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INFLUENCE OF SOIL TYPE ON THE PHYSICOCHEMICAL AND BIOLOGICAL PROPERTIES OF BIOACTIVE COMPOUNDS OF *Portulaca oleracea* L. FROM ALGERIAN SAHARA

Aida BOUSBIA BRAHIM[*,**], Abdelmalek ZAATER[***], Bachir KHEZZANI[*], Fatma ALIA[*], Atef CHOUIKH[*]

[*] *Laboratory Biology, Environment and Health, Faculty of Natural Sciences and Life, El Oued University, Algeria*
[**] *Biology Department, Faculty of Natural Sciences and Life, Souk Ahras University, Souk Ahras, Algeria*
[***] *Department of Agronomy, Faculty of Natural Sciences and Life, El Oued University, El-Oued, Algeria*
Corresponding author: Atef Chouikh, Laboratory Biology, Environment and Health, Faculty of Natural Sciences and Life, El Oued University, P.O. Box 789, 39000, El-Oued, Algeria. Phone : 00213 666684715, e-mail: chouikhateff@gmail.com/ atef-chouikh@univ-eloued.dz / atchouikh@yahoo.fr

Abstract: This work aims to carry out a quantitative and qualitative assessment of the effect of type of soil on the physicochemical and biological properties of the *Portulaca oleracea* L. growing in two different regions of the southeast of Algeria. For this purpose, sampling tests on saline and sandy soils were considered and values of electrical conductivity, ash percentage, the polyphenol content and its fractions were measured for both types of soil. It was shown that the plant cultivated in sandy soil showed better physicochemical and biological properties, except the anthocyanin content, which has the tendency to increase in some saline soil. According to High-Performance Liquid Chromatography (HPLC) results, it was observed that the chlorogenic acid and naringin are present in all the subtracts issued from the *Portulaca oleracea* L. However, higher quercetin concentration compared to the other phenolic compounds was observed. The Inhibition Concentration (IC_{50}) values obtained by the ($DPPH^{\cdot}$) test show fluctuation in the antioxidant activity of extracts that varies between 18.62 to 399.60 µg/mL. This indicates that the reducing capacity of the extracts is medium in saline soil and highly variance in sandy soil. In addition, the extracts of aerial part showed a better total antioxidant capacity compared to the extracts roots. Regarding the values of the Sun Protection Factor (SPF), we could say that all samples of the plant have given average protection values, highlighing that the roots showed better values compared to aerial parts of the extracts. Statistically, the type of soil shows significant differences in the pH, also an influence on the total polyphenols content ($p \leq 0.01$), and in flavonoids content ($p \leq 0.05$). On the other hand, the parts of the plant have exhibited significant differences in the amount of ashes and in the total antioxidant capacity ($p \leq 0.01$), and in the SPF values ($p \leq 0.05$).

Key words: *Portulaca oleracea* L.; soil type; physicochemical characteristics; bioactive compounds; biological properties; Antioxidant activity; HPLC.

INTRODUCTION

Portulaca oleracea L. (purslane) is a much-branched herb with ovate leaves and yellow flowers. The flowers are supported by calyx green sepals, with trigonal-shaped embedded seeds assembled form having 20-25 per capsule [18], It's the eighth most common plant distributed throughout the world, being a heat- and drought-tolerant plant [8].

The chemical composition of purslane indicates that it is an important source of nutrients [3], and has a high potential to be used as vegetable nutrition with added value for both animals (fodder) and human consumption [8], and can also be used to make nutritional supplements [51].

In traditional medicine, the purslane is astringent and diuretic, bile anodyne, stoppage of bleeding, crushing of bladder stones and hemorrhoids, and could be used for cardiovascular diseases [35, 52] proved the purslane aqueous extract and fish oil have therapeutic potential to improve hepatic, renal functions, and oxidative stress in irradiated rats. In addition, Alam *et al.* (2015) [4] proved that the different levels of salinity treatment at purslane resulted in the increased production of bioactive compounds about 8–35% in total phenolic contents and 35% in total flavonoid contents.

In this context, the purslane cultivated in Southeast Algeria is considered to carry out a qualitative and quantitative assessment of the effect of the soil type on the bioactive compounds and their distribution in the plant organs. In addition, the physicochemical (pH, electrical conductivity and ash content) and biological properties (total phenolic content and its fractions, qualitative analysis and antioxidant activity) of purslane are also studied.

MATERIALS AND METHODS

Plant material

The Purslane plant was collected in the summer of 2020 from the Southeast of the Algerian Sahara; three sites in the Lemghaier province (saline soil) and three sites in the El-Oued province (sandy soil) (see Table 1). The plant was dried, crushed, and kept away from moisture and light.

Physiochemical characteristics

Physiochemical parameters in plant material such as the percentage of ash values, pH, and electrical conductivity were measured following the methodology performed by Benesi *et al.* (2004) [11] and Silva *et al.* (2009) [47] respectively. All the analyses were performed based on the collected and dehydrated samples plant.

Preparation of methanolic extract

Ten grams of the dry plant was macerated with 150 mL of methanol (99%) at room temperature in the dark for 24 hours. After filtration, the solvent evaporated to dryness under reduced pressure in a rotary evaporator at 50°C (type Buchi R-200), to get the crude extract. The extract was stored in a place protected from bright light and humidity [21].

