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EFFECT OF CINNAMON BISCUIT AND CINNAMON AQUEOUS EXTRACT ON SERUM GLUCOSE OF DIABETIC RATS AS HYPOGLYCEMIC AGENT.

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ABSTRACT

The anti-diabetic effect of cinnamon biscuit (CB) and cinnamon aqueous extract (CAE) in type I diabetic rats was studied. Cinnamon biscuit which made by replacement 15% of wheat flour with cinnamon powder and cinnamon aqueous extract at two doses (5 and 10ml/day/kg body weight) was administered to different groups of diabetic rats' diet for 8 weeks. The results showed that, the serum glucose concentration significantly decreased in groups which administrated with Cinnamon Biscuit (CB) or cinnamon aqueous extract (CAE) compared with the diabetic control. Also, the concentrations of serum triglyceride (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), urea and creatinine, activity of alanine amino transferase (ALT) and activity of aspartate amino transferase (AST) were significantly decreased after 8 weeks of the administration. On the other hand, serum high density lipoprotein cholesterol (HDL–C) level was significantly increased. These results suggested that cinnamon has a regulatory role in blood glucose level and serum lipids and the most significant effect showed in the group administrated with CAE (10ml/day/kg body weight).

Keywords: cinnamon**;** cinnamon biscuit; chemical composition; sensory evaluation; anti-diabetic**;** serum glucose; cholesterol; transferase; urea; creatinine

INTRODUCTION

Diabetes mellitus (DM) is widely recognized as one of the leading causes of death in the world. It is defined as a state in which homeostasis of carbohydrate and lipid metabolism is improperly regulated, resulting in elevated blood glucose levels. The long-term effects of DM include dysfunction and failure of various organs (Devendra *et al.*, 2004).

Diabetes mellitus is a chronic metabolic disorder affecting approximately 4% population worldwide and is expected to increase by 5.4% in 2025 (Kim *et al.*, 2006). It is characterized by abnormalities in carbohydrate, lipid and lipoprotein metabolism, which not only lead to hyperglycemia but also cause many complications, such hyperlipidemia, hyperinsulinemia, hypertension and atherosclerosis (Chait and Brunzell., 1996). Diabetes mellitus is classified as: insulin-dependent diabetes mellitus (IDDM) and non-insulin-dependent diabetes mellitus (NIDDM). About 90% of patients are NIDDM with insulin resistance playing a key role in the development of the disease (Fuller *et al.*, 1980). Insulin resistance includes decreased stimulation of muscle glycogen synthesis, defects in glycogen synthesis and hexokinase activity (Müller *et al.*, 1973). Plants have been used for the treatment of diabetes since 1550 BC (Gray, and Flatt, 1997). These plants are important for the prevention and control of type 2 DM, especially for people with elevated levels of blood glucose and glucose intolerance who have a greater risk of developing diabetes. Plant seeds, fruits, leaves, and bark contain polyphenols. These compounds are the end products of the flavonoid biosynthetic pathway in plants and are used by plants for the protection against predators (Dixon *et al.*, 2005). Plant polyphenols are also widely present in the diet (Prior and Gu, 2005) and are important for human health (Yang *et al.*, 2001). Cinnamon is one of the traditional folk herbs used in Korea, China and Russia for diabetes mellitus (Bailey and day, 1989 and Chung, 1994). Cinnamon is the bark of the *Cinnamomi cassiae* (*Lauraceae*). Cinnamic aldehyde (Wijesekera, 1978), cinnamic acid (Hiromu *et al.*, 1974), tannin (Inokuchi *et al.*, 1984) and methylhydroxychalcone polymer (MHCP) (Jarvull-Taylor *et al.*, 2001) are its main components.

