Wydawnictwo UR 2024
ISSN 2544-1361 (online)
doi: 10.15584/ejcem.2024.4.11

http://www.ejcem.ur.edu.pl
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2024; 22 (4): 763–769

ORIGINAL PAPER

The relationship between the consumption of traditional Turkish brewing style coffee and other brewing style coffee and HbA1c levels in patients with type 2 diabetes

Rumeysa Önal Tatar [1], Esra Meltem Koç [2]

[1] Family Medicine Department, Balıkesir Atatürk State Hospital, Balıkesir, Türkiye
[2] Department of Family Medicine, İzmir Katip Çelebi University School of Medicine, İzmir, Türkiye

ABSTRACT

Introduction and aim. To investigate the relationship between the consumption of traditional Turkish brewing style coffee and other brewing style coffee and hemoglobin A1c:glycated hemoglobin (HbA1c) levels in patients with type-2 diabetes mellitus.

Material and methods. One hundred fifty patients were included in the study. The research sample was obtained from a family health center that called İzmir Karşıyaka 16 -Family Health Center in İzmir-Türkiye. Sociodemographic characteristics, medications, diet, nutritional status, self-reported health status, and consumption of Turkish and other coffee consumption style and other beverages of the patients were recorded. HbA1c, high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglyceride, total cholesterol, and fasting plasma glucose levels in the previous year were obtained from medical records. All patients had their HbA1c readings taken on quarterly basis. In addition, routine blood tests, including HbA1c measurements, were conducted every six months as part of the regular follow up at the family health center. The International Physical Activity Questionnaire (IPAQ) was used to evaluate the daily physical activities of the patients.

Results. The median HbA1c value of the group taking oral antidiabetic drugs was significantly lower than the median HbA1c value of the group using insulin (p=0.012). There was no significant difference in HbA1c levels regarding missing a meal, drinking coffee (sugar-free or not), and physical activity (p>0.05). Correlation analysis showed a significant weak relationship between the amount of Turkish coffee consumption per week and fasting blood glucose level (p=0.041, r=-0.088). There was a negative weak and significant relationship (p<0.05) between HbA1c levels and the amount of Turkish coffee consumption per week (p=0.014). In the exponential regression model, coffee consumption per week explained the HbA1c level in proportion to 2.9% (F=4.386; p=0.038).

Conclusion. Consumption of Turkish coffee was inversely correlated with fasting glucose and HbA1c levels. Future studies are needed to determine the effect of coffee in the treatment of diabetes mellitus.

Keywords. blood glucose, coffee, diabetes mellitus, fasting glucose level, glycated hemoglobin A, physical activity

Introduction

This study investigates the consumption of coffee prepared in the traditional Turkish style, which involves a unique brewing method, and the consumption of other types of coffee. The term 'Turkish and other coffee consumption style' refers to these distinctions. The effects of these different coffee consumption styles on hemoglobin A1c:glycated hemoglobin (HbA1c) levels in patients with type 2 diabetes are examined. Traditional Turkish coffee is prepared using finely ground Arabica

Corresponding author: Rumeysa Önal Tatar, e-mail: ronalsa@gmail.com

Received: 21.02.2024 / Revised: 5.06.2024 / Accepted: 10.06.2024 / Published: 30.12.2024

Tatar RÖ, Koç EM. The relationship between the consumption of traditional Turkish brewing style coffee and other brewing style coffee and HbA1c levels ın patients with type 2 diabetes. *Eur J Clin Exp Med.* 2024;22(4):763–769. doi: 10.15584/ejcem.2024.4.11.

beans boiled in a special pot called a cezve, resulting in a distinctive flavor and higher levels of bioactive compounds compared to other brewing methods.[1]

Diabetes mellitus (DM) is one of the most important health problems and it is one of the leading causes of death. Nearly half a billion people have DM worldwide and the global diabetes prevalence is estimated to be 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045.[2] Factors that cause an increase in the frequency of diabetes mellitus are rapid population growth and prolongation of life expectancy, increase in the prevalence of the obesity due to urbanization and decrease in physical activity. Due to the risk factors like age, lacking physical activity and obesity diet-based strategies are an important part of medical treatment. Therefore, the use of natural compounds for diet regimens in DM has gained much attention for a long time. In this manner, evidence-based literature data has been expanded in recent years.[3,4]