Table 1. The location of the sample collection and coding area of the Purslane plant (*Portulaca oleracea* L.)

Type of soil	Collection area	Plant organ	Abbreviation
Saline (Lemghaier province)	Ain Choucha (33°25'17.346"N;6°5'57'8.718"E)	roots	AA
		aerial part	AS
	M'rara (33°28'25.567"N;5°38'28.281"E)	roots	MA
		aerial part	MS
	Tegudidine (33°32'34.336"N;6°1 '11.060"E)	roots	TA
		aerial part	TS
Sandy (El-Oued province)	Rebah (33°19'39.802"N;6°53'7.927"E)	roots	RA
		aerial part	RA
	Souihla (33°33'13.758"N;6°52'59.046"E)	roots	SA
		aerial part	SS
	Gummer (33°31'22.480"N;6°44'26.799"E)	roots	GA
		aerial part	GS

Determination of total phenolic content (TPC)

The amount of total phenolic in extract was determined according to Folin-Ciocalteu's method of Singleton-Rossi cited in Chouikh and Rebiai (2020) [16] with slight modification; 0.2 mL of methanolic extract were introduced into a test tube containing 1 mL of Folin-Ciocalteu reagent (10% v/v), and 0.8 mL of Na_2CO_3 (7.5%). After 30 min incubation at room temperature, the absorbance was measured at 765 nm with a spectrophotometer UV-Vis (Jenway 6715, UK). The total phenolic content was expressed as mg of gallic acid equivalents per gram of extract.

Determination of flavonoid content (FC)

The total content of flavonoids was measured according to the method of Ordonez *et al.* cited in Chouikh *et al.* (2018) [15]. 1 mL of each extract were blended with 1 mL of $AlCl_3$ (2% w/v). After stirring the solution, it incubated for 15 min at room temperature. The absorbance was measured at 430 nm with a spectrophotometer UV-Vis. The flavonoids content was expressed as mg equivalents quercetin per gram of extract.

Determination of tannin content (TC)

The content of tannins was measured based on Folin-Denis's assay described by Killedar and More (2010) [31]. About 0.5 mL of Folin-Denis's reagent (99%) and 1 mL of Na_2CO_3 (35 %) were added to 100 µLof the diluted extract. A certain amount of distilled water was added in order to get a total volume of 100 mL. The mixture was left for about 30 min in the dark before being analyzed by the spectrophotometer UV-Vis with a wavelength value of 700 nm. The amounts of tannins were expressed in mg of gallic acid equivalents per gram of extract.

Determination of anthocyanin content (AC)

The total anthocyanin content was determined using the method described by Çam *et al.* (2009) [12] with minor modifications. AC was evaluated by the pH differential method using two buffer systems: KCl/HCl [pH 1.0 (0.025 M)] and $H_2C{=}CHCO_2Na$ [pH 4.5 (0.4 M)]. Two aliquots (200 µL) of the crude extract were mixed with 1.8 mL of corresponding buffers. The absorbance was then measured at 510 nm and 700 nm by the spectrophotometer UV-Vis.

AC of samples (mg cyanidin-3-glucoside / 100 g of extract) was calculated by following equation:

$$AC = (A \times MW \times DF \times 100)/ MA$$

where: $A = (A_{510}\text{-}A_{700})\ pH_{1.0} - (A_{510}\text{-}A_{700})\ pH_{4.5}$; MW: molecular weight (449.2 g/mol); DF: dilution factor (10); MA: molar absorptivity of cyanidin-3-glucoside (26.9 L/mol.cm).

Qualitative analysis by HPLC

In this work, we have used HPLC type Shimadzu LC 20 AL equipped with the universal injector (Hamilton 25 µL). An analytical column of Shim-pack VP-ODS C18 (4.6 mm×250 mm, 5 µm), UV-VIS detector SPD 20A type (Shimadzu) were used to detect the phenolic compounds of crude extract. The mobile phase (acetonitrile /acetic acid 0.1% v/v) consisted in performing a gradient elution, and the reverse chromatography phase analyses were carried out with non-polar aliphatic residues. The flow rate was 1 mL/min, and the injection volume was 0.45 µl. The monitoring wavelength was 268 nm, and the injected volume of samples and standards phase was 20 µl [15].

Identification of some compounds was done by comparing their retention time and UV absorption spectrum with those of the phenolics standards all (99%) from Sigma Aldrich, Chemicals Co (USA).

Evaluation of Antioxidant activity

DPPH˙ free radical scavenging

The DPPH• scavenging activity of the extracts was measured method of Rebiai *et al.* (2015) [41]. One mL of different concentrations of each extract was added to 1 mL of DPPH• solution (0.1×10^{-3} mol). After incubation or during 15 min at room temperature, the absorbance was measured at 517 nm by the spectrophotometer UV-Vis. The inhibition activity was calculated in the following way [13]:

$$I\ (\%) = [(A_c - A_s) / A_c] \times 100$$

where: Ac: Absorbance of the control. As: Absorbance of the sample.

The IC_{50} (50% of free radical inhibition of each extract) was calculated from equation linear of concentration by the percentage of inhibition. The lower the IC_{50} value (µg/mL) expressed as high antioxidant capacity [50].

