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Effect of aqueous extracts of some medicinal plants on blood glucose level and lipid profile in diabetic rats

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Abstract: The objective of the present study was to investigate the effects of aqueous extracts of chamomile, lavender, rosemary, marjoram, fenugreek and cinnamon on blood glucose and lipid profile in alloxan-induced diabetic rats. Total phenols (mg/100gm), antioxidant activity (DPPH %) and Phenolic acids of the plants under study were determined. Forty five rats were divided into nine groups (n=5).One of themuntreated rats which was considered normal control (group 1) ,while the rest of rats were injected (i.p) with alloxan- monohydrate (100 mg/kg bw) dissolved in normal salineinduced diabetic.Diabetic rats divided into eight group ,one of them wasdiabetic control positive untreated received 1ml of distilled water(group 2), followed by diabeticreferencereceived glipisidetablets (group 3). The rest of diabetic rats groupstreated with the plants extracts orally at a dose of 300 mg/kg body weight dissolved in 1ml distilled water. Blood samples were collected from the eyes of the rats by capillary tube at 2, 4, and 6 h. after extract administration and were analyzed for glucose content and lipidprofile. The results showed that, rosemary had the highest level of total phenols which record (6.27 g/100g), followed by lavender which record (4.76 g /100g), followed by cinnamonwhich record (4.26 g/100g) followed by marjoram which record(4.25g /100g).On the other hand, lavender and cinnamon have higher contents of Chlorogenic,P.OH.Benzoic , Caffeic, Benzoic and Ellagic acids. The results also showed that blood glucose level decreased significantly in all the treated groups at 2, 4 and 6h. after treatment as compared to the diabetic control group. The highest decrease was noticed in the group treated with rosemary extract followed by cinnamon group. Concerning blood lipid profile, the diabetic group treated with extracts of lavender leaves exhibited the lowest level in plasma total cholesterol followed by aqueous extracts of rosemary at 2,4 and 6h.after treatment. Also, the group treated with rosemary, lavender and marjoram showed significant decrease in triglyceride level while the extracts of lavender, cinnamon and rosemary caused a significant increase in HDL-c and a significant decrease in LDL-c level in comparing with diabetic control.

Keywords: Diabetes, chamomile-lavender, cinnamon, rosemary, fenugreek, marjoram, hypoglycemia, hyperlipidemia, phenols

Introduction

Diabetes mellitus (DM) is the common metabolic disorder characterized by hyper glycaemia. There are an estimated 143 million people worldwide suffering from the disease (**Harris and Macaulay, 1998**). And this is almost five times the estimate ten years ago. It has been predicted that the number may probably double by the year 2030 **(Kingh *et al.,* 1998).** Diabetes mellitus is a chronic disease caused by inherited and acquired deficiency in production of insulin by the pancreas or by the ineffectiveness of the insulin produced (**Yazdanparast *et al.,* 2005 and Atef, 2010**). Many macrovascular complications resulting from defects in insulin secretion **(Chandra et al., 2007)**. The macrovascular complications of diabetes are associated with oxidative stress induced by hyperglycemia (**Evans et al., 2002**).

There is possibility of hyperlipidemia and liver damage in the later stages of diabetes due to disorders in lipid metabolism and increased gluconeogenesis and ketogenesis**(Virdi *et al.,* 2003)**. The field of herbal medicines research has been gaining significant importance in the last few decades and the demand to use natural products in the treatment of than400plant species showing anti diabetic activity, although some of these may remain to be scientifically established **(Rai., 1995, Nalamolu *et al.,* 2006)**.Increased oxidative stress has been postulated in the diabetic state (**Lawrence *et al.,* 2001**). It has also been shown that alloxan induces its diabetogenic activity mainly by inducing the formation oxygen free radicals and thereby damaging the pancreas (**Halliwell and Gutteridge 1985**).It is important to mention that antioxidant compounds either naturally or synthetic, could provide effects against various disease including DM (**Giugliano *et al.,* 1996; Ceriello, 2003; Rahimi *et al.,* 2005; Batubara et al., 2010**).The side effects of antidiabetic drugs has led to use several species of medicinal plants with hypoglycemic properties **(Li and Crawford 2004).** The hypoglycemic properties of these plants are reported to be due to their higher contents of flavonoides and different bioactive compounds. Chamomile (Matricariachamomilla L.) which was known in ancient Egypt and Rome, is one of the common medicinal plants used in the world. The main active components of M. chamomilla L. are bisabolol, bisabololoxide, bisabolonoxide, and chamazulene. It contains 0.75% of a volatile oil that is blue in colour**(Baytop 1984).**Chamomile is well known for its pharmaceutical properties such as anti-inflammatory, immunomodulatory activity, arcaricadalproperty,anti-cancer activity and antipruritic effect (**Cemek *et al.*, 2008**).

