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Effect of Figs Fruit (*Ficus carica* L.) And its Leaves on Hyperglycemia in Alloxan Diabetic Rats

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Abstract: Flavonoids have anti-inflammatory and antioxidative effects and thus may be useful to relief side effects and severity of diabetes. *Ficus carica* L., Fruit and its leaves contain considerable number of healthy compounds namely polyphenols such as flavonoids. The present work was carried out to identify the total flavonoids content and the individual fractions. Also to investigate the effect of different levels of *Ficus carica* L., (F.C.L.,) and its leaves (F.C.L., L.) on blood sugar level, daily food intake, body weight gain, feed efficiency ratio (F.E.R) and organs weight to body weight ratio in alloxan diabetic rats. Serum lipid profile, kidney function and liver function were also studied. Forty eight male albino rats (Sprago Dawley strain) were divided into two main groups. The first main group (n = 6) was fed on basal died (B.D.) and used as a control negative group. The second main group (42 rats) was injected with alloxan (150 mg/kg b.wt) to induce hyperglycemia this group was divided into seven equal subgroups. One of them (6 rats) was fed on B.D used as a positive control group. The other sex subgroups as a follows: groups (1-3) received B.D. containing different levels of F.C.L., (5, 10 and 20%): groups (4-6) received B. D. containing different levels of F.C.L., L. (4, 6 and 8%) respectively. Analysis of polyphenol content of either the fruit or leaves revealed the presence of progallic acid, ferulic acid, coumaric acid, galangin, cinnamic acid, quercitin pinostorbin and others. Results showed that the elevation of blood sugar level of alloxan injected rats was improved when F.C.L. or the leaves were included in different levels with B.D. In addition, the complications due to alloxan injection were markedly improved. The hypercholesterolemia and hyperlipidemia were significantly corrected. The liver and kidney function also behaved similarly. The conclusion reached was that inclusion of F.C.L or its leaves in food may help to correct the hyperglycemia due to diabetes. The antioxidant power and fiber content of figs and its leaves are the bases for contribution of these actions.

Key words: *Ficus carica* L. · Liver function · Lipid profiles · Kidney function · Diabetes mellitus · Rats

INTRODUCTION

Diabetes mellitus is a complex and multifarious group of disorders that disturbs the metabolism of carbohydrate, fat and protein. It results from shortage or lack of insulin secretion or reduced sensitivity of the tissue to insulin [1]. Diabetes mellitus is associated with an increased production of reactive oxygen species and a reduction in antioxidant defenses. This leads to oxidative stress, which is partly responsible for diabetic complication. Tight glycemic control is the most effective way of preventing or decreasing these complications. Nevertheless, antioxidants micronutrient can be proposed as adjunctive therapy in patients with diabetes [2]. Phenols, especially those with multiple phenolic groups, are better antioxidants than the well-known-antioxidant vitamins [3].Fruits have significantly higher quality of phenol antioxidants than vegetables. Nutrient score was significantly better for dried fruits compared to the fresh varieties. Apricots and figs had the best nutrient score among dried fruits, the total phenols due to the liberation of phenolic groups following hydrolysis [4].

Figs (*Ficus carica* L.), family Moraceae, is a plant cultivated and grows in Egypt and many other countries. This plant possesses nutritive value and medicinal properties [5]. All parts of this plant are medicinally

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important in the traditional system of medicine and have been used extensively in jaundice, diabetes, diarrhea, nutritional anemias and as anti-inflammatory [6]. Based on the aforementioned findings this study designed to investigate the potential use of ground dried *Ficus carica* L. and its leaves on hyperglycemia in alloxan diabetic rats.

MATERIALS AND METHODS

Material: Figs (*Ficus carica* L.) and its leaves were obtained from a farm in Kafr El-Sheihk governorate. Olive section and semi Arid Zone, Horticultural Research Institute, Agriculture Research Center Giza, Egypt, authenticated Figs as Alsultany. Figs and its leaves were dried by solar energy at National Research Center

Chemical Analysis: Moisture, Protein, fat, ash, crud fiber, polyphenols content in *Ficus carica* L. and its leaves were determined according to the method outlined in A.O.A.C. [7]. The total carbohydrates were determined by Abd El-Latif [8]. Flavonoids were determined in *Ficus carica* L. and its leaves according to the method of Pric *et al.* [9]. Phenolic compounds of Figs and leaves samples were extracted according to the method outlined by Ben-Hammouda *et al.* [10]. Identification of individual phenolic compounds of plant samples were performed on a JASCO HPLC [11].