Coffee is one of the most consumed drinks in the world and coffee consumption increases gradually due to suggested beneficial effects. Along with protective effects on the cardiovascular system, favorable outcomes on some diseases including type 2 diabetes mellitus, non-alcoholic fatty liver disease, liver cancer, gout, kidney stones, and Parkinson's disease were investigated in the literature.[5,6] Although the biological mechanism of the inverse relationship between diabetes and coffee consumption is not fully known, several different mechanisms are proposed.[6,7] Some studies suggest that its positive effects on chronic diseases may be due to the antioxidant effects via various pathways.[8] It contains vitamins and minerals such as ascorbic acid, riboflavin, niacin, folic acid, pantothenic acid, magnesium, potassium, manganese, and fluoride.[9] Also, it contains polyphenols (hydroxycinnamic acids); which are supposed to be the best candidate for the beneficial effects of coffee and tea consumption on various metabolic disorders.[10] The effects of polyphenols (active dietary chlorogenic acid) in the prevention of chronic diseases are attributed to their ability to improve endothelial function and suppress vascular endothelial cell expression of proinflammatory cytokines.[11]

Many studies have shown that coffee consumption can reduce the risk of developing type-2 diabetes in a dose-dependent manner.[5,12,13] High coffee consumption is associated with higher insulin secretion, insulin sensitivity, and β-cell function.[5,14] Chlorogenic acid, one of the most important phenolic components in coffee was shown to have antihyperglycemic effects.[6] Another possible mechanism related to the antihyperglycemic effect is the inhibition of sodium-dependent glucose transporters in the gut. Another hypothesis to explain the relationship between coffee and type 2 DM is the idea that chlorogenic acid competes with the glucose-6-phosphate translocase enzyme, inhibiting its activity and reducing intestinal glucose absorption.[15] Another possible mechanism is explained by adiponectin. Intake of caffeine, polyphenols, and metabolites is significantly associated with levels of adiponectin, an important regulator of insulin sensitivity and tissue inflammation.[16] It is suggested that magnesium, one of the components of coffee, also contributes to this effect by increasing insulin sensitivity.[17] Coffee may also affect the secretion of gastrointestinal peptides such as glucagon-like peptide 1 and gastric inhibitory polypeptide.[18,19]

Aim

There are a lot of studies about coffee intake that have beneficial effects on type-2 DM prevalence and glycemic control. So, we aimed to investigate whether Turkish coffee consumption would affect the HbA1c levels in patients with type-2 DM.

Material and methods

Our research was a cross-sectional-descriptive type. The sample size was 80% power with, a 5% margin of error and 50% unknown frequency since no similar study was conducted in our country before. With a 5% deviation, it was calculated that at least 150 patients should be recruited to study. Patients with type-2 DM whose medical records included HbA1c, high-density lipoprotein (HDL), low-density lipoprotein (LDL), total cholesterol, triglyceride, and fasting plasma glucose values in the previous year were included in the study. Type 1 DM patients, patients who reject to study, pregnant and, <18 years of age were excluded from the study.

Before the study approval of the local ethical committee was obtained (Clinical Research Ethics Committee of the Faculty of Medicine at İzmir Katip Çelebi University in June 2021 with the code 2605). The participants were first informed about the study, and verbal and written consent of the volunteers was obtained. A 34-question sociodemographic data questionnaire, liquid consumption questionnaire, and international physical activity test prepared by the researchers in line with the relevant literature, were applied to the participants by face-to-face interview technique. Participants' age, gender, employment status, marital status, income status, smoking, chronic diseases, health status, medications, the time of diagnosis with DM, diet, nutritional status, and the number of meals were examined. Height and weight measurements of the participants and body mass index (BMI) were recorded. Consumption of Turkish coffee, granulated coffee, espresso, coffee with milk, black tea, green tea, cold tea, cola, and energy drink with their amount and frequency were questioned, which was formed by the researchers in line with the relevant literature. The International Physical Activity Questionnaire (IPAQ) was used to evaluate the dai-

ly physical activities of the patients. This questionnaire provided information about sitting, walking, moderately vigorous activities, time spent in vigorous activities, and physical activity levels are determined by grouping individuals according to this information. International validity and reliability studies were carried out by Craig et al.[20] The Turkish versions of the IPAQ short and long forms are reliable and valid in the assessment of physical activity.[21] The biochemical values and HbA1c levels of the patients in the previous year were screened from the medical records.

