European Journal of Nutrition & Food Safety

12(7): 13-23, 2020; Article no.EJNFS.58608
ISSN: 2347-5641

Antidiabetic Activity of Aerial Parts and Seeds of Purslane (*Portulaca oleracea*) on Diabetic Rats

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/EJNFS/2020/v12i730244
Editor(s):
(1) Dr. Rasha Mousa Ahmed Mousa, University of Jeddah, Saudi Arabia.
Reviewers:
(1) Arvind Lal, Central University of Jharkhand, India.
(2) Ira Arundina, Universitas Airlangga, Indonesia.
Complete Peer review History: http://www.sdiarticle4.com/review-history/58608

Original Research Article

Received 22 April 2020
Accepted 29 June 2020
Published 07 July 2020

ABSTRACT

This study has been proposed to study the effect of aerial parts and seeds of purslane on diabetic rats. Chemical composition, phenolic compounds and fatty acids of purslane and seeds powder were determined. A biological experiment was performed using 30 male albino rats. The rats were divided into six groups (five in group) and the duration of experiment was 8 weeks. Normal control (G1) non- diabetic rats fed on the basal diet, diabetic control (G2) diabetic rats fed on the basal diet only, the other groups of diabetic rats fed on basal diet supplemented with purslane (5 and 10%) and seeds (5 and 10%). The results of biological experiment indicated that adding of purslane and seeds to basal diet for diabetic rats, led to improvement in liver and kidney functions and an increase in body weight and HDL cholesterol and decrease blood glucose, TC, TG, LDL cholesterol, v-LDL cholesterol comparing to those of diabetic rats fed on basal diet only diabetic control. Purslane (5 and 10%) and seeds (5 and 10%) were added to burger as a replacement of fat. The results of sensory evaluation indicated that all sensory properties of the burger prepared with purslane and seeds were acceptable. Through the results of this study, we recommend the possibility of using purslane and seeds to prevent and reduce the symptoms caused by diabetes.

Keywords: Aerial parts of purslane; purslane seeds; diabetic; lipid profile; liver functions; kidney functions; burger.

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1. INTRODUCTION

Diabetes mellitus is the killer disease after cancer and cardio cerebrovascular diseases [1]. It is predestined that 5% of all deaths worldwide due to diabetes, and this percentage may increase to 50 percent in the next ten years [2]. Most tests state that weakened immunity is the main cause affecting insulin-producing total β-cells, as there are the absence of a specific treatment for diabetics, Thus, the main goal in treating diabetics is to maintain and restore beta cells [3].

Natural products produced from medicinal plants have been used in the treatment of many different diseases such as, heart disease, cancers, high blood pressure, and diabetes mellitus [4]. The use of complementary and alternative medicine among diabetes patients increases from 17 to 72.8%. Dietary supplements, herbal medicines and nutritional advice are becoming more used among diabetics. Evidence indicates that a high percentage of diabetics use these treatments in conjunction with other medicines [5]. Medicinal plants and herbs have long been used in treating diseases and illnesses, Herbs are powerhouses of nutrition and if it is used wisely and regularly, it can replace costly pills and supplements and even some drugs, *portulaca oleracea* is listed in the World Health Organization as one of the most used medicinal plants and it has been given the term 'Global Panacea' [6].

Portulaca oleracea (*P. oleracea*,) Family Portulacaceae, also known as Purslane, it is an herbaceous plant spread all over the world and it is commonly called "*Rejlah*" in Egypt. It is widely taken around the Mediterranean and tropical Asian countries and has been used as a folk medicine in many countries, the purslane is of the plants rich in nutritional value in addition to that the purslane contains many biologically active compounds such as omega-3 fatty acids, alkaloids, flavonoids, antioxidant, coumarins, anthraquinone, free oxalic acids tyramine, protein, vitamins C and A, tannins, saponins, triterpenoids, saccharides and glutathione a lot of research has been done on *P. oleracea* extract in several pilot regimens and it has been listed as one of the most useful medicinal plants and has been dubbed "the universal healing medicine" by the World Health Organization [7]. The use of men for different therapeutic purposes in the field of health care, especially in the prevention of some infections, cardiovascular diseases and the maintenance of a healthy immune system [8].