Chemicals: Casein, vitamins, minerals, cellulose and choline chloride were purchased from EL-Nasr Pharm and Chem. Ind. Comp. Cairo, Egypt. Corn oil and corn starch were obtained from local market. Kits used to determine serum biochemical parameters were purchased from Alkan Pharm. Ind. Comp. Cairo, Egypt.

Experimental Animals: Forty eight male albino rats of Sprague Dawley strain weighing 180 ± 10 g were obtained from the laboratory of animal's colony, Ministry of Health, Helwan, Cairo, Egypt.

Experimental Animals Design: Rats were housed in individual cages under hygienic laboratory conditions and were fed on basal diet adlibitum for one week for adaptation in the animal house of Faculty of Home Economics, Helwan University.

The basal diet in the preliminary experiment consists of 14% casein (protein > 85%), corn oil 4%, salt mixture 3.5%, vitamins mixture 1%, choline chloride 0.25%, cellulose 5% and (72.25%) corn starch [12]. The salt mixture and vitamin mixture were prepared according to Hegsted *et al.* [13] and Campbell [14]. After a period of adaptation on basal diet, rats were divided into two main groups. The first main group (6 rats) fed on basal diet (negative control group). The second main group: Forty two rats were injected with (150mg/kgb.wt.) of recrystallized alloxan to induce hyperglycemia [15]. After 4 days, blood samples were obtained from rats eyes to estimate glucose levels. Serum glucose was 88.332 ± 7.421 and 250.744 ± 9.592 mg/ dl in healthy and injected rats respectively. Diabetic rats was randomly assigned to seven equal subgroups: one of them was left as positive control, fed on B.D. and other sex groups fed on B.D. containing (1) 5% very ripening (VR) dried figs (2) 10% (VR) dried figs (3) 20% (VR) dried figs (4) 4% dried fig leaves (5) 6% dried fig leaves (6) 8% dried fig leaves. Body weight, food consumption were measured twice a week and total food intake of the experimental period (4 weeks) was calculated. Body weight gain %, F.E.R. was determined according to Chapman *et al.* [16].

Biochemical Analysis of Serum: At the end of the experiment the rats were starved for 12 h and then Sacrificed under ether anaesthetized. Blood samples were collected from hepatic portal vein by the means of fine capillary glass tubes [17].Blood samples were received into clean dry centrifuge tube and left to clot at room temperature, then centrifuged for 10 minutes at 3000r.p.m. to separate serum. Serum was carefully separated into dry clean Wasserman tubes, using a Pasteur pipette and kept frozen at (-20°C) till estimation of some biochemical parameters. Serum samples used for determination of total cholesterol (TC) [18], triglycerides (TG) [19], high-density lipoprotein cholesterol (HDL-c) [20]. Serum low-density lipoprotein cholesterol (LDL-c) and very low density lipoprotein cholesterol (VLDL-c) were calculated according to the equation of Friedwald [21]. Serum samples were also used for determination of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities [22], uric acid [23], urea [24] and creatinine [25].

Statistical Analysis: Statistical analysis was carried out using SPSS statistical software version 11. The results were expressed as mean ± SD. Data was analyzed by one way analysis of variance (ANOVA). The differences between means were tested for significance using least significant difference (LSD) test at $P < 0.05$.

RESULTS AND DISCUSSION

Chemical Composition of Figs and its Leaves: Major chemical composition of fresh figs and its leaves are presented in Table 1. Results revealed that, the moisture and fat content of figs were higher (82.20 and 1.70, respectively) as compared to those of leaves (65.90 and 0.81, respectively). In contrast ash, protein, fiber and carbohydrate contents of figs were lower (0.65, 1.00, 1.55 and 12.90%, respectively) as compared to those of leaves (5.30, 5.90, 4.50 and 17.59%, respectively). The results of ash and crud fiber contents are in agreement with Chen and Reui [26].

Determination of Polyphenols and Flavonoids Compounds of Dried *Ficus carica* L. And its Leaves: Table 2 shows that total polyphenols and flavonoids were 36mg/100g dry matter and 192 mg/ 100g dry matter in pre-ripening F.C.L. 40mg/ 100g and 82mg/100g dry matter in ripening F.C.L. and 49mg/100 gm and 106 mg/ 100g dry matter in very ripening F.C.L., while in F.C.L. leaves polyphenols and flavonoids, reached to 32mg/100g and 275 mg/ 100g dry matter, respectively. This shows that either the fruit or the leaves contain considerable amount of polyphenol compounds that may contribute to the antioxidant power of *Ficus* or its leaves.

