Research article

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The consumption of tahini meal regulates hemodynamic parameters in type 2 diabetes patients postprandially

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ABSTRACT

Aim: Tahini (sesame paste) is rich in polyunsaturated fatty acids and polyphenols, mainly lignans (sesamine, sesamolin, sesamol). Given the gap in literature, the aim of the present study was to investigate the effect of tahini meal consumption on hemodynamic parameters in type 2 diabetes mellitus (T2DM) patients postprandially.
Patients and methods: The study involved 12 T2DM patients with well-controlled blood glucose levels (HbA1c<7%) and stable antidiabetic treatment over the previous three months, excluding insulin treatment. Following an overnight fast, participants underwent baseline hemodynamic assessments before consuming either a test meal (two slices of bread with 50g of tahini) or a control meal (two slices of bread with 46g of margarine and 38.2g of cheese). The meals, matched for overall nutritional content but differing in fatty acid composition and fiber levels, were administered in random order. Hemodynamic parameters were reassessed 4 h after meal consumption.
Results: A statistically significant increase in flow-mediated dilatation was observed at the end of the intervention compared to baseline, after consuming both tahini **(p=0.022)** and control meal **(p=0.038)**. Systolic blood pressure (SBP) increased 4h postprandially compared to baseline after control meal **(p=0.042)**. No significant differences in SBP were observed either after tahini meal or between the 2 meals at the end of the trial. No changes were observed in other indices measured at the end of the intervention compared with baseline.
Conclusions: The consumption of a meal with tahini may exhibit a cardioprotective effect in T2DM patients, suggesting a good choice for breakfast or snack.

KEY WORDS: *Tahini; diabetes; blood pressure; endothelial function; FMD*

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INTRODUCTION

Cardiovascular disease (CVD) remains the leading cause of death and disability, despite the steady decrease in the global burden that is evident in developed countries over

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the last years. CVD is responsible for approximately one of every four deaths in Europe and one of every three deaths in the United States[1,2]. The significant global impact of CVD, even with advancements in treatment, highlights the critical need for effective prevention and intervention strategies to curb this prevalent condition. Accounting for nearly one-third of worldwide mortality, dietary risk factors stand out as a key target for CVD prevention and management[3].

Studies have shown that sesame, a seed rich in polyunsaturated fatty acids, proteins, vitamins, and lignans, such as sesamin, sesamolin and sesamol[4] has important antihypertensive properties[5,6], reducing the risk of CVD.

Regarding tahini, a recent cross-over clinical trial[7] showed that 50 g of tahini consumption led to significant reduction of diastolic blood pressure (DBP), pulse rate and an increase in endothelial function in healthy males. Similarly, another clinical trial conducted in patients with type 2 diabetes mellitus (T2DM) showed a decrease of atherogenic index of plasma (AIP) after tahini consumption for six weeks[8]. The aim of the current study was to investigate the potential effects of tahini meal consumption on hemodynamic parameters in T2DM patients, postprandially.

MATERIALS AND METHODS

Study design and sample collection

Men and postmenopausal women with T2DM (minimum interval since diagnosis 3 y), selected from the diabetes outpatient clinic of "Laiko" University Hospital (Athens Medical School) were recruited to the study. Diagnosis of diabetes was based on the American Diabetes Association criteria[9]. Recruitment was based on the following inclusion criteria: age 40 to 65 y, good glycemic control (HbA1c<7%) and stable antidiabetic treatment at least 3 months before screening (no insulin treatment). Exclusion criteria were alcohol or drug abuse, any medication or vitamin/mineral supplementation or alternative diet (vegetarian, macrobiotic, etc.), recent use of antibiotics, and history of any chronic disease prior to the study. After a full explanation of the study protocol, all patients provided written consent and completed appropriate privacy authorization. The research protocol was approved by Harokopio University Research Bioethics Committee (34th Meeting of 19/11/2021). All procedures were compliant with the Declaration of Helsinki. The trial was registered with ClinicalTrials.gov, where the full trial protocol can be accessed (Identifier: NCT05396079).

