Journal of medical & pharmaceutical Sciences (JMPS) • Vol 8, Issue 1 (2024) • P: 53 – 37
https://journals.ajsrp.com/index.php/jmps
ISSN: 2522-333X (Online) • ISSN: 2522-333X (Print)

Portulaca oleracea L. (Purslane): Protective Properties against Metabolic Syndrome (A review)

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Received: 28/02/2024

Revised: 09/03/2024

Accepted: 26/03/2024

Published: 30/03/2024

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Citation: Ahmed, W. A., & Alnoumesi, A. A. (2024). Portulaca oleracea L. (Purslane): Protective Properties against Metabolic Syndrome (A review). *Journal of medical and pharmaceutical sciences, 8*(1), 37–53. https://doi.org/10.26389/AJSRP.N280224

Abstract: A complex health disease that is common, metabolic syndrome is caused by a number of interrelated risk factors, such as insulin resistance, obesity, high blood pressure, and dyslipidemia. Dietary plant consumption has drawn interest recently as a possible tactic for managing and preventing the metabolic syndrome. Due to its high nutrient content and possible health advantages, purslane, a succulent plant with a long history of traditional use in a variety of cuisines, has attracted attention. The purpose of this research is to demonstrate how purslane affects metabolic syndrome based on earlier studies. Research indicates that purslane contains a high concentration of bioactive substances with anti-inflammatory and antioxidant qualities, including potassium, flavonoids, and omega-3 fatty acids. These bioactive chemicals from purslane have been shown in multiple studies to effectively lower obesity-related parameters, such as body weight, body mass index (BMI), and fat mass. This helps prevent and treat metabolic syndrome. Consuming purslane has also been linked to improvements in blood pressure, blood glucose, insulin sensitivity, and lipid profile, among other metabolic syndrome components. Purslane extracts have been demonstrated in animal experiments to modulate lipid and glucose metabolism, resulting in a better lipid profile and a reduction in insulin resistance. These results imply that purslane may have a major role in the regulation of metabolic risk variables. In conclusion, given its rich nutritional profile and possible health advantages, purslane consumption offers promise as a dietary strategy for controlling and avoiding the metabolic syndrome.

Key Words: Type 2 Diabetes, Dyslipidemia, Metabolic syndrome, Obesity, Portulaca oleracea, Purslane

الرجلة (Portulaca oleracea) : خصائص وقائية ضد متلازمة التمثيل الغذائي (دراسة نظرية)

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المستخلص: متلازمة التمثيل الغذائي هي مرض صحي معقد شائع، وينتج عن عدد من عوامل الخطر المترابطة، مثل مقاومة الأنسولين، والسمنة، وارتفاع ضغط الدم، واضطراب شحوم الدم. لقد لفت استهلاك النباتات الغذائية الاهتمام مؤخرًا كتكتيك محتمل لإدارة ومنع متلازمة التمثيل الغذائي. نظرًا لمحتواها العالي من العناصر الغذائية ومزاياها الصحية المحتملة، فقد جذبت الرجلة الانتباه، وهي نبات عصاري له تاريخ طويل من الاستخدام التقليدي في مجموعة متنوعة من المأكولات. الغرض من هذا البحث هو توضيح كيفية تأثير الرجلة على متلازمة التمثيل الغذائي بناءً على دراسات سابقة. تشير الأبحاث إلى أن الرجلة تحتوي على تركيز عالٍ من المواد النشطة بيولوجيًا ذات الصفات المضادة للالتهابات ومضادات الأكسدة، بما في ذلك البوتاسيوم والفلافونويد وأحماض أوميجا 3 الدهنية. أظهرت دراسات متعددة أن هذه المواد الكيميائية النشطة بيولوجيًا المستخرجة من الرجلة تخفض بشكل فعال العوامل المرتبطة بالسمنة، مثل وزن الجسم ومؤشر كتلة الجسم (BMI) وكتلة الدهون. وهذا يساعد على منع وعلاج متلازمة التمثيل الغذائي. كما تم ربط استهلاك الرجلة بالتحسينات في ضغط الدم، ومستوى الجلوكوز في الدم، وحساسية الأنسولين، ومستوى الدهون. لقد ثبت أن مستخلصات الرجلة في التجارب على الحيوانات تعدل استقلاب الدهون والجلوكوز، مما يؤدي إلى تحسين صورة الدهون وتقليل مقاومة الأنسولين. تشير هذه النتائج إلى أن الرجلة قد يكون لها دور رئيسي في تنظيم متغيرات الخطر الأيضي. في الختام، نظرًا لفوائدها الغذائية الغنية والمزايا الصحية المحتملة، فإن استهلاك الرجلة يعد بمثابة استراتيجية غذائية للسيطرة على متلازمة التمثيل الغذائي وتجنبها.

الكلمات المفتاحية : داء السكري من النوع 2، اضطراب شحوم الدم، متلازمة التمثيل الغذائي، السمنة، الرجلة ، Portulaca oleracea.

1. Introduction

A collection of distinct risk factors linked to cardiovascular disease describe metabolic syndrome. The risk of diabetes, heart disease, stroke, and blood lipid disorders is greatly increased in those with metabolic syndrome. The National Heart, Lung, and Blood Institute (NHLBI) defines this group of metabolic variables as having a waist circumference more than 88 cm for women and 102 cm for men. Among them is abdominal obesity. Research indicates a considerable correlation between metabolic syndrome and abdominal obesity. Another significant risk factor is high blood pressure, which is characterized as a measurement of 130/80 mm Hg or greater. On the other hand, normal blood pressure is defined as having a systolic pressure of less than 120 mm Hg (the top number) and a diastolic pressure of less than 80 mm Hg (the bottom number). Another significant risk factor is high blood pressure, which is characterized as a measurement of 130/80 mm Hg or greater. On the other hand, normal blood pressure is defined as having a systolic pressure of less than 120 mm Hg (the top number) and a diastolic pressure of less than 80 mm Hg (the bottom number). Obesity and high blood pressure are closely associated, and people with insulin resistance are often found to have high blood pressure. Another factor is impaired fasting blood glucose, defined as a level of 100 mg/dL or higher. In addition, low levels of HDL (good) cholesterol (less than 40 mg/dL for men and less than 50 mg/dL for women) and triglyceride levels above 150 mg/dL are regarded as risk factors. The NHLBI and AHA jointly recommend diagnosing metabolic syndrome if an individual presents with three or more of these factors (National Heart Lung and Blood Institute, 2022).

1.1. The problem of the research

Recent studies have indicated that herbal supplements have the potential to influence multiple aspects of cardiovascular diseases (CVDs) and other metabolic disorders. These supplements have been found to be economically viable therapeutic compounds (Asbaghi et al., 2020; Asbaghi, Soltani, et al., 2019; Ashtary-Larky et al., 2021; Eslampour et al., 2020).Purslane, or Portulaca oleracea, is a herb with several health advantages. According to research, it possesses antioxidant, anti-diabetic, and anti-hypertensive qualities (Dehghan et al., 2016). Additionally, preclinical research has demonstrated that it can affect CRP (Karimi, 2018) and the lipid profile (Mousa et al., 2021). Moreover, it has been connected to lower levels of biomarkers in the human population, including LDL-C (Gheflati et al., 2019), TG, total cholesterol (El-Sayed, 2011), and CRP. (Recent research indicates that increased CRP levels are strongly associated with coronary artery disease, stroke, and sudden cardiac death.) (Dehghan et al., 2016). Nevertheless, the findings of a few additional investigations were contradictory (Esmaillzadeh et al., 2015; Zakizadeh et al., 2015). In light of the inconsistent results, the researchers set out to perform a comprehensive analysis of randomized controlled trials in order to compile earlier findings and evaluate the effect of purslane on adult lipid profiles and CRP levels.