Cinnamon extract decreases blood glucose in Wistar rats (Qin *et al.*, 2003) and cinnamon increases the insulin sensitivity and glucose uptake in adipocytes (Jarvull-Taylor *et al.*, 2001). Cinnamaldehyde was administered at different doses (5, 10 and 20 mg/ kg bwt) for 45 days to streptozotocin (STZ) (60 mg/ kg bwt)-induced diabetic male Wistar rats. It was found that plasma glucose concentration was significantly ($p < 0.05$) decreased in a dose-dependent manner (63.29%) compared to the control. In addition, oral administration of cinnamaldehyde (20mg/ kg bwt) significantly decreased glycosylated hemoglobin (HbA1C), serum total cholesterol, triglyceride levels and at the same time markedly increased plasma insulin, hepatic glycogen and high-density lipoprotein-cholesterol levels. Also cinnamaldehyde restored the altered plasma enzyme (aspartate aminotransferase, alanine aminotransferase, lactate dehydrogenase, alkaline phosphatase and acid phosphatase) levels to near normal levels (Subash Babu *et al.,* 2007). Cinnamon exhibits the potential to increase the amount of proteins involved in insulin signaling, glucose transport and anti-inflammatory/ anti-angiogenesis response (Heping *et al.*, 2007). A cinnamon extract improves the postprandial overproduction of intestinal apoB48-containing lipoproteins by ameliorating intestinal insulin resistance and may be beneficial in the control of lipid metabolism (Qin *et al.*, 2009). The conventional pharmacological treatments for type II diabetes have a number of limitations, such as adverse effects and high rates of secondary failure. However, medicinal herbs are expected to have a similar degree of efficacy without the troublesome side effects associated with conventional drug treatment. So the aim of this work was to investigate the effect of administration cinnamon biscuit (15% cinnamon powder) and oral administration of cinnamon aqueous extract (CAE) on serum glucose, total cholesterol, triglycerides, high density lipoprotein cholesterol (HDL–C), low-density lipoprotein cholesterol (LDL-C), urea and creatinine, activity of alanine amino transferase (ALT) and activity of aspartate amino transferase (AST) in diabetic rats.

MATERIALS AND METHODS

Materials:

Cinnamon Bark:

Commercial cinnamon bark was obtained from local market- Giza, Egypt.

Wheat flour:

Commercial wheat flour extraction 72% was obtained from local market- Giza, Egypt.

Animals:

Thirty (30) adult male winster albino rats weighing 170g to 190g were obtained from the experimental Animal house of Agriculture Research Center, Giza, Egypt,

Source of Kits and Streptozotocin:

Kits of glucose; Total Cholesterol (T. Chol.); HDL–Cholesterol (HDL-C); Triglycerides (TG); ALT; AST; Urea and Creatinine were obtained from El Massrry Medical Services Co., 1 El-Diroty St., El Kalaa -Cairo, Egypt. Streptozotocin (STZ) was obtained from Sigma Chemical Co., Saint Louis, Missouri, USA.

Methods:

Chemical analysis of cinnamon:

Cinnamon bark was ground then the moisture, crude protein, crude fiber, total lipid and ash contents were determined according to the methods outlined (AOAC, 2000). Total hydrolysable carbohydrates were determined according to the method described by Montgomry (1961).

Preparation of cinnamon aqueous extract (CAE):

The cinnamon aqueous extract (CAE) was prepared by soaking 10g of the cinnamon powder in 100 ml water at 60°C for 2 h. The suspension was then centrifuged (700 G, 5 min) at room temperature and the supernatant was saved as a 10% stock extract to use in subsequent experiments (Kannappan *et al*., 2006).

Preparation of Marie biscuits:

Rolled Marie Biscuit was prepared according to the method of Wade (1988). The wheat flour in the formula of the biscuits (control), 100g were replaced with cinnamon powder at 5, 10, 15 and 20 %. Rolled Marie Biscuits ingredients were illustrated in Table 1.

Table 1: Rolled Marie Biscuits Ingredients.

Ingredients	Amounts (g)
Wheat flour	100
Sugar	34
Milk butter	27
Powdered skimmed milk	11.2
Ammonium bicarbonate	0.4
Sodium Carbonate	0.8

Organoleptic evaluation of biscuits:

Rolled Marie Biscuits were evaluated organoleptically by 10 experienced panelists from Food Technology Research Institute (FTRI) according to Amerine *et al.* (1965). The score sheet of sensory evaluation of Rolled Marie Biscuits was illustrated in Table 2

Table 2: Score sheet of sensory evaluation of Rolled Marie Biscuits.

Item	Degree
Shape	10
Crust color	15
Crumb color	10
Texture	15
Odor	10
Taste	30
Chewing	10
Total score	100

Gas chromatography/Mass spectrometry GC/MS spectrum for cinnamon essential oil:

After steam distillation of raw cinnamon essential oil, GC / MS spectrum was used to identify the components of cinnamon essential oil.

