

# The effect of sesame seeds on fast blood sugar, haemoglobin A<sub>1c</sub>, liver enzymes and lipid profile in patients with type 2 diabetes: a randomised clinical trial

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**A** – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

**Summary Background.** Diabetes is one of the most common diseases typically seen in modern societies.

**Objectives.** This research aimed to study the impact of consuming sesame seeds on some biochemical factors in type 2 diabetic patients.

**Material and methods.** This clinical trial was carried out on 60 patients diagnosed with type 2 diabetes who were assigned into the experimental ( $n = 30$ ) and control groups ( $n = 30$ ). The experimental group received 60 g sesame seeds per day for two months, while the control group did not receive any treatment. The demographic characteristics of patients were collected by a questionnaire-based survey method. The fasting blood sugar of patients was collected at the beginning and end of the clinical trial, and the biochemical factors were measured. For data analysis, the independent two-sample *t*-Test and paired *t*-Test were conducted using SPSS software version 20, and the level of significance was set at  $p < 0.05$ .

**Results.** In this study, the mean age of the experimental group was  $52.48 \pm 5.72$  years old, while the average age of the control group was  $56.00 \pm 6.11$  years old. The results showed that the serum levels of fasting blood glucose, HbA<sub>1c</sub>, cholesterol, triglycerides, low-density lipoprotein (LDL), alanine transaminase (ALT) and alkaline phosphatase (ALP) were significantly ( $p < 0.05$ ) decreased in the experimental group compared to the control group.

**Conclusions.** Regarding the harmless effects of sesame seeds, it seems that complementary therapy would be useful for the treatment and prevention of diabetes.

**Key words:** sesamum, blood glucose, glycated haemoglobin A, liver, diabetes mellitus, type 2.

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## Background

Diabetes mellitus is a metabolic disorder caused by impaired insulin secretion or resistance to insulin (or both) that affects a wide majority of people globally. A recent study reports that 1 in every 11 adults suffer from diabetes, and diabetes has been the ninth cause of death in the past decade. Type 2 diabetes has greater prevalence comparing to type 1 diabetes. One in every 10 diabetes patients has type 2 diabetes [1]. Numerous complications have been found for this disease, such as cardiovascular disease, diabetic foot, higher susceptibility to infections, stroke, as well as microvascular complications including neuropathy, retinopathy and nephropathy [2].

Numerous approaches and drugs have been introduced for the treatment and management of diabetes. Although several chemical drugs are available for treating diabetes, these drugs are both expensive and are associated with complications such as anorexia, diarrhoea, nausea, lactic acidosis and weight gain [3, 4]. However, inadequate attention has been paid to medicinal plants as an alternative and effective treatment for diabetes mellitus. Rigorous studies have shown that medicinal plants are effective in reducing hyperglycaemia along with its complications, such as neuropathy, retinopathy, nephropathy and hypertension. These plants can also stimulate insulin secretion

through several pathways and reduce peripheral insulin resistance [5, 6].

*Sesamum indicum* is a popular edible plant in Asian and Middle Eastern countries such as Iran and Japan. Numerous bioactive compounds have been found in sesame seeds, including phytosterols, vitamin B<sub>1</sub>, tocopherols, polyunsaturated fatty acids (PUFA), sesamol, sesamin and various phenylpropanoid compounds. Several studies have indicated that sesame seeds can prevent oxidative stress, have anti-carcinogenic properties and protects from tumour progression [7]. One recent study has investigated the anti-inflammatory actions of the bioactive compounds of sesame seeds and concluded that sesame oil can modulate the macrophage and dendritic cells' proinflammatory functions [8]. Another study has indicated that sesame seeds can decrease muscle damage and improve their aerobic capacity [9].

Few recent studies have investigated the effect of sesame seeds' compound on blood glucose level and the potential therapeutic effect of this plant in treating and managing diabetes. The effect of sesame oil on fasting blood sugar and HbA<sub>1c</sub> has been previously evaluated in a randomised controlled trial. It has been shown that sesame oil can reduce fasting blood sugar and oxidative stress along with improving renal and hepatic biomarkers [10]. Sesame oil consumption significantly improved



glycaemic control in diabetes patients and is a viable candidate to reduce the inimical effects of this disease [11]. Another randomised controlled trial reported that sesame seeds can improve atherogenic lipid factors and subsequently reduce the risk of cardiovascular incidence [12]. Another study also suggests that it can be used as an adjuvant therapy in cardiovascular disease and help reduce its morbidity and mortality [13].

