WATER REGIMES EFFECT ON THE GROWTH AND ANTIOXIDANT CONTENT OF PURSLANE (*Portulaca oleracea* L.)

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DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF AGRICULTURAL SCIENCE WITH HONOURS

CROP PRODUCTION PROGRAMME

FACULTY OF SUSTAINABLE AGRICULTURE

UNIVERSITI MALAYSIA SABAH

2016

PUMS 99:1

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN TESIS

JUDUL: Water Regimes Effect on the Growth and Antioxidant Content of Purslane (Portulaca oleracea L.)

IJAZAH: Degree of Bachelor of Agricultural Science with Honours

SAYA: SU GING SAM SESI PENGAJIAN: 2013-2016
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ACKNOWLEDGEMENT

Firstly, I would like to express my sincere thanks to my supervisor, Dr. Md. Kamal Uddin, for his excellent guidance, advice, caring and patience throughout the research. Apart from that, he also let me experience the research of water stress effect on purslane in the field and financially supported my research. Special thanks go to my co-supervisor, Dr. Mohammed Selamat Madom, who was willing to provide me knowledge on how to produce a good thesis. I was really appreciated their consultation.

Furthermore, I would like to thank laboratory assistants of Faculty of Sustainable Agriculture as well, especially Mr. Panjiman, Madam Anika, Miss Nurul Syakina and Mr. Rohizan, who were willing to guide me for experiment. I would also like to acknowledge Mr. Frederic and Miss Sitti Aminah for their help in the rain shelter throughout whole planting process. My research would not have been possible without their helps. I would also like to thank Assoc. Prof. Dr. Harpal Singh Saini and Dr. Suzan Benedick for being my examiners to give me suggestions and corrected my writing.

Last but not least, I would like to express my sincere appreciation to my beloved family members who were always giving spiritual support to me. Also, I would like to thank my friends for their continuous inspiration and heartiest assistance during the study.

ABSTRACT

A pot experiment was conducted at the rain shelter and laboratory in the Faculty of Sustainable Agriculture, Universiti Malaysia Sabah Sandakan Campus to investigate the effect of different water regimes on the growth, antioxidant content, and carbon, hydrogen and nitrogen content of purslane (*Portulaca oleracea* L.). The soil media used had soil organic matter content of 22.02%, electrical conductivity (EC) 1.15 dS m^{-1} and pH 5.23. The experimental design was Completely Random Design using five treatments namely continuous field capacity condition, continuous saturated condition, continuous flooded condition, flooded 10 days followed by saturated condition, and saturated 10 days followed by field capacity condition with 5 replications. The data on the plant height, leaf length, leaf width, stem diameter, internode length, shoot moisture content, relative leaf water content, total phenolic content, total flavonoid content, ash content, carbon, hydrogen and nitrogen content, and crude protein content were collected after 20 days of treatment application. Results were analyzed by ANOVA using SPSS program and treatment means were compared using LSD test at the 5% probability level. The results revealed that effects of different water regimes on plant height, leaf length, leaf width, stem diameter, total phenolic content, total flavonoid content, ash content, hydrogen content, nitrogen content, and crude protein content in purslane were significant. However, there were no significant effects of different water regimes on internode length, leaf relative water content, shoot water content, and carbon content in purslane. Field capacity condition had produced purslane with longest internode length (76mm), highest leaf relative water content (79.85%), highest total phenolic content (3.06 mg GAE/g), and highest ash content (17.5%). Continuous saturated condition produced purslane with highest plant height (429.0mm), and highest shoot water content (90.59%). Continuous flooded condition produced purslane with longest leaf (26.3mm), widest leaf (14mm), highest total flavonoid content (1.35 mg QE/g), highest carbon(40.3%), hydrogen(6.14%), nitrogen (3.14%) and crude protein content (19.62%). It may be recommended as a water saving technology for the water scarce areas for purslane production.

KESAN REJIM AIR TERHADAP PERTUMBUHAN DAN KANDUNGAN ANTIOKSIDAN PADA PURSLANE (Portulaca oleracea L.)

