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Effect of Carob, Doum, and Cinnamon Powder on Blood Lipid Profile in Diabetic Rats

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Abstract

Researchers in this study tested the effects of carob, doum, and cinnamon powder on diabetic rats' blood lipid profiles. During the experiment, 36 adult albino male rats were employed. After the rats had a chance to adjust to their new surroundings, they were divided into six groups at random. Group 1 was used as a negative control and was fed a simple diet for the length of the research. STZ (streptozotocin) (40 mg/kg BW) was administered to the rats in groups of two to six. As soon as the diabetic rats in Group 2 became diabetic, their use as a positive control was ceased. Glibenclamide (10mg/kg BW/day orally) was given to the group that was fed a normal diet. Group (3) got no therapy (as standard drug). Group (4) utilized carob powder, Group (5) used doum powder, and Group (6) used cinnamon powder (6). After the trial, the results show that the plants have grown. Serum LDL-c(Low density lipoprotein–cholesterol) and TC(total cholesterol) and TG(Triglyceride) levels decreased, but HDL-C(Hight density lipoprotein–cholesterol) ratios increased considerably throughout the feeding phase of the study. Carob, doum, and cinnamon powder meals reduced the levels of blood aspartate aminotransferase (AST/GOT) and alanineaminotransferase (ALT/GPT) enzymes in rats compared to the positive control diets. All of the examined diets had the same result. Additionally, diabetic rats had better renal function than diabetic rats under positive control. Histopathological differences were seen in the pancreas of diabetic rats compared to animals given carob, doum, and cinnamon powder.

Keywords: Diabetic rats, Carob, Doum, and Cinnamon powder –lipid profile

1. Introduction

Diabetes mellitus (DM), the most prevalent long-term condition in modern society, is a primary cause of death. There are two basic types of diabetes mellitus: type 1 and type 2. Insulin-Dependent Diabetic Mellitus (IDDM) Type 1, often known as juvenile diabetes, mainly affects children and young people under the age of 40. A lack of insulin is the major cause of type II diabetes in people over the age of 40 who have non-insulin-dependent diabetes mellitus (NIDDM), a form of diabetes caused by the entire or partial regeneration of beta cells in the pancreas. It is because of this that T2DM (90–95 %) is the most common kind of DM worldwide. Diet and oral hypoglycemic medicine may be used to control this disease [1]. Currently, diabetes is a global epidemic. The number of persons globally with diabetes is predicted to climb significantly in the next several years [2]. In addition to conventional pharmaceuticals, WHO might consider using natural goods such as dietary supplements and herbal remedies (WHO). As many as 1,200 different species of herbal remedies may be used to treat type 2 diabetes. People throughout the world have long relied on natural remedies like herbs and plants to treat and prevent ailments. Plants, microorganisms, marine life, vertebrates, and invertebrates are only some of the various sources of this chemical [3]. When it comes to new medicines, there is no limit to the number of chemicals found in natural products like plant extracts [4]. Carob (Ceratonia siliqua L.), a member of the Leguminosae family, is a popular crop in the Mediterranean area for both economic and ecological reasons. Carob pods are low in fat and high in fiber, polyphenols, and other healthy compounds such as cyclitols [5]. The carob pod's

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pulp and seeds account for around 90% of its weight [6]. The principal sugars in carob pulp are sucrose, glucose, fructose, and maltose (48–56 %). There is a lot of carob pulp in the fruit. About 18 % of the total is composed of cellulose and hemicellulose, 3-4 % of which is made up of protein, and between 0.4 and 0.8 % is made up of lipids. Sugars, cyclitols, fiber, polyphenols, amino acids, and minerals are among the carob pulp's bioactive components [7]. Antitussive, anti-diarrheal, and diuretic properties of C. Siliqua (carob) have been historically employed [8]. Aside from its antioxidant, anti-ulcer, and anti-inflammatory properties, the carob pod has a plethora of other health advantages. An indigenous palm tree, Hyphaene thebaia, produces edible oval fruits that may be eaten raw or cooked (Hyphaene thebaia). The Arecaceae palm family has a high antioxidant content [9]. More than 40% of the fiber content is found in the epicarp. At 3.6 mg/kg of epicarp, niacin (vitamin B3) is the most abundant B vitamin, followed by pyridoxine (vitamin B6) at 13.6 mg/kg, all found in Doum fruit. When it comes to the doum fruit's flesh, glucose and fructose are both plentiful [10]. Medicinal plant Hyphaene thebaica contains flavonoids [11]. The fruits of doum were shown to have antibacterial, antioxidant, hypolipidemic, and antihypertensive effects. It belongs to the Lauraceae family, Cinnamomum zeylanicum. It is one of the most used and oldest spices in human history as a spice and flavoring component. If you're looking to improve your health, this is one of the healthiest spices you can utilize [12]. Polyphenols, flavonoids, and carotenoids are medicinally significant phytochemicals. Antioxidant-rich vitamins and minerals [13]. As a result, it inhibits the growth of several bacteria and fungi. Cinnamon has been used safely as a spice for a long time. Studies have been conducted on cinnamon bark, essential oils, bark powder, phenolic compounds, flavonoids, and the individual components. Each of these characteristics contributes to the advancement of human health. It is possible to generate anti-oxidant and antimicrobial benefits directly by targeting oxidants or bacteria, whereas anti-inflammatory, anticancer, and antidiabetic actions are accomplished through receptor-mediated pathways [14]. Cinnamon's many health benefits have been extensively studied. There is a lack of clinical evidence to support traditional uses of this spice in cancer and inflammation, cardiovascular protection, and neurological illnesses [15]. Various human cancer cells are inhibited by cinnamon, making it a safe and trustworthy herbal remedy for the treatment of malignant diseases [16]. Type 2 diabetes may be prevented by using cinnamon, according to several studies [17,18,1,&20]. Researchers investigated the effects of a commercial medicine on diabetic rats fed a carob, cinnamon, or doum diet supplemented with powdered cinnamon (glibenclamide). Three plants were substituted for fiber in the diet. Dietary fiber may benefit a variety of health conditions, including diabetes, colon cancer, and heart disease. It is because of their function as an insoluble matrix that they have a beneficial effect on glucose absorption