Identification of Phenolic Compounds: Table 3 shows the identified phenolic compounds extracted from either dried F.C.L. fruits or its leaves which fractionated using high performance liquid chromatography. In our study we found about 49 phenolic compounds in F.C.L. and 68 phenolic compounds in F.C.L. leaves. However we could identify nine phenolic compounds in figs and eleven phenolic compounds in its leaves because of the available standard phenolic compounds. The phenolic compounds identified in figs were pyrogallic, 3-5 dimethoxy, pinocembrine, galangin, phenol, ferulic, chysin, coumaric and phenol phetahlin. However, phenolic compounds such as ferulic, coumaric, phenol, vinallin, phenol phethlin, pinocembrine, pinostrobin, chrysin, protocetc-hol, cinnamic and quercetin respectively are presented in leaves.

In this respect Hansson *et al.* [27] confirmed that phytochemical investigations of some *Ficus* species revealed that phenolic compounds constitute the major components of them. Also some studies reported that the presence of antioxidant activity of some *Ficus* species which attributed the antioxidant activity to the phenolic content of them [28]. The mechanism of antioxidant effects of *Ficus* extract was attributed to the presence of these specific polyphenolic and flavonoid compounds [29].

Biological Effect of *Ficus carica* L. and its Leaves on Daily Food Intake, Body Weight Gain % and Feed Efficiency Ratio in Hyperglycemic Rats: The effect of *Ficus carica* L. Figs (F.C.L.) and its leaves on the daily food intake (F.I), body weight gain % (B.W.G%) and feed efficiency ratio (F.E.R) in non-diabetic and diabetic rats. Results are presented in Tables 4 and 5 as shown that the mean value ± SEM of daily F.I (g/ day) for negative control group (non-diabetic rats) fed on B.D only, diabetic group fed on B.D plus 10 and 20% were decreased as compared to rats in the control positive group (diabetic rats) which fed on the B.D. only and diabetic group fed on B.D plus 5% figs. In contrast, results showed that, there is a decrease in daily F.I for rats in the negative group (non diabetic rats) which fed on the B.D only compared to positive group which fed on B.D only and diabetic group fed on the B.D plus (4,6 and 8%) F.C.L. leaves. The reduction in F.I could be possibly explained on the basis that figs have higher contents of carbohydrate especially glucose and fructose that have impact on satiety, these results in agreement with Anderson and Woodend [30],who mentioned that high glycemic carbohydrate are associated with a reduction in appetite and food intake in the short time, whereas the satiating effects of lower glycemic carbohydrate appear to be delayed.

The results also showed that diabetic groups which fed on B.D only (positive control group) and diabetic groups which treated with different levels of Figs (5, 10 and 20) and leaves (4, 6 and 8%) were have lower values of body weight gain as compared to non diabetic group fed on B.D only. In this respect, Badr El-Din [31] attributed this different side effect such as the inability to use carbohydrates including lypolysis, glycogenolysis and acidosis. It also may be attributed to disturbances in one or many metabolic pathways. Associating such condition, diabetic rats treated with B.D containing 5 and 10% F.C.L. or different levels (4, 6 and 8%) of F.C.L. leaves showed increase in B.W.G as compared to rats in the positive group. Our results are in agreement with Perez *et al.* [32], who mentioned that F.C.L. leaves extract induced significant hypoglycemic effect, body weight loss prevented in treated diabetic rats. This may be explained by possible increased insulin secretion [33].

Table 1: Major chemical composition of *Ficus carica* L. and its leaves (%)

Chemical composition	*Ficus carica* L.	*Ficus carica* L. leaves
Moisture	82.20	65.90
Ash	0.65	5.30
Protein	1.00	5.90
Fat	1.70	0.81
Fiber	1.55	4.50
Carbohydrates	12.90	17.59

Table 2: Total polyphenols and flavonoids compounds of dried *Ficus carica* L. and its leaves

	Parameters (mg/100g dry matter)	
Groups	Total polyphenols	Flavonoids
Pre-ripening *Ficus carica* L.	36	192
Ripening *Ficus carica* L.	40	82
Very ripening *Ficus carica* L.	49	106
Ficus carica L. Leaves	32	275

Table 3: Identified phenolic compounds found in dried *Ficus carica* L. and leaves

		(%) of identified compounds µg/100mg	
Identified compounds	Retention Time	*Ficus carica* L.	Leaves
Pyrogallic	9.17	265.30	-
Phenol	19.40	18.69	110.82
Ferulic	25.43	17.79	557.60
3-5 dimethoxy	25.95	77.95	-
Coumaric	28.32	5.785	189.15
Phenolphethlin	40.02	4.25	94.59
Pinocembrine	46.27	46.935	52.85
Chysin	47.05	7.64	7.14
Galangin	48.37	24.76	-
Protocetchol	13.78	-	3.22
Vinallin	21.58	-	9.62
Cinnamic	34.16	-	2.74
Quercetin	34.63	-	0.14
Pinostrobin	46.27	-	19.47