Statistical analysis

All data were analyzed using SPSS 23.0 package program (IBM, Armonk, NY, USA). The numeric variables were presented as mean and standard deviations; categorical variables were presented as numbers (n) and percentages (%). Normality assumption was tested with Kolmogorov-Smirnov and Shapiro-Wilk test. Continuous data that did not show normal distribution were tested for their conformity to the normal distribution by data transformation. Mann-Whitney U test was used for pairwise comparisons. The Kruskal-Wallis test was used to compare more than two independent groups. Post hoc Dunn's test was used for within-group comparisons when a significant difference was detected in the comparison of multiple groups. While examining the relationship between measurement-based numerical data, Pearson and Spearman's correlation analysis was carried out according to whether or not conditions were met or not for Pearson correlation. ETS exponential regression analysis was conducted to evaluate the extent of the relationship between continuous variables. For all analysis results, the significance level of $p < 0.05$ was accepted.

Results

Sociodemographic features of the patients are presented in Table 1.

Self-declaration of the health status of the patients is shown in Table 2. Most of them (73.3%) thought that their health status was fair. 84% of patients have been using only oral antidiabetic. Adaption to the diet list was only 29.3%. The prevalence of following a diet recommended by a doctor or a dietician perpetually was 20%. Regular medication use for DM was 70.3% (Table 2).

59.3% of the patients said that they consumed three main meals a day, and 72.7% had consumed less than three snacks a day, 48% did not miss a meal. 57% of the patients said they consumed fruit every day, and 66% of them said they consumed vegetable food every day. The consumption of black Turkish coffee ratio was 60.7% among patients. It was observed that 75.3% of the patients consumed other kinds of black coffee. The prevalence of drinking sugar-free tea was 66.7. Water consumption of less than 3 L/per day among patients was 80%. The nutritional habit of the patients is presented in Table 3.

Table 1. Distribution of sociodemographic characteristics of individuals

		Mean±SD
Age		61.69±12
Height (cm)		166.5±8.59
Weight (kg)		83.23±15.95
BMI (kg/m^2)		30.05±5.6
		n (%)
Gender	Male	61 (40.7)
	Woman	89 (59.3)
What is your education status?	Illiterate	12 (8)
	literate	13 (8.7)
	Primary school	73 (48.7)
	Middle school	19 (12.7)
	High school	21 (14)
	University	12 (8)
What is your working status?	Working	23 (15.3)
	Retired	87 (58)
	Not working	40 (26.7)
What is your marital status?	Married	114 (76)
	Single	1 (0.7)
	Divorced	10(6.7)
	Widow	25 (16.7)
Your income status?	Equal to my expenses	127 (84.7)
	Less than my expenses	19 (12.7)
	More than my expenses	4 (2.7)
Smoking	Yes (1 or more per day)	34 (22.7)
	I am a social drinker (less than 1 per day)	10 (6.7)
	No	106 (70.7)
Total		150 (100)

Table 2. Information about the health status of individuals

		n (%)
How do you think your health is?	Very good	1 (0.7)
	Good	31 (20.7)
	Fair	110 (73.3)
	Poor	7 (4.7)
	Very poor	1 (0.7)
What do you use to treat diabetes?	Oral antidiabetic	126 (84)
	Oral antidiabetic + insulin	20 (13.3)
	Insulin	4 (2.7)
Duration of diagnosis of DM	≤9 years	89 (59.3)
	≥10 years	61 (40.7)
Have you received a diet list before?	Yes	102 (68)
	No	48 (32)
Do you follow your diet list?	Yes	44 (29.3)
	No	106 (70.7)
Do you follow a diet recommended by your doctor or dietician in the treatment of diabetes?	Yes	30 (20)
	Sometimes	86 (57.3)
	None	34 (22.7)
Do you use your medications regularly in the treatment of diabetes?	Yes	119 (70.3)
	Sometimes	26 (17.3)
	none	5 (3.3)
Total		150 (100)

