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Chemical, technological and biochemical studies of purslane leaves

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ABSTRACT

This study was aimed to determine the best way to dry purslane leaves and estimate the nutritional value of purslane leaves powder, wheat flour and pan bread, prepared by replacing 2, 4 and 6% of wheat flour by purslane leaves powder and determine the best replacement ratios that lead to obtain properties of sensory acceptable and study the effect of feeding rats with basal diet and pan bread prepared using purslane leaves powder on biochemical characteristics of rats after 28 days, the results revealed that using 50 °C in the drying was one of the best used methods, because The loss of phenolics, flavonoids and Radical scavenging activity as expected was found to be lower with hot-air drying at 50ºC (34.48%, 1.09%, and 13.88% respectively) than the other drying treatments, also from the chemical analysis, it clear that the purslane leaves powder has high content of protein, minerals, fiber and linolenic acid and the increase of replacer level of purslane leaves powder is directly proportional to the increase in protein, ash, fiber, phenols, flavonoids, Radical scavenging activity, iron, manganese, calcium and potassium in pan bread; moreover pan bread containing up to 4% purslane leaves powder was acceptable and that when fed rats on this pan bread decrease blood sugar, Total cholesterol and LDL-C, enzymes AST, ALT, and increased the percentage of cholesterol high density HDL-C pan.

***Key words*:** purslane leaves, drying methods, pan bread, hypercholesterolemia

Introduction

Coronary heart disease (CHD) continues to be a leading cause of mortality and morbidity (Smith, 2000). It has been well established that hypercholesterolemia is a major risk factor for coronary atherosclerosis. Hyperlipidemia, particularly elevated serum cholesterol and Low-Density Lipoprotein (LDL) levels, are the risk factors in the development of atherosclerotic heart disease (Romero Corral *et al.,* 2006). Although several studies have reported that cholesterol lowering drugs like statins have been quite effective in lowering total cholesterol, low-density lipoprotein cholesterol, and prevent incidence of coronary heart disease, and of ischaemic stroke(Colivicchi *et al.,* 2007).However, some of these drugs have been associated with side effects like elevated liver enzymes, muscle pain and joint aches, nausea, diarrhea, constipation (Silva *et al.,* 2006)

To aid in cholesterol reduction, there have recently been many attempts to use certain common plants that are already well-known in traditional medicine for having biological components that can be used to reduce the lipid levels in body (Rhee *et al.,* 2005). Since it is more beneficial to prevent dietary diseases than to cure them and to change one's diet rather than take medicine, the diet of choice in modern societies should include food with functionality. *Portulaca oleracea* (*P. oleracea*) belonging to the family "*Portulacaceae*" is an herbaceous plant widely distributed throughout the world and is commonly called "Rejlah" in Egypt (Shehata and Soltan, 2012). It contains many biologically active compounds and it is a source of many nutrients like linolenic acid and carotene (Liu *et al.,* 2000), N-trans-feruloyltyramine (Mizutani *et al.,* 1998), alkaloids, omega- 3 fatty acids, coumarins, flavonoids, anthraquinone, protein, free oxalic acids(Michael *et al.,* 1999), mono terpene glycoside, (Sakai *et al.*, 1996). It was also found to contain vitamin C, saponins, tannins, polysaccharides, triterpenoids,-tocopherol and glutathione (Simopoulous *et al.,* 1992). The high contents of a variety of phytoconstituents present in this plant were considered to be responsible for the biological activities reported for the plant like antibacterial, antifungal (Oh *et al.,* 2000),

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analgesicanti-inflammatory (Chan *et al.,* 2000), anti-fertility (Verma *et al.* 1982), muscle relaxant (Parry *et al.,* 1993) and wound healing properties (Rasheed *et al.,* 2003).

In addition, purslane may have a protective effect against oxidative stress caused by vitamin A deficiency (Arruda *et al.,* 2004). Also, purslane contains active molecules for the treatment of some parasitic infectious diseases such as leishmaniasis and trypanosomiasis (Costa *et al.,* 2007). However, Little information has been published regarding the antioxidant activity of purslane.

