Effect of Using Sweetness Products Fortified by Stevia Plant and other Materials on some Biochemical Parameters in Diabetic Rats

Shalaby AO; Hala EM El Elkewawy and Al-Zahraa A Abdo

Home Economics Dept., Faculty of Specific Education, Mansoura University, Egypt.

ABSTRACT

The effect of using food products fortified with stevia leaves and other materials such as pomegranate molasses, ginger, sesame seeds, and pumpkin seeds on the general acceptability of the sweetness and its ameliorative impacts on diabetes caused by STZ in rats. The sweets were prepared as (control and supplemented with stevia leaves individually and in combination with the other materials). The proximate chemical composition of raw materials, products, and sensory properties were evaluated. The results revealed that STZ induced diabetes in rats caused a significant decrease in FBW, BWG%, G%, FI and FER compared to the negative control group. While, found a increase in ALT and AST, TC, TG, VLDL-C, and LDL-C, however, serum HDL-C level, testosterone, LH and FSH, SOD, activity and GPA and NO were decreased significantly compared to the healthy rats. Administration of stevia with other materials such as pomegranate molasses, ginger, sesame seeds, and pumpkin seeds alleviates the impact of diabetic disease. The conclusion was that sweetness products supplemented with stevia received acceptable sensory scores and exhibited protection in diabetes. This effect can be attributed to their high nutritional quality and their rich content of the antioxidant activity, and minerals especially phosphorus, calcium, sodium, zinc, copper, iron, and magnesium.

***Key words**: stevia, pomegranate molasse, ginger, sesame, pumpkin and diabetic*

INTRODUCTION

Diabetes is the most widely recognized reason for blindness and the main source of chronic renal failure (**Shahriari *et al.* 2018**). It is known as the main source cause of amputation in the world (**Ridwanto *et al.* 2020**). Diabetes is a metabolic problem fundamentally caused by insulin inadequacy or dysfunction those outcomes in hyperglycemic conditions. Expanded blood glucose in this disease for quite a while causes many issues like stroke, heart disease, neuropathy, renal problems and retinopathy (**Shahriari *et al.* 2018**). It was shown that insulin opposition is the main variable in advancing kind two diabetes mellitus (T2DM). It is strongly connected to obesity, diet, especially abdominal obesity and physical activity (**Hosseini *et al.* 2013**).

The stevia plant is a nutrient rich plant, which has a place in *Asteraceae* family. Stevia is named a natural sweetener. Stevia herb is extremely low in calories parts by parts, its dry leaves have approximately multiple 40 times more sweetness than sugar rebaudioside-A, are found to be multiple times better than sugar. Stevia contains natural antioxidants, which helps in lowering cholesterol, blood pressure and control diabetes (**Suresh *et al.* 2018**). It possesses anti-hypertensive, anti-hyperglycaemic, anti-oxidant, diuretic, gastro, anti-diarrheal, anti-tumor and renal-protective and immunomodulatory properties (**Ferrazzano *et al*., 2016**). **Thomas and Stevia (2010)** studied the anti-hyperglycemic impact of S. rebaudiana in both rats and humans. They referenced that stevioside demonstrates a beneficial impact on hyperglycemia through diminishing the absorption of glucose in the duodenum, gluconeogenesis and glycogenolysis. As the manufactured medications utilized for the treatment of diabetes bring about numerous difficulties. Hence the utilization of natural sources (*Stevia rebaudiana* Bertoni) for the treatment of diabetes is may safe and non-carcinogenic (**Lemus-Mondaca *et al*., 2012**). Sativoside improves glucose-stimulated insulin secretion, however does not influence fasting insulinemia (**Xiao and Hermansen, 2005; Chen *et al.* 2006**).

Stevia products find widespread utilization in the

industry food, like soda drinks or fruit, sauces, desserts, delicacies, bread, sweet corn, biscuits, and table sweetener juices (**Moussa *et al.*, 2003; Massoud *et al.*, 2005a; Goyal *et al.*, 2010**). Stevia diterpene replaces sucrose in cereals (muesli) (**Wallin, 2007**), pickles (**Koyama *et al.*, 2003**), candy, soy sauce and seafood **(Goyal *et al.*, 2010**). In Egypt, the hole between sugar creation and utilization turns out to be clearly huge, in the year 2010, it was assessed to be 0.843 million tons (**Richard and Won, 2011**). These days, consideration is concentrated after involving stevia in food industries, to close the hole between production and consumption. In addition, recently the stevia plant was introduced to Egyptian agriculture in order to create a natural sweetener than can cover a portion of the absence of sugar creation in Egypt (**Allam, 2007**).

Pumpkin (*Cucurbita maxima*) is a fruit that is generally considered to have anti-diabetic traits and has been utilized as useful food (**Patel, 2013**). Notwithstanding, the hypoglycemic impact of pumpkin is frequently due to herbal extracts from its pulp, such as pectin and non-pectin polysaccharides, or from its seeds, such as oil and proteins (**Adams *et al.* 2011**). In any case, the seed of pumpkin is a good source of fibers, protein, unsaturated fatty acids, minerals, and phytosterols (**Patel, 2013**). Ginger (*Zingiber officinale* Roscoe) has been generally utilized as a dietary spice and in numerous traditional and elective medicines worldwide (**Saravanan *et al.* 2017; Saain *et al.* 2020**). It has been accounted for that ginger contains potent compounds including shogaols, (6)-gingerol, phenolic compounds, oleoresin resin, and essential oils through them ginger shows its antioxidant properties **(Qian *et al.* 2019**). As of late, investigators have studied the potential impact of *Zingiber officinale* in improving fertility in diabetic males, as it possesses anti-diabetic activity (**Menezo *et al.* 2014**). Ginger has a place in the family (*Zingiberaceae*) and it is described by its anti-inflammatory, antiapoptotic, androgenic, hypoglycemic, and antioxidant properties (**Hosseini *et al.* 2016**).

One of the therapeutic plants utilized generally in Middle Eastern nations is sesame seeds (**Mohammed *et al,* 2018**). White sesame was demonstrated to be a

great sources of minerals, proteins and fat as well as the content of Vitamin K, E, and C were fundamentally higher. The two kinds of sesames are significant sources of unsaturated fatty acids, for example, linoleic and oleic acid, and are the source for saturated fatty acids, including stearic and palmitic acid (**Kanu, 2011; Mohammed *et al.*, 2011**). It was accounted for that these compounds act as anti-inflammatory, antioxidant, antihypertensive, antithrombotic, antimutagenic, and cardioprotective agents (**Wan *et al.*, 2015**).

Pomegranate molasse is a pomegranate product utilized in salads, as a flavoring sauce and sweetener in some meals (**Maskan, 2006**). Pomegranate molasse is a high nutritional benefit product and has a strong antioxidant impact. In such a manner, it has the capacity of preventing cancer, diabetes, and cardiovascular diseases (**El-Darra *et al.*, 2017**). In addition, pomegranate molasses is a product that is rich in terms of minerals such as Mg, K, Ca, Zn, and phenolic compounds (**Fadavi *et al.*, 2005**).

These days' consumers show a developing inclination for low-calorie items in order to avoid obesity and overweight, which have been connected to health-threatening diseases, like cardiovascular diseases, metabolic syndrome, and diabetes. Overweight and obesity have expanded globally. Subsequently, as of late, food industries have communicated a growing development in sucrose substitutes as a response to the public interest in low-calorie products (**Mariotti and Alamprese, 2012**).

Considering the economic resource constraints and cheapness of the stevia plant parts, the present study was aimed to preparation of sweetness products from some amendments for diabetes with using stevia plant parts fortified with some sources such as (ginger, pumpkin, pomegranate molasses, and sesame) and study its ameliorative effect on some biochemical parameters of diabetic rats.

MATERIAL AND METHODS

Materials:

Dried stevia leaves (*Stevia Rebaudiana Bertoni*) were obtained from the institute of sugar Crops, Agriculture Research Center, Giza, Egypt. Pomegranate molasses (*Punica granatum*), ginger

(*Zingiber officinale*), sesame seeds (*Sesamum indicum*), Pumpkin seeds (*Cucurbita maxima*) and sugar were obtained from a local herbal medicine market (El-Nekity) in Mansoura city, Egypt.

Chemicals: Streptozotocin (STZ) and kits of biochemical analysis were obtained from Sigma Company (USA).