Reducing power assay

According to the method of Oyaizu (1986) [40] with slight modification as done by Huda-Faujan *et al.* (2009) [25] and Jayanthi *et al.* (2011) [28], 0.5 mL of each extracts at various concentrations (from 5 to 100 µg/mL) was mixed with 1.25 mL of a phosphate buffer (0.2 mol, pH 6.6) and 1.25 mL of potassium ferrocyanide $K_3[Fe(CN)_6]$ (1% w/v). The mixture was

incubated in a hot bath at 50°C for 20 min. Then, 1.25 mL of trichloroacetic acid (10%) was added and centrifuged at 3000 rpm for 10 min. A 1.25 mL aliquot of the supernatant, was mixed with 0.25 mL of $FeCl_3$ (0.1%) and diluted with 1.25 mL of distilled water. The absorbance was measured at 700 nm by the spectrophotometer UV-Vis. Ascorbic acid was used as a positive control.

Determination of total antioxidant capacity (TAC)

The phosphomolybdate assay system was used to determine the total antioxidant activity of various fractions of the extract determined by the method described by Zengin *et al.* (2011) [53]. 150 µLof extract solution was mixed with 1.5 mL reagent solution [6 M: sulfuric acid, 28 mM: sodium phosphate and 4 mM: ammonium molybdate], and stirred well then left for 1 h in a water bath at 95°C. After a cooldown period, the mixture reached room temperature, a wavelength was measured at 695 nm by the spectrophotometer UV-Vis. The antioxidant capacity is deduced from the regression equation ($y=0.3513x-0.0073$/ $R^2=0.9948$) for a calibration range established with ascorbic acid, the results expressed mg equivalents ascorbic acid per gram of extract (mg AA E/g extract).

Determination of sun protection factor (SPF) by UV-Vis Spectrophotometry

The Determination of the effectiveness of protection against UV rays was carried out *in vitro* by determining the SPF value by UV-Vis spectrophotometry. According to Dutra *et al.* (2004) [19], this factor is determined by calculating the difference in the spectroscopy readings of an methanolic solution of each exract (0.5 mg/mL) in the spectral range from 290 nm to 320 nm, where; the amount of spectral transition is determined by 5 nm according to the following law:

$$SPF = CF \times \sum EE(\lambda) \times I(\lambda) \times Abs(\lambda)$$

Where: EE: erythemal effect spectrum; I: solar intensity spectrum; Abs: absorbance of sunscreen product; CF: correction factor (= 10).

The values of EE x I (Table 2) are constants predetermined by Mbanga *et al.* (2015) [37].

The results were obtained by comparing to categories of sunscreens in table 3 according to Schalka *et al.* (2011) [45].

Table 2. Normalized product function used in the calculation of SPF

Wavelength (nm)	EE x I (normalized)
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0837
320	0.0180
Total	**1**

Table 3. Categories of sunscreens based on the value of the SPF

Protection Level	SPF Value
Maximum	> 50
High	30-50
Medium	15-30
Low	2-15

Statistical analysis

All the analyses of the tests were triplicated. The data were analyzed by comparing two observations of different variances tests (T-test) using Microsoft Excel software (Version 2010), which was also used to plot the different curves.

RESULTS

Physicochemical parameters

The results obtained by the physicochemical analysis are shown in Table 4. the pH, all samples of plants show similar values. The electrical conductivity values and ash percentage varied according to soil type. In fact, the plant grown in sandy soil shows higher conductivity and ash percentage values that the plant harvested from saline soil.

The contents of polyphenol and its fractions in methanolic extracts of the plant

The content of the polyphenol and its fractions are shown in (Fig. 1). Generally, the extracts issued from sandy soil provide higher polyphenol contents and its fractions, except the anthocyanin content, which shows higher values in MA and TA in saline soil.

The qualitative analysis by HPLC

The analyses by HPLC chromatography helped us identify the total number of phenolic compounds in methanolic extracts (Fig. 2). According to the retention time and the standards, we were able to identify and determine the concentration of nine phenolic

Table 4. Physicochemical analysis of the Purslane (*Portulaca oleracea* L.) harvested in saline and sandy soils: mean value ± standard errors for each parameter analyzed.

Type of soil	area/organ	pH	Electrical Conductivity (mS/cm)	Ash %
Sandy	RA	6.52±0.02	3.13±0.05	29.61±0.2
	RS	6.32±0.03	4.03±0.07	19.73±0.1
	SA	6.12±0.01	7.17±0.03	29.99±0.16
	SS	5.75±0.05	6.03±0.07	21.53±0.21
	GA	6.29±0.01	6.46±0.04	27.33±0.12
	GS	6.43±0.02	5.54±0.05	24.15±0.18
Saline	AA	7.16±0.04	3.88±0.02	24.25±0.2
	AS	6.7±0.03	4.2±0.05	14.95±0.05
	MA	7.02±0.03	5.01±0.07	21.38±0.1
	MS	6.63±0.06	2.59±0.03	14.04±0.08
	TA	7.02±0.03	8.56±0.06	26.34±0.2
	TS	6.29±0.01	3.8±0.05	15.79±0.16

compounds out of twelve extracts outlined in (Table 5). According to these results, we observed the presence of chlorogenic acid and naringin in all extracts. Furthermore, we observed high concentrations of quercetin in the plant extracts compared to the other compounds.