1.2. The objective of the research

The effect of Purslane on metabolic syndrome from previous study.

1.3. Purslane

Purslane, scientifically known as Portulaca oleracea, is a versatile leafy vegetable that offers both raw and cooked culinary options. This green veggie is delightfully nicknamed pigweed, little hogweed, fatweed, and pusley. Bursting with about 93% water content, this succulent plant boasts vibrant red stems paired with small, green leaves. Its taste is mildly tangy and salty, akin to the flavors of spinach and watercress. Like its leafy counterparts, spinach and lettuce, purslane can effortlessly be incorporated into delightful salads and sandwiches. Thriving in various regions across the globe, this hardy plant can grow in everything from well-tended gardens to humble sidewalk crevices. Furthermore, it boasts an impressive ability to adapt to even the harshest conditions, including droughts, nutrient-deficient soils, and excessively salty environments. (Kristina R Mulry et al.,2015)(Rodrigo Matías DAndrea et ' (al.,2014, Portulaca oleracea (PO) has been used to treat a wide range of illnesses in some European countries, including Italy, Greece, and Turkey. These illnesses include fever, hemorrhoids, intestinal worms, dysentery, kidney pains, and urogenital infections (Bosi et al., 2009; Simopoulos, 2004; Brussell, 2004; Cakilcioglu and Turkoglu, 2010). Furthermore, the medical benefits of PO's seeds and leaves have long been used in nations in Central Asia and the Middle East. As an illustration, in Afghanistan and Saudi Arabia, PO is employed as a remedy for various ailments such as antidiarrheal, throat infections, liver and gastrointestinal issues, as well as inflammatory diseases (Al-Asmari, 2014).

Table 1: Nutritional facts of purslane

Nutrition facts
A 100-gram serving provides:
26% of the Daily Value for Vitamin A (from beta-carotene).
35% of the DV is vitamin C.
17% of the DV is magnesium.
15% of the DV is manganese.
14% of the DV is potassium.
11% of the DV is iron.
7% of the RDI is calcium.
Additionally, it has trace levels of folate, copper, phosphorus, and the vitamins B1, B2, and B3.

With just 16 calories, you can acquire an impressive array of nutrients, making it an unrivaled source of nutrition that is among the most concentrated on Earth.(USDA,.2019)

1.4. Portulaca oleracea's phytochemistry

Even now, a number of phytochemicals from Portulaca oleracea have been identified. These consist of alkaloids, coumarins, anthraquinone glycoside, cardiac glycoside, fatty acids, terpenoids, polysaccharides, vitamins, sterols, proteins, and minerals; flavonoids (such as Apigenin, kaempferol, quercetin, luteolin, myricetin, genistein, and genistin). Numerous investigations, including those by Sharma MM et al. in 2011, Zhou YX et al. in 2015, and Uddin M et al. in 2014, documented these findings.

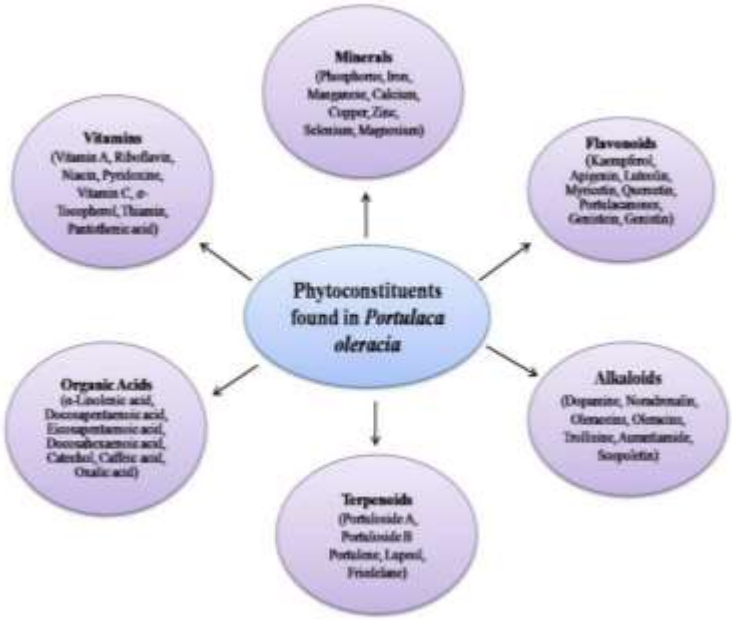

Figure 1: the different phytochemical found in Purslane

Table 2: Purslane's primary nutrients and the amount of each are listed.

Nutritional component	Component concentration
Carbohydrate (% DW)	40.67
Protein crudeness (% DW)	23.47
Lipid crude (% DW)	5.26

Nutritional component	Component concentration
Fibre crude (% DW)	8.00
Zinc (mg/100 g)	5.83 ± 0.08
Ash (% DW)	22.66
Calcium (mg/100 g)	131.44 ± 3.21
Lipids (mg/100 g)	3.81
Ascorbic acid (mg/g)	2.27 (stem) to 3.99 (leaves)
Iron (mg/100 g)	72.14 ± 505
Sodium (mg/100 g)	571.41 ± 16.63
Potassium (mg/100 g)	2842.38 ± 91.68
Manganese (mg/100 g)	9.75 ± 1.02
Magnesium (mg/100 g)	66.47 ± 1.43
Phosphorus (mg/100 g)	79.7
Carotenes (mg/100 g)	89.2
α-tocopherol (mg/100 g)	26.6 mg
Omega-3-fatty acid (mg/100 g)	188.48 ± 6.35
Linoleic acid (LA, mg/100 g)	34.0 ± 5.2
α-linolenic acid (LNA, mg/100 g)	132.8 ± 22.0
LNA/LA ratio	5.2 ± 0.03
B6 – pyridoxine (mg/100 g)	0.073
B1 – thiamine (mg/100 g)	0.047
B2 – riboflavin (mg/100 g)	0.112
B3 – niacin (mg/100 g)	0.480
B5 - pantothenic acid (mg/100 g)	0.036
B9 – folates (mg/100 g)	0.012
β-carotene (mg/g)	0.29 (stem) to 0.58 (leaves)
Lutein (mg/100 g)	5.4
Zeaxanthin (mg/100 g)	0.19
α-carotene (mg/100 g)	0.009

(2120 ., et alAjay Kumar)

Table 3: Compounds in Portulaca oleracea extracts, both steamed and raw.