Animals: 63 adult male albino rats (*Sprague Dawely*) weighing (170 to 180 g per each) were obtained from Laboratory Animal Unit, Faculty of Veterinary Medicine, Zagazig University, Egypt.

Methods:

***Preparation of sweets*:** Sweets were prepared in many forms until reaching a certain one. The sweets were prepared as (control and supplemented with stevia leaves individually and in combination), as a total and a partial replacement for sucrose in the stander formula **(Table 1),** sweets were prepared according to the method reported by (**Prabha and Mahaboob, 2015**). Ingredients like sugar powder with a small amount of water and made it to a creamy form (as control). Placed in a chocolate mold tray and refrigerated for 15 minutes. The same procedure was followed for the test samples with the addition of stevia leaves, pomegranate molasses, sesame seeds, ginger powder, and pumpkin seeds

***Sensory evaluation of sweets products*:** 20 master students and staff members in the department of nutrition and food science, Faculty of Home Economics of Specific Education, El-Mansoura, University, performed sensory evaluation of sweets products. Panelists were selected based on their interests and availability. Randomly coded samples were served to the panelist in divinely. Sweets products were evaluated for appearance, odor, color, taste, and texture. The scoring of sensory characteristics ranges from 1-10 degrees was determined according to **Smith, (1972)**.

***Determination proximal composition*:** Moisture content, crude protein, total fats, and total ash contents were carried out according to the methodology given by (**AOAC, 2000**), Total carbohydrates were calculated by difference. Evaluation of minerals: Ca, Na, Zn, Fe, Cu, and Mg by using Atomic Absorption Spectrometry as maintained by **Luten *et al.* (1996)**. Estimation of total phenols was carried out in the opinion of **Slinkard and Singleton, (1977)**. Limitation of

flavonoid was estimated as claimed by **Zhishen *et al.*, (1999)**.

***Biological evaluation*:**

Basal Diet: The basic diet prepared and modification as claimed by **Reeves *et al.*, (1993).**

After a period of adaptation, seven rats continued feeding on the basal diet, which served as ~~a~~ normal control. The remaining 56 rats were injected with Streptozotocin (60 mg/kg) to induce diabetes according to **Kim *et al.* (2011**).

All rats were divided into nine groups (n=7rats) after acclimatization periods; all the rats fed the basal diet with sweets and different ingredients for each group throughout the experiment period; rats were randomly assigned as follows:

- The first group (-ve 1): was kept as a negative control group (-ve control).
- Second group (+ve): diabetes rats were kept as a positive control group (+ve control).
- The third group (-ve): diabetes rats were fed stevia leaves (group A).
- The fourth group: diabetes rats were fed sweet (T1 sweet contains only stevia) (group B).
- The fifth group: diabetes rats were fed sweet (T2 sweets contains stevia + pomegranate molasses (group C).
- The sixth group: diabetes rats were fed sweet (T3 sweets contain stevia, pomegranate molasses, sesame seeds and pumpkin seeds (group D).
- The seventh group: diabetes rats were fed sweet (T4 sweets contain stevia, pomegranate molasses, sesame seeds and ginger (group E).
- The eighth group: diabetes rats were fed sweet (T5 sweets contain stevia, pomegranate molasses, sesame seeds, ginger and pumpkin seeds (group F).
- The ninth group: diabetes rats were fed sweet (T6 sweets contain sugar, pomegranate molasses, sesame seeds, ginger and pumpkin seeds (group G).

To examine the effectiveness of induction, blood samples were withdrawn from the eye flexus and serum glucose level was determined, then to validate diabetes induction, rats with fasting blood glucose levels of more than

300 mg/dL were employed in trials according to **Kim *et al.* (2011**).

Biological Evaluation: Throughout the experiment, daily consumed or wasted quantities of diet were weighted and weekly body weight gain was calculated. Food efficiency ratio and organs relative weight were calculated as described by **Chapman *et al*., (1959).**

***Blood sample collection*:** At the end of the experiment period, 45 days, blood samples were collected after 12 hours fasting using the abdominal aorta after rats were sacrificed under anesthetized. Blood samples were received into clean dry centrifuge tubes and left to clot at room temperature, then centrifuged at 4000 rpm (855× g) for 15 min to separate serum according to **Drury and Wallington (1980**). Serum was carefully aspirated, transferred into clean covet tubes and stored frozen at -20 ^{0}C until analysis.

Biochemical determination: glucose, insulin and HbAlc were determined according to (**Trinder, 1959**; **Burgi *et al*., 1988**; **Sudhakar and Pattabiraman, 1981**), respectively. Triglycerides (TG) and total cholesterol (TC) were evaluated according to (**Fassati and Prencipe 1982** and **Allain *et al*., 1974**), respectively. High-density lipoprotein–cholesterol (HDL_C) was assessed according to (**Lopes *et al*., 1977**) and low-density lipoprotein– cholesterol (LDL-c) calculated by equation of **Friedewable *et al*., (1972),** LDL-c = TC-[HDL-c + (TG/5)]; VLDL-c = TG/5. Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were measured according to the method described by **Burtis *et al*., (1999**). Total testosterone hormones estimated by the methods of **Orczyk *et al.* (1974).** Follicle- stimulating hormone (FSH) and Luteinizing hormone (LH) were determined according to **Accubind (2016).** Glutathione peroxidase activity (GPA) was determined spectrophotometrically as the method described by **Weinhold *et al*. (1990)**. Nitric oxide (NO) level was estimated spectrophotometrically according to **Montgomery and Dymock (1961)** by using Bio-diagnostic kits. Superoxide dismutase (SOD) activity was rated according to **Dechatelet *et al.* (1974)**.

Statistical analysis

The results were expressed as mean ± standard deviation

(mean ± SD). All data were statistically analyzed according to the technique of analysis variance (ANOVA) test. The significance between different groups was indicated using the least significant difference (L.S.D) at <0.05 and Duncan's test according to the methods described by **Gomez and Gomez, (1984)** using analysis of variance technique by means of **CoSTATE** Computer software.

RESULTS AND DISCUSSION

Raw materials (stevia powder, pumpkin seeds, ginger powder, sesame seed, and pomegranate molasses) were analyzed for their constituents of moisture, protein, ash, fat, fiber, and total carbohydrates %) and their results are reported in **Table (2)** all as g %.

The obtained data are given in the same table (2) indicated that the moisture content of raw materials was 6.84, 3.91, 7.14, 5.89, and 56.18 gm% for stevia powder, pumpkin seeds, ginger powder, sesame and pomegranate molasses, respectively.

The protein contents of stevia powder, pumpkin seeds, ginger powder, sesame seed, and pomegranate molasses were 17.86, 17.41, 10.18, 18.11, and 12.94 g %, respectively. Sesame seed was the highest in protein content.

As for the ash, content found it range from 1.98 g % in pomegranate molasses to 10.91 gm% in stevia powder. The fats seeme to be high in sesame seeds (43.26), followed by ginger powder (37.96 g %) then pumpkin seeds (34.18 g %), the lowest value of fat recorded with stevia powder as (5.96 g %).

Fiber is a significant part of a healthy balanced diet. It can help prevent diabetes, heart disease, some cancers, and weight gain and can improve digestive health (**Shokry, 2017**). Fiber contents recorded the lowest value with pomegranate molasses (0.56 g %), while the highest value scored with stevia powder.

The maximum value of carbohydrates content was observed with the stevia powder (58.43 g %), followed by pumpkin seeds (40.76 g %) with near value with ginger powder (40.51 g %), then decreased with, sesame, and pomegranate molasses which scored (27.03 and 16.54 g %), respectively.

These previous results were in agreement with those of **El-Nassag *et al.* (2019)** evaluated the chemical composition of stevia

(*Stevia rebaudiana*) leaves were total protein (9.63%), crude fat (3.47%), ash (3.08%), crude fiber (17.12%) and carbohydrates (66.50%). In addition, **Hemada *et al*. (2019**) resulted that stevia plants are a good source of carbohydrates (58.2%), crude fiber (10.30%), and ash (9.4%). As for pumpkin seeds, **Devi *et al.* (2018**) reported that the proximate composition of moisture (5.53%), protein (28.90%), crude fat (31.75%), crude fiber (4.59%), ash (60.90%), and carbohydrate (27.86%) for a completely pumpkin seed. **Latona *et al.* (2012)** resulted that ginger has 13.75% moisture content, 34.13% crude protein, 4.02% crude fiber content, 4.07% ether extract, and 7.64% ash content. In the same line, **Christian *et al.* (2019)** resulted that proximate analysis of sesame showed moisture (6.21%), crude protein (14.73%), crude fiber (6.12%), ash (8.46%), and carbohydrate (64.00%). While, **Ullah *et al.* (2012**) showed that pomegranate contains moisture content (4 %), ash (5 %) and fat (9.4 %).