Table 4: Effect of feeding *Ficus carica* L. on daily food intake (FI), body weight gain (BWG %) and feed efficiency ratio (FER)

	Parameters as means ± SEM		
Groups	FI (gm/ day)	BWG %	FER
Control (-ve)	17.58±0.293 ^{a}	45.83±0.338 ^{a}	0.17±0.0041 ^{a}
Control (+ve)	18.25±0.273 ^{a}	41.22±0.273 ^{b}	0.14±0.0012 ^{b}
5% *Ficus carica* L.	17.66±0.278 ^{a}	45.09±0.452 ^{a}	0.17±0.003 ^{a}
10% *Ficus carica* L.	16.33±0.278 ^{b}	42.08±0.224 ^{b}	0.16±0.002 ^{a}
20% *Ficus carica* L.	16.32±0.200 ^{b}	38.08±0.425 ^{c}	0.15±0.002 ^{b}
L.S.D.	0.728	1.0184	0.0089

* No significant differences between the values had the same letter in each column.
- Significant differences at $P < 0.05$.
- L.S.D. means least significant differences.

Table 5: Effect of administration of *Ficus carica* L. leaves on daily food intake (FI), body weight gain (BWG %) and feed efficiency ratio (FER).

	Parameters as means ± SEM		
Groups	FI (gm/ day)	BWG %	FER
Control (-ve)	17.58±0.293 ^{b}	45.83±0.338 ^{a}	0.17±0.0041 ^{a}
Control (+ve)	18.25±0.273 ^{a}	41.22±0.273 ^{c}	0.14±0.0012 ^{c}
4% *Ficus carica* L. leaves	18.32±0.129 ^{a}	43.25±0.446 ^{b}	0.15±0.003 ^{bc}
6% *Ficus carica* L. leaves	18.42±0.190 ^{a}	43.52±0.079 ^{b}	0.15±0.002 ^{bc}
8% *Ficus carica* L. leaves	18.33±0.190 ^{a}	44.02±0.814 ^{b}	0.16±0.005 ^{b}
L.S.D.	0.6514	1.3307	0.0112

* No significant differences between the values had the same letter in each column.
- Significant differences at $P < 0.05$.
- L.S.D. means least significant differences.

Table 6: Effect of feeding *Ficus carica* L. on organs weight to body weight ratio.

	Relative Organs Weights as means ± SEM			
Groups	Liver	Kidneys	Heart	Spleen
Control (-ve)	3.16±0.005 [b]	0.62±0.007 [c]	0.32±0.014 [b]	0.26±0.005 [c]
Control (+ve)	4.18±0108 [a]	0.85±0.010 [a]	0.39±0.006 [a]	0.39±0.006 [a]
5% *Ficus carica* L.	4.05±0.171 [a]	0.85±0.022 [a]	0.38±0.008 [a]	0.37±0.001 [a]
10% *Ficus carica* L.	3.35±0.284 [b]	0.73±0.026 [b]	0.34±0.008 [b]	0.29±0.005 [b]
20% *Ficus carica* L.	3.11±0.113 [b]	0.76±0.022 [b]	0.34±0.013 [b]	0.28±0.015 [bc]
L.S.D.	0.4787	0.0556	0.0313	0.0248

* No significant differences between the values had the same letter in each column.
- Significant differences at $P < 0.05$.
- L.S.D. means least significant differences.

Table 7: Effect of feeding *Ficus carica* L. leaves on organs weight to body weight ratio

	Relative Organs Weights as means ± SEM			
Groups	Liver	Kidneys	Heart	Spleen
Control (-ve)	3.16±0.005 [d]	0.616±0.007 [d]	0.319±0.014 [c]	0.261±0.005 [d]
Control (+ve)	4.18±0108 [a]	0.847±0.010 [a]	0.392±0.006 [a]	0.389±0.006 [a]
4% *Ficus carica* L. leaves	3.54±0.073 [c]	0.768±0.005 [b]	0.378±0.003 [a]	0.369±0.005 [b]
6% *Ficus carica* L. leaves	3.53±0.021 [c]	0.726±0.006 [c]	0.351±0.003 [b]	0.362±0.005 [b]
8% *Ficus carica* L. leaves	3.74±0.027 [b]	0.728±0.013 [c]	0.327±0.002 [c]	0.338±0.008 [c]
L.S.D.	0.1769	0.0272	0.0218	0.0191

* No significant differences between the values had the same letter in each column.
- Significant differences at $P < 0.05$.
- L.S.D. means least significant differences.