Lavender (Lavandulaangustifolia) is a widely distributed ornamental plant belongs to the family Lamiaceae and cultivated extensively in temperate climates of South America, Europe, and Asia. It has been traditionally considered for its very pleasant smell and a bitter taste. Its purple flowers and essential oil are used in toiletry, cosmetics, perfume, pharmaceutical, food and flavor industries. Many compounds have been detected in lavender aerial parts and flowers extract, including geraniol, linalool, linalyl acetate, ursolic acid, luteolin, umbelliferone, coumarin etc. The plant is used in traditional and folk medicines in the different parts of the world for the treatment of several skin sores, insect bites, gastrointestinal, nervous and rheumatic disorders. It also showed carminative, diuretic, antiepileptic, anti-rheumatic, pain reliever, relaxant, sedative, antioxidant, burn healing, antibacterial and anti-inflammatory properties (**Brajesh *et al.*, 2016**).Its leaves and stems are used to prepare decoctions against rheumatism, chill and digestive system diseases **(El-Hilaly *et al.*, 2003).**

Lavender essential oils are advocated for their use as an antibacterial agent in both early and modern aromatherapy texts **(Lawless, 1992).**Lavender has been extensively phytochemically studied, with limited work on pharmacological aspects and is used by traditional healers for various diseases of the central nervous system, like epilepsy and migraine (**Nadkarni, 1982**). Rosemary (Rosmarinusofficinalis Linn.) and mint Labiataefamily are common household plant grown in many parts of the world. They are commonly used as a spice and flavoring agent in food processing **(Saito *et al.*, 2004)**.

Also, rosemary is used as an antispasmodic in renal colic and dysmenorrheal, in relieving respiratory disorders and to stimulate hair growth. Extract of rosemary relaxes smooth muscles of trachea and intestine, and has choleretic, hepatoprotective and antitumergenic activity. (**Al-Sereiti *et al.*, 1999; Masuda *et al.*, 2002; Sotelo-Fleix *et al.*, 2002; Osakabe *et al.*, 2004).**

Marjoram is one of the most familiar kitchen herbs. It is cultivated for use of its aromatic leaves for flavouring and other culinary purposes.

Sweet marjoram leaves are also excellent in salads. The medicinal effects of marjoram are gastrointestinal tract stimulant, tonic, carminative, diaphoretic, hypoglycemic, diuretic as well as antibacterial (**Leeja and Thoppil, 2007**) and as antioxidant (**Handl *et al.*, 2008** and **Lamiaa *et al.*, 2009**). Thus food additives like herbs, which have free radical scavenging activity, may be useful in controlling glucose levels in diabetic patients.

Cinnamon (C. zeylanicum, Family Lauraceae) bark is commonly used in Arabian countries as a spice for most foods. In Eastern and Western folk medicine it used for treating abdominal and chest pains, chronic diarrhea, hypertension, kidney disorders and rheumatism. Intake of 3g or 6g of cinnamon bark reduced serum glucose in people with type 2 diabetes (**Khan *et al.*, 2003**).Cinnamon extracts have also demonstrated hepatoprotective and antioxidant effects in CCL4 - intoxicated rats (**Moselhy and Ali, 2009**).

Fenugreek (Trigonellafoenumgraecum) seeds is an old herbal remedies used to treat metabolic and nutritive dysfunctions (**Eskander and won 1995 and Chevassus *et al.*, 2009**). Fenugreek is a leguminous herb, commonly cultivated and used as a condiment in India and North African countries. The seeds are yellow in colour, bitter to taste(**Mishkinsky *et al* ., 1967**) and are a rich source of fiber. It contains mucilaginous fiber and total fiber to the extent of 20% and 50% respectively. (**Raghuram *et al*., 1993**).

Accordingly, this study was carried out to evaluate antioxidant activity of the selectedplants concerning total phenols, antioxidant activity and phenolic acids and investigate the effects of aqueous extracts of chamomile, lavender, rosemary, marjoram, fenugreek and cinnamon on blood glucose and lipid profile in alloxan- induced diabetic rats.

Materials and methods

Plant Samples: The leaves of lavender, rosemary, marjoram, chamomile in addition to fenugreek seeds and cinnamon were purchased from Mansoura local markets,Egypt.

Kits: Glucose, Total cholesterol (TC), Triglycerides (TG), High density lipoprotein cholesterol (HDL-c). All chemicals are purchased from Sigma.

Samples preparation

The leaves of lavender, rosemary, marjoram , chamomile, in addition to fenugreek seeds and cinnamonwere washed with tap water three times and then used a cross flow drier to dried at 70 °C for 5 h.. The dried lavender, rosemary, marjoram, chamomile, in addition to fenugreek seeds and cinnamon were powdered using a hammer mill to obtain a fine powder, through a 0.5 mm sieve. The samples powder were stored in freezer until use.