In order to foster the potential use of *sesamum indicum* on glucose control and enhance the therapeutic properties of this plant in treatment and management of diabetes, this study aimed at evaluating the effect of sesame seeds on the serum levels of fasting blood glucose, glycosylated haemoglobin (HbA<sub>1c</sub>), cholesterol, triglyceride, low-density lipoprotein (LDL), alanine transaminase (ALT) and alkaline phosphatase (ALP) in patients with type 2 diabetes.

### Material and methods

This randomised clinical trial was registered in the Iranian Registry of Clinical Trials ([www.irct.ir](http://www.irct.ir)) in 2019 under the registry code IRCT20190114042359N1. The study population included patients with type 2 diabetes who were referred to the specialised laboratory of Rafsanjan University of Medical Sciences in 2014.

According to a study by Mosallaiee et al. in 2008 [14], using the equation

$$n_1 = n_2 = \frac{2\sigma_d^2(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2}{\delta^2},$$

where  $\alpha = 0.05$  is the standard deviation of LDL changes in the experimental group,  $\sigma_d = 33.60$  mg/dl,  $\beta = 0.10$ ,  $\delta = 20$  mg/dl (the lowest difference in the mean LDL changes in the two groups is clinically important), the sample size was estimated to be 30 individuals for each group (total = 60). The randomisation process of patients was performed using randomly permuted blocks with a block size of 2.

The inclusion criteria included having type 2 diabetes, ages between 40–65 years old, fasting blood glucose > 12 mg/dl and < 250 mg/dl, serum cholesterol between 210–250 mg/dl, triglyceride > 200 mg/dl, not using lipid- and glucose-lowering drugs. The exclusion criteria were insulin infusion, history of cardiovascular, liver and kidney diseases, hypothyroidism or hyperthyroidism, high blood pressure, history of insulin therapy, consuming sesame seeds, changes in daily physical activity and diet during the course of the study, pregnancy and lactation, the use of oral contraceptives, history of alcohol use, smoking and narcotics.

Due to the fact that only sesame seeds are commonly consumed in society, there was no ethical problem in terms of using this substance for the research. However, this study was approved by the Ethics Committee of Rafsanjan University of Medical Sciences (code 31/3757). After the enrolment of patients and assigning them into two groups, informed consent was obtained from all participants, and the questionnaires were given to patients in each clinical centre. Blood samples were collected daily at a volume of 5 ml for two weeks (except for holidays).

### Preparation of sesame seeds

Sesame seeds were purchased from the local market of Rafsanjan city, and their genus and species were botanically confirmed by an expert botanist. Afterward, 30 g packages of sesame seeds were provided.

### Sesame consumption

In the experimental group, patients received 60 grams per day of sesame seeds in two 30 g portions for two months, while the control group did not receive sesame seeds. In the intervention group, patients were asked to consume 2 packets of sesame seeds in 2 meals. After two months, blood samples were taken from both groups, and biochemical parameters were measured.

### Statistical analysis

The data was analysed by SPSS software version 20. The quantitative data was expressed as means and standard deviation (means ± SD), while the qualitative data was represented as percentages. The independent two-sample *t*-Test was used to compare the average of biochemical factors in the experimental and control groups. In order to compare the means of biochemical factors in each group at the beginning and end of the experiment, the paired *t*-Test was also applied at a significant level of 0.05.

### Results

In this study, 60 patients with type 2 diabetes referred to the specialised laboratory of Rafsanjan Medical School were evaluated. The mean age of the experimental group was 52.48 ± 5.72 years old, and the mean age of the control group was 56.00 ± 6.11 years old. The average duration of diabetes in the experimental group was 7.97 ± 4.03 years, while this was 10.73 ± 4.16 years in the control group (Table 1).

**Table 1. Comparison of demographic variables in type 2 diabetic patients consuming sesame seeds and those not consuming sesame seeds**

Group	Consuming sesame seeds (n = 30)	Not consuming sesame seeds (n = 30)	p
Parameters			
Gender			0.787
male	10 (33.3)	11 (36.7)	
female	20 (66.7)	19 (63.3)	
Age (years)	52.48 ± 5.72	56.00 ± 6.11	0.022
Weight (kg)	65.53 ± 6.33	68.27 ± 6.16	0.096
Height (cm)	162.90 ± 8.13	165.13 ± 6.66	0.249
Body mass index (kg/m <sup>2</sup> )	24.67 ± 1.14	25.03 ± 1.75	0.341
Duration of diabetes (years)	7.97 ± 4.03	10.73 ± 4.16	0.011

Data is reported as "standard deviation ± mean" or "number (percent)".

