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The Influence of Cinnamon and Ginger on Serum Glucose, Triglycerides and Cholesterol Fractions in Albino Induced Diabetic Rats

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Abstract

The present investigation was carried out in an attempt to assess the effect of cinnamon and ginger on serum glucose, triglycerides and cholesterol fractions levels. Ninety male Sprague-Dawley rats weighting 120±5 g and divided into two groups. The first groups negative control group consisted of (10) rats fed on basal diet. The second main group consisted of (80) rats were injected intraperitoneal with alloxan monhydratein single dose (150 mg / kg) body weight and reclassified into eight sub groups (10 rats each). Subgroup (1), diabetic group was fed on basal diet only control positive group, subgroup (2), diabetic group was fed on basal diet plus 5% cinnamon, subgroup (3), diabetic group was fed on basal diet plus 10% cinnamon, subgroup (4), diabetic group was fed on basal diet plus 5% ginger, subgroup (5), diabetic group was fed on basal diet plus 10% ginger, subgroup (6), diabetic group was fed on basal diet plus 5% of both cinnamon and ginger, subgroup (7) diabetic group was fed on basal diet plus 10% of both cinnamon and ginger, subgroup (8) diabetic group was fed on basal diet plus (10 mg Atorvastatin + 30 mg Gliclagide). The study was assigned for six weeks.

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At the end of the experimental period rats were fasted over night before sacrificing, blood was collected then centrifuged to separate the serum. The results revealed that feeding rats on cinnamon, ginger and their combinations led to significant decreased in serum glucose, total cholesterol, triglycerides, LDL-cholesterol, VLDL-cholesterol and increased HDL-cholesterol.

The best improvement was subgroup (8) diabetic group was fed on basal diet plus (10 mg Atorvastatin + 30 mg Gliclagide) followed by subgroup (7) diabetic group was fed on basal diet plus 10% of both cinnamon and ginger, then subgroups (3) and (5) namely diabetic group was fed on basal diet plus 10% cinnamon and diabetic group was fed on basal diet plus 10% ginger.

Therefore, this study recommended that the daily intake of cinnamon and ginger as a drink may be useful in the management of diabetes and improve serum levels of glucose and lipid profile.

Key words : Cinnamon, Ginger, Rats, Serum glucose, Lipid profile.

Introduction

Diabetes mellitus (DM) is a heterogeneous metabolic disorder, a high occurrence of disease in noted and the numbers of diabetic patients are gradually increasing, thus the disease constitutes a major health concern **(Narendhirakannan *et al.*, 2005 and Etuk, 2010).**

According to the World Health Organization (WHO), there are approximately 347 million diabetics worldwide, the number of diabetics had been double in the last few years and diabetes death will increase by two thirds between 2008 and 2030 (**WHO, 2012**). Reasons for this rise include an increase in sedentary lifestyle, the consumption of energy-rich diet, obesity (**Yajmk, 2001**). Diabetes is the fourth or fifth leading cause of death in most high-income countries and there are substantial evidences that it is epidemic in many economically developing and newly industrialized countries (**IDF, 2011**).

Plants have always been an exemplary source of drugs, it's used in traditional medicine to treat diabetes mellitus represent a valuable alternative

for the management of this disease, amongst such plants reported to have beneficial effects in the treatment of diabetes are spices such as cinnamon and ginger (**Ugwuja *et al.*, 2010; Gandhi and Sasikumar, 2012**).

Cinnamon is a common spice used by different cultures around the world for several centuries. It is obtained from the inner bark of trees from the genus Cinnamomum, a tropical evergreen plant that has two main varieties; Cinnamomum zeylanicum (CZ) and Cinnamon cassia (CC) (also known as Cinnamomum aromaticum / Chinese cinnamon). In addition to its culinary uses, in native Ayurvedic medicine Cinnamon is considered a remedy for respiratory, digestive and gynecological ailments. Almost every part of the cinnamon tree including the bark, leaves, flowers, fruits and roots, has some medicinal or culinary use. The volatile oils obtained from the bark, leaf, and root barks vary significantly in chemical composition, which suggests that they might vary in their pharmacological effects. **(Shen *et al.*, 2002).**

Ginger (Zingiber officinale, Roscoe Zingiberaceae) is one of the most widely consumed spices for the flavoring of food worldwide **(Li *et al.*, 2012).** Ginger rhizome has been used in traditional herbal medicine. Ginger has enormous health promoting potential effects in number of ailments including degenerative disorders (arthritis and rheumatism), digestive health (indigestion and constipation), cardiovascular disorders (atherosclerosis and hypertension), diabetes mellitus and cancer. Also it has anti-inflammatory properties, which are beneficial in controlling the process of aging. Moreover, it has antimicrobial potential, which can help in treating infectious diseases and helminthiasis (**Jiang *et al.*, 2006; White, 2007; Ali *et al.*, 2008 and Nicoll and Henein, 2009**).

This investigation was carried out in an attempt to study the influence of cinnamon and ginger on serum glucose, triglycerides and cholesterol fractions in diabetic rats.

Materials and Methods

Materials

Source of samples

5kg of both cinnamon and ginger were obtained from Local Market, Assiut, Egypt, in March (2014).