2. Material and Methods

2.1. Materials

2.1.1. Plants

Carob (Ceratonia silique L.), doum fruits (Hyphaene Thebaica), and cinnamon (Cinnamomum zeylanicum) powder were used in this experiment at Giza, and all of the items were purchased from the local market there.

1.2. Animals

The adult male albino rats used in this study weighed 200 5 g and were obtained from the Animal Experimental House of the College of Veterinary Medicine, Cairo University Giza, where they were raised in a laboratory environment. In the journal Veterinary Research, the investigators' findings were published as part of their inquiry. Where the research was conducted at the Institute of Food Technology, Agricultural Research Center in Giza.

2.1.3. Standard drug

In this investigation, glibenclamide was administered orally at a dose of 10.0 mg/kg body weight, which was considered a conventional dose. Sigma-Aldrich provided both the streptozotocin (STZ) and the glibenclamide for this study, and all of the chemicals were of analytical purity.

2.1.4. Kits

Spectral Diagnostics, Egyptian Company for Biotechnology (S.A.E.) Obour city industrial area in the United Arab Emirates, provided the sugar, total cholesterol (TC), high-density lipoprotein cholesterol (HDL-c), triglycerides (TG), aspartate transaminase (AST), alanine transaminase (ALT), creatinine, urea, and Uric acid kits used in this study. Cairo serves as Egypt's capital city.

2.2. Methods

2.2.1. Proximate Analysis

The amounts of moisture, protein, total fat, crude fiber, and ash were measured, and the carbohydrate content was calculated by dividing the difference between the two measurements by the total amount of moisture [21].

2.2.2. Minerals Analysis

A description of the mineral analysis process that is currently in use may be found in HCl was added to the ash before it was brought to the requisite volume in a 100 cm standard flask with 0.36 ml HCI. This was done to prepare the sample for analysis by atomic absorption spectrophotometer before the mineral elements were determined (Agilent Technologies 4210 MP-AES). [21].

2.2.3. Total phenolic and flavonoids

Two studies [22-23] looked at the total phenolic and flavonoid content of the samples, and the results were similar.

2.2.4. Phenolic and flavonoid compounds

Using high-performance liquid chromatography, the researchers were able to detect and quantify phenolic and flavonoid compounds in samples using a method reported by [24-25].

2.2.5. Antioxidant activity

Following the method described by [26], the antioxidant activity of the compounds was evaluated using the stable diphenyl-1-picryl-hydrazine (DPPH) in line with the method As previously disclosed [27], the presence of ABTS 2,2′-azinobis (3-ethyl benzothiazoline-6-sulfonate was determined by utilizing the procedure described above.

2.2.6. Biological Experimental Design

The animals were kept in plastic cages and provided a basic diet consisting of grains and vegetables. Following Table 1, which contained water ad libitum for one week as an adaptation period, the container was sealed. The temperature in the animal room was maintained at 21°C 2 with scheduled illumination 12 hours a day and relative air humidity of 40-60 % throughout the experiment. Following the adaptation phase (which lasted one week), the rats were separated into six groups using a random number generator. Animals in Group (1) were fed on a baseline diet for the whole study period, serving as a negative control. According to [28], the STZ (40 mg/kg BW) [29]. was administered to the rat in Groups (2-6) to induce vomiting. Dietary restriction was followed by intraperitoneal administration of STZ, which dissolved 0.1M cold citrate buffer, pH 4.5, in a single dosage after the rats had fasted for 8-10 hours. After that, the rats were given a glucose solution (10 %) to drink to overcome the hypoglycemia caused by the medication. After a week, the rats' blood glucose levels were measured and evaluated. Glycemia levels less than 250 mg/dl were chosen for future investigation. During the study period, the diabetic rats in (G2) were given a baseline diet, which served as a positive control. Additionally, diabetic rats in (G3) were given a baseline diet throughout the experimental period, but they were administered with 10 mg glibenclamide/Kg BW rat/days for the duration of the study. During the trial period, the medication was administered via a stomach tube (8 weeks). The G4 and G5 groups were treated separately, whereas the G6 group was treated together. Instead of fiber, carob, doum, and cinnamon powder were used as flavoring agents (5 % of diet). as seen in Table 1. During the study phase, the rats were weighed once a week. All animal experiments were conducted according to the guidelines of the National Institute of Health Guide for laboratory animal care and use (NIH Publications No. 8023, revised 1978).

