# Research Paper: Comparative Effects of Olive Oil and Flaxseed Oil on Glycemic Control and Lipid Profile in Burn Patients: A Randomized Clinical Trial

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## ABSTRACT

Burn injuries often result in hyperglycemia and dyslipidemia, complicating recovery and increasing the risk of adverse outcomes. While olive oil and flaxseed oil have been associated with improved metabolic health, their comparative effects on burn-induced glycemic and lipid disturbances remain unclear. This study aimed to compare the effects of olive and flaxseed oil on glycemic control and lipid profiles in burn patients. In this double-blind, randomized clinical trial, 112 patients with burns covering 20-50% of total body surface area were randomly assigned to four groups: control, olive oil, flaxseed oil, and a mixture of both groups. Interventions were administered from day 2 to day 22 post-burn. Fasting blood sugar (FBS), cholesterol, triglycerides, high-density lipoprotein (HDL), and low-density lipoprotein (LDL) levels were measured at baseline and during follow-up. Data were analyzed using analysis of variance and Kruskal-Wallis tests. After two weeks, the OO group showed a significant reduction in FBS (-34.03±69.65, P<0.05), whereas the FO group demonstrated an increase in cholesterol levels (+26.14±79.08 mg/dl, P<0.05). Significant changes were observed in HDL, LDL, and triglyceride levels across the groups (P<0.05). Olive oil was more effective in reducing LDL and cholesterol, compared to flaxseed oil, while the mixture group exhibited the most significant improvement in HDL levels. None of the groups showed a substantial impact on overall glycemic control. Olive oil was more effective than flaxseed oil in improving lipid profiles, particularly in reducing LDL and cholesterol levels in burn patients. However, neither oil demonstrated a significant effect on post-burn glycemic control. Future studies should explore the long-term metabolic outcomes of these interventions in burn patients.

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## 1. Introduction

Burn injury is one of the most considerable health problems facing developing countries (1). As reported by the World Health Organization in 2014, approximately 265,000 individuals lost their lives due to burn injuries, with the majority (96%) of these fatalities occurring in low-income and middle-income countries (2).

In Iran, burns rank as the 8th leading cause of death and the 13th leading cause of disability (3). Secondary consequences of burns are loss of glycemic control and delayed wound healing (4). Burns are characterized by hypoglycemic events which lead to hyperglycemia (5). Adequate glycemic control is a remarkable casual yet challenging factor to achieve after a thermal burn (6). As hypoglycemia causes complications in burn patients, hyperglycemia is a common metabolic alteration in these patients (5). Burn patients suffer from hyperglycemia due to altered processes, physiological responses, inflammatory reactions, systemic stress, and increased insulin resistance (6, 7).

Following burn injuries, the increased production of catecholamines, glucagon, and glucocorticoids in the body triggers greater glycogen breakdown and protein catabolism in both the liver and muscles. Additionally, heightened production of triglycerides, glycerol, urea, and glucose (via gluconeogenesis) contributes to hyperglycemia (8).

It is observed that olive oil, as part of a Mediterranean diet, with its high content of monounsaturated fatty acids and antioxidant compounds, mainly phenolic compounds, tyrosol, and secoiridoids can improve glycemic control and blood lipid profiles. Moreover, it is one of the most frequently used treatments for burn injury in herbal medicine lignans (2, 9, 10).

*Linum usitatissimum*, an annual plant from the linseed family, is commonly native to the Mediterranean region (11). Flaxseed oil contains a high concentration of alpha-linolenic acid, a precursor to long-chain omega-3 fatty acids, making up around 55% of its total fatty acid content. The primary lignan in flaxseed, secoisolariciresinol diglucoside, undergoes further metabolism after consumption, producing enterodiol and enterolactone (12-14). A growing body of evidence suggests that secoisolariciresinol diglucoside metabolites and flaxseed consumption may protect against metabolic syndrome by reducing lipid and glucose concentrations, delaying postprandial glucose absorption, and decreasing oxidative stress and inflammation. Moreover, the Lignans in flaxseed could also contribute to glycemic control (12, 13).