Purslane is eaten raw as a salad and also is eaten cooked as a sauce in soups or as greens. Purslane is considered as a rich plant source of nutritional benefits (Sudhakar *et al.,* 2010). In areas where this 'weed' is eaten, there is a low incidence of cancer and heart disease, possibly due to purslane's naturally occurring omega-3 fatty acids (Simopoulos, 1991).

The aim of the present study was evaluate the beneficial effect of utilizing the dried purslane leaves as food and as an antioxidant that may make it one of the more important foods in the future. The present study aimed to determine the nutritional value of the pan bread manufactured by adding the dried purslane leaves as a natural source of nutrients to the tested formalas. Also to evaluate the influence of dried purslane leaves on the change of the lipid profile in serum and liver tissue of hypercholesterolemic rats.

Materials and Methods

Materials:

Fresh Purslane (*Portulaca oleracea* L.) plants were harvested from a private fields (Quisna city, Minufiya Governorate, Egypt) prior to flowering period during August 2016. Green leaves were manually separated from plant, washed with water and then drained and left to dry on a cheese cloth for 15 min at room temperature (35 ± 2°C). The moisture content of the fresh leaves was immediately determined according to the (A.O.A.C., 2000) method (number 934.01), and found to be 90.78 ± 0.03 g water per 100 g sample.

Chemicals and Kits:

Bread-making ingredients such as wheat flour (extracting rate 72%, instant yeast, sugar and salt, etc), starch and oil were purchased from local market at Giza. Casein, minerals, vitamins and cellulose were purchased from El-Gomhoria Pharm. and Chem. Ind. Company, Cairo, Egypt. All kits for biochemical analysis were purchased from Biodiagnostic Co., Dokki, Giza, Egypt. 1, 1-diphenyl-2-picrylhdrazylradical (DPPH) and Follin-Ciocalteus phenol reagent were purchased from Sigma-Aldrich Inc. (St.Louis, Mo, USA).All chemicals used for analysis were of analytical grade.

Animals:

Thirty six male albino rats with average weight 160 ±5 g were obtained and housed individually in the Ophthalmology Research Institute, Giza, Egypt. Rats were kept under normal health laboratory conditions and fed on basal diet for one week (adaptation period). Water and basal diet were provided *ad libitum*. Basal diet composition prepared according to AIN- 93M diet guidelines (Reeves *et al.,* 1993).

Drying Methods:

Hot-air oven drying: One hundred grams of purslane leaves were distributed uniformly as a thin layer onto stainless steel trays of size36.5 cm × 60 cm and dried in a convective dryer (WT-binder, type F115, Germany) at 50, 60 and 70°C at a constant air velocity (0.6 m/s) and ambient relative humidity (Youssef and Mokhtar,2014). The drying time required to reach the equilibrium moisture content was 425 ±28, 227 ± 39 and 107±16 min and the moisture content of the dried leaves was 6.61± 0.30, 7.35 ±0.13 and 7.24 ±0.50 g water per 100 g leaves dried at 50, 60 and 70°C, respectively.

Microwave oven drying:

A domestic microwave oven (Microchef2335, Type 907, Moulinex, France) with maximum output of 1250W at 2450 MHz was used for the drying experiments. The dimensions of the microwave cavity were 335 mm × 330 mm × 195 mm. The microwave oven consisted of a rotating glass plate with 280 mm diameter at the base of the oven. Time adjustment is done with the aid of a timer located on the oven. 100 g of purslane leaves were spread on the glass plate inside the microwave cavity and processed until the leaves were completely dried at three microwave output powers (360, 900 and 1250 W) (Youssef and Mokhtar,2014).The drying time required to reach the equilibrium moisture content was55.0 ± 1.0, 26.0 ±1.2 and 12.0 ±3.0 min and the moisture content of the dried leaves was 7.80 ± 0.02, 4.28 ±0.19 and 4.29 ± 0.25 g water per 100 g leaves dried at 360, 900 and 1250 W, respectively.