N°.		Raw	Steamed
Phenolic Acids			
4	Caffeoylglucaric acid	18.1 ± 0.6 a	16.4 ± 0.7 b

N°.		Raw	Steamed
5	Caffeic acid glucuronide isomer	14.30 ± 0.08 a	12.3 ± 0.4 b
6	Caffeic acid-O-hexoside	14.12 ± 0.08 a	12.9 ± 0.7 b
7	Caffeic acid glucuronide isomer	27.8 ± 0.7 a	23 ± 1 b
9	Ferulic acid-O-hexoside	9.3 ± 0.5 a	7.7 ± 0.2 b
11	Sinapic acid-O-hexoside	38.0 ± 0.4 a	32 ± 1 b
17	Ferulic acid derivative	18.44 ± 0.03 a	15 ± 1 b
Total		140 ± 1 a	119 ± 2 b
Flavonoids			
12	Epicatechin	28 ± 2 a	30 ± 3 a
18	Quercetin-O-hexoside isomer	13.2 ± 0.3 a	11.2 ± 0.7 b
22	Kaempferol-O-hexoside	15 ± 1 a	13.6 ± 0.9 a
23	Isorhamnetin-O-hexoside	15.9 ± 0.2 a	13 ± 1 b
24	Quercetin-O-hexoside isomer	18.4 ± 0.7 a	13.8 ± 0.7 b
Total		91 ± 2 a	82 ± 3 b
Other compounds			
1	Isocitric acid	550 ± 40 a	500 ± 40 a
2	Citric acid	600 ± 50 a	440 ± 20 b
3	Hydroxytyrosol hexoside	3.89 ± 0.02 a	3.83 ± 0.08 a

(1220 .,ndez-Poyatos et aláa del Pilar FernMarí)

1.5. Medical & Pharmacological properties of Portulaca oleracea

Antidiabetic activity

The aqueous extract of Portulaca oleracea has demonstrated potential in reducing diabetic endothelium dysfunction, hyperglycemia, and diabetic vascular inflammation in type 2 diabetic db/db mice, per a study conducted in 2012 by Lee AS et al. This shows that the extract might be preventive against vascular problems associated with diabetes. Additionally, Portulaca oleracea L. has been shown to lower blood glucose and cholesterol levels linked to diabetes, according to Gao D. et al. Additionally, it restores damaged pancrease β-cells in diabetic rats induced with alloxan, improving aberrant glucose metabolism and increasing insulin secretion. These results offer more proof of Portulaca oleracea's possible hypoglycemic effects, indicating its potential value in the treatment of diabetes. In diabetic rats, oral administration of CPOP (crude Portulaca oleracea L. polysaccharide), a crude water soluble polysaccharide isolated from purslane, has been shown to considerably increase body weight and improve glucose tolerance (Bai Y et al., 2016). Additionally, it was discovered that in diabetic rats, CPOP could considerably lower the fasting blood glucose level and raise the fasting serum insulin level as well as the insulin sensitivity index value. Furthermore, it is possible for CPOP to significantly lower TNF- αand IL-6 levels in diabetic rats. It's also important to remember that CPOP might successfully lower MDA levels in the liver tissue of these rats while simultaneously lowering SOD activities.

Antioxidant activity

The contents of Portulaca oleracea, including gallotannins, omega-3 fatty acids, ascorbic acid, α -tocopherols, kaempferol, quercetin, and apigenin, are responsible for the plant's antioxidant properties (Chan K et al., 2000). (2010) Zhu HB et al. It was discovered that giving Purslane to diabetic rats led to higher levels of TAS and GSH in a 2017 study by Samarghandian et al. This improvement is explained by a reduction in free radical generation and an increase in antioxidant defenses. The ethanol extract of

Portulaca oleracea (EEPO) has been shown in a study by Yue T et al. (2015) to have a protective effect on the lungs of mice exposed to hypoxia. Additionally, the study demonstrated that EEPO administration before exposure could lessen vascular permeability and prevent pulmonary edema. Furthermore, by lowering oxidative stress during hypoxia, the research implies that the underlying mechanism of EEPO's protective effects may entail the mitigation of inflammatory pulmonary reactions in mice.

Anticancer activity

Bioactive features of Portulaca oleracea polysaccharides include anti-inflammatory, anti-oxidant, anti-cancer, and immunity-boosting effects (Y. Liu et al., 2009).Yang, X. B., and others (2008). Polysaccharides clearly affect immune activities in rats with ovarian cancer and scavenge the build-up of free radicals (Y. G. Chen et al 2009). According to a study by T. Chen et al., the water-soluble polysaccharide POP, which is derived from the plant Portulaca oleracea, has the ability to suppress the proliferation of HeLa and HepG2 cells in lab conditions when it is sulfated.This implies that POP's capacity to exhibit cytotoxicity, particularly against tumor cells, is improved by the sulfation process. Apart from polysaccharides, other bioactive substances that have in vitro cytotoxic effects against human cancer cell lines include cerebrosides, homoisoflavonoids, and alkaloids. By activating the p38 MAPK- and JNK-triggered mitochondrial death pathway, portulacerebroside A promotes the apoptosis of human liver cancer HCCLM3 cells (G.-Y. Zheng et al., 2014). with an IC50 value of 1.6 ug/mL against the cell line SGC-7901, and 2,2′6,′4-dihydroxy-′-dimethoxychalcone is more active than mitomycin C, which has an IC50 value of 13.0 ug/mL.With an IC50 value of 16.2 ug/mL, portulacanones B is active against SGC-7901 cell lines, a number that is remarkably similar to that of mitomycin C. Portulacanones B—D have selective cytotoxic action against SF-268 and/or NCI-H460 cells with IC50 values of 14.3—20.1 ug/mL, whereas 2,2′6,′4-dihydroxy-′-dimethoxychalcone is moderately active against K-562 cells with an IC50 value of 24.6 ug/mL (J. Yan et al., 2012). 7′R-N-trans-FeruloyltyramineThe compounds 1,5-dimethyl-6-phenyl-1,2-dihydro-1, 2,4-triazin-3(2H)-one, and (3R) -N-feruloylnormetanephrine3,5-bis(4-hydroxyphenyl-3-methoxy)-2,3-dihydro-2(1H)According to J. L. Tian et al. (2014), -pyridinone has moderate bioactivities against A549 with IC50 values of 28.80, 21.76, 24.54, and 37.20 umol/L, and weak bioactivities against K562 with IC50 values of 222.77, 66.94, 90.09, and 41.52 umol/L. These findings suggest that using Portulaca oleracea offers a potentially effective cancer treatment option.

arhtritic activity-Anti

The petroleum-ether extract of Portulaca oleracea L. shown encouraging anti-arthritic benefits in male Wistar rats utilizing the Fruends adjuvant arthritis model, according to a 2012 study by Rao BM et al. Similar results were obtained from a different study in which the researchers found that the petroleum ether extract from Portulaca oleracea shows encouraging potential in the treatment of arthritis by improving inflammation control in a rat model of adjuvant arthritis (Rao NJ et al., 2012). Another similar investigation examined the anti-arthritic properties of ethanolic extracts of Portulaca olaracea L. sativa leaves after injecting 0.05 ml of a 0.5 (w/v) suspension of dead Mycobacterium TB in paraffin oil into the left hind leg of rats. Oral administration of the extract was found to significantly suppress the increase in white blood cell count, and to restore the increased lymphocyte count in the adjuvant control group to normal in the inflammatory area. This action is comparable to that of the majority of non-steroidal anti-inflammatory drugs, which also have a beneficial effect by inhibiting the release of lysosomal membrane, which is responsible for the inflammatory process (Reddy R et al., 2011).