Results of some minerals including Phosphorus (P), potassium (K), Calcium (Ca), sodium (Na), Iron (Fe), Zinc (Zn), and manganese (Mn) in raw materials such as (stevia powder, pumpkin seeds, ginger powder, sesame, and pomegranate molasses) were observed in the Table (2) as mg/100g.

The data obtained in **Table (2**), found that phosphorus content recorded the highest value in stevia powder (386.41 $mg.100g^{-1}$), while the lowest value was in pomegranate molasses (7.91 $mg.100g^{-1}$). On the other hand, stevia powder had the highest value of potassium content, while ginger powder was recorded the lowest one (1837.14 and 89.16 $mg.100g^{-1}$), respectively. Sesame was recorded the highest value of calcium content (274.16 $mg.100g^{-1}$), while pomegranate molasses (2.94 $mg.100g^{-1}$). As for the content of sodium found that pumpkin seeds was scored the highest value (98.46 $mg.100g^{-1}$), while the lowest value was recorded with pomegranate molasses (2.81 $mg.100g^{-1}$).

Results in the same table, represented the microelements content of iron (Fe) zinc (Zn) and manganese (Mn). Pumpkin seed had the highest value of iron content, while pomegranate molasses obtained the lowest value of iron content (21.43 and 0.28 $mg.100g^{-1}$). Ginger powder

represented the highest content of zinc (7.51 $mg.100g^{-1}$, while pomegranate molasses was recorded the lowest value of zinc 0.21 $mg.100g^{-1}$. As for the manganese content found that stevia powder was recorded the highest value with a score of 9.16 $mg.100g^{-1}$, while the lowest value was recorded with pomegranate molasses as 0.43 mg /100 g^{-1}.

Those results were **accepting** with those recorded by **Hemada *et al.* (2019**) stevia powder was recorded the **best** value of minerals as, Ca (1220 mg/100g) and P (330 mg/100g). Whereas **Devi *et al.* (2018**) reported that pumpkin seeds had a high content of minerals such as Zn, P, Mn, Mg, K, Cu, Fe, Ca, Co, and Na. In addition, **Ogbuewu *et al.* (2014**) resulted that ginger powder had predominant mineral elements were Mn, Zn, Cu, Ca Na, Fe, K, and P. The mineral values follow the order of Na (38.96 µg / g) > K (36.34 µg / g) > Ca (34.55 µg / g) > P (26.70 µg / g) > Mn (18.90 µg / g) > Zn (4.19 µg / g) > Fe (1.59 µg / g) > Cu (0.86 µg / g). **Within** the same line, **Christian *et al.* (2019)** found that mineral analysis of sesame seeds were Na (0.80%), K (1.12%), Ca (0.10%), Mg (0.45%), Zn (0.21%) and Fe (0.11%). The distribution showed that Na and Zn had the highest percentage (18%) while the lowest was Mg (6%). While, **İncedayi *et al.* (2010)** found that pomegranate molasses rich in minerals e.g. potassium (450-4700 mg/100g), magnesium (7.48-409.10 mg/100g), calcium (71.88-1803.63 mg/100g), and iron (1.05-22.99 mg/100g).

Effect of addition different combination between raw material (stevia powder, pumpkin seed, ginger powder, sesame and pomegranate molasses) on proximate chemical composition of processed sweetness samples were studied and the results are presented **in table (3)**.

It could be observed that sweets (T6) had the highest values of moisture (9.49%) followed by sweets (T7) with a value (8.80%) and the lowest value scored with the treatment of sweets (T3), which was recorded (2.38). The highest values in both T6 and T7 may be due to the pomegranate molasses, which contains more moisture as indicated in Table (1).

Whereas protein content recorded the highest value with sweets (T7) as (13.11 %), followed by sweets (T6) as (9.43%), both

treatments contain stevia powder and pomegranate molasses beside other raw materials in T6. While the lowest values of protein was indicated with sweets (T3).

The obtained data found that (T2) which includes only stevia powder recorded the lowest value of ash and fats (0.49, 1.54%), respectively. When sweets (T7) contain the highest value of ash (7.26%), while sweets (T6) contain a high value of fats (12.87%).

In addition, in table (3), there was a significant decrease in total carbohydrates with the addition of all raw materials. The highest value indicated with sweets (T2) which contains only stevia powder (91.89%), while the lowest values scored with sweets (T6) as (66.28%).

These results agreements with **Hemada *et al.* (2019)** observed that bread supplemented with stevia obtained the highest fiber value with the addition stevia dry leaves powder (100%) individually comprised with all supplemented samples and control. In addition, in the same study, there were no variations in moisture, protein, carbohydrate, or fat content between supplemented and control chocolate nut spread samples when mannitol and stevia were used separately or together. In compared to the control, however, all chocolate samples produced with (mannitol and/or stevia with increasing its concentration) had a higher ash content. In terms of fiber, it was discovered that the stevia100 % sample had a larger fiber content than the control.

Mineral content of sweetness samples presented **in table (4),** from the obtained results, the sweetness fortified with all raw materials increased in the minerals content. In addition, it could be observed that all processed sweetness samples were superior in phosphorus, potassium, calcium, sodium, copper, zinc, magnesium and iron compared with (T2) sample, which includes just stevia powder.

From nutritional view, processed sweetness samples contained higher content of studied minerals. For example, sweets (T7) contain sugar with some raw materials contained nitrogen, potassium, calcium, sodium, copper, magnesium and iron followed by sweets (T6) which includes all raw materials. While sweets (T6) were higher than (T7) in phosphorus and zinc. All comparing with sweets (T2) which contains only stevia powder.

The highest increase of minerals in sweets fortified with stevia and other raw materials may be attributed to higher level of macro and micronutrients content in stevia, ginger, sesame seed, pumpkin seeds and pomegranate molasses as indicated by **Hemada *et al*. (2019**). Stevia powder recorded highest value of minerals Ca and P as 1220 and 330 mg /100 g, respectively. whereas, **Devi *et al.* (2018**) reported that pumpkin seeds had high content of minerals as Zn, P, K, Mn, Mg, Ca, Cu, Fe and sodium. Also, **Ogbuewu *et al*. (2014**) resulted that ginger powder had predominant mineral elements were zinc (Zn), copper (Cu), manganese (Mn), calcium (Ca), iron (Fe), sodium (Na), phosphorus (P) and potassium (K). In the same line, **Christian *et al*. (2019)** found that mineral analysis of sesame seeds was sodium (0.80%), potassium (1.12%), calcium (0.44%), magnesium (0.29%), zinc (0.82%) and iron (1.02%). While, **İncedayi *et al.* (2010)** found that pomegranate molasses rich in minerals e.g. K, Ca, Mg and Fe

The antioxidant activity including total phenol and antioxidant activity of sweets samples under study are shown **in table (5).** From the obtained results, it could be indicated that total phenol and antioxidant activity significantly increased with the addition of different raw materials compared with sweets containing only stevia powder (T2). The highest total phenol recorded with sweets (T7) which scored (23.96 $mg.g^{-1}$), followed by sweets (T6) which had no significance with (T3 or T7), while the lowest total phenol indicated with sweets (T2) which includes only stevia powder.

Antioxidant activity of sweetness fortified with some raw materials understudy was indicated in the same Table. It could be observed that the highest value of antioxidant activity recorded with sweets (T7), which includes sugar with some raw materials followed by sweets (T6), which includes all raw materials compared with sweets (T2) which contains only stevia powder and recorded the lowest values of antioxidant activity (48.04 %).