ABSTRAK

Satu kajian menggunakan pasu telah dijalankan di Perlindungan Hujan dan Makmal Ladang di Fakulti Pertanian Lestari, Universiti Malaysia Sabah Kampus Sandakan, untuk mengkaji kesan rejim air terhadap pertumbuhan, dan kandungan antioksidan pada purslane. Media tanah yang digunakan mempunyai kandungan bahan organik tanah 22.02%, kekonduksian elektrik 1.15 dS m^{-1} dan pH 5.23. Reka bentuk eksperimen adalah CRD dengan menggunakan lima jenis rawatan iaitu keadaan kapasiti ladang berterusan, keadaan tepu berterusan, banjir berterusan, banjir 10 hari diikuti dengan keadaan tepu, dan tepu 10 hari diikuti dengan keadaan kapasiti bidang dengan 5 replikasi. Data pada ketinggian pokok, panjang daun, lebar daun, diamter batang, panjang ruas, kandungan kelembapan batang, relatif kandungan air daun, jumlah kandungan fenol, jumlah kandungan flavonoid, kandungan abu, kandungan karbon, hidrogen dan nitrogen, dan kandungan protein kasar telah dikumpul selepas 20 hari dari tarikh pemberian rawatan. Keputusan yang diperolehi telah dianalisis dengan ANOVA menggunakan program SPSS dan cara-cara rawatan dibandingkan menggunakan ujian LSD pada tahap kebarangkalian 5%. Hasil kajian menunjukkan kesan rejim air yang berbeza pada ketinggian pokok, panjang daun, lebar daun, diameter batang, jumlah kandungan fenol, jumlah kandungan flavonoid, kandungan abu, kandungan hidrogen, kandungan nitrogen, dan kandungan protein kasar dalam purslane adalah ketara. Walau bagaimanapun, tidak ada kesan rejim air yang berbeza yang signifikan pada panjang ruas, kandungan air daun relatif, kandungan kelembapan batang, dan kandungan karbon dalam purslane. Keadaan kapasiti ladang telah menghasilkan purslane dengan panjang ruas terpanjang (76mm), relatif kandungan air daun tertinggi (79.85%), kandungan jumlah fenol tertinggi (3.06 mg GAE/g), dan kandungan abu tertinggi (17.5%). Keadaan tepu berterusan telah menghasilkan purslane yang paling tinggi (429.0mm), dan kandungan air batang tertinggi (90.59%). Keadaan banjir berterusan telah menghasilkan purslane yang daun terpanjang (26.3mm), daun paling luas (14mm), jumlah kandungan flavonoid tertinggi (1.35 mg QE/g), dan kandungan karbon (40.3%), hidrogen (6.14%), nitrogen (3.14%) dan kandungan protein kasar (19.62%) yang tertinggi. Keputusan ini boleh disyorkan kepada kawasan yang sumber air terhad sebagai teknologi penjimatan air untuk pengeluaran purslane.

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LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

ANOVA	Analysis of Variance
C	Carbon
Ca	Calcium
cm	Centimetre
°C	Degree Celsius
DM	Dry Mass
g	Gram
GAE	Gallic Acid Equivalent
H	Hydrogen
Mg	Magnesium
mg	Milligram
mm	Millimetre
N	Nitrogen
ppm	Parts Per Million
%	Percent
K	Potassium
QE	Quercetin Equivalent
Na	Sodium
SPSS	Statistical Packaging of Social Science
S.D.	Standard Deviation
v/v	Volume Per Volume

LIST OF FORMULAE

3.6 $$C = \frac{QE \times V \times DF}{m}$$ 21

Where:

C = Total flavonoid content in mg QE/g dry sample

QE = Concentration of quercetin from the calibration curve in mg/ml

V = Volume of the sample in ml

DF = Dilution factor

m = Weight of dry sample extract in g

3.7 $$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$ 22

3.8 Crude protein (%) = Total nitrogen (%) × 6.25 23

CHAPTER 1

INTRODUCTION

1.1 Introduction

Purslane (*Portulaca oleracea*) naturally found in turfgrass areas as well as field crops and lawn (Uddin *et al.*, 2009; 2010). In North America, purslane is typically regarded as a weed, but it is consumed as a vegetable in many countries in the worldwide (Proctor, 2013). Purslane has broad acceptability as a potherb in Central Europe, Asia and the Mediterranean regions (Uddin *et al.*, 2014). Thus, it is important to evaluate purslane under different water stress conditions since purslane can be considered as a source of food with its benefits.