Several studies have reported that Portulaca oleracea seeds have strong antioxidant effects due to the presence of antioxidant components such as glutathione, omega-3 fatty acids, ascorbic acid, alpha tocopherols, quercetin, apigenin, beta-carotene, oxalate and melatonin [9]. So *Portulaca oleracea* seeds may inhibit lipid peroxidation by scavenging free radicals and increasing intracellular concentration of glutathione, and thereby decrease oxidized LDL and improve insulin receptor activity and increase of HDL levels resulted in a decrease of total cholesterol and improves liver functions. improves liver functions of diabetic subjects by decreasing ALT, AST and direct bilirubin close to normal levels and increasing albumin synthesis by the liver [10].

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Purslane and seeds

The fresh aerial parts of purslane obtained from the local performer field and seeds were obtained from a local market in Mansoura, Egypt. Other materials alloxan, vitamins, casein, cellulose and minerals were purchased from El-Gomhoria Company for chemicals and drugs, Cairo, Egypt. Kits for blood analysis were obtained from Bio diagnostic Company, Cairo, Egypt.

2.1.2 The drying process aerial parts of purslane

purslane were cleaned from dust and from forgein matters, washed with tap water and then purslane were dried in a hot air oven maintained at 55ºC, then milled and kept in polyethylene bags until used.

2.1.3 Preparation of burger

Burger was prepared from beef meat according to [11]. With some modifications. Fat was removed by knife to obtain red muscles. Mass of 300 g red meat were mixed with 50 g fat, 50 g bread sticks, 3 g spices mixture (35% coriander, 50% black pepper, 5% cubeb, 5% red pepper and 5% cinnamon), 3 g dried onion and 6 g sodium chloride. As for the other samples, the fat is replaced by 5 and 10% of purslane and seeds

powder. The mixture with 30 g of ice water using electro meat mincer (Japan k400 MG). After mixing, the mixture was cut into small parts (about 50 g weight) and round by hand. The pieces were formed into patties using a Hollymatic machine (Model 200 U) with 8 mm thickness and 10 cm diameter. The burger patties were fried with a little oil at 170°C for 10 min.

2.2 Methods

2.2.1 Methods of analysis

Crude protein, ether extract, crude fiber and ash were analyzed according to [12]. Total carbohydrate was calculated by the following equation:

%Total carbohydrate = 100- (crude protein% + ash% + ether extract%)

The energy value (on dry weight basis) was calculated using the Atwater Formula as:

energy (kcal/100 g) = 4× crude protein (%)+ 9×ether extract (%)+4×available carbohydrate (%). Calorie value were calculated agreeing to the Atwater system [13]

2.3 Determination of Minerals

Calcium (Ca), magnesium (Mg), iron (Fe), copper (Cu), zinc (Zn), sodium (Na) and potassium (K) content minerals were evaluated according to the methods of [12].

2.4 Phenolic Compounds in Aerial Parts and Seeds of Purslane

Phenolic compounds in aerial parts and seeds of purslane were determined by HPLC according to the method of [14].

2.5 Fatty Acids in Purslane and Purslane Seeds

Fatty acids composition of purslane and purslane seeds according to the method described by [15].

2.6 Animal Feeding

Thirty animals of adult male albino rats weighted (80-90 g) were used in present experiment in the animal house of food Technology. Research Institute, Agric., Res., Center, Giza, Egypt, under normal healthy conditions for ten days and fed on a normal diet (basal diet) according to [16]. The animals were allowed free access of tap water and were fed on uniformly basal diet. All experiments were conducted according to the ethical guidelines of the International Association [17].

