

Awareness of Saudi society with benefits prickly pear to lowering diabetes in rats

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ABSTRACT

This study aims to increase the nutritional awareness of Saudi society and beneficial of the importance of the prickly pear through an electronic questionnaire that includes the extent of Saudi society's awareness of prickly pear and the percentage with diabetes. The results showed that the percentage of diabetes in Saudi society is high. In addition, the percentage that was aware of the relationship of prickly pear with diabetes was high. This is a good indication of Saudi society's awareness of the importance of prickly pear to lower blood sugar. Therefore, it was confirmed by conducting a determination of the nutritional values, total phenolic content, and flavonoids compounds, in addition, biological experiment on rats with high blood sugar, lipids, and cholesterol. The results indicated that the prickly pear the highest in total carbohydrate was 91.04%, meanwhile, the total fats, ash content, and crude fiber were lowering. Mineral content noticed that the potassium, magnesium, calcium, and phosphorus were higher contained amounts in prickly pear. The highest amounts of the prickly pear extract as total phenolic and flavonoids content, in addition, antioxidants capacity. The results after four weeks from biological experiment demonstrated that the prickly pear extract when taken orally at 400 ppm/day/kg body weight, it had contained the natural antioxidant, which important role in contributing to the health benefit of lowering glucose and reducing the lipid profiles. It could be recommended to increase nutrition awareness and health awareness of the importance of prickly pears and their effect on blood sugar levels.

Keywords: Prickly pear, Saudi society, Electronic questionnaire, Diabetes, Antioxidant

1. INTRODUCTION

The uses of traditional medicines for the treatment of metabolic disorders and pathological consequences of diabetes lead to an elevation in complications caused to side effects. Thus, shifting in the herbal drugs is much influential; lesser side influences, and may little toxicity (Rahman et al., 2021). Prickly pear (*Opuntia ficus-indica*) is a ceteaceous plant, widely found worldwide. It can be considered a drug plant, existence a source of many bioactive phytochemicals (Vicidomini et al., 2021). Prickly pear fruits had contained a natural antioxidant that has been linked to many health benefits. The red and

purple varieties had contained betanin, which is linked with anti-inflammatory activity and hepato-protective functions (Han et al., 2015). Prickly is rich wealthy in xanthine, which cells' neuronal activity was elevated in vivo (Gambino et al., 2018). Prickly pears are also sources of phenolic acid and flavonoids have shown anti-hypercholesterolemia effects by inhibiting cholesterol permeation (Ressaissi et al., 2017) and it has been recognized in the prickly pear of various species as an effective anti-inflammatory (Antunes-Ricardo et al., 2017). Moreover, antioxidants are phenolic acid and flavonoids isolated, and purified, in vitro from prickly pear fruit were anti-inflammatory, and it had lowering glucose in blood characteristics (Gómez-Maqueo et al., 2019).

Prickly pear is an enchanted fruit that may be due to having contained vitamins, carotenoids, antioxidant constituents, and betalains are phytochemicals. It is also a mineral good source and also constitutes a variety of amino acids, in addition, chemical nutritional value (Sabtain et al., 2021). Consumer benefit in natural ingredients is an increasing general direction in the food industry. Prickly pear juices obtained from three different varieties with white, red, and yellow pulp, it could be noticed that it was contained through chemical examinations high contents of total polyphenols, flavonoids, betalain, and remarkably antioxidant capacity could be found (Palmeri et al., 2020). The fruits of prickly pear had contained the greatest nutrition value that is exceedingly utilized in folk drugs for their health interests like lowering glucose in the blood, lesser lipid profile, and antioxidant characteristics (Elshehy et al., 2020).

The aim of this infestation was to be aware of Saudi society with benefits prickly pear, and conducting a questionnaire to measure the Saudi society's awareness of the prickly pear fruit. Therefore, it was evaluating the *Opuntia ficus-indica* as natural antioxidant activity and capacity. In addition, it was assessed the influence of *Opuntia ficus-indica* consumption on diabetic and lipids profiles in rats.