Antimicrobial activity

The antifungal effect of portulaca oleracea against dermatophytes of the genera Trichopyton indicates that it has antibacterial, antifungal, and antiviral properties (K.-B. Oh et al., 2000). A study by C.-X. Dong et al. (2010) indicated that this plant's aboveground section contains a pectic polysaccharide that efficiently inhibits the herpes simplex virus type 2. This is accomplished by preventing the virus from penetrating rather than obstructing its adsorption. According to E. S. Elkhayat et al. (2008), a 70% methyl alcohol extract of Portulaca oleracea exhibits antibacterial activity against the Gram-negative stains Escherichia coli, Pseudomonas aeruginosa, and Neisseria gonorrhea, with inhibition zones of 14, 15, and 15 mm, respectively, and the Gram-positive strains Staphylococcus aureus, Bacillus subtilis, and Streptococcus faecalis, with inhibition zones of 13, 14, and 15 mm, respectively, as well as antifungal activity against Candida albicans, with an inhibition zone of 12 .mm

Anti-Inflammatory activity

When human umbilical vein endothelial cells (HUVECs) are subjected to tumor necrosis factor- α(TNF-α), pretreatment with an aqueous extract of Portulaca oleracea can effectively inhibit the formation of reactive oxygen species (ROS) and the expression of different adhesion molecules. Furthermore, this extract stops nuclear factor κB (NF-κB) p65 from moving to the nucleus, which stops TNF-α-induced NF-κB binding and the breakdown of inhibitor molecule IκBα) α). Additionally, it exhibits the ability to decrease HL-60 cells' adherence to TNF-α-induced HUVECs and regulate TNF-α-induced mRNA expression of interleukin-8 (IL-8) and monocyte chemoattractant protein-1 (MCP-1). Overall, vascular inflammation and the onset of atherosclerosis may be significantly reduced by the aqueous extract of Portulaca oleracea (A. S. Lee et al., 2012).

Anti-hyperlipidermic activity

Purslane's low cholesterol and calorie level set it apart from fish oils. As an excellent source of healthful ω-3 fatty acids, on the other hand, it lacks the cholesterol present in fish oils. In order to generate hyperlipidemia in a group of mice fed a high-cholesterol diet, the study tried to assess the cholesterol-lowering effect of purslane extract. While other mice were treated as high-fat and normal controls, a subset of mice were fed a purslane aqueous extract (AEP) and lovastanin diet. When comparing the AEP-fed rats to the control group, the results indicated a substantial ($p<0.05$) drop in TC, LDL-C, VLDL-C, and TAG as well as an increase in blood HDL-C levels for AEP-induced hyperlipidemia. According to Niharika S and Sukumar D. (2016), the administration of AEP revealed that 150 mg/kg body weight AEP is a potent cardioprotective agent and has a preventative and therapeutic impact against hyperlipidemia. On heavily fed Wester albino rats, three preparations of Portulaca oleracea (POS) stems were also reported to have a hypolipidemic effect: stem powder (POS-powder), stem infusion (POS-infusion), and 70% ethanol extract (POSthanolic 70%). fats. He has a diet heavy in fat (El-Newary SA., 2016). When POS preparations were used instead of lipid control, the author found that there was a considerable improvement in body weight, feed intake, triglycerides (TG), total cholesterol (TC), total lipid (TL), low-density lipoprotein cholesterol (LDL-C), and low-density lipoprotein cholesterol (VLDL-C) levels and risk.

Antiulcerogenic activity

According to research by G. Karimi et al. (2004), aqueous and ethanolic extracts of the plant Portulaca oleracea have been shown to have therapeutic potential for the treatment of gastrointestinal disorders, including stomach ulcers. According to the study, these extracts had effects similar to sucralfate in reducing the severity of stomach ulcers caused by hydrochloric acid at different doses. Furthermore, it was discovered that both extracts suppressed lesions brought on by pure ethanol. Additionally, the investigation demonstrated that the extracts' oral and intraperitoneal administration raised the pH of gastric juice in mice with pylorus ligation in a manner that was dose-dependent. When considered collectively, these results point to the possibility that Portulaca oleracea, with its gastroprotective qualities, may offer a therapeutic benefit for gastrointestinal disorders.

Hepatoprotective activity

Rats administered CCl4 intraperitoneally suffer hepatic damage, as evidenced by elevated levels of total bilirubin and blood hepatic marker enzymes, including GPT and GOT. Remarkably, a 2008 study by E.S. Elkhayat and associates proved that a 70% alcohol extract from Portulaca oleracea can successfully offset these increased hepatic marker enzyme levels and total bilirubin, supporting the plant's hepatoprotective qualities.

Nephroprotective activity

A 2010 study by Gholamreza et al. found that Portulaca oleracea, or purslane, exhibits strong nephroprotective properties in its aqueous extract. It might be useful in the treatment of acute renal damage brought on by nephrotoxins, specifically cisplatin. Hozayen et al. (2011) also looked at the effects of co-administration of oral purslane extract (400 mg/kg BW/day) and fish oil (5 mg/kg BW/day) in adult male rats weighing 80-120 g, who were also given gentamicin (80 mg/kg BW/day). Urea, uric acid, and creatinine levels in the plasma were lowered after gentamicin treatment. Additionally, it resulted in decreased GSH, SOD, and CAT activities and an increase in MDA concentration in the kidney. Nevertheless, it was shown that taking purslane extract and fish oil together could lessen these negative effects by improving renal function, raising antioxidant levels, and lowering peroxidation. Furthermore, it has

been proposed that adding purslane extract or fish oil to the diet may provide a long-term, potentially side-effect-free therapy option for GM nephropathy.

Neuroprotective activity

Previously, P. oleracea extracts have been studied in rodent models to understand their neuropharmacological effects. These studies have shown that these extracts can reduce locomotor activity and delay the onset of seizures in mice induced by pentylenetetrazole. Additionally, they have demonstrated opioid-mediated anti-nociceptive and muscle relaxant properties in rats (Radhakrishnan R et al., 2001). Other research by Moneim (2013) suggested that Portulaca oleracea has antioxidant properties and can protect against neuronal apoptosis, dopamine depletion, and complex-I inhibition in the striatum of rats, making it a potential candidate for neuroprotection against Parkinson's disease. According to Martins WB et al. (2016), P. oleracea extracts, specifically ethanolic and aqueous extracts, have the therapeutic potential to cure neurodegenerative illnesses by reversing motor impairments and neuronal death caused by 6-hydroxydopamine. Additionally, P. oleracea provides protection against D-galactose-induced toxicity in vivo (Hongxing Z et al., 2007) and hypoxia injury (Wanyin W et al., 2012). Additionally, it has been demonstrated that P. oleracea betacyanins ameliorate cognitive deficiencies and lessen oxidative damage in the brains of aged mice given D-galactose (Wang CQ and Yang GQ., 2010). Lastly, it has been discovered that P. oleracea extracts lessen oxidative stress-induced neurotoxicity and apoptosis brought on by the pesticide rotenone (Al-Quraishy S et al., 2012).