Prepration of the aqueous extracts

The extraction procedure for the hydro-alcoholic extract was carried out according to (**Charles *et al.*, 1993)**. About 250 grams of each milled plant samples were macerated in 500 ml of methanol over night at room temperature, then filtered and the methanolic crude extract was collected. Another portion of 500 ml of methanol were added to the plant residue and boiled for two hours under reflux condenser in a water bath and then filtered. The filtered was collected to the previous crude extract. In the same manner 500 ml portion of water were added to the residue plant and left at room temperature overnight, then filtered.

The filtrate was added to the previous crude extract. Another volume of water was added to the residue, boiled for two hours under reflux condenser and filtered. The hot water filtrate and the methanolic crude extract obtained previously were gathered to from the hydro-alcoholic crude extract. The solvents were evaporated under vacuum using rotary evaporator. The crude extract was obtained, kept in dark bottles and stored in a deep freezer until use.

Experimental, Biological Evaluation

Animals

Adult male white rats weighing (250-300) were used in this study.The animals were purchased fromthe animal house of National Research Center, Cairo-Egypt. All animal were kept under standardized conditions (12h light/ dark cycle, 22 °C) and were provided free access to standard diets (Table1) and wateraccordance with the National Institute of

Health guidelines for the care and use of laboratory animals. Half of the rats were subjected to alloxan monohydrate to be diabetic.

Table (1): Composition of the standard diet.

Ingredients	g/kg Diet
Casein	200
Corn starch	497
Sucrose	100
Vitamin mixture	020
Mineral mixture	100
Corn oil	050
Cellulose	030
Methionine	003

Induction of Diabetes

Rats were injected (i.p) with alloxan- monohydrate (BDH) (100 mg/kg bw) dissolved in normal saline(**Djrolo *et al.*, 1998)**. Seven days after alloxan administration, blood was collected from the rat eye by means of Haematocrit tubes in EDTA tubes. Plasma was separated by centrifugation and analysed for blood glucose. Animals showing fasting blood glucose higher than 200mg/dl (**Misra and Fridovich1972**)were selected and used as diabetic rats.

Experimental design

Forty five rats were divided into nine groups (n=5), one of themisuntreated rats (Group1) which was considered normal control ,while the rest of the groups were diabetic and treated with the extracts (300 mg/kg b w) dissolved in 1ml distilled water and distilled to sup groups as follows: Group2 (Diabetic control): received 1ml of distilled water, Group3 (reference): received glipisidetablets, Group4: received the extract of chamomile, Group5:received the extract of lavender, Group6: received the extract of rosemary, Group7: received the extract of marjoram, Group8:received the extract of cinnamon and Group9:received the extract of fenugreek. At the end the of the experiment animals were deprived of food overnight and, blood samples were collected from eyes of the rats by capillary tubes for hematology it all analyses.

Chemical analysis

Determination of antioxidant activity(%)

The effect of plant samples on DPPH radical was studied, employing the modified method described earlier by (**AOAC Methods 2000 and Ranganna1979**). Briefly, 1.5 ml of DPPH solution (0.1 Mm, in 95% Ethanol)was incubated with varying concentrations of the extract (plant samples , 0.75 - 5.0 mg).The reaction mixture was shaken well and incubated for 20 min at room temperature and the absorbance of the resulting solution was read at 517 nm agains a blank. The radical scavenging activity was measured as a decrease in the absorbance of DPPH and was calculated using the following equation:

Scavenging effect % = $\underline{1\text{- ASample (517nm)} \times 100}$

AControl (517nm)

Determination of total phenolic compounds

Total phenolic compounds were determined by HPLC according to the method of **(Goupy et al., 1999)** at Central lab. ofFood Technology Research Institute Agric. Res. cent. Egypt .

Fractionation and identification of phenolic acids

Phenolic acids were estimated in Central Laboratory of Food Tech. Res. Inst., Agric. Res. Center, Giza, Egypt. An HP 1100 HPLC system equipped with an alpha Bond C18 125A column

(4.6 · 250 mm, particle size 5 lm) and coupled with Agilent 1100 series Chem Station software was used for quantifying the individual phenolic acids. The mobile phases consisted of 2.0% acetic acid in distilled water (A) and acetonitrile (B). The column was eluted at 1.0 ml/min under a linear gradient from 5% mobile phase B to 75% over 20 min, to 100% over 5 min, isocratic for 5 min, to 25% over 5 min and to 5% over 5 min. Plant samples injection volumes were 20 ll. Compounds were detected at 280 nm with an HP 1100 series ultraviolet (UV) Diode Array Detector. Standards of ellagic, catechin, caffeic, protocatchioc, syrengic, furan, vanillic, gallic and coumarinwere injected for identification at 280 nm.

Biochemical analysis

Fasting blood glucose was estimated by an enzymatic colorimetric method according to **(Siest *et al.,* 1981).**Total cholesterol, HDL-cholesterol and triglyceride content were determined by enzymatic colorimetric method according to (**Allian *et al.*, 1974, Richmond 1973 and Fossati and Principle 1982)**, respectively.LDL-cholesterol and VLDL-cholesterol were calculated according to **Friedewald *et al.*, 1972).**

Statistical analysis

Results of the biochemical estimations of the rats are reported as mean ± SD.. The total variation was analysed by performing one-way analysis of variance. Least Significant Difference(LSD) was used for determining significance (**Sümbüloglu, 1998**).