2. MATERIALS AND METHODS

Materials

Prickly pear (*Opuntia ficus-indica*) was obtained from the local market in Saudi Arabia. Kits for determination of various parameters of biological experimental, streptozotocin, DPPH (2, 2'-diphenyl-1-picrylhydrazyl), potassium ferricyanide, and all chemical uses in the study were purchased from Sigma-Aldrich Corp., MO.

Male albino rats (n=36 rats), 160-170g for one, obtained from Pharmacy Faculty at King Saud University, as well as, fed the basal diet according to Pell et al., (1992).

Subjects consisted of 240 Participants (144 female and 96 male) enrolled in the Western Region of Saudi Arabia during the year 2020-2021 AD.

2. METHODS

Research Methodology

The research will follow the experimental approach that takes the equivalent group method. Where this method uses more than one group, the experimental factor is applied to one of them, and the other group or groups are left in their natural conditions. Therefore, the difference is the result of the influence of the experimental group on the experimental factor.

Search tools

Research tools: a questionnaire to collect information using a questionnaire electronic limited to multiple-choice questions in different regions such as central, southern, western, northern, and eastern region.

The research sample

The purpose of the questionnaire is to measure the awareness of the Saudi society about the prickly pear as fruit and its definition of having health benefits to the body.

The physical properties and regions for participants

General characteristics of subjects were included age (Less than 20, 20-25, 30-35, 40-45 and more than 50) and area or region (Central region, Southern region, Western region, Northern region, and Eastern region).

Data Collection

The six-part, electronic questionnaire was applied and incorporates dimensions of self-generated coping proposed. The questionnaire succeeded in collecting data form participants about, Is prickly pear one of your favorite fruits that you want to eat?,

Does anyone in your family have diabetes?, Do you think there is a relationship between diabetes and prickly pear?, Are there benefits that prickly pears have for diabetics?, Do you think that eating prickly pear reduces blood sugar?, and Do you think prickly pears contain a lot of nutrients and water that would satiate a diabetic?

Nutritional values of prickly pear and its effects on diabetic rats

Determination of chemical composition of prickly pear

Chemical compositions and minerals content as calcium, copper, iron, magnesium, zinc, phosphorus, sodium and potassium, of prickly pear were estimated according to AOAC (2010).

Preparation of crude aqueous extract from prickly pear

The fresh prickly pear was washed carefully with tap water to remove debris cut into small pieces and it was extracted by ethanol 70%. The mixture was filtered using filter paper (Whitman No 1) and this step was repeated twice. The filtrate was then concentrated and stored in a refrigerator until further analysis according to Muyenga et al., (2015).

Estimation of antioxidant activity from prickly pear extract

Total phenolic measured by Folin-Ciocalteu reagent with method Qawasmeh et al., (2012) were calculated as mg Gallic acid Equiv./g dry weight. The total flavonoids content was estimated with Eghdami and Sadeghi, (2010) and calculated as milligrams of quercetin equivalent per gram dry weight

Determination antioxidants capacity

The DPPH radical capacity was estimated with different concentrations from prickly pear extract at 2, 4, 6, 8, and 10 mg/ml⁻¹ and compared with Trolox as the reference compound according to the method of Oktay et al., (2003).

The ferric reducing power (FRAP) was estimated with different concentrations from prickly pear extract at 1, 2, 3, 4, and 5 mg/ml⁻¹ and compared with Ascorbic acid as the reference compound according to the method of Chu et al., (2000)

Biological experimental

Experimental rats were adapted for 7 days on a basal diet and randomly divided into six groups, six rats for each group. The 1st rats' group namely the control negative rats group (1). It was fed a basal diet for four weeks.