Our results revealed that diet supplemented with 5 and 10% F.C.L. induced a significant increase ($P<0.05$) in F.E.R., while diet supplemented with 20% F.C.L. resulted in nonsignificant change in F.E.R. as compared to diabetic rats fed on B.D only. On the other hand, diet supplemented with 4 and 6% F.C.L., L caused non significant change in F.E.R, while diet supplemented with 8% F.C.L., L lead to a significant increase ($P < 0.05$) in F.E.R. as compared to control (+ve group). This may be attributed to increased insulin secretion. Insulin is key hormone involved in the storage and controlled release of the chemical energy available from food within the body [34].

Effect of Feeding *Ficus carica* L. and its Leaves on Organs/Body Weight Ratio: The mean value ± SEM of (liver, kidney, heart + and spleen) weight as a percent of body weight of normal rats and diabetic rats fed on diets supplemented with different levels of F.C.L. and its leaves are presented in Tables 6 and 7. The results demonstrated that diabetic groups fed on the B.D only and those fed on B.D containing different levels of figs and leaves have higher organ weight to body weight ratio as compared to non diabetic rats (negative group). Our results are in agreement with Chen and Dowing [35]. Who found that both the absolute and relative weights of kidney were dramatically increased in diabetic rats. In this respect, Fryer [36] reported that increased kidney weight may indicate the progression to renal failure worsened by oxidative stress in diabetic nephropathy. However, diabetic rats fed on the B.D containing different levels of figs and leaves have lower organs weight to body weight ratio compared to positive group fed on B.D only.

In this respect, Masatoshi *et al.* [37] reported that the reduction in organ weight up on treatment with figs and its leaves, may be attributed to the antioxidant compounds present and that can be a promising intervention to prevent progression of kidney disease.

Effect of *Ficus carica* L. and its Leaves on Lipid Fractions: Effect of figs and its leaves on serum total cholesterol (TC) triglycerides (TG) (Tables 8 and 9), low density lipoprotein cholesterol (LDL-c), very low density lipoprotein cholesterol (VLDL-c) and high density lipoprotein cholesterol (HDL-c) in hyperglycemic rats are presented in Tables 10 and 11, results revealed that the values of serum (TC) and (TG) significantly increased ($P < 0.05$) for positive control (diabetic group), as compared to negative control group. Concerning the mean

Table 8: Effect of feeding *Ficus carica* L. on serum total cholesterol and triglyceride levels

	Parameters (mg/dl) as means ± SEM	
Groups	Total cholesterol	Triglycerides
Control (-ve)	95.84±1.761 [e]	44.07±0.780 [d]
Control (+ve)	245.00±3.838 [a]	75.03±1.376 [a]
5% *Ficus carica* L.	214.27±3.160 [b]	70.32±0.611 [b]
10% *Ficus carica* L.	179.45±4.356 [c]	53.90±0.969 [c]
20% *Ficus carica* L.	159.37±1.771 [d]	53.667±2.118 [c]
L.S.D.	9.2053	3.754

* No significant differences between the values had the same letter in each column.
- Significant differences at P < 0.05.
- L.S.D. means least significant differences.

Table 9: Effect of feeding *Ficus carica* L. leaves on serum total cholesterol and triglyceride levels

	Parameters (mg/dl) as means ± SEM	
Groups	Total cholesterol	Triglycerides
Control (-ve)	95.841±1.761 [e]	44.072±0.780 [c]
Control (+ve)	245.00±3.838 [a]	75.031±1.376 [a]
4% Ficus *carica* L. leaves	192.400±3.850 [b]	50.583±0.928 [b]
6% *Ficus carica* L. leaves	180.050±2.240 [c]	45.800±1.096 [c]
8% *Ficus carica* L. leaves	165.400±1.207 [d]	49.000±0.447 [b]
L.S.D.	8.1488	2.845

* No significant differences between the values had the same letter in each column.
- Significant differences at P < 0.05.
- L.S.D. means least significant differences.

Table 10: Effect of feeding *Ficus carica* L. on levels of serum lipoprotein fraction

	Parameters (mg/d1) as means ± SEM		
Groups	HDL-c	LDL-c	VLDL-c
Control (-ve)	55.41±1.403 [a]	31.61±0.892 [e]	8.81±0.155 [d]
Control (+ve)	32.00±0.892 [d]	197.90±3.015 [a]	15.01±0.275 [a]
5% *Ficus carica* L.	37.19±0.577 [c]	162.00±2.471 [b]	14.06±0.122 [b]
10% *Ficus carica* L.	48.23±1.724 [b]	120.90±3.968 [c]	10.78±0.193 [c]
20% *Ficus carica* L.	47.77±1.904 [b]	100.80±1.419 [d]	10.73±0.423 [c]
L.S.D.	4.0574	7.5688	0.7506

* No significant differences between the values had the same letter in each column.
- Significant differences at P < 0.05.
- L.S.D. means least significant differences.