The highest values in phenol and antioxidant activity in sweets contain stevia and other materials may be due to that stevia and other material are a good source of antioxidant activity. When compared to common antioxidants

(Butylhydroxytoluene, BHT; -Toc, alpha-tocopherol), **El-Nassag *et al*. (2019**) found that the aqueous extract of Stevia leaves had high antioxidant activity (AA= 82.05 percent). Pumpkin seed, according to **Rohman (2019**), contains tocopherols and other phenolic chemicals, suggesting that it could be used to treat disorders caused by oxidative stress. According to **Tohma *et al.* (2016**), ginger has effective antioxidant qualities, and its use may help to prevent or delay the onset of diseases caused by oxidative stress due to a lack of antioxidant supplementation. Sesame seed had excellent antioxidant activity, scavenging 60.12% DPPH, 96.45 % ABTS, and a FRAP value of 0.408, according to **Dravie *et al.* (2020**). It was also high in total Phenolic contents, which was highly connected with antioxidant activity.

Sensory evaluation continues to play an important role in assessing the quality of food because it measures what consumers actually perceive and among the main characteristics associated with quality surface color, flavor, taste, and texture (**Bryhni *et al*. 2002**). The organoleptic properties of sweetness prepared by using different resistance raw materials of diabetes disease namely (stevia powder, pumpkin seeds, ginger powder, sesame seed and pomegranate molasses) were evaluated to select the best substitution for produced high quality accepted diabetic supplementation. Twenty panelists for their external and internal properties as shown **in table (6)** evaluated sweetness samples.

Tabulated data revealed that all sensory attributes of sweetness samples were decreased by the addition of all raw materials. There was a significant difference in all sensory attributes between the sample (T1) and other samples. Significant decrease for color, test, odor for all samples. There were no significant differences was recorded between T5, T6, and T7 for color.

Concerning to addition of all raw materials to sweetness samples, there was a significant decrease compared with the T1 sample (control contains only sugar) which recorded the highest value followed by T2 (contains only stevia). There was a significant difference in the texture and general appearance.

The results in table (6), it can be indicated that all sweetness samples with different addition from raw materials resistance diabetes disease were recorded a significant decrease compared with sample (T1 sweetness contains only sugar powder). The sweetness samples T1 and T2 were considered good samples and recorded the highest values from other samples. T2 (only stevia powder) recorded the highest values after T1 in color, taste, texture and general appearance. In general, all panelists preferred sugar and stevia powder ($p<0.05$) on texture, taste, flavor and acceptance. These previous results were in good agreement with those obtained by **Salama, (2004**) proposed that the physical properties of the products are improved when stevia is replaced by 20, 40, and 60% sucrose in an ice cream mix. Similarly, overall acceptability scores were also resulted by another researcher for stevia as a bio sweetener and as a sweetening agent in soft ice creams (**Alizadeh *et al.* 2014**). In addition, **Fatima *et al.* (2018**) reported the mean of the sensory evaluations of twelve food products prepared by using sucrose as control and stevia extract as an experimental sweetener.

The statistical data **in table (7)** illustrated the initial body weight (IBW), final weight, gain weight, feed intake and FER in normal and the diabetic rats fed on basal diet and diet sweetness fortified with (stevia powder, pumpkin seeds, ginger powder, sesame, and pomegranate molasses). The initial body weight of rats was (173.00±2.00), there were no significant differences in IBW among all groups. Diabetic rats had a significant decrease in the final body weight (FBW) compared to the negative control group. It was observed that STZ induced diabetes in rats caused a significant decrease in FBW compared to the healthy rats.

The treated diabetic rats of all groups with different plants significantly sweetness had higher values of final body weight gain (FBW) compared to the positive control group.

Treatment (F) group caused the highest increase in FBW compared to other treatments. Concerning body weight gain (BWG %), gain (G %), food intake (FI) and FER, diabetic rats had significantly ($P<0.05$) lowered BWG %, G%, FI and FER

compared to the negative control group. There were no significant differences in BWG % and G% between groups fed on (A and B), while the sweetness with other raw materials showed significant differences. However, the sweetness with the tested materials caused a significant increase in BWG %, G%, FI, and FER. The combination of all raw materials in the group (E) caused the highest increase in BWG %, G%, FI, and FER compared to other treatments.

Hemada *et al*. (2019) resulted that the biological experiment showed that final weight (g) and body weight gain (%) decreased in rats groups fed on stevia and mannitol compared to the group fed on basal diet. In addition**, Aboelnaga (2017)** scrutinized the impacts of supplementing obese-diabetic rats with pumpkin seeds, husk tomato or their combination decreased body weight gain. Whereas **Eleazu and Eleazu, (2013**) resulted in that body weights and growth rates increased with the utilizing ginger powder than the diabetic rats' control. **Faddladdeen (2021**) found that body weight in diabetic rats increased with using pomegranate peel extract compared with the (STZ)-diabetic rats.

Data presented **in table (8)** showed the serum glucose, HbAlc and insulin levels. Rats injected with STZ had a significant level of higher glucose, HbAlc and insulin compared to the control negative group. Feeding diabetic rats on Toffee fortified with (stevia powder, pumpkin seeds, ginger powder, sesame and pomegranate molasses) caused a significant decrease, in the elevated serum glucose and HbAlc while insulin level was increased, compared to the control positive group. It was clear that, there were significant differences in glucose, HbAlc and insulin level among the treated groups with different raw materials (stevia powder, pumpkin seeds, ginger powder, sesame, and pomegranate molasses). The percent of glucose and HbAlc reduction as a result of Toffee contains only normal powder are (71.00 and 2.57), respectively while increased in insulin was happened with the same treatments (249.00), as compared to the value of glucose level in the positive control group which scored (463.00, 4.92 and 74.00) respectively.

In this respect, **Lestari *et al*. (2019**) showed that blood glucose levels over 36 days were significantly (p=0.043) lower in the group treated with *Stevia rebaudiana Bertoni* leaves extract. In addition, **Rashad *et al.* (2019)** found that in the diabetic group, sativoside for 24 weeks improved the plasma glucose, 2-h plasma glucose, fasting serum insulin, homeostasis model assessment of insulin resistance and hemoglobin A1c (HbA1c). **Abd- Elnoor (2019)** studied the nutritional evaluation of pumpkin seed on blood level of glucose and fat in diabetic rats. The results showed that pumpkin seeds improved the blood glucose and insulin were decreased in diabetic rats as compared to the negative control group. When, **Ibrahim *et al.* (2020**) revealed that blood glucose, fructosamine and insulin levels were improved following treatment by ethanol extract of ginger, if matched with the diabetic control group. **Alamri, (2019**) reported that both dark and white sesame seeds can improve blood glucose, oxidative stress markers and kidney function in streptozotocin-induced diabetic rats. Therefore, sesame seeds area potential protective natural agent against diabetes complications. **Shujaat and Hussain (2016)** found that pomegranate peel extract is hypoglycemic alone or with other treatments in type 2 diabetic rats by reduction glucose.

The results **in table (9)** revealed the effect of sweetness fortified with stevia powder individually or in combination with (pumpkin seeds, ginger powder, sesame, and pomegranate molasses) on liver function of diabetic eats expressed in (ALT and AST). The activities of serum ALT and AST significantly increased ($P \leq 0.05$) in the diabetic group, compared with the corresponding value of the normal control group.

Sweetness fortified with stevia powder individually or in combination with (pumpkin seeds, ginger powder, sesame, and pomegranate molasses), significantly decreased ($P \leq 0.05$) the elevated levels of both serum ALT and AST compared to the positive control group. In this respect found that rats groups feed on stevia powder in-group (A) that caused the highest reduction in liver function as compared with positive control.

In agreement with our results, **Abdel-Azim *et al*. (2019)** and **AbdelAzim *et al.* (2020**)

resulted that the ALT and AST in treated rats significantly reduced with using the aqueous extract of stevia compared with diabetic rats. In addition, **Aboelnaga (2017)** revealed that using pumpkin seeds decreased ALT, AST, and ALP. In addition, **Hanna *et al*. (2014)** said that rats fed with 5% ginger improved liver functions were improved in diabetic groups. **Mohamed and Abdel-Salam (2021**) indicated that the dietary supplementation containing sesame limited the disturbance in profile liver function. Additionally, **Osman *et al.* (2012**) focused on the ability of pomegranate peel and juice to liver function and found that ALT and AST were significantly increased in the diabetic group, but after treatment with peel and juice, ALT and AST levels decreased and become near to the control level, especially ALT value.

