Effect of Yogurt Supplemented with Date Fruit, Seeds and Leaves on Blood Sugar of Diabetic Rats

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Abstract: Nowadays, tend to use synthetic drugs to lower serum glucose in diabetic patients is gradually decreased because of their related side effects, as well as a progression of drug resistance. In this regard, tend to use of medicinal plants has been doubled. Therefore, this work was conducted to investigate the effect of date fruit, leaves and seed at the level of 10% on diabetic rats. Thirty five adult male albino rat of Sprague Dawley strain, weighing (176.5±1.20 g) were divided in two main groups. The first main group (n=7) was kept as negative control group, the second main group (n=28) was injected interperitonial with Streptozotocin (STZ) to induce diabetes, then these rats were divided into four subgroups. Subgroup one was fed on the basal diet and served as a positive control group, subgroups from 2 to 3 were fed on basal diet and supplemented with yogurt and date fruit, seed, and leaves at the level of 10% respectively. At the end of the experimental period (8 weeks), rats were sacrificed and blood samples were collected to obtain serum. The results indicated that, STZ treated rats showed significant reduction (P<0.05) in serum insulin concentration and, increased glucose levels compared to normal rats. Supplementation with yogurt and date fruit, seed, or leaves in the diet caused significant (P<0.05) increase in the concentration of insulin while glucose level was significantly (P<0.05) decreased compared to the positive control one. It was also observed that, liver and kidney functions and lipid profile of the treated rats was improved compared to the positive control group. In conclusion, diet supplemented with yogurt and date fruit, seed, and leaves caused an improvement of the biochemical results from diabetes, therefore yogurt and date fruit, seed, or leaves could be used as a suitable supplementation therapy for diabetic patients.

Keywords: Diabetes, Date fruit, Date seed, Date leaves, glucose, serum lipid profile, fortification.

Introduction

Diabetes mellitus is an endocrine dysfunction resulting from insulin deficiency or incapability of peripheral tissues to respond to insulin (Singh et al., 2008). The cumulative effects of metabolic disorders of diabetes lead to cell damage, circulatory changes and eventually to cardiovascular disorders including increased plasma lipoproteins, atherosclerosis, hypertension and cardiomyopathy. Other clinical consequences of diabetes include nephropathy, neuropathy, retinopathy and liver dysfunction (Vidro et al., 1999). Chronic hyperglycemia causes damage to the eyes, kidneys, nerves, heart and blood vessels (Susman and Helseth, 1997).

The world prevalence of diabetes among adults (aged 20–79 years) was 6.4%, affecting 285 million adults, in 2010, and will be increased to 7.7%, affecting 439 million adults by 2030. It has been estimated that by the year 2030, there will be 8.6 million adults with diabetes in Egypt, making it the country with the tenth largest
population of diabetics in the world (Shaw et al., 2010). Reasons for this rise includes an increase in sedentary lifestyle, the consumption of energy-rich diet, obesity, and a higher life span, etc. (Yajnik, 2001).

Diabetes mellitus is probably the fastest growing metabolic disease in the world and as knowledge of the heterogeneous nature of the disease increases so we need for more challenging and appropriate therapies. Traditional plant remedies have been used for centuries in the treatment of diabetes (Kesari et al., 2005). The use of traditional medicine and medicinal plants in most developing countries, as a normative basis for the maintenance of good health, has been widely observed (Tiwari and Madhusudanarao, 2002). Most of the oral drugs are costly and have a lot of side-effects. Alternative to these synthetic agents, plants provide a potential source of hypoglycemic drugs and are widely used in several traditional systems of medicine to prevent diabetes (Lo et al., 2011). Simple and inexpensive diet strategies should aid in achieving and maintaining optimal control of diabetes and diabetic complication (Xuemei et al., 2012).

Date fruits are a significant component of the diet in the majority of the Arab countries with low cost. For Muslims, dates are of religious value and have been mentioned several times in the Quran. They are usually breaking their long day fasting with dates in the month of Ramadan. Fruits of the date palm (Phoenix dactylifera L.) are very commonly consumed in many parts of the world and a vital component of the diet and a staple food in most of the Arabian countries (Al-farsi and lee, 2008).

Egypt is considered one of the major producers of dates in the Middle East with 17% of the world production (Saleh et al., 2011). The importance of the date in human nutrition comes from its rich composition of carbohydrates (70–80%), salts and minerals, dietary fiber, vitamins, fatty acids, amino acids, protein (El-Beltagy et al., 2009) and phytochemicals (Vayalil, 2011).