2.2.7. Blood analysis

To evaluate the serum that has been separated, the following tests were performed:

For the biochemical tests, it was essential to collect blood samples and spin them at 3000 rpm for 5 minutes to get serum samples, which were then used for the tests themselves (Glucose, total cholesterol TC, HDL-c, triglyceride TG, AST, ALT, urea, creatinine, and uric acid).

a. The determination of serum glucose was carried out following the technique described in [30]. The following equation 1 was used to determine the glucose concentration in the blood:

Glucose (mg/dl) = (A sample)/ (A standard) x 100 (1)

b. The number of triglycerides [TG] in the blood is determined. It was determined that the concentration of triglycerides in serum was estimated using the approach described in equation 2 [31].

Triglycerides (mg/dL) = (A sample)/ (A standard) x 200 (2)

c. Determination of cholesterol profile

In this test, the total cholesterol levels are assessed (TC). It was decided to use the enzymatic approach described by [32] for the calorimetric measurement of cholesterol. The following equation 3 was used to assess whether there was a cholesterol concentration present:

Table 1: Composition of diets (g/100g DM).

Item g/100g	Control (-)	Control (+)	Drug	Carob Powder	Doum Powder	Cinnamon Powder
Protein	12	12	12	3.2	1.2	1.3
Fat	10	10	10	3.55	1.8	1.9
Salt mixture	4	4	4	4	4	4
Vitamin mixture	1	1	1	1	1	1
Sugar	10	10	10	10	10	10
Choline chloride	0.2	0.2	0.2	0.2	0.2	0.2
Cellules(fiber)	5	5	5	59	40	30.3
Corn starch	57.8	57.8	57.8	-	-	-
Carob Powder	-	-	-	19.05	-	-
Doum Powder	-	-	-	-	41.8	-
Cinnamon Powder	-	-	-	-	-	51.3

Total cholesterol = (A sample)/ (A standard) x 200 (3)

According to [33], the high-density lipoprotein cholesterol (HDL-cholesterol) was tested by using the method described in the paper in question. According to the following equation 4 was used to calculate the amount of very-low-density lipoprotein cholesterol (VLDL-C) in the blood.

VLDL-C (mg/dL) = Triglycerides/5 (4)

The low density of lipoprotein cholesterol [LDL-C] level was calculated using the following equation 5 :

LDL-C [mg/dL] = TC – [VLDL + HDL] (5)

2.2.8. Liver function estimation

The activity of the enzymes alanine aminotransferase (ALT) and aspartate aminotransferase (AST) in the serum were determined using the method described by [34].

2.2.9. kidney function estimation

It was determined that there was urea present using the approach described in [35]. It was decided to use the accompanying equation 6 approaches of [36] for determining creatinine levels in the bloodstream.

Creatinine in mg/dl= A Sample/ A Standard 2 (6)

Uric acid concentration in serum was estimated using equation 7 of the approach described by [37].

Uric acid in the sample (mg/dl) = A Sample/ A Standard x n (7)

2.2.10. Statistical analysis

The people who use the statistical analysis used the data that had been gathered was made available to the User's Guide (SPSS.V.19). Duncan's multiple range tests were carried out for the [38]. at a threshold of significance of 5 % .

The histological examination consists of the following procedures:

After being removed from (pancreas, liver, and kidney) of rats in separate groups, autopsy samples were fixed in 10 % formal saline for twenty-four hours before being employed in the experiment. Following a thorough washing with tap water, dehydration was induced by the application of a succession of dilutions of methyl alcohol and 100 % ethyl alcohol to the skin A hot air oven at 56 degrees Celsius was used to embed the specimens in paraffin for twenty-four hours after they had been cleaned in Xylene. A sludge microtome was used to make paraffin beeswax tissue blocks for sectioning at a thickness of 4 microns, which were then sectioned. Tissue slices were collected on glass slides, deparaffinized, and stained with hematoxylin and eosin stains after being deparaffinized and mounted on slides. To conduct histological investigations under a light microscope[39].

3. Result and discussion

3.1. Chemical composition and phytochemical contents

Carob, doum, and cinnamon powders have different chemical compositions, which are shown in Table 2. It was found that carob powder contained the greatest levels of protein, carbs, and calories (5.49 %, 76.85 %, and 383 kcal), among other things. While doum had the greatest concentration of ash (7.12 %), cinnamon had the second-highest concentration (4.28 %), and carob had the lowest concentration of ash (0.3 %) (3.31 %). Additionally, the cinnamon powder included the largest amounts of fiber (16.50 %) and fat (6.60 %). These findings are consistent with [40-42].

