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Using Coffee Beans And Peels To Improve Biochemical Changes In Rats With Hyperglycemia

Sultan Mashnafi[1] , Ali Mahzari[2] , Lobna Saad Mohammed Abd Elmeged[3a,b] , Ali A. Zaeri[4] , Abdulbaset Mohammad Mostafa Kabli[5]

[1]Department of Basic Medical Sciences, Faculty of Applied Medical Sciences, Al-Baha University, Saudi Arabia Email :sqasem@bu.edu.sa
[2]Department of Laboratory Medicine, Faculty of Applied Medical Sciences, Al-Baha University, Al-Baha, Saudi Arabia. Email :amoosa@bu.edu.sa
[3a] Department of Nutrition, Faculty of Applied, AL-Baha University, AlMakhwa, Saudi Arabia
[3b] Department of Nutrition and Food Sciences, Faculty of Home Economics, Menoufia University, Shibin el Kom, Menofia Governorate 6131567, Egypt. Email: lobna@bu.edu.sa
[4]Department of Laboratory Medicine, Faculty of Applied Medical Science, Al-Baha University, Al-Baha, Saudi Arabia. Email:azaeri@bu.edu.sa
[5]Department of Laboratory Medicine, Faculty of Applied Medical Sciences, Al-Baha University, Al-Baha, Saudi Arabia Email: akabli@bu.edu.sa

Abstract
Arabic coffee has several unique characteristics, including its distinctive taste and aroma resulting from the addition of spices such as cardamom and saffron, as well as its health benefits, such as boosting energy and concentration, and strengthening the immune system thanks to its antioxidant properties.
Aim: present research aims to enhance the using coffee beans and peels to improve biochemical changes in rats with hyperglycemia.
Materials and Methods: Thirty-six male Sprague Dawley mice have been categorized into a normal group (n =6)and a diabetic group (n =30). The 2nd group received an intraperitoneal injection of streptozotocin at a dosage of seventy-five milligrams per kilogram, and individuals exhibiting blood glucose levels over 250 milligrams per deciliter were categorized as diabetic. Rats have been categorized into six groups: (1) non-diabetic group (n =6) received distilled water (2 mL/ day); (2) diabetic control group (n =6) received distilled water (two milliliters per day); (3) diabetic group (n =6) received a basal diet supplemented with 5 % coffee peels; (4) diabetic group (n =6)received a standard diet supplemented with 10% coffee peels; (5) diabetic group (number = six) received a standard diet supplemented with 5% coffee beans; (6) diabetic group (n =6)received a standard diet supplemented with 10% coffee beans. Following twenty-eight days, blood has been drawn, and serum has been extracted to assess glucose, HbA1c, & blood lipids.
Results: From the outcomes of biochemical analysis of serum examined plants not only reduced serum glucose, but additionally cured or ameliorated completely the side effects of diabetes mellitus, being liver, kidney, & lipid profile disorders. In present work, coffee (peel and bean) revealed the maximum hypoglycemic effect, reducing serum glucose, besides a considerable reduction of diabetes side effects. Coffee peel is advised to be added to herb formulations assigned for diabetics, since it enhances the therapeutic effect of the herbs.

KEYWORDS: - Coffee peels - therapeutic and immunological benefits - therapeutic nutrition.

Introduction

Coffee, rich in compounds like chlorogenic acid, may help prevent or manage type 2 diabetes through dropping oxidative stress and enhancing insulin sensitivity, though the effects can differ depending on coffee type, roast, and individual sensitivity. While raw green coffee beans and extracts show promise due to high chlorogenic acid levels, long-term, moderate consumption of both decaffeinated and caffeinated coffee is related to a diminished risk of progressing type 2 diabetes. Nevertheless, it is crucial to avoid adding sugar or high-carb ingredients, and those with diabetes should consult their