Estimation of Antioxidant activity

Free radical DPPH˙ scavenging test

The IC_{50} of the plant extracts was compared to standard ascorbic acid. The values for IC_{50} (µg/mL) of the extracts ranged from 18.62 µg/mL in SS to 399.60 µg/mL in TA, while IC_{50} of AA was 15.01 µg/mL (Fig. 3).

In comparison to samples from both locations, IC_{50} values for two parts of the plant were higher in the sandy region, indicating that sandy region plants have a greater ability to scavenge radicals, even at lower concentrations, which is consistent with the quantitative polyphenols content data. In general, the antioxidant activity of the roots appears to be higher than that of the other parts studied. Regardless, distinctions in plant parts and places are clearly shown.

Evaluation of the reducing power

The reducing capacity of Purslane extracts was found to have medium reducing power in extracts of saline soil with an EC_{50} (Fig. 4) ranging from 37.32 to 133.46 µg/mL. However, the reducing capacity of the extracts issued from sandy soil was found to be heterogeneous (high, medium, and low values were observed). When comparing the extracts between themselves, we observed that the SS extract has better reducing ability compared to the rest of the extracts of the plant and the ascorbic acid.

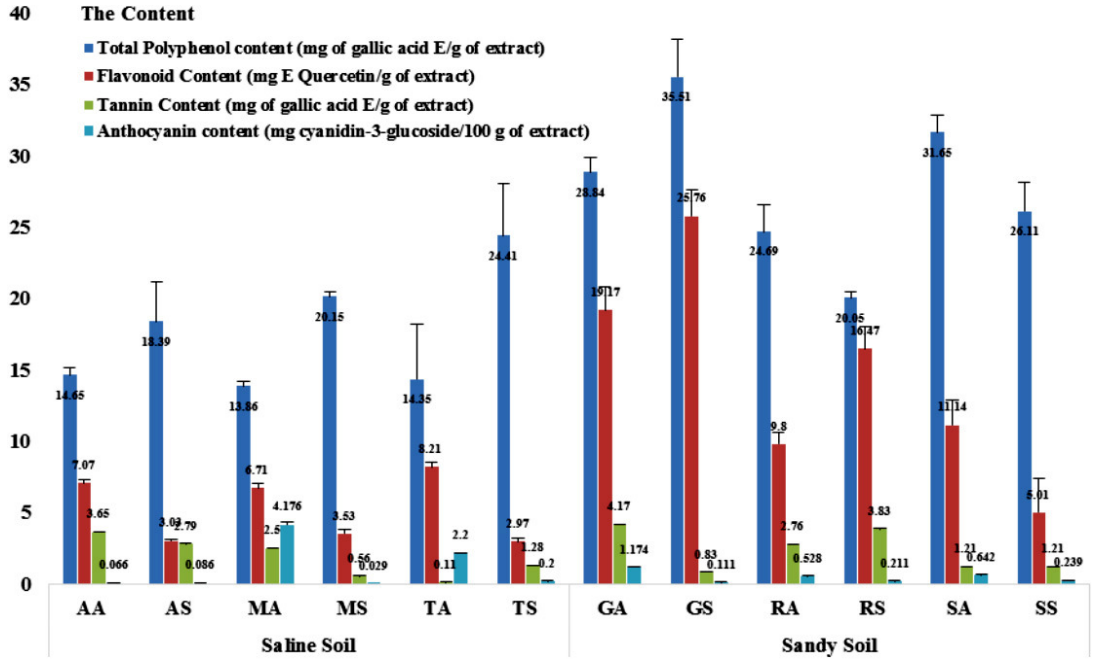

Figure 1. The polyphenol content and its fractions from Purslane (*Portulaca oleracea* L.) collected in saline and sandy soil.

Table 5. The number of peaks and the concentration (mg/g of extract) of some phenolic acids and flavonoids compounds in the extracts of the Purslane (*Portulaca oleracea* L.) (n=1).

Type of soil			Saline Soil						Sandy Soil					
Extracts			AS	AA	MA	MS	TS	TA	GS	GA	RS	RA	SA	SS
Number of peaks			55	61	54	59	58	49	55	50	52	53	49	54
Compounds	**Ret. Time(min)**	**Equation (regression curve)**	**Quantity (mg/g extract)**											
Gallic acid	5.29	y=54681x	0.371	0.198	/	0.052	0.179	/	0.201	0.088	0.418	0.018	0.217	/
Chlorogenic acid	13.392	y=21665x	0.19	0.163	0.212	0.456	0.227	0.116	0.09	0.282	0.124	0.099	0.087	0.068
Vanilic acid	15.531	y=65077x	0.02	/	0.069	/	/	/	/	0.062	/	/	/	/
Caffeic **acid**	16.277	y=84066x	/	0.032	0.05	0.031	/	0.028	0.009	0.047	/	0.011	0.017	0.025
Vanilin	21.46	y=58930x	/	/	0.092	/	/	/	/	0.018	/	0.106	/	0.024
p-Comaric acid	23.817	y=49495x	/	0.01	/	0.008	/	/	/	/	/	0.009	0.075	0.057
Rutin	28.37	y=28144x	/	/	/	0.009	/	/	0.013	/	/	/	/	/
Naringin	34.788	y=19379x	0.067	0.072	0.129	0.417	0.262	0.058	0.172	0.153	0.269	0.237	0.095	0.234
Quercetin	45.047	y=45378x	2.308	1.093	1.345	1.129	1.573	1.368	1.409	2.281	0.115	2.162	/	0.824

Evaluation the Total Antioxidant Capacity (TAC)

The concentrations of TAC (Fig. 5) for all the extracts ranged between 1.30 and 2.56 mg E AA/g Ex, were found to be lower than the value of BHT 0.56 mg E AA/g Ex. Also, the aerial part of the extracts showed better total antioxidant capacity compared to roots extracts, especially extract of AA, TA and SA.

