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Review Article

Potential Roles of Purslane (*Portulaca oleracea* L.) as Antimetabolic Syndrome: A Review

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ABSTRACT

The number of cases of obesity and type 2 diabetes mellitus (T2DM) is part of the metabolic syndrome case. Purslane (*Portulaca oleracea* L.) is a plant that has been clinically tested and has the potential to prevent and treat metabolic syndrome as well as pathogenic and pathophysiological activities that cause disease. The aim of this study is to discuss and conclude information regarding the activity and use of purslane (*P. oleracea*) as an antimetabolic. This review article is based on scientific publications found on Google Scholar and PubMed databases using the keywords of "*Portulaca* obesity", "*Portulaca* overweight", "*Portulaca* dyslipidemia", and "*Portulaca* metabolic syndrome". This plant acts on numerous pathways in the metabolic syndrome such as reduction of lipids, blood sugar, body weight and total cholesterol. Purslane (*P. oleracea)* can be used as a candidate for a new herbal plant as an anti-metabolic syndrome.
Key words: Body weight, *Portulaca oleracea*, Insulin resistance, Metabolic syndrome, Obesity.

INTRODUCTION

The prevalence of metabolic syndrome leads to an increase in the prevalence of obesity or overweight, T2DM (type 2 diabetes mellitus), and cardiovascular disease.[1] Obesity contributes to abnormal fat accumulation in the body and causes several metabolic diseases such as hypertension, coronary heart disease, hyperlipidemia, and T2DM.[2,3] Obese people are also at risk for mental illness and psychopathological symptoms such as ADHD (attention deficit hyperactivity disorder), PTSD (post-traumatic disorder), mood changes, SCZ (schizophrenia), substance abuse and BED (binge eating disorder).[4]

Recently, obesity has been recognized as a global health and economic problem due to rising health care cost for sufferers.[3] Current conventional health care for obese people still uses synthetic drugs that are known to have many side effects and reduce quality of life.[5] Therefore, many studies have been conducted to prevent and reduce diabetes. One of the studies was conducted by utilizing the bioactive and pharmacogenic potential of natural ingredients in herbal medicines as anti-obesity.

P. oleracea is a cosmopolitan succulent species of the *Porthulaceae* family that is distributed in tropical and subtropical areas.[6] This plant is reported as one of the herbal medicines that has been widely used in treating degenerative diseases such as liver disease, obesity, and dyslipidemia.[7-9] Several studies showed that this plant was able to reduce glucose levels in mice on days 7 and 14 (dose of 125, 250, 500 mg/kg) ($P < 0.05$).[10] Based on the potential effects of *P. oleracea* and the many scientific publications regarding the potential of purslane to treat obesity and overweight, the purpose of this review article is to discuss and conclude the potential of *P. oleracea* in treating obesity, overweight and other diseases associated with the metabolic syndrome.

Taxonomy

Kingdom: Plantae; Subkingdom: Tracheobionta; Superdivision: Spermatophyta; Division: Magnoliophyta; Class: Magnoliopsida; Subclass: Caryophyllidae; Order: Caryophyllales; Family: Portulaceae; Genus: *Portulaca*; Species: *P. oleracea* L.[11,12]

Plant description

P. oleracea is an annual prostrate succulent plant; forked; stem length of 15.30 cm; reddish green or purplish green stems; swelling of the nodes; quite bald. The roots are thick taproots and rich in secondary roots. Simple leaves; succulents; sub-sessile; alternate or sub-opposite; sometimes clustered at the ends of the stems; margined edge. Flowers are several with 20-30 pieces, opposed to 2 involucres like bract that produce seeds; sessile terminal head. Flowering lasts from May to September. Flowers only bloom under bright sunlight. Seed is small; the width is less than 1 mm; dark with white connecting dots. Dispersal of seeds can be done by autochory, anemochory, zoochory and anthropochory. Seed germination is affected by photo- and thermo-period. C4 type of photosynthesis to help plants survive heat and light stress. It is reported that *P. oleracea* could change its metabolism to CAM after 21 days of exposure to drought stress.[13-15]

Geographic distribution

The origin of *P. oleracea* is uncertain, but there was an article reporting that *P. oleracea* is native to Europe, Africa, North America, Australia, and Asia.[16,17] This plant is easy to grow in warm humid to dry and semi-arid climates.[12] In Indonesia, *P. oleracea* can be grown in all regions and climates.[18-20]