Research proves that when dates are eaten alone or as mixed meals with yoghurts they have low glycemic indexes (Gad et al., 2010). Unlike most other fruits, dates can be consumed at any of the three major stages of maturity such as khalal or besser (fresh, hard ripe, color stage), rutab (crisp to succulent or ripe stage), or tamr (soft and pliable, fully ripe stage) (Saleh et al., 2011). The date fruit is used in folk medicine to treat the different infectious diseases probably because of their antibacterial ability, immuneomodulatory activity and antifungal property (Baliga et al., 2011). Date pits can be used to improve the nutritional value of incorporated food products. Also, extract shows hepatoprotective and antimicrobial activity in rat (Jassim and Naji, 2010).

In literature, it is well known that date fruits and its seeds, in the form of powder, pulp and infusion, are widely used against atherosclerosis, cancer, asthenia, pulmonary diseases, and throat diseases. In addition, date fruits and seeds are used as hypoglycaemic, expectorant, tonic, aphrodisiac, mouth hygiene and anti-diarrheic (Bnouham et al., 2002). The weight of the seeds is 5.6-14.2% of the date. Moreover, several saturated and unsaturated fatty acid are present in the flash and seeds of date
Date seeds contain high levels of valuable bioactive compounds (Al–Farsi and Lee, 2011). Date seeds can also be used as a functional food ingredient because they are a good source of dietary fiber, phenolic compounds, and antioxidant activity. In addition, date seeds contain a considerable amount of food ingredients such as protein and minerals (Golshan et al., 2017).

The utilization of the seeds as by-product of date industry in medicine would be of great interest (Alkhateeb, 2008). Date seeds have been used successfully in the folk medicine to treat diabetes mellitus for many years without scientific basis. The seed powder is also used in some traditional medicines (Sabah et al., 2007). Date seed extract has protective effect against toxicity caused by carbon tetrachloride, possibly due to antioxidant's effects of date seed that can inhibit radicals created by carbon tetrachloride (Siahpoosh et al., 2012). In addition, one study demonstrated that date seed extract has cerebroprotective role in male rats (Kalantaripour et al., 2012).

Therefore, this work aimed to investigate the biological effects of dried date fruit, seeds, and leaves on blood glucose level of diabetic rats.

Materials and Methods:

Materials:

Plants: Palm date fruits, seeds (Phoenix dactylifera) at tamr stage and date leaves were obtained from the Agriculture Research Center, Giza.

Rats: Thirty-five adult male albino rats of Sprague Dowley strain, weighing (176.5±1.20 g) were purchased from Helwan Farm for Experimental Animals, Cairo, Egypt.

Chemicals: Streptozotocin was obtained from Sigma Company. Kits were purchased from Gama Trade Company, Egypt. Casein, vitamins, minerals, cellulose, and choline were obtained from El-Gomhoria Company, Cairo, Egypt.

Methods:

Preparation of dried date fruit, seeds and leaves: Date fruit, seeds were cut into small pieces with a sharp knife and ground into a fine powder. The leaves were subject to dryness process under vacuum at the National Research Center, Dokki, Giza, and then were ground to fine particles.

Chemical composition: Moisture, protein, ash, crude fiber, and fat content of date fruit, leaves, and seed were determined according to the method described in A.O.A.C, (2005). Total carbohydrate was calculated by the following equation: Total carbohydrate = 100 – (protein% + fat% + ash% + fiber).

Phytochemical analysis of date fruit, seed and leaves: Total phenolic and total flavonoid content were expressed as mg of gallic acid equivalent (GAE) and catechin equivalent (CE) per g of sample, respectively and determined according to the procedure of (Zilic et al., 2012).

Fortification: Ten gram of each date fruit, seed, and leaves was added separately to one cup of prepared yogurt (75 g) and was added to the basal diet as one cup of fortified yogurt/kg diet.
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**Induction of Diabetes**: Diabetes was induced to rats by single intraperitoneal injection of freshly prepared Streptozotocin (60 mg/kg b.wt.). Three days after STZ administration, serum glucose level of each rat was measured. Rats with fast serum glucose (≥200 mg/dl) were considered diabetic (Sarkar, et al., 1996).