The conditions of GC/MS technique:

The conditions of *GC/MS* technique used were (50m×0.2mm×0.3 for thickness film of Carbowax 20M capillary column, 20 cm/sec., helium Carrier gas, 100: 1 split ratio, 150°C for Injector temperature, 60°C, prog. 3°C/min up to 200°, Oven temperature, 280°C, transferring temperature, 2uL for sample volume (1:10 diluted in alcohol), 10 min for initial time and 60 min for final time). The conditions for Mass (MS) selective detector were 8 min. for scan start delay, 35-350 amu. for Scan range (Atom Mass Unit), 2000 for threshold, 3 scan/sec for a/d sampling rate and 2000 for electron multiplier.

Automatic injection:

The HP 7673A automatic injector was used to inject 2.0µl of sample diluted in ethyl alcohol (1:10).

Mass spectrum chemstation:

The color computer 10 MHZ 68,010 processor 12 inch monitor, 2 Megabyte RAM with 40 Megabyte Hard disc drive was used to control and compare the spectrum with the other stored in NBS Mass Spectral library containing over 43,000 compounds.

Biological methods

30 male albino rats were housed in individual cages with screen bottoms and fed on basal diet as shown in Table (5) for seven days. After equilibration, rats were weighed and divided into six groups; the first group (5 rats) were fed on the basal diet and considered as normal control group; and the others 5 groups (5 rats for each group) fed on different diets and considered as diabetic groups [group 2 (diabetic control), groups 3 and 4 were fed on normal diet and given cinnamon aqueous extract orally per 24h (5ml, 10ml/kg body weight respectively), group 5 were fed on cinnamon biscuit (15% cinnamon powder), group 6 were fed on basal diet and orally administrated by Glibenclamide 600 µg/Kg/24h (as anti-diabetic drug)].

Diabetes was induced in rats as described by Dawson *et al.* (1986) as follows: overnight fasted rats were injected intraperitoneally by streptozotocin (STZ) at dose 60 mg/kg b.wt. After 4 days of injection (zero time), blood samples were taken from each rat for the determination of serum glucose to ensure the occurrence of diabetes. Animals with serum glucose levels of 250 – 550 mg/100 ml were considered as diabetic rats. At the end of the experiment (8 weeks), blood samples were collected from the orbital plexus by mean of heparinized capillary glass tubes according to Schermer (1967).

Each sample was placed into a dry clean centrifuge tube and centrifuged at 1500xg for 30 min. at 4°C to obtain serum. Serum glucose was determined according to the method described by Trinder (1969). Total cholesterol was determined according to the method described by Allain *et al.* (1974), and triglycerides were determined according to the method described by Fossati and Prencipe (1982).

HDL-C was determined according to the method described by Lopez-Virella *et al.* (1977) and LDL-C level was determined according to the method of Levy (1981).

Risk of coronary heart disease was calculated according to Stein and Myers (1994) as in the following equation:

[Risk of coronary heart disease = [HDL-cholesterol/Total cholesterol) × 100]

Serum transaminases sAST and sALT (Aspartate transferase and Alanine transferase) activities were measured colorimetrically according to the method described by Reitman and Frankel (1957). Serum urea was determined according to Fawcett and Soctt, (1960) and Tietz (1995) and creatinine was determined according to the method described by Barthes, *et al.*, (1972).

Table 3: Composition (%) of different diets of experiment:

Diet	Corn starch	Casein	Oil	cellulose	Salt mixture	Vitamin mixture	CB
Normal Control (NC)	65.00	15.00	10.00	5.00	4.00	1.00	—
STZD	65.00	15.00	10.00	5.00	4.00	1.00	—
STZD + CAE 1.	65.00	15.00	10.00	5.00	4.00	1.00	—
STZD + CAE 2.	65.00	15.00	10.00	5.00	4.00	1.00	—
STZD + Biscuit 15% CP	—	7.0	—	4.42	4.00	1.00	86.58
Glibenclamide 600 µg/Kg bw.	65.00	15.00	10.00	5.00	4.00	1.00	—

NC = Normal Control (basal diet).
STZD = streptozotocin induced diabetic rat
CAE 1,2 = (5ml, 10ml CAE/kg bw. respectively).
CB = cinnamon Biscuit (15% cinnamon powder (CP))

Statistical analysis of data

Data collected from sensory evaluation of Rolled Marie Biscuits were statistically analyzed according to the method of Fisher (1970). Least square differences test (LSD) was used to compare significant differences between means of treatments according to the method of Waller and Duncan (1969). Data collected from nutritional evaluation were statistically analyzed using one– way ANOVA with post hoc Newman Keuls, test. $P < 0.05$ was considered significant. All data are expressed as mean ± S.E.