The five groups were injected with streptozotocin to induced diabetic rats according to Madar (1983). A positive control group (2) was also fed the basal diet only, while the groups were third, fourth, and fifth fed on basal diets and taken orally 100, 200, 300, and 400 ppm /kg bw rat /day from *Opuntia ficus-indica* aqueous extract by stomach tube for four weeks. After the end experiment, the blood was pull withdrawn from different rats groups and centrifuged to obtain serum after that, it was kept at -20°C until analysis. Serum glucose, total cholesterol, and triglycerides were estimated by Tietz (1986), Allain *et al.*, (1974) and Fossati and Prencipe (1982). In addition; high and low density lipoprotein was estimated by Burstein (1970) and Fruchart (1982).

Statistical analysis

Means \pm SD of the results are analysis of difference (ANOVA), $p \leq 0.05$ was used to significance Statistical Analysis System SAS, (2004).

3. RESULTS AND DISCUSSION

The current study focused on raising awareness in the Saudi society of the importance of the prickly pear. Therefore, it was our responsibility as researchers to realize this by conducting a biological experiment on rats with high blood sugar, lipids, and cholesterol, and the results were very good. Thus, Saudi society should realize the importance of the prickly pear as health, safety, and nutrition. Table 1 and figure 1 reported anthropometric measurements as age/year and area/region of the study and had contained 240 participants. From the results, it could be observed that the age/year was the highest participants from 20-25 age/year was 108 participants equal 45.0%, this means the active participation in the study sample of the youth group, followed by from 40-45 age/year was 36 participants equal 15.0%, and 30-35 age/year was 32 participants equal 13.3%, as well as, more than 50 age/year was 24 participants equal 10.0%, respectively. Whilst, the lowest participants was less than 20 year, and from 25.30 age/year was 20 participants equal 8.3% for both.

In addition, the results in the same table showed the participants in the fifth areas/regions were Central region (52 participants equal 21.7%), Southern region (36 participants equal 15.0%), Western region (68 participants equal 28.3%), Northern region (36 participants equal 15%), and Eastern region (48 participants equal 20%), respectively.

Table 1 Descriptive statistics of participants

Participants characteristics	N= 240	±SD	%
Age/year			
Less than 20	20	±0.67	8.3
20-25	108	±1.01	45.0
25-30	20	±0.43	8.3
30-35	32	±0.76	13.3
40.45	36	±0.34	15.0
More than 50	24	±0.03	10.0
Area/Region			
Central region	52	±0.67	21.7
Southern region	36	±0.65	15.0
Western region	68	±0.45	28.3
Northern region	36	±0.61	15.0
Eastern region	48	±0.68	20.0