The previous study on purslane showed that the purslane has better nutritional quality than the major cultivated vegetables. It is known to be high in antioxidants and is a good source of essential fatty acids and carotenes, which have been shown beneficial to human health (Proctor, 2013). Purslane also has the highest amount of α-linolenic acid as well as high concentrations of the antioxidants α-tocopherol, β-carotene, and glutathione (Simopoulos *et al.*, 1992). Besides used in treatment of osteoporosis and psoriasis, it is also used as purgative, cardiac tonic, emollient, muscle relaxant, and anti-inflammatory and diuretic treatment which make it important in herbal medicine (Uddin *et al*, 2014). Therefore, this study is aimed to evaluate the effect of different water regimes on the chemical characteristics of purslane.

Aberoumand (2009) reported that the leaves and stems of *P. oleracea* contained ashes (22.66%), crude protein (23.47%), lipid (5.26%) and fibers (40.67%). The stems and leaves also have high energy values 303.9 Kcal/100g dry weight. Mineral contents (mg/100g DM) were K (14.71), Na (7.17), Ca (18.71), Fe (0.48) and Zn (3.02). Lim and Quah (2007) reported that total phenolic compounds of *P. oleracea* ranged from 127±13 to 478±45mg GAE/100g fresh weight of plant.

Natural antioxidants also known as secondary metabolites, are derived from plants, mainly plant phenolics such as phenolic acids, flavonoids and carotenoids, which are amongst various antioxidants produced by plants for their sustenance (Dai and Mumper, 2010). Recently, phenolic acids and flavonoids have been considered as great antioxidants and proved to be more effective than Vitamin C, E and carotenoids (Apak *et al.*, 2007).

Plant growth development and production are affected by natural stresses in the form of biotic and abiotic stresses such as drought, salinity and others. Drought or water deficit is one of the most important environment stresses that influences on plant production (Abdalla and El-khoshiban, 2007). Purslane is categorized as an annual broadleaf weed. In the previous study on weed control in paddy field showed that seeds from broad-leaved weeds largely dominated in all water regime-treated soil samples compared to the other weed groups (Juraimi *et al.*, 2012). According to another research done by Juraimi *et al.* (2009), broadleaved weeds predominantly *Monochoria vaginalis* and *Limnocharis flava* were the most dominant weeds in most of the water regime treatments in his experiment.

1.2 Objectives

i. To investigate the effect of water regimes on the growth of purslane (*P. oleracea*).

ii. To compare the effect of water regimes on the antioxidant content (total phenolic content and total flavonoid content) and CHN content of purslane (*P. oleracea*).

1.3 Justification of the study

Purslane was chosen in this study because there were research findings that reported *P. oleracea* comprises more nutritive value than other vegetables due to its valuable components such as omega-3 fatty acid, α-tocopherol, ascorbic acid, β-carotene and glutathione-rich. In fact, it is a weed that could found abundantly in Malaysia due to its high adaptability to many adverse conditions such as drought, saline, and nutrient deficient conditions. Nowadays, due to climate changes and global warming, more frequent and prolonged drought events are expected in different parts of the world, leading to weaker crop yields and, in more severe cases, food shortages. Hence, this experiment would like to compare the growth, antioxidant (total phenolic content and total flavonoid content), and carbon, hydrogen and nitrogen content of purslane even under different water regimes. With respect to the important of purslane as a medicinal and valuable plant and because of low information regarding its physiological and chemical reactions under water stress, doing this project is necessary. The results of this study able to provide information to those people suffering from food shortage due to water stress problem since purslane is edible and able to provide nutrients.