RESULTS AND DISCUSSION

Sample of commercial cinnamon powder was subjected to chemical analysis (ash, crude protein, crude oil, crude fiber and hydrolyzable carbohydrates). The results in Table 4 show that ash; crude protein, crude oil, crude fiber and hydrolyzable carbohydrates are amounted to 3.40, 4.12, 2.21, 22.81 and 67.46%, respectively. These results are in agreement and confirmed with results obtained by Abd El Rahman *et al.* (2010).

Table 4: Chemical composition of cinnamon powder (CP) on dry weight

Constituents	%
Ash	3.40
Crude Protein	4.12
Crude Oil	2.21
Crude Fiber	22.81
Hydrolyzable Carbohydrate	67.46

Mean of three replicate for every determination.

Results in Table 5 show that there is significant increase in sensory evaluation of Marie Biscuits which prepared with wheat flour replaced with cinnamon powder at levels 10 and 15% compared with control. There were increases in scores values of shape, crumb color, odor, taste, chewing and total score than control. On the other hand, use cinnamon powder at level 20% showed significant decrease in all values levels compared with control.

One can conclude that the addition of CP at levels 10 and 15% for making Marie Biscuits improve all parameters, and level 15% was more acceptable to panelist and has a highest total score. So, it's possible to use this level (15%) to make Mari biscuit for diabetes mellitus patient.

The chemical composition of cinnamon essential oil is shown in Table 6, it was analyzed by using GC/MS spectroscopy. The results show that cinnamaldehyde, cinnamic acid and cinnamyl acetate are found to be the highest (75.59, 11.92 and 2.84%, respectively). Eugenol, linalool, caryophellene, ρ-cymene and limonene amounted to 1.75, 1.60, 1.45, 1.030 and 1.06%, respectively. On the other hand, α-pinane, myrcene, phenel ethyl alcohol, α -terpinol, benzaldehyde and camphene were found to be lowest components (0.65, 0.47, 0.37, 0.34, 0.32 and 0.24%, respectively).

Table 5: Sensory evaluation of Marie biscuits with CP at levels of 5, 10, 15 and 20%:

Samples	Shape	Crust color	Crumb color	Texture	Odor	Taste	Chewing	Total
C	9.02 ±0.13^{c}	14.65 ±0.15^{ab}	8.90 ±0.99^{a}	14.80 ±0.99^{a}	9.65 ±0.15^{a}	28.30 ±0.26^{a}	8.90 ±0.28^{b}	94.22 ±2.88
CB (5% CP)	9.25 ±0.20^{bc}	13.70 ±0.58^{b}	9.30 ±0.26^{a}	13.90 ±0.26^{a}	9.55 ±0.16^{a}	28.30 ±0.50^{a}	8.90 ±0.35^{b}	92.90 ±2.84
CB (10% CP)	9.56 ±0.14^{ab}	14.14 ±0.21^{ab}	9.62 ±0.17^{a}	14.29 ±0.17^{a}	9.70 ±0.13^{a}	29.45 ±0.16^{a}	9.65 ±0.13^{ab}	96.41 ±2.96
CB (15% CP)	9.80 ±0.08^{a}	14.95 ±0.05^{a}	9.85 ±0.11^{a}	14.90 ±0.11^{a}	9.85 ±0.11^{a}	29.75 ±0.13^{a}	9.85 ±0.11^{a}	98.95 ±2.98
CB (20% CP)	7.95 ±0.25^{d}	12.00 ±0.42^{c}	7.05 ±0.44^{b}	12.00 ±0.44^{b}	7.85 ±0.47^{b}	21.95 ±0.99^{b}	7.85 ±0.42^{c}	76.50 ±2.16
LSD ($p<0.05$)	0.489	0.972	1.445	1.083	0.696	1.473	0.810	

C = Control (Mari biscuit 100 wheat flour).
CB = cinnamon biscuit (replacement of wheat flour with 5, 10, 15 and 20% cinnamon powder (CP)).
^{a,b,c,d,e} Values are means of five replicates ± SE, number in the same column followed by the same latter are not significant different at $P < 0.05$ percentage relative to control is reported in parameters.