3.1.1. Total phenolic acids and flavonoids

Doum powder has a higher total phenolic acids and flavonoids content (64.78) than cinnamon (64.38) and carob (57.22) mg/gm. Doum powder also has a higher polyphenols concentration (64.78) than cinnamon (64.38) and carob (57.22) mg/gm. Our results demonstrate unequivocally that antioxidant capabilities may be found in all plants. The antioxidant activity of doum powder was shown to be much higher than that of other antioxidants when compared to the 1,1-diphenyl-2-picrylhydrazyl radical (DPPH). Polyphenols are found in high concentrations in both carob and cinnamon powders (89.95% in carob powder and 88.09% in cinnamon powder), both of which have powerful antioxidants and reducing activities and maybe a beneficial source of natural antioxidants. Carob powders have high concentrations of polyphenols, while cinnamon powder includes high concentrations of cinnamon powders. Additionally, it was shown that doum powder had much greater amounts of flavonoids than any other powder, with 10.91 mg/g, followed by cinnamon powder and carob powder, with 8.56 and 1.12 mg/g, respectively, and that cinnamon powder and carob powder were the least effective. That was corroborated by the results that were obtained. The antioxidant properties of phenolic acids and flavonoids are enhanced by the fact that they are also beneficial for medical and nutritional purposes. Phenolic and flavonoid compounds have been found to have a preventive impact on the development of cancer, inflammation, atherosclerosis, and thrombosis, and they have a high antioxidant capacity. The presence of flavonoids in the body has been found to block the enzyme aldose reductase, which prevents the activation of the sorbitol pathway, which has been linked to a range of diabetes problems.Their interaction with a broad variety of enzyme systems, such as the enzymes cyclooxygenase and lipoxygenase, results in a decrease of platelet activation and aggregation, as

well as cardiovascular disease prevention, cancer chemoprevention, and anti-inflammatory properties.Additional biological effects of flavonoids and phenolic acids are known, including antiviral, antibacterial, and antihepatotoxic characteristics [43]. Flavonoids and phenolic acids have also been shown to exhibit antioxidant capabilities [44].

3.2. Fractions of phenolic and flavonoid compounds identified by HPLC

The phenolic and flavonoid components in carob, doum, and cinnamon powders were fractionated and identified using the HPLC technique, and the findings are reported in Tables 3,4. It was discovered that 19 phenolic compounds and 14 flavonoids compounds were detected with varying amounts in Tables 3,4, indicating that phenolics have a role as an antioxidant in modifying cardiovascular risk factors, which merits further investigation [45]. To counteract this, several flavonoids and polyphenols are more effective antioxidants than vitamins [46].

Table 2: Chemical composition and antioxidant profile of raw materials (on dry weight)

Items %	Sample name		
	Carob	Doum	Cinnamon
Moisture	6.71	3.55	4.93
Protein	5.49±0.36 [a]	2.99±0.04 [c]	4.24±0.13 [b]
Ash	3.13±0.03 [c]	7.12±0.04 [a]	4.28±0.04 [b]
Fat	6.01±0.03 [b]	3.93±0.03 [c]	6.60±0.03 [a]
Fiber	8.52±0.03 [c]	12.51±0.06 [b]	16.5±0.08 [a]
Carbohydrates	76.85±0.33 [a]	73.45±0.16 [b]	68.38±0.04 [c]
Energy value (kcl)	383	341	350
	Minerals (mg/100g)		
K	1707.94	528.71	923.53
Mg	189.09	695.41	447.14
Mn	1.59	0.20	65.01
Na	61.51	158.95	891.13
Ca	1051.59	1396.78	2226.83
P	18.85	56.63	17.98
Fe	18.65	30.60	22.92
Cr	0.40	1.39	0.59
	Antioxidant profile		
Total phenolic content (mg Gallic/100 g)	57.22±2.19[c]	64.78±2.79[b]	64.89±0.63 [a]
Total flavonoid content (mg quercetin/100g)	1.12±0.18 [c]	10.91±0.38[a]	8.56±0.29[b]
Radical scavenging activity (DPPH, %)	89.95±2.48[b]	93.34±2.65[a]	88.09±2.26[c]
ABTS%	81.90±1.95[b]	92.21±1.50[a]	70.13±1.63[c]

Table 3: Identification of phenols (mg/100g) in Carob, Doum, and Cinnamon powder by HPLC-**(High Performance Liquid Chromatography)**

Polyphenol's components	Carob	Doum	Cinnamon
	(mg/100g)		
Pyrogallol	201.472	34.722	62.166
Gallic	17.875	1.008	11.458
Protocatchoic	2.21	2.838	3.098
4-Aminobenzoic	1.311	3.529	1.954
Catechein	3.642	36.013	18.689
Chlorogenic	3.539	10.747	7.117
Catechol	5.899	ND	11.104
P-OH- benzoic	10.963	12.371	7.53
caffeic	0.25	0.857	0.351
Vanillic	1.476	8.442	5.561
Caffeine	1.83	12.889	3.802
P-Coumaric	0.381	3.588	0.594
Ferulic	0.653	1.074	1.95
Iso-Ferulic	0.486	0.292	1.843
Salycillic	10.783	5.826	23.587
Benzoic	23.911	4.183	294.828
Coumarin	0.804	0.363	2.036
3,4,5-methoxy-cinnamic	0.598	0.773	4.047
Cinnamic	1.817	0.14	244.028

ND**:** Not Detected

Table 4: Effect of feeding with different experimental diets on serum Glucose (mg/dl) of diabetic rats