Prior to the trial, participants were instructed to abstain from the consumption of foods rich in antioxidant content and vigorous exercise for three days. Then, after an overnight fast (10-12 h), participants came to the lab and, after a 10-min resting period in the supine position in a quiet room with temperature a constant 20-25°C, assessment of blood pressure (BP), pulse rate, hemodynamic parameters and endothelial function was performed (0 h). Using the randomized cross-over design, the tahini meal and the control meal were provided in random order on separate occasions with a minimum of three days between each visit. The tahini meal included 2 slices of white bread and 50 g of tahini while the control meal consisted of 2 slices of white bread, 46 g of margarine και 38.2 g of low-fat cheese. Assessment of hemodynamic parameters was repeated at the end of the trial (4 h postprandially). During the trial, subjects were not allowed to eat or drink anything apart from water. The nutritional value of the 2 meals is presented in Table 1.

Measurements

Blood pressure

After a 10-min rest in the laboratory, BP at the brachial artery was measured using an appropriate cuff three consecutive times at 5-min intervals with the participant in a seated position.

Central blood pressure and augmentation index

Assessment of central BP and augmentation index (Aix) was performed by the technique of pulse-wave analysis with a validated noninvasive device (SphygmoCor, AtCor Medical, Sydney, Australia), as previously described[10]. In summary, all participants were examined in the supine position after an acclimatization period of about 20 min. Measurements were performed on the radial artery with the wrist at the heart level by a high-fidelity Millar micromanometer (SPC-301, Millar Instruments, Inc., Houston, TX). Radial waveforms calibrated from the measured brachial SBP and DBP were used for the determination of central BP. After 20 sequential stable radial waveforms were ac-

TABLE 1. Nutritional value of the two meals.

	TAHINI MEAL	CONTROL MEAL
Energy (kcal)	458.0	445.5
Total fat (g)	30.5	30.9
Saturated fat (g)	5.5	8.4
Carbohydrates (g)	24.4	23.4
Sugars (g)	2.7	2.0
Proteins (g)	17.4	17.4
Fibers (g)	6.3	1.2

quired, the SphygmoCor System Software generated an average peripheral and corresponding central-ascending aortic-pressure waveform, which was subjected to further analysis to determine Aix (the ratio of the augmentation pressure over the PP).

Carotid-radial and carotid-femoral pulse-wave velocity

Carotid-radial and carotid–femoral pulse-wave velocity *(*PWV) were calculated from measurements of pulse transit time and the distance traveled between two recording sites [PWV=distance (m)/transit time (s)] using a validated noninvasive device (SphygmoCor, AtCor Medical, Sydney, Australia), as previously described[11,12]. Two different pulse waves were obtained (at the base of the neck for the common carotid and over the right radial or femoral artery) with transducers. Distance was defined as (distance from sternal notch to radial or femoral artery)-(distance from radial or carotid artery to sternal notch) and PWV was expressed in m/s.

Flow-mediated dilatation

A B-mode high-resolution ultrasound imaging (Vivid 7 Pro, GE Healthcare, Little Chalfont, UK) was used for assessment of Flow-mediated dilatation (FMD), as previously described[13]. Briefly, measurements were obtained from the right brachial artery at a specific anatomic point. The measurement of the arterial diameter was performed manually by two independent observers who were unaware of the study aims, at end diastole, using electronic calipers. The procedure was guided by electrocardiographic assessment. After initial measurement at resting conditions, a cuff fitted 8 cm distal to the brachial artery and near the wrist was inflated to 250-300mmHg, altering arterial flow for 5min. Then, after cuff deflation, which increased arterial flow (reactive hyperemia), there was a continuous scan for 90sec, and the maximal resting diameter of the vessel at the same point was defined again (diameter during reactive hyperemia). FMD is typically expressed as the change in post-stimulus diameter as a percentage of the baseline diameter.

Statistical analysis

Statistical analysis was performed using the statistical package SPSS (SPSS for Windows, version 25.0, SPSS Inc., Chicago, IL, USA). Normality of variables was assessed using the Kolmogorov-Smirnov test. The differences in concentrations of biomarkers between time 0 and time 4 h after each meal consumption were assessed by Paired-samples T-test. The differences between the two meals were assessed by the independent sample t test. Level of significance was set at $p<0.05$. Data are shown as mean ± standard deviation (SD) or standard error of mean (SEM).

RESULTS

Twelve patients with type 2 diabetes were included in the study. They had mean age of 65.0±8.4 y, mean BMI of 84.4±12.7 kg/m^2, and 66% of them were nonsmokers (Table 2). All biochemical markers were within normal range at baseline (Table 3). A statistically significant increase in FMD was observed at the end of the trial compared with time 0 h for both meals (6.29±2.67 vs 8.64±3.23, p=0.022, and 6.08±3.03 vs 7.68±3.23, p=0.038, respectively) (Fig. 1). However, no differences were observed between the two meals. SBP was found to be significantly higher 4 h after consumption of the control meal compared with baseline (122.50±11.94 vs 126.08±12.14, p=0.042) (Fig. 2). Central BP, Aix and PWV were not affected by consumption of either tahini or control meal (Table 4).