Table 3. Nutritional habits of individuals

		n (%)
How many main meals do you have a day?	Less than 3 meals	53 (35.3)
	3 meals	89 (59.3)
	More than 3 meals	8 (5.3)
How many snacks do you have a day?	Less than 3 meals	109 (72.7)
	3 meals	31 (20.7)
	More than 3 meals	10 (6.7)
If you miss a meal, which meal do you miss?	Morning	6 (4)
	Noon	68 (45.3)
	Evening	4 (2.7)
	None	72 (48)
Do you consume fruits every day?	Yes	86 (57.3)
	Sometimes	59 (39.3)
	None	5 (3.3)
Do you consume vegetables every day?	Yes	99 (66)
	Sometimes	47 (31.3)
	None	4 (2.7)
How do you consume your Turkish coffee?	Simple	91 (60.7)
	Low sugar	28 (18.7)
	Middle	21 (14)
	Sugary	10 (6.7)
How do you consume your coffee (other kinds of coffee)	Simple	113 (75.3)
	Sugary	37 (24.7)
How do you consume your tea?	Simple	100 (66.7)
	Sugary	50 (33.3)
How many liters of water do you consume per day?	Less than 3 liters	120 (80)
	3 liters	24 (16)
	More than 3 liters	6 (4)
Total		150

The HbA1c levels of the individuals were compared according to the duration of DM, having a diet list, compliance with the diet list, following a diet list recommended by a doctor or a dietician, and individual perception of their health. There was no difference between the groups (p>0.05) (Table 4). However, when we compared HbA1c levels were compared according to the medication used in the treatment of DM; diabetes, it was seen that the median HbA1c value of the group taking oral antidiabetic drugs was significantly lower than the median HbA1c value of the group using insulin (p=0.012). The International Physical Activity Questionnaire (IPAQ) was used to evaluate the daily physical activities of the patients. This questionnaire provided information about sitting, walking, moderately vigorous activities, time spent in vigorous activities, and physical activity levels are determined by grouping individuals according to this information. International validity and reliability studies were carried out by Craig et al.[19] The Turkish versions of the IPAQ short and long forms are reliable and valid in the assessment of physical activity.[21]

HbA1c levels according to the nutritional habits of individuals were shown in Table 6. There was no significant difference in terms of missing a meal, drinking coffee sugar-free or not, and physical activity questionnaire (p>0.05).

Table 4. List of how many people consume Turkish coffee and how many people consume other coffee consumption style

Beverage consumption	n	%
Turkish brewing style coffee (plain)	91	60.7
Other brewing styles coffee (plain)	113	75.3
Tea (plain)	100	66.7
Less than three liters of water per day	120	80

Table 5. Comparison of HbA1c levels of individuals according to their health status, diet status, and medications, physical activity

Category	n	Median (min–max)	p
Duration of diabetes diagnosis			
≤9 years	89	7.2 (5.3–13.8)	0.242
≥10 years	61	7.5 (5.3–15.4)	
Regular medication use for DM			
Yes	119	7.1 (5.3–13.8)	0.383
No	31	7.7 (5.9–15.4)	
Received a diet list			
Yes	102	7.5 (5.3–15.4)	0.283
No	48	6.9 (5.8–10.6)	
Physical activity			
Inactive	109	7.5 (5.3–15.4)	0.333
Minimally active	37	6.9 (5.3–11.6)	
Very active	4	7.55 (5.9–8.4)	