doctor about caffeine intake. (Riserus et al., 2009). Prolonged consumption of caffeine is related to a diminished possibility of Type 2 Diabetes (T2DM) and its implications, as well as a reduction in body weight. This has been due to the consumption of coffee rich in bioactive compounds. (Wilhelmina et al ., 2020). Prospective epidemiological research agrees on a correlation between regular consumption of coffee and a reduced incidence of T2DM. Multiple facets of these investigations support a cause–effect association. There exists a dependence on a daily coffee intake. Research result exhibit consistency across several global areas, demonstrating no variances between genders, between obese and lean individuals, between young and old subjects, or between smokers and nonsmokers, irrespective of the number of confounding variables accounted for. Randomized controlled intervention trials didn't demonstrate a consistent effect of coffee consumption on acute metabolic control, aside from the influence of caffeine. Consequently, the reduction of diabetes risk associated with consuming caffeine doesn't involve an immediate impact on postprandial blood glucose levels, insulin, or insulin resistance. (Mahasin et al., 2020). Multiple investigations in both animals and people demonstrate that the consumption of coffee phytochemicals triggers an adaptive cellular response distinguished by the increased expression & de novo creation of enzymes associated with cellular repair & defense. The nuclear factor erythroid 2-related factor 2 (Nrf2) is a major regulator in conjunction with the aryl hydrocarbon receptor, sirtuins, & AMP-activated kinase. The liver is a 1^{ry} location of coffee's effects, leading to enhanced fat oxidation and a decreased probability of steatosis. A significant benefit of coffee consumption is the preservation of functional ß-cell mass through improved mitochondrial activity, reduced endoplasmic reticulum stress, & the prevention or removal of aggregation of misfolded amylin or proinsulin. (Chew et al ., 2018). Identifying acute metabolic effects of consumption of coffee in randomized controlled intervention trials has proven difficult, with the exception of caffeine's effects. (Paquette et al ., 2017)

2- AIM OF STUDY: -

The goal of this study is to use coffee beans and peels to improve biochemical changes in rats with hyperglycemia.

3- MATERIALS AND METHODS: -

A- Source of coffee beans and peels**:** Coffee beans and peels were purchased from Al-Baha City, KSA, local market, washed, cleaned, blended, & ground into fine powder utilizing an electric grinder. To reduce oxidation, they were stored in dark-stoppered glass bottles until ready to be used. according to (Russo, 2001).

B-Rats: Thirty-six male Sprague Dawley mice (number =36), each weighing between 150 & 170 grams, were procured from the Animal Unit of Egypt's Ministry of Health at Helwan Farm. Over a duration of two weeks, the mice have been maintained in single plastic enclosures under regulated settings, with a temperature of twenty-two degrees Celsius and a twelve-hour light/dark cycle at the Faculty of Home Economics, Menoufia University, Egypt. The mice were granted unlimited access to water & food. All experiments adhered to the National Institutes of Health's Guiding Principles for Animal Care & Use. Following a two-week acclimatization period, mice have been weighed & randomly assigned to one of 2 groups: diabetic (thirty mice) & normal (six rats).

C- Induction of Diabetes (T1DM): Following a two-week acclimatization period, type 1 diabetes mellitus has been developed in mice via intraperitoneal injections of Streptozotocin (STZ) as earlier outlined. The mice received an intraperitoneal injection of seventy-five milligrams per kilogram of Streptozotocin (Sigma-Aldrich, St. Louis, MO, United States of America). Subsequently, all rats had an eight-hour fast, after which blood samples have been collected from the retro-orbital veins to assess blood glucose levels. The investigation involved diabetic mice with blood glucose levels exceeding 250 milligrams per deciliter. After excluding rats with blood glucose levels below 250 milligrams per deciliter and those who were died, twenty-four rats were incorporated into the trial and eventually manifested diabetes. In addition, diabetic rats

D- Diets:

- Basal diet: The basal diet comprises corn oil (ten percent), protein (ten percent), cellulose (five percent), choline chloride (0.2 percent), combination of vitamin (one percent), salt combination (four percent) **(Hegested et al., 1941),** & corn starch (to one hundred percent). in accordance with **AIN (1993)**

E- Experimental Design

1- The research encompassed all normal (six rats) and diabetic (thirty rats). Alongside the experimental technique, all rats participating in this study were provided with a regular diet. The suggested therapies were taken orally once day. AIN, 1993 The weights of the rats have been documented and the diabetic rats were categorized into experimental groups appropriately. The subsequent groups were the experimental groups:

2- The non-diabetic group (ND-Gr) involved six normal mice that received a daily two milliliters of distilled water orally per rat one time per day.