Results illustrated in table (10) show–the effect of sweetness fortified with stevia powder individually or in combination with (pumpkin seeds, ginger powder, sesame and pomegranate molasses) fed on the lipid profile of diabetic rats. STZ injection to rats caused a significant increase ($P \leq 0.05$) in serum lipid profile, however, serum HDL was significantly decreased, compared to the healthy rats. All sweetness groups significantly decreased the mean value of serum TC, TG, VLDL-C, and LDL-C, however, serum HDL-C level was increased significantly ($P \leq 0.05$), compared to the positive control group. It was clear that, no significant difference in TC, TG, and VLDL-C among the treated groups (A and E). It was obvious that the treatments with stevia powder gave the highest beneficial effect in improving the lipid profile in diabetic rats.

Findings of the present study are in concordance with **Al-Hamdani (2019**) and **Abd El-Baky *et al.* (2020**) observed that all tested groups with stevia were significantly improved the concentration of serum lipid profile, compared to the positive control group. Other results confirmed by **Abd- Elnoor (2019),** the use of pumpkin seeds powder resulted in a significant decrease in triglycerides, cholesterol, VLDL, LDL, and lipid peroxidation compared to positive control. In addition, **Hanna *et al*. (2014)** revealed that rats fed 5% ginger showed a decrease in, triglycerides, total cholesterol, VLDL-C, LDL-C, and an increase in HDL-C

compared with diabetic control. While, **Gabr, (2017**) found that oral administration of pomegranate juice and peel extract to diabetic rats for 4 weeks significantly decreased serum levels of TC, TG, LDL-c, and liver enzymes when compared to the control group. Levels of HDL-c and antioxidant enzymes significantly increased as compared to the control group.

Change in sexual hormones of testosterone, luteinizing (LH) and follicle- stimulating hormone (FSH) levels of diabetic rats are listed **in table (11)** as affected by sweetness fortified with stevia powder individually or in combination with (pumpkin seeds, ginger powder, sesame, and pomegranate molasses). The highest values of testosterone, testosterone and FSH levels found in the negative control group and that feed on stevia powder (A), while positive control recorded significantly the lowest value of the hormone. The results showed that changes in the hormone LH–and FSH—levels were increased significantly in all groups injected by STZ and treated with sweetness fortified with stevia individually or in combination with (pumpkin seeds, ginger powder, sesame seeds and pomegranate molasses) than that fed positive control. Group (E) fed on sweetness containing stevia with all raw materials recorded the highest value of testosterone, LH and FSH as (293.43, 0.31, and 0.18) respectively, compared with the positive group (187.47, 0.21, and 0.10) respectively.

In parallel, antioxidants levels represented by Superoxide dismutase (SOD) activity and glutathione——peroxidase activity (GPA) were decreased in diabetic rats. STZ administration resulted in a significant decrease of antioxidant enzymes SOD and GPA compared to the negative control group. When rats were administered with sweetness under investigation the enzyme activity was restored nearly to normal and was significant when compared to the diabetic group (positive control). Sweetness contains stevia powder and other raw materials increased the level of antioxidant enzymes and could be effective through scavenging these free radicals. Group (E) fed on all raw material with stevia powder scored the highest levels of SOD and GPA as 20.87 and 39.17 compared with the positive group, which recorded 9.37 and 19.40.

On the contrary, the nitric oxide (ON) is in the same table

(11). Diabetic nephropathy addresses a complex metabolic process characterized by pathophysiological events that both stimulate and depress intra-renal nitric oxide (NO) production. The net impact on renal NO level depends on the stage of the disease. A large of literature has built up abnormalities and the part of intra-renal nitric oxide release in the development of diabetic nephropathy. These distinctions could be explained by the different methods utilized for the evaluation of NO, the NOS isoforms studied (**Sharma, 2004**). The results revealed that STZ injection to rats caused a significant increase ($P \leq 0.05$) in serum NO level, compared to the healthy rats. All sweetness groups significantly decreased the mean value of serum NO level significantly ($P \leq 0.05$), compared to the positive control group. It was clear that, no significant difference in NO level among the treated groups (C and F). It was obvious that the treatments with stevia powder gave the highest beneficial effect in improving nitric oxide levels in diabetic rats.

Saleh *et al*. (2016) found that sativoside on the enzyme activity, superoxide dismutase (SOD), glutathione reductase (GR) and catalase were restored to normal and was significant when compared to diabetic group. While **AbdelAzim *et al.* (2020**) represented that stevia reduced eNOS expression in renal tissues compared to the diabetic rats. **Sankar *et al.* (2011**) incubation of beta cells damaged by STZ with sesamin significantly improved activities of glutathione peroxidase (GSHpx), superoxide dismutase (SOD) and reduced glutathione (GSH) content. Significant reductions in nitric oxide (NO) production, the enzyme activities of NO synthase (NOS), and induced NOS (iNOS) were observed in these cells when they were incubated with sesame. **Mohamed and Abdel-Salam (2021**) found that rats fed on supplements containing sesame reversed the elevation of nitric oxide.

Conclusion

Recently, the use of low-calorie sweeteners has increased, and consumers' interest in low-calorie natural sweeteners has increased, and the demand for adding stevia has increased because it is low in calories and 40 times sweeter than sugar. This

study aimed to introduce stevia leaves to some other substances to obtain Sweet the results showed that the introduction of Stevia into the products affected the organoleptic properties and chemical composition in different ways. Sweets containing stevia were very acceptable and the addition of some other substances (ginger, pomegranate molasses, sesame seeds, pumpkin seeds) gave an excellent flavor and antioxidant effect on sweets. This study demonstrated the potential to develop sweets rich in stevia and other substances as an alternative to sugar to reduce the side effects of diabetes and improve fertility.

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Table (1): Ingredients of sweets for total and a partial replacement.

	T1	T 2	T 3	T 4	T 5	T 6	T 7
Water (ml)	**100**	**100**	**-**	**-**	**-**	**-**	**100**
Stevia leaves (g)	**-**	**15**	**3**	**3**	**3**	**3**	**-**
Pomegranate molasses (ml)	**-**	**-**	**50**	**50**	**50**	**50**	**50**
Ginger powder (g)	**-**	**-**	**-**	**-**	**1**	**1**	**1**
Sesame seeds (g)	**-**	**-**	**-**	**10**	**10**	**10**	**10**
Pumpkin seeds (g)	**-**	**-**	**-**	**15**	**-**	**15**	**15**
Sugar (g)	**250**	**-**	**-**	**-**	**-**	**-**	**250**

T1: sweets contains only sugar.
T2: sweets contain only stevia.
T3: sweets contain (stevia leaves + pomegranate molasses)
T4: sweets contain (stevia leaves + pomegranate molasses+ sesame seeds + pumpkin seeds)
T5: sweets contain (stevia leaves + pomegranate molasses+ ginger powder + sesame seeds)
T6: sweets contain (stevia leaves + pomegranate molasses + sesame seeds + ginger powder +pumpkin seeds)

Table (2): Chemical composition of raw material used

Samples	Stevia powder	Pumpkin seed	Ginger powder	Sesame	Pomegranate molasses
g %					
Moisture	6.84	3.91	7.14	5.89	56.18
protein	17.86	17.41	10.18	18.11	12.94
Ash	10.91	3.74	4.21	5.71	1.98
Fat	5.96	34.18	37.96	43.26	12.36
Fiber	13.74	2.84	11.18	3.27	0.56
Total carbohydrates	58.43	40.76	40.51	27.03	16.54
Minerals (mg/100g)					
P	386.41	98.74	236.21	101.03	7.91
K	1837.14	177.18	89.16	211.16	261.16
Ca	18.41	22.21	210.71	274.16	2.94
Na	21.16	98.46	41.18	35.34	2.81
Fe	7.71	21.43	11.48	3.88	0.28
Zn	1.36	0.54	7.51	4.21	0.21
Mn	9.16	1.16	2.31	0.98	0.43

Table (3): Proximate analysis of sweetness fortified with different raw materials

Sweetness samples	Moisture %	C. protein%	Ash %	T. fat %	Total carbohydrates %
T2	3.09^{e}±0.030	2.99^{e}±0.115	0.49^{f}±0.040	1.54^{f}±0.020	91.89^{a}±0.145
T3	2.38^{f}±0.070	2.65^{e}±0.230	0.95^{e}±0.030	7.25^{d}±0.040	86.78^{b}±0.230
T4	6.49^{d}±0.050	6.50^{d}±0.230	2.16^{c}±0.050	10.15^{b}±0.030	74.70^{c}±0.300
T5	6.79^{c}±0.040	8.11^{c}±0.172	2.51^{b}±0.020	8.21^{c}±0.040	74.38^{c}±0.273
T6	9.49^{a}±0.040	9.43^{b}±0.172	1.93^{d}±0.040	12.87^{a}±0.030	66.28^{e}±0.203
T7	8.80^{b}±0.040	13.11^{a}±0.345	7.26^{a}±0.050	3.85^{e}±0.030	66.98^{d}±0.285
LSD at 0.01	**0.12**	**0.56**	**0.10**	**0.08**	**0.61**
LSD at 0.05	**0.08**	**0.40**	**0.07**	**0.06**	**0.44**
LSD at 0.001	**0.16**	**0.78**	**0.14**	**0.11**	**0.86**

T2: sweets contain only stevia.