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Ethnopharmacology

Purslane has many ethnopharmacological applications around the world to treat certain diseases. It is known that *P. oleracea* has many benefits as an analgesic, anti-inflammatory, diuretic, anti-fever, vermifugal, antioxidant, anti-bacterial, anti-ulcerogenic and has wound healing properties.[14,21,22] This plant is consumed as a salad and traditional food in Italy for hundreds of years.[14,15]

Processed *P. oleracea* in the form of juice is helpful for the swelling of male genitalia. Besides, the mixture of purslane juice with honey can be used as a cough traditional medicine.[12] The seeds are applied to treat burns and blisters. On the other hand, boiled seeds can be used for diuretic and antidysenteric agent. In addition, the stem juice and leaves can be used to treat scorpion bites. The leaves and bud of *P. oleracea* can be used as an anti-hemorrhagic.[15]

Phytochemistry composition for metabolic syndrome

P. oleracea is highly nutritious compared to other common edible plants like spinach, kale, cabbage and basil.[12] The phytochemical content of *P. oleracea* is related to its pharmacological properties based on ethnomedicine data. Phytochemicals are heterogeneous compounds with diverse structures and wide distributions. The phytochemical components of this plant are dominated by flavonoids followed by alkaloids, terpenoids, organic acids and other classes of natural compounds.[23] On the other hand, *P. oleracea* is known as non-animal source of omega-3 and polyunsaturated fatty acid. The various environmental factors and different extraction methods can influence the final content of bioactive compunds.[24] Several groups of *P. oleracea* compounds have been demonstrated to be anti-metabolic agents.

Pathogenesis and pathophysiology of metabolic syndrome

There are four pathogenesis of metabolic syndrome: IR (insulin resistance), adipose tissue dysfunction, metabolic disorder, and the presence of vascular and immune diseases.[32] IR causes hyperglycemia that is characterized by a reduced ability of the organs to respond to insulin due to dysfunction of the PI3K-Akt pathway regulation in the cells.[33,34] Adipose tissue dysfunction leads to lipolysis resulting in more FFA (free fatty acid) production causing immune response and IR.[35]

Meanwhile, metabolic syndrome can occur in patients with metabolic disorder in the form of mitochondrial malfunction, inhibition of antioxidant formation, and increased total lipids in the body.[36-38] Finally, there are vascular and immune disease characterized by T2DM, cardiovascular disease, hypertension and stroke.[39,40]

Metabolic syndrome causes fat accumulation in the body that leads to abdominal obesity.[41] Adipose tissue is dysfunctional due to environmental factors such as nutrients and genetics.[32] Meanwhile, cells are triggered to be in hypoxia condition which causes inflammation and excessive lipid influx.[42] As a result, insulin resistance and other diseases can occur.

Bioactivity and pharmacological properties-related metabolic syndrome of purslane

P. oleracea is known as a plant rich in benefits and used in traditional medicine with broad pharmacological activities. One of the pharmacological effects is its antimetabolic activity. The bioactivity and pharmacological effects are shown in Figure 1. *P. oleracea* antioxidant compound has an antiobesity effect by suppressing glucogenic and lipogenic activities at the gene, cell, and organ levels. In addition, these antioxidant compounds can also maintain the organ health due to their antimetabolic activity.[22,27,43]

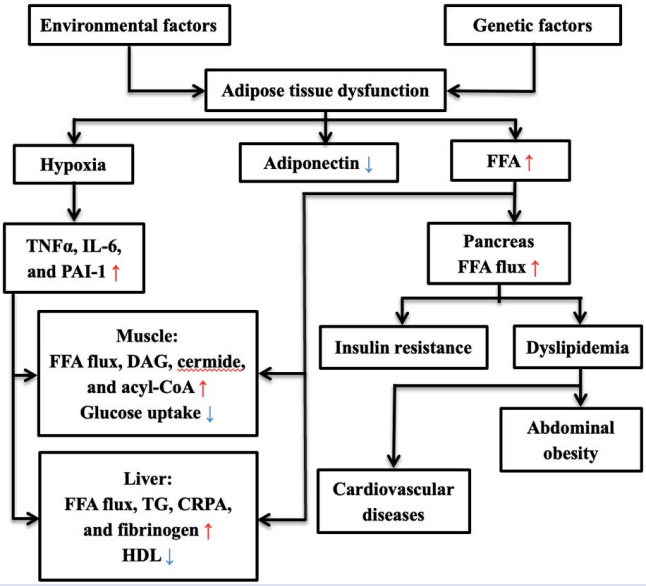

Figure 1: Metabolic syndrome pathophysiology.