Preparation of purslane leaves powder (dried at 50°C); fortified Pan Bread (PPB):

The standard formula according to Abdelghafor *et al.,*(2011) showed in Table (1): Included 1500g of wheat flour, 22.5g yeast, 22.5g salt (NaCl), 45g shortening, 45g sugar (sucrose). Three formulas were prepared with different levels of purslane leaves powders 2%, 4% and 6% on wheat flour replacement basis and pure water added to make the dough. All dry ingredients were weighed and placed in a mixer for 5 sec, and then a suspension of the yeast in water was added. The mixture was further run at high speed for 92sec and water was added to the mixture for making the dough.The dough's were scaled into three portions, rounded into balls by hand in fermentation bowls and placed in fermentation cabinet at 30^{o}C and 85% relative humidity for 20 min. The fermented dough's were placed in pans and finally returned into the fermentation cabinet for 50 min. The pans were placed in a convection oven at 212 ^{o}C for 18 min. Loaves were weighed after cooling at room temperature, sensory evaluation and the volume of loaves were recorded.

Table 1: Formulas composition of purslane leaves pan bread

Ingredients (g)	Control pan bread	Pan bread PPP formula (g)		
		2 %	4%	6%
Wheat flour	1500.0	1470	1440.0	1410
Purslane leaves powders	-	30	60	90
Instant yeast	22.5	22.5	22.5	22.5
Improver	15	15	15	15
Sugar	45	45	45	45
Salt	22.5	22.5	22.5	22.5
Oil	25	25	25	25
Shortening	45	45	45	45
Water	850	850	850	850
Total	2525	2525	2525	2525

Chemical Composition:

Moisture, crude protein, crude fat, crude fiber and carbohydrate (by difference) of purslane leaves powders and pan bread formulas were done according to the standard A.O.A.C. method (A. O. A. C., 2000). Total phenols were estimated by the Folin-Ciocalteu method reported by (Elfalleh *et al.,* 2009). The amount of total flavonoids was measured spectrophotometrically by the method according to (Nasri *et al.,* 2011). DPPH scavenging activity was determined using a modified method of (Ohnishi *et al.,* 1994). The free radical scavenging activity of food extracts were tested, indicated as bleaching of the stable 1,1 -diphenyl-2-picrylhydrazyl radical (DPPH).

Fatty acids analysis:

The standard procedure for analyzing the fatty acid contents of plants was used, the fatty acids were extracted and separated by the method described by Stroescu *et al.,* (2013).

Determination of Mineral Contents:

The minerals contents i.e. (sodium, potassium, magnesium, calcium, iron, zinc, manganese and phosphorus of wheat, purslane leaves powder and pan bread were determined according to the methods described in A.O.A.C.,(2000). The samples were wet acid digested using a nitric acid and perchloric acid mixture (HNO3, HCLO4, 2:1 v/v). The amounts of iron, zinc, and manganese in the digested sample were determined using a GBC Atomic Absorption 906. Sodium and potassium were determined by flame photometer 410. Calcium and magnesium were determined using Double Beam Atomic Absorption. Phosphorus was deter-mined according to the method described in A.O.A.C., (2000)

Sensory Evaluation of Pan Bread:

Samples of pan bread were evaluated by 10 panelists (staff in Food Tech. Res., Institute Agric. Res. Center) for color of crust (15), color of crumb (15), taste (20), flavor (15), crumb distribution (15) and general appearance (20). The total value of these sensory properties was evaluated as overall acceptability and descriptive category as follows: 90-100: very good 80-89: good 70-79: satisfactory: less than 70: questionable (Khorshid *et al.,* 2011).

Experimental Protocol:

Thirty- male albino adult rats with an average weight (160 ±5g) were obtained from animal house, Ophthalmology Research Institute, Giza, Egypt. The rats were kept under normal laboratory conditions (temperature remain 25± 2ºC) for one week before the beginning of experiment (8 weeks). During this period, the rats were allowed free access of water and basal diet. Body weight was recorded for each rat. The basal diet prepared according to AIN- 93M diet guidelines (Reeves *et al.,* 1993), casein 14%, soybean oil 4%, salts mixture 3.5%, vitamins mixture 1% and cellulose 5% and the remaining were completed with corn starch. High fat diet 30% fat (soybean oil, 7% and animal fat, 28%) was prepared according to Santos *et al.,*(2013) induce obesity. Rats were randomly divided into five groups, the group one fed on basal diet and reserved as negative control (NC). Group (2) fed on high fat diet (HFD) and reserved as positive control (PC). Groups (3-5) fed on HFD plus 25% basal diet, 75% purslane leaves powder fortified pan bread (PPB) 2%, 4% and 6% respectively. Each diet was prepared to give an equal amount of nutritional value as control casein diet. The changes in body weight were recorded. At the end of experimental blood samples were also taken and centrifuged at 3000 rpm for 15 min to obtain the serum which was kept frozen at -20°C until analysis. Gain in body weight, food intake and food efficiency ratio were estimated according to Chapman *et al.,* (1959).

Biochemical Analysis of Serum:

Total cholesterol, triglycerides, HDL-C were determination according to the methods of Allain *et al.,* (1974), Fassati and Prencipe, (1982) and Lopez- Virella *et al.,* (1977), respectively. LDL-C was calculated by Friedwold *et al.,* (1972) method. Serum liver activities AST and ALT were determined according to the method of Reitman and Frankel, (1957**)**.

Statistical Analysis:

Statistical analysis was carried out according to (Fisher,1970). LSD (Least significant difference) test was used to compare the significant differences between means of treatment (Waller and Duncan, 1969).

Results and Discussion

1- Total phenolics,total flavonoids and radical scavenging activity contents in dried purslane leaves:

The results in table 2 showed that the Total phenolics , total flavonoids and radical scavenging activity contents for fresh purslane leaves were found to be 1450.34 mg GAE , 5007.56 mg QE per 100 g and 94.51 (%RSA) (dry weight) sample, respectively. The results also showed the degradation

of total phenolics and flavonoids according to the drying methods. It was noted that, extracts of dried leaves always showed lower concentration of total phenolics and flavonoids than those from fresh leaves. The loss of phenolics and flavonoids might be due to the process conditions, in particular the temperatures and the duration used (Michalczyk *et al.,* 2009). The loss of phenolics , flavonoids and radical scavenging activity as expected was found to be lower with hot-air drying at 50ºC (34.48% , 1.09%, and 13.88% respectively) than the other drying treatments. Zhang *et al.,* (2009) found that the oven dried (60ºC/ 16 h) bitter melon leaves lost about 21.5% to 33.2 and 44.4% to 65.9% of total flavonoids and total phenolics, respectively when compared with the fresh product. The same trend is observed in this study.

Table 2: Effect of drying methods on the total phenolics , total flavonoids and Radical scavenging activity percent (%RSA) of purslane leaves.

	Fresh	50 ºC	60 ºC	70 ºC	360w	900w	1250w
Total phenolics mg *GAE/100gm.DM	1450.34	950.24	892	901.21	850.51	870.43	860.21
total flavonoids mg **QE / 100gm.DM	5007.56	4953.12	3950	4130.43	3700.00	3900.23	4010.23
Radical scavenging activity (%RSA)	94.51	81.39	78.34	71.00	66.01	73.12	70.11

**GAE: Gallic Acid Equivalent, ** QE: Quercetin Equivalent.*

According to Mrad *et al.* (2012), the decrease in total phenolics content during drying can be attributed to the binding of polyphenols with other compounds (proteins) or to alterations in the chemical structure of polyphenols which cannot be extracted or determined by available methods. de Ancos *et al.,* (2000) suggested that polyphenolics compounds may be deteriorated depending upon many factors other than heat treatment. These included the activity of polyphenol oxidase, organic acid content, sugar concentration and the pH. The maximum Radical scavenging activity was observed in samples dehydrated by different hot-air drying temperatures method, while no changes observed in scavenging activity DPPH. In addition, the lowest values were observed in samples dried by microwave at different output powers. This coincides with the contents of total phenolics and flavonoids. Chen ,(2008) found that E elatior leaves microwave-dried for 2, 4, 6 and 8 min inhabitited declines in ascorbic acid equivalent antioxidant capacity (AEAC) and ferric-reducing power (FRP).