Preparation of samples

Preparation of (5% and 10%) concentration of cinnamon and ginger (50 and 100 g) were dissolved in 10 ml toleween 80 (obtained from El Gomhorya Company) then diluted to 500 ml with distilled water, then were shacked for 6 hours.

Experimental animals

One hundred and ten adult male white albino rats (Sprague dawley strain) weighing between (120 g±5) were obtained from the animal house of the Faculty of Medicine, Assuit University. The animals were housed as groups in wire cages under the normal laboratory individually conditions and fed on the basal diet the rats were fed for a week as adaption period. Body weight gain and feed intake weighed weekly and at the end of the experimental feeding period.

Basal diet and untreated diabetic diet

The basal diet used is outlined in table (1)

Table (1): Constituents of the basal diet for 100g diet.

Item	%
Corn starch	67.8
Casein	12.5
Corn oil	10.0
Vitamins mixture	1.0
Salt mixture	3.5
Cellulose	5.0
Choline chloride	0.2
Total	100%

Reeves *et al.*, (1993).

Chemicals

Alloxan (Sigma, chemical company Lot 110H3367 for laboratory use only) was pruched from New Assiut Company, Toleween 80 was obtained from El Gomhorya Company and Atorvastatin + Gliclagide were

obtained from local pharmacy, Assiut city, Assiut.

Methods

Design of the experiment

The rats were randomly allocated into (9) main Groups of (10) rats each. The number of animals in need during the course of the study was collectively (90) males the other rest (20) were used to overcome the loss in number of animals due to sudden death. Each rats was marked on the tail to differentiate between the animals in the (9) groups. Daily administrations were continued for two successive, periods (6) weeks each. In the first period group used as control and was fed on basal diets while the other eight groups were injected intraperitoneal with alloxan in a single does of 150 mg/kg body weight **(Pang *et al*,. 1985).** The drug was dissolved in distilled water. In the eight groups the animals were tested for diabetes after five days the start of injection of alloxan . The animals were considered diabetic when its glucose level was 250 mg/100 ml or more (normal blood glucose level was ranged between 90-120 mg/100 ml)

After the onset of induced diabetic with alloxan, the animals were reclassified into the following groups fed on treated cinnamon and ginger as follows:

Treated cinnamon and ginger groups

Group (1) control group was fed on basal diet

Group (2) diabetic group was fed on basal diet.

Group (3) diabetic group was fed on basal diet plus 5% cinnamon.

Group (4) diabetic group was fed on basal diet plus 10% cinnamon.

Group (5) diabetic group was fed on basal diet plus 5% ginger.

Group (6) diabetic group was fed on basal diet plus 10% ginger.

Group (7) diabetic group was fed on basal diet plus 5% of both (cinnamon and ginger).

Group (8) diabetic group was fed on basal diet plus 10% of both (cinnamon and ginger).

Group (9) Diabetic group was fed on basal diet plus (Atorvastatin 10mg + Gliclagide 30mg).

Ginger and cinnamon extract were given orally to the rats through a gastric tube daily at a dose of 4 ml/kg body weight.

Blood sampling

At the end of each experiment, rats were fasted overnight and anesthetized. Blood samples were collected from the retro-orbital plexus from all animals of each group into clean, dry and labeled tube. The tubes contained heparin (10.0 IU/ml) as anticoagulant. Blood was centrifuged (3500 r-p. m for 15 min) to separate plasma. Which was tightly kept in sealed aliquot tubes at 20°C until biochemical assays.

Biochemical methods

Prepared samples (as mentioned in blood sampling) were used to study the following biochemical parameters using PHOTO Mech 301-D spectrophotometer (Optima).

Determination of blood serum glucose

Blood serum glucose level was analyzed calorimetric procedures kits developed by Diamond Diagnostics kits Cairo, Egypt using 550 n/m. According to (**Trinder, 2000**).

Determination of triglycerides

Fully enzymatic determination of total triglycerides in serum was estimated spectrophtomtrically at 500ηm according to the method of **(Wahlefeld, 1974**) of the enzymatic hydrolysis of triglycerides using Stanbio kits followed by determination of the liberated glycerol by colorimetry.

Determination of serum total cholesterol

Enzymatic determination of cholesterol was carried out according to the method of **(Allian *et al.,* 1974)** using kits purchased from stanbio (Taxas, USA).

Determination of High Density Lipoprotein (HDL-c) cholesterol

The kits were provided from Stanbio, Lab., Inc. Texas. According to **(Warnick *et al.,* 1983).** Low density Lipoprotein (LDL-c) cholesterol is precipitated from serum by magnesium chloride/ dextran sulfate reagent.

High density lipoprotein (HDL-c) cholesterol is then determined in supernatant using cholesterol reagent.

Determination of low Density lipoprotein (LDL-c) cholesterol

LDL was calculated by the difference between total cholesterol, HDL cholesterol and triglyceride according to as the method of **(Friedewald *et al.,* 1998)** and was calculated using the following equation.