Table 6: Chemical composition of cinnamon essential oil

Chemical Constituents		%
1. Cyclic terpene	α - pinine	0.65
	ß- pinine	0.23
	Limonene	1.06
	α – terpineol	0.34
Total		2.28
2. Aliphatic hydro carbon	Myrcene	0.47
3. Aromatic hydro carbon	ρ-cymene	1.030
4. Aromatic Aldeydes	Benzaldehyde	0.32
	Cinnamic aldehyde	75.59
Total		75.91
5. Aromatic terpene alcohol	Phenel ethyl alcohol	0.37
	Eugenol	1.75
Total		2.12
6. Terpene Ester	Cinnamyl acetate	2.84
7. Aliphatic terpene alcohol	Linalool	1.60
8. Sesquterpene	Caryophellene	1.45
	Camphene	0.24
9. Aromatic acid	Cinnamic acid	11.92

Table 7: Effect of CB and CAE on serum glucose level (mg/dl) in diabetic rats:

Treatments	Zero time	After 2 week	After 4 weeks	After 6 weeks	After 8 weeks
Normal Control	109.98 ±0.33^{e}	112.20 ±2.43^{e}	111.20 ±1.49^{e}	110.60 ±1.56^{e}	110.80 ±1.75^{e}
STZD	371.80 ±9.90^{b}	420.80 ±12.46^{a}	443.00 ±6.90^{a}	465.00 ±7.83^{a}	485.60 ±4.35^{a}
STZD + CAE 1.	358.30 ±8.73^{bc}	314.80 ±15.23^{b}	270.60 ±4.94^{c}	248.80 ±4.15^{c}	240.40 ±3.33^{c}
STZD + CAE 2.	323.20 ±20.77^{cd}	280.20 ±11.56^{c}	230.20 ±9.70^{d}	209.60 ±5.50^{d}	205.20 ±4.19^{d}
STZD + Biscuit 15% CP	417.80 ±13.17^{a}	338.60 ±13.23^{b}	301.80 ±13.97^{b}	278.60 ±14.03^{b}	269.80 ±20.77^{b}
STZD + glibenclamide	312.80 ±10.32^{d}	238.00 ±24.97^{d}	215.60 ±24.14^{d}	209.20 ±23.98^{d}	196.80 ±21.81^{d}
LSD (P<0.05)	35.462	33.600	28.397	27.431	28.565

NC = Normal Control (basal diet).
STZD = streptozotocin induced diabetic rat
Biscuit 15% CP = cinnamon Biscuit contained 15gm cinnamon powder).
CAE 1, CAE2 = cinnamon aqueous extract 5 ml, 10ml/kg body weight/day respectively.
Glibenclamide= 600 µg/Kg body weight/day (as anti diabetic drug)
^{a,b,c,d,e} Values are means of five replicates ± SE, number in the same column followed by the same latter are not significant different at $P < 0.05$ percentage relative to control is reported in parameters.

This hypoglycemic effect may be due to the active components of cinnamon bark.

These results are in accordance with those reported (Subash Babu *et al*., 2007). The increased levels of plasma glucose in STZ-induced diabetic rats were lowered by cinnamaldehyde administration. The antihyperglycemic action of cinnamaldehyde results from the potentiation of insulin from existing β-cells of the islets of Langerhans. Glibenclamide has been used for many years to treat diabetes, to stimulate insulin secretion from pancreatic β-cells (Tian *et al.*, 1998). Sheehan and Zemaitis. (1983) suggested that the mechanism of action of cinnamaldehyde is similar to glibenclamide.

Identified polyphenolic polymers from an aqueous extract of commercial cinnamon increase glucose metabolism several fold in an epididymal fat cell assay (Anderson *et al.*, 2004). Strong evidence

suggests that cinnamon polyphenols exhibit insulin-like activity in cells, animals and people with type II diabetes. First, a water-soluble cinnamon extract (CE), like insulin, increases the activity of autophosphorylation of the insulin receptor β (IRβ) and decreases the activity of tyrosine phosphatase *in vitro* (Imparl-Radosevich *et al.*, 1998). Second, cinnamon polyphenols, like insulin, stimulate glucose uptake inhibit glycogen synthase kinase-3β (Jarvull-Taylor *et al.*, 2001). It also decreases glucose and increases insulin in blood of rats fed diets containing CE (Verspohl *et al.*, 2005) and decreases blood pressure (Preuss *et al.*, 2006).

Lipids play a vital role in the pathogenesis of diabetes mellitus. The most common lipid abnormalities in diabetes are hypercholesterolemia, hyperlipidemia and hypertriglyceridemia. In our study, we have noticed elevated levels of serum lipids such as cholesterol and triglycerides in diabetic rats to evaluate the role of CB and CAE on metabolism of total cholesterol, and triglycerides.