DISCUSSION

This is the first postprandial study to examine the effect of a tahini meal on hemodynamic parameters in patients with type 2 diabetes. The results of our study indicated that an acute dietary intervention with a meal containing 50 g of tahini led to an increase in FMD after the intervention, suggesting a positive contribution of tahini consumption to endothelial function. Additionally, SBP increased significantly 4 h after consumption of the control meal compared with baseline, while no differences were observed regarding tahini meal, suggesting a possible protective effect of tahini against hypertension development.

Our study showed that tahini meal consumption increased FMD 4 h postprandially. In a recent postprandial

TABLE 2. Baseline characteristics of the study participants.

N	**12**
men	**5**
women	**7**
Age (y)	65.0±8.4
MedDietScore	33.9±4.9
Smoking (n, %)	4 (33)
Height (cm)	165.50±8.08
Body weight (kg)	84.43±12.70
Body mass index (kg/m^2)	30.87±4.27
Waist circumference (cm)	104.57±10.79
Hip circumference (cm)	110.57±0.33
Fat mass (%)	36.01±9.04

TABLE 3. Baseline biochemical markers of the study participants.

Fasting glucose (mg/dL)	120.75±34.93
HbA1c (%)	6.48±0.67
Total cholesterol (mg/dL)	146.67±39.48
HDL cholesterol (mg/dL)	47.36±10.78
LDL cholesterol (mg/dL)	73.09±38.19
Triglycerides	129.42±43.24
SGOT (U/L)	16.55±4.13
SGPT (U/L)	18.00±8.50
γGT (U/L)	26.50±17.43
Alkaline phosphatase (U/L)	64.17±29.00
Urea (mg/dL)	43.17±19.56
Creatinine (mg/dL)	0.85±0.34
Uric acid (mg/dL)	5.62±1.22

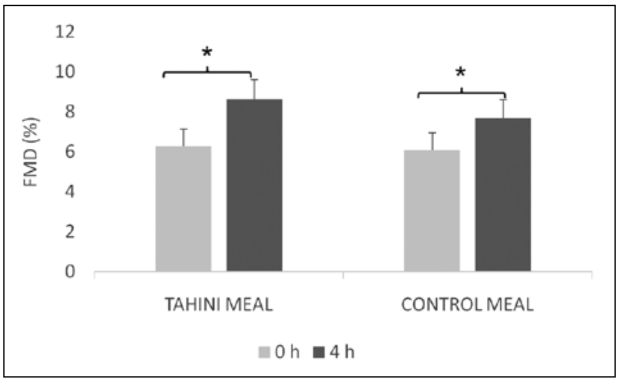

FIGURE 1. Flow-mediated dilatation (FMD) (mean±SEM) at baseline (0 h) and following the two meals (4 h). Statistical significance ($p<0.05$) is indicated by *.

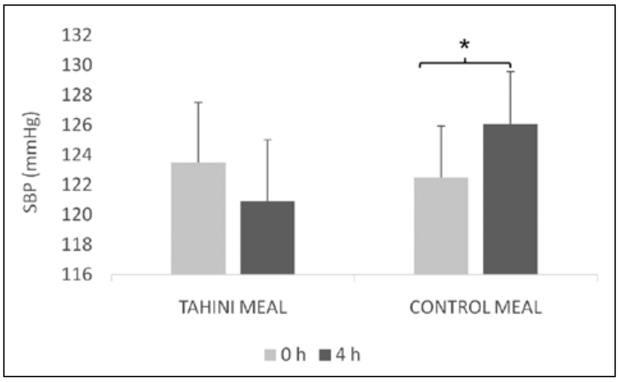

FIGURE 2. Systolic blood pressure (SBP) (mean±SEM) at baseline (0 h) and following the two meals (4 h). Statistical significance ($p<0.05$) is indicated by *.

study involving 20 healthy men, tahini consumption led to a statistically significant increase in FMD 4 h postprandially compared to baseline, highlighting its potential cardioprotective benefits[7]. In addition, a study by Karatzi et al. evaluated the impact of sesame oil on endothelial function both short- and long-term and found that consumption of 35 g of sesame oil could increase FMD 2 h postprandially in hypertensive men[14].