**Biological study:**

Thirty five rats were housed in well aerated cages under hygienic conditions and fed on basal diet for one week for adaptation. The basal diet was consisted of 14% protein (casein), 4% oil, 0.25% choline, 1% vitamin mixture, 3.5% mineral mixture, 10% sucrose, 5% cellulose, 0.3% DL-methionine and the remainder was starch. The diet was formulated according to (Reeves et al., 1993). After this week rats were divided into two main groups as follows:-

The first main group (7 rats) was fed on basal diet (as a negative control). The second main group: (diabetic rats, n=28) was divided into (4 subgroups, 7 rats each) as follows: Subgroup (1): was fed on basal diet (as a positive control group). Subgroup (2): was fed on basal diet supplemented with one cup of yogurt fortified with dried date fruit. Subgroup (3): was fed on basal diet supplemented with one cup of yogurt fortified with dried date seeds. Subgroup (4): was fed on basal diet supplemented with one cup of yogurt fortified with dried date leaves.

Each rat was weighted at the beginning and at the end of experiment and feed intake was also recorded daily. At the end of experimental period (8 weeks), rats were sacrificed after overnight fasting and blood of each rat was taken from the abdominal aorta under anesthesia by diethyl ether. The serum was separated by leaving the blood samples 15 minutes at room temperature then centrifuged at 3000 rpm for 20 minutes, and then kept in plastic vials at -20°C until biochemical analysis.

The biological effect of date fruit, leaves and seeds were assessed by the determination of body weight gain percent (BWG%) and feed efficiency ratio (FER) according to the method of Chapman et al., (1959).

**Biochemical analysis of serum:**

Insulin activity was estimated using enzyme linked immunosorbent assay ELISA method as described by Clark and Hales, (1994). Glucose level was determined according to Asatoor and King, (1954). Calorimetric determination of total cholesterol and triglycerides were carried out according to the method of Richmond, (1973) and Fossati and Praneipe, (1982) respectively. Determination of HDL-c level was carried out according to the method of Richmond, (1973). VLDL-c and LDL-c were calculated according to the equation of Friedewald et al., (1972). Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined according to method of Reitman and Frankel, (1957). Serum creatinine, urea and uric acid level were determined by the method of Tietz, (1999), Wills and Savory, (1981) and Patton and Crouch, (1977) respectively.

**Statistical analysis:**

The results were expressed as mean ± SE. The statistical analysis was carried out by using SPSS, PC statistical software (Version 18) using the Duncan' test multiple
range post-hoc test. Data was analyzed by one way analysis of variance (ANOVA). The values were considered significantly different at (P<0.05) (SPSS, 1986).

Result and Discussion:

The concerned chemical composition of dried date fruit, seeds and leaves in Table (1) indicated that, Siwa date (fruit, seed and leaves) is rich in total carbohydrates(84.25,81.32 and 79.88 %), Protein (4.2 , 3.78 and 2.98%). Total fiber was (8.5, 10.1 and 15.23%), but low in fats (2.0, 3.6 and 0.94%) respectively. Regarding the minerals content, it is cleared that, contains a high level of Zn (0.94, 2.3 and 4.1 mg) and Mg (1.43, 1.88 and 0.680 mg) %, respectively. These results are agreed with (Myhara et al., 1998; Al-farsi et al. 2008 and Safi et al., 2008) who mentioned that Dates are rich in certain nutrients and provide a good source of rapid energy due to their high carbohydrate content (70–80%). Most of the carbohydrates in dates are in the reducing sugars form of (fructose and glucose) which are easily absorbed by the human body. These results are agreed with Assirey et al., (2015) who reported that date flesh samples also had a very low fat content.

Table (1): The crude chemical composition of dried date fruit, seeds and leaves.

<table>
<thead>
<tr>
<th>Nutrients (100 g sample)</th>
<th>Siwa date</th>
<th>Siwa seed</th>
<th>Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NUTRIENTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proteins (g)</td>
<td>4.2</td>
<td>3.78</td>
<td>2.98</td>
</tr>
<tr>
<td>Fats (g)</td>
<td>2.0</td>
<td>3.6</td>
<td>0.94</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>84.25</td>
<td>81.32</td>
<td>79.88</td>
</tr>
<tr>
<td>Total fiber (g)</td>
<td>8.5</td>
<td>10.1</td>
<td>15.23</td>
</tr>
<tr>
<td>Ash (g)</td>
<td>1.05</td>
<td>1.2</td>
<td>0.97</td>
</tr>
<tr>
<td><strong>MINERALS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>0.94</td>
<td>2.3</td>
<td>4.1</td>
</tr>
<tr>
<td>Mg (mg)</td>
<td>1.43</td>
<td>1.88</td>
<td>0.680</td>
</tr>
</tbody>
</table>