Results and discussion

Total phenols and antioxidantactivity of the selected plants

Total phenols and antioxidant activity of chamomile, lavender, rosemary, marjoram, cinnamon and fenugreek are tabulated in Table (2). The antioxidant activity (%) of rosemary and cinnamon had the highest levels which recorded 92.12% and 91.17%, respectively, followed by lavender and marjoramwhich recorded (89.13% and 85.33%) respectively. On the other hand, the results showed that antioxidant activity (%) of chamomile and fenugreek were 46.47% and 20.81%, respectively. Our results are in agreement with that obtained by (**Hopia *et al.*, 1996**) who observed that , antioxidant activity of rosemary extracts depends on their composition. Aqueous extracts with higher content were the most effective.

The results also showed that, rosemary had the highest level of total phenols was (6.27g\100g), followed by lavender was (4.76g\100g), cinnamon was (4.26g/100g) and marjoram was (4.25g\100g) while the fenugreek had the lowest content was (0.95g/100g). Lavender essential oils a higher scavenging capacity which may be related to the presence of phenolic compounds **(Pascual *et al.*, 1983 and Nogueira and Romano 2002).** They found that this antioxidant capacity remained lower than that of ascorbic acid.

A good correlation between the phenols and antioxidant activityto agents that scavenge free radicals (**Haung *et al.*, 2005, Silva *et al.*, 2006 and Gonzalez *et al.*, 2011).**Free radicals have been implicated in the causation of several disorders, which includes diabetes, and the agents that scavenge free radicals may have great potential in ameliorating these disease processes **(Wilson, 1988)**.Antioxidants play an important role in protecting the human body against damage by reactive oxygen species (**Lollinger, 1981**).

Table (2): Total phenols and antioxidant activityof the selected plants .

Sample	Antioxidant activity (%)	Total phenols (g/100g on DW)
Chamomile	46.47	2.84
Lavender	89.13	4.76
Rosemary	92.12	6.27
Marjoram	85.33	4.25
Cinnamon	91.17	4.26
Fenugreek	20.81	0.95

Phenolic acids of the selected plants

Polyphenolic compounds are very important constituents, by virtue of their antioxidant activity by chelating redox- active meta ions, inactivating lipid free radical chains and preventing hydroperoxide. The main phenolic acids identified inchamomile, lavender, rosemary, marjoram, cinnamon and fenugreek are presented in Table (3). The results showed that lavender and cinnamon have higher contents of Chlorogenic,P.OH.Benzoic , Caffeic, Benzoic and Ellagic acids, these were (220.68 vr 330.93, 1267.70 vr 234.10, 72.30 vr 67.73, 1209.08 vr 1514.84, 538.01 vr 1565.44 mg/100g,) respectively. **El-Ashmawy *et al.*, (2005)** reported that majorana contains phenolic terpenoids, flavonoids, tannins, hydroquinone and phenolic glycosides. They stated that natural dietary antioxidants are extensively studied for their ability to protect cells from miscellaneous damages.

Phenols are very important plant constituents because of their scavenging ability on free radicals due to their hydroxyl groups **(Heim *et al.*, 2002).**The beneficial effect of polyphenols is associated with a multitude of biological activities, including antioxidant and free radical-scavenging properties, anti-platelet aggregation and inhibition of vascular smooth muscle cell proliferation. These observations might explain their cardiovascular protective properties (**Fuhrman and Aviram 2001). Frankel, (1999)** demonstrated that rosemary extracts contain a large number of phenolic compounds, including carnosic acid, carnosol, and rosmarinic acid. The rosmarinic acid and other phenolic compounds were found in the leaves of

Flavonoids and phenolic compounds such as hispidulin, cirsimaritin, apigenin, genkwanin, naringin, caffeic acid and rosmarinic acid are also present rosemary extracts (**Zheng and Wang, 2001; Ibáñez *et al.*, 2003).**

Table (3): Phenolic acids (mg/100g) DW ofthe selectedplants

Test items	Chamomile	Lavender	Rosemary	Marjoram	Cinnamon	fenugreek
Syring	36.60					
Pyrogallol	-	174.76	-	-	-	2506.58
Gallic	22.02	-	3.11	-	-	4.11
Protocatechuic	-	-	24.97	-	467.53	3.93
Catechol	-	-	-	9.60	103.71	2.08
c4-Amnopenzoic	5.89	12.52	4.77	-	-	1.14
Catechein	27.56	-	8.55	-	227.12	3.65
Chlorogenic	89.91	220.68	24.56	28.64	330.93	2.38
P.OH.Benzoic	-	1267.70	59.11	27.84	234.10	4.23
Epicatechen	2022.30	873.39	37.27	48.74	1126.74	41.53
Caffeic	-	72.30	4.68	28.80	67.73	5.08
Vanillic	28.53	79.74	10.28	3.54	14.50	2.91
Caffiene	78.40	-	14.05	19.78	57.70	19.80
Ferulic	82.74	57.82	28.40	35.88	146.92	4.45
Benzoic	-	1209.08	732.22	-	1514.84	45.98
Salicylic	309.50	622.52	-	475.03	2259.29	-
Coumarin	-	159.82	83.09	45.10	301.70	3.06
Ellagic	174.10	538.01	83.11	317.43	1565.44	15.49
Cinnamic	10.75	26.45	17.24	49.30	5370.00	4.57