In this study, the high content of monounsaturated fatty acids and the significant antioxidant properties of these two vegetable oils led the researchers to emphasize using herbal medicines to improve serum glucose and lipid levels in burn patients.

## 2. Materials and Methods

This double-blind, randomized controlled trial included 112 burn patients (20-50% total body surface area [TBSA]) admitted to Velayat Burn and Plastic Surgery Center, Rasht, Iran, between May 2018 and February 2019. Patients were randomly allocated to four groups: olive oil (OO), flaxseed oil (FO), a mixture of both (OF), and control. All patients received the standard burn care alongside the nutritional interventions, consisting of the consumption of 30 cc of oil daily for 21 days.

The inclusion criteria were being an adult burn patient (15-65 years old) who was hospitalized within 24 h post-burn and could consume oral nutrition. Exclusion criteria were diabetes, renal or hepatic failure, malnutrition, or allergy to the oils. The fasting blood sugar (FBS), cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), hemoglobin, and hematocrit levels were measured at baseline and on days 7, 14, and 21. Block randomization with concealed allocation was used, and the oils were blinded to patients and staff. Data were analyzed in SPSS software (version 23), employing analysis of variance, Chi-square, and Kruskal-Wallis tests where appropriate. A P value of $< 0.05$ was considered significant.

## 3. Results

In this study, 110 out of 112 burn patients initially enrolled in the study, completed the trial, with two patients succumbing to septicemia. The mean age of participants was 43.25 ± 13.25 years, and 24.1% of them were female. No significant differences were observed among the four groups in terms of baseline

characteristics, such as age, gender, body mass index, TBSA, or blood pressure.

The OO group experienced a significant reduction in FBS after two weeks (-34.03±69.65 mg/dl, P<0.05), whereas the FO group underwent a significant increase in cholesterol (+26.14±79.08 mg/dl, P<0.05). Changes in triglycerides, HDL, and LDL were statistically significant across groups (P<0.05). The mixed oil group (OF) demonstrated the most favorable changes in HDL levels, while OO experienced the most significant reduction of LDL and total cholesterol. No significant changes in hemoglobin were observed across groups.

Despite these lipid profile improvements, glycemic control was not consistently affected in any of the groups by day 21. Moreover, nutritional intake did not significantly affect the results. The alterations in fasting blood sugar levels across the intervention period are provided in Table 1. In addition, the detailed alterations in serum proteins and lipid profiles across the groups are presented in Table 2.

**Table 1.** Changes in fasting blood sugar in burn patients during the intervention[a]

| Characteristics | FBS | FBS day7 | FBS day14 | FBS day21 | Changes after 1st week | Changes after 2d week | Changes after 3d week |
|---|---|---|---|---|---|---|---|
| Olive oil (n=29) | 152.07±58.04 | 155.57±56.29 | 186.11±71.71 | 113.54±24.97 | -3.50±43.5 | -34.03±69.6 | 38.53±44.3 |
| Flaxseed oil (n=28) | 175.60±68.4 | 191.43±85.4 | 200.37±106.7 | 125.71±33.7 | -15.82±79.8 | -24.03±81.6 | 49.89±56.7 |
| Olive oil and flaxseed oil (n=28) | 192.46±80.5 | 178.29±73.5 | 162.89±66.5 | 116.75±31.0 | 14.17±53.8 | 29.57±79.9 | 75.71±65.0 |
| Control group (n=29) | 186.67±88.0 | 181.79±88.8 | 174.50±95.5 | 133.82±46.0 | 4.89±63.7 | 12.17±91.4 | 52.85±62.3 |
| P value[b] | 0.222 | 0.354 | 0.515 | 0.194 | 0.596 | 0.026 | 0.233 |

[a]Data are presented as mean±SD.
[b]Inter-group differences are examined using the Kruskal-Wallis test.
FBS: fasting blood sugar