Table 6. HbA1c levels according to the nutritional habits of the patients (Kruskal-Wallis test)

		n	Median (min–max)	p
If you miss a meal, which meal do you miss?	Morning	6	7.45 (6.2–9.4)	0.384
	Noon	68	7.50 (5.7–15.4)	
	Evening	4	8.15 (6.3–9.4)	
	I'm not jumping	72	7 (5.3–13.5)	
How do you consume Turkish coffee?	Simple	91	7.6 (5.3–15.4)	0.311
	Low sugar	28	7.4 (5.7–11.6)	
	Middle	21	6.5 (5.6–9.9)	
	Sugary	10	6.9 (6–12.4)	
Physical activity questionnaire	Inactive	109	7.5 (5.3–15.4)	0.333
	Minimally active	37	6.9 (5.3–11.6)	
	Very active	4	7.55 (5.9–8.4)	

We used correlation analysis with the amount of Turkish coffee and BMI, fasting blood glucose, triglyceride, and physical activity score. It was found that there was a significant weak relationship between the amount of consumption of Turkish coffee/per week and fasting blood glucose level. (p=0.041, r=-0.088) (Table 7).

There was a negative, weak and significant relationship (p<0.05) between HbA1c levels and the amount of consumption of Turkish coffee per week (p=0.014). No significant relationship was found between HbA1c lev-

els and consumption of the amount of black tea, other coffees, other beverages per week, and physical activity levels (p>0.05) (Table 8).

Table 7. Correlation analysis of coffee consumption and health metrics*

Variable	BMI	Fasting blood glucose	HDL	Triglyceride	Physical activity
Turkish coffee (per week)	-0.088	-0.167	0.073	-0.018	0.056
p	0.284	0.041	0.377	0.828	0.493

* Spearman correlation analysis, BMI – body mass index, HDL – high-density lipoprotein

Table 8. Correlation analysis between HbA1c and the beverages consumed by individuals and weekly physical activities*

		Turkish coffee per week	Black tea per week	Other kinds of coffees per week	Other drinks per week	Physical activity
HbA1c level	r	-0.200	-0.071	-0.065	0.105	-0.107
	p	0.014	0.388	0.430	0.201	0.193

* Spearman correlation analysis

In the exponential regression model between Turkish coffee consumption amount (mL)/per week which has a negative relationship with the HbA1c level, coffee consumption amount/per week explained the HbA1c level in proportion to 2.9% (F=4.386; p=0.038) (Table 9).

Table 9. The role of Turkish coffee consumption in explaining the change in HbA1c level*

	B	Std. Error	β	t	F	R2_	p
	8,065	0.263		30.633			
Turkish coffee consumption/per week (mL)	0.0003	0.000143	-0.170	-2.094	4.386	0.029	0.038

* ETS exponential regression analysis

The relationship between HbA1c levels of the patients and coffee consumption/per week was demonstrated in Figure 1.

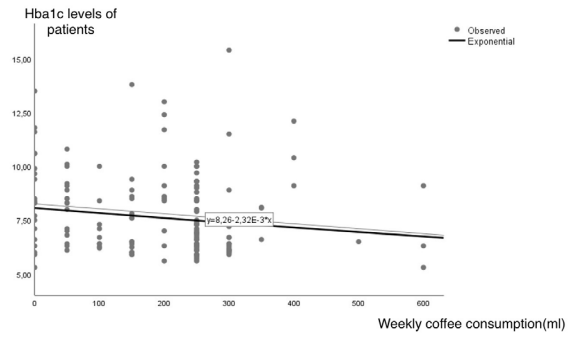

Fig. 1. Weekly coffee consumption (mL) (x), HbA1c levels of the patients (y)

Discussion

DM is one of the most important health problems today. Treatment of DM includes medications, diet, and lifestyle changes. Nutritional support especially has begun to be considered mainly in recent years become a rising field of interest for the treatment of DM.

Coffee is one of the most consumed beverages in our country as well as all over the world. Turkish coffee which is cooked with traditional techniques in our country takes an important place in the daily diet and social life of individuals in people of all ages in our society.