Table 11: Effect of feeding *Ficus carica* L. on levels on serum lipoprotein fraction levels

	Parameters (mg/d1) as means ± SEM		
Groups	HDL-c	LDL-c	VLDL-c
Control (-ve)	55.41±1.403 [a]	31.61±0.892 [e]	8.81±0.155 [c]
Control (+ve)	32.00±0.892 [c]	197.90±3.015 [a]	15.01±0.275 [a]
4% *Ficus carica* L. leaves	50.68±1.060 [b]	131.60±2.953 [b]	10.12±0.185 [b]
6% *Ficus carica* L. leaves	49.93±0.796 [b]	120.90±2.607 [c]	9.16±0.219 [c]
8% *Ficus carica* L. leaves	50.22±0.751 [b]	105.30±2.048 [d]	9.80±0.089 [b]
L.S.D.	2.9387	7.0882	0.5688

* No significant differences between the values had the same letter in each column.
- Significant differences at P < 0.05.
- L.S.D. means least significant differences.

value of serum HDL-c. It could be noticed that the positive control group exhibited a markedly significant decrease, as compared to the negative control group. This action may be related to the action of alloxan, which cause an increase in oxidative state. Such finding agreed with results reported by El-Demerdash *et al.* [38].

Our results revealed that, addition of F.C.L. (5, 10 and 20%) or its leaves (4, 6 and 8%) to the B.D resulted in a significant ($P < 0.05$) reduction in the mean values of serum (TC, TG, LDL-c and VLDL-c) as compared to the positive control group. On the other hand, all treated groups with different levels of figs and its leaves showed significantly increased ($P < 0.05$) in the level of serum HDL-c, as compared to the positive control group which fed only on the B.D.

In this respect, Dominguez *et al.* [39] reported that F.C.L. significantly lowered plasma T.G levels in rats with insulin dependent diabetes. Moreover Perez *et al.* [40] found that the aqueous decoction of F.C.L. leaves induced decline in the level of T.C and a decrease in the T.C/HDL-c ratio with a reduction of hyperglycemia. The hypolipidemic and hypocholesterolemic effects of F.C.L. were attributed to the presence of calotropenyl acetate, lupeol acetate and oleanolic acid.

In addition of these actions, Asadi *et al.* [41] reported that the extract of fig leaves could be used to decrease hepatic (TG) content and secretion of TG and cholesterol from the liver. Our study showed that figs or its leaves contain some effective components that can decrease the lipid parameters in diabetic rats. These compounds are phynolic in nature and act as antioxidant. The potent antioxidant activity of phynolic compounds may be related to its action as scavenger and inhibitors of lipid peroxidation [42]. Phytochemical studies indicate the presence of steroids/triterpenoids and their glycosides and cumarins in the methanolic extract of leaves of F.C.L. it may be speculated that these constituents of F.C.L. are be responsible for the observed protective effects [43]. On the other side our results are in agreement with Adisakwattama *et al.* [44] who found that Coumaric acid or 4.hydroxy-trans Cinnamic acid showed to possess antioxidant activity it minimized the oxidation of (LDL) involving direct scavenger of reactive oxygen species (ROS). On the other hand, Ferulic acid (FA), a most abundant natural phenolic compound in F.C.L. and its leaves can be characterized as natural antioxidant scavenger free radicals. In this respect, Sudheer *et al.* [45] reported that F.A exerts its protective effect by modulating lipid peroxidation and augmenting antioxidant defense system in tissues. On the other side cinnamic related flavonoids are present in F.C.L. leaves. A series of cinnamic acid derivatives inhibited human acetyl CoA: Cholesterol acyltransferase also served as antioxidant against copper mediated low-density lipoprotein (LDL) oxidation. Additionally, decrease of HDL. Particle size under the presence of LDL was inhibited by the cinnamic acid [46].