Total phenols and total flavonoids content of Date (fruit, seed and leaves) were recorded in Table (2). It contains have total phenols and total flavonoids in the following concentrations (233.8, 430.00 and 580mg GAE) and (66, 142 and 125,64mg CE), respectively. Baliga et al., (2011) reported that phytochemical investigations have revealed that the fruits contain anthocyanins, phenolics, sterols, carotenoids, procyanidins and flavonoids, compounds known to possess multiple beneficial effects. Preclinical studies have shown that the date fruits possess free radical scavenging, antioxidant, antimutagenic, antimicrobial, anti-inflammatory, gastroprotective, hepatoprotective, nephroprotective, anticancer and immunostimulant activities.

Many studies have showed that date fruit is rich in phenolic acids (Al-Farsi et al., 2005a and Mattila et al., 2006). Differences in date fruit phenolic acid concentration are attributed to date cultivar, environmental conditions, etc. Mansouri et al., (2005) found that the main phenolic acids in seven varieties of date fruit were p-coumaric acid, ferulic acid, sinapic acid, some cinnamic acid derivatives and three different isomers of 5-o-caffeoyl shikimic acid. The main phenolic acids date fruit were ferulic acid, caffeic acid, p-coumaric acid and o-coumaric acid (Al-Farsi et al., 2008 and Farsi et al., 2005b). The total concentration of these phenolic acids varied from 0.0261 to 0.1227 g kg−1 and from 0.0606 to 0.1477 g kg−1 in fresh and dried dates respectively. Chaira et
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al., (2009) found the lowest phenolic acid concentration in Mermella cultivar (0.0573 g kg$^{-1}$) and the highest in Korkobbi cultivar (0.5466 g kg$^{-1}$). The main phenolic acids were ellagic acid, gallic acid and $p$-coumaric acid. Caffeic acid was not detected.

It was observed that date–pits contained high levels of phenolic compounds (21.0–62.0 mg gallic acid equivalents, GAE/100 g date–pits) and antioxidants (580–929 mL Trolox equivalents/g) (Al–Farsi et al., 2007 and Suresh et al., 2013).

Flavonoids are important phenolic compounds that include proanthocyanidins, flavanoid glycosides and anthocyanins (Gu et al., 2003; Farsi et al., 2005a and Mansouri et al., 2005). Hong et al., (2006) identified 13 flavonoid glycosides of luteolin, quercetin and apigenin in date fruit at the khalal stage. Chaira et al., (2009) found the highest concentration of flavonoids dates (544.6 g kg$^{-1}$). Biglari et al., (2008) reported that the flavonoid concentration in date fruit varied from 0.0162 to 0.8179 g kg$^{-1}$.

Table (2): Total phenols and total flavonoids of dried date fruit, seeds and leaves.

<table>
<thead>
<tr>
<th>Sample (100 g) Parameters</th>
<th>Date</th>
<th>Date seeds</th>
<th>Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total phenols</td>
<td>233.8 mg GAE</td>
<td>430.00 mg GAE</td>
<td>580.6 mg GAE</td>
</tr>
<tr>
<td>Total flavonoids</td>
<td>66 mg CE</td>
<td>142 mg CE</td>
<td>125.64 mg CE</td>
</tr>
</tbody>
</table>

GAE: Gallic acid equivalent, CE: Catechin equivalent.

Table (3): Effect of date fruit, seeds and leaves on serum glucose level and insulin activity on diabetic rats.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Glucose (mg/dl)</th>
<th>% of glucose reduction</th>
<th>Insulin (mIU/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (-ve)</td>
<td>122.22±2.42 a</td>
<td>-</td>
<td>3.0225±.29 a</td>
</tr>
<tr>
<td>Control (+ve)</td>
<td>277.40±3.63 a</td>
<td>-</td>
<td>1.3750±11 c</td>
</tr>
<tr>
<td>Date seeds (10%)</td>
<td>153.52±2.96 c</td>
<td>44.65</td>
<td>2.4500±.25 b</td>
</tr>
<tr>
<td>Date Fruit (10%)</td>
<td>169.72±2.74 b</td>
<td>38.81</td>
<td>2.0700±.05 a</td>
</tr>
<tr>
<td>Leaves Date (10%)</td>
<td>157.95±2.59 c</td>
<td>43.06</td>
<td>2.2750±.17 b</td>
</tr>
</tbody>
</table>

Values were expressed as Means ± SE. Values at the same column with different letters are significantly different at P<0.05.