The effect of CB and CAE oral administration during 8 weeks on lipid profile is recorded in Table 8.

Table 8: Effect of CB and CAE on Total cholesterol and Total triglycerides levels (mg/dl) in diabetic rats:

Treatments	Total Cholesterol mg /dl	Triglycerides mg /dl
Normal Control	103.05±3.42^{e}	82.95±2.93^{d}
STZD	265.74±6.81^{a}	282.10±8.50^{a}
STZD + CAE 1.	179.60±4.87^{b}	122.66±4.40^{b}
STZD + CAE 2.	148.01±2.84^{d}	100.99±6.24^{c}
STZD + Biscuit 15% CP	150.33±2.30^{d}	104.33±6.03^{c}
STZD + glibenclamide	163.69±4.26^{c}	101.42±3.42^{c}
LSD (P<0.05)	12.682	16.299

NC = Normal Control (basal diet).
STZD = streptozotocin induced diabetic rat
Biscuit 15% CP = cinnamon Biscuit contained 15gm cinnamon powder).
CAE 1, CAE2 = cinnamon aqueous extract 5 ml, 10ml/kg body weight/day respectively.
Glibenclamide= 600 µg/Kg body weight/day (as anti diabetic drug)
^{a,b,c,d,e} Values are means of five replicates ± SE, number in the same column followed by the same latter are not significant different at $P < 0.05$ percentage relative to control is reported in parameters.

The obtained data revealed that, there was a significant decrease in the levels of serum cholesterol and serum triglycerides in groups

where administrated cinnamon aqueous extract (CAE) at two dose and cinnamon biscuit (CB) compared to diabetic group.

The present results indicated that the levels of serum total cholesterol and triglycerides were highly in diabetic control (265.74 and 282.10 mg/dl), respectively, compared with normal control (103.05 and 82.95 mg/dl). On the other hand, there were a significant decrease in levels of total cholesterol and triglycerides (179.60, 148.01, 150.33 and 163.69 mg/ dl) and (122.66, 100.99, 104.33 and 101.42 mg/ dl) in groups (STZD + CAE 1., STZD + CAE 2., STZD + Biscuit 15% CP and STZD + glibenclamide), respectively. Generally, it can be concluded that, CAE showed a highest hypocholesterolemic and hypotriglyceridemic effect in diabetic rats.

Spices and natural products have an effect on cholesterol in humans. Cinnamon bark has also shown strong lipolytic action (ability to hydrolyze fats) **(**Leung and Foster, 1996).

Al Jamal (2009) showed that 4 weeks of cinnamon supplementation, improved the mean of triglyceride (36%), LDL (30%), and total cholesterol (30%) in diabetic animals.

The results of high density lipoprotein (HDL-C), low density lipoprotein cholesterol (LDL-C) and the risk ratio [(HDL-C/total cholesterol)×100] of hyperglycemic rats fed on CB and CAE at two doses were reported in Table (9).

The data revealed that groups treated with (CB) and (CAE 2) reported highest value of 51.46 and 53.52 mg/dl, respectively, close to the normal Control (56.80 mg/dl). On the other hand, diabetic rats which administrated with glibenclamide as anti-diabetic drugs and CAE 1 reported lowest values of HDL-C (46.64 and 45.60 mg/dl), respectively, compared with other groups (CB and CAE 2).

The data reported that, in hyperglycemic rats value of LDL-C was significantly ($p<0.05$) higher compared with Control. In addition, administration of CAE 2 and CB amounted significant decrease value of LDL-C in rats, compared with that administrated with glibenclamide as anti-diabetic drugs and CAE 1.

The risk value of coronary heart disease (CHD) is usually calculated as HDL-cholesterol % of total cholesterol (Stein, 1986). The normal value in the present study, was about 55 and its decrease is an alarm for increasing the risk of CHD and vice versa. Diabetes mellitus often decrease the risk of CHD, as shown in Table (9).

Treatment of diabetic rats with CB, CAE and glibenclamide improved the risk ratio of CHD to be around the normal value.