1.4 Hypothesis

H_O: There was no significant difference among continuous flooded condition, continuous saturated condition, continuous field capacity condition, flooded 10 days followed by saturated condition, and saturated 10 days followed by field capacity condition on the growth of *P. oleracea*.

H_A: There was a significant difference among continuous flooded condition, continuous saturated condition, continuous field capacity condition, flooded 10 days followed by saturated condition, and saturated 10 days followed by field capacity condition on the growth of *P. oleracea*.

H_O: There was no significant difference among continuous flooded condition, continuous saturated condition, continuous field capacity condition, flooded 10 days followed by saturated condition, and saturated 10 days followed by field capacity condition on the antioxidant content and carbon, hydrogen and nitrogen content of *P. oleracea*.

H_A: There was a significant difference among continuous flooded condition, continuous saturated condition, continuous field capacity condition, flooded 10 days followed by saturated condition, and saturated 10 days followed by field capacity condition on the antioxidant content, and carbon, hydrogen and nitrogen content of *P. oleracea*.

CHAPTER 2

LITERATURE REVIEW

2.1 Purslane

Common purslane (*Portulaca oleracea* L.), a member of the Portulacaceae family, is one of 25 genera of succulent herbs and shrubs in this family (Mitich, 1997). Seven subspecies belong to this species, but the subspecies *oleracea* and *sativa* are the most common. *P. oleracea* is mostly an annual, but it may be perennial in some tropics (Matthews *et al.*, 1993). *P. oleracea* L. is a cosmopolitan species (Danin and Reyes-Betancourt, 2006).

The site of origin is not known for a certainty and several temperate areas of the Northern Hemisphere are proposed: Eurasia, in particular Southern Europe (Walters, 1993), Europe, Western Asia, China (Schoch *et al.*, 1988), India, but also sub-desert areas of Northern Africa, which could explain the succulent aspect of the plant (Holm *et al.*, 1977). Through De Candole (1883), purslane seems be originated in the Western Himalayan area, then spreaded towards the South of Russia and Greece, perhaps as far back as 4,000 years ago because of the nutritional value of the plant and also its adaptability to hostile environments (Bois, 1927). Moreover, purslane is a summer herbaceous plant and the cultivated species are more upright and vigorous than the wild forms.

Salah and Chemli (2004) stated that *P. oleracea* subsp. *oleracea* and *P. oleracea* subsp. *sativa* are distinguished by several vegetative and floral characteristics, while the ornamentations of the seeds are identical with differences in size, although modest. The ornamentations are determined by rounded tubercles arranged in a row, in a regular pattern, with scarce papillae.

Moreover, purslane have a unique morphology that could encourage the growth of the plants even though in adverse environment such as drought condition. Stems are glabrous, fleshy, purplish-red to green in colour, arising from a taproot, often prostrate, forming mats (Muenscher, 1955). They are freely branched 10-56 cm long, and the shoots are erect when young, but often becoming prostrate with age (U.S. Department of Agriculture, 1970). Besides that, the leaves of the purslane are alternate, usually in clusters at the ends of the branches, succulent, thickened, sessile, smooth margined and broad rounded tips, occasionally larger, rounded or nearly truncate at the apex (Vengris, 1972). The leaves may range from 4-28 mm long and 2-13 mm broad in fertile soils. Apical whorls have 2-5 leaves, usually 4. Axillary hairs are missing, inconspicuous or barely visible. In general, the thick succulent leaves, stems and roots enable the plant to absorb and store water. Thus this characteristic helps this weed can easily withstands soil conditions of dry hot weather (Vengris, 1972).

Besides that, flowers are sessile solitary in the leaf axils or several together in the clusters at the end of the branches, 3-10 mm broad, including the 5 pale yellow petals which open only on sunny mornings, fugacious, and 3-4.6 mm long, 1.8-3 mm broad (Vengris, 1972). The style lobes 4-6. Calyx is the lower portion fused with the ovary, the upper part with 2 free sepals, pointed at the tip and 3-4 mm long. Petals and the 6-12 stamens appear to be inserted on the calyx (Zimmerman, 1969).