3- The diabetic control group (DC-Gr) involved six diabetic mice that received a daily two milliliters of distilled water orally per rat one time per day

4- The diabetic group (DC-Gr), involved six mice, received basal diet + 5% coffee beans

5- The diabetic group (DC-Gr), consisting of six mice, received basal diet + 10% coffee beans

6- The diabetic group (DC-Gr), consisting of six mice, received basal diet + 5% coffee peels

7- The diabetic group (DC-Gr), consisting of six mice, received basal diet + 5% coffee peels

F- Biological evaluation:

The biological evaluation of the diverse diets has been performed thru calculating the food efficiency ratio (FIR) and body weight gain % (BWG) in accordance **with Chapman et al., 1959]** utilizing the following formulas:

$$BWG = \frac{\text{Final weight} - \text{initial weight}}{\text{Initial weight}}$$

$$FER = \frac{\text{Gain in body weight (g)}}{\text{Feed intake (g)}}$$

G- Blood sampling: Initially, blood samples have been collected from the retro-orbital vein following a fasting period of twelve hours, while at the end of each experiment, they have been gathered from the hepatic portal vein. Samples of the blood have been gathered into clean, dry centrifuge glass tubes & permitted to clot in a water bath at thirty-seven degrees Celsius for twenty-eight minutes. The serum was subsequently separated by centrifuging the tubes at four thousand revolutions per minute for ten minutes. The serum has been cautiously aspirated & transferred to a clean Eppendorf tube, where it was kept at minus twenty degrees Celsius until analysis. This method was labeled by (Schermer,1967).

H- Biochemical Analysis:

Lipid profile:

- Measurements of serum triglycerides: The serum triglycerides were calculated using enzymatic techniques and kits in accordance with (Young, 1975 and Fossati,1982).

- - Measurements of serum total cholesterol: Serum total cholesterol has been determined using the colorimetric technique previously explained by **(**Thomas,1992).

Measurements of high-density lipoprotein (HDL-c): HDL-c has been estimated in accordance with the technique established with **(**Fredewaid 1972 & Grodon & Amer, 1977).

- - Measurements of very low-density lipoprotein cholesterol (VLDL-c): very low-density lipoprotein cholesterol has been evaluated in milligrams per deciliter in accordance with **(**Lee & Nieman,1996).

Measurements of low-density lipoprotein cholesterol (LDL-c): low-density lipoprotein cholesterol has been determined in milligrams per deciliters in accordance with **(**Lee and Nieman ,1996)

- Determination of atherogenic index (AI): Determination of AI = (LDL-c + very low-density lipoprotein cholesterol) (Kikuchi-Hayakawa et al., 1998).

Liver functions:

- Measurements alanine transaminase: - carried out regarding the procedure of (Clinica Chimica Acta, 1980),

- Measurements aminotransferase (AST) Measurements of serum aminotransferase has been carried out in accordance with the technique of (Hafkenscheid ,1979).

- Measurements of serum globulin**:** Serum globulin has been determined in accordance with the method described by (Henry, 1964).

- Serum albumin (SAlb): Serum albumin has been determined with regard to the technique described by **(Doumas et al., 1971).**

Kidney functions:

- Determination of serum urea: Urea was determined thru enzymatic technique in accordance with **(**Patton & Crouch ,1977).

- Measurements of serum creatinine: Serum creatinine has been determined in accordance with the method expressed with **(**Henry ,1974).