Many studies have been conducted about the relationship between coffee and chronic diseases. It is known that coffee contains many bio-phytochemicals that affect serum lipids and metabolism. The phytochemicals in coffee are affected by the cooking technique. Boiled coffee such as Turkish coffee, contains more phytochemicals than filter coffees.[22] When we searched the literature we found a few studies that investigated the relationship between Turkish coffee and type-2 DM.

In a study conducted by Grosso et al. it was shown that coffee and tea consumption was inversely related to the metabolic syndrome and its components.[6] In our study, there was a significant negative correlation between Turkish coffee consumption and HbA1c level, but no significant relationship was found between HbA1c levels and other types of coffee types and tea. The lower consumption rate of other coffee types in our country compared to Turkish coffee may have affected the results. As for tea, the high amount of consumption and generally drinking with sugar may cause high glucose intake. Future studies comparing sugar-free tea with coffee in large equal groups will reveal more informative results. In a cross-sectional study with 300 participants conducted by Peksever et al. in our country, no significant relationship was found between type-2 DM and coffee, but the normal body fat ratio was found to be significantly higher in those who consumed more than 800 mL of black tea per day compared to those who consumed less than 800 mL.[23] But in contrast to this study, the percentage of participants who consumed Turkish coffee without sugar was higher in our study at 48.3% and 73% percentages. The Japan Public Health Center-based Prospective Diabetes study by Kabeya et al.[25] found that coffee consumption of ≥240 mL/day was significantly associated with a change in the FPG level by -1.9 mg/dL in men (p=0.013) and -1.4 mg/dL in women (p=0.015), as compared to coffee consumption of 0 mL/day in contrast to other beverages. But unlike our study, their study showed some conflicting relationships between the HbA1c levels and consumption of some types of beverages. Therefore, in a study by Albar et al. no association was found between average caffeine intake and HbA1C levels.[24] Sar-

riá et al. showed that regular consumption of the green/roasted coffee blend produces positive effects on blood pressure, glucose and triglyceride levels.[26] In their meta-analysis Kondo et al., suggested that green tea, but not caffeinated/decaffeinated coffee or black tea, may reduce FBG levels, compared with placebo/water.[27] So there are conflicting findings on the relationship between glycemic control and coffee consumption despite the beneficial effects of coffee being mentioned in DM, HT, and many various diseases.[5,6,26,28,29]

When we compared the HbA1c levels according to the individuals' perception of their health and their diet status, no difference was observed between the groups ($p>0.05$). However, HbA1c levels were significantly higher in the group using insulin treatment. This situation may be due to the fact insulin treatment was usually kept for patients with unregulated glucose levels and high HbA1c values

In the study, no correlation was found between the amount of Turkish coffee consumption per week and HDL, LDL, triglyceride, or total cholesterol values contrary to Sarriá et al. Karabudak et al. found no significant differences in DL, VLDL, TG, or total cholesterol levels between groups when participants were assigned to 3 groups as who do not drink coffee, who drink Turkish coffee, and who drink granulated coffee.[26,30] Therefore the review by Grosso et al. also found conflicting results about serum lipids associated to coffee consumption.[6]

There are some limitations of our study. The incomplete questioning of the amount of sugar added to coffee and tea, the high mean average, and the low physical activity level may affect study outcomes. Increased sample size with equal distribution and lower mean age will provide beneficial findings.

Conclusion

According to the results of our study consumption of Turkish coffee was inversely correlated with fasting glucose and HbA1c level. Future studies with a higher sample size will give more information about the effect of coffee in DM and whether coffee may be nutritional support for treatment.

Declarations

Funding
None

Author contributions
Conceptualization, R.Ö.T.; Methodology, E.M.K.; Software, R.Ö.T.; Validation, R.Ö.T.; Formal Analysis, R.Ö.T.; Investigation, R.Ö.T.; Resources, R.Ö.T.; Data Curation, R.Ö.T.; Writing – Original Draft Preparation, R.Ö.T.; Writing – Review & Editing, R.Ö.T.; Visualization, R.Ö.T.; Supervision, R.Ö.T.; Project Administration, R.Ö.T.; Funding Acquisition, R.Ö.T.

Conflicts of interest
The authors have no conflicts of interest to disclose.