2.7 Design of Experiment

After feeding on basal diet for ten days (adaptation period). Five rats were kept as control which fed on basal diet during the experiment period G1 (normal control). The other rats (25) were injected with Alloxan solution (120 mg/kg body weight) after 24 hours fasting, to induce hyperglycemia according to the method described by [18]. After three days of injection with Alloxan, blood glucose concentration was determined. Animals were having diabetes as reported by [19]. After three days of injection with Alloxan the second main group (25) rats were divided into five subgroups (5 rats each) and treated as following:

2.7.1 Hyperglycemia experiment of purslane and purslane seeds used in the study

- G1: Fed on the basal diet (negative control).
- G2: Fed on the basal diet (Positive diabetic control).
- G3: Fed on the basal diet supplemented with 5% aerial parts of purslane.
- G4: Fed on the basal diet supplemented with 10% aerial parts of purslane.
- G5: Fed on the basal diet supplemented with 5% purslane seeds.
- G6: Fed on the basal diet supplemented with 10% purslane seeds.

Body weight gain (BWG%), food intake and food efficiency ratio (FER) were calculated at the end of the experiment according to [20].

2.8 Biochemical Analysis

Serum was analyzed for the following biochemical parameters: Blood glucose level was estimated according to the method of [21]. Total cholesterol, triglycerides, HDL-c and LDL-c were estimated by the method of [22]. Liver functions: total protein and alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities were estimated according to the methods of [23,24]. Uric acid and Creatinine were determined according to the method described by [25,26].

2.9 Sensory Evaluation

Sensory evaluation of prepared burger was performed by ten trained panelists in the staff of Sakha Food Technology Research Laboratory., Agric. Res. Center. Egypt. Using nine-point hedonic-scale ratings for color, taste, odor, texture, tenderness and overall acceptability [27].

2.10 Statistical Analysis

Results were expressed as the mean ± SD. Data for multiple variable comparisons were analyzed by one-way analysis of variance (ANOVA). For the comparison of significance between groups, Duncan's test was used as a post hoc test according to the statistical package program [28].

3. RESULTS

3.1 Chemical Composition of Purslane and Purslane Seeds Powder

The chemical composition of purslane and purslane seeds shown in Table 1. The obtained results were studied on dry weight basis. From the tabulated data, it could be noticed the crude protein content of purslane was 22.97%. In addition, crude fat was 5.30%, crude fiber content was 22.17%, ash content was 16.04%, total carbohydrates was 55.69% and energy value were 273.66 Kcal/100 g.

The chemical composition of purslane seeds powder was shown in the same Table 1 and the obtained results studied on dry weight basis. The results showed that it contain 21.73% crude protein, 8.79% crude fat, 14.62% ash, 12.53% crude fiber, 54.86% total carbohydrates and 335.35 Kcal/100 g energy value.

These results are in agreement with those obtained by [29]. who reported that the crude protein content of purslane and purslane seeds powder was 23.71% and 22.34%. respectively, crude fat content in purslane (4.42%) is lower than fat content in seeds (9.1%). These results are in line with those obtained by [30]. who indicated that the ash content in purslane (16.62%) is higher than that in seeds (15.39%).

3.2 Mineral Contents of Purslane and Purslane Seeds

Data of mineral contents were presented in Table 2. The results in the table showed that purslane and purslane seeds are rich in mineral elements such as potassium, calcium, sodium and magnesium. In addition, to the small elements that the body needs in small quantities such as iron, zinc and manganese. The obtained results agree with [31] who found that the mineral contents of dried powder (mg /100 g) of *portulaca oleracea* was very high in calcium, potassium, magnesium and iron.