- Measurements of serum uric a`: Serum uric a` been measured calorimetrically in accordance with the technique of **(**Barham & Trinder ,1972).

- Measurements of blood glucose: Enzymatic measurements of serum glucose have been performed calorimetrically in accordance with the technique of **(**Tinder ,1969).

I- Statistical analysis:

The student-Newman-Keuls test has been applied to separate the means following a significant main effect has been discovered. The information has been examined via an entirely randomized factorial design [SAS, 1988]. Treatment variances (P-value under 0.05) have been deemed significant by the Costat Program. Analyses of biological results have been carried out utilizing one-way ANOVA. **(1967, Snedecor and Cochran)**

- **Ethical Approval**

The Science Research Ethics Committee of the Faculty of Home Economics accepted the protocol of the research #15-SREC-06-2025.

4- RESULTS AND DISCUSSION

- **RESULTS**

4.1. Biological results.

Effect of various levels of coffee beans and peels on BWG %, feed intake, & feed efficiency ratio (FER) of diabetic rats.

Table (1) results illustrate the effect of different levels of coffee beans and peels **on** for twenty-eight days on FER, FI, & BWG in diabetic mice. The mean value of body weight gain for the control (+)was greater than that of the control (-), recorded at -0.36±0.0026 and 0.076±0.0017, correspondingly. However, the values of all groups were significantly greater (p-value under 0.05) in comparison with the p control (+), with averages of 1.71±0.010, 1.95±0.064, 1.21±0.010, and 1.86±0.053 grams, correspondingly.

The mean value of FI for the control (+) was greater compared to of the ne control (-), recorded at 6.50±0.050 grams and 6.90±0.010 grams, correspondingly. The results of all groups exceeded that of the control (+), with means of 21.90±0.010, 23.30±0.029, 14.20±0.007, 23.80±0.007, and 27.90±0.008 g, correspondingly. However, the values of all groups were significantly greater compared to the positive control by an average of 17.77±0.039 grams, correspondingly.

The FER of the control (+) was significantly greater (p-value under 0.05) than that of the control (-), measuring 0.06±0.0007 and 0.011±0.005, correspondingly. However, the values for all groups exceeded those of the control (+), with means of 0.078±0.001, 0.084±0.002, 0.085±0.002, and 0.078±0.007, correspondingly.

Table (1): Effect of various levels of coffee beans & peels on BWG %, nourished intake, & FER of diabetic rats.

Group Parameter	Control (-ve)	Control (+ve)	5%Coffee beans	10%Coffee beans	5% Coffee peels	10% Coffee peels
BWG(g) Mean±SD	0.076±0.0017	0.36±0.0026	1.71 ±0.010	1.951±0.064	1.211±0.010	1.861±0.053
Fi(g) Mean±SD	6.90±0.010	6.50+±0.050	21.901±0.010	23.301±0.029	14.201±0.007	23.801±0.007
FER Mean±SD	0.011±0.005	0.06±0.0007	0.0781±0.001	0.0841±0.002	0.0851±0.002	0.0781±0.007

Variances are significant at 5% (P-value under 0.05). Control-Ve: Rats nourished on basal diet. Control +Ve: Diabetic mice nourished on basal diet.

4.2. Biochemical results

Effect of various levels of coffee beans and peels on serum glucose of diabetic rats.

Information in table (2) illustrated that in control (-) normal mice, serum glucose was 117. 75 ± 2. 72 (milligrams per deciliter), which increased by the rate of 111.88% as the result of diabetic diet feeding. Adding of coffee beans (5 and 10 %) and coffee peels (5 %and 10%) to the basal diets leads to a significant reduction in serum glucose by the ratio of -42.98, -27.85, -39.07, and -49.29% respectively. 10% coffee beans the best management.

Table (2): Effect of various levels of coffee beans & peels on serum glucose of diabetic rats.