On the other hand, when FRAP and total antioxidant capacity are compared, saline samples were found to be more effective. The quality of the phenolic compounds is most likely to be responsible for this performance. Several results show that anthocyanins are important antioxidants with nutritional, physiological, and pharmacological effects.

Estimation of Sun Protection Factor (SPF)

After calculation of SPF values (Fig. 6), the samples of Purslane exhibited median protection values (27.71 to 11.47) except for TA and SA samples (4.27 and 8.9 respectively) which showed weak values of sun protection factors. generally, we could say the roots samples provided a much better sun protection factor compared to aerial parts samples.

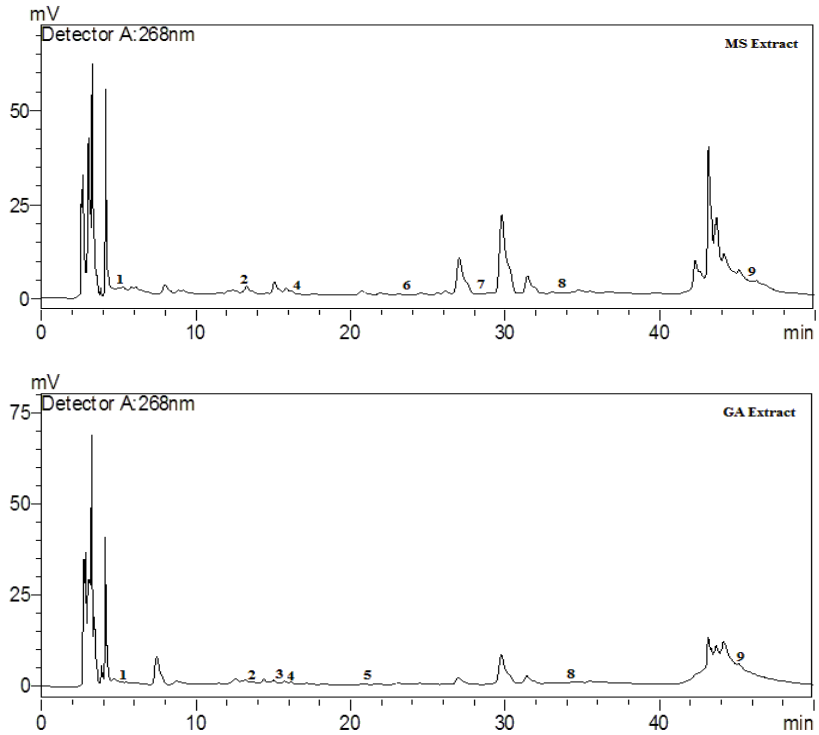

Figure 2. HPLC chromatograms of some extracts. monitored at 268 nm: 1: Gallic acid; 2: Chlorogenic acid; 3: Vanillic acid; 4: Caffeic acid; 5: Vanilin; 6: p-Coumaric acid; 7: Rutin; 8: Naringin; 9: Quercetin

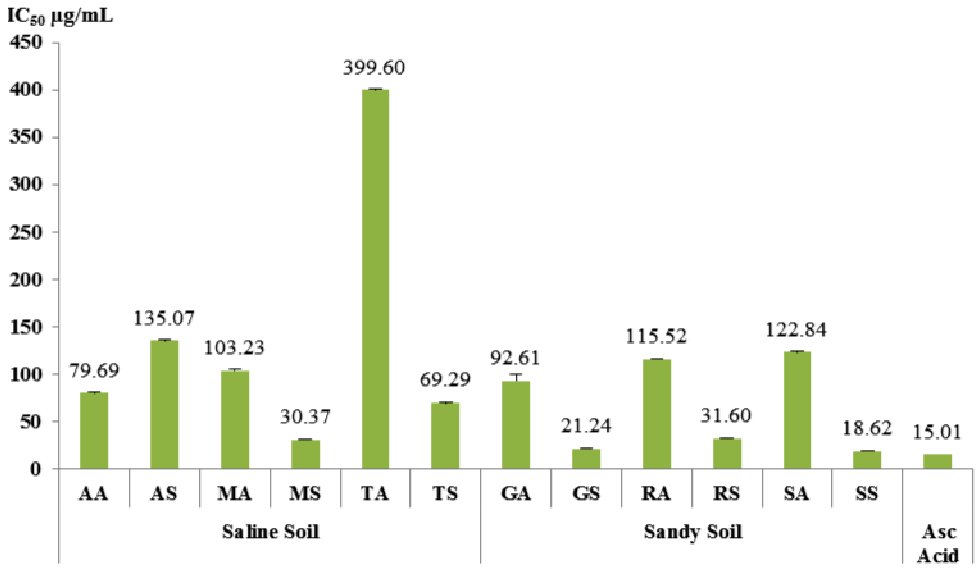

Figure 3. IC_{50} values of extracts of Purslane (*Portulaca oleracea* L.) in DPPH• Free radical scavenging test.