Rats injected with STZ had significantly (P<0.05) higher glucose level and significantly (P<0.05) lower insulin concentration, compared to the control negative group Table (3). Feeding diabetic rats on diet supplemented with date fruit, leaves, or seed at the level of 10% caused a significant decrease (P<0.05) in the elevated serum glucose level, compared to the control positive group. It was clear that, there were no significant differences in glucose level between the treated groups with date seeds and
date leaves. The percent of glucose reduction as a result of supplementation with date seed, fruit or leaves are (44.65%, 38.81% and 43.06%) respectively, as compared to the value of glucose level in the positive control group. Supplementation with date seeds or leaves caused the highest reduction in glucose level.

These results are in agreement with A study carried out by Abuelgassim (2010) who investigated the effect of date-palm leaves at (2%) on glucose level among diabetic rats, which found that extract of date-palm leaves had a hypoglycemic and hypopoepidemic properties. Mard et al., (2010) found that hydroalcoholic extract of Phoenix Dactylifera Palm Leaves exhibits antidiabetic and antilipaemic effects in alloxan-induced diabetic rats.

The antidiabetic effect of date seeds, leaves or fruit may be due to the effect of active flavonoids, phenols, steroids, and saponins; these compounds may scavenge free radicals liberated by alloxan in diabetic rats (Jurgoński et al., 2008 and Rauter et al., 2009).

Prolong treatments with the extract of seed extracts of Ajwa/ Sukkari date (100g/L in dosage of 10ml/day/rat.) restores the function of liver and kidney and balance the oxidative stress condition in diabetic treated rats (Hasan and Mohieldein, 2016).

Date fruit has been reported as a good source of fibre, sugars and minerals (Ali et al., 2009), which exhibit many effective benefits to health such as antimutagenic (Vayalil, 2002), antioxidant (Mrabet et al., 2016). A study by Zangiabadi et al., (2011) also reported that date fruit extracts are deliberated as an effective treatment in preventing diabetic diseases and in enhancing the pathological parameters concerned with diabetic neuropathy.

In regarding to insulin concentration, the level of insulin activity was significantly (P<0.05) higher in the treated groups date fruit, leaves, or seed, compared to the control diabetic group. Moreover, there were no significant differences in insulin activity level between the treated groups. Biochemical results suggested an increase in endogenous insulin secretion in the case of type 1 diabetic rats treated with date seed extract, which might be the cause of its hypoglycemic effect (El Fouhil et al., 2013).

Results illustrated in Table (4) shows the effect of date fruit, seeds and leaves on lipids profile of diabetic rats. STZ injection to rats caused a significant increase (P<0.05) in serum lipid profile, however, serum HDL-C was significantly lowered, compared to the healthy rats. Diet supplemented with date fruit, seeds and leaves at the level of 10% significantly decrease (P<0.05) the mean value of serum TC, TG, VLDL-C and LDL-C, however, serum HDL-C level was increased significantly (P<0.05), compared to the positive control group. It was obvious that, the treatments with date fruit, seeds or leaves at the level of 10% gave the highest beneficial effect in improving lipid profile in diabetic rats.

The most common lipid abnormalities in diabetics are hypertriglycaemia and hypercholesteraemia (Suba et al., 2004). Previous studies have reported that some
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phytocomponents, particularly saponins and steroids elicit anti-hyperlipidaemic action by inhibiting intestinal lipid absorption via resin-like action and inhibition of lipase activity (Adeneye et al., 2010 and Juárez-Rojop et al., 2012). Saponins are one of main component of date seed extract (Hasan M and Mohieldein A (2016).

Insulin also plays an important role in the metabolism of lipids. Insulin is a potent inhibitor of lipolysis because it inhibits the activity of hormone-sensitive lipases in adipose tissue and suppresses the release of free fatty acids. In diabetes, enhanced activity of this enzyme increases lipolysis and releases more free fatty acids into circulation (Riyad et al., 1998).