**Table 2. Intra-group and inter-group comparison of FBS, A<sub>1c</sub>, liver enzymes, cholesterol and triglyceride in type 2 diabetic patients consuming sesame seeds and those not consuming sesame seeds**

Parameters	Consuming sesame seeds (n = 30) SD ± mean			Not consuming sesame seeds (n = 30) SD ± mean			p Intergroup	
	before	after	p	before	after	p	before	after
Fasting blood sugar (mg/dl)	177.27 ± 40.95	161.03 ± 41.59	< 0.001	163.27 ± 26.33	175.87 ± 30.95	< 0.001	0.122	0.122
Glycosylated haemoglobin (Haemoglobin percentage)	7.11 ± 1.18	6.52 ± 1.04	< 0.001	7.69 ± 1.26	7.76 ± 1.24	0.526	0.072	< 0.001

**Table 2. Intra-group and inter-group comparison of FBS, A<sub>1c</sub>, liver enzymes, cholesterol and triglyceride in type 2 diabetic patients consuming sesame seeds and those not consuming sesame seeds**

Parameters	Consuming sesame seeds (n = 30) SD ± mean			Not consuming sesame seeds (n = 30) SD ± mean			p Intergroup	
	before	after	p	before	after	p	before	after
Cholesterol (mg/dl)	230.10 ± 16.94	200.57 ± 24.54	< 0.001	228.83 ± 14.11	233.77 ± 15.06	< 0.001	0.754	< 0.001
Triglyceride (mg/dl)	283.5 ± 68.05	213.13 ± 46.51	< 0.001	274.07 ± 61.69	276.40 ± 57.74	0.399	0.576	< 0.001
LDL-C (mg/dl)	125.33 ± 32.39	111.27 ± 24.28	0.024	130.93 ± 18.12	134.67 ± 17.77	0.039	0.413	< 0.001
Alanine aminotransferase (IU/L)	25.60 ± 9.68	23.07 ± 8.78	0.058	22.27 ± 6.62	23.2 ± 7.93	0.079	0.125	0.951
Aspartate transaminase (IU/L)	22.53 ± 11.33	23.93 ± 13.17	0.372	23.03 ± 8.11	23.53 ± 10.06	0.574	0.845	0.895
Alkaline phosphatase (IU/L)	198.3 ± 35.18	187.70 ± 39.35	0.109	200.70 ± 37.34	205.90 ± 41.26	0.021	0.799	0.086

Statistical test: Independent two-sample *t*-Test and Paired *t*-Test. *p* < 0.05. Differences were statistically significant.

**Table 3. Comparison of mean changes in FBS, A<sub>1c</sub>, liver enzymes, cholesterol and triglycerides in type 2 diabetic patients consuming sesame seeds and those not consuming sesame seeds**

Parameters	Group	Consuming sesame seeds (n = 30) mean ± SD	Not consuming sesame seeds (n = 30) mean ± SD	p
Fasting blood sugar (mg/dl)		16.23 ± 19.31	-12.60 ± 18.43	< 0.001
Glycosylated haemoglobin (Haemoglobin percentage)		0.59 ± 0.68	-0.07 ± 0.57	< 0.001
Cholesterol (mg/dl)		29.53 ± 24.42	-4.93 ± 5.03	< 0.001
Triglyceride (mg/dl)		70.37 ± 53.62	-2.33 ± 14.93	< 0.001
LDL-C (mg/dl)		14.07 ± 32.30	-3.73 ± 9.45	0.007
Alanine aminotransferase (IU/L)		2.53 ± 7/02	-0.93 ± 2/80	0.016
Aspartate transaminase (IU/L)		-1.40 ± 8.46	-0.50 ± 4.82	0.615
Alkaline phosphatase (IU/L)		10.60 ± 35.06	-5.20 ± 11.65	0.025

Statistical test: Independent two-sample *t*-Test. *p* < 0.05. Differences between the two groups were statistically significant.

The mean serum levels of fasting blood glucose, glycosylated haemoglobin, cholesterol and triglyceride were significantly decreased in the experimental group (*p* < 0.001) compared to the control group (Table 2).

As shown in Table 3, the level of alanine aminotransferase (*p* = 0.016) and alkaline phosphatase (*p* = 0.025) was significantly diminished in the experimental group in comparison with the control group.