2. Materials and Methods from previous study

2.1. Enhancing Biomarkers Linked to Atherosclerosis in Women with Type 2 Diabetes (T2D) through Purslane (Portulaca oleracea) Seed Consumption and Aerobic Training

196 women with type 2 diabetes participated in a double-blind study. They were divided into four groups of eight people at random: (1) placebo (PL); (2) aerobic training + placebo (AT + PL); (3) purslane seeds (PS); and (4) aerobic training plus purslane seeds (AT + PS). The following parameters were measured in blood samples: NF-κB, GLP1, GLP1R, TIMP-1, MMP2, MMP9, CRP, CST3, and CTSS mRNA and protein expressions; LDL, HDL, cholesterol, TG, creatinine, urea, and uric acid.

2.2. Hypolipidemic Effect of Purslane (Portulaca oleracea L.) in Rats Fed on High Cholesterol Diet

The purpose of this study was to look at how purslane extract affected the lipid metabolism of male Wistar rats. The rats were split up into seven groups: one for hyperlipidemia, one for normalcy, and five test groups that were fed a diet rich in cholesterol and administered varying amounts of purslane aqueous extract. As a positive control, atorvastatin was given to a standard group. Following a 60-day feeding trial, the rats were killed, and measurements were made of a number of lipid metabolism-related parameters, such as serum glucose, total cholesterol, HDL-C, TG, LDL-C, SGOT, SGPT, and ALP.

2.3. A Triple-blinded Randomized Controlled Trial Investigating the Impact of Portulaca Oleracea Seeds on Dyslipidemia in Obese Adolescents: Clinical Findings

The study conducted from July 2011 to June 2012 aimed to evaluate the effect of powdered P. oleracea seeds on adolescents with dyslipidemia and high BMI. Seventy-four male and female non-smokers were randomly assigned to either the cases group or the placebo group. The cases group took one capsule containing powdered P. oleracea seeds (500 milligrams) twice a day for one month, while the placebo group took one capsule containing a lactose powder twice a day for the same duration.

2.4. Effect of *portulaca oleracea* (purslane) extract on inflammatory factors in nonalcoholic fatty liver disease: A randomized, double-blind clinical trial

A 12-week, double-blind, placebo-controlled clinical experiment with 74 eligible participants—43 men and 31 women—was enrolled. The study comprised individuals who were at least 18 years old, had been diagnosed with hepatic steatosis (grades 1-3), and had ALT levels greater than 19 U/l for women and greater than 30 U/l for males. Next, these subjects were randomized into two groups: one with 37 purslane individuals and the other with 37 placebo participants. One capsule a day, comprising 300 mg of toast

powder and 300 mg of purslane extract, was given to each participant in the purslane group and the placebo group during the trial. While NF-B levels were ascertained, adiponectin levels and GPX activity were evaluated.

3. Results from previous study and Discussion

3.1. Enhancing Biomarkers Linked to Atherosclerosis in Women with Type 2 Diabetes (T2D) through Purslane (Portulaca oleracea) Seed Consumption and Aerobic Training

Table 4 shows the impact of aerobic exercise and purslane seed ingestion on the serum biochemicals of diabetic women. After 16 weeks, there was a substantial decrease in blood glucose, LDL, cholesterol, and TG concentration in the (PS), (AT+PL), and (AT+PS) groups as compared to pre-experimental levels or the (PL) ($p > 0.05$). There were no noteworthy distinctions found between (PS) and (AT PL) ($p + > 0.05$), however there were noteworthy interactions found between (PS) and (AT + PL) in contrast to (AT + PS) p) > .(0.05

Table 4: Variations in the diabetic individuals' blood variables before and after 16 weeks of studies in four groups.

Variable	Stage	Placebo (PL) Mean ± SEM	Aerobic Training + Placebo (AT + PL) Mean ± SEM	Purslane Seeds (PS) Mean ± SEM	Aerobic Training + Purslane Seeds (AT + PS) Mean ± SEM
Glucose, mg/dL	Pre	168.2 ± 18.1	164.8 ± 17.5	167.4 ± 14.1	167.6 ± 20.6
	Post	173.1 ± 19.7	147.3 ± 18.3	152.1 ± 11.9	140.1 ± 15.2
LDL-C, mg/dL	Pre	83.3 ± 8.6	87.1 ± 12.4	84.1 ± 14.2	86.3 ± 11.7
	Post	82.1 ± 19.7	75.5 ± 17.2	79.9 ± 12.6	72.8 ± 19.7
HDL-C, mg/dL	Pre	35.8 ± 4.9	36.7 ± 8.3	35.3 ± 7.2	34.9 ± 3.7
	Post	33.6 ± 9.1	39.8 ± 10.3	39.2 ± 6.9	46.7 ± 7.4
Cholesterol, mg/dL	Pre	197.2 ± 22.4	198.5 ± 26.1	196.9 ± 22.6	198.7 ± 24.8
	Post	209.2 ± 20.1	169.7 ± 14.8	172.3 ± 19.3	155.2 ± 16.4
TG, mg/dL	Pre	183.1 ± 26.3	182.8 ± 21.7	183.6 ± 27.2	183.1 ± 23.8
	Post	182.9 ± 24.7	152.7 ± 29.2	159.3 ± 22.0	142.2 ± 21.5
Creatinine, mg/dL	Pre	1.43 ± 0.04	1.41 ± 0.05	1.40 ± 0.05	1.41 ± 0.03
	Post	1.43 ± 0.02	0.81 ± 0.06	0.88 ± 0.06	0.42 ± 0.07
Urea, mg/dL	Pre	19.31 ± 1.19	18.99 ± 1.04	18.86 ± 0.82	19.01 ± 0.63
	Post	19.31 ± 1.11	14.21 ± 0.98	14.42 ± 0.07	10.62 ± 0.98
Uric Acid mg/dL	Pre	4.65 ± 0.15	4.82 ± 0.18	4.59 ± 0.16	4.71 ± 0.15
	Post	4.66 ± 0.42	3.38 ± 0.21	3.11 ± 0.14	2.39 ± 0.23

However, when compared to pre-experimental levels or the (PL) ($p > 0.05$), the HDL levels considerably rose in all (PS), (AT + PL), and (AT + PS) groups. There were no significant differences between (PS) and (AT+PL) ($p>0.05$), but there were significant differences between (PS) and (AT+PL) and (AT+PS) ($p<0.05$). The (AT + PS) group experienced more noticeable alterations. Additionally, after 16 weeks, there was a substantial decrease in creatinine, urea, and uric acid in the (PS), (AT+PL), and (AT+PS) groups compared to the pre-experimental levels or the (PL) ($p > 0.05$).There were no significant differences between (PS) and (AT+PL) ($p>0.05$), but there were significant differences between (PS) and (AT+PL) and (AT+PS) ($p<0.05$). The (AT + PS) group experienced more significant level drops.