Groups	Glucose (mg/dl)	
	After one week	After eight weeks
Negative group	94.71±4.21 [b]	101.92±4.73 [d]
Positive group	689.61±6.36 [a]	649.23±1.81 [a]
Standard drug	689.61±6.36 [a]	149.41±1.15 [b]
Carob powder	689.61±6.36 [a]	115.94±1.69 [c]
Doum powder	689.61±6.36 [a]	118.6±3.86 [c]
Cinnamon powder	689.61±6.36 [a]	114.31±4.06 [c]
LSD (p<0.05)	11.20	5.67

Table 4 shows the impact on diabetic rats' blood glucose levels after feeding carob, doum, and cinnamon powder. Diabetes rats treated with a medication exhibited the lowest drop in blood glucose levels of diabetic rats after 8 weeks of feeding (78.33 %). Diabetes rats were given cinnamon powder had the greatest reduction in blood glucose (83.42 %) and (82.39 %) compared to diabetic rats in positive control after eight weeks of powder feeding. Carob, doum, and cinnamon powder improved diabetic rats' blood glucose levels more than conventional medicines, according to the results of this study. Diabetes is now far more common than it used to be. Obesity, coronary heart disease, and insulin sensitivity are the most common causes of insulin resistance [47]. To prevent and cure diabetes, lowering blood glucose levels is critical [48]. It was shown that STZ at a dosage of 40mg/kg considerably raised blood glucose levels to (628.13 %) at zero time and compared to (537 %) after the experimental diabetic rats in the negative control group. Adiponectin levels are elevated, and insulin's hypoglycemic effect is enhanced, which Doum attributes to flavonoids [49]. Aside from that, traditional and folk medicine uses Cinnamomum zeylanicum as a flavoring ingredient. Because it includes flavonoids, carotenoids, and polyphenols, it has anti-inflammatory properties. By preventing glucose from entering the circulation via the intestines, also lowers blood glucose levels. STZ diabetic rats treated with cinnamon saw a considerable reduction in their blood glucose levels. Lipemic-oxidative health is also improved. Table 4 shows that Carob, Doum, and Cinnamon powder had a positive impact on blood Total cholesterol levels in diabetic rats (TC). After eight weeks of feeding, the diabetic rats in G3 received the conventional medication treatment, which resulted in the lowest drop in blood TC levels (38.90 %) when compared to the positive control of diabetic rats. Doum powder given diabetic rats exhibited the greatest drop in serum TC (40.07 %), but cinnamon and carob

powder fed diabetic rats had statistically identical drops (39 %). Carob, Doum, and Cinnamon powder reduced serum TC in diabetic rats more effectively than the conventional medication treatment for diabetic rats. Diabetes rats given medication as the conventional treatment had the lowest rise in HDL-C levels (33.26 %), whereas rats fed Carob (66.91 %) and Doum (66.91 %) had the largest increase (60.30 %). In the positive control, the diabetic rat with the lowest drop in blood LDL-Clevel was treated with medication as usual (54.78 %) for 8 weeks whereas the Cinnamon-fed rats (33.26 %). Doum powder-fed diabetic rats exhibited the greatest reduction in LDL-C (63.60 %), but carob powder and cinnamon powder-fed diabetic rats were statistically equivalent (60 %). as compared to rats with diabetes in a positive control study. A comparable impact on serum TG and VLDL-C levels was seen when diabetic rats were fed the same amounts of carob, doum, and cinnamon powder. Cinnamon treatment improved TG and VLDL-C in diabetic rats by 36.12% and 28.68%, respectively. Diabetic rats given Doum powder showed the least reduction in weight (28.68 %). Cinnamon powder, Doum, and Carob powder were shown to enhance HDL-C, LDL-C, and triglyceride levels in diabetic rats more than usual medications.