Group Parameter	Control (-ve)	Control (+ve)	5%Coffee beans	10%Coffee beans	5% Coffee peels	10% Coffee peels
Glucose (mg/dl)Mean±SD	117. 7 ± 2. 7* f	249. 5 ± 2. 2 a**	135± 2. 04 c	126. 5 ± 1. 76 e	142. 2± 2. 1 d	180 ± 2. 08 b
% of change	---	+111.88	-39.07	-49.29	-42.98	-27.85

* Values are expressed as mean ± SD.** Values which don't share the same letter in each column are significantly different at P-value under 0.05.

Serum liver enzymes

Table (3) Demonstrate the impact of various unsupplemented & supplemented meals on serum AST, ALT, ALP, & the AST/ALT ratio in diabetic rat groups. The mean AST value of the control positive group was significantly elevated (p-value under 0.05) in comparison with the control negative group, with values of 145.00±4.58 and 42.00±2.05 Units per liter, correspondingly. Additionally, the values of all other groups were significantly lower than that of the control (+), recorded at 60.70±1.54, 50.00±1.00, 55.00±1.73, and 40.00±2.64 Units per liter, correspondingly.

The ALT levels in the control (+) group were significantly elevated (p -value under 0.05) in comparison with that of control (-) mice, measuring 40.00±2.65 & 18.00±0.87 units per liter, correspondingly. Additionally, the values for all groups were markedly lower when compared to the control (+) mice, which had values of 17.60±0.53, 15.00±0.61, 21.00±1.32, and 15.80±0.72 units per liter, correspondingly.

Table (3) demonstrates that the mean AST/ALT ratio of the control (+) group was significantly elevated (p-value under 0.05) in comparison with the control (-) group, with values of 3.63±0.092 and

2.33±0.061, correspondingly. The values of all groups were considerably lower than those of the control (+) group, which were 3.45±0.027, 3.33±0.057, 2.62±0.036, and 2.53±0.026, correspondingly.

Table (3): Effect of various levels of coffee beans & peels on **ALT, AST, ALP, & AST/ALT ratio on diabetic rats.**

Group Parameter	Control (-ve)	Control (+ve)	5%Coffee beans	10%Coffee beans	5% Coffee peels	10% Coffee peels
AST (U/L) Mean±SD	f42.00±2.05	145.00±4.58	60.70±1.54	50.00±1.00	55.00±1.73	40.001±2.64
ALT (U/L) Mean±SD	18.00±0.87	40.00±2.65	17.60±0.53	15.00±0.61	21.001±1.32	15.801±0.72
AST/ALT Ratio Mean±SD	2.33+0.061	3.63±0.092	3.45±0.027	3.33±0.057	2.621±0.036	2.531±0.026

Kidney Function

Information in table (4) results illustrate the effect of various levels of coffee beans & peels on urea, uric a`, & serum creatinine in diabetic groups.

The data indicates that the mean creatinine concentration in the control (+) group was greater in comparison with that in the control (-) group, measuring 1.20±0.044 and 0.70±0.032 milligrams per deciliter, correspondingly. Furthermore, the results for all groups were inferior to the control (+), measured at 0.90±0.017, 0.78±0.019, 0.70±0.023, and 0.63±0.026 milligrams per deciliter, correspondingly.

Serum Urea of control (+) was greater compared to control (-), which were 162.00±7.21 & 37.00±2.45 milligrams per deciliter, correspondingly. The values for all groups were less than those of the control (+), with means of 148.00±7.15, 82.00±2.64, 108.00±2.51, and 86.00±3.61 milligrams per deciliter, correspondingly.

The outcomes indicated that the mean value of uric a` in the control (+) group was greater compared to that in the control (-) group, measuring 3.50±0.22 and 2.00±0.11 milligrams per deciliter, correspondingly. The readings for all groups were less than the control (+), with mean values of 2.40±0.06, 1.70±0.09, 2.60±0.13, and 1.06±0.05 milligrams per deciliter, correspondingly.