The fruit of the purslane is a globular capsule that consists of many seeds, ranging from 4-9 mm long, opening by a lid at the middle with the upper part of the calyx attached (Vengris, 1972). The seeds are nearly oval, only about 0.5-0.8 mm in diameter, flattened, broadly ovate, with a yellowish scar and small concave area at the smaller end, edges rounded, roughened by curved rows of minute rounded tubercles, slightly glossy, black in colour (Zimmerman, 1976). Furthermore, the size of the seeds is larger in subsp. sativa (average size 1.2 mm; ± 0.07 S.D.) with respect to subsp. *oleracea* (average sizes 0.86-0.87 mm; ± 0.03 to 0.06 mm S.D.), depending on the populations (Danin *et al.*, 1978; Ricceri and Arrigoni, 2000). Other biometric data (again concerning fresh seeds, generically attributed to *P. oleracea*) are accompanied by descriptions that seem to indicate either one or the other subspecies: the sizes reported by Delorit (1970) was 0.6-0.9mm , could be referred to subsp. *oleracea*, while those of Schoch *et al.* (1988) seem to include the cultivated subspecies (0.7-1.1 mm).

Common purslane is an annual weed, it is very troublesome in any fertile gardens, mucks lands, ornamental crops, cotton fields and lawns in some southern states. This purslane can also be found is waste areas, barren driveways, eroded slopes waysides and bluffs from sea level to 8500 ft. Because of the short life cycle and needs of high temperature for germination and growth, purslane in maritime European provinces is commonly found in warmer vineyard areas. While some in continental climate regions, this plant can establish well even when the winter temperatures drop to -30°c (Vengris, 1972).

2.2 Purslane as a crop

According to Mason (2013), purslane has spread throughout the world as an edible plant. Many cultures embrace purslane as a food. Purslane has been studied for its high ability tolerant to saline growing condition, especially as it can be used as a vegetable crop (Teixeira and Carvalho, 2009). Purslane is also known to be high in antioxidants and is a rich source of essential fatty acids (18:2ω6 and 18:3ω3) and carotenes, which have been shown to have human health benefits (Guil-Guerrero and Rodriguez-Garcia, 1999). Of edible wild plants tested, purslane has the highest amount of α-linolenic acid as well as high concentrations of the antioxidants α-tocopherol, β-carotene, and glutathione (Simopoulos *et al.*, 1992). In addition, melatonin has been discovered in relatively high amounts in purslane leaves (Simopoulos, 2005). The function of melatonin in plants is less well understood. In addition to its antioxidative properties, it is thought to perform roles in diurnal regulation as a plant hormone-like molecule (Kolar and Machackova, 2005).

2.3 Purslane as a weed

Purslane is an aggressive weed and is considered a major problem in many crops throughout the world (Proctor, 2013). Purslane had reported as the eighth most common plant on earth (Holm *et al.*, 1977; Zimmerman, 1976). Singh and Singh (1967) cited purslane as one of the ten most noxious weeds in the Upper Gangetic Plain of India and it is listed as a noxious weed by the state of Arizona. Holm *et al.* (1977) reports that purslane is a weed of forty-five crops in eighty-one different countries. Zimmerman (1976) compared the purslane with two other species of the *Portulaca* genera to determine the "weediness" of purslane. One of the reasons on why the purslane had characterized as a weed is due to the plant's quick response capability. Purslane thrives under a wide variety of photoperiods and capsule numbers are positively correlated with the amount of light received. Purslane can tolerate a wide range of light intensity, temperature regimes, soil types, and produces capsules over a broad range of these factors. When these factors occur at optimal levels, purslane rapidly produces large numbers of capsules (Zimmerman, 1976). Dunn (1970) studied the effects of light quality on purslane's growth and development, and found that increased light intensity and temperature stimulates growth, and yields are greatest under cool white light followed by green, blue, red, and yellow light respectively.