Table 1: Types of compounds as anti-metabolic syndrome in purslane.

Number	Compounds	Reference
1	Phenol	25,26,27
2	Flavonoid	25,22,27
3	Tannin	28,22
4	Saponin	28,22
5	Carotenoid	29,30,27
6	Fatty acid	31,23

Table 2: Purslane effects on several body weight decrease and metabolic syndromes.

Number	Nutraceutical	Effect	Reference
1	*P. oleracea* extract	Lipid ↓, glucose ↓, adipogenic transcription ↓, and adipogenic-targeted gene interaction ↓.	3
2	*P. oleracea* powder	AI ↓, CRF ↓, HOMA-IR ↓, ALT ↓, PPAR-α ↑, GLUT-4 ↑, PPAR-γ ↑, and TNF-α ↓	43
3	Ethanol extract of *P. oleracea*	Body weight ↓ and fat in organs ↓	27
4	Atorvastatin *P. oleracea* extract *Salvia officinalis* extract	TC ↓, TG ↓, HDL-C ↑, LDL-C ↓, VLDL-C ↑, AI ↓, and CRI↓	44
5	*P. oleracea* seed	FBS ↓, QUICKI ↓, TC ↓, and LDL-C ↓	7
6	Atorvastatin *P. oleracea* aqueous extract	Glucose ↓, TG ↓, TC ↓, HDL-C ↑, LDL-C ↓, VLDL ↓, GOT ↓, GPT ↓, GSH ↑, LPO ↓, and body weight ↓.	22

The presence of antioxidants in *P. olaracea* is associated with cellular oxidative stress. Oxidative stress is caused by reactive oxygen species that trigger cell and tissue damage, especially liver tissue.[22,45] The presence of antioxidants such as phenols and flavonoids can inhibit the oxidation and lipid peroxidation of adipose cells because they can reduce triglyceride activity and cholesterol levels.[25] In addition, tannins and saponins are also able to reduce oxidative stress on adiposite cells.[28] Meanwhile, the carotenoids produced by *P. olaracea* are able to reduce cholesterol in the body by inhibiting the activity of HMG-CoA reductase (3-hydroxy-3-methylglutaryl coenzyme A), an enzyme that

promotes mevalonate synthesis as a cholesterol material and facilitates fat absorption in the small intestine.[29,30] Therefore, the antioxidants produced by *P. olaracea* have a hypolipidemic effect.

Homoisoflavonoid, a flavonoid member, is applied to adipocytes *in vitro* were able to reduce lipid accumulation, glucose consumption and increase glycerol production in culture medium.[3] The anti-adipogenic properties of homoisoflavin also act genetically by suppressing the interaction of adipogenic genes. These genes encode adipogenic genes such as PPARγ (peroxisome activated receptor γ) and C/EBPα (CCAT/enhancer-binding proteins) proliferator as well as their target genes, namely the gene encoding the protein FAB4 (fatty acid binding protein 4), FATP1 (fatty acid transport protein 1) and ACS1 (acyl-CoA synthase 1).[46] In addition, there are also unsaturated fatty acids such as omega 3 linoleic acid which can reduce LDL (low density lipoprotein) and increase HDL (high density lipoprotein) in the blood so that it can prevent vascular diseases such as atherosclerosis and inflammatory diseases.[47,48]

P. olaracea has ability to alter body metabolism. Several studies have shown that *P. olaracea* can reduce body lipids, obesity and overweight. There are numerous hypothesized mechanisms regarding the pathophysiology of the metabolic syndrome. Most experts agree that fat influx is linked to insulin resistance. Furthermore, there is inflammation as well as oxidative stress. Metabolic diseases may include insulin resistance, fatty acid accumulation, cell hypoxia, dyslipidemia, obesity, hypertension, diabetes mellitus, cardiovascular disease and stroke.[32,49]

A variety of herbal therapies can be used to improve metabolic syndrome and their effects on hormones, lipids, blood glucose and inflammatory factors. The reduction of lipids in the body can be done by reducing TC (total cholesterol), TG (total glucose) and LDL (low density lipoprotein) through the consumption *P. olaracea* extract in mice with an effective dose of 400 mg/kg/day.[22] In addition, an ethanol extract of *P. oleracea* leaves of 200 mg/kg body weight can be used to increase HDL levels in the body.[44]