Table 9: Effect of CB and CAE on HDL-C and LDL-C level (mg/ dl) and risk ratio (HDL-C as % of total cholesterol) in diabetic rats:

Treatments	HDL (mg /dl)	LDL (mg / dl)	Risk Ratio
Normal Control	56.80±2.56[a]	29.66±2.80[e]	55.18±2.15
STZD	36.78±1.00[d]	172.55±6.16[a]	13.86±0.39
STZD + CAE 1.	45.60±1.29[c]	109.47±4.42[b]	25.42±0.65
STZD + CAE 2.	53.52±1.30[ab]	74.30±2.51[d]	36.23±1.27
STZD + Biscuit 15% CP	51.46±0.96[ab]	78.00±3.11[d]	34.27±0.91
STZD + glibenclamide	46.64±1.44[bc]	96.76±4.61[c]	28.53±0.92
LSD (P<0.05)	5.468	12.060	

NC = Normal Control (basal diet).
STZD = streptozotocin induced diabetic rat
Biscuit 15% CP = cinnamon Biscuit contained 15gm cinnamon powder).
CAE 1, CAE2 = cinnamon aqueous extract 5 ml, 10ml/kg body weight/day respectively.
Glibenclamide= 600 µg/Kg body weight/day (as anti diabetic drug)
[a,b,c,d,e] Values are means of five replicates ± SE, number in the same column followed by the same latter are not significant different at $P < 0.05$ percentage relative to control is reported in parameters.

The increase in HDL-C and decrease in LDL-C may be due to the increase in hepatic HDL-C binding activity and significant increase in hepatic LDL-C receptor activity. HDL-C is an antiatherogenic lipoprotein. It transports cholesterol from peripheral tissues into the liver and thereby acts as a protective factor against coronary heart disease. The level of HDL-C, which increased after cinnamaldehyde administration, might be due to the increase in the activity of lecithin cholesterol acyl transferase (LCAT), which may contribute to the regulation of blood lipids (Patil *et al.*, 2004). Cinnamon was shown to decrease the level of glucose, triglycerides and LDL cholesterol in people with type II diabetes (Khan *et al.*, 2003).

The increase in the activities of serum alanine amino transferase (ALT) and aspartate amino transferase (AST) indicated that diabetes may be induced due to liver dysfunction. The activities of ALT and AST were determined in serum to evaluate the role of CB and CAE on liver functions. The effect of CB and CAE on ALT and AST levels (U/L) in diabetic rats are shown in Table 10.

Data of ALT and AST activities showed high increas in serum of STZD group (63.25, 86.30 U/L, respectively), compared with normal control group (21.00, 18.8 U/L, respectively), after 8 weeks of administration, the activities of serum ALT and AST showed a high significant decrease. Serum ALT activity amounted 37.70, 27.45, 29.65 and 28.8 U/L and serum AST amounted 28.6, 24.00, 28.85 and 29.6 U/L in groups CAE 1, CAE 2, CB and glibenclamide, respectively.

These results are in agreement and confirmed with those obtained by Subach Babu *et al.* (2007) who mentioned that the activities of plasma enzymes AST, ALT, LDH, ALP and ACP were significantly ($p< 0.05$) increased in diabetic rats compared to controls. Oral administration of cinnamaldehyde for 45 days significantly restores the enzyme levels to near normal in diabetic rats.

Table 10: Effect of CB and CAE on ALT and AST activities (U/L) in diabetic rats:

Treatments	ALT U/L	AST U/L
Normal Control	21.00 ± 1.70^{d}	18.80 ± 1.49^{d}
STZD	63.25 ± 1.24^{a}	68.30 ± 4.57^{a}
STZD + CAE 1.	37.70 ± 0.72^{b}	28.60 ± 0.66^{bc}
STZD + CAE 2.	27.45 ± 0.19^{c}	24.00 ± 0.91^{c}
STZD + Biscuit 15% CP	29.65 ± 1.01^{c}	28.85 ± 1.17^{bc}
STZD + glibenclamide	28.80 ± 0.75^{c}	29.60 ± 0.77^{b}
LSD (P<0.05)	2.368	4.740

NC = Normal Control (basal diet).
STZD = streptozotocin induced diabetic rat
Biscuit 15% CP = cinnamon Biscuit contained 15gm cinnamon powder).
CAE 1, CAE2 = cinnamon aqueous extract 5 ml, 10ml/kg body weight/day respectively.
Glibenclamide= 600 µg/Kg body weight/day (as anti diabetic drug)
^{a,b,c,d,e} Values are means of five replicates ± SE, number in the same column followed by the same latter are not significant different at $P < 0.05$ percentage relative to control is reported in parameters.