T3: sweets contain (stevia leaves + pomegranate molasses)

T4: sweets contain (stevia leaves + pomegranate molasses+ sesame seeds + pumpkin seeds)

T5: sweets contain (stevia leaves + pomegranate molasses+ ginger powder + sesame seeds)

T6: sweets contain (stevia leaves + pomegranate molasses + sesame seeds + ginger powder +pumpkin seeds)

T7: sweets contain (sugar + pomegranate molasses+ sesame seeds + ginger powder +pumpkin seeds)

Each value is the mean ± SD

Mean values in each column have different subscript (a, b, c, d……..) are significant different at $P<0.05$

Table (4): Minerals content of sweetness fortified with different raw material used.

Sweetness samples	P%	K%	Ca%	Na%	Cu ppm	Zn ppm	Mg ppm	Fe ppm
T2	0.050^{e} ±0.005	0.07^{f} ±0.030	0.03^{c} ±0.020	0.10^{b} ±0.020	0.022^{d} ±0.002	0.023^{d} ±0.003	0.000^{e} ±0.000	0.796^{f} ±0.006
T3	0.030^{f} ±0.007	0.30^{d} ±0.040	0.04^{bc} ±0.040	0.11^{b} ±0.040	0.055^{b} ±0.003	0.006^{e} ±0.004	0.090^{d} ±0.004	1.129^{c} ±0.003
T4	0.130^{d} ±0.008	0.57^{c} ±0.030	0.06^{bc} ±0.020	0.11^{b} ±0.060	0.055^{b} ±0.004	0.049^{c} ±0.005	0.310^{c} ±0.005	1.035^{d} ±0.005
T5	0.210^{c} ±0.005	0.23^{e} ±0.050	0.05^{bc} ±0.030	0.13^{b} ±0.020	0.034^{c} ±0.004	0.049^{c} ±0.003	0.322^{c} ±0.002	0.909^{e} ±0.005
T6	0.330^{a} ±0.002	0.71^{b} ±0.040	0.09^{b} ±0.040	0.07^{b} ±0.020	0.056^{b} ±0.004	0.102^{a} ±0.004	61.800^{b} ±0.090	1.236^{b} ±0.005
T7	0.230^{b} ±0.004	1.17^{a} ±0.040	0.50^{a} ±0.040	0.20^{a} ±0.050	0.076^{a} ±0.004	0.079^{b} ±0.003	140.350^{a} ±0.060	2.807^{a} ±0.004
LSD at 0.01	**0.013**	**0.10**	**n.s**	**0.10**	**0.008**	**0.009**	**0.11**	**0.012**
LSD at 0.05	**0.009**	**0.07**	**0.06**	**n.s**	**0.006**	**0.007**	**0.08**	**0.008**
LSD at 0.001	**0.019**	**0.14**	**n.s**	**n.s**	**0.012**	**0.013**	**0.16**	**0.017**

T2: sweets contain only stevia.
T3: sweets contain (stevia leaves + pomegranate molasses)
T4: sweets contain (stevia leaves + pomegranate molasses+ sesame seeds + pumpkin seeds)
T5: sweets contain (stevia leaves + pomegranate molasses+ ginger powder + sesame seeds)
T6: sweets contain (stevia leaves + pomegranate molasses + sesame seeds + ginger powder +pumpkin seeds)
T7: sweets contain (sugar + pomegranate molasses+ sesame seeds + ginger powder +pumpkin seeds)
Each value is the mean ± SD
Mean values in each column have different subscript (a, b, c, d……..) are significant different at $P<0.05$

Table (5): Antioxidant activity of sweetness fortified with different raw material used.

Sweetness samples	Total phenol mg of Gallic acid/g dry weight	Antioxidant activity %
T2	13.39^{d}±0.070	48.04^{c}±1.070
T3	18.23^{c}±0.100	64.29^{c}±1.310
T4	23.78^{ab}±0.140	72.62^{b}±1.080
T5	23.75^{b}±0.070	64.09^{c}±1.120
T6	23.83^{ab}±0.090	74.80^{b}±1.260
T7	23.96^{a}±0.100	88.49^{a}±1.620
LSD at 0.01	**0.25**	**3.14**
LSD at 0.05	**0.18**	**2.24**
LSD at 0.001	**0.36**	**4.43**

T2: sweets contain only stevia.
T3: sweets contain (stevia leaves + pomegranate molasses)
T4: sweets contain (stevia leaves + pomegranate molasses+ sesame seeds + pumpkin seeds)
T5: sweets contain (stevia leaves + pomegranate molasses+ ginger powder + sesame seeds)
T6: sweets contain (stevia leaves + pomegranate molasses + sesame seeds + ginger powder +pumpkin seeds)
T7: sweets contain (sugar + pomegranate molasses+ sesame seeds + ginger powder +pumpkin seeds)
Each value is the mean ± SD
Mean values in each column have different subscript (a, b, c, d……..) are significant different at $P<0.05$

Table (6): Sensory evaluation of sweetness fortified with different raw material used.

Sweetness samples	Color	Test	Odor	Texture	Appearance
T1	9.70^{a}±0.080	9.86^{a}±0.050	9.44^{a}±0.050	9.50^{a}±0.090	9.66^{a}±0.070
T2	9.38^{b}±0.050	9.44^{b}±0.060	9.12^{b}±0.070	8.53^{cd}±0.080	9.22^{b}±0.060
T3	8.90^{d}±0.040	9.04^{e}±0.050	8.90^{c}±0.060	8.81^{b}±0.080	8.69^{de}±0.060
T4	8.78^{e}±0.090	8.93^{f}±0.040	8.89^{c}±0.050	8.36^{e}±0.080	8.50^{f}±0.070
T5	9.10^{c}±0.070	9.29^{c}±0.040	8.80^{c}±0.060	8.84^{b}±0.070	8.88^{c}±0.050
T6	9.06^{c}±0.060	9.15^{d}±0.040	9.02^{b}±0.060	8.56^{c}±0.055	8.62^{e}±0.070
T7	9.14^{c}±0.050	9.12^{de}±0.050	8.63^{d}±0.050	8.40^{de}±0.080	8.76^{d}±0.040
LSD at 0.01	**0.16**	**0.12**	**0.14**	**0.18**	**0.15**
LSD at 0.05	**0.11**	**0.08**	**0.10**	**0.14**	**0.11**
LSD at 0.001	**0.22**	**0.16**	**0.19**	**0.26**	**0.21**

T1: sweets contains only sugar.

T2: sweets contain only stevia.