**Table 2.** Changes in serum protein and lipid profile in burn patients during the intervention[a]

| Characteristics | | Olive oil (n=29) | Flaxseed oil (n=28) | Control group (n=29) | Olive oil flaxseed oil (n=28) | P value[b] |
|---|---|---|---|---|---|---|
| Hemoglobin | Before | 14/5±2.5 | 13.7±2.0 | 13.6± 2.3 | 13.7± 2.3 | 0.195 |
| | After | 12.5±2.0 | 12.6±1.3 | 11.8±1.9 | 12.5±1.8 | 0.260 |
| | Change | -2.03±2.10 | -1.04±1.97 | -1.57±2.04 | -1.25±2.52 | 0.207 |
| Hematocrit | Before | 43.0±6.2 | 39.3±4.7 | 39.7±5.0 | 39.0±5.8 | 0.054 |
| | After | 36.5±4.8 | 36.9±2.9 | 35.2±4.5 | 35.9±4.3 | 0.348 |
| | Change | -6.46±5.06 | -2.43±4.92 | -4.48±5.15 | -3.12±5.89 | 0.016 |
| Cholesterol | Before | 169.21±83.69 | 154.25±76.25 | 123.46± 43.48 | 126.36± 39.54 | 0.072 |
| | After | 162.89±93.10 | 180.39±180.39 | 179.11±108.75 | 123.11±59.27 | 0.021 |
| | Change | -6.32±124.59 | +26.14±79.08 | +55.64±112.43 | -3.29±60.89 | 0.023 |
| Triglyceride | Before | 136.36±51.23 | 139.39±76.25 | 112.68± 43.48 | 133.96± 39.54 | 0.362 |
| | After | 127.68±65.74 | 140.82±89.99 | 150.86±108.75 | 139.14±59.27 | 0.486 |
| | Change | -8.68±82.01 | +1.43±79.08 | +38.18±112.43 | -5.18±60.89 | 0.013 |
| High-density lipoprotein | Before | 37.46±15.71 | 35.39±13.63 | 30.12± 63.20 | 35.46±9.36 | 0.084 |
| | After | 46.00±15.33 | 41.82±12.53 | 35.07±14.38 | 45.14±13.64 | 0.010 |
| | Change | +8.54±17.75 | +6.43±12.04 | +4.86±12.29 | +9.68±14.46 | 0.552 |
| Low-density lipoprotein | Before | 76.79±27.44 | 80.07±28.92 | 65.86± 24.03 | 67.46± 26.46 | 0.172 |
| | After | 66.14±21.13 | 77.82±23.46 | 80.11±24.21 | 63.36±66.00 | 0.010 |
| | Change | -10.64±26.70 | -2.25±22.91 | +14.25±27.05 | -4.11±11.75 | <0.001 |

[a]Data are presented as mean±SD.
[b]Between-group differences are examined using the Kruskal-Wallis test

## 4. Discussion

Hyperglycemia is one of the significant complications of burns (15) and is usually observed in critically ill patients. Although initially considered a beneficial and adaptive response, hyperglycemia has been associated with adverse outcomes, including wound infection, bacteremia, and pneumonia. Glucose variability has been shown to predict mortality after burn injury. It has also been reported that stress response hyperglycemia in results of burn patients from increased hepatic gluconeogenesis is due to increased catecholamines, not decreased insulin production or reduced insulin response (7).

Several previous studies have shown that flaxseed oil effectively lowers blood sugar (9, 16, 17). However, neither oil demonstrated a significant

effect on glycemic control, highlighting the complexity of managing post-burn hyperglycemia. Our findings are consistent with the growing evidence supporting the cardioprotective benefits of olive oil, particularly due to its high monounsaturated fat content and antioxidant properties. Previous studies have also shown that olive oil significantly lowers LDL and cholesterol levels, as observed in trials on healthy subjects and patients with metabolic disorders (16).