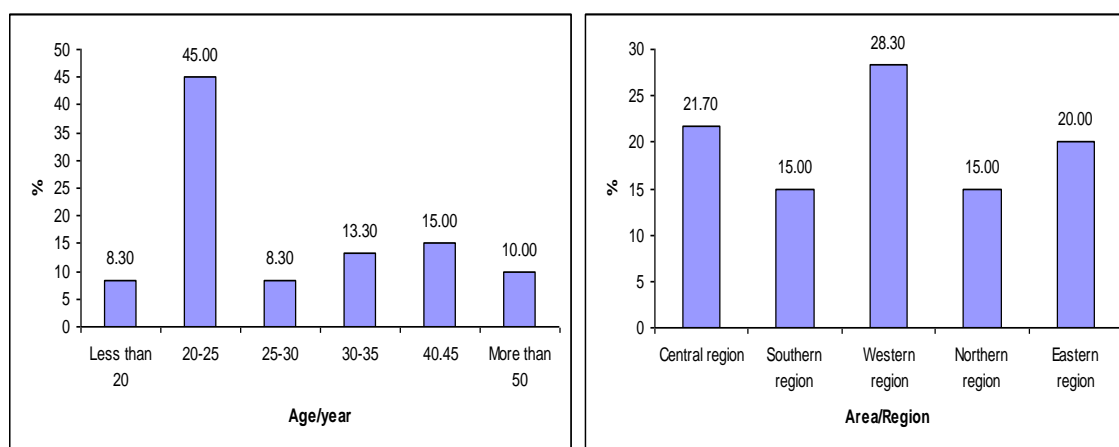


Figure 1 Descriptive statistics of participants for age/years and area/region

Measurement awareness of Saudi society to benefits prickly pear

A total of 240 participants were evaluated in the questionnaires measurement awareness of Saudi society to benefit prickly pear, according to the search method of this study and the evaluations are reported in Table (2) and figure (2). From the question, Is prickly pear one of your favorite fruits that you want to eat? It can be seen that 65% of respondents answered no, which is not careful to eat the prickly pear and that it is not their favorite. As for those who answered yes, they were 35%, which are aware of the benefits of the prickly pear and that it is their favorite fruit. From the question, Does anyone in your family have diabetes?, The results showed that 86.7% answered yes, which indicated that one of his family members suffers from diabetes. In addition, 13.3% answered that there is no one with diabetes in the family. This gives an indicated that there is a high percentage of the participants in the study have family members with diabetes.

From the question, do you think there is a relationship between diabetes and prickly pear? From the results, it could be noted that there is a convergence between the participants' awareness and knowledge of their belief that there is a relationship between diabetes and the prickly pear. Thus, it finds that the percentage of approval of 53.3% of the existence of a relationship and the percentage of disapproval was 46.7%, which indicates the need to increase awareness of the benefits of the prickly. Treatment of diabetic rats with prickly pear fruit was reducing blood sugar levels and lipids profile in the diabetic rats' group. As well, the urea concentration was found to decrease in diabetic rats treated with prickly pear fruit (Elshehy et al., 2020). From the question, are there benefits that prickly pears have for diabetics? A high percentage of the participants, up to 72.9%, had knowledge of the

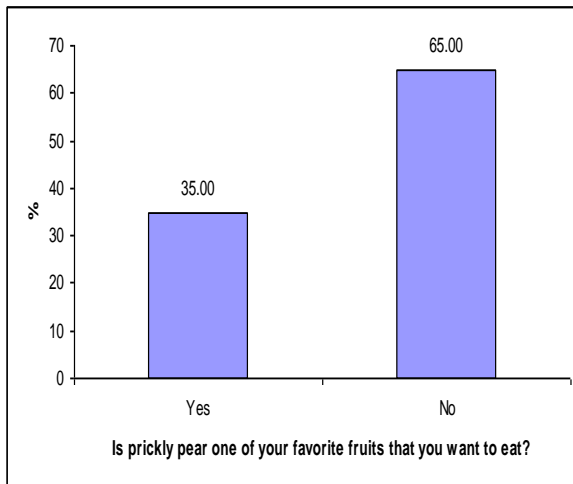
benefits of the prickly pear for diabetic patients, and 27.1% had no knowledge of it. These results give an indication that needs to clarify the concepts of knowing the benefits of the prickly pear for diabetics of knowing the extent of the relationship between diabetes and the prickly pear.

In diabetic rats when taken orally from prickly pear extract, the blood glucose was happened lowering may be due to the intestinal absorption of glucose by soluble dietary fiber or found an antioxidant as substances hypoglycemic (Costacou and Mayer-Davis, 2003). From the question, do you think that eating prickly pear reduces blood sugar? The participants responded 55.0% that there is a lack of knowledge of the use of *Opuntia ficus-indica* as an alternative or complementary therapy in reducing or managing diabetes risk. However, 45% of the participants showed that have sufficient information about the effects of the prickly pear on lowering glucose. Mokuia et al., (2016) demonstrated that the extracts of prickly pear have potential in managing blood sugar in diabetic mice.