The total cholesterol, HDL, LDL, and VLDL levels in diabetic rats fed on Carob were all dramatically reduced. Carob's increased antidiabetic effect may be due in part to its antioxidative properties. Increased insulin secretion and decreased hormone-sensitive lipase activity are two ways flavonoids reduce insulin resistance [50-56]. Polyphenols in Cinnamomum cassia and Cinnamomum zeylanicum have insulin-like action and a hypoglycemic impact, according to [57]. Cinnamon is also known to lower cholesterol. In HFD rats, insulin resistance may be prevented by activating the nitric oxide route of insulin signaling [58]. Intestine insulin resistance may be alleviated by increasing postprandial intestinal apo B-48-overproduction in the management of lipid metabolism [59,60]. A study conducted on cinnamon extract found that it has the potential to promote mitochondrial UCP-1 and GLUT4 translocation in muscle and adipose tissues, which was beneficial in the treatment of type 2 diabetes [61]. Previous research has shown that the regulation and expression of glucose homeostatic enzymes, such as glucokinase (GK), glucose-6-phosphatase (G6Pse), phosphoenolpyruvate carboxykinase (PEPCK), glucose-6-phosphate dehydrogenase (G-6-PDH), and insulin II (Ins II), may be enhanced. Carob significantly lowers total cholesterol, HDL, LDL, and VLDL in diabetic rats, as well as in humans. Following a previous investigation, our findings are compatible with [62]. Carob's heightened antidiabetic efficacy is mostly owing to its antioxidative qualities, which are found in high concentrations in the fruit. In addition to increasing insulin secretion and lowering hormone-sensitive lipase activity, flavonoids have been shown to decrease insulin resistance [52-54]. As shown in Table 4, there is a significant relationship between lipoprotein ratios, such as total cholesterol to HDL-c and LDL to HDL-c, and the risk of coronary heart disease (CHD). A trend like that seen in the serum TC and LDL-c ratios of rat groups was observed in the acquired ratios. At the start of the experiment, the TC/HDL-c and LDL-c/HDL-c risk ratios ranged from 3.42 to 3.61 and from 1.93-2.09, respectively, for each animal group. After eight weeks of feeding, serum rats with high TC/HDL-c and LDL-c/HDL-c ratios were observed (control positive). The serum concentrations of 6.61-2.68 and 4.70-1.27 in the negative control group, respectively, were greater than the concentrations of 6.61-2.68 and 4.70-1.27 in the positive control group. The weight and body mass of the rats fed on (control positive + drug) increased moderately, with mean values of 3.03 and 1.60 approaching those of the control group, respectively. When comparing serum TC/HDL-c and LDL-c/HDL-c ratios in animal groups given carob, doum, and cinnamon powder to serum ratios in the control rats' group, the ratios in the carob, doum, and cinnamon powder groups were reduced to 2.40, 1.13, 2.68, 1.16, 2.68, and 1.27. After eight weeks, carob doum and cinnamon powder significantly lowered this ratio in diabetic rats when compared to a diabetic rat in positive control. During the feeding period, rats fed high-STZ diets (positive controls) had an increasing impact on the risk ratios as the feeding period continued. About LDL-c and HDL-c, the corresponding ratios were 6.61 and 4.70, respectively, which were considerably higher than those of the control negative rats' group as well as those of the other groups of rats studied. The use of carob, doum, and cinnamon powder had a good influence on the renal functions of diabetic rats, according to Table 5, but conventional drugs did not affect the kidney functions of diabetic rats, according to Table 6. (40 %). Diabetes rats fed a meal containing doum powder (47.85 %) and carob powder (47.35 %) had lower uric acid levels than diabetic rats fed a meal containing standard medication (48.14 %) and Doum powder (47.85 %). Diabetic rats fed a meal containing standard medication (48.14 %) and Doum powder (47.85) had lower levels of urea than diabetic rats. According to many studies, diabetic rats exhibited greater ALT, AST, and ALP concentrations than non-diabetic rats [63,64]. Diabetes is associated with hepatocellular damage. Compared to the positive control group (STZ non-treated), carob significantly lowered liver enzymes in diabetic rats from 46.72 4.09 to 33.11

1.77, but they were 47.44a 3.23 and 56.66a 5.80 in the negative control group (STZ treated). Several studies have connected carob components to improved liver health [63]. It is also important to remember that the carob has a significant amount of fructose, which causes stomach emptying to take longer and digesting to take longer. Through their antioxidant action, the flavonoids and phenolic components of the carob may have the ability to promote insulin secretion [63,64].

Table 5: Effect of feeding with different experimental diets on liver and kidney functions of rat

GROUPS	Liver Enzymes(U/L)				Kidney Function (mg/dl)					
	ALT (GPT)		AST (GOT)		Creatinine		Uric acid		Urea	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Negative group	$27.21^{b}\pm1.53$	$26.45^{e}\pm3.10$	$35.88^{c}\pm2.70$	$35.45^{d}\pm1.93$	$0.51^{b}\pm0.06$	$0.57^{e}\pm0.068$	$1.35^{b}\pm0.26$	$1.37^{c}\pm0.28$	$34.72^{c}\pm1.13$	$34.56^{b}\pm1.19$
Positive group	$47.44^{a}\pm3.23$	$56.66^{a}\pm5.80$	$60.91^{a}\pm1.63$	$74.00^{a}\pm1.26$	$1.21^{a}\pm0.21$	$1.25^{a}\pm0.253$	$2.39^{a}\pm0.38$	$3.22^{a}\pm0.20$	$47.81^{b}\pm2.13$	$63.08^{a}\pm2.31$
Standard drug	$45.93^{a}\pm3.24$	$31.65^{de}\pm1.02$	$57.54^{ab}\pm4.41$	$43.11^{bc}\pm2.75$	$1.21^{a}\pm0.21$	$0.79^{cd}\pm0.038$	$2.65^{a}\pm0.09$	$1.67^{c}\pm0.14$	$49.13^{b}\pm5.64$	$35.88^{b}\pm1.00$
Carop powder	$46.72^{a\pm}4.09$	$33.11^{cd}\pm1.77$	$56.96^{ab}\pm1.71$	$41.21^{c}\pm2.81$	$1.17^{a}\pm0.186$	$0.75^{d}\pm0.034$	$2.21^{a}\pm0.38$	$2.44^{b}\pm0.37$	$56.65^{a}\pm0.73$	$33.21^{b}\pm2.11$
Doum powder	$47.54^{a}\pm2.21$	$38.32^{bc}\pm2.05$	$57.93^{ab}\pm3.70$	$47.95^{b}\pm1.59$	$1.19^{a}\pm0.210$	$0.94^{bc}\pm0.056$	$2.59^{a}\pm0.23$	$1.68^{c}\pm0.15$	$47.31^{b}\pm1.52$	$34.39^{b}\pm1.89$
Cinnamon powder	$43.25^{a}\pm2.11$	$42.45^{b}\pm2.19$	$53.14^{b}\pm0.93$	$45.12^{bc}\pm5$	$1.21^{a\pm}0.21$	$1.08^{b}\pm0.044$	$2.7^{a}\pm0.17$	$1.81^{c}\pm0.16$	$48.14^{b}\pm2.43$	$36.40^{b}\pm2.22$
LSD 0.05	5.10	5.45	4.98	5.05	0.147	0.250	0.49	0.42	4.95	3.31

Table 6: Effect of feeding with different experimental diets on serum total lipid (mg/dl) of rats.