Table (4): Effect of date fruit, seeds and leaves on serum lipids profile of diabetic rats.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control (-ve)</th>
<th>Control (+ve)</th>
<th>Date seeds (10%)</th>
<th>Date Fruit (10%)</th>
<th>Leaves Date (10%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC (mg/dl)</td>
<td>77.60±0.62 c</td>
<td>117.82±3.43 a</td>
<td>92.82±2.49 b</td>
<td>91.82±2.20 b</td>
<td>88.75±2.32 b</td>
</tr>
<tr>
<td>TG (mg/dl)</td>
<td>58.42±3.26 c</td>
<td>100.45±1.88 a</td>
<td>80.40±1.99 b</td>
<td>86.42±2.44 b</td>
<td>79.20±1.73 b</td>
</tr>
<tr>
<td>HDL-C (mg/dl)</td>
<td>54.50±1.44 a</td>
<td>36.25±0.85 b</td>
<td>48.50±2.32 a</td>
<td>45.75±2.30 a</td>
<td>51.75±5.52 a</td>
</tr>
<tr>
<td>VLDL-C (mg/dl)</td>
<td>11.68±0.65 c</td>
<td>20.09±0.37 a</td>
<td>16.08±0.39 b</td>
<td>17.28±0.48 b</td>
<td>15.84±0.34 b</td>
</tr>
<tr>
<td>LDL-C (mg/dl)</td>
<td>11.41±1.59 c</td>
<td>61.48±3.92 a</td>
<td>28.24±2.83 b</td>
<td>28.79±0.34 b</td>
<td>21.16±3.52 b</td>
</tr>
</tbody>
</table>

Values were expressed as Means ± SE. Values at the same column with different letters are significantly different at P<0.05.

Table (5): Effect of date fruit, seeds and leaves in serum urea, uric acid and creatinine on diabetic rats

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Urea (mg/dl)</th>
<th>Uric acid (mg/dl)</th>
<th>Creatinine (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (-ve)</td>
<td>25.72±1.11 a</td>
<td>2.52±0.08 c</td>
<td>0.37±0.02 c</td>
</tr>
<tr>
<td>Control (+ve)</td>
<td>45.82±1.72 a</td>
<td>3.57±0.21 a</td>
<td>0.90±0.04 a</td>
</tr>
<tr>
<td>Date seeds (10%)</td>
<td>31.05±1.75 bc</td>
<td>2.80±0.09 bc</td>
<td>0.56±0.05 b</td>
</tr>
<tr>
<td>Date Fruit (10%)</td>
<td>35.67±1.93 b</td>
<td>2.95±0.06 b</td>
<td>0.56±0.03 b</td>
</tr>
<tr>
<td>Leaves Date (10%)</td>
<td>29.79±1.67 cd</td>
<td>2.75±0.13 c</td>
<td>0.57±0.05 b</td>
</tr>
</tbody>
</table>

Values were expressed as Means ± SE. Values at the same column with different letters are significantly different at P<0.05.

Table (5) illustrates the effects of date fruit, seeds and leaves at the level of 10% in serum kidney functions on diabetic rats. Injection with STZ significantly increase (P<0.05) the level of urea, uric acid and creatinine, compared to the control normal
group (control –ve). Feeding diabetic rats on diet supplemented with date fruit, seeds or leaves at the tested level caused a significant decrease (P<0.05) in the mean values of uric acid, creatinine and urea as compared to the positive control group. There were no significant differences in serum urea and uric acid between the groups fed either date seeds or date fruit, and also between the rats fed on date seeds or date leaves. Moreover, there was no significant differences in serum creatinine among the three treated groups.

In line with agreement with El Arem et al., (2014) attributed the nephroprotective effect of the aqueous extracts of palm date against the renal damage induced by dichloroacetic acid to its richness in antioxidant compounds such as ferulic, caffeic and p-coumaric acids. Previous studies demonstrated significant increase in plasma serum urea levels (Dewanjee et al., 2011), creatinine and uric acid (King and Locken, 2004) in diabetic rats compared to normal. The elevated levels of serum lipids in DM cause the risk of development of diabetic nephropathy (Vaziri, 2006).

The obtained results were also in the line with (El-Mousalamy et al., 2016) who mentioned that, aqueous and methanolic fruit and seed extracts of palm date protect kidneys from diabetic nephropathy in rats which might be due to their antioxidant properties. El Fouhil et al., (2011) demonstrated the safety of date seed extract administration on liver and kidneys of rats, and showed that a date seed extract-insulin combination minimizes the diabetic toxic effects on the liver and kidneys of rats, compared to insulin administration as a single drug.