Data availability
The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval
The protocol for the study was approved by a suitably constituted Ethics Committee (June 2021 with the code 2605) of the institution in which them work was undertaken and the study conformed to the provisions of the Declaration of Helsinki.

References

1. Yilmaz B, Acar-Tek N, Sözlü S. Turkish cultural heritage: a cup of coffee. *J Ethn Foods.* 2017;4(4):213-220.
2. Saeedi P, Petersohn I, Salpea P, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Res Clin Pract.* 2019;157:107843. doi: 10.1016/j.diabres.2019.107843
3. Choudhury H, Pandey M, Hua CK, et al. An update on natural compounds in the remedy of diabetes mellitus: A systematic review. *J Tradit Complement Med.* 2018;8(3):361-376. doi: 10.1016/j.jtcme.2017.08.012
4. Patle DM, Vyas GL, Khatik A. A Review on Natural Products and Herbs Used in the Management of Diabetes. *Curr Diabetes Rev.* 2021;17(2):186-197. doi: 10.2174/1573399816666200408090058
5. Kolb H, Martin S, Kempf K. Coffee and Lower Risk of Type 2 Diabetes: Arguments for a Causal Relationship. *Nutrients.* 2021;13(4):1144. doi: 10.3390/nu13041144
6. Grosso G, Godos J, Galvano F, Giovannucci EL. Coffee, Caffeine, and Health Outcomes: An Umbrella Review. *Annu Rev Nutr.* 2017;37:131-156. doi: 10.1146/annurev-nutr-071816-064941
7. Kusumah J, Gonzalez de Mejia E. Coffee constituents with antiadipogenic and antidiabetic potentials: A narrative review. *Food Chem Toxicol.* 2022;161:112821. doi: 10.1016/j.fct.2022.112821
8. Lonati E, Carrozzini T, Bruni I, et al. Coffee-Derived Phenolic Compounds Activate Nrf2 Antioxidant Pathway in I/R Injury In Vitro Model: A Nutritional Approach Preventing Age-Related Damages. *Molecules.* 2022;27(3):1049. doi: 10.3390/molecules2703104
9. Higdon JV, Frei B. Coffee and health: a review of recent human research. *Crit Rev Food Sci Nutr.* 2006;46(2):101-123. doi: 10.1080/10408390500400009
10. Rashidi R, Rezaee R, Shakeri A, Hayes AW, Karimi G. A review of the protective effects of chlorogenic acid against different chemicals. *J Food Biochem.* 2022;46(9):e14254. doi: 10.1111/jfbc.14254