Effect of plants extracts on blood glucose and total cholesterol levels of the diabetic rats

Data in Table (4) revealed a significant elevation in fasting blood glucose and plasma total cholesterol levels of diabetic control (+) when compared with normal control (-). All the groups treated with plant extracts in addition to the reference group exhibited significant reduction in blood glucose and total cholesterol levels at 2, 4 and 6 h. after extract administration. The highest decrease in blood glucose level was noticed in diabetic rats treated with the extract of rosemary leaves which was (115.3$\pm$11.9, 102.3$\pm$ 4.04 and 91.3$\pm$ 16.4 mg/dl) after 2, 4 and 6h. respectively, followed by diabetic rats treated with the extract of cinnamon (130.6$\pm$22.1, 110$\pm$19.4 and 105$\pm$15 mg/dl) after 2, 4 and 6h. respectively. The lowest effect was noticed in the rats group treated with fenugreek extract where it did not show significant decrease in blood glucose after 2 hours of administration .Activity of chamomile extract has shown to be independent of insulin secretion (**Eddouks *et al.*, 2005**), and studies further reveal its protective effect on pancreatic beta cells in diminishing hyperglycemia-related oxidative stress (**Cemek *et al.*, 2008**).

Our results clearly demonstrated that continuous infusion ofchamaemelumnobile extract for three hours lowered both blood glucose levels and endogenous glucose production, whereas the metabolic clearance rate of glucose remains unchanged. Previously, we have reported that inhibition of endogenous glucose production accounts for the hypoglycaemic activity of Spergulariapurpurea aqueous extract in streptozotocin-induced mice(**Eddouks, 2003**). Hyperglycemia in diabetic subjects caused stress (free radical generation) and vice versa **(Lawrence *et al.*, 2001; West., 2000 and Sushruta *et al.*, 2006**). Our results are in agreement with that obtained by (**Vijayakumar *et al.*, 2005; Qin *et al.*, 2004; Choi *et al.*, 2004 andQin *et al.*,2003)** they reported that to explain the insulin sensitizing activity of cinnamon and fenugreek extracts. After three weeks of cinnamon treatment (300 mg kg−1), the skeletal muscle insulin-stimulated IR-β and the IRS-1 tyrosine phosphorylation levels were 18 and 33% higher in treated rats. Our results are in agreement with that obtained by (**Gilani *et al.*, 2000)** who found thatcinnamon reduce blood sugar levels**.** Also,water-soluble cinnamon extract induced significant decrease in free blood glucose level**(Hiebauiczetal, 2007** and **Time *et al.*, 2006)**, found also that cinnamon with rice pudding reduces postprandial blood glucose.

Also, the hypoglycaemic activity of fenugreek seed extract was mediated through the stimulation of an insulin signalling pathway especially in adipocytes and liver cells (**Reaven, 1995**) promotes glucose utilization and leads to decrease blood glucose levels. Fenugreek seeds contains trigonelline, an alkaloid known to reduce blood glucose level. Fenugreek seed powder in the diet reduces blood sugar and urine sugar with concomitant improvement in glucose tolerance and diabetic symptoms in both NIDDM and IDDM. (**Raghuram *et al.*, 1993**).

Concerning plasma total cholesterol, Data present in Table (4) revealed that the rats group treated with the extract of lavender leaves showed the lowest reduction in total cholesterol as being (86.3$\pm$7.5, 75.3 $\pm$ 10.9 and 73.3 $\pm$ 15 mg/dl) at 2,4 and 6h. after treatment, respectively in comparing with diabetic control. Also both rosemary and fenugreek extracts decreased blood total cholesterol to levels better than that of glipiside drug. So, it is possible to suggest that the extracts of marjoram, rosemary and lavender leaves and cinnamon might directly improve the blood glucose level and plasma total cholesterol.

Lavender extracts have also positive effects on wound, urinal infections, cardiac diseases and eczema **(Benabdelkader *et al.,* 2011**). Lavender is a medicinal plant largely used in the Tunisian traditional medicine. This plant is known to protect against headaches, depression and diabetes **(Gilani *et al.,* 2000 and Cavanagh and Wilkinson 2002).**

Rosemary constituents have a therapeutic potential in the treatment or prevention of bronchial asthma, spamogenic disorders, diabetes mellitus, peptic ulcer, inflammatory diseases, hepatotoxicity, atherosclerosis, ischemic heart diseases, cataract, cancer and poor sperm motility (**Al-Sereiti *et al.,* 1999; Masuda *et al.,* 2002; Sotelo-Fleix *et al.,* 2002 and Osakabe *et al.,* 2004).**

The present study showed that the extracts under study caused high reduction in blood glucose level in treated diabetic rats as compared to diabetic control. It was likely that the antioxidant activity of the extracts produced better response in such stressful conditions.