The results in Table (6) revealed the effect of date fruit, seeds and leaves on liver function of diabetic rats. The activities of serum ALT and AST significantly increased (P<0.05) in the diabetic group, compared with the corresponding value of normal control group. The elevation of serum AST and ALT level might be due to the release of these enzymes from the cytoplasm, into the blood circulation rapidly after rupture of the plasma membrane and cellular damage (Dunsford et al., 1989). High concentrations of serum transaminases are considered to be an index of hepatic injury where elevation of ALT is regarded as a more sensitive indicator and is usually accompanied by a rise in AST (Ha et al., 2001). Previous studies reported increased activities of liver enzymes such as AST and ALT in cases of insulin resistance (Marchesini et al., 2001), metabolic syndrome and type 2 diabetes (Wannamethee et al., 2005).

Supplementation with date fruit, seed and leaves at the level of 10% significantly decreased (P<0.05) the elevated levels of both serum ALT and AST compared to the negative control group. Moreover, there was no significant difference in serum ALT among the three treated groups, however, serum AST was significantly different (P<0.05) among the treated groups. These findings suggest hepatic injury in type 2 DM and the hepatoprotective effect for date fruit, seed and leaves.

Liver plays a major role in the regulation of carbohydrate metabolism, as it uses glucose as a fuel, it has the capability to store glucose as glycogen and also synthesize glucose from non-carbohydrate sources. This key function of liver makes it vulnerable to diseases in subjects with metabolic disorders, particularly diabetes (Levinthal and
Tavill, 1999). Date fruit and seed extracts have hepatoprotective effect in type 2 diabetic rats which might be due to their phenolics and flavonoids contents (Hussein et al., 2015). Moreover, Chukwugozie et al., (2014) reported that the hepatoprotective effect for palm date extracts could be attributed to its contents such as quercetin which has a strong antioxidant effects. Al-Qarawi et al., (2004) revealed a significant reduction in elevated ALT, AST, and ALP activities due to CCl₄ in rats subjected to both pre- and post-treatments with the aqueous extracts of P. dactylifera flesh and seeds.

Table (6): Effect of date fruit, seeds and leaves on liver function of diabetic rats.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>ALT</th>
<th>AST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>(μ/L)</td>
<td>(μ/L)</td>
</tr>
<tr>
<td>Control (-ve)</td>
<td>53.60±3.59&lt;sup&gt;c&lt;/sup&gt;</td>
<td>119.00±3.16&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control (+ve)</td>
<td>90.92±3.26&lt;sup&gt;a&lt;/sup&gt;</td>
<td>166.12±1.78&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Date seeds (10%)</td>
<td>73.97±2.52&lt;sup&gt;b&lt;/sup&gt;</td>
<td>141.25±3.59&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Date Fruit (10%)</td>
<td>80.02±3.39&lt;sup&gt;b&lt;/sup&gt;</td>
<td>123.00±2.61&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Leaves Date (10%)</td>
<td>75.45±2.00&lt;sup&gt;b&lt;/sup&gt;</td>
<td>103.00±2.58&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values were expressed as Means ± SE. Values at the same column with different letters are significantly different at  P<0.05

Regarding to changes in body weight status, Table (7) illustrated the changes of body weight, feed intake and FER in the diabetic rats fed on diet supplemented with of date fruit, seeds and leaves. The initial body weight of rats was (176.5±1.20 g), there were no significant differences in IBW among all groups. Diabetic rats had significant decrease (P<0.05) in the FBW compared to the negative control group. It was observed that STZ induced diabetic in rats caused significant decrease (P<0.05) in FBW compared to the healthy rats.

The supplementation with date seeds, fruit or leaves significantly (P<0.05) increased the lowered FBW compared to the positive control group. There were significant differences (P<0.05) in FBW among the three treated groups. Date seeds caused the highest increase in FBW compared to other treatments. In regarding to BWG% and FER, diabetic rats had significantly (P<0.05) lowered BWG% and FER compared to the negative control group. However, the supplementation with the tested materials caused a significant increase (P<0.05) in BWG% and FER compared to the positive control group. Date seeds caused the highest increase in BWG% and FER compared to other treatments.