Effect of Different Levels of *Ficus carica* L. and its Leaves on Kidney Function of Hyperglycemic Rats: Data represented in Tables 12 and 13 shows the effect of different levels of F.C.L. and its leaves on kidney functions. Results revealed that diabetic rats (positive control group) had significant ($P < 0.05$) higher levels of uric acid, urea nitrogen and creatinine as compared to nondiabetic rats (negative control group). In this respect, Banupriva *et al.* [47] indicated that, there was a significant increase in protein and globulin observed in rats given alloxan which indicate hepatic disorders. Blood urea nitrogen was significantly increased in rats given alloxan. An increase in blood urease nitrogen may be due to renal dysfunction and is another characteristic change in diabetes. The above mentioned results may be related to the oxidative damage. These include the ability of oxidants to damage the glomerular basement membrane and directly induce proteinuria, effects that would lead to a fall in the glomerular filtration rat and account for the morphologic changes observed in chronic kidney disease [48]. Our results revealed that all diabetic groups which were supplemented with different levels of F.C.L. (5, 10 and 20%) or its leaves (4, 6 and 8%) showed a significant decrease ($P < 0.05$) in the level of uric acid, urea nitrogen and creatinine, as compared to the positive control group. Results revealed that the greatest decrease in serum urea nitrogen and creatinine level was achieved in case of F.C.L. leaves. This may be attributed to the antioxidants properties of phynolic compounds presented in figs and its leaves. In this respect Musabayane *et al.* [49] reported that figs extract posses reno protective effects in diabetes mellitus.

Effect of Different Levels of *Ficus carica* L. and its Leaves on Liver Enzymes and Glucose Levels in Rats Suffering from Hyperglycemia: Results in Tables 13 and 14 illustrate the effect of different levels of F.C.L. and its leaves on the levels of serum aspartate aminotransferase (AST), alanine aminotransferase (ALT) and glucose. Results revealed that the levels of AST, ALT and glucose increased significantly in the positive control group, as compared with the negative control group. In this respect,

Table 12: Effect of feeding *Ficus carica* L. on parameters of kidney functions

	Parameters (mg/d1) as means ± SEM		
Groups	Uric acid	Urea nitrogen	Creatinine
Control (-ve)	1.69±0.038 [e]	17.35±0.828 [c]	0.55±0.030 [a]
Control (+ve)	2.72±0.033 [a]	27.35±1.021 [a]	1.14±0.031 [a]
5% *Ficus carica* L.	2.54±0.046 [b]	19.60±0.5366 [b]	0.85±0.030 [b]
10% *Ficus carica* L.	2.25±0.063 [c]	20.14±0.653 [b]	0.83±0.0277 [b]
20% *Ficus carica* L.	1.93±0.0562 [d]	16.55±0.4299 [c]	0.80±0.012 [b]
L.S.D.	0.1425	2.112	0.0804

* No significant differences between the values had the same letter in each column.
- Significant differences at P < 0.05.
- L.S.D. means least significant differences.

Table 13: Effect of feeding *Ficus carica* L. leaves on the parameters of kidney functions

	Parameters (mg/d1) as means ± SEM		
Groups	Uric acid	Urea nitrogen	Creatinine
Control (-ve)	1.69±0.038 [d]	17.35±0.828 [d]	0.55±0.030 [d]
Control (+ve)	2.72±0.033 [a]	27.35±1.021 [a]	1.14±0.031 [a]
4% *Ficus carica* L. leaves	2.27±0.053 [b]	21.86±0.761 [b]	0.88±0.030 [b]
6% *Ficus carica* L. leaves	2.09±0.029 [c]	18.16±1.181 [cd]	0.69±0.020 [c]
8% *Ficus carica* L. leaves	1.98±0.054 [c]	20.57±0.967 [cb]	0.80±0.016 [b]
L.S.D.	0.1248	2.8062	0.0778

* No significant differences between the values had the same letter in each column.
- Significant differences at P < 0.05.
- L.S.D. means least significant differences.

Table 14: Effect of feeding *Ficus carica* L. on the serum AST, ALT and glucose levels.

	Parameters (mg/d1) as means ± SEM		
Groups	AST (µ/L)	ALT (µ/L)	Glucosemg/d1
Control (-ve)	64.55±1.579 [e]	18.05±1.398 [c]	94.23±1.524 [d]
Control (+ve)	129.10±3.103 [a]	45.14±2.183 [a]	228.32±3.270 [a]
5% *Ficus carica* L.	116.40±1.546 [b]	40.22±1.941 [a]	198.18±2.069 [b]
10% *Ficus carica* L.	100.13±2.79 [c]	34.27±1.994 [b]	198.62±4.912 [b]
20% *Ficus carica* L.	89.74±1.74 [d]	29.90±1.489 [b]	177.07±1.990 [c]
L.S.D.	5.3214	6.5606	8.7761

* No significant differences between the values had the same letter in each column.
- Significant differences at P < 0.05.
- L.S.D. means least significant differences.