While rich in Omega-3 fatty acids, flaxseed oil has shown inconsistent effects on lipid profile and blood sugar in different populations. For example, a meta-analysis by Mohammadi Sartang et al. (2018) concluded that whole flaxseed, rather than flaxseed oil, was more effective in improving blood glucose control (18). Furthermore, a study performed in Greece showed that flaxseed oil does not affect inflammatory markers and lipid profile, compared to olive oil in young, healthy, normal-weight adults (19). These findings are consistent with those of the present study, where flaxseed oil failed to significantly affect blood glucose regulation and support the hypothesis that the oil form may not provide the full metabolic benefits of the whole seed.

In the present study, the changes in hematocrit in the four groups were statistically significant; the highest and lowest levels of decrease in hematocrit were observed in the olive oil group and the flaxseed oil group, respectively. Hemoglobin and FBS changes were not significantly different in the intervention groups. Burn patients with TBSA > 20% undergo poor wound healing, muscle weakness, frequent infections, and anemia due to malnutrition and extensive debridement (20).

Based on the results of the present study, olive oil can effectively reduce cholesterol, triglycerides, and LDL, and when combined with flaxseed oil, it has the best results in increasing HDL and reducing cholesterol and LDL. Olive oil was more effective than flaxseed oil in these indicators, and flaxseed oil, besides not lowering triglycerides, also increased cholesterol. In addition, the synergistic effect observed in the combined group (olive and flaxseed oils) regarding the improvement of HDL can be attributed to the complementary mechanisms of both oils. Olive oil phenolic compounds and flaxseed oil lignans are known to increase lipid metabolism and modulate inflammatory pathways, which may explain the superior improvement in HDL when used together.

Results of two previous studies carried out in Iran and Italy have also shown that olive oil reduces triglycerides, cholesterol, and LDL and also improves HDL status (16, 21). Olive oil may exert its beneficial effects through several mechanisms, including improvement of the lipid profile by lowering total cholesterol (TC), increase of the ratio of HDL to TC, amelioration of vascular oxidative damage, and improvement of endothelial function and blood pressure (10, 22-25). Contrary to these results, Kontogianni found that flaxseed oil consumption better reduces cholesterol and LDL levels in patients. Cholesterol and triglycerides increased in these people after consuming olive oil. Moreover, the two groups had no significant difference in terms of blood glucose and lipid profiles (19). The difference in results can also be due to the type of oil consumers. In the Cantonese study, these oils were studied in healthy subjects, but in the present research, the consumers were burn patients.

Findings of a study conducted by Soleimani et al. also showed a decrease in the average levels of triglycerides in diabetic patients consuming flaxseed oil; however, cholesterol, HDL, and LDL levels did not change significantly (17).

Another study performed in Shiraz also focused on reducing triglycerides and cholesterol in burn patients after oral administration of flaxseed oil and soy protein. However, these results may be due to the effect of soy protein (20). Since flaxseed oil alone can raise cholesterol, adding it to the diet should be done cautiously, although more research is needed. Due to the single-center nature of this review, future studies with larger sample sizes and more extended follow-up periods are required to fully elucidate the potential benefits of these oils in burn patients, especially regarding long-term glycemic control and inflammatory response.

## 5. Conclusion

Overall, olive oil demonstrated greater efficacy than flaxseed oil in enhancing lipid profiles, especially in lowering cholesterol and LDL levels. The combination of olive and flaxseed oil produced the most significant increase in HDL levels. However, neither oil demonstrated a substantial or sustained

effect on glycemic control. Nutritional intake and burn severity did not significantly influence these results. The findings suggested that while olive oil may benefit lipid management in burn patients, its effect on blood glucose requires further study in more extensive trials with extended follow-up periods.

## Ethical Considerations

### Compliance with ethical guidelines

The study design was approved by the regional Ethics Committee of Guilan University of Medical Sciences (IR.GUMS.REC.1395.501) and was in accordance with the declaration of Helsinki.

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### Authors' contributions

A. Gh., and A. A. contributed to the study design. S. M. and S. B. collected the data. E. K. L. performed the data analysis. E. P. and M. M-R. interpreted the data. M. S. and S. M. contributed to the manuscript writing. All authors read and approved the final manuscript.

### Conflict of Interests

The authors declare no potential conflicts of interest.

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