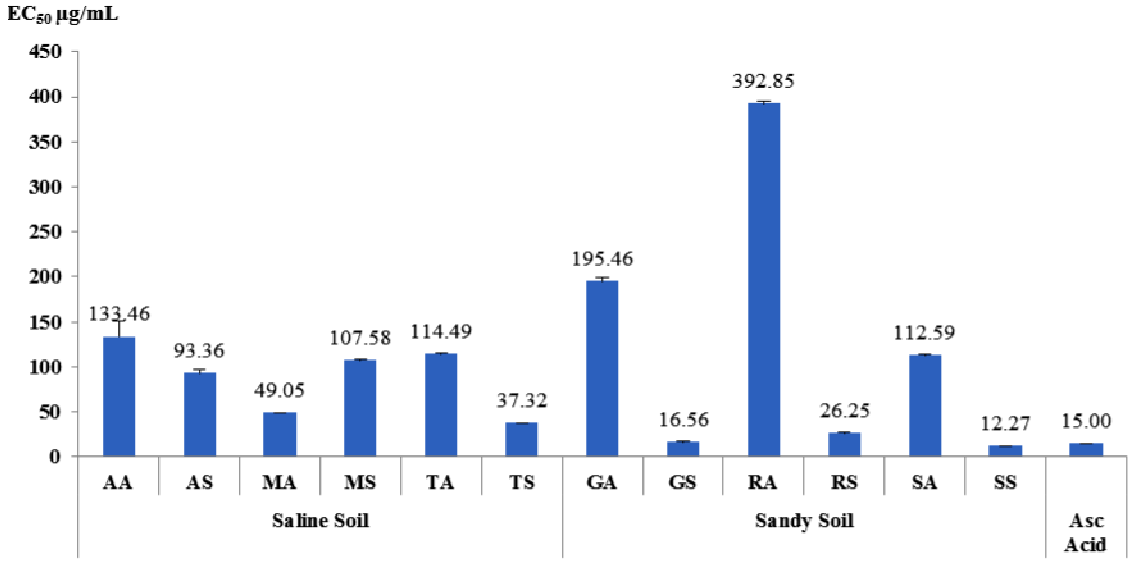

Figure 4. EC_{50} values in reducing power assay of different extracts of Purslane (*Portulaca oleracea* L.) and positive controls.

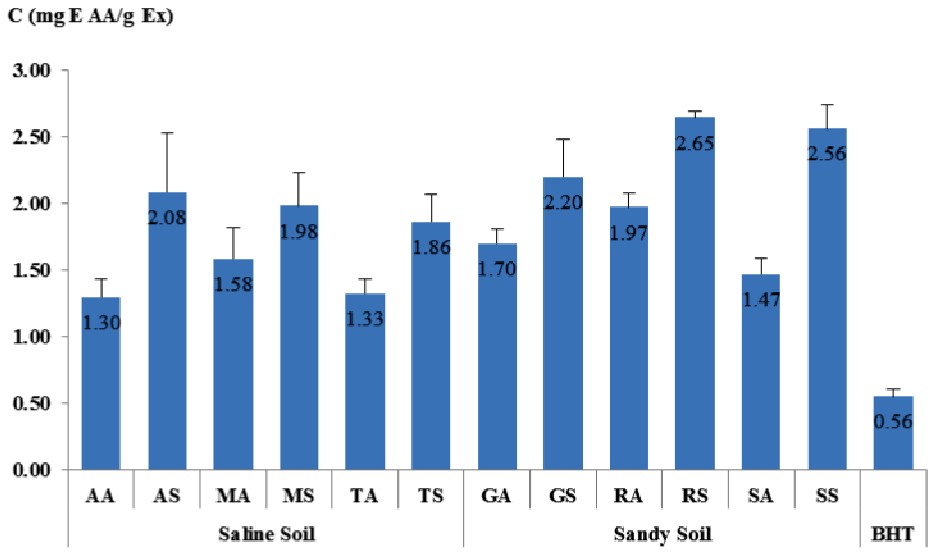

Figure 5. Total antioxidant capacity by of different extracts of Purslane (*Portulaca* oleracea L.) and the BHT.