Table 15: Effect of feeding Ficus carica L. leaves on the serum AST, ALT and glucose levels

	Parameters (mg/d1) as means ± SEM		
Groups	AST (µ/L)	ALT (µ/L)	Glucosemg/d1
Control (-ve)	64.55±1.579 [d]	18.05±1.398 [d]	94.23±1.524 [d]
Control (+ve)	129.10±3.103 [a]	45.14±2.183 [a]	228.32±3.270 [a]
4% *Ficus carica* L. leaves	101.07±2.39 [b]	38.55±1.301 [a]	158.73±22.160 [b]
6% *Ficus carica* L. leaves	90.33±1.128 [c]	31.55±1.77 [c]	138.67±4.100 [c]
8% *Ficus carica* L. leaves	84.91±2.803 [c]	27.30±1.680 [c]	131.27±2.908 [c]
L.S.D.	4.9384	6.7668	8.538

* No significant differences between the values had the same letter in each column.
- Significant differences at P < 0.05.
- L.S.D. means least significant differences.

Sallie *et al.* [50] demonstrated that the rise in levels of serum AST and ALT has been attributed to the damaged structural integrity of the liver, because these enzymes are cytoplasmic in location and released into circulation after cellular damages. Feeding diabetic group B.D containing 5% F.C.L. lead to non significant differences in the level of ALT, while the other two levels. (10 and 20%) F.C.L. induced a significant decrease ($P<0.05$) in the level of AST and ALT as compared to the control positive group. Moreover, results revealed that there was a drastic reduction in blood glucose level in all tested groups which fed on B.D. containing different levels of F.C.L. as compared to control positive group. The highest reduction in blood sugar was achieved by feeding the high level of F.C.L. In this respect, Ghosh *et al.* [51] reported that *Ficus hispida* (F.H) induced reduction of blood glucose level both in the normal and diabetic rats. They suggested that F.H has significant hypoglycemic activity. Increase glycogensis and enhanced peripheral uptake of glucose are the probable mechanisms involved in the hypoglycemic activity.

Concerning the effect of F.C.L., leaves on the serum AST,ALT and glucose level of hyperglycemic rats which were fed on B.D. containing the three tested levels (4, 6 and 8%) of F.C.L. leaves revealed a significant increase ($P<0.05$) in the serum glucose level as compared to the control negative group. On the other side, serum glucose level showed a significant decrease as compared to the control positive group. Whereas, ALT enzyme level showed non significant changes in hyperglycemic rats which treated with B.D containing only 4% F.C.L. leaves. On the other side, the other two groups which treated with B.D containing 6 and 8% F.C.L. leaves revealed a significant decrease ($P < 0.05$) in AST and ALT enzymes level as compared to the control positive group. The highest decrease in AST and ALT enzymes levels were obtained in case of 8% of F.C.L leaves, while, the AST and ALT enzymes showed a significant increase ($P < 0.05$) in diabetic groups treated with the three tested levels of F.C.L. leaves as compared to the negative group.

Concerning, the serum glucose level, results showed a significant increase ($P<0.05$) in hyperglycemic rats treated with different levels (4, 6 and 8%) of F.C.L. leaves as compared to the control negative group. On the other hand all treated animals with three different levels of F.C.L. leaves showed a significant decrease ($P<0.05$) in serum glucose level as compared with the positive control group; there were significant differences between the level of 4% and the other two levels. The greatest significant decrease in serum glucose level was achieved by 8% followed by 6% of F.C.L., leaves.

In this respect, Song *et al.* [52] reported that flavonoids have hypoglycemic properties because they improve altered glucose and oxidation metabolisms of diabetic rats. They found that when diabetic rats were administered glucose with quercetin, hyperglycemia was significantly decreased compared with glucose was given alone; flavonoids modulate glucose transport by their respective intestinal transporters. Adewole *et al.* [53] found that quercetin caused. Significant decrease in elevated blood sugar and an increase in plasma insulin concentration in streptozitosin STZ- Induced diabetic rats. Moreover, flavonoids have hypoglycemic properties because they improve altered glucose and oxidation metabolism of diabetic rats. Our results revealed that the predominant phenol compound was ferulic acid which amounted 55706µg/100mg leaves. The antioxidant activity and biological properties of ferulic acid are well recognized. In this respect Hideko *et al.* [54] found that ferulic acid at 0.01 and 0.1% of the B.D showed to suppress significantly blood glucose level in STZ induced diabetic mice. Ferulic may be useful in alleviating oxidation stress.

In conclusion, *Ficus carica* L. and its leaves contain considerable number and amount of healthy compounds namely polyphenols and flavonoids, which act as antioxidants, that can be of help for treatment of hyperglycemia and disturbed lipid pattern, further studies are needed to fortification of some staple foods with figs leaves should be taken in to consideration to produce a high nutritive value food for diabetic patients.

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