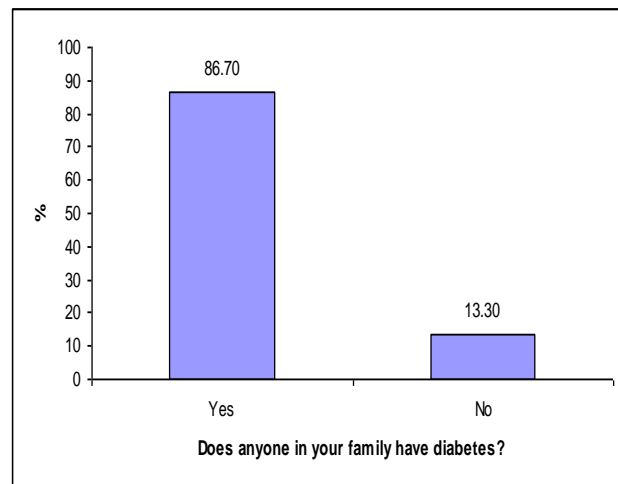
From the question, Do you think prickly pears contain a lot of nutrients and water that would satiate a diabetic?, From the results, it can be noted that a high percentage of up to 88.3% of those who agreed with yes, that the prickly pear contains a lot of nutrients that satisfied to the full the diabetic, and 11% disagree. Prickly pears are having a rich source of healthy foods, which have contained their antioxidants like betalain pigments and phenolic compounds (Khatabi et al., 2016).

Table 2 The questionnaire measurement awareness of Saudi society to benefits prickly pear

Questionnaire question	N= 240		±SD	%
Is prickly pear one of your favorite fruits that you want to eat?	Yes	84	±1.99	35.0
	No	156	±1.76	65.0
Does anyone in your family have diabetes?	Yes	208	±2.1	86.7
	No	32	±0.21	13.3
Do you think there is a relationship between diabetes and prickly pear?	Yes	128	±1.52	53.3
	No	112	±1.76	46.7
Are there benefits that prickly pears have for diabetics?	Yes	175	±1.45	72.9
	No	65	±0.76	27.1
Do you think that eating prickly pear reduces blood sugar?	Yes	132	±1.45	55.0
	No	108	±1.12	45.0
Do you think prickly pears contain a lot of nutrients and water that would satiate a diabetic?	Yes	212	±2.56	88.3
	No	28	±0.34	11.7



Is prickly pear one of your favorite fruits that you want to eat?



Does anyone in your family have diabetes?