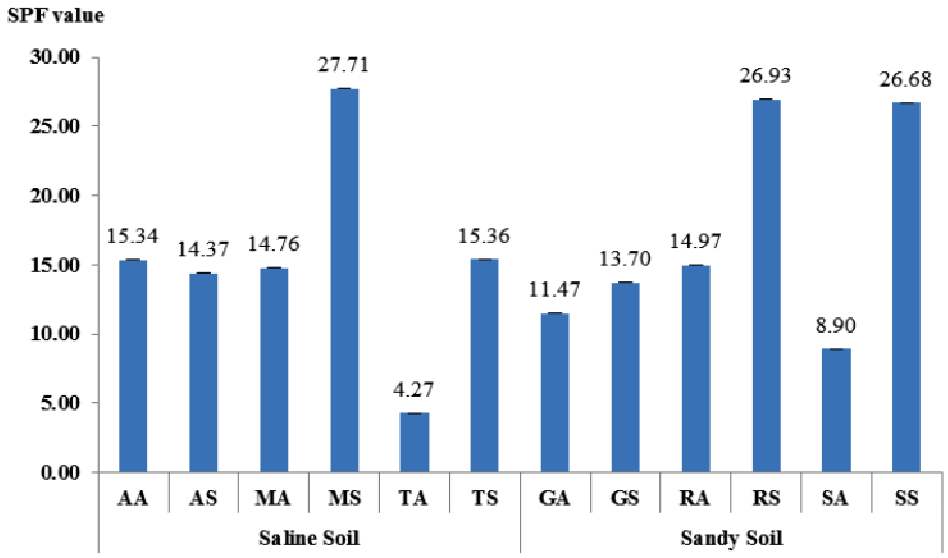

Figure 6. SPF values of Purslane (*Portulaca oleracea* L.) samples cultivated in two types of soil.

Statistical analysis

Through the results achieved at T-test (Table 6), the variation of soil shows significant differences in the pH, the total polyphenols content ($p \leq 0.01$), and flavonoids content ($p \leq 0.05$). Significant differences in the organs of the plant were noticed in the ash values and total antioxidant capacity ($p \leq 0.01$) and in Sun Protection Factor ($p \leq 0.05$).

Table 6. P values at T-test between two types of soil and between two plant organs

Parameter	Between two types of soil	Between two organs of the plant
Electrical Conductivity	0.5089	0.2116
pH	0.0086**	0.1714
Ash values	0.0727	0.0047**
Total Polyphenol Content	0.0054**	0.5244
Flavonoids content	0.0264*	0.8430
Tannin Content	0.5398	0.4409
Anthocyanin Content	0.4061	0.0867
DPPH free radical scavenging	0.2788	0.1056
Reducing power test	0.5794	0.0646
Total Antioxidant Capacity	0.1202	0.0031**
Sun Protection Factor	0.6902	0.0257*

DISCUSSION

In the current study, we have found that the pH values are higher than those reported by the previous research of Abd El-Aziz *et al.* (2014) [1], This difference in the pH values may be due to the plant's physiological state [22]. Abiotic stress - particularly water and salt stress - creates a difference in the concentration of asmolite from one plant to another. This may lead to the variation of the plant's acidity values. On the other hand, potassium may also be a cause of this difference. Indeed, during abiotic stress [24]. In addition, Khelef *et al*. (2019) [30] pointed out that the variation or similar pH value depends on the effect of genetic factors of the plant, and According to Silva *et al*. (2009) [47] the pH values are due to the presence of organic substances such as starch; proteins; carbohydrates and organic acids, and inorganic ions, such as phosphate, sulfate and chloride.

In general, a plant's pH reveals the stability of its bioactive metabolites [49]. It is considered to be the most sensitive physiological criterion, because the Redox potential (Eh) and pH are respectively and jointly major drivers of soil, plant and microorganism systems, so they alter Eh and pH in the rhizosphere to ensure homeostasis at the cell level [26]. This latter is influenced by the quantitative content of acids, proteins, sugars, and the ratio of cations and inorganic ions [17], especially ions of phosphate, sulfate, and chloride [47].

The electrical conductivity and ash content express the amount of electrolytes (mg/dL) in the plant. According to Amalfitano *et al.* (2017) [7], the ash quantity is related to the physiological state of the plant and its need for mineral salts and it is also affected by the climatic conditions prevailing in the area of its growth.

The difference in the mineral content in the plant depends on several variables, such as is water absorption, nature of the soil, its physiological growth stage and the plant organ [33].

The quantitative difference in the mineral content in Purslane between the two studied parts of the plant may be attributed to their structural and functional differences. Sarić *et al.* (1991) [44] suggested that the difference in the morphological structure, as well as the morphological functions of the plant organs, would make a positive difference in their mineral content. Bao *et al*. (2021) [10] mentioned that the plants have regulatory mechanisms to coordinate cytoskeletal functions in response to incoming signals, such as calcium ions (Ca^{2+}) working on the regulation of the cytoskeleton to coordinate plant development and cell shape formation. Indeed, when we compared our results with the previously published data, we have found that the total polyphenolic contents are much lower than those reported by researchers like Silva *et al.* (2014) [48] and Alu'datt *et al.* (2019) [6].

The phenolic content of the Purslane is affected by the availability of nutrients in the soil solution. Amalfitano *et al.* (2017) [7] mentioned that the presence of unfavourable elements in the rhizosphere leads to the accumulation of magnesium ions, calcium and potassium in plant tissue. According to recent studies published by Morano *et al.* (2017) [38] and Lam *et al.* (2020) [32], the cationic accumulation in the plant body leads to a decrease in its biomass, especially the phenolic ones. Accordingly to Lam *et al.* (2020) [32] appointed the phenolic acid content in the plant was increased under nutrient deficiency (nitrogen, phosphorus and potassium) and the total polyphenols content was maximized under nitrogen deficiency.