Table (4): Effect of various levels of coffee beans and peels on serum creatinine, urea, & uric a` in diabetic groups.

Group Parameter	Control (-ve)	Control (+ve)	5%Coffee beans	10%Coffee beans	5% Coffee peels	10% Coffee peels
Creatinine (mg/dl) Mean±SD	0.70±0.032	1.201±0.044	0.901±0.017	0.781±0.019	0.701±0.023	0.631±0.026
ALT (U/L) Mean±SD	18.00±0.87	40.00±2.65	17.60±0.53	15.00±0.61	21.001±1.32	15.801±0.72
AST/ALT Ratio Mean±SD	2.33+0.061	3.63±0.092	3.45±0.027	3.33±0.057	2.621±0.036	2.531±0.026

lipid profile

The information in Table (5) demonstrates the effect of dietary interventions & herbal mixture supplementation over twenty-eight days on total cholesterol, serum high-density lipoprotein cholesterol, triglycerides, LDL-c, very low-density lipoprotein cholesterol, & atherogenic index ratio in diabetic mice.

The table indicates that the mean total cholesterol value for the control (+)group was greater compared to that of the control (-) group, recorded at 191.00±3.61 milligrams per deciliter and 142.00±2.64 milligrams per deciliter, correspondingly. Furthermore, the values for all other groups were significantly lower (p-value under 0.05) in comparison with the control (+), with means of 176.00±4.36, 137.00±3.46, 172.00±7.21, and 136.00±3.61 milligrams per deciliter, correspondingly.

The TG of the control (+) was more than that of the control (-), recorded at 188.00±6.08 and 121.00±3.41 milligrams per deciliter, correspondingly. The readings for all groups were lower in comparison with the positive control, with averages of 137.00±2.64, 120.00±4.36, 163.00±6.27, and 150.00±4.35 milligrams per deciliter, correspondingly.

The mean value of HDLc for the control (+) was reduced compared to that of the control negative group, recorded at 68.00±1.73 and 110.00±4.35 milligrams per deciliter, correspondingly. Furthermore, the values for all groups exceeded those of the c control (+), with means of 89.00±3.46, 95.30±1.13, 97.20±1.06, 100.60±2.12, 92.60±1.51, and 95.30±1.13 milligrams per deciliter.

The table illustrated that the LDL concentration of the control (+) was greater compared to that of the control (-), measuring 85.40±2.51 and 7.80±0.26 milligrams per deciliter, correspondingly. The values of all groups were inferior to the control (+), with means of 59.60±2.25, 17.70±0.61, 42.20±1.59, and 5.40±0.17 milligrams per deciliter, correspondingly.

The outcomes illustrated that the mean value of VLDLc in the control (+) group was greater in comparison with that in the control (-) group, measuring 37.60±2.42 and 24.20±0.72 milligrams per deciliter, correspondingly. Furthermore, the readings for all groups were inferior to the control (+), with mean values of 27.40±1.51, 24.00±1.73, 32.60±1.96, and 30.00±1.00 milligrams per deciliter, correspondingly.

The table demonstrated that the A.I. ratio for the control (+) group was superior to that of the control (-) group, recorded at 1.81±0.025 and 0.29±0.017, correspondingly. In contrast, the values for the other groups were less to the control (+) , measured at 0.98±0.032, 0.44±0.025, 0.77±0.015, and 0.35±0.036, correspondingly.