Other foods with similar lipid profile have also been studied, concluding to similar results. In a cross-over study of 24 men and women with type 2 diabetes, the consumption of walnut-enriched ad libitum diet, including 56 g (366 kcal) walnuts/day led to significant increase in FMD compared with ad libitum diet without walnuts, for 8 weeks[15]. Similarly, Cortés et al. showed that adding walnuts to a high-fat meal acutely improves FMD independently of changes in oxidation, inflammation, or plasma asymmetric

TABLE 4. Differences in hemodynamic parameters before (0 h) and after (4 h) meal consumption (mean±SD).

	TAHINI MEAL			CONTROL MEAL			
Variable	**0 h**	**4 h**	**p-value**	**0 h**	**4 h**	**p-value**	***p-value**
Systolic BP (mmHg)	123.50±13.98	120.92±14.23	0.455	122.50±11.94	126.08±12.14	**0.042**	0.108
Diastolic BP (mmHg)	72.67±8.36	72.25±9.99	0.783	73.75±7.86	72.58±9.15	0.493	0.738
Pulse rate (min^{-1})	63.33±7.35	63.58±9.68	0.870	62.08±9.30	62.50±9.15	0.649	0.925
PWV carotid-radial (m/s)	7.07±0.62	7.34±0.57	0.139	7.27±0.75	7.34±0.90	0.667	0.401
PWV carotid-femoral (m/s)	8.28±1.46	8.44±2.06	0.488	8.69±1.61	8.74±1.54	0.858	0.736
Central pressure (mmHg)	117.67±14.40	114.58±16.53	0.399	115.25±13.07	117.83±14.10	0.132	0.156
Augmentation index (%)	26.75±6.80	28.13±10.61	0.540	26.33±8.23	26±8.53	0.815	0.514
FMD (%)	6.29±2.67	8.64±3.22	**0.022**	6.08±3.03	7.68±3.23	**0.038**	0.471

p-value: Differences before (0 h) and after (4 h) each meal consumption
*p-value: Differences between the two meals
Level of significance $p<0.05$.

dimethylarginine (ADMA) in both healthy patients and patients with hypercholesterolemia[16]. In an older cross-over study of 21 hypercholesterolemic men and women, substitution of walnuts for monounsaturated fat to provide approximately 32% of the energy in a Mediterranean diet improved endothelium-dependent vasodilation after 4 weeks[17]. Contrary to the abovementioned results, a study involving 20 patients with metabolic syndrome did not find significant changes in endothelial function following a meal with pistachios[18].

Moreover, results herein indicated that the consumption of a control meal led to increase in SBP at the end of the trial. However, SBP after consumption of tahini meal did not differ significantly, revealing a potential protective role of tahini against hypertension. Several studies have suggested that tahini or other sesame products may exert cardioprotective properties. Recently, Sakketou et al. showed that the consumption of 50 g of tahini led to a significant reduction of DBP in healthy males, 4 h postprandially[7]. Similarly, in a study of 75 patients with metabolic syndrome, sesame oil consumption for 8 weeks led to a significant improvement of both SBP and DBP levels[19]. In addition, another study of 22 women and 8 men found that consumption of black sesame seed for 4 weeks decreased SBP at the end of the trial, suggesting possible antihypertensive effects of black sesame meal[6].

While the findings of this study appear promising in the context of CVD prevention, they should be interpreted with caution. Firstly, SBP remained stable following the tahini meal, which does not directly support a risk reduction effect; the conclusions are drawn from comparisons with the control meal, which showed an increase in SBP 4 h postprandially. Secondly, although the tahini meal improved FMD 4 h after consumption, similar results were also observed after consumption of the control meal. Therefore, further research is needed to investigate these effects in greater depth, aiming to confirm or refute these findings and identify specific components in the tahini meal that may contribute to the observed effects.

Strengths and limitations

Several strengths of the study should be noted. The study used complete meals rather than single food items. This approach more closely replicates real-world dietary patterns, providing findings that are more applicable to everyday eating habits. The cross-over design of the study allowed each participant to serve as their own control minimizing inter-participant variability, making it possible to detect treatment effects with greater precision. Additionally, the cross-over approach increases statistical power, enabling more robust results with a small sample size, which was especially advantageous given the limited availability of participants. These factors collectively strengthen the reliability and applicability of our findings.