The results of urea and creatinine values in serum of normal and streptozotocin–induced diabetic rats at the end of the experiment period after treatment for 8 weeks are reported in Table 11.

The obtained results illustrate that, urea content at the end of experimental period for the normal control was 20.20 mg/dl in serum. Urea content of STZD control showed a significant increase (70 mg/dl), while the values of urea in serum of other groups (STZD+CAE1, STZD+CAE2, STZD+Biscuit 15% CP and

glibenclamide as anti-diabetic drugs) were 33.40, 23.60, 24.20 and 24.00 mg/dl, respectively. Data show that the highest decrease in serum urea levels in rats was in group administrated with CAE 2. On the other hand, STZD+Biscuit15% CP and glibenclamide as anti-diabetic drugs groups gave in the same.

Data of creatinine showed that STZD group resulted in the highest value (1.64 mg/dl), but glibenclamide grou resulted in the lowest (0.72 mg/dl). These results are in agreement and confirmed with those obtained by Abd El Rahman *et al.* (2010),

Table 11: Effect of CB and CAE on urea and creatinine levels (mg/dl) in diabetic rats:

Treatments	Urea mg/dl	Creatinine mg/dl
Normal Control	20.20 ± 1.49^{c}	0.66 ± 0.07^{c}
STZD	70.00 ± 2.80^{a}	1.64 ± 0.08^{a}
STZD + CAE 1.	33.40 ± 1.39^{b}	0.90 ± 0.04^{b}
STZD + CAE 2.	23.60 ± 0.66^{c}	0.78 ± 0.05^{bc}
STZD + Biscuit 15% CP	24.20 ± 1.49^{c}	0.74 ± 0.07^{c}
STZD + glibenclamide	24.00 ± 1.35^{c}	0.72 ± 0.08^{c}
LSD (P<0.05)	3.749	0.143

NC = Normal Control (basal diet).
STZD = streptozotocin induced diabetic rat
Biscuit 15% CP = cinnamon Biscuit contained 15gm cinnamon powder).
CAE 1, CAE2 = cinnamon aqueous extract 5 ml, 10ml/kg body weight/day respectively.
Glibenclamide= 600 µg/Kg body weight/day (as anti diabetic drug)
^{a,b,c,d,e} Values are means of five replicates ± SE, number in the same column followed by the same latter are not significant different at $P < 0.05$ percentage relative to control is reported in parameters.

Conclusion

- Cinnamon extracts may actually help to repair or to regenerate the pancreas beta cells that are responsible for insulin secretion.
- Cinnamon assists the pancreas in the production of insulin in type II diabetes, Cinnamon also improves the ability of insulin to lower blood sugar type I diabetes.
- Results of our study suggested that cinnamon extract has a regulatory role in blood glucose levels and lipids in both type I diabetes such as chemical drugs.

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استخدام بسكويت القرفة والمستخلص المائي للقرفة لخفض سكر الدم فى الفئران المصابة بارتفاع سكر الدم

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يهدف هذا البحث الى دراسة تأثير مستخلص القرفة بنسبة (5، 10 ملجم/كجم من وزن الجسم/يوم) وأيضاً بسكويت القرفة (نسبة استبدال 15٪ من دقيق القمح) على الفئران المصابة بمرض السكر لمدة 8 أسابيع، وقد اوضحت النتائج انه حدث انخفاض بشكل ملحوظ في تركيز جلوكوز الدم وذلك في المجموعة التي تغذت على بسكويت القرفة والمجموعات التي تناولت مستخلص القرفة مقارنة مع المجموعة المصابة بالسكر (الكنترول المريض).

كما حدث انخفاض معنوي في مستوى الدهون الثلاثية والكوليسترول والليبوبروتين منخفض الكثافة وكذلك في نشاط انزيمات الكبد (AST, ALT) وأيضاً نسبة اليوريا والكرياتينين ومن ناحية أخرى حدث ارتفاع معنوي في الليبوبروتين عالي الكثافة وذلك في مصل دم الفئران المصابة بالسكر والتي تغذت على بسكويت القرفة ومستخلص القرفة مقارنة بالمجموعة المصابة بالسكر.

من هذه النتائج يتضح ان للقرفة دور في تنظيم مستوى سكر الدم ودهون الدم وأن احسن نتائج متحصل عليها كانت في المجموعة التي تناولت مستخلص القرفة بنسبة(10 مل/كجم وزن جسم/يوم).