2.4 Purslane as animal feed

Purslane can be beneficial whether eaten directly or indirectly from animal sources. Previous studies with laboratory animals showed that 10% dietary supplementation of purslane using a commercial rat chow was effective in reducing plasma cholesterol and triglycerides in rats (Ezekwe *et al.*, 1995). In another study of Ezekwe *et al.* (2011) has demonstrated the potential for purslane to provide nutritional as well as hypocholesterolemc benefits in animal species. Purslane also has been used in pig (Toan and Preston, 2007) and rabbits feeding (Leung and Foster, 1996). Thus, the purslane can make available contribution on the net income by improving the performance of the birds or reduction of the cost.

Even though under most conditions purslane is a palatable and nutritious livestock food, nitrate poisoning and oxalate poisoning have been reported in livestock feeding on the plant (Schmutz *et al.,* 1968). However, Cantella *et al.* (1968) did not observe any symptoms of poisoning in cattle (*Bos spp.*) fed substantial amounts of purslane leaves and stems. Interestingly, purslane has not been reported toxic in North America (Kingsbury, 1964). In Australia, potentially toxic amounts of oxalate and nitrate have been isolated from purslane. Cases of poisoning have been reported in sheep (*Ovis aries*) and cattle starved for a time and then allowed to graze large amounts of the plant while the plant was in a succulent state. Suspect plants usually grow on soils rich in nitrogen, such as that found in stockyards or in bare clay soils, where there has been a flush of growth after a good rain, then a dry period. Cattle should not be permitted to graze on large amounts of these plants without adequate amounts of roughage (Everist, 1974).

2.5 Pharmalogical activity

2.5.1 Antioxidant activity

Purslane has been reported the antioxidant activity of *P. oleracea* over the different growth stages by using 1, 1-diphenyl-2-picrylhydrazyl (DPPH), ferric-reducing antioxidant power (FRAP) assays and ascorbic acid content (Uddin *et al.*, 2012). The concentrations of Ca, Mg, K, Fe and Zn increased with plant maturity. Calcium (Ca) was negatively correlated with sodium (Na) and chloride (Cl), but positively correlated with magnesium (Mg), potassium (K), iron (Fe) and zinc (Zn). Furthermore, the mature plants of *P. olerecea* had a higher total phenol content and antioxidant activities than immature plants. According to Dkhil *et al.* (2011), aqueous juice form purslane that contain its antioxidant activity resulted in marked improvement in all the studied parameters on the adult male Waster albino rats.

2.5.2 Hepatoprotective activity

Purslane also are said to have hepatoprotective activity. Mohammed Abdalla and Soad Mohamed (2010) had done research on *in vivo* Hepato-protective properties of purslane extracts on paracetamol-induced liver damage. Paracetamol (1g/kg bw) administration to rats resulted in massive elevation in serum and hepatic lactate dehydrogenase (LDH) activity and thiobarbituric acid reactive substances (TBARS) as well as in serum tumor necrosis factor–alph (TNF-α) levels, with a significant decrease in serum and hepatic protein thiols (Pr-SHs) and reduced glutathione (GSH) superoxide dismutase (SOD) and glutathione peroxidase (GPx) in blood and liver. Oral administration of both the leaves extracts at a concentration of 150 mg/kg bw daily for 15 days showed significant protection against an induced increase in serum and hepatic LDH an TBARS as well as serum tumor necrosis factor–alph (TNF-α) levels. The treatment also resulted in a significant increase in serum and hepatic Pr-SHs as well as GSH, SOD and GPx in blood and liver. Apart from that, Anusha *et al.* (2010) also reported the hepaoprotective activity of aqueous extract of the aerial parts of *P. oleracea* in combination with lycopene against carbon tetrachloride induced hepatotoxicity in male wistar rats by intraperitoneal injection of carbon tetrachloride (0.1 ml/kg for 14 days). These studies concluded that both the treatment groups showed hepatoprotective activity against carbon tetrachloride induced hepatotoxicity by significantly restoring the levels serum enzymes to normal when compared with silymarin group and also concluded that oral administration of *P. oleracea* in combination with lycopene significantly ameliorates carbon tetrachloride hepatoxicity in rats.