## Discussion

Our randomised clinical trial study showed that two months of consumption of sesame seeds had significantly reduced the serum levels of fasting blood glucose, glycosylated haemoglobin (HbA<sub>1c</sub>), cholesterol and triglyceride in the experiment group in comparison to the control group, which makes sesame oil a viable substance in the co-treatment and management of diabetes.

In two consecutive studies by Aslam et al., they primarily evaluated the effect of sesame oil consumption on glycaemic control and cardiac, hepatic and renal biomarkers in rats. The first study concluded that sesame oil consumption significantly enhanced glycaemic control and hepatic stress biomarkers [11]. The second study, under the same subject, was a case-control study on 46 type 2 diabetes patients. In the experiment group, fasting blood glucose along with HbA<sub>1c</sub> had significantly decreased, while hepatic enzymes, such as superoxide dismutase, catalase and glutathione peroxidase, had significantly increased in comparison to the control group [10]. In a similar study by

Shahi et al., they evaluated the effect of sesamin supplementation on glucose control, inflammatory cytokines and serum adiponectin. They concluded that sesamin supplementation can significantly decrease the fasting blood sugar, HbA<sub>1c</sub> and serum levels of cytokines such as IL-6. It also increased serum adiponectin in the experiment group compared to the control group [15]. A systematic review on the effects of consumption of sesame seeds and their derivatives on oxidative stress indicated that despite the blinding and randomisation biases in the evaluated study, sesame seed consumption can improve the antioxidant capacity [16]. It should be duly noted that this systematic review was performed on studies that were published before 2014, and several studies, such as the studies mentioned above, have been conducted afterwards.

In a similar animal study conducted by Heidari et al. on comparison of the effects of sesame butter (Ardea) and sesame oil, they concluded that both have increased HDL, total antioxidant capacity (TAC) and malondialdehyde (MDA) while reducing serum glucose [17]. Another study compared the effects of canola and sesame oil on glucose control and liver function in diabetic patients. This study reported that sesame oil can significantly decrease beta-cell function along with gamma glutamyl transferase (GGT). They concluded that sesame oil consumption is more effective in the improvement of glycaemic control in comparison to canola oil consumption [18]. A similar case-control study evaluated the effect of a blend of sesame and rice bran oil on hyperglycaemia and the lipid profile of type 2 diabetes patients. This blend reduced HbA<sub>1c</sub> and improved the lipid profile of these patients [19].

One recent animal study evaluated the effectiveness of sesamin on cognitive decline in diabetic rats. Spatial cognitive decline, neural loss and elevated apoptotic index were seen in these rats. Sesamin therapy was as effective as insulin therapy in the improvement of these symptoms [20]. Few studies have investigated the therapeutic effect of sesame seeds on factors other than glycaemic control. Further evaluations may reveal other potential effects of this plants.

An important case-control study investigated the synergistic effect of sesame oil consumption with an antidiabetic drug in diabetic patients. Glibenclamide and sesame oil combination therapy improved glycaemic control by 36% and reduced HbA<sub>1c</sub> by 43% in the combination therapy group compared to monotherapy groups. Total cholesterol and triglycerides were also significantly decreased in the combination therapy group. Antioxidant activity was also significantly increased [21]. There is a lack of evidence in literature regarding the interaction of anti-diabetic drugs and medicinal plants. Further studies should investigate this potential synergistic interaction to increase the effectiveness of both chemical drugs and medicinal plants [22].

Although a statistically significant difference was found between age and diabetes duration in the experimental and control groups, other similar studies have not reported the mean age in experimental and control groups. Important factors that should not be significantly different in both groups, according to other studies, are mean body weight, height and body mass

index (BMI), which, in our study, were not significantly different in the experimental group in comparison to the control group. Further studies should investigate the effect of age in both experimental and control groups regarding the efficacy of sesame seed consumption in lowering fasting blood glucose, glycosylated haemoglobin, cholesterol, triglyceride, alanine aminotransferase and alkaline phosphatase [10, 14, 15, 18, 19].

## Conclusions

The results of this study indicate the beneficial effects of sesame seeds on fasting blood glucose, glycosylated haemoglobin, cholesterol, triglyceride, alanine aminotransferase and alkaline phosphatase. Due to the high prevalence of type 2 diabetes and its known complications, sesame seeds could be consumed as a supplement to reduce blood glucose and some chemical metabolites.

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Conflicts of interest: The authors declare no conflicts of interest.

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