3.3 Phenolic Compounds of Purslane and Purslane Seeds Powder

Polyphenolic compounds of purslane and purslane seeds were recorded in Table 3.The results indicated that purslane and purslane seeds contain nine phenolic compounds. The salicylic acid was major phenolic compound in purslane (2.13 mg/100 g) while its value in purslane seeds was 0.23 mg/100 g. Catechol, Catechin, Gallic acid and Ferulic acid were the major phenolic compounds in purslane seeds (3.58 mg/100 g, 3.52 mg/100 g, 2.85 mg/100 g and 2.71 mg/100 g, respectively). It could be noticed that purslane seeds are richer in total phenolic compounds, compared with purslane aerial parts. These results are in agreement with [32] they indicated that purslane seeds are rich in phenolic compounds such as catechol, catechin, gallic acid, ferulic acid and vanillic acid while the dried purslane powder contains of salicylic acid, catechol and caffeic acid.

Table 1. The chemical composition of purslane and purslane seeds powder (On dry weight basis)

Component	Purslane	Purslane seeds
Crude protein	22.97	21.73
Crude fat	5.30	8.79
Ash	16.04	14.62
Crude fiber	22.17	12.53
Available carbohydrates*	33.52	42.33
Total carbohydrates**	55.69	54.86
Energy value Kcal/100 g	273.66	335.35

**Available carbohydrate (%) = Total carbohydrate - crude fiber **Total carbohydrate was calculated by difference*

Table 2. Mineral contents of purslane and purslane seeds (on dry weight basis mg/100 g)

Mineral	Purslane	Purslane seeds
Potassium (K)	56.11	19.08
Calcium (Ca)	32.17	43.63
Sodium (Na)	10.30	7.75
Magnesium (Mg)	18.48	20.09
Iron (Fe)	3.63	2.46
Zinc (Zn)	0.29	0.31
Manganese (Mn)	0.10	0.19

Table 3. Phenolic compound from purslane and purslane seeds powder using (HPLC)

Phenolic compounds	purslane (mg/100 g)	purslane seeds (mg/100 g)
Catechin	0.23	3.52
p-coumaric acid	0.08	1.79
Vanillic acid	0.70	1.42
Syringe acid	0.67	0.12
Caffeic acid	0.47	0.63
Ferulic acid	0.05	2.71
Catechol	0.68	3.58
Salicylic acid	2.13	0.23
Gallic acid	0.34	2.85
Total	**5.35**	**16.85**

Table 4. Fatty acids content of purslane and purslane seeds (mg/100 g)

Fatty acids	Symbol	Purslane	Purslane seeds
Saturated fatty acids			
Caprice	C10:0	01.67	0.05
Caprylic	C10:0	13.67	0.57
Lauric	C12:0	06.34	0.27
Myristic	C14:0	2.310	0.08
Myristicoleic	C14:0	Trace	0.60
Palmitic	C16:0	24.05	8.50
Heptadecanoic	C17:0	2.090	1.03
Stearic	C18:0	02.41	0.09
Total saturated fatty acids	**%**	**51.44**	**11.19**
Unsaturated fatty acid			
Oleic (Omega 9)	C18:1	07.80	05.17
Linoleic (Omega 6)	C18:2	14.66	10.65
Linolenic (Omega 3)	C18:3	25.89	73.83
Total Unsaturated fatty acids	%	**48.35**	**88.55**

3.4 Fatty Acids Composition of Purslane and Purslane Seeds Powder

Fatty acids composition of purslane and purslane seeds were given in Table 4. The results showed that palmitic and caprylic are the main saturated fatty acids in the purslane while linolenic acid (Omega 3) and linoleic acid (Omega 6) were the major unsaturated fatty acids in both purslane and purslane seeds. It could be observed that purslane seeds have higher content of total unsaturated fatty acids (88.55%), particularly, linoleic acid compared with purslane. These results are agree with [32], who indicated that major fatty acids for purslane and purslane seeds were oleic acid, linoleic acid, linolenic acid, palmitic acid and caprylic acid.