Table (4): Effect of plants extracts on blood glucose and plasma total cholesterol levels in alloxan-induced diabetic rats

Groups	blood glucose (mg/dl)			T.C.(mg/dl)		
	2h	4h	6h	2h	4h	6h
Control(-)	100± 1.1*	97.3±4.01*	90.3± 9.5*	97.3±4.0*	89±3.46*	84.6±6.9*
Control (+)	258.3+7.6	280+10	291.6+10.4	170+5.0	210.3+7.5	220.66+4.04
Glipizide	132.3±17.4*	104±12.1*	87± 1.7*	103.66±2.9*	86.7±9.8*	68±10.3*
Chamomile	233.6±19.2	178±9.9*	125.6±7.23*	123 ±8.7*	86.6±7.5*	83.3 ± 8*
Lavender	175± 6.3*	169.6± 11.4*	133± 10.4*	86.3±7.5*	75.3±10.9*	73.3 ± 15*
Rosemary	115.3±11.9*	102.3± 4.04*	91.3± 16.4*	88.00± 13.2*	86±7.3 *	82.7± 3.5*
Marjoram	158.3± 2.9*	140.3± 3.5*	128±11.1*	115± 1.7*	89.6±21.4*	84.4± 9.2*
Cinnamon	130.6±22.1*	110±19.4*	105±15*	108.66±2.8*	98 ± 12.1*	88.66 ± 4.6*
Fenugreek	248.6± 9.3	215.6±19.9*	161±23.1*	96.6±4.6*	85.3± 4.6*	79.3±9.2*

Each value is the mean± SD of 5 rats.
*p<0.05 when compared to diabetic control group (+)

Effect of plants extracts on plasma triglycerides and plasma HDL-c levels in alloxan- induced diabetic rats

Administration of plant extracts to diabetic rats recorded a significant decrease in plasma triglyceride levels and a significant increase in HDL-cholesterol levels as shown in Table 5 at 2, 4 and 6 h. after administration as compared to diabetic control group (+). The results revealed that the diabetic rats groups treated with glipiside and plant extracts had significantly lower values of plasma triglyceride than those of diabetic control (+). The highest decreases in plasma triglyceride levels were noticed in diabetic rats group treated with aqueous extracts of rosemary leaves which were (92±10.4,74.3±7.5 and 61.7±2.9 mg/dl) after 2, 4 and 6h. respectively, followed by diabetic rats group treated with aqueous extracts of lavender leaves with values of 94.3±4.1, 80.3±5.2and 64.7±9.2mg/dl after 2, 4 and 6h., respectively, while diabetic rats group treated with aqueous extracts of marjoram leaves reduced plasma triglyceride to levels of 96.7±1.2, 81.3±2.3 and78±6.9mg/dl after 2, 4 and 6h., respectively. Marjoram powder was the most effective in reducing the values of the biochemical parameters of lipid profiles and antioxidant properties **(Soltan and Abdel-Wahab 2006 and Shelbaya *et al.,* 2014).**

On the other hand, a significant increases in HDL-cholesterol in the diabetic group treated with lavender leaves extract were observed with values of (29.3±1.15, 35±4.2 and 42.6±4.8mg/dl), followed by diabetic rats group treated with aqueous extracts of cinnamon (29.3±5.7,34.3±2.3 and 40.7±6.3 mg/dl), the diabetic group treated with rosemary extract (23.6±8.1,32±3.4 and 39±1.73mg/dl) at 2, 4 and 6h.after extract administration, respectively as compared to diabetic control (19.3±3.75, 15.6±1.2and15±3.7 mg/dl) after 2, 4 and 6h., respectively.Our results are in agreement with that obtained by (**Pimple *et al.,* 2012**)who observed that the extract of chamomile was more effective in reducing the serum lipid levels significantly in NIDDM rats.