Atherosclerosis Biomarkers

Figures 2 ,3, and 4 show the impact of purslane seed ingestion and aerobic exercise on changes in mRNA and serum protein indicators in diabetic women. After 16 weeks, there was a substantial decrease in the protein and mRNA concentration levels of NF-ĸB, TIMP-1, MMP 2 & 9, CRP, CST3, and CST3 in the (PS), (AT + PL), and (AT + PS) compared to the pre-experimental levels or the (PL) ($p > 0.05$). There were no significant changes found in the protein and mRNA concentration levels of NF-ĸB, MMP2 &9, CRP, CST3,

and CTSS between (PS) and (AT + PL) ($p > 0.05$), however there were significant differences found in (PS) and (AT + PL) when compared to (AT + PS) ($p > 0.05$). Moreover, there was a significant difference in TIMP-1 protein and mRNA concentration levels between (PS) and (AT+PL), as well as a significant difference between (PS) and (AT+PL) in comparison to (AT+PS) ($p > .(0.05$

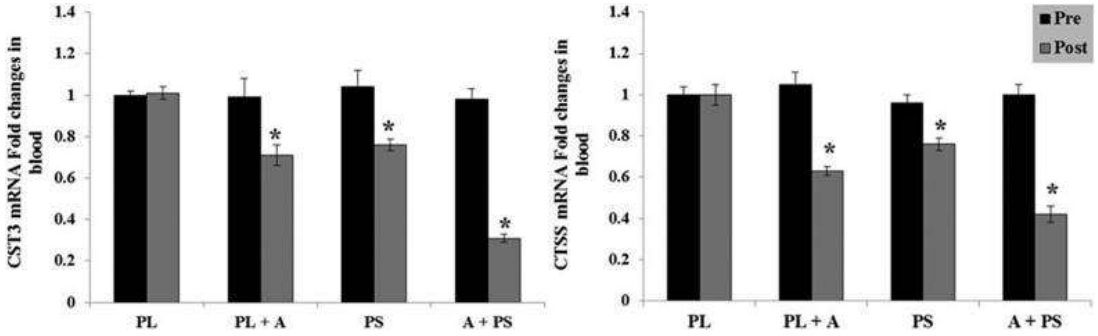

Figure 2: Women with type 2 diabetes who have blood levels of CST3 and CTSS mRNA expression and activity before and after therapy.

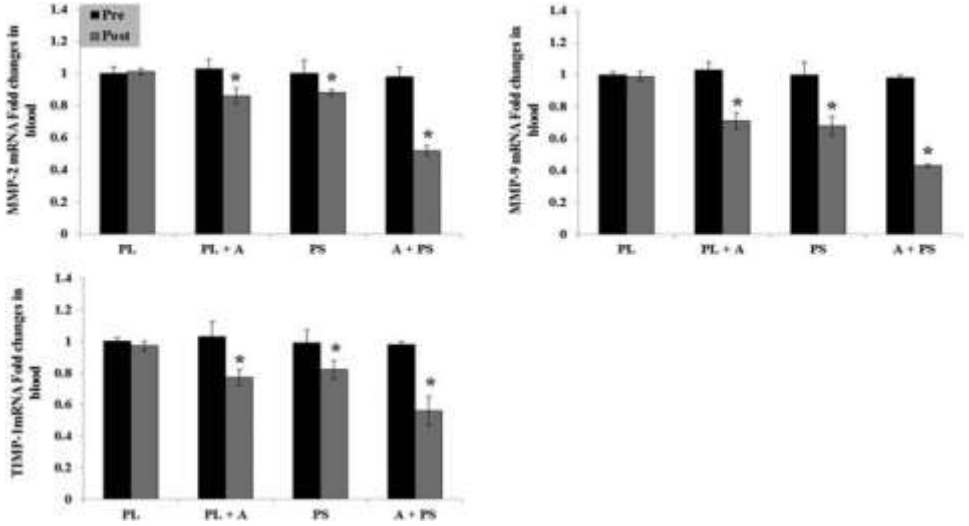

Figure 3: Type 2 diabetic women's blood MMP-2, MMP-9, and TMP-1 mRN A expression and activity before and after therapy.

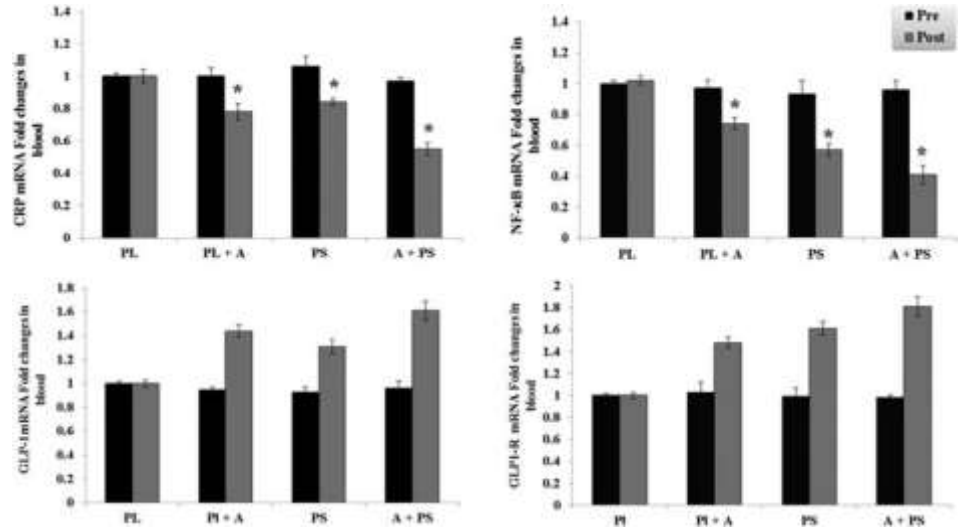

Figure 4: Pre- and post-treatment blood CRP, NF-ΚB, GPL-1, and GPL1-R, as well as mRNA expression and activity in type 2 diabetic women.

3.2. Hypolipidemic Effect of Purslane (Portulaca oleracea L.) in Rats Fed on High Cholesterol Diet

Figure 5 depicts the impact of AEP on the serum lipid levels in treated rats. The findings demonstrated that, in comparison to the normal and other treated groups, the HDL-C level was significantly lower ($p<0.01$) and the levels of TG, TC, LDL-C, and VLDL-C were significantly higher ($p<0.05$) in the HCD treated group. When comparing the serum lipid profile of HCD groups given doses of AEP (150 mg/kg) to that of the high cholesterol diet group, the results showed a significant ($p<0.05$) decrease in serum parameters TG, TC, LDL, and VLDL and a significant ($p<0.05$) increase in HDL. In contrast, atorvastatin showed a significant ($p<0.05$) decrease in TG, TC, LDL, and VLDL and an increase ($p<0.01$) in HDL. AEP supplementation at four different doses (i.e., 50, 100, 150, and 200 mg/kg bw) reduced the lipid profiles in a dose-dependent manner.