3.5 Effect of Purslane and Purslane Seeds Powder on Body Weight, Final Body Weight, Body Weight Gain (%), Food Intake and Food Efficiency Ratio of Normal and Diabetic Rats

Data in Table 5 shown that, the mean values of initial body weight of all rat's groups after adaptation ranged between 82.92 to 88.62g. At the end of experiment (8 weeks), the final body weight of diabetic control rats (G2) was lower than the normal control (G1).While diabetic rats that fed on basal diet supplement with purslane and purslane seeds powder (G3, G4, G5 and G6) have higher final body weight compared to diabetic control rats (G2).

The obtained results illustrated that body weight gain at the end of experimental period for the normal control 35.02 g, while the diabetic control rats decreased to (- 12.83 g) under zero. While feeding diabetic rats on basal diet supplement with purslane and purslane seeds increased body weight gain compared to diabetic control (G2).

Concerning food intake, the results for rats fed on normal and diabetic rats were showed in Table 5. The values of food intake of normal control (G1) and diabetic control (G2) were 414.32 g and 344.24 g. respectively, while the values of food intake of diabetic rats fed on purslane and purslane seeds were increased compared with diabetic control rats (G2). From the results in the same Table 5 the data cleared that the food efficiency ratio of normal control rats was 13.63% while of the diabetic control rats was (-7.12%). On the other hand, the FER values of rats fed on diets supplemented with purslane and purslane seeds increased compared to control rats. Our findings are in good agreement with those obtained by [33] who indicated that body weights and food intake increased in rats fed on purslane, while rats fed on basal diet have lower in body food intake and weight gain.

3.6 Effect of Purslane and Purslane Seeds Powder on Blood Glucose Level of Diabetic Rats

Table 6 presented that blood glucose levels of diabetic groups (after 3 days induced diabetes with Alloxan) were markedly higher than the normal control (G1). The data in Table 6 showed that the level of blood glucose in the groups (G3, G4, G5 and G6) of rats that feed on basal diet supplemented with purslane and purslane seeds powder decreased compared to the control diabetic rats (G2). It could be observed that blood glucose levels were decreased after ten days of feeding till the end of experiment period and the reduction increased with increasing the feeding period. Apparent also from the Table 6 that, the highest level used of purslane and purslane seeds powder (10%) led to a more reduction of blood glucose level comparing with the ratio (5%). These results are agree with [34] who reported that the possibility of using the purslane plant to reduce the level of blood glucose by stimulating insulin secretion.

3.7 Effect of Purslane and Purslane Seeds Powder on Some Serum Lipid Parameters of Diabetic Rats

At the end of the experiment, a blood sample is taken from the rats for analysis of serum total cholesterol TC, low lipoprotein cholesterol LDL, very low lipoprotein cholesterol vLDL-c, high-density lipoprotein HDL-c and triglycerides concentration and the results were shown in Table 7. The obtained results indicated that TC, triglycerides, LDL-c cholesterol and vLDL-c in the groups G3, G4, G5 and G6 of rats that fed on basal diet supplemented with purslane and purslane seeds powder decreased, but HDL-c cholesterol increased compared to diabetic control rats (G2).

This results were in agreement with [35], who reported that administration of the purslane seeds in type 2 diabetic patients resulted in reduction of fasting and post-prandial blood glucose, also were effective at increasing serum high-density lipoprotein HDL-c and at reducing serum total cholesterol, triglycerides, total lipids, LDL-c and vLDL-c cholesterol, improvement of insulin resistance and liver function. Natural antioxidants can have complementary and overlapping mechanisms of action, stimulation of immune system, including modulation of detoxification enzymes, modulation of cholesterol synthesis and hormone metabolism, reduction of blood pressure, prevented the onset of chronic disease, reduction of platelet aggregation, antioxidant, control to cystic fibrosis, ant hyperglycemic, ant hyperlipidemia, antibacterial, anticancer, and antiviral effects [36].