Calculation:

$$\text{LDL cholesterol} = \text{Total cholesterol} - \left[\frac{\text{T.G.}}{5} - \text{HDL- c} \right]$$

Calculation of Very Low Density Lipoproteins (VLDL-c) cholesterol

VLDL-c could be estimated reasonably well as TG concentrations divided by constant (5 for mg/dl), according to **(Sniderman *et al.,* 2003; Bairaktari *et al.,* 2005 and Gazi *et al.,* 2006)** as follow

Calculation:

$$\text{VLDL-c mg/dl} = \text{Triglycerides}/5$$

Statistical analysis

Data was analyzed with analysis of variance (ANOVA) procedures using the MSTAT-C Statistical software package **(Michigan State University, 1983)**.Where the F-test showed significant differences among means **(Duncan)** multiple range test **(1955)** was performed at the 0.05 level of probability to separate means.

Results and Discussion

Table (2): Effect of different concentrations of cinnamon and ginger on blood serum glucose levels (mg/dl) in the different diabetic rat groups.

Weeks	Control	Diabetic	Cinnamon		Ginger		Cinnamon + Ginger		Drug
			5%	10%	5%	10%	5%	10%	
	Group 1	Group 2	Group 3	Group4	Group5	Group6	Group7	Group8	Group9
1	108.4m ±3.12	256.1^{cd} ±5.23	251.5d ±3.54	233.0e ±6.21	239.4e ±4.51	224.3e ±3.45	228.2e ±4.51	221.0ef ±3.56	189.0i ±2.31
2	108.0m ±2.08	266.2^{cd} ±4.15	245.8d ±3.47	225.5ef ±2.93	231.0e ±2.60	207.2gh ±2.81	214.4g ±3.04	193.0i ±3.04	136.4l ±6.41
3	100.6m ±1.96	288.7^{c} ±2.36	238.1de ±3.2	216.8fg ±2.5	222.3ef ±3.2	204.5gh ±3.4	205.7gh ±2.1	185.7i ±1.6	130.6l ±2.1
4	93.2 m ±5.31	311.1^{bc} ±7.16	230.3e ±2.53	208.2Gh ±2.76	216.2fg ±3.23	193.2i ±2.6	194.8i ±2.22	181.4j ±2.70	128.9l ±7.43
5	102.0 m ±4.15	343.0^{b} ±9.11	223.7e ±6.91	205.1gh ±4.56	209.8 hi ±2.35	189.7i ±6.12	183.6j ±3.15	175.2j ±5.23	123.7l ±3.21
6	106.9m ±6.10	361.6^{a} ±7.04	213.0gh ±2.77	197.2i ±3.53	203.0hi ±3.44	182.8j ±2.32	177.8j ±4.03	166.5k ±3.61	116.0m ±7.74
Mean	103.23 G	304.45 ^{A}	233.73 B	214.42 C	220.28 C	200.28 D	200.75 D	187.13 E	137.43 F

Values are presented as mean ± SD

For each group of rats n = 10 S.E. Standard Error

Values followed by the same letter within the same column were not significantly different

F-test group (G) = (A) 178.6** P<0.01 F-test weeks (W) = (B) 23.6** P <0.01

F-test (G×W) = (AB) 32.9** P <0.01

Effect of different concentrations of cinnamon and ginger on blood serum glucose levels (mg/dl) in the different diabetic rat groups

The results given in the table (2) revealed that blood serum glucose levels showed significant differences among all the nine studied groups, all feeding weeks as well as interaction between studied groups at ($p<0.01$).

The results showed that the mean blood serum glucose levels in diabetic

rats groups treated with either cinnamon or ginger (3, 4, 5, 6, 7 and 8) recording (233.73, 214.42, 220.28, 200.28, 200.75 and 187.13 mg/dl); respectively were significantly decreased as compared to diabetic group (2) fed on basal diet without any treatment recording 304.45 mg/dl. however, these levels were significantly increased than that of the control group of rats (103.23 mg/dl) while, group (9) standard fed on basal diet plus (Atorvastatin 10mg + Gliclagide 30mg) was recorded 137.43 mg/dl by the end of the feeding time of experiments (the 6th week). These results of this present were in accordance with those reported by (**Kamble and Rambhimaiah 2013)**, **(Naserzadeh *et al.,* 2014)** and **(Muhamed *et al.,* 2016)** in cinnamon while, the results content in ginger was agreement (**Elshater *et al.,* 2009)**, (**Abdulrazaq *et al.,* 2010)**, (**Jafri *et al.,* (2010)**, (**Diaa and Al-Azhary 2011)**, (**Manal and Anfenan 2014), (Khandouzia *et al.,* 2015)**, (**Hossain and Islam 2016).**