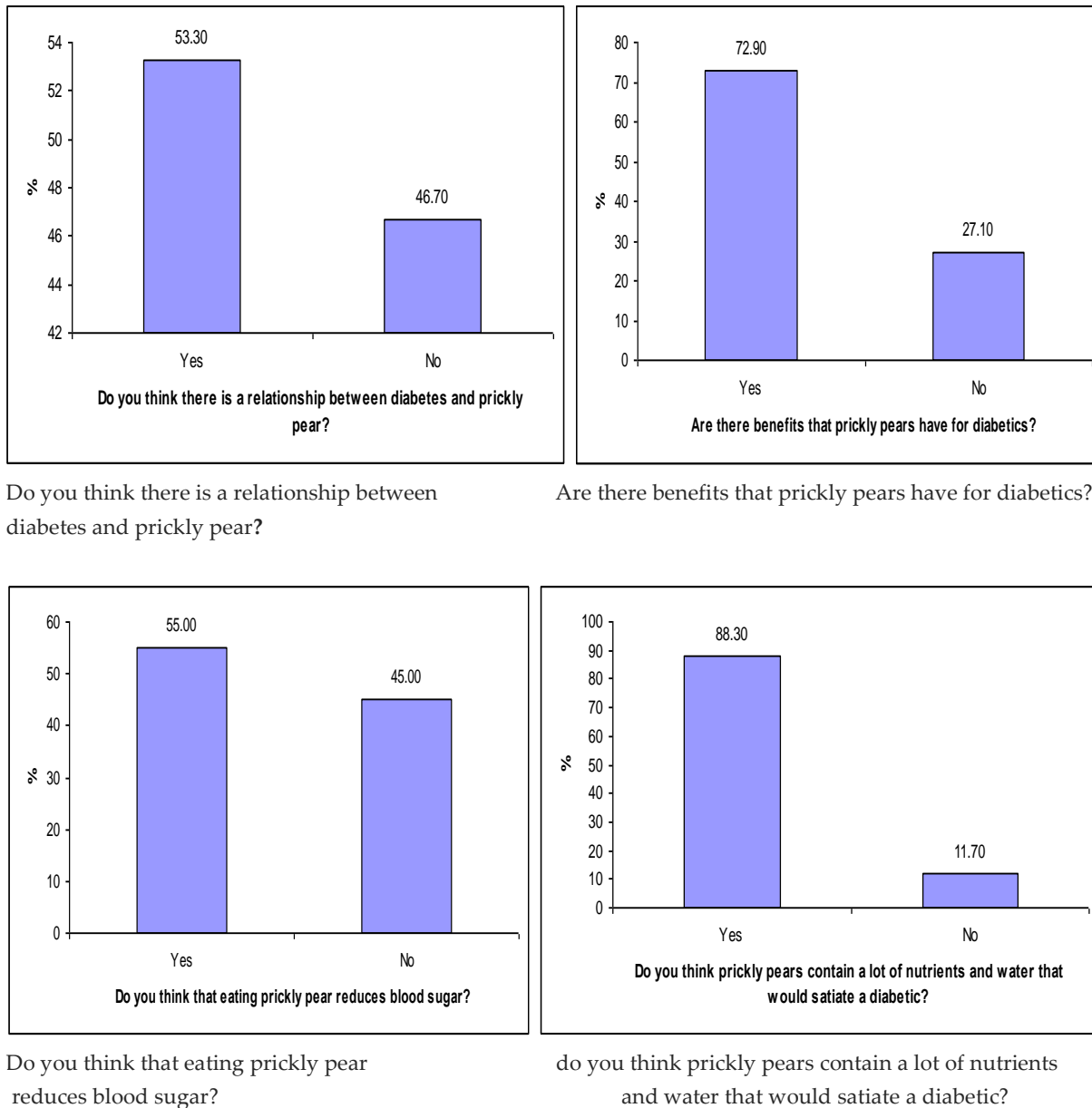


Figure 2 Measurement awareness of Saudi society to benefits prickly pear

From the previous results obtained from the questionnaire is that Saudi society is not enough aware of the nutritional benefits of prickly pear. Moreover, the highest percentage with diabetes was found in Saudi society; in addition, it needs to clarify the concepts of knowing the benefits of the prickly pear for diabetics of knowing the extent of the relationship between diabetes and the prickly pear. Therefore, it was necessary to conduct a biological experiment on diabetes in rats.

Nutritional values of prickly pear and its effects on diabetic rats

Chemical composition, minerals content and antioxidant in prickly pear

Table 3 presented that the chemical composition, minerals content and antioxidant in prickly pear and the results showed that the prickly pear the highest in total carbohydrate was 91.04%, meanwhile, the total fats, ash content and crude fiber were lowering. These results are confirmed with Stintzing (2005) who found that the major compounds of *Opuntia ficus-indica* had contained high amounts of moisture, and, carbohydrates, in addition, small amounts of fiber, and protein.

Minerals content noticed that the potassium, magnesium, calcium, and phosphorus were higher contained amounts by 180.37, 90.26 and 51.46 mg/100g, respectively than iron, sodium, zinc and copper were 25.41, 11.29, 2.11 and 0.35 mg/100g, respectively. *Opuntia ficus-indica* has had been a rich source of minerals content (Feugang *et al.*, 2006). As well, it represents an excellent source of phenolic and flavonoids compounds (Lee, 2003)

Meanwhile, the same table indicated that the highest amounts from the prickly pear extract as total phenolic and flavonoids content were 55.34 mg GAE/g and 41.23mg QE /g, respectively. Prickly pear fruit contains antioxidants that play a vital role in promoting redox balance in the body and reducing fat oxidation by acting as a radical scavenger (Du Toit et al., 2018). Rbia and Smiti, (2019) found that the extract from *Opuntia ficusindica* demonstrated antioxidant activity and it can inhibit the hydroxyl radical which produce from the process of decomposition of hydrogen peroxide catalyzed by iron salts.