Table 5. Effect of purslane and purslane seeds powder on final body weight, body weight gain, food intake and food efficiency ratio of normal and diabetic rats

Group	Diets	Initial weight (g)	Final weight (g)	Body weight gain		Food intake (g)	Food efficiency ratio (FER)
				(g)	%		
G1	Normal control	82.93^{b}±1.71	117.99^{a}±3.34	35.02^{a}±1.14	42.23	414.32^{a}±4.43	13.63^{a}±0.43
G2	Diabetic control	83.61^{ab}±0.40	70.68^{d}±0.67	-12.93^{e}±0.31	-15.35	344.24^{c}±3.42	-7.12^{e}±0.41
G3	5% purslane	85.45^{ab}±3.66	89.54^{c}±2.05	4.18^{d}±0.76	4.89	391.35^{c}±11.87	2.15^{d}±0.77
G4	10% purslane	88.62^{a}±2.31	96.65^{b}±3.04	8.13^{c}±0.90	9.17	414.44^{b}±3.54	3.62^{c}±0.67
G5	5% purslane seeds	87.89^{ab}±2.14	94.92^{b}±1.40	7.13^{c}±0.61	8.11	407.44^{b}±8.38	3.37^{c}±0.46
G6	10% purslane seeds	83.61^{ab}±5.51	93.51^{bc}±3.45	10.00^{b}±1.04	11.9	369.28^{b}±14.56	4.42^{b}±0.67

** Each value was an average of five determinations ± standard deviation,* Values followed by the same letter in columns are not significantly different at LSD at p ≤ 0.05*

Table 6. Effect of purslane and purslane seeds powder on blood glucose level (mg/dl) of normal and diabetic rats

Group	Diets	After 3 days	After 10 days	After 20 days	After 30 days	After 40 days	After 50 days
G1	Normal control	97.76^{b}±1.57	98.42^{d}±1.10	101.33^{d}±8.35	103.01^{d}±6.45	103.52^{e}±3.09	95.84^{f}±4.23
G2	Diabetic control	290.22^{a}±11.15	292.35^{a}±10.52	298.82^{a}±9.78	293.25^{a}±9.56	305.89 ^{a}±5.63	306.38^{a}±5.34
G3	5% purslane	292.00^{a}±1.61	279.32^{b}±4.95	271.30^{b}±8.56	264.06^{b}±6.63	255.73^{b}±4.90	255.23^{b}±4.55
G4	10% purslane	294.^{22a}±5.56	264.42^{c}4.62	247.27^{c}±4.76	235.50^{c}±9.10	233.33^{c}±2.78	222.13^{d}±5.62
G5	5% purslane seeds	294.52^{a}±7.15	276.98^{b}±2.62	266.13^{bc}±5.45	253.63^{b}±2.74	240.67^{c}±5.13	233.46^{c}±2.46
G6	10% purslane seeds	295.39^{a}±5.47	271.09^{bc}±8.45	252.17^{bc}±9.31	240.37^{c}±8.19	228.66^{c}±2.98	186.53^{e}±3.20

** Each value was an average of five determinations ± standard deviation,* Values followed by the same letter in columns are not significantly different at LSD at p ≤ 0.05*

Table 7. Effect of purslane and purslane seeds powder on some lipid parameters of normal and diabetic rats

Group	Diets	TC. mg/dl	Triglyceride mg/dl	HDL-c mg/dl	LDL-c mg/dl	VLDL mg/dl
G1	Normal control	113.51^{e}±2.16	107.25 ^{e}±3.46	71.57 ^{a}±1.82	20.49 ^{e}±1.35	21.45^{e}±0.67
G2	Diabetic control	185.04 ^{a}±1.45	167.60 ^{a}±3.11	39.31^{f}±2.59	112.21^{a}±2.63	33.52 ^{a}±0.53
G3	5% purslane	172.17^{b}±3.28	151.45 ^{b}±3.73	44.62 ^{e}±2.55	97.26 ^{b}±3.65	30.29 ^{b}±0.78
G4	10% purslane	156.78 ^{c}±3.63	140.61 ^{c}±3.74	48.95 ^{d}±2.45	79.71^{c}±4.52	28.12 ^{c}±0.97
G5	5% purslane seeds	153.82 ^{c}±3.21	120.67 ^{d}±4.84	51.45 ^{c}±0.85	78.25^{c}±4.91	24.12 ^{d}±0.97
G6	10% purslane seeds	122.71^{d}±2.16	106.65^{e}±3.31	58.51^{b}±1.41	42.87^{d}±3.36	21.33^{e}±1.14