T3: sweets contain (stevia leaves + pomegranate molasses)

T4: sweets contain (stevia leaves + pomegranate molasses+ sesame seeds + pumpkin seeds)

T5: sweets contain (stevia leaves + pomegranate molasses+ ginger powder + sesame seeds)

T6: sweets contain (stevia leaves + pomegranate molasses + sesame seeds + ginger powder +pumpkin seeds)

T7: sweets contain (sugar + pomegranate molasses+ sesame seeds + ginger powder +pumpkin seeds)

Each value is the mean ± SD

Mean values in each column have different subscript (a, b, c, d……..) are significant different at $P<0.05$

Table (7): Experimental rats fed on sweets fortified with raw materials

Diabetic rats	IBW	FBW	BWG	G%	FI	FER
N	173.00^{a}±2.00	223.67^{b}±6.11	50.67^{b}±4.16	29.27^{b}±2.09	18.64^{b}±0.509	0.060^{ab}±0.003
+Ve	173.67^{a}±2.52	181.33^{e}±3.21	7.67^{e}±1.53	4.41^{e}±0.86	15.11^{e}±0.268	0.011^{d}±0.002
A	173.33^{a}±1.52	184.33^{e}±1.52	11.00^{e}±1.00	6.35^{e}±0.60	15.36^{e}±0.127	0.016^{d}±0.001
B	173.67^{a}±3.22	183.67^{e}±4.16	10.00^{e}±1.73	5.75^{e}±0.96	15.31^{e}±0.347	0.014^{d}±0.002
C	175.00^{a}±3.61	204.00^{d}±8.54	29.00^{d}±12.12	16.67^{d}±7.32	17.00^{d}±0.712	0.038^{c}±0.014
D	174.67^{a}±2.52	201.33^{d}±3.22	26.67^{d}±2.31	15.27^{d}±1.37	16.78^{d}±0.268	0.035^{c}±0.003
E	175.00^{a}±2.63	237.67^{a}±2.52	62.67^{a}±5.03	35.84^{a}±3.43	19.81^{a}±0.210	0.070^{a}±0.005
F	173.67^{a}±2.08	214.33^{c}±2.09	40.67^{c}±2.08	23.42^{c}±1.36	17.86^{c}±0.173	0.051^{b}±0.002
G	175.00^{a}±1.00	206.00^{d}±6.56	31.00^{d}±7.02	17.72^{d}±4.04	17.17^{d}±0.546	0.040^{c}±0.008
LSD at	**5.79**	**11.20**	**12.50**	**7.50**	**0.93**	**0.014**
LSD at	**4.22**	**8.17**	**9.12**	**5.48**	**0.68**	**0.010**
LSD at	**7.89**	**15.25**	**17.03**	**10.22**	**1.27**	**0.019**

N: negative control, normal rats fed on basal diet

+Ve: positive control, diabetic rats fed on basal diet

A: T1 normal rats fed on stevia powder

B: diabetic rates fed on T2: sweets contain only stevia.

C: diabetic rates fed on T3: sweets contain (stevia leaves + pomegranate molasses)

D: diabetic rates fed on T4: sweets contain (stevia leaves + pomegranate molasses+ sesame seeds + pumpkin seeds)

E: diabetic rates fed on T5: sweets contain (stevia leaves + pomegranate molasses+ ginger powder + sesame seeds)

F: diabetic rates fed on T6: sweets contain (stevia leaves + pomegranate molasses + sesame seeds + ginger powder +pumpkin seeds)

G: diabetic rates fed on T7: sweets contain (sugar + pomegranate molasses+ sesame seeds + ginger powder +pumpkin seeds)

Each value is the mean ± SD

Mean values in each column have different subscript (a, b, c, d……..) are significant different at $P<0.05$

IBW: initial body weight

FBW: final body weight

BWG: body weight gain

G: gain

FI: food intake

FER: Feed Efficiency Ratio

Table (8): Effect of toffee fortified with raw materials on serum glucose, HbAlc and insulin levels of diabetic rats.

Diabetic rats samples	Blood glucose (mg/dl)	HbA1c (%)	Insulin (pg/ml)
N	103.00^{e}±5.00	2.72^{fg} ±0.105	238.00^{ab}±20.00
+Ve	463.00^{a}±8.00	4.92^{a}±0.286	74.00^{f}±13.00
A	71.00^{f}±3.00	2.57^{g}±0.066	249.00^{a} ±4.00
B	334.00^{b}±40.00	4.21^{b}±0.252	110.00^{e}±12.00
C	222.00^{c}±18.00	3.32^{cd}±0.121	194.00^{d}±8.00
D	306.00^{b}±9.00	3.96^{b}±0.145	130.00^{e}±8.00
E	123.00^{e}±13.00	2.94^{ef}±0.045	221.00^{bc}±16.00
F	161.00^{d}±26.00	3.06^{de}±0.170	216.00^{c}±13.00
G	234.00^{c}±13.00	3.50^{c}±0.062	175.00^{d}±12.00
LSD at 0.01	**43.74**	**0.38**	**29.58**
LSD at 0.05	**31.92**	**0.28**	**21.59**
LSD at 0.001	**59.58**	**0.51**	**40.31**

N: negative control, normal rats fed on basal diet
+Ve: positive control, diabetic rats fed on basal diet
A: T1 normal rats fed on stevia powder
B: diabetic rates fed on T2: sweets contain only stevia.
C: diabetic rates fed on T3: sweets contain (stevia leaves + pomegranate molasses)
D: diabetic rates fed on T4: sweets contain (stevia leaves + pomegranate molasses+ sesame seeds + pumpkin seeds)
E: diabetic rates fed on T5: sweets contain (stevia leaves + pomegranate molasses+ ginger powder + sesame seeds)
F: diabetic rates fed on T6: sweets contain (stevia leaves + pomegranate molasses + sesame seeds + ginger powder +pumpkin seeds)
G: diabetic rates fed on T7: sweets contain (sugar + pomegranate molasses+ sesame seeds + ginger powder +pumpkin seeds)
Each value is the mean ± SD
Mean values in each column have different subscript (a, b, c, d……..) are significant different at P<0.0
HbA1c: **A** hemoglobin A1c

Table (9): Effect of sweetness fortified with raw materials on liver function of diabetic rats.

Diabetic rats samples	ALT (U/L)	AST (U/L)
N	27.23^{f}±5.29	84.27^{f}±9.38
+Ve	57.63^{a}±4.48	223.30^{a}±24.94
A	19.23^{g}±2.20	72.30^{f}±10.89
B	48.87^{b}±2.54	190.90^{b}±14.14
C	35.20^{de}±4.66	141.60^{d}±16.52
D	43.57^{bc}±1.70	173.33^{bc}±18.89
E	30.97^{ef}±1.31	95.70^{ef}±11.03
F	31.23^{ef}±2.35	113.60^{e}±11.86
G	39.10^{cd}±1.51	148.40^{cd}±12.84
LSD at 0.01	**7.57**	**35.78**
LSD at 0.05	**5.53**	**26.12**
LSD at 0.001	**10.31**	**48.75**

N: negative control, normal rats fed on basal diet
+Ve: positive control, diabetic rats fed on basal diet
A: T1 normal rats fed on stevia powder
B: diabetic rates fed on T2: sweets contain only stevia.
C: diabetic rates fed on T3: sweets contain (stevia leaves + pomegranate molasses)
D: diabetic rates fed on T4: sweets contain (stevia leaves + pomegranate molasses+ sesame seeds + pumpkin seeds)
E: diabetic rates fed on T5: sweets contain (stevia leaves + pomegranate molasses+ ginger powder + sesame seeds)
F: diabetic rates fed on T6: sweets contain (stevia leaves + pomegranate molasses + sesame seeds + ginger powder +pumpkin seeds)
G: diabetic rates fed on T7: sweets contain (sugar + pomegranate molasses+ sesame seeds + ginger powder +pumpkin seeds)
Each value is the mean ± SD
Mean values in each column have different subscript (a, b, c, d……..) are significant different at P<0.0
AST: Aspartate aminotransferase
AST: Aspartate transaminase

Table (10): Effect of sweetness fortified with raw materials on lipid profile of diabetic rats.

Diabetic rats samples	TC (mg/dl)	TG (mg/dl)	HDLC (mg/dl)	LDLC	vLDLc
N	70.27^{ef}±3.787	85.40^{ef}±9.10	43.03^{a}±7.28	10.15^{g}±5.66	17.08^{ef}±1.82
+Ve	156.13^{a}±15.081	189.00^{a}±15.63	19.10^{a}±4.32	99.23^{a}±10.03	37.80^{a}±3.13
A	69.90^{ef}±3.659	72.10^{f}±2.87	47.70^{a}±6.21	7.78^{g}±2.66	14.42^{f}±0.58
B	126.60^{b}±11.635	154.53^{b}±15.67	22.47^{fg}±2.85	73.23^{b}±6.08	30.91^{b}±3.13
C	82.13^{de}±5.805	102.67^{de}±11.89	32.33^{cde}±2.99	29.27^{e}±1.73	20.53^{de}±2.37
D	105.80^{c}±9.602	134.37^{c}±4.65	25.20^{efg}±2.24	53.73^{c}±11.22	26.87^{c}±0.93
E	64.53^{f}±4.944	84.17^{f}±6.79	36.43^{bc}±5.05	11.27^{fg}±3.49	16.83^{f}±1.36
F	73.53^{ef}±7.751	89.33^{ef}±6.50	34.02^{cd}±1.54	21.65^{ef}±4.98	17.87^{ef}±1.30
G	93.07^{cd}±5.086	117.13^{cd}±11.47	28.90^{def}±2.11	40.74^{d}±4.82	23.43^{cd}±2.30
LSD at 0.01	**19.61**	**24.31**	**10.05**	**14.98**	**4.86**
LSD at 0.05	**14.31**	**17.74**	**7.33**	**10.93**	**3.55**
LSD at 0.001	**26.72**	**33.12**	**13.70**	**20.41**	**6.63**