So it is advised by giving aqueous extracts of rosemary, lavender and marjoram leaves and aqueous extracts of cinnamon to the patients with hyperlipidemia or those exposed to atherosclerosis.Other studies showed that diabetic rats which fed on groundnut oil exhibited significant reductions in the blood levels of triglycerides, cholesterol, LDL-c, and elevation in HDL-c level when compared with corresponding controls **(Ramesh *et al.,* 2006 and Khan *et al.,* 2005).**

Table (5): Effect ofplants extracts on plasma triglycerides and plasma HDL-c levels in alloxan-induced diabetic rats

Groups	Plasma Triglycerides level			Plasma HDL-c level		
	2h	4h	6h	2h	4h	6h
Control(-)	88±6.9*	83.3±2.8*	82.3±2.9*	31±15.5	27.3±17.9*	42±8.6*
Control (+)	165.8±3.9	186.3±7.1	204.3±5.13	19.3±3.75	15.6±1.2	15±3.7
Glipiside	91.3±1.5*	80±17.3*	69.3±8.08*	22.7±4.6	22.7 ±2.3	26±3.5*
Chamomile	115.7±15.1*	91±11.2*	81.7±1.15*	21±1.9	24.6±5.1	24±1.7*
Lavender	94.3±4.1*	80.3±5.2*	64.7±9.2*	29.3±1.15	35±4.2*	42.6±4.8*
Rosemary	92±10.4*	74.3±7.5*	61.7±2.9*	23.6±8.1	32±3.4*	39±1.73*
Marjoram	96.7±1.2*	81.3±2.3*	78±6.9*	17.3±5.8*	21.6±1.9	29±1.73*
Cinnamon	128±17.3*	114.3±9.6*	69±15.6*	29.3±5.7	34.3±2.3*	40.7±6.3*
Fenugreek	99±1.7*	82.7±1.7*	75.7±9.8*	17±8.6	24.6±2.1	33.7±2.9*

Each value is the mean± SD of 5 rats.
*p<0.05 when compared to control group (+)

Effect of plants extracts on plasma LDL-c and plasma VLDL-c levels in alloxan- induced diabetic rats

The results in Table (6) revealed significant decreases in plasma LDL- cholesterol and plasma VLDL-cholesterol levels as shown in the diabetic rats group treated with glipiside, and all the diabetic groups treated with the plant extractsunder study when compared with diabetic control (+) at 2, 4 and 6 h. after treatment. The highest decreasein plasma LDL-c levels was noticed in diabetic rats group treated with aqueous extracts of lavender leaves as being (38.4 ± 1.6,24.3±4.2,and 17.8±2.7 mg/dl) after 2, 4 and 6h. respectively, followed by diabetic rats group treated with aqueous extracts of rosemary leaves (46+ 4.7, 39.14+ 5.3 and 31.4+11.54 mg/dl) and the diabetic rats group treated with aqueous extracts of cinnamon (53.76+1.1, 40.84+11.6 and 34.16+4.8 mg/dl) after 2, 4 and 6h., respectively.

Concerning plasma VLDL- cholesterol, Data present in Table (6), revealed that the rats group treated with aqueous extracts of rosemary leaves caused significant decrease in plasma VLDL- cholesterol as follows (18.4±2.1, 14.86±0.23 and 12.3±0.577 mg/dl) after 2, 4 and 6h., respectively in comparing with the diabetic control

(33.15±0.78,37.26±1.4 and 40.86+1.1 mg/dl) after 2,4 and 6h. respectively. Also the group treated with aqueous extracts of lavender leaves exhibited low levels in plasma VLDL- cholesterol (18.86±0.8, 16.0± 1.1 and 12.9 ±1.8 mg/dl) after 2,4 and 6h., respectively when compared with the diabetic control (+) .Fenugreek seeds have the potential to alter glycemic and lipidemic status and reduce abdominal fat in normal rats (**Gee *et al*., 1983; Srichamroen *et al*., 2008**) and reduced the risk of heart-attack.

Table (6): Effect of plants extracts on plasma LDL-c and plasma VLDL-c levels in alloxan-induced diabetic rats

Groups	Plasma LDL-c levels			Plasma VLDL-c levels		
	2h.	4h.	6h.	2h.	4h.	6h.
Control(-)	53.4±14.2*	45±10.4*	26.5±5.77 *	17.6±1.4*	16.7± 0.67*	16.4 ± 2.4*
Control (+)	117.6± 2.1	157.4±7.5	164.8±3.3	33.15±0.78	37.26±1.4	40.86±1.1
Glipizide	62.6±1.7*	48 ± 8.6*	28.1±12.2*	18.3±0.11*	16.0± 3.5*	13.86±1.6*
Chamomile	78.9± 4.6*	43.8±1.3*	43±5.4*	23.1±2.77*	18.2±7.3*	16.3±0.23*
Lavender	38.4 ± 1.6*	24.3±4.2*	17.8±2.7*	18.86±0.8*	16.0± 1.1*	12.9±1.8*
Rosemary	46± 4.7*	39.14± 5.3*	31.4±11.54 *	18.4±2.1*	14.86±0.23*	12.3±0.577*
Marjoram	78.4 ± 4.3*	51.74±24.1*	39.8±5.7*	19.3±0.23*	16.26±1.5*	15.6±1.38*
Cinnamon	53.76±1.1*	40.84±11.6*	34.16±4.8	25.6±3.5*	22.86±5.4*	13.8±3.1*
Fenugreek	59.8±13.62*	44.16±9.1*	30.2± 1.4*	19.8±0.34*	16.54±0.46*	15.14±1.9*

Each value is the mean± SD of 5 rats.
*p<0.05 when compared to control (+).