Table 3 Chemical composition, mineral content and antioxidant in prickly pear on dry weight

Chemical nutrition g/100g dry weight	Prickly pear	Minerals	Prickly pear mg/100g dry weight
Moisture	10.25±0.95	Calcium	51.46±2.86
Protein content	1.47±0.04	Copper	0.35±0.01
Total lipids	0.57±0.01	Iron	25.41±1.38
Ash content	2.37±0.07	Magnesium	90.26±6.17
Crude fiber	4.55±0.08	Zinc	2.11±0.02
Total carbohydrates	91.04±5.38	Phosphorus	32.18±1.28
Total phenolic mg gallic acid/g	55.34±2.57	Potassium	180.37±10.16
Total flavonoids mg quercetin/g	41.23±2.79	Sodium	117.29±9.28

Values expressed are means ± S.D. of three replicate.

DPPH radical-scavenging activity

The DPPH is the synthetic root utilized to search structural properties of the radical scavenging activity of compounds (Nenadis et al., 2007). The DPPH free radical scavengers were determined to prickly pear (*O. ficus-indica*) and compared with trolox was used as the reference standard and the results are reported in Table (4). The DPPH radical capacity of prickly pear extract has been shown to increase the concentration of their extract increasing from 24.91% at concentrate 2.0 mg/ml to 80.74 % at concentrate 10.0 mg/ml. The DPPH-scavenging activity of prickly pear EC₅₀ (6.12 mg/ml) revealed the highest antiradical activities was 2.0fold lower than Trolox, as a reference antioxidant, (3.05 mg/ml). Moreover, earlier published data (Alimi et al., 2010) reported that the DPPH measurement of *Opuntia ficus-indica* extracts, the results of EC₅₀ values were 118.65 ± 2.51 µg/ml.

Table 4 Percent DPPH capacity of prickly pear extract

Sample	Sample concentration (mg ml ⁻¹)					EC ₅₀
	2	4	6	8	10	
Prickly pear	24.91±1.28	35.34±1.86	56.12±3.48	67.61±4.23	80.74±5.16	6.12±0.24
Trolox	45.67±2.46	60.32±4.64	70.61±4.83	80.54±7.24	95.28±7.26	3.05±

Values expressed are means ± S.D. of three replicate.

Ferric reducing activity power (FRAP) assay

Table 5 noticed that the best-reducing power from the *Opuntia ficus-indica* extract arrives at was 0.86 when the higher concentrate was 5 mg/ml compared with the reducing power of the ascorbic acid standard was 0.7for the same concentration. EC₅₀ values were found to be 2.41 and 3.52 mg/ml for *Opuntia ficus-indica*, and ascorbic acid. Reducing properties are generally by breaking the chain of free radicals during hydrogen atom donation (Subhasini et al., 2011). This will more stable products in order to inhibit oxidative damage

Table 5 Ferric reducing power of *Opuntia ficus-indica* extract

Sample	Sample concentration (mg ml ⁻¹)					EC ₅₀
	1	2	3	4	5	
Prickly pear	0.35±0.02	0.50±0.04	0.65±0.04	0.74±0.05	0.85±0.07	2.41±0.07
Ascorbic acid	0.25±0.01	0.41±0.02	0.52±0.04	0.66±0.05	0.78±0.05	3.52±0.08

Values expressed are means ± S.D. of three replicate.