These findings were in agreement with (**Khan *et al.,* 1990; Shalaby and Samar 2010 and Al-Jamal and Rasheed, 2010).** hypoglycemic effect of cinnamon could be due to Insulin Potentiating Factor (IPF) that was isolated from cinnamon, which increased the activity of insulin 3 folds in glucose metabolism in the epididymal fat cells of rat. Later, this isolated factor (IPF) from cinnamon was termed as Methyl Hydroxy Chalcone Polymers (MHCP). They reported that MHCP was increased insulin dependent glucose metabolism many folds (more than 3 folds) when it was examined during in vitro studies **(Broadhurst, *et al.,* 2000).** Others explained that MHCP caused fat cells more responsive to insulin through activating the insulin-receptor-kinase enzyme that causes binding of insulin to the cells and inhibiting insulin-receptorphosphatase enzyme that blocks this binding process thereby MHCP leads to maximal phosphorylation of the insulin receptor, which is associated with increased insulin sensitivity and enhances glycogen synthase activity **(Khan *et al.,* 2003; Anderson *et al.,* 2006; Kim *et al.,* 2006 and Nadia *et al.,* 2011). (Ugochukw and Babady, 2003)** mentioned that cinnamon increases the production of Glucose-6-Phosphate Dehydrogenase (G-6-PDH) in the liver in which G-6-PDH leads to reduce glucose transporting by pentose phosphate pathway (pentose shunt) and storage of glucose as a glycogen in the liver**.** Cinnamon

was mentioned in other study to activate the function glucokinase enzyme which in turn stimulates Glucose Transporter-4 (GLUT4) for entering of glucose to the hepatic cells (glycogenesis) and adipocytes lead to increase in glycogen storage available for energy production.

(Ramudu *et al.*, 2011 and Chakraborty *et al.*, 2012) revealed that ginger has been shown to modulate insulin release in rat pancreatic β-cells, thus enhanced plasma insulin levels in conjunction with lowered blood glucose, this may be due to 6-gingerol, which is considered an active component in ginger, so showed a protective effect on pancreatic β-cells and restored the plasma insulin level.

(White, 2007) reported that ginger is contain over 20 phenolic compounds, these compound displays diverse biological activities such as antioxidant, antidiabetic, hypoglycemic and a lose reductase inhibitory properties.

Kar *et al.*, (1999) reported that, the inorganic part of a medicinal plant contains mainly mineral elements, which are responsible for the hypoglycemic activity. In support of this view, a number of essential minerals (Ca, Zn, K, Mn and Cr), are known to be associated with the mechanisms of insulin release and its activity in different animals and in human beings (**Castro**, **1998**).

Table (3): Effect of different concentrations of cinnamon and ginger on serum triglycerides levels (mg/dl) in the different diabetic rat groups.

Weeks	Control	Diabetic	Cinnamon		Ginger		Cinnamon+ Ginger		Drug
			5%	10%	5%	10%	5%	10%	
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
1	110.1q ±3.9	233.8a ±4.6	227.7cd ±4.1	216.7de ±3.2	217.8ef ±3.4	205.6ef ±3.2	199.3fgh ±2.1	179.7ij ±2.3	156.7kl ±1.6
2	110.0q ±4.2	244.9c ±3.3	223.2cd ±4.3	210.1ef ±3.9	213.8de ±4.2	202.2efg ±3.0	190.9hi ±5.9	163.4k ±5.5	147.2mn ±3.9
3	110.3q ±1.6	238.7b ±2.6	216.8e ±1.8	204.6ef ±2.1	207.3ef ±3.1	196.7gh ±1.6	182.3hi ±2.3	156.1k ±2.3	133.9n ±2.3
4	110.6q ±6.6	252.7b ±3.6	211.0ef ±3.8	196.3gh ±4.0	200.2fgh ±3.4	189.4hi ±3.7	178.9ij ±7.7	150.7kl ±4.2	121.1pq ±3.4
5	110.6q ±2.6	254.5a ±5.1	200.9fgh ±4.1	185.7hi ±1.9	191.8gh ±2.1	173.4k ±2.1	156.8kl ±1.8	142.7mn ±2.3	118.9pq ±1.7
6	110.3q ±6.7	256.0a ±3.0	192.7gh ±3.5	170.8jk ±6.7	179.7ij ±4.7	154.2lm ±7.1	140.8mn ±6.9	130.7pq ±5.3	115.2q ±3.3
Mean	108.7 H	246.8 A	212.1 B	197.4 C	200.4 C	186.9 D	174.8 E	154.2 F	131.2 G

Values are presented as mean ± SD

For each group of rats n = 10 S.E. Standard Error

Values followed by the same letter with in the same column were not significantly different

F-test group (G) = (A) 112.6** P<0.01 F-test weeks (W) = (B) 33.25** P<0.01

F-test (G×W) = (AB) 5.09** P<0.01

Effect of different concentrations of cinnamon and ginger on serum triglycerides levels (mg/dl) in the different diabetic rat groups

The results given in the table (3) revealed that serum triglycerides levels showed significant differences among all the nine studied groups, all feeding weeks as well as interaction between studied groups at ($p<0.01$).

The results of the study showed that the mean triglyceride levels in diabetic rats groups treated with either cinnamon and ginger (3,4,5,6,7 and 8) recording (212.1, 197.4, 200.4, 186.9, 174.8 and 154.2 mg/dl); respectively were significantly decreased as compared to diabetic group (2) fed on basal diet

without any treatment recording 246.8mg/dl. However, these levels were significantly increased than that of the control group of rats (108.7 mg/dl). While, group (9) standard fed on basal diet plus (Atorvastatin 10 mg + Gliclagide 30 mg) was recorded 131.2 mg/dl by the end of the feeding time of experiments (the 6th week).