However, the current study has also some limitations. The small sample size may limit the extent to which these findings can be generalized to larger populations. Additionally, without a chemical analysis of tahini, it is uncertain whether the observed effects can be attributed to specific components, such as lignans.

CONCLUSIONS

The results of our study suggest that tahini consumption as part of a meal may have beneficial effects on endothelial function and blood pressure in T2DM patients, indicating a potential cardioprotective effect. Thus, tahini could serve as a nutritious snack alternative to other options with less favorable lipid profiles and as a valuable tool for dietitians in promoting healthy dietary habits and managing chronic diseases.

Conflict of Interest

The authors declare no conflict of interest.

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ΠΕΡΙΛΗΨΗ

Η κατανάλωση γεύματος με ταχίνι μπορεί να ρυθμίσει αιμοδυναμικές παραμέτρους σε ασθενείς με σακχαρώδη διαβήτη τύπου 2 μεταγευματικά

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Σκοπός: Το ταχίνι (πάστα σουσαμιού) είναι πλούσιο σε πολυακόρεστα λιπαρά οξέα και πολυφαινόλες, κυρίως λιγνάνες (σεσαμίνη, σεσαμολίνη, σεσαμόλη). Δεδομένου του κενού στη βιβλιογραφία, σκοπός της παρούσας μελέτης ήταν να διερευνήσει την επίδραση της κατανάλωσης γεύματος με ταχίνι σε αιμοδυναμικές παραμέτρους σε ασθενείς με σακχαρώδη διαβήτη τύπου 2 (ΣΔ2) μεταγευματικά.

Ασθενείς και μέθοδοι: Στη μελέτη συμμετείχαν 12 ασθενείς με ΣΔ2 με καλά ελεγχόμενα επίπεδα γλυκόζης (HbA1c<7%) και σταθερή αντιδιαβητική αγωγή τους προηγούμενους τρεις μήνες (μη χορήγηση ινσουλίνης). Μετά από ολονύκτια νηστεία, οι συμμετέχοντες υποβλήθηκαν σε αξιολόγηση των αιμοδυναμικών παραμέτρων πριν από την κατανάλωση είτε του υπό εξέταση γεύματος (δύο φέτες ψωμί με 50 g ταχίνι) είτε του γεύματος ελέγχου (δύο φέτες ψωμί με 46 g μαργαρίνης και 38,2 g τυριού). Τα γεύματα, τα οποία είχαν παρόμοια διατροφική σύσταση αλλά διέφεραν ως προς τη σύνθεση των λιπαρών οξέων και την περιεκτικότητά τους σε φυτικές ίνες, χορηγήθηκαν με τυχαία σειρά. Οι αιμοδυναμικές παράμετροι επαναξιολογήθηκαν 4 ώρες μετά από την κατανάλωση των γευμάτων.

Αποτελέσματα: Παρατηρήθηκε στατιστικά σημαντική αύξηση στην ενδοθηλιο-εξαρτώμενη αγγειοδιαστολή στο τέλος της παρέμβασης σε σύγκριση με τον χρόνο 0 έπειτα από την κατανάλωση τόσο του γεύματος με ταχίνι (p=0,022) όσο και του γεύματος ελέγχου (p=0,038). Η συστολική αρτηριακή πίεση (ΣΑΠ) αυξήθηκε 4 ώρες μετά το γεύμα ελέγχου σε σύγκριση με την αρχική τιμή (p=0,042). Δεν παρατηρήθηκαν σημαντικές διαφορές στη ΣΑΠ είτε μετά το γεύμα με ταχίνι είτε μεταξύ των 2 γευμάτων στο τέλος της δοκιμής. Δεν παρατηρήθηκαν αλλαγές στους υπόλοιπους δείκτες που μετρήθηκαν στο τέλος της παρέμβασης σε σύγκριση με την αρχική τιμή.

Συμπεράσματα: Η κατανάλωση ενός γεύματος με ταχίνι μπορεί να επιδείξει καρδιοπροστατευτική δράση σε ασθενείς με ΣΔ2, προτείνοντας μια καλή επιλογή για πρωινό ή σνακ.

ΛΕΞΕΙΣ ΚΛΕΙΔΙΑ: *Ταχίνι, Διαβήτης, Αρτηριακή πίεση, Ενδοθηλιακή λειτουργία, FMD*

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