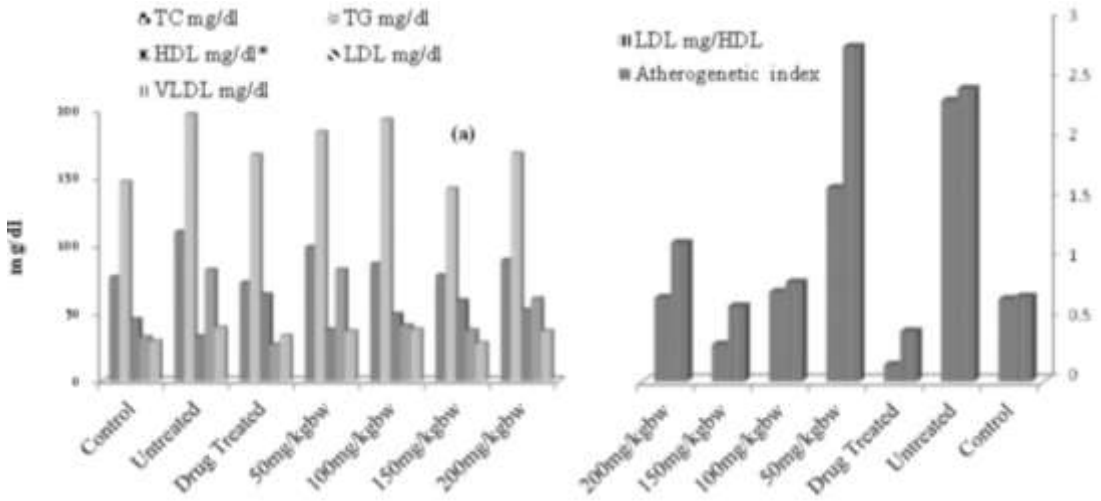

Figure 5: Adult male albino wistar rats' serum lipid profile after feeding them a meal containing 1% cholesterol and the AEP

Impact of AEP extract on hepatic enzyme levels

Reduced levels of SGOT, SGPT, and ALP indicate a hepatoprotective benefit of AEP extract administration, as Table 5 illustrates. Significant increases in liver weight are associated with elevated liver enzyme levels and the development of hepatic steatosis (fatty liver) in the diet-fed animals with high cholesterol. Hepatocytes were protected against hepatic fatty accumulation by the extract's treatment.

Table 5 :AEP's impact on the activity of liver enzymes in rats with normal and high cholesterol.

	Control	Untreated	Drug Treated	50 concentration (mg/kgbw)	100concentration (mg/kgbw)	150 concentration (mg/kgbw)	200 concentration (mg/kgbw)
SGOT U/dL	40.14 ± 0.4	56.71 ± 1.2	38.83 ± 0.9	58.02 ± 1.4	41.88 ± 0.6	47.99 ± 1.1	46.05 ± 0.8
SGPT U/dL	56.78 ± 0.3	78.17 ± 1.4	54.15 ± 0.9	58.75 ± 1.5	64.56 ± 0.7	40.57 ± 1.4	57.94 ± 1.6
ALP U/dL	152 ± 0.7	256 ± 1.1	157 ± 0.8	280 ± 1.4	211 ± 1.6	172.4 ± 0.8	225 ± 1.8
Values are expressed as mean ± SE of animals, p values <0.05							

3.3. A Triple-blinded Randomized Controlled Trial Investigating the Impact of Portulaca Oleracea Seeds on Dyslipidemia in Obese Adolescents: Clinical Findings

Before and after the study, biochemical markers were evaluated, including fasting serum levels of TG, LDL-C, HDL-C, and Total-C. Over the course of a month, it appears that the P. oleracea group saw substantial improvements in LDL-C, TG, and Total-C, while the control group did not. Only LDL-C and TG, on the other hand, revealed statistically significant changes between the two groups. It's also wonderful to learn that neither group's participants experienced any serious adverse effects. All things considered, the data points to a potential benefit for P. oleracea in terms of LDL-C and TG levels.

Table 6: Biochemical parameters in two study groups both prior to and following the conclusion of the study protocol.

Study	Group	HDL-C (mg/dl)	LDL-C (mg/dl)	TG (mg/dl)	Total-C (mg/dl)
	Before	42.51±11	112.87±22	145.86±62	197.19±32
P.oleracea	After	42.08±9	101.73±24	129.59±62	187.05±35
	P-value*	0.735	0.001	<0.001	<0.001
	Before	41.35±9	125.81±37	169.35±55	201.19±43
Placebo	After	41.81±9	124.62±36	165.24±52	199.19±42
	P-value*	0.713	0.070	0.098	0.115
P-value**		0.663	<0.001	0.006	0.280

3.4. Effect of *portulaca oleracea* (purslane) extract on inflammatory factors in nonalcoholic fatty liver disease: A randomized, double-blind clinical trial

The results of the liver ultrasonography method regarding the severity of hepatic steatosis are shown in Table 7. Regarding the degree of hepatic steatosis, there was no difference between the two groups at the beginning of the trial (P = 0.419) or at the conclusion (P = 1.000).

Table 7: Comparison of the two groups' mean hepatic steatosis at the start and finish of the research.

Variable	Time	Type	Group		P-Value
			Purslane (n = 37)	Placebo (n = 37)	
Hepatic Steatosis grade	Before	Mild	9 (24.3 %)	9 (24.3 %)	0.419a
		Moderate	21 (56.8 %)	25 (67.6 %)	
		Severe	7 (18.9 %)	3 (8.1 %)	
	After	Mild	12 (32.4 %)	11 (32.4 %)	1.000a
		Moderate	21 (56.8 %)	19 (55.9 %)	
		Severe	4 (10.8 %)	4 (11.8 %)	

Table 8 displays results for waist circumference, body mass index, and weight. These indicators did not show a statistically significant difference between the two groups at the start of the trial. In the purslane group, weight, BMI, and waist circumference all significantly decreased when compared to baseline (P = 0.003, P = 0.002, and P < 0.001, respectively). Nonetheless, there was no discernible difference between the two study groups in any of the anthropometric measure changes that occurred during the trial.

Table 8: Mean NF-ĸB, serum adiponectin, and GPX were compared between the two groups at the start and finish of the research.

Variable	Time	Group		P-Value	Adjusted P-value
		Purslane (n = 37)	Placebo (n = 37)		
NF-ĸB (OD)	Before	0.28 (0.21, 0.45)	0.27 (0.20, 0.35)	0.569a	0.012
	After	0.23 (0.20, 0.34)	0.23 (0.21, 0.30)	0.700a	
	Difference	−0.03 (-0.12, 0.03)	−0.02 (-0.08, 0.05)	0.486a	
	P-value	0.083b	0.191b	–	
Adiponectin (ng/ml)	Before	1.17 (0.71, 2.45)	1.03 (0.81, 3.44)	0.863a	0.790
	After	1.95 (1.21, 7.79)	1.78 (1.08, 18.46)	0.904a	
	Difference	0.43 (-0.18, 6.33)	0.72 (-0.23, 15.35)	0.721a	
	P-value	0.008b	0.007b	–	
Glutathione peroxidase (mU/ml)	Before	7.70 (2.66)	7.67 (1.70)	0.967c	0.237
	After	9.77 (7.58, 13.11)	10.56 (8.14, 15.34)	0.351a	
	Difference	2.59 (-0.59, 5.89)	3.22 (0.00, 8.76)	0.577a	
	P-value	0.002b	<0.001b	–	

Table 8 demonstrates that at baseline, there was no discernible difference between the two groups' levels of glutathione peroxidase, adiponectin, or NF- βnuclear activity. After 12 weeks, no significant change was found between the two groups, despite within-group analysis showing a substantial drop in GPX activity (purslane group, P = 0.002; placebo group, P < 0.001) and adiponectin concentration (purslane group, p = 0.008; placebo group, p = 0.007). At the end of the experiment, there was a significant difference (P = 0.012) in the NF-ƙB p65 nuclear activity between the purslane group and the placebo group. By using the quantitative Real-Time PCR approach, there was no discernible difference in the relative expression levels of NF-əB p65 between the purslane and placebo groups.