These results are in agreement with **(Gullapalli *et al*., (2013), (Khogali *et al.,* 2014)** and (**Amal *et al.,* 2016)** in cinnamon while, the results content in ginger was agreement with **(Ramudu *et al.,* 2011)**, **(Hussein, 2012)**, (**Maisa *et al.,* 2016)** and **(El-Sayed** and **Reham 2016)**.

Table (4): Effect of different concentrations of cinnamon and ginger on serum total cholesterol levels (mg/dl) in the different diabetic rat groups.

Weeks	Control	Diabetic	Cinnamon		Ginger		Cinnamon + Ginger		Drug
			5%	10%	5%	10%	5%	10%	
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
1	154.7p ±1.96	235.4c ±4.1	230.6c ±4.23	227.3c ±3.12	229.9c ±2.88	218.6def ±3.12	221.2def ±1.85	212.3fgh ±2.13	193.0lmn ±1.96
2	139.8q ±6.1	238.0b ±2.1	222.7cd ±3.7	215.9efg ±3.2	217.8def ±5.3	206.6ijk ±4.2	207.7hij ±3.9	191.5lmn ±4.0	163.6p ±2.9
3	136.6q ±4.1	245.1b ±4.4	219.2de ±2.1	212.0ghi ±3.1	213.6ghi ±4.1	201.3jkl ±2.1	200.7jkl ±2.3	180.7n ±2.1	154.5p ±2.1
4	138.7q ±5.3	256.7b ±3.89	218.7de ±3.3	210.2hij ±3.6	211.9fgh ±4.8	199.8jkl ±3.8	196.8klm ±3.9	183.2n ±4.2	146.9q ±3.0
5	145.6 p ±1.86	280.5a ±5.9	213.6ghi ±3.12	204.2jk ±2.65	209.1hij ±3.56	192.3lmn ±3.11	190.1lmn ±2.21	178.6no ±1.26	139.6q ±1.56
6	157.0p ±8.5	282.6a ±2.13	211.2ghi ±3.3	200.8jkl ±4.0	204.3ijk ±4.7	188.4mn ±3.9	187.8mn ±3.5	173.4o ±4.1	129.3r ±3.3
Mean	145.4E	255.6A	220.0B	211.7BC	214.4B	201.2C	200.7C	186.6D	146.8E

Values are presented as mean ± SD

For each group of rats n = 10 S.E. Standard Error

Values followed by the same letter with in the same column were not significantly different

F-test group (G) = (A) 106.7** P<0.01 F-test weeks (W) = (B) 80.45** P<0.01

F-test (G×W) = (AB) 11.98** P<0.01

Effect of different concentrations of cinnamon and ginger on serum total cholesterol levels (mg/dl) in the different diabetic rat groups

The results given in the table (4) revealed that total cholesterol levels showed significant differences among all the nine studied groups, all feeding weeks as well as interaction between studied groups and feeding weeks at ($p<0.01$).

The results showed that the mean total cholesterol levels in diabetic rats groups treated with either cinnamon or ginger (3, 4, 5, 6, 7 and 8) recording (220.0, 211.7, 214.4, 201.2, 200.7 and 186.6 mg/dl); respectively

were significantly decreased as compared to diabetic group (2) fed on basal diet without any treatment recording 255.6 mg/dl. However, these levels were significantly increased than that of the control group of rats (145.4 mg/dl). While, group (9) standard fed on basal diet plus (Atorvastatin 10mg + Gliclagide 30mg) was recorded 146.8 mg/dl by the end of the feeding time of experiments (the 6^{th} week). These results are in agreement with (**Srinivasan** and **Sambaiah 1991**) reported that feeding rats with ginger significantly elevated the activity of hepatic cholesterol 7-alpha-hydroxylase which is a rate-limiting enzyme in the biosynthesis of the bile acids and stimulates the conversion of cholesterol to bile acids leading to the excretion of cholesterol from the body. In support of this view, the study of (**Bhandari *et al*., 1998**[b]) revealed that posttreatment with ginger extract to the cholesterol-fed rabbits for 70 days resulted in less marked hyperlipidaemic when compared to the pathogenic rats. Moreover, the marked hyperlipidemia that characterizes the diabetic state may therefore be regarded because of the uninhibited actions of lipolytic hormones on the fat depots due to the absence of insulin (**Goodman** and **Gilman 1985**).

(Thomson *et al.,* 2002 and **Verma *et al.,* 2004)** stated that ginger significantly lowered serum total cholesterol, LDL, VLDL and triglycerides and raised HDL., their results to the reducing effect of ginger acted on cholesterol biosynthesis in the liver and may stimulate cholesterol's conversion to bile acid and increase its fecal excretion.

Table (5): Effect of different concentrations of cinnamon and ginger on the serum High Density Lipoprotein (HDL) levels (mg/dl) in the different diabetic rat groups.