2- Chemical composition of purslane leaves powder and wheat flour:

Chemical composition of purslane leaves powder (dried on 50 ºC) and wheat flour are shown in table (3). Data in Table (3) showed that purslane had high contents in protein, fat, ash and fiber which were 22.80 %, 6.80%, 26.21%, and 2.540% respectively. Such results agreed with Aberoumand, (2009) who elucidated that the amount of fat, protein, and ash were 5.26, 24.0% and 22.66, respectively.

It can be noticed from table (3) purslane leaves, had a high content of Micro minerals, zinc, iron, manganese and Chromium which were 4.1, 315, 18.2 and 110 mg/100g, respectively, also some Macro minerals like calcium , potassium and magnesium contents were higher compared with wheat flour. These results were similar to those achieved by Petropoulos *et al.,* (2016) who mentioned that the dietary minerals in purslane leaves such as iron (Fe), zinc (Zn), potassium (K), boron (B), nitrogen (N),manganese (Mn), calcium (Ca), copper (Cu), magnesium (Mg) are the most abundant in purslane plant, whereas other minerals (i.e. phosphorus (P), sulfur (S), sodium (Na)) that exist in elative lower amounts, they also contribute to purslane valuable nutritional profile.

Purslane has a high content of phenols and flavonoids (950 mg GAE /100g and 4953 mg QE /100g) compared with wheat flour (3.60 mg GAE /100g and1.2 mg QE /100g) respectively. The results are in range with findings by Lim and Quahf, (2007) who reported that purslane phenols content was ranged between 127 and 478 mg GAE /100g fresh weight. The radical scavenging activity (RSA) is high in purslane leaves (81.39%). The present results are higher than those found by Abas *et al.,* (2006), but it was lower than that found by Odhava *et al.,* (2007) who reported RSA is 95% in fresh leaves. The variability could be due to environmental factors and collection period.

Previous studies have indicated that the level of active compounds in plants increased when sunlight and temperature increased (Lim and Quah, 2007). In general, it could be stated that purslane has high contents of protein, ash and fiber and a good source of minerals as reported by Domingo, (2007).

Table 3: Chemical composition of purslane leaves powder and wheat flour (72% ext.).

Macronutrients (%)	Wheat flour (72% ext.)	Purslane leaves
Protein	11.98	22.8
Fat	0.71	6.8
Ash	0.55	26.21
Fiber	0.88	2.54
Carbohydrates	85.88	41.65
Macro minerals mg/100g		
Ca	160.11	1070
Phosphors	129.67	830
K	290.2	5230
Mg	50.12	1210
Micro minerals mg/100g		
Fe	1.8	315
Mn	0.57	18.2
Zn	1.44	4.1
Chromium(mg/100g)	-	110
cupper	0.01	0.6
Total phenolics mg GAE/100gm.DM	3.6	950
total flavonoids mg QE / 100gm.DM	1.2	4953
Radical scavenging activity (%RSA)	8.4	81.39

3- Chemical composition of purslane leaves powder fortified pan bread:

Due to purslane is rich with nutritional value, it has high protein, ash and fiber contents in comparison with some other edible plants. It was incorporated in the present pan bread formulas. The results of chemical composition of purslane leaves powder (PLP) fortified pan bread are shown in Table (4). The addition of purslane increased protein, ash and fiber content of pan bread. The increase of replacer level is directly proportional to the increase in protein, ash and fiber. This is mainly due to the high content of protein, ash and fiber in purslane leaves than that found in wheat flour. Also, the addition of purslane leaves, which had a high content of minerals, caused zinc and iron contents to be higher. This is also due to purslane leaves have rich content of calcium, zinc and iron. Almasoud and Eman, (2014) mentioned that the addition of purslane significantly increased protein, ash and fiber content of cracker. The increase of fortification level is directly proportional to the increase in protein, ash and fiber. This is mainly due to the high content of protein, ash and fiber in purslane than that found in wheat flour. Also, the addition of purslane, which had a high content of minerals, caused zinc and iron contents to be doubled. This is also due to the purslane high content of calcium, zinc and iron.