3.5. Discussion

The advantages of eating purslane seeds for lowering diabetes-related markers. The presence of beta-sistosterol and unsaturated fatty acids may be the cause of the positive effect. According to earlier research, unsaturated fatty acids improve insulin function, lower levels of LDL and cholesterol production, improve lipid profiles and glucose tolerance, and improve insulin function (Oh J. Y., 2010).(Samimi M et al., 2015). Furthermore, the previous study evaluated the effect of the intervention on biomarkers associated with insulin and beta cell activity. GLP-1 and GLP-1R concentrations were assessed. Insulin-dependent insulin secretion is stimulated by GLP-1, an insulinotropic that helps with type 2 diabetes by improving insulin secretion through its receptor. GLP-1 mimetics are further possible medications for the treatment of T2D (Coughlan K. A et al., 2014). The previous research demonstrated that interventions had a positive impact on GLP-1 and its receptor levels. Decreased concentrations of CRP and other inflammatory markers are linked to increased physical activity and weight loss. As a result, either intervention alone or in combination may function via the AMPK pathway to prevent the activation of downstream inflammation by blocking NFκB and CRP. Among the various insulin signaling pathways, the AMPK pathway—which is insulin independent and metformin activated—is typically activated by diabetes therapies. This leads to the inhibition of NF-kB activity in endothelial cells (Schultze S. M et al., 2012)(Katerelos M. et al., 2010). Purslane consumption and/or aerobic exercise decreased the amount of NF-kB, a master inflammation key, which may have been caused by activation of the AMPK pathway.

It is commonly accepted that the quantity of biologically active substances found in purslane (P. oleracea), including flavonoids, alkaloids, coumarins, and a high concentration of ω-3 fatty acids, is what gives the plant its therapeutic effects. It has been demonstrated that these fatty acids offer major benefits for immune system support and reducing the risk of heart attacks. Additionally, by lowering LDL-C oxidation and raising HDL-C levels, purslane's antioxidant content may help stop atherosclerosis from progressing. Studies by Okafor IA, Ezejindu DN. and Alam MA et al. (2014) and in 2014 corroborate these results.The study used dietary hyperlipidemic rats as dietary models for hyperlipidemia. Elevated levels of TL, TG, VLDL-C, TC, LDL-C, and lower levels of HDL-C were seen in these models. Purslane aqueous extract (AEP) preparations enhanced the lipid profile in the direction of normalcy. When compared to the hyperlipidemic control, the impact of AEP preparations was evident in a notable decrease in TL, TG, and VLDL-C, TC, and LDL-C, as well as a significant increase in HDL-C. As a result, the danger ratio dramatically decreased (Samah Ali El-Newary, 2016).

Polyphenolic and antioxidant substances found in P. oléracea L. may have a favorable impact on the serum lipid profile in humans. Furthermore, given that it is well-tolerated in the adolescent population, as demonstrated by the previous study, it may be taken into account for long-term future research on the prevention and treatment of dyslipidemia and atherosclerotic disorders in this population. (Sabbazaee, Ali Mohammad et al., 2014), Prior research on P. oleracea L.'s ability to decrease cholesterol has been done on both humans and animals. Purslane's ability to lower high lipid levels was investigated in a study including ninety-three Iranian patients who were referred to an internal clinic in Shahrekord, Iran and had LDL-C values greater than 100 mg/dl. The patients were split into two groups, with one group receiving 20 mg of lovastatin daily and the other 50–60 g of purslane leaves daily. The patients' lipid profiles were evaluated both prior to and following the 45-day research period. The findings demonstrated that the levels of TG, LDL-C, and Total-C significantly decreased in both groups. But as compared to the lovastatin group, the purslane group's TG levels decreased noticeably more .(Samani K et al., 2011-Gatreh)

The most recent study examined the function of glutathione peroxidase (GPx) as a measure of Purslane's effect on NAFLD patients' antioxidant defense. The results showed that both groups' GPx activity increased noticeably over time. At the conclusion of the trial, there was no discernible variation in GPx activity between the two groups. This indicates that GPx activity in these patients is not affected by 300 mg of extract from Portulaca Oleracea, or purslane, taken over a period of 12 weeks. Due in part to small sample sizes

that make statistical differences difficult to detect, there aren't many clinical research looking at Purslane's impact on antioxidant and oxidative stress assessments. The last study's sample size was greater than the other studies', but it was still insufficient to identify a meaningful difference in GPx activity. Nonetheless, research on animals has shown that consuming purslane, especially in the form of an extract, has a favorable impact on the ratio of antioxidants to oxidants. For example, a 200 mg/kg dose of Purslane extract improved the total antioxidant status (TAS) of diabetic rats in a 4-week trial as compared to the rats who were not treated. A 400 mg/kg dose, on the other hand, stopped the TAS's rising trend. Furthermore, a dose of 400 mg/kg lowered MDA levels. As a result, it seems that there is variability in the effects of different dosages of Portulaca oleracea on different measurements. Only at high doses of Portulaca Oleracea extract did significant reductions in serum MDA levels show up in another investigation by Kaveh et al.

3. Conclusion

the studies indicated that purslane, specifically its seed and leaf extracts, has positive effects on diabetic parameters, biomarkers associated with atherosclerosis, hyperlipidemia, and non-alcoholic fatty liver disease. Ingestion of purslane has shown benefits in regulating these conditions and reducing health risk factors. The potential synergistic effects of purslane with aerobic training, its polyphenolic and

antioxidant compounds, and its impact on lipid metabolism contribute to its therapeutic value. Further research is needed to determine the specific properties, dosage, and interactions of purslane and its active compounds. Overall, purslane can be considered as a natural alternative in the prevention and management of these diseases, particularly in controlling inflammation and improving lipid profile in patients.

Author Contributions: Conceptualization, methodology, and investigation, W.E.A. and A.A.A.; data curation, W.E.A. and A.A.A.; formal analysis, A.A.A. and W.E.A.; writing—original draft preparation, W.E. A and A.A.A.; review and editing, A.A.A. and W.E.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Data are contained within the article.

Acknowledgments: The researchers would like to thank the Deanship of Scientific Research, Qassim University for funding the publication of this project.

Conflicts of Interest: The authors declare no conflict of interest.

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