N: negative control, normal rats fed on basal diet
+Ve: positive control, diabetic rats fed on basal diet
A: T1 normal rats fed on stevia powder
B: diabetic rates fed on T2: sweets contain only stevia.
C: diabetic rates fed on T3: sweets contain (stevia leaves + pomegranate molasses)
D: diabetic rates fed on T4: sweets contain (stevia leaves + pomegranate molasses+ sesame seeds + pumpkin seeds)
E: diabetic rates fed on T5: sweets contain (stevia leaves + pomegranate molasses+ ginger powder + sesame seeds)
F: diabetic rates fed on T6: sweets contain (stevia leaves + pomegranate molasses + sesame seeds + ginger powder +pumpkin seeds)
G: diabetic rates fed on T7: sweets contain (sugar + pomegranate molasses+ sesame seeds + ginger powder +pumpkin seeds)
Each value is the mean ± SD
Mean values in each column have different subscript (a, b, c, d……..) are significant different at P<0.0
TC: Total cholesterol
TG: Triglycerides
HDL: high-density lipoproteins
LDL: low-density lipoproteins

Table (11): Effect of sweetness fortified with raw materials on hormones and antioxidants levels of diabetic rats.

Diabetic rats samples	Testosterone (ng/dl)	LH (MlU/MI)	FSH (MIU / MI)	SOD (U/GT)	GPA (U/GT)	NO (UMOI/L)
N	$317.90^{b}\pm5.23$	$0.33^{ab}\pm0.008$	$0.19^{b}\pm0.006$	$27.83^{a}\pm1.53$	$42.53^{b}\pm1.16$	$0.68^{g}\pm0.045$
+Ve	$187.47^{f}\pm9.42$	$0.21^{h}\pm0.010$	$0.10^{g}\pm0.005$	$9.37^{e}\pm1.12$	$19.40^{g}\pm1.21$	$3.86^{a}\pm0.140$
A	$337.40^{a}\pm1.97$	$0.34^{a}\pm0.006$	$0.20^{a}\pm0.011$	$29.63^{a}\pm0.95$	$51.23^{a}\pm1.30$	$0.74^{fg}\pm0.075$
B	$242.17^{e}\pm2.32$	$0.23^{g}\pm0.016$	$0.13^{f}\pm0.003$	$12.43^{d}\pm2.20$	$21.97^{g}\pm2.05$	$3.05^{b}\pm0.095$
C	$261.17^{d}\pm1.55$	$0.29^{d}\pm0.007$	$0.15^{d}\pm0.003$	$19.80^{b}\pm0.36$	$32.77^{d}\pm2.67$	$1.12^{e}\pm0.047$
D	$241.27^{e}\pm6.15$	$0.26^{f}\pm0.014$	$0.14^{e}\pm0.004$	$14.63^{c}\pm1.46$	$27.37^{f}\pm1.46$	$2.36^{c}\pm0.083$
E	$293.43^{c}\pm.79$	$0.31^{bc}\pm0.007$	$0.18^{b}\pm0.003$	$20.87^{b}\pm0.57$	$39.17^{c}\pm1.38$	$0.85^{f}\pm0.106$
F	$263.60^{d}\pm7.65$	$0.30^{cd}\pm0.009$	$0.16^{c}\pm0.006$	$19.43^{b}\pm0.78$	$31.50^{de}\pm1.74$	$1.06^{e}\pm0.101$
G	$255.60^{d}\pm6.14$	$0.28^{e}\pm0.009$	$0.15^{cd}\pm0.005$	$14.47^{cd}\pm1.36$	$29.87^{ef}\pm0.86$	$2.05^{d}\pm0.095$
LSD at 0.01	**14.07**	**0.02**	**0.01**	**2.96**	**3.80**	**0.22**
LSD at 0.05	**10.27**	**0.02**	**0.01**	**2.17**	**2.78**	**0.16**
LSD at 0.001	**19.17**	**0.03**	**0.02**	**4.04**	**5.19**	**0.29**

N: negative control, normal rats fed on basal diet
+Ve: positive control, diabetic rats fed on basal diet
A: T1 normal rats fed on stevia powder
B: diabetic rates fed on T2: sweets contain only stevia.
C: diabetic rates fed on T3: sweets contain (stevia leaves + pomegranate molasses)
D: diabetic rates fed on T4: sweets contain (stevia leaves + pomegranate molasses+ sesame seeds + pumpkin seeds)
E: diabetic rates fed on T5: sweets contain (stevia leaves + pomegranate molasses+ ginger powder + sesame seeds)
F: diabetic rates fed on T6: sweets contain (stevia leaves + pomegranate molasses + sesame seeds + ginger powder +pumpkin seeds)
G: diabetic rates fed on T7: sweets contain (sugar + pomegranate molasses+ sesame seeds + ginger powder +pumpkin seeds)
Each value is the mean ± SD
Mean values in each column have different subscript (a, b, c, d……..) are significant different at $P<0.0$
LH: Luteinizing hormone
FSH: Follicle stimulating
SOD: Superoxide dismutase
GPA: Glutathionee peroxidase activity
NO: Nitric oxide

تأثير إستخدام بعض الحلوى المدعمه نبات الإستيفيا و بعض المواد الأخرى على بعض العوامل البيوكيميائيه فى الجرذان المصابه بمرض السكرى

أحمد عثمان عبد الرحمن شلبى، هاله عزت الكواوى و الزهراء أحمد عبده

قسم الاقتصاد المنزلى – كلية التربيه النوعيه – جامعة المنصوره

الملخص العربي

يهدف هذا البحث إلى دراسة تأثير إستخدام المنتجات الغذائيه المدعمه بأوراق نبات الستيفيا و بعض المواد الأخرى مثل دبس الرمان، الزنجبيل، بذور السمسم، و بذور اليقطين على القبول العام لمنتج الحلويات و تأثيراتها التحسينيه على مرض السكر الذى يسببه الأستربتوزين فى الجرذان. تم تحضير الحلويات وتقسيمها (مجموعه كنترول و مجموعات مدعمه بالستيفيا و بعض المواد الأخرى المذكوره سابقا). تم التقييم الكيميائى و الحسى و البيولوجى للمنتجات. و أظهرت النتائج أن إصابة الجرذان بمرض السكرى بعد الحقن بالستربتوزين مما أدى إلى إنخفاض فى كل من الوزن، معدل كفاءة الغذاء ، و زياده ملحوظه في إنزيمات الكبد، الكوليسترول الكلى و الكوليسترول المرتبط بالبروتين منخفض و شديد الانخفاض فى الكثافه و الدهون الثلاثيه بينما أدى إلى انخفاض فى الكوليسترول المرتبط بالبروتين عالى الكثافه و انزيم السوبر ديسميوتيز، جلوتاثيون بيروكسيديز، هرمون التستيستيرون و FSH و LH و كذلك مستوى أكسيد النيتريك ارتفع مقارنه بالجرذان السليمه. و قد أدت التغذيه على الحلويات المحتويه على الاستيفيا و المواد الأخرى مثل دبس الرمان و الزنجبيل و بذور السمسم و بذور اليقطين على التخفيف من الاعراض الجانبيه لمرض السكرى. وخلصت النتائج أن منتجات الحلويات المدعمه بالاستيفيا منتجات مقبوله حسيا و لها تأثير وقائى على خفض نسبه السكر فى الدم و قد يرجع هذا التأثير إلى إرتفاع قيمتها الغذائيه و ارتفاع محتواها من مضادات الأكسده و بعض الأملاح المعدنيه خاصة الفوسفور والكالسيوم والصوديوم والزنك والنحاس والحديد والمغنيسيوم.

الكلمات المفتاحية: *نبات ستيفيا، دبس رمان، زنجبيل، بذور سمسم ، بذور قرع و مرض السكر*