Conclusion

The study indicates that since theaqueous extracts of chamomile, lavender, rosemary, marjoram leaves and fenugreek, cinnamon are used in the preparation of foods, they may be useful in the control of postprandial rise of blood glucose particularly in diabetic patients. Additionally, their daily use may help in reducing complications associated with chronic diabetes as noticed by improving lipid profile of the diabetic rats and hence prevent cardiovascular diseases.

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تأثير المستخلصات المائية لبعض النباتات الطبية على مستوى سكر ودهون الدم في الفئران المصابة بداء السكري

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تهدف الدراسة الحالية الى إستكشاف تأثير المستخلص المائي للبابونج، واللافندر وإكليل الجبل والبردقوش والحلبة والقرفة على مستوي سكر ودهون الدم بواسطه الالوكسان المحث علي اصابة الفئران بالسكري. وتم تحديد الفينولات الكلية ، ودراسة النشاط المضاد للأكسدة وتفريد الأحماض الفينولية للنباتات عينه الدراسة. تم تقسيم خمسة وأربعين فأرا إلى تسع مجموعات (ن = ٥). احدهم وهو مجموعه الفئران السليمة غير المعالجة التي اعتبرت كنترول سالب (مجموعه ١) ، في حين أن بقية الفئران تم حقنها بالالوكسان (١٠٠ مجم/ كجم من وزن الجسم) الذائب في محلول ملحي للحث علي الإصابة بالسكري . ثم تم تقسيم الفئران المصابة بداء السكري إلى ثمانية مجموعات، احدهم وهو الكنترول الموجب وهو السكري غير المعالج واعطي له امل من الماء المقطر (مجموعه ٢)، تليها مجموعه الفئران السكري التي تم علاجها بأقراص glipiside (مجموعه٣). بقية الفئران المصابة بداء السكري تم علاجها بمستخلصات بعض النباتات الطبية بجرعة ٣٠٠ ملجم / كجم من وزن الجسم المذاب في ١مل من الماء المقطر عن طريق الفم ٠ تم جمع عينات الدم من العين من جميع الفئران بعد تناول المستخلصات بواسطة أنبوب شعري خلال ٢ و ٤ و ٦ ساعات. وتم تحليل مستوي الجلوكوز ودهون الدم. وأظهرت النتائج أن اعلي محتوي للفينولات الكليه في اكليل الجبل (٢٧ ,٦جم / ١٠٠جم)، يليها اللافندر(٧٦,٤جم / ١٠٠جم)، ثم القرفة (٢٦, ٤جم / ١٠٠جم)، ثم البردقوش (٢٥, ٤جم / ١٠٠جم). واشارت النتائج الي ارتفاع محتوي اللافندر والقرفة من Chlorogenic، P.OH.Benzoic، Caffeic، Benzoic، Ellagic acids.كما أظهرت النتائج أن مستوى سكر الدم انخفض بشكل ملحوظ في جميع المجموعات التي تم علاجها خلال ٢ و ٤ و ٦ساعات بالمقارنة بالكنترول السكري. ولوحظ ايضا ان أكبر انخفاض في مستوي سكر الدم اتضح في المجموعة التي تم علاجها بالمستخلص المائي لأوراق إكليل الجبل تليها المجموعة التي تم علاجها بالمستخلص المائي للقرفة. وفيما يتعلق بدهون الدم، كشفت النتائج أن مجموعة الفئران السكري التي تم علاجها بالمستخلص المائي لأوراق اللافندر أظهرت أدنى مستوى في الكوليسترول الكلي ، تليها المجموعة التي تم علاجها بإكليل الجبل خلال ٢و٤ و٦ ساعات بعد تناول المستخلص بالمقارنة بالكنترول السكري.واشارت النتائج ان مجموعة الفئران المصابة بداء السكري والتي تم علاجها بالمستخلص المائي لإكليل الجبل واللافندر والبردقوش اظهرت انخفاض ملحوظ في مستوى الدهون الثلاثية ، في حين تسبب كلا من المستخلص المائي للافندر، والقرفة، وإكليل الجبل في زيادة كبيرة في مستوي الليبوبرتينات المرتفعة الكثافة ، وانخفاض ملحوظ في مستوى في الليبوبرتينات المنخفضة الكثافة مقارنة مع الكنترول السكري٠ وتوصي الدراسة باستخدام البابونج، اللافندر وإكليل الجبل، وأوراق البردقوش وبذور الحلبة، والقرفة في إعداد الأطعمة، وأنها تفيد في السيطرة على ارتفاع السكر في الدم بعد الأكل لاسيما في حالة السكري. بالإضافة إلى ذلك، الاستخدام اليومي قد يساعد في الحد من المضاعفات المرتبطة بداء السكري المزمن. وايضا توصي الدراسة باستخدام تلك النباتات وخاصه لمرضي السكري لما لها اثر فعال في خفض سكر وليبيدات الدم .