The quantitative and qualitative difference of the secondary metabolites between individuals of the same species is due to the difference in their physiological regulation mechanisms, as these compounds are synthesized as media for rapid adaptation to the conditions of the growth medium [14]. This is consistent with the study of Hait *et al.* (2019) [23], which mentioned that the phenolic compounds and the polyphenols present in all the parts of the plant, even those underground, play several physiological roles and participate in the control of the development of the living system. Furthermore, Khelef *et al.* (2019) [30] underline that the quantitative difference of polyphenols in the extracts of a species is due to the different components of the tissues that compose them on the one hand, and to the intensity of photosynthesis on the other hand.

The obtained results are in accordance with what was reported in Silva *et al.* (2014) [48] related to the Portugal Purslane. They found that the total polyphenols content changes with the change in the growth region of the plant. However, our results do not agree with the findings of Alu'datt *et al.* (2019) [6] related to the Jordan Purslane. The latter found that the total polyphenols content in the wild plant is generally

lower than what we have obtained. On other hand, our study demonstrated that the polyphenol content in purslane varied from 14 to 36 mg GAE g-1 which was not consistent with the results of Saffaryazdi et al. (2020) [42] about purslane. Generlly, our results showed that the amount of phenolic compounds in the roots part was higher than the aerial part, except the samples of RA and SA, they showed the opposite (Fig. 1). In sandy soil, the phenolic content of aerial part significantly was greater than the aerial part of saline soil. But, in root part the values of total phenol were similar, except in GS the content was much larger than the rest of the samples.

In fact, according to Silva *et al.* (2014) [48], differences between locations may be explained by differences in growing conditions, including temperature, humidity or drought and characteristics of the soil. As it is commonly known, the plants growing in saline regions are subjected to higher drought than plants growing in sandy regions. Variation of phenolic concentrations in purslane parts confirms the influence of both location and climate factors on the production and release of these metabolites.

In general, according to Youssef *et al.* (2014) [52], the decrease in total phenolic content can be attributed to the binding of polyphenols with other compounds (proteins). It may also be deteriorated due to other factors such as the activity of polyphenol oxidase during preservation, organic acid content, sugar concentration and pH.

The difference observed in the quantitative content of anthocyanin between the plants of the saline and sandy regions may be due to the severity of the nutritional stress in particular. Akula *et al.* (2011) [2] indicates that these values would lead to a tripling of the amount of anthocyanin produced in the nutritionally stressed plants compared to the unstressed species, or by the different production of each pigment at different locations, in response to the environmental factors, according to their function as pigmentation and photo-protection [48].

The content of such phenol compounds varied greatly amongst plant parts depending on their geographic origin. These findings are consistent with those of Sdouga *et al.* (2020) [46], who found that environmental variables influence the amount of Purslane in bioactive chemicals. The chlorogenic acid was the most abundant phenolic acid in our samples. In reality, hydroxycinnamic acids are phenolics that are non-flavonoid and have a C6-C3 structure. These chemicals are used in plant defence tactics that are both structural and chemical [39].

Gallic and chlorogenic acids were found in our samples, and they can occur spontaneously or as components of plant polymers. Flavonoids play a role in a wide range of biological processes. This study successfully quantified three flavonoids: rutin, naringin, and quercetin, with different concentrations in different plant samples. Previous studies identified only two flavonoids, rutin, and naringin, in wild *Portulaca oleracea* L. [46]. Furthermore, the current findings indicate a considerable level of diversity within the different investigated samples, particularly for flavonoids and phenolic acids, implying a strong relationship between geographic origin and environmental conditions, and phenolic composition. Flavonoid compounds levels vary depending on the portion of the plant analyzed, according to Zhu *et al.* (2010) [54]; the root usually has the highest levels, followed by the aerial part. This is largely in line with what we have found in our research. In reality, quercetin is a flavanol, which is the most widely distributed of flavonoids, which was consistent with our results and of Santiago-Saenz *et al.* (2018) [43]

In general, phenolic acids and flavonoids are found in both parts of the plant with different concentrations. Accordingly, the quantitative and qualitative variation of polyphenols between plant parts can be attributed to the extent to which this organ contains primary metabolites and the extent of its physiological need for these compounds. According to many studies, these substances have shown antioxidant properties that have varying effects depending on the chemical [34] stated that chlorogenic acid is due to scavenging species of oxygen and nitrogen. Quercetin is also one of the most important bioflavonoids found in plants, and it has been shown to be an effective ROS scavenger [36]. Naringin has also been reported to have antioxidant properties [29].

The polyphenols have the best antioxidant activity, because of their capabilities of hydrogen donors and as reducing agents [27], metal chelators [9].

We can explain the difference in antioxidant activity between the samples to the functional capability of the antioxidants compounds, structure and purity [15, 20]. Previous studies have shown that phenolic compounds with ortho- and para-dihydroxylation, or a hydroxy and a methoxy group, or both, have higher antioxidant activity than simple polyphenols and that the presence of double bond conjugated and ketone groups in the whole molecule may play different polarities in the structure of antioxidants [5].

In purslane plant the soil type influence on electrical conductivity, ash percentage, polyphenol content and its fractions and on the presence, absence and concentration of some phenolic compounds concentrations and also on antioxidant activity and sun protection factor.

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