11. Jiang X, Zhang D, Jiang W. Coffee and caffeine intake and incidence of type 2 diabetes mellitus: a meta-analysis of prospective studies. *Eur J Nutr.* 2014;53(1):25-38. doi: 10.1007/s00394-013-0603-x
12. Lim Y, Park Y, Choi SK, Ahn S, Ohn JH. The Effect of Coffee Consumption on the Prevalence of Diabetes Mellitus: The 2012-2016 Korea National Health and Nutrition Examination Survey. *Nutrients.* 2019;11(10):2377. doi: 10.3390/nu11102377
13. Muley A, Muley P, Shah M. Coffee to reduce risk of type 2 diabetes?: a systematic review. *Curr Diabetes Rev.* 2012;8(3):162-168. doi: 10.2174/157339912800564016
14. Gao F, Zhang Y, Ge S, et al. Coffee consumption is positively related to insulin secretion in the Shanghai High--Risk Diabetic Screen (SHiDS) Study. *Nutr Metab (Lond).* 2018;15:84. doi: 10.1186/s12986-018-0321-8
15. Arion WJ, Canfield WK, Ramos FC, et al. Chlorogenic acid and hydroxynitrobenzaldehyde: new inhibitors of hepatic glucose 6-phosphatase. *Arch Biochem Biophys.* 1997;339(2):315-322. doi:10.1006/abbi.1996.9874
16. Williams CJ, Fargnoli JL, Hwang JJ, et al. Coffee consumption is associated with higher plasma adiponectin concentrations in women with or without type 2 diabetes: a prospective cohort study. *Diabetes Care.* 2008;31(3):504-507. doi: 10.2337/dc07-1952
17. Paolisso G, Barbagallo M. Hypertension, diabetes mellitus, and insulin resistance: the role of intracellular magnesium. *Am J Hypertens.* 1997;10(3):346-355. doi: 10.1016/s0895-7061(96)00342-1
18. Meier JJ, Hücking K, Holst JJ, Deacon CF, Schmiegel WH, Nauck MA. Reduced insulinotropic effect of gastric inhibitory polypeptide in first-degree relatives of patients with type 2 diabetes. *Diabetes.* 2001;50(11):2497-2504. doi:10.2337/diabetes.50.11.2497
19. Nauck MA, Heimesaat MM, Orskov C, Holst JJ, Ebert R, Creutzfeldt W. Preserved incretin activity of glucagon-like peptide 1 [7-36 amide] but not of synthetic human gastric inhibitory polypeptide in patients with type-2 diabetes mellitus. *J Clin Invest.* 1993;91(1):301-307. doi: 10.1172/JCI116186
20. Craig CL, Marshall AL, Sjöström M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc.* 2003;35(8):1381-1395. doi: 10.1249/01.MSS.0000078924.61453.FB
21. Saglam M, Arikan H, Savci S, et al. International physical activity questionnaire: reliability and validity of the Turkish version. *Percept Mot Skills.* 2010;111(1):2782-2784. doi: 10.2466/06.08.PMS.111.4.278-284
22. Shi L, Brunius C, Johansson I, et al. Plasma metabolite biomarkers of boiled and filtered coffee intake and their association with type 2 diabetes risk. *J Intern Med.* 2020;287(4):405-421. doi: 10.1111/joim.13009
23. Peksever D, Yıldırım Şimşir I, Meseri R, Haznedaroğlu YDDMZ. Evaluation of the effect of coffee and tea consumption in individuals with type 2 diabetes and insulin resistance with a cross-sectional study. *Mersin University Journal of Health Sciences.* 2021;14(1):44-55.
24. Kabeya Y, Goto A, Kato M, et al. Cross-sectional associations between the types/amounts of beverages consumed and the glycemia status: The Japan Public Health Center-based Prospective Diabetes study. *Metabol Open.* 2022;14:100185. doi: 10.1016/j.metop.2022.100185
25. Albar SA, Almaghrabi MA, Bukhari RA, Alghanmi RH, Althaiban MA, Yaghmour KA. Caffeine Sources and Consumption among Saudi Adults Living with Diabetes and Its Potential Effect on HbA1c. *Nutrients.* 2021;13(6):1960. doi:10.3390/nu13061960
26. Sarriá B, Martínez-López S, Sierra-Cinos JL, García-Diz L, Mateos R, Bravo-Clemente L. Regularly consuming a green/roasted coffee blend reduces the risk of metabolic syndrome. *Eur J Nutr.* 2018;57(1):269-278. doi: 10.1007/s00394-016-1316-8
27. Kondo Y, Goto A, Noma H, Iso H, Hayashi K, Noda M. Effects of Coffee and Tea Consumption on Glucose Metabolism: A Systematic Review and Network Meta-Analysis. *Nutrients.* 2018;11(1):48. doi: 10.3390/nu11010048
28. Marventano S, Salomone F, Godos J, et al. Coffee and tea consumption in relation with non-alcoholic fatty liver and metabolic syndrome: A systematic review and meta-analysis of observational studies. *Clin Nutr.* 2016;35(6):1269-1281. doi: 10.1016/j.clnu.2016.03.012
29. Shang F, Li X, Jiang X. Coffee consumption and risk of the metabolic syndrome: A meta-analysis. *Diabetes Metab.* 2016;42(2):80-87. doi: 10.1016/j.diabet.2015.09.001
30. Karabudak E, Türközü D, Köksal E. Association between coffee consumption and serum lipid profile. *Exp Ther Med.* 2015;9(5):1841-1846. doi: 10.3892/etm.2015.2342