The total phenols content of the pan bread fortified with purslane increased as the amount of purslane increased. The pan bread with 6% purslane leaves had the highest percent of phenols (88.45mg/100g) compared with control (33 mg/100g). Radical scavenging activity (%RSA) of pan bread increased by the addition of purslane. The addition of 6% purslane leaves caused an increase in Radical scavenging activity (%RSA) to 41.55% compared with 28.78 % for control. This may be due to purslane leavese has powerful antioxidants activity as reported by Oliveira *et al.,* (2009).

Table 4: chemical composition of purslane leaves powder fortified pan bread.

Components*	Control	Pan bread with 2% purslane leaves	Pan bread with 4% purslane leaves	Pan bread with 6%purslane leaves
Protein	11.98	12.23	12.41	12.65
Fat	3.50	3.63	3.74	3.87
Ash	0.93	1.44	1.96	2.47
Fibers	0.67	0.70	0.75	0.77
Carbohydrates	82.92	82.00	81.14	80.24
Macro minerals mg/g				
Ca (mg/100g)	14.98	31.43	46.65	63.76
Phosphorus (P)	115.91	128.2	1412.43	154.54
K (mg/100g)	102.79	191.20	265.32	351.23
Magnesium (Mg)	31.89	50.32	69.98	91.34
Micro minerals mg/g				
Fe (mg/100g)	1.72	6.32	10.21	14.43
Manganese (Mn)	0.63	0.91	1.18	1.29
Zn (mg/100g)	1.35	1.42	1.49	1.56
Copper (Cu)	0.21	0.22	0.23	0.24
Total phenolics mg GAE	33.00	52.43	69.00	88.45
total flavonoids mg QE per 100	4.00	105.2	191.00	302
Radical scavenging activity (%RSA)	28.78	33.21	37.00	41. 55

As % on dry weight basis. Carbohydrate contents were determined by difference.

4- Fatty acids content of purslane leaves powder:

Purslane leaves contains large quantities of fatty acids. Linolenic acid (omega 3 fatty acid) was the most abundant one in purslane (49.50%)and linoleic acid (27.81%) as shown in table (5). Such results are higher than that given by Oliveira *et al*., (2009) who mentioned that linolenic acid was ranged between 24.48 and 39.06 % and linoleic acid was ranged between 4 and 6.31 %. Palmitic acid (19.3- 24.3%) and oleic acid (11.6 -19.5%).

Purslane leaves contain high amounts of omega-3 and omega-6 polyunsaturated fatty acids, which are essential dietary fatty acids that cannot be synthesized by humans but have to be ingested. 100 g of fresh purslane leaves (about 1 cup) contains 300–400mg of alpha-linolenic acid (YouGuo *et al*., 2009). The difference in amount may be due to the difference in plant tissues and origin as reported by (Liu *et al*., 2000) who mentioned that the total fatty acid content ranged from 1.5 to 2.5 mg/g of fresh mass in leaves, 0.6 to 0.9 mg/g in stems and 80 to 170 mg/g in seeds. α-Linolenic acid accounted for around 60% and 40% of the total fatty acid content in leaves and seeds, respectively.

Table 5: Fatty acids content of Purslane leaves powder (% of total fatty acids)

Fatty acid	Common name	%
15:0	Pentadecanoic acid	0.35
16:0	Palmitic acid	13.36
18:0	Stearic acid	2.23
Total SFA		15.94
16:1	Palmitoleic acid	0.58
18:1	Oleic acid (trans)	4.20
Total MUFA		4.78
18:2n-6	Linoleic acid	27.81
18:3n-3	α-Linolenic acid	49.50
20:0	Arachidic acid	0.25
22:0	Behenic acid	0.22
24:0	Lignoceric acid	1.50
Total PUFA		79.28

5- Sensory evaluation of pan bread fortified by purslan leave powder:

Sensory properties of pan breads made from purslane leaves powder and wheat flour as well as the 100% wheat bread are shown in Table (6). All sensory scores of color, taste, flavor, general appearance and overall acceptability were good between all fortified pan breads except 6% PLP fortified bread for crumb color (11.6±0.5), general appearance (16.8±0.7) and overall acceptability (79.2±5) which were lower than 2 %(93.0±4) and 4%(86.6±7) PLP fortified pan bread. The control pan bread (100% WF) recorded the highest scores for all sensory attributes compared with PLP fortified pan breads Similar results were obtained by Tarkergari *et al*., (2013) who found significant differences in a few of the recipes fortified with purslane than of control. Almasoud and Eman, (2014) found that crackers with purslane had high sensory scores, except in aftertaste, in comparison with control. There were no significant difference between the control and 5% fortified samples, except in after taste. With respect to the color preference, a significant difference could be detected between 10% and 15% snack products. The most preferable purslane fortified samples, was the 5% fortified samples.