Weeks	Control	Diabetic	Cinnamon		Ginger		Cinnamon + Ginger		Drug
			5%	10%	5%	10%	5%	10%	
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
1	39.10a ±0.65	21.90kl ±1.21	23.80n ±0.79	26.60m ±1.12	26.90m ±1.13	28.20j ±1.23	28.00j ±0.65	29.80ij ±0.65	30.20gh ±0.89
2	39.00a ±0.75	21.70o ±0.67	24.60n ±0.65	27.50lm ±0.72	27.80kl ±0.59	29.70hij ±0.47	29.40ij ±0.52	30.90gh ±0.48	32.40ef ±0.40
3	39.70a ±0.96	20.95p ±0.87	25.01n ±0.73	28.20ij ±0.78	28.20ij ±0.63	30.00gh ±0.65	30.10gh ±0.69	31.20fg ±0.69	33.00cd ±0.66
4	39.20a ±0.80	20.20p ±0.70	26.50m ±0.76	29.50ij ±0.56	29.30ij ±0.56	31.20fg ±0.36	30.60ghi ±0.37	32.40ef ±0.40	33.90cd ±0.55
5	39.20a ±0.81	18.90q ±0.51	27.20lm ±0.98	30.10gh ±0.88	30.50gh ±0.92	32.30de ±0.77	31.80fg ±0.38	33.60cd ±0.71	35.30b ±0.78
6	39.20a ±0.80	18.70q ±0.47	29.00jk ±0.67	30.90gh ±0.57	31.30fg ±0.37	32.90de ±0.28	32.50ef ±0.43	34.20c ±0.36	36.20b ±0.55
Mean	39.33 A	21.39 F	26.03 E	28.80 D	29.00 D	30.72 C	30.50 C	32.02 B	33.50 B

Values are presented as mean ± SD

For each group of rats n = 10 S.E. Standard Error

Values followed by the same letter with in the same column were not significantly different.

F-test group (G) = (A) 156.4** P<0.01 F-test weeks (W) = (B) 55.35** P<0.01

F-test (G×W) = (AB) 6.343** P<0.01

Effect of different concentrations of cinnamon and ginger on the serum High Density Lipoprotein (HDL) levels (mg/dl) in the different diabetic rat groups

The results given in the table (5) revealed that High Density Lipoprotein (HDL) levels showed significant differences among all the nine studied groups, all feeding weeks as well as interaction between studied groups and feeding weeks at ($p<0.01$).

The results showed that the mean HDL levels in diabetic rats groups

treated with either cinnamon or ginger (3, 4, 5, 6, 7 and 8) recording (26.03, 28.80, 29.00, 30.72, 30.50 and 32.02 mg/dl); respectively were significantly increased as compared to diabetic group (2) fed on basal diet without any treatment recording 21.39 mg/dl. However, these levels were significantly decreased than that of the control group of rats (39.33 mg/dl). While, group (9) standard fed on basal diet plus (Atorvastatin 10 mg + Gliclagide 30 mg) was recorded 33.50mg/dl by the end of the feeding time of experiments (the 6^{th} week).

These data are in agreement with (**Hussein, 2012)** reported that the effect of daily intraperitoneal injection of ginger extract for four weeks on some biochemical parameters (serum cholesterol, HDL, LDL) and kidney functions (urea, uric acid, creatinine), were significant decrease ($p<0.01$), while (HDL) appeared significant increase when compared with control group antioxidative properties of ginger represent the main way for protecting vascular wall against oxidative stress induced in diabetic cholesterol-fed animals. This effect may work independently of ginger ability to low increased lipid parameters associated with diabetic complications. While, an increased oxidative stress has been shown to be increased in both insulin dependent diabetes.

Table (6): Effect of different concentrations of cinnamon and ginger on the Low Density Lipoprotein (LDL) Levels (mg/dl) in the different diabetic rat groups.

Weeks	Control	Diabetic	Cinnamon		Ginger		Cinnamon + Ginger		Drug
			5%	10%	5%	10%	5%	10%	
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
1	78.7op ±1.23	160.0d ±3.5	157.0d ±4.1	148.2de ±2.1	149.9de ±3.2	138.7hi ±2.1	143.8gh ±2.3	134.6ij ±1.5	109.7m ±0.8
2	79.8op ±2.3	161.8d ±4.2	153.4cd ±3.5	146.3efg ±3.3	147.7def ±5.1	136.3hij ±4.1	145.0efg ±4.4	132.8ijk ±4.7	103.6n ±2.4
3	78.4op ±2.3	167.2d ±3.1	150.5de ±1.6	143.1ghi ±1.7	144.2ghi ±3.2	132.6ijk ±2.1	140.3ghi ±2.3	127.5jk ±2.6	96.7n ±3.1
4	77.0p ±4.1	175.9c ±4.5	149.9de ±3.1	141.2ghi ±3.6	140.9ghi ±5.3	130.6ijk ±4.0	137.2hij ±4.1	123.8kl ±4.1	87.3no ±3.0
5	79.2op ±1.23	194.0b ±4.2	147.2e ±3.2	138.4hi ±1.5	139.3ghi ±1.2	126.4k ±1.8	132.6ijk ±2.1	120.7kl ±1.6	79.5op ±0.9
6	94.1n ±8.2	210.7a ±6.0	142.8fgh ±2.9	136.6hij ±3.5	137.3hij ±4.4	124.8kl ±3.0	128.8jk ±3.9	115.1l ±3.7	70.2p ±3.3
Mean	81.20 H	178.27 A	150.13 B	142.40 C	143.22 C	131.57 E	137.95 D	125.75 F	91.17 G

Values are presented as mean ± SD

For each group of rats n = 10 S.E. Standard Error

Values followed by the same letter with in the same column were not significantly different

F-test group (G) = (A) 178.5** P<0.01 F-test weeks (W) = (B) 5.231** P<0.01

F-test (G×W) = (AB) 11.36** P<0.01

Effect of different concentrations of cinnamon and ginger on the Low Density Lipoprotein (LDL) Levels (mg/dl) in the different diabetic rat groups

The results given in the table (6) revealed that Low Density Lipoprotein (LDL) levels showed significant differences among all the nine studied groups, all feeding weeks as well as interaction between studied groups at ($p<0.01$).