** Each value was an average of five determination ± standard deviation* Values followed by the same letter in columns are not significantly different at LSD at p ≤ 0.05*

Table 8. Liver and kidney function activities in rats fed on different experimental diets for 8 weeks

Group	Diets	GPT (ALT)U/L	GOT (AST) U/L	Total protein mg/dl	Creatinine mg/dl	Urea mg/dl
G1	Normal control	18.37^{d}±1.17	39.68^{f}±1.24	7.33^{b}±.49	0.65^{a}±.09	47.16^{b}±.5
G2	Diabetic control	32.68^{a}±2.33	71.37^{a}±1.26	5.76^{a}±.19	0.96^{c}±.04	69.60^{d}± 1.2
G3	5% purslane	30.75^{a}±0.64	61.56^{b}±1.13	6.70^{ab}±0.77	0.78^{b}±.01	62.65^{c}±2.6
G4	10% purslane	28.12^{b}±0.94	55.51^{c}±0.62	6.98^{b}±.44	0.70^{ab}±.03	49.35^{b}±1.6
G5	5% purslane seeds	26.37^{b}±1.17	46.81^{d}±1.23	6.51^{ab}±.77	0.78^{b}±.01	58.89^{c}±1.2
G6	10% purslane seeds	23.44^{c}±1.32	41.80^{e}±.61	6.76^{ab}±.45	0.67^{a} ±.01	43.28^{a}±3.2

** Each value was an average of five determinations ± standard deviation*

** Values followed by the same letter in columns are not significantly different at LSD*

Table 9. Effect of purslane and purslane seeds as a fat replacer at different levels on sensory properties of burger

Blends	Taste	Color	Odor	Texture	Tenderness	Overall acceptability
Control	9.00^{a}±0.00	8.80^{a}±0.20	8.67^{a}±0.15	8.67^{a}±0.28	8.70^{a} ±0.20	8.74^{a} ±0.13
5% purslane	8.67^{ab}±0.29	7.83^{cd}±0.23	7.87^{bc}±0.15	7.70^{b}±0.17	7.83^{bc} ±0.15	7.98^{bc} ±0.22
10% purslane	8.17^{c}±0.29	7.53^{d}±0.09	7.73^{c}±0.11	7.53^{b}±0.06	7.63^{c} ±0.28	7.72^{c} ±0.09
5% purslane seeds	8.83^{a}±0.29	8.23^{b}±0.25	8.17^{b}±0.23	8.03^{ab}±0.21	8.17^{b} ±0.23	8.29^{b} ±0.46
10% purslane seeds	8.33^{c}±0.28	8.08^{bc}±0.14	7.83^{bc}±0.30	7.47^{b}±0.75	7.67^{c} ±0.28	7.94^{c} ±0.35

3.8 Effect of Purslane and Purslane Seeds Powder on Liver and Kidney Function of Normal and Diabetic Rats

Table 8 showed that liver functions GPT and GOT activity were significantly increased for the diabetic control rats (G2) compared with normal control rats (G1). The diabetic rats fed on basal diet supplement with purslane and purslane seeds powder showed decreased liver functions compared to diabetic control rats (G2). As shown in Table 8, total protein in the diabetic control rats (G2) decreased compared with normal control rats (G1). Also, the total protein increased in the groups G3, G4, G5 and G6 of rats that fed on basal diet supplemented with purslane and purslane seeds powder.