Groups	TC		HDL		LDL		VLDL		TG		RF		Ai	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Ai	Af	Bi	Bf
Negative group	74.89^{b}	74.26^{c}	44.44^{a}	43.32^{a}	17.32^{b}	16.92^{d}	13.12^{b}	14.02^{cd}	65.62^{b}	70.11^{cd}	1.69	1.71	0.39	0.39
Positive group	126.48^{a}	185.93^{a}	36.93^{b}	28.14^{c}	71.22^{a}	132.34^{a}	18.31^{a}	25.44^{a}	91.58^{a}	127.23^{a}	3.42	6.61	1.93	4.70
Standard drug	123.72^{a}	113.60^{b}	33.39^{b}	37.50^{b}	71.57^{a}	59.84^{b}	18.75^{a}	16.25^{bc}	93.79^{a}	81.27^{bc}	3.71	3.03	2.14	1.60
Carop powder	$129.33^{a}\pm1.88$	112.76^{b}	35.27^{b}	46.97^{a}	75.2^{a}	53.06^{bc}	18.87^{a}	12.73^{d}	94.28^{a}	63.66^{d}	3.67	2.40	2.13	1.13
Doum powder	124.19^{a}	111.42^{b}	35.88^{b}	41.61^{a}	69.55^{a}	48.16^{c}	18.75^{a}	18.14^{b}	93.79^{a}	90.74^{b}	3.46	2.68	1.94	1.16
Cinnamon powder	127.58^{a}	111.72^{b}	35.38^{b}	41.61^{b}	73.94^{a}	52.71^{bc}	18.25^{a}	17.40^{b}	91.26^{a}	87.01^{b}	3.61	2.68	2.09	1.27
LSD	5.28	7.51	4.67	5.21	8.40	8.84	1.14	2.73	5.73	13.68	-	-	-	-

A(Risk factor) =TC/HDL-C. B(Athearogenic Index)=LDL-C/HDL-C.,Ai ,Bi (intial).Af ,Bf (final),;LSD: least significant difference.

3.3. Histopathological Changes of The Pancreas

Micrograph A: The pancreas of rats from the control negative group, showing no histopathological abnormalities (H&E); Micrograph B: The pancreas of rats from the control positive group, showing no histopathological abnormalities (H&E); Fig. 1 shows the micrographs A and B: The pancreas of rats from the control negative group, showing no histopathological abnormalities (H&E); (H&E). The pancreas taken from the control positive group showed vacuolation of cells in the islets of Langerhans and congestion of blood capillaries (H&E); (Micrograph C) - The pancreas taken from the standard group glibenclamide showed normal islets of Langerhans (H&E); (Micrograph D) - The pancreas taken from the control negative group showed normal islets of Langerhans (H&E); Neither histological nor histochemical changes were seen in the pancreas of rats from group 1 (rats given carob powder), which was a control group (Micrograph E). It was discovered that no histological nor biochemical changes occurred in the pancreas of rats from group 2 (rats fed on doum powder) (H&E). On micrograph F (Micrograph F), group 3 rats (rats given cinnamon powder) showed no histological changes in their pancreas, but group 2 rats showed

changes in their pancreas. The pancreas of rats from the control negative group did not show any signs of hepatopathological changes, and this was confirmed
According to the results of the study, vacuolation of the epithelial cells lining the pancreatic acini, localized bleeding, vacuolation of islets of Langerhans cells, and congestion of blood capillaries were observed in the pancreas of rats from the control positive group, but no such findings were observed in rats from the control negative group (photomicrograph B). After being inspected under a microscope (photomicrograph C) it was discovered that the exocrine units, as well as the endocrine components of the pancreas, were in their normal structural configuration. The islets of Langerhans seemed to be of normal size and to contain enough -cells.

Fig. 1: Histopathological Changes of the Pancreas

There were no histological changes seen in specific sections from the groups (rats fed a diet consisting of carob powder, doum powder, and cinnamon powder), however, there were histological changes observed in other parts (photomicrograph D, E&F). Given the high cost of synthetic pharmaceuticals, as well as the possibility of side effects from these treatments, we recommend that the powders of three plants (carob, doum, and cinnamon) be used as a novel treatment option for diabetic, obese, and atherosclerotic patients who are suffering from these conditions [64,65].