The results of the study showed that the mean LDL levels in diabetic rats groups treated with either cinnamon or ginger (3, 4, 5, 6, 7 and 8) recording (150.13, 142.40, 143.22, 131.57, 137.95, and 125.75 mg/dl); respectively were significantly decreased as compared with diabetic groups (2) fed on basal diet without any treatment recording 178.27 mg/dl. However, these levels were significantly increased than that of the control group of rats (81.20 mg/dl). While, group (9) standard fed on basal diet plus (Atorvastatin 10mg + Gliclagide 30mg) was recorded 91.17 mg/dl by the end of the feeding time of experiments (the 6^{th} week).

Ginger lowered the level of total cholesterol, TG, VLDL and LDL and improved the level of hyperlipidemic and diabetic rats these results were in agreement with those previously reported **(Fuhrman *et al.*, 2000** and **Nicoll** and **Henein 2009)** found that The adding ginger rhizome powder to the food could be useful in the management of cardiovascular disease in which atherosclerosis is the most important factor may be due to the presence poly-phenolic and flavonoids may prevent coronary artery disease by reducing plasma cholesterol level or by inhibiting LDL oxidation, a process which is through to play a key role in the pathogenesis of atherosclerosis.

Table (7): Effect of different concentrations of cinnamon and ginger on the Very Low Density Lipoprotein (VLDL) levels (mg/dl) in the different diabetic rat groups.

Weeks	Control	Diabetic	Cinnamon		Ginger		Cinnamon + Ginger		Drug
			5%	10%	5%	10%	5%	10%	
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
1	22.00o ±0.91	45.90b ±1.65	44.1b ±1.13	43.3c ±2.14	43.9b ±2.12	42.1d ±1.23	39.2g ±1.46	35.3hi ±1.87	29.9kl ±1.35
2	22.00o ±0.83	46.90b ±0.64	42.70c ±0.82	40.10d ±0.78	40.90cd ±0.82	38.60de ±0.58	34.20hi ±1.16	30.80jk ±1.10	27.60klm ±0.75
3	22.00o ±0.79	47.60b ±1.12	41.20c ±1.32	39.70d ±0.88	40.00d ±0.99	37.60de ±0.66	30.90jkl ±0.78	28.10jk ±0.65	26.30klm ±0.69
4	22.10o ±1.35	49.00ab ±0.73	40.30d ±0.76	37.50ef ±0.73	38.50de ±0.72	36.00fg ±0.70	29.00jkl ±1.54	27.00lm ±0.91	25.70mn ±0.67
5	22.1o ±0.86	50.7a ±1.13	37.8ef ±1.36	36.2fg ±1.16	35.6ef ±1.87	32.8g ±1.54	27.7kl ±0.89	25.4mn ±1.56	24.8mn ±1.74
6	22.10o ±1.35	51.10a ±0.62	31.60ef ±0.69	31.30h ±1.26	33.30g ±0.89	29.90ij ±1.43	24.50m ±1.38	22.80no ±1.11	21.10o ±0.69
Mean	22.05 F	49.20 A	41.38 B	38.68 C	40.90 B	37.07 C	30.17 D	26.67 E	25.07 E

Values are presented as mean ± SD

For each group of rats n = 10 S.E. Standard Error

Values followed by the same letter with in the same column were not significantly different

F-test group (G) = (A) 231.5** P<0.01 F-test weeks (W) = (B) 63.5** P<0.01

F-test (G×W) = (AB) 7.12** P<0.01

Effect of different concentrations of cinnamon and ginger on the Very Low Density Lipoprotein (VLDL) levels (mg/dl) in the different diabetic rat groups

The results given in the table (7) revealed that Very Low Density Lipoprotein (VLDL) levels showed significant differences among all the nine studied groups, all feeding weeks as well as interaction between studied groups at ($p<0.01$).

The results of the study showed that the mean (VLDL) levels in diabetic rats groups treated with either cinnamon and ginger (3, 4, 5, 6, 7 and 8) recording (41.38, 38.68, 40.90, 37.07, 30.17 and 26.67 mg/dl); respectively were significantly decreased as compared to diabetic group (2) fed on basal diet without any treatment recording 49.20mg/dl. However, these levels were significantly increased than that of the control group of rats (22.05 mg/dl). While, group (9) standard fed on basal diet plus (Atorvastatin 10 mg + Gliclagide 30 mg) was recorded 25.07 mg/dl by the end of the feeding time of experiments (the 6^{th} week).