Table 8 shows the effect of purslane and purslane seeds on kidney functions of creatinine and urea in plasma. The obtained results illustrated that the creatinine and urea increased of diabetic control rats (G2) compared with normal control rats (G1). While there is a decrease in creatinine and urea of the groups that fed on basal diet supplemented with purslane and purslane seeds compared with diabetic control rats (G2). These results are agree with [37], who indicated that purslane improves liver and kidney functions by regulating and adjusting the ratio of total protein, urea, uric acid, hepatic enzymes including GOT and GPT in diabetic rats and the reason is due to the high content of antioxidants in the purslane.

3.9 Effect of Purslane and Purslane Seeds on Sensory Evaluation of Meat Products

Sensory evaluation of some food product is the major part of important attributes that affect the consumer choice [38]. Sensory evaluation of burger as affected by replacing fat with purslane and purslane seeds powder at different levels (5 and 10%) were evaluated and the results were listed in Table 9.

From the results in Table 9, it could be observed simply differences between control (0% purslane powder) sample of burger and that contained 5% purslane and purslane seeds powder as a fat replacer for all sensory properties. While the scores of these properties decreased for burger contained 10% purslane and seeds instead of fat compared with control sample. We find that all sensory properties scores of the burger are acceptable compared to the control, The results cleared that adding the purslane and purslane seeds powder to the burger up to 10% as an

alternative to fat, has not negative effects on the sensory properties of the burger.

4. DISCUSSION

Alloxan could damage pancreatic beta cell, resulting in a decrease in endogenous insulin secretion, which decreased utilization of glucose by the tissues consequently. It is reported purslane seeds increased the concentration of serum insulin in Alloxan induced diabetic rats. So, the possible mechanism of action of purslane seeds could be correlated with promoting insulin secretion [39].

Purslane mechanism can be in connection with increasing insulin secretion by closing of the channel gate $ATP^{-}K^{+}$, membrane depolarization, and Ca^{2+} entry stimulation as the first key step in insulin secretion [40].

Purslane and purslane seeds components such as flavonoids (quercetin), omega-3, ascorbic acid, carotene and glutathione have antioxidant activity, so this plant may prevent lipid peroxide by chelating free radicals and increasing intracellular glutathione concentration, thereby reducing oxidized LDL and improving Insulin receptor activity. Also, increased levels of HDL-cholesterol have lowered total cholesterol and improved liver function. Moreover, this herb is important for scurvy liver disease [41]. Polyphenols were able to inhibit digestive enzymes such as salivary amylase, and a-glycosidase, which reduced digestive action and promoted pancreatic B cell regeneration [42].

The antidiabetic influence of the ethanolic extract of Purslane on high fat diet induced diabetic rats was previously investigated by [43]. They referred the antidiabetic effect to high content of flavonoids, phenolic compounds, melatonin and omega-3 fatty acids found in the ethanolic extract purslane. However, other bioactive compounds found in purslane (dopamine, dopa, coumarins, alkaloids and saponins, polyphenols, flavonoids) may influence glucose metabolism by several mechanisms, such as inhibition of carbohydrate digestion and glucose absorption in the intestine, stimulation of insulin secretion from the pancreatic B cell, modulation of glucose release from liver, activation of insulin receptors and glucose uptake in the insulin sensitive tissues, and modulation of hepatic glucose output [43]. The crude polysaccharide extract of Purslane plant was also found to lower blood glucose and modulate the metabolism of blood lipids and glucose in alloxan [44].

5. CONCLUSION

Our research indicates that purslane and purslane seeds are used to prevent diabetes, whether it is fresh or added to other foods. Aerial Parts and Seeds of Purslane have effects on hypoglycemia and lipid deficiency in diabetic rats caused by alloxan. The mechanism of the plant, the purslane can increase the concentration of insulin in the blood in rats with diabetes. The results of the current study show that purslane and purslane seeds are beneficial for diabetics, as it works to reduce the level of sugar in the blood, increases HDL-c, reduces the level of LDL-c, TC, triglycerides and improves liver and kidney functions.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Peer-review history:
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