Table 6: Sensory evaluation of purslane leaves powder (PLP) fortified pan bread

Pan bread	General appearance (20)	Taste (20)	flavor (15)	Crust color (15)	Crumb color (15)	Crump distribution (15)	Overall acceptability	Grade
Control	19.4±0.3	19.3±0.5	14.3±0.5	14.5±0.3	14.0±0.6	13.9±0.6	95.4±4	Very good
2% PlP	19.3±0.5	18.6±0.5	14.1±0.5	13.8±0.5	13.5±0.4	13.7±0.6	93.0±4	Very good
4% PlP	17.6±0.4	17.5±0.3	13.4±0.5	12.8±0.4	12.7±0.3	12.6±0.5	86.6±7	Good
6% PlP	16.8±0.7	15.9±0.5	11.8±0.4	12.3±0.6	11.6±0.5	10.8±0.4	79.2±5	Satisfactory
LSD	0.60	0.70	0.72	0.80	0.70	0.80	1.40	

6- Biochemical evaluation of pan bread fortified by purslane leaves powder:

Body weight changes, gain %, food consumption and feed efficiency are presented in Table (7). The results indicated that the rats fed on high fat diet had increase in food consumption, food efficiency ratio and gain body weight compared with the others fed on basal diet (Negative control).The rats fed on PLP fortified pan bread formulas resulted in decrease in food intake, feed efficiency and body weight gain compared with the others fed on high fat diet (PC) and basal diet. Body gain % of rats fed on 4% and 6% PLP fortified pan bread diets were 51.16% and 43.82 lower than high fat diet free bread (70.05%). The purslane leaves powder substitution of wheat flour for making pan bread had a powerful antioxidant activity and weight loss effects Hussein, (2010) indicating that purslane extract has the potential to control body weight gain despite increased food intake.

Table 7: Body weight (g), gain%, feed intake (g) and feed efficiency of rats fed on purslane leaves powder fortified pan bread.

Groups	NC	PC	2%	4%	6%
Initial	167.85±2.25	168.3±3.5	169.4±1.2	168.5±3.3	167.5±4.3
Final weight	233.5±2.3	286.2±2.9	263.7±1.7	254.7±1.2	240.9±2.9
Body gain	63.65±0.87	116.9±0.23	92.3±0.62	84.2±0.36	70.5±0.79
Food intake	935.9±6.5	972.2±4.2	955.2±9.8	947.7±8.5	929.8±3.6
Feed Efficiency (x10 $^{-2}$)	6.8	12	9.66	8.88	7.58
Body gain %	39.11	96.46	55.67	51.16	43.82

High fat diet (positive control PC), basal diet (Negative control NC) Values represent the mean ± SE. Experimental groups were compared with the high-fat diet control rats. Feed efficiency = [weight gain (g/8 wk)]/[food intake (g/8 wk)].

7- Glucose content of rats fed on purslane leaves powder fortified pan bread:

Table (8) shows the decreases of serum glucose for all obese fed groups experimental diets. The mean values of serum glucose content after (28) days of fed of experimental diet were 112±1.70, 150±3.2, 132±2.7, 124±1.5and 115±2.4 mg/dl serum for groups (NC, PC, purslane leaves powder fortified pan bread 2%, purslane leaves powder fortified pan bread 4% and purslane leaves powder fortified pan bread 6%) respectively. These results in agreement with those treatment by Hussein,

(2010). He found that, purslane ethanolic extract 150 and 300 mg/kg significantly decreased blood glucose levels in a dose dependent manner. When compared to obese control group.