Zangiabadi et al., (2011) demonstrated that aqueous date extract improved body weight and fasting blood glucose in rat model of diabetic peripheral neuropathy.
Table (7): Changes of body weight, feed intake and FER in the diabetic rats fed on diet supplemented with date fruit, seeds and leaves.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Initial Body weight (g)</th>
<th>Final Body Weight (g)</th>
<th>BWG%</th>
<th>Feed intake (g/day/rat)</th>
<th>FER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (-ve)</td>
<td>175.00±1.77 a</td>
<td>204.33±1.89 b</td>
<td>16.80±1.30 a</td>
<td>16.60</td>
<td>0.029±0.12 b</td>
</tr>
<tr>
<td>Control (+ve)</td>
<td>176.83±1.57 a</td>
<td>140.00±1.23 b</td>
<td>-20.78±1.13 d</td>
<td>19.00</td>
<td>-0.032±0.12 d</td>
</tr>
<tr>
<td>Date seeds (10%)</td>
<td>178.16±1.01 a</td>
<td>210.33±1.14 a</td>
<td>18.08±1.17 a</td>
<td>14.50</td>
<td>0.036±0.13 a</td>
</tr>
<tr>
<td>Date Fruit (10%)</td>
<td>176.00±1.75 a</td>
<td>191.33±2.09 a</td>
<td>8.71±0.66 a</td>
<td>11.70</td>
<td>0.021±0.10 a</td>
</tr>
<tr>
<td>Leaves Date (10%)</td>
<td>177.16±1.10 a</td>
<td>198.50±2.45 c</td>
<td>12.03±1.18 b</td>
<td>12.50</td>
<td>0.028±0.16 b</td>
</tr>
</tbody>
</table>

Values were expressed as Means ± SE. Values at the same column with different letters are significantly different at P<0.05.

References


A.O.A.C., (2005): "Official methods of analysis of AOAC international., 18th ED., AOAC international Gaithersburg, MD, USA."
Effect of Yogurt Supplemented with Date Fruit, Seeds and Leaves on Blood Sugar of Diabetic Rats

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المتخصص:

في الوقت الحاضر، تهدف الدراسات العلمية إلى تقليل استخدام الأدوية لتفادي ارتفاع نسبة السكر في الدم في المرضى الذين يعانون من مرض السكري تدريجياً بسبب الآثار الجانبية المرتبطة بها. في هذا السياق، تسعى الدراسات العلمية إلى استخدام النباتات الطبية. لذلك، تهدف الدراسة الحالية إلى دراسة تأثير الزبادي المدعم بفاكهة البلح والبذور والأوراق بنسبة 10% على الفئران المصابة بمرض السكر. أجريت الدراسة لمدة 8 أسابيع على الفئران المصابة بالسكري، حيث تم تقسيم عدد 35 من ذكور الفئران البالغة إلى مجموعتين رئيسيتين: المجموعة الأولى (7 فئران) تتغذى بالغذاء الأساسي فقط، والمجموعة الثانية (28 فأر) تم حقنها بمادة الاستربتوزوتين (60مل/كم من وزن الجسم) لاحذال السكر، ثم تم تقسيم هذه المجموعة المصابة بالسكري إلى 4 مجموعات فرعية وكل مجموعة تغذى بالغذاء الأساسي والذي تم تدعيمه بالزبادي المدعوم بفاكهة البلح والبذور والأوراق بنسبة 10%. في نهاية التجربة تم أخذ عينات الدم وفصل السيرام. تشير النتائج إلى أن تغذية الفئران المصابة بالسكري على الغذاء الأساسي المدعم بالزبادي المضاف يلي فاكهة البلح أو البذور أو الأوراق في الفئران أدت إلى حدوث انخفاض معنوي (P<0.05) في متوسط قيم جلوكوز الدم. وزيادة تركيز الأنسولين مقارنة بالمجموعه الضابطة الموجبة المصاحبة بالسكري. وقد لوحظ بأن الزبادي المدعم بفاكهة البلح أو البذور أو الأوراق ادي إلى حدوث انخفاض معنوي في مستوى سكر الدم وتحسين صورة دهون الدم ووظائف الكبد والكلي وارتفاع معنوي في نسبة تركيز الأنسولين مقارنة بالمجموعة الضابطة الموجبة. وبالتالي يمكن التوصية باستخدام الزبادي المدعم بفاكهة البلح أو الأوراق أو الزبادي في علاج مرضى السكري.

الكلمات المفتاحية: مرض السكري، ثمار البلح، بذور البلح، أوراق البلح، جلوجوز، صورة دهون الدم، تدعيم.