitage test for trend.

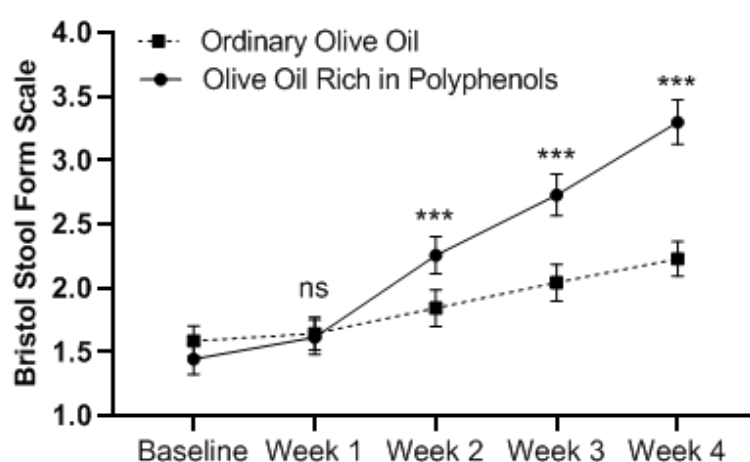


Figure 4. Comparison of BSFS scores at different time points after the intervention between patients with chronic constipation receiving refined olive oil and extra virgin olive oil. Data are mean and 95% confidence interval (95% CI); P-Values are based on the ANCOVA; ***P<0.001; ns Non-significant.

Discussion

According to the current study's findings, by considering the patients' almost similar dietary habits, the effectiveness of consuming extra virgin olive oil in ameliorating constipation symptoms was higher than refined olive oil. Constipation is a common gastrointestinal disorder that can significantly impact an individual's quality of life (27). Over the past few years, there has been a surge in interest regarding the potential therapeutic benefits of olive oil, particularly those rich in polyphenols, in relieving symptoms of constipation (14, 28). The objective of this study was to evaluate and compare the efficacy of extra virgin olive oil and refined olive oil in the management of

constipation among a group of participants. Patients consuming extra virgin olive oil experienced increased bowel movement frequency reduced hard stools and straining, improved feelings of complete defecation, and higher scores for normal stool consistency. Similarly, other studies have shown that foods rich in polyphenols can reduce symptoms of constipation (29, 30). Also, studies have reported that polyphenol compounds stimulate the production of serotonin, modulate gut bacteria, and increase bile acid secretion and bowel movements (31-34) (figure 4, figure 5). Therefore, it is essential to investigate the role and mechanisms of action of polyphenol-rich compounds in individuals suffering from chronic constipation.

Our study showed a significant increase in bowel movements and improved constipation symptoms among participants who consumed extra virgin olive oil. These findings align with other clinical trial studies that reported a significant increase in bowel movements and a reduction in constipation severity scores among participants who incorporated a polyphenols-rich diet into their daily dietary (35, 36). Polyphenols have been shown to exert antioxidant and anti-inflammatory effects, which can help reduce intestinal inflammation and oxidative stress, promoting smoother bowel movements (37, 38). Furthermore, we observed a notable reduction in stool hardness in patients receiving extra virgin olive oil. In the study conducted by Ramos et al., the effect of olive oil on constipation management in hemodialysis patients was investigated. The results of the study showed that the consumption of olive oil over a period of four weeks led to an improvement in the Rome III criteria score, particularly in relation to symptoms like incomplete evacuation, hard stools, and the sensation of anorectal obstruction. Their results suggested that incorporating olive oil into daily dietary habits may be beneficial in treating constipation (16).

Moreover, our findings revealed that participants in the extra virgin group reported a significant decrease in the sensation of incomplete stool evacuation compared to the control group. A study by Morvaridi et al. supports the notion that polyphenol compounds, particularly those found in olive oil, may contribute to more complete stool evacuation and reduce these distressing symptoms (28). Our results demonstrated that individuals who consumed extra virgin olive oil experienced a significant reduction in straining during defecation compared to those consuming refined oil. Research has demonstrated that stimulant laxatives, including polyphenol compounds, trigger proliferative contractions in the large intestine and enhance the secretion of water and electrolytes into the intestinal lumen (39, 40). The study's findings underscore the potential effectiveness of extra virgin olive oil in alleviating constipation symptoms compared to refined olive oil despite the participants' similar dietary habits. Patients consuming extra virgin olive oil exhibited increased bowel movement frequency, reduced hard stools and straining, improved feelings of complete defecation, and higher scores for normal stool consistency. Additionally, the consumption of extra virgin olive oil was linked to a substantial reduction in the feeling of incomplete stool evacuation when compared to the control group. Notably, the individuals who consumed extra virgin olive oil reported decreased difficulty with bowel movements, which may be due to the laxative properties of the polyphenol compounds in the