2.5.3 Antimicrobial activity

Antimicrobial effect of *P. oleracea* extracts on food borne pathogens was assessed by Bae (2004). He found ethyl acetate extract was having highest anti-microbial activity against *Staphylococcus aureus* and *Shigella dysentrica* in comparison to petroleum ether, chloroform and methanol extracts. The ethyl acetate extract of *P. oleracea* showed strong antimicrobial activity against *Staphylococcus aureus* at 4000 ppm concentration. This concentration retarded the growth of *S. aureus* by more than 24 hours and *S. dysentrica* up to 12 hours at 37 °C. On the other hand, Dhole *et al.* (2011) also screened the aqueous and ethanolic extracts of root and leaves of *P. oleracea* for antimicrobial activity against two gram-positive bacteria (*Bacillus subtilis*, *Staphylococus aureus*), one gram-negative bacterium (*Pseudomonas aeruginosa*) and a mould *Aspergillus niger* by agar diffusion method. The highest antibacterial and anti-fungal activity was observed at the concentration of 750 μg/ml. Ethanolic root extract was more potent to inhibit growth of *P. aeruginosa*, while aqueous extract was comparatively more potent for other three microbes.

2.5.4 Nephroprotective effect

Aqueous and ethanolic extract of *P. oleracea* against cisplatin induced acute renal toxicity was studied in rats. Treatment with aqueous and ethanolic extracts in the highest dose (0.8 and 2 g/ kg), 6 and 12 hour before cisplatin injection reduced blood urea nitrogen and serum creatinine. Tubular necrotic damage was also not observed. In another group rats treated with aqueous and ethanolic extract, 6 and 12 hour after cisplatin injection also had blood urea nitrogen and serum creatinine levels significantly lower than those receiving cisplatin alone but mild to moderate cell injury was observed (Karimi *et al.*, 2010).

2.5.5 Antidiabetic effect

A study aimed at revealing the effects of polysaccharide from *P. oleracea* on alloxan-induced diabetic rats and its mechanisms. The polysaccharide treatment resulted in significant decreases of fasting blood glucose, total cholesterol and triglycerides. Polysaccharide also showed a tendency of improvement body weight gain on diabetic rats. Furthermore, the diabetic control group had low serum insulin level comparing with that of normal control group, at the same time, the insulin levels were dose-dependently raised in the polysaccharide treated groups than that of diabetic control group. According to single cell gel electrophoresis and LD50 analysis, polysaccharide was proved to be nontoxic to the animals. The results indicate that polysaccharide would alleviate the blood glucose and lipid rising associated with diabetes, and improve the abnormal glucose metabolism and increase insulin secretion by restoring the impaired pancreas cells in alloxan-induced diabetic rats, which suggest that polysaccharide has the hypoglycemic potential and could be useful on the diabetes therapy (Gao *et al.,* 2010).

2.5.6 Wound healing activity

The preliminary wound healing activity of *P. oleracea* was studied using *Mus musculus* JVI-1 by Rashed *et al.* (2003). For this purpose fresh homogenized crude aerial part of *P. oleracea* were applied topically on the excision wound surface as single and two doses in different amounts. The results obtained indicated that *P. oleracea* accelerates the wound healing process by decreasing the surface area of the wound and increasing the tensile strength. The greatest contraction was obtained at a single dose of 50mg and the second greatest by two doses of 25mg. Measurements of tensile strength and healed area were in agreement.

2.6 Chemical composition of purslane

The chemical composition of the leaves of *P. oleracea* is given in Table 2.1. The antioxidant contents (total phenols, total flavonoids, chlorophylls and carotenoids) in dried powder of *P. oleracea* showed in Table 2.2. It was clear that total phenols and total flavonoids amounted in 354.23 and 95.94 mg/100g (on dry weight basis) respectively. Chlorophyll A, B, total Chlorophyll and total carotenoids were 32.24, 21.63, 53.87 and 110.97 mg/100g respectively.

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