Table 8: glucose content (mg/dl)of rats fed on purslane leaves powder fortified pan bread.

Groups	NC	PC	2%	4%	6%
glucose(mg/ dl)	112±1.70	150±3.2	132±2.7	124±1.5	115±2.4

8- Lipid profile of rats fed on PLP fortified pan bread:

Serum lipid profile in rats fed on HFD and HFD containing PLP fortified pan breads are presented in Table (9) triglycerides, total cholesterol and LDL-C mg/dl) were higher in rats fed on HFD (positive control) group, 170.5±0.97 , 240.9±3.56 and 180.15± 2.42, respectively while HDL-C was lower (30.56±0.34 than negative group. Diets contained PLP fortified pan breads significantly decreased for the previous parameters particularly, 6 % PLP fortified bread which were 125.58±2.65, 121.85±0.83, 144.49±2.35, respectively. Reduction of HDL-C (46.79 %) was observed in rats fed on HFD (PC) compared to the others fed on basal diets (NC).

Table 9: Lipid profile of rats fed on PLP fortified pan bread

Groups	Triglycerides(mg/dl)	Total cholesterol(mg/dl)	HDL-C (mg/dl)	LDL- C(mg/dl)
NC	126.54±1.20	123.83±.76	57.43±0.34	147.32±1.15
PC	170.5±0.97	240.9±3.56	30.56±0.34	180.15±2.42
2%	141±1.11	154.8±1.16	44.93±0.12	160±1.12
4%	137±1.13	136.57±2.12	48.62±0.83	151±1.15
6%	125.58±2.65	121.85±0.83	55.5±1.5	144.49±2.35

Movahedian *et al.,* (2007) demonstrated that serum total cholesterol significantly reduced in rabbits fed purslane extract. Ezekwe *et al*., (1995) previously showed that rats fed 10 or 20% purslane for 6-weeks significantly reduced plasma total cholesterol level and triacylglycerol concentrations .

Moreover, Ezekwe *et al*., (2004) founded that pigs fed purslane show a decreased serum total cholesterol (26.8%), LDL-cholesterol (53.4%) and triacylglycerol (16.2%). Our data revealed that purslane has a positive effect on HDL-cholesterol. The potential effect of purslane on HDL-cholesterol may be attributed to the presence polyunsaturated fatty acids content in purslane. Previous studies have shown that consumption of omega-3 fatty acids derived from fish oil significantly lowered plasma triacylglycerol concentrations and decreased LDL-cholesterol significantly by 11% after 28 days (Laidlaw and Holub, 2003). Experimental data from human subjects suggest an association between dietary intake of polyunsaturated fatty acids, specifically omega-3 fatty acids improved plasma HDL-cholesterol and reduced LDL-cholesterol levels suggested that polyunsaturated fatty acids improved HDL cholesterol and reduced LDL-cholesterol levels (Okuda *et al*., 2005).

9- Liver functions of rats fed on PLP fortified pan bread:

Table (10) showed the estimated levels of serum AST and ALT in control and various experimental groups of rats. Administration of purslane leaves powder pan breads to high fat diet fed rats caused marked reduction in the elevated activities of AST, ALT towards the normal values. Ali *et al*., (2011) and Lee *et al*., (2011) they reported that there were significant elevated in AST, ALT in non-treated obese rat group.

Table 10: Liver functions of rats fed on PLP fortified pan bread.

Groups	AST	ALT
NC	81±0.34	39.8±0.32
PC	105.57±0.23	57.24±0.15
2%	89.5±0.36^{e}	49.54±0.12
4%	83.6±0.12	41±0.32
6%	80.3±0.11	37.4±0.13

Conclusion

Purslane is an important plant naturally, As a significant source of omega-3 oils, the antioxidant content and nutritional value of purslane are important for human consumption. Moreover pan bread containing up to 4% purslane leaves powder was acceptable and that when fed rats on this pan bread decrease blood sugar, total cholesterol and increased the percentage of cholesterol high density .On the other hand, Purslane could yield considerable health benefits to vegetarian and other diets. It revealed tremendous nutritional potential and has indicated the potential use of this plant for the future.

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