Cinnamon lowered the level of total cholesterol, TG, VLDL and LDL and improved the level of hyperlipidemic and diabetic rats. The observation of higher level of serum lipids in diabetic rats in many studies were found.

(Brahmachari, *et al.,* 2009) mentioned that major compounds of cinnamon (cinnamaldehyde, cinnamyl acetate and cinnamyl alcohol) are converted into cinnamic acid by oxidation and hydrolysis, respectively. In the liver, cinnamic acid oxidized to benzoate that exists as sodium benzoate or benzoyl-CoA. Sodium benzoate was found to reduce the level of cholesterol in vivo in mice.

Conclusion:

In conclusion on the basis of above mentioned data. There were significant differences between untreated group and all other (8) studied groups of the experimental rats ($p < 0.01$) in the serum glucose, serum triglycerides, total cholesterol, HDL cholesterol, LDL cholesterol and VLDL cholesterol. The best improvement on the serum glucose, triglycerides and cholesterol fractions

in diabetic standard group was fed on basal diet plus (10 mg Atorvastatin + 30 mg Gliclagide) followed by diabetic group was fed on basal diet plus 10% of both cinnamon and ginger then diabetic group was fed on basal diet plus 10% cinnamon and diabetic group was fed on basal diet plus 10% ginger.

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تأثير القرفة والزنجبيل على مستوى السكر والجليسريدات الثلاثية وتجزؤات الدهون في فئران الألبينو المصابة بالسكر

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الملخص العربي

تناول البحث دراسة تأثير القرفة والزنجبيل على مستوى السكر والجليسريدات الثلاثية وتجزؤات الدهون على الفئران المصابة بالسكر.

وقد أجريت الدراسة على (٩٠) من ذكور فئران الألبينو البيضاء التي يتراوح وزنها ١٢٠±٥ جرام حيث تم تقسيم الفئران إلى مجموعتين، المجموعة الأولى الضابطة وتتكون من عشرة فئران تم تغذيتها على الوجبة الأساسية والمجموعة الثانية الرئيسية وتتكون من ثمانين فأراً تم حقنهم في الغشاء البروتوني بجرعة الألوكسان (١٥٠ ملي جرام لكل كيلو جرام) من وزن الجسم لكل فأر، كما تم إعادة تقسيم المجموعة الثانية الرئيسية إلى ثمان مجموعات فرعية، المجموعة الأولى الفرعية: مصابة بالسكر وتتغذى على الوجبة الغذائية الأساسية، المجموعة الفرعية الثانية: مصابة بالسكر وتتغذى على الوجبة الغذائية الأساسية مضاف لها ٥٪ من القرفة، المجموعة الفرعية الثالثة: مصابة بالسكر وتتغذى على الوجبة الغذائية الأساسية مضاف لها ١٠٪ من القرفة، المجموعة الفرعية الرابعة: مصابة بالسكر وتتغذى على الوجبة الغذائية الأساسية مضاف لها ٥٪ من الزنجبيل، المجموعة الفرعية الخامسة: مصابة بالسكر وتتغذى على الوجبة الغذائية الأساسية مضاف لها ١٠٪ من الزنجبيل، المجموعة الفرعية السادسة: مصابة بالسكر وتتغذى على الوجبة الغذائية الأساسية مضاف لها ٥٪ خليط كل من القرفة والزنجبيل، المجموعة الفرعية السابعة: مصابة بالسكر وتتغذى على الوجبة الغذائية الأساسية مضاف لها ١٠٪ خليط كل من القرفة والزنجبيل، المجموعة الفرعية التاسعة: مصابة بالسكر وتتغذى على الوجبة الغذائية الأساسية مضاف لها (١٠ ملي جرام اتروفاستاتن + ٣٠ ملي جرام جليكلاجيد) واستغرقت التجربة ستة أسابيع.

وفي نهاية التجربة تم تجميع عينات الدم ثم فصل السيرم بجهاز الطرد المركزي.

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وقد أظهرت النتائج أن الفئران المغذاة على القرفة والزنجبيل وخليط منهما أحدثت إنخفاضاً معنوياً في سكر الدم والكوليسترول الكلي والجليسريدات الثلاثية وكوليسترول البروتين منخفض الكثافة وكوليسترول البروتين منخفض الكثافة جداً وزيادة في مستوى الكوليسترول مرتفع الكثافة وكان أفضل تحسن في المجموعة الفرعية الثامنة المصابة والمغذاة على الوجبة الغذائية الأساسية و (١٠ ملي جرام اتروفاستاتن + ٣٠ ملي جرام جليكلاجيد) وتليها المجموعة الفرعية السابعة المصابة والمغذاة على الوجبة الغذائية الأساسية و ١٠٪ من كل من القرفة والزنجبيل ثم المجموعة الفرعية الثالثة والخامسة المصابة والمغذاة على ١٠٪ قرفة و١٠٪ زنجبيل. ولذلك توصي الدراسة بأن شرب القرفة والزنجبيل يومياً تساعد على السيطرة على مرض السكر وتحسن مستويات الجلوكوز وتجزؤات الدهون.

الكلمات المفتاحية: القرفة. الزنجبيل. الفئران. سكر الدم. تجزؤات الدهون.