Conclousion

The result presented in this paper indicate that. Carob, doum, and cinnamon powder have great potential as a food or feed due to their high content of phenols, flavonide, antioxidant and fiber which reduced the levels of blood gloucose in diabetic rats and useful for human nutrition

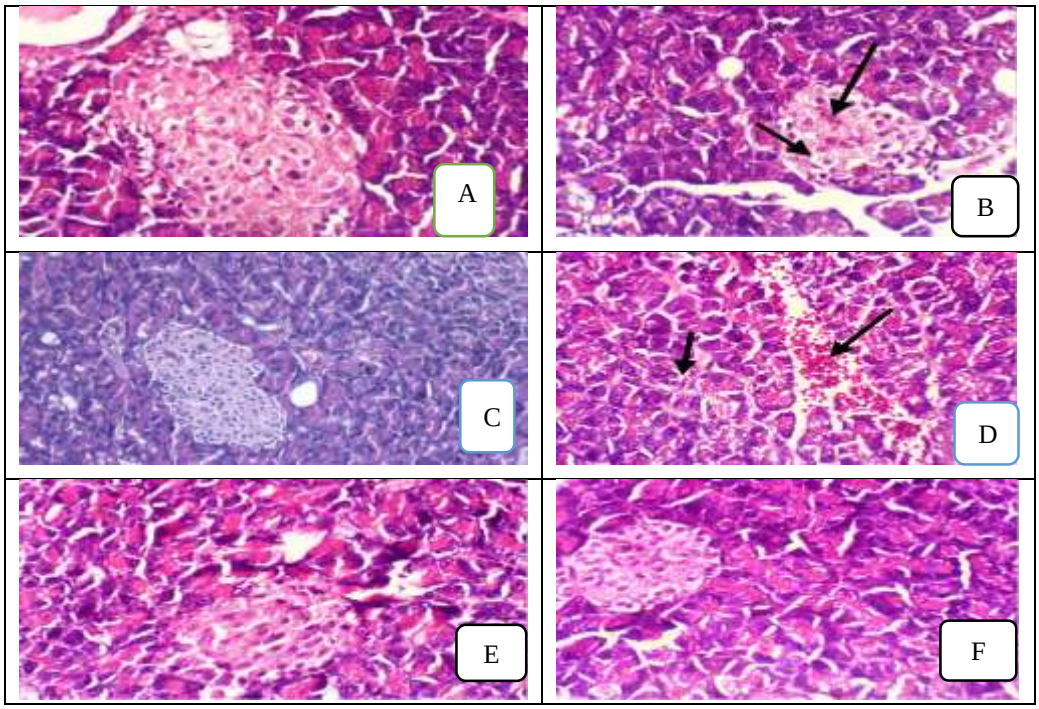

Fig. 1: Histopathological changes in pancreas tissue sections.
Micrograph A: Negative control
Micrograph B: Positive control
Micrograph C: Diabetic rat +standard drug
Micrograph D: Diabetic rat +carob powder
Micrograph E: Diabetic rat +doum powder
Micrograph F: Diabetic rat +cinnamon group

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تأثير مسحوق الخروب والدوم والقرفة على مستوى الدهون في الدم في الفئران المصابة بمرض السكرى

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الملخص العربى

تهدف هذه الدراسة لمعرفة تأثير مسحوق (الخروب والدوم والقرفة)على دهون الدم لدى الفئران المصابة بداء السكري. خلال التجربة ، تم توظيف ٣٦ من ذكور الجرذان البالغة. بعد أن أتيحت الفرصة للفئران للتكيف مع محيطها الجديد ، تم تقسيمها إلى ست مجموعات بشكل عشوائي. تم استخدام المجموعة ١ كعنصر تحكم سلبي وتم تغذيتها بنظام غذائي بسيط طوال مدة البحث. تم إعطاء(STZ) (40) مجم / كجم من وزن الجسم) للجرذان في مجموعات من اثنين إلى ستة. بمجرد أن أصيبت الفئران بداء السكري في المجموعة ٢ بمرض السكري ، توقف استخدامها كعنصر تحكم إيجابي. تم إعطاء عقار جليبنكلاميد (١٠ ملجم / كجم من وزن الجسم / يوم عن طريق الفم) (كدواء قياسي). للمجموعة التي كانت تتغذى على نظام غذائي عادي للمجموعة (٣) . وتم اعطاء مساحيق النباتات محل الدراسة في الوجبات كبديل للالياف بنسبة ٥%.فكانت المجموعة (٤) مسحوق الخروب المستعمل مع الوجبات و المجموعة (٥) مسحوق دوم والمجموعة (٦) مسحوق القرفة المستعمل (٦). بعد التجربة ، أظهرت النتائج استخدام النباتات ادى اللى انخفاض مستويات مصل LDL-c و TC و TG ، لكن نسب HDL-C زادت بشكل كبير خلال مرحلة التغذية. وكذلك أنخفاض مستويات إنزيمات GOT و GPT في الدم في الجرذان مقارنة بوجبات التحكم الإيجابية. جميع الحميات التي تم فحصها كانت لها نفس النتيجة. بالإضافة إلى ذلك ، كان لدى الفئران المصابة بداء السكري وظيفة كلوية أفضل من الفئران المصابة بداء السكري تحت السيطرة الإيجابية. شوهدت اختلافات في الأنسجة في بنكرياس الجرذان المصابة بداء السكري مقارنة بالحيوانات التي أعطيت الخروب والدوم و القرفة.