olive oil. These polyphenols appear to stimulate contractions in the large intestine and increase the secretion of water and electrolytes into the intestinal tract, thereby facilitating easier defecation. These findings highlight the potential of extra virgin olive oil as a natural and effective therapeutic option for managing constipation symptoms, warranting further exploration into its mechanisms and broader implications for digestive health. The study's unique approach involves utilizing olive oil as a therapeutic intervention, which aligns with natural and daily dietary habits rather than relying solely on medications. The findings indicate a potential benefit of polyphenol compounds in improving defecation dynamics and reducing excessive straining, with no reported complications or side effects associated with olive oil consumption. One strength of the study lies in its approach of utilizing olive oil as a therapeutic intervention, aligning with natural and daily dietary habits rather than relying solely on medications. However, a notable limitation is the lack of measurement of the polyphenol content in the oils used. This omission could potentially impact the generalizability and interpretation of the results. Moving forward, it is recommended that future studies address this limitation by quantifying the polyphenol content in the oils under investigation. Additionally, evaluating inflammatory markers and considering other relevant factors in individuals consuming extra virgin olive oil could provide further insights into its potential mechanisms of action and broader effects on gastrointestinal health. By addressing these aspects, future research can enhance the understanding of the therapeutic potential of olive oil and its components in promoting digestive health. The research showed that extra virgin olive oil was more effective than refined olive oil in relieving constipation. These results emphasize the value of extra virgin olive oil as a possible therapeutic option for managing constipation.

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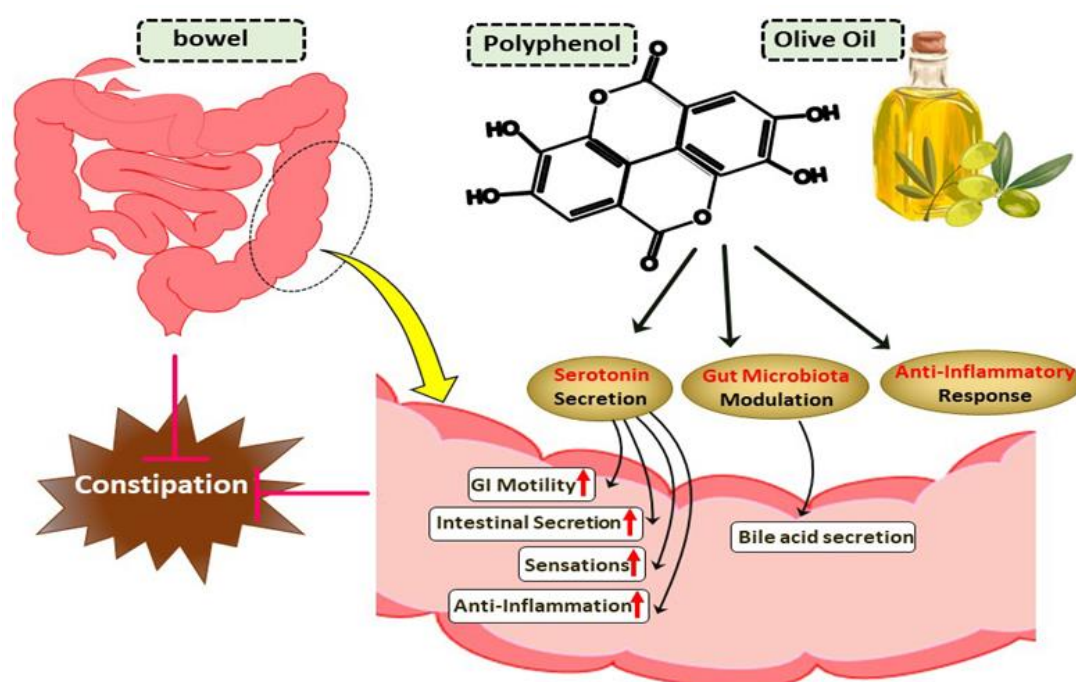


Figure 5. The mechanism of polyphenol compounds in ameliorating constipation

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Ethics approval: This study was confirmed by the Ethical Committee of the Guilan University of the Medical Sciences, Rasht, Iran [IR.GUMS.REC.1399.600]. The project was registered on the Iran Clinical Trials Registration System (IRCT) website (<https://en.irct.ir/trial/54490?revision=173199>, <https://en.irct.ir/trial/54490?revision=181530>, first registration date: 01/03/2021, revision date: 02/05/2021) with registration number: IRCT20080901001155N33. All patients gave their informed consent to participate in the study.

Conflict of interests: The authors declare that they have no competing interests in this work.

Authors' contribution: FMGH and FJ participated in the research design. TZ and NF participated in writing the first draft. NE has drawn the Figure. FJ and NM participated in the performance of the research and analytic tools. SM participated in data analysis. All authors reviewed and confirmed the final manuscript.

Availability of data and materials: The study protocol and the datasets analyzed are available from the corresponding author upon request.

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