Table (5) Effect of various levels of coffee beans and peels on serum TC, TG, HDLc, LDLc, VLDLc & A.I. ratio in diabetic mice

Group Parameter	Control (-ve)	Control (+ve)	5%Coffee beans	10%Coffee beans	5% Coffee peels	10% Coffee peels
TC (mg/dl) Mean±SD	142.00±2.64	191.00±3.61	176.00 ±4.3	137.001±3.46	172.001±7.21	136.001±3.61
TG (mg/dl) Mean±SD	121.00±3.41	188.001±6.08	137.001±2.64	120.001±4.36	163.001±6.27	150.001±4.35
HDL (mg/dl) Mean±SD	110.001±4.35	68.00±1.73	89.001±3.46	95.301±1.13	97.201±1.06	100.601±2.12

LDL (mc/dl) Mean±SD	7.80±0.26	85.401±2.51	59.601±2.25	17.701±0.61	42.20±1.59	5.401±0.17
VLDL (mg/dl)	24.20±0.72	37.601±2.42	27.401±1.51	24.001±1.73	32.601±1.96	30.001±1.00
Atherogenic index (A.I. Ratio	0.29±0.017	1.81±0.025	0.98±0.032,	0.44±0.025,	0.77±0.015	0.35±0.036

- **DISCUSSION**

The goal of this study is to utilize coffee beans and peels to enhance biochemical changes in rats with hyperglycemia. Coffee, and its active component chlorogenic acid, may reduce the risk of developing diabetes and improve blood sugar control by enhancing insulin sensitivity and inhibiting glucose absorption. Both caffeinated and decaffeinated coffee show a protective effect, and long-term consumption of up to 3-4 cups daily is associated with lower risks of diabetes. However, caffeine can temporarily affect blood sugar levels in individuals with diabetes (Djunarko et al., 2022). Nevertheless, hypercholesterolemic individuals were administered a daily capsule containing 150 milligrams of cranberries, which reduced their cholesterol levels (Fahmi et al., 2022). Coffee contains a high amount of polyphen ols, particularly chlorogenic acid, which combats inflammation and oxidative stress. This is beneficial for preventing diabetes and its related complications, also coffee constituents can improve insulin sensitivity and absorption of glucose, helping to manage blood sugar levels (Furqan et al.,2020), offee beans are also a source of beneficial minerals like chromium and magnesium , which help the body use insulin to control glucose (Hamdani et al.,2020). Coffee contains several chemicals, such as chlorogenic acids and lignans, that enhance glucose metabolism in animal experiments. Additional investigation on coffee phytochemicals may uncover novel ways by which food influences the beginning of type 2 diabetes. Furthermore, understanding the impacts of coffee constituents may facilitate the progress or selection of coffee varieties with enhanced health benefits. (Handajani et al. 2021), Consistent coffee intake may diminish the likelihood of developing Type 2 diabetes. Research indicates that both caffeinated and decaffeinated coffee positively influence blood glucose concentrations. Long-term research indicate that frequent consumption of coffee decreases the incidence of Type 2 diabetes. (Hidayati et al. 2021), a decrease in pro-inflammatory factors and a rise in anti-inflammatory biomarkers. Consistent intake of both decaffeinated and caffeinated coffee aids in protecting against the onset of Type 2 diabetes. The European Food Safety Authority deems the consumption of three to four cups of coffee daily (up to 400 milligrams of caffeine for adults) to be safe. A daily consumption of 200 milligrams of caffeine is deemed safe for pregnant females. To avoid diabetes, it is recommended to integrate additional coffee breaks into your regular regimen. As a coffee drinker, you can enjoy as much decaffeinated coffee as you like, anytime during the day. (Kartikasari et al. 2022), The research found that the consumption of coffee or decaffeinated coffee resulted in a reduction of pro-inflammatory variables and an elevation of anti-inflammatory biomarkers. The habitual intake of both decaffeinated and caffeinated coffee aids in protecting against the onset of Type 2 diabetes. To mitigate the risk of diabetes, it is advisable to integrate additional coffee breaks into your routine. As a coffee drinker, you can enjoy as much decaffeinated coffee as you like, anytime during the day. (Sukara et al. 2023)

5. Conclusion

The evidence suggests that the bioactive compounds present in Arabic coffee beans and, to a lesser extent, its peels and leaves, are important in lowering blood sugar. Through increased insulin sensitivity and antioxidant effects, moderate consumption of Arabic coffee can contribute to better blood sugar management & a diminished possibility of type 2 diabetes.

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