Biological experimental

Glucose and lipid profile as triglycerides, total cholesterol, LDL, and HDL were estimated in the diabetic different rat groups fed on basal diet and taken orally from prickly pear extract at 100, 200, 300, and 400 ppm/kg rat/ day and the data found in Table (6). It observed the highest in control positive in glucose, triglycerides, total cholesterol, and LDL were 270.0, 250.0, 290.4, and 140.7mg/dl, and the lowest in control negative was 110.0, 115.0, 180.4, and 30.0 mg/dl, respectively. Whilst, the HDL was the lowest in control positive 25.3mg/dl and the highest in control negative was 55.7mg/dl.

Moreover, the results from diabetic different rat groups observed that the rat groups were taken the prickly pear extract orally at 400 ppm/kg rat/ day give the best results and nearly control negative in all parameters may be due to the prickly pear extract contains high amounts of natural antioxidants that scavenging the free radical in the blood. Constantinou et al., (2008) found that the uniquely high level of polyphenols may play a great significant role in health benefits like diabetics and LDL cholesterol levels and reducing the risk of heart diseases. Prickly pear is of great significance may be due to a high content of fibers and antioxidant compounds (Osuna-martínez et al., 2014). The prickly pear is useful in treating chronic diseases and is also useful in inhibiting digestive troubles by improving body mass and blood glucose, as well as, act as anti-hyperlipidemia agent (Hegwood, 2019). Prickly pear is the inhibition of chronic heart diseases. In addition, oxidative stress plays a main role in type 2 diabetes, mostly in the development of chronic heart diseases, which are the major complications of diabetes (Giacco and Brownlee, 2010).

Table 6 Effect of prickly pear on diabetic and lipid profile in rats

Treatment Groups	Sugar (mg/dl)	T.cholesterol (mg/dl)	Triglycerides (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)
Group (1) Control negative	110.0 ^e 6.35	180.4 ^e ±7.25	115.0 ^e ± 5.38	55.7 ^a ±3.28	30.0 ^e ±2.87	23.00 ^e ±0.95
Group (2) Control positive	270 ^a ± 11.38	290.4 ^a ±15.36	250.0 ^a ± 14.76	25.3 ^e ±1.25	140.7 ^a ±9.56	50.00 ^a ±3.27
Group (3) 100 ppm prickly pear	230.2 ^b ± 14.26	265.8 ^b ±12.68	220.2 ^b ± 12.59	32.0 ^d ±1.54	115.67 ^b ±8.29	44.04 ^b ±2.98
Group (4) 200 ppm prickly pear	190.0 ^c ± 12.29	240.5 ^c ±15.36	190.0 ^c ± 10,29	39.0 ^c ±21.68	90.3 ^c ± 5.11	38.00 ^c ±2.63
Group (5) 300 ppm prickly pear	150.0 ^d ±9.64	220.4 ^d ±11.68	155.0 ^d ±10.24	47.0 ^b ±2.12	62.0 ^d ±4.38	31.00 ^d ±2.93
Group (6) 400 ppm prickly pear	112.0 ^e ± 7.53	185.8 ^e ±7.63	120.0 ^e ± 6.94	53.0 ^a ±3.76	35.0 ^e ±2.17	24.00 ^e ±1.15

Values are mean and SD (n = 6); where: Mean values in the same with the letter are significantly different at 0.05 levels.

4. CONCLUSION

It could be recommended to increase nutrition awareness and health awareness of the importance of prickly pears for Saudi society may be due to it was high amounts of nutritional value, minerals, antioxidant content. Moreover, to increase Saudi society's awareness of the relationship of prickly pear to lowering diabetes and lipid profile.

Ethical approval

Ethical approval was cleared by the ethic committee of the College of Science, Taif University; Kingdom Saudi Arabia, (CS-TUSA/2/21), and participants were informed of the confidentiality of the information collected, in addition, All the experiments were carried out according to the regulations and rules laid down by the committee of animals' experimentation of Taif University.

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Conflict of interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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