P. oleracea can be used to reduce glycogenic and lipogenic activities that may lead to obesity and other metabolic diseases. Purslane powder has the ability to increase the activity of PPAR-α (peroxisome proliferator-activated receptor-α), PPAR-γ and GLUT-4 (glucose transporter-4) which triggers lipolysis, inhibits adipocyte formation, and decreases glucose-related IR.[18,50] Moreover, purslane extract is known to inhibit reactive oxygen species; decrease adipogenic activity involving the protein PPAR-γ, C/EBPα, FABP4, FATP1 and ACS1, and also acts as an anti-inflammatory agent by reducing TNF-α (tumor necrosis factor α).[3,18,43]

As a result, there was a decrease in TC, TG, LDL-C (low density lipoprotein-cholesterol), VLDL-C (very low density lipoprotein-cholesterol), LPO (lipid peroxidation), AI (anthrogenic index), CRF (cardiac risk factor), CRI (coronary risk index), GOT (glutamate-oxaloacetate transaminase), GPT (glutamate pyruvate transaminase), GSH (glutathione), HOMA-IR (homeostatic model assessment of insulin resistance), FBS (fasting blood sugar), and QUICKI (quantitative insulin sensitivity check index) compared with untreated obese mice.[7,22,43,44] Concurrently with this decrease, there was an increase in HDL-C (high density lipoprotein-cholesterol) which resulted in a decrease in body fat and weight loss.[3,22,27]

CONCLUSION

The results of this review show that *P. olaracea* has bioactive and pharmacological properties for the treatment of metabolic syndromes such as anti-obesity and hypolipidemia which act on various mechanisms and pathways. Moreover, it is hoped that purslane could be widely applied in the treatment of metabolic diseases.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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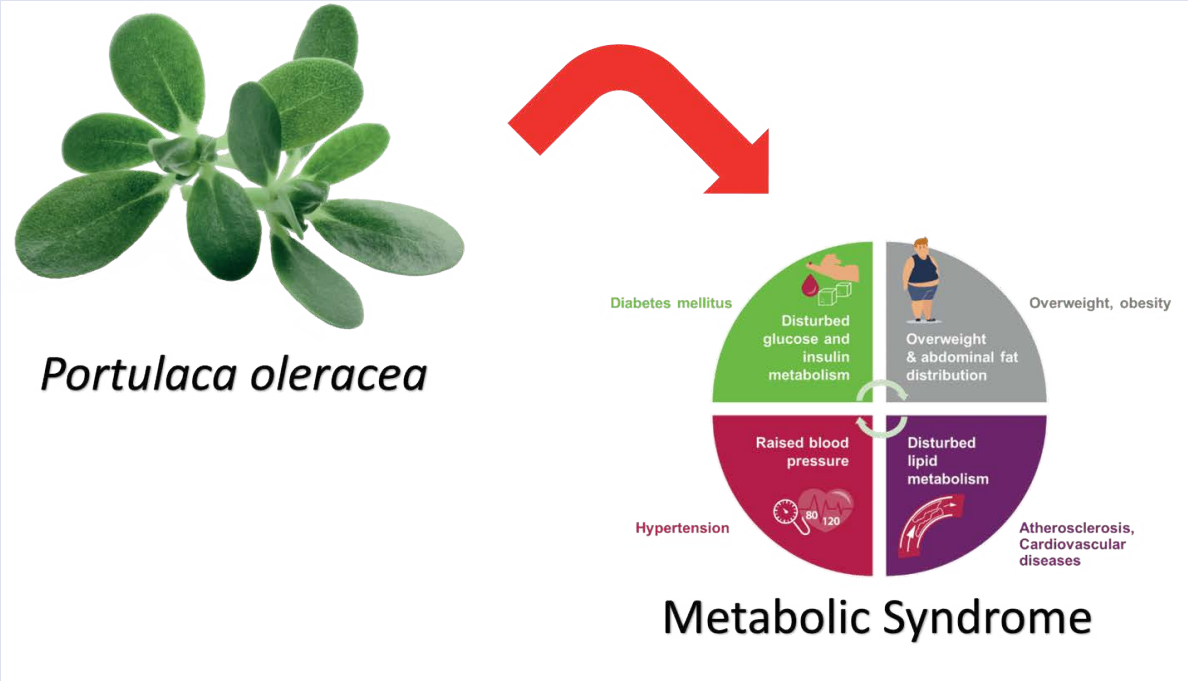
GRAPHICAL ABSTRACT



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