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Variations In Composition and Activity of *Matricaria Pubescens* (Desf.) Schultz Harvested from Different Regions in Algeria

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Matricaria pubescens is traditionally used as a postpartum antihemorrhagic and to treat digestive disorders. The aim of this study is to determine the total amounts of phenols, flavonoids, condensed tannins, hydrolysable tannins, anthocyanins and total antioxidant capacity of samples from different regions and periods in Algeria in order to guide the selection of varieties and the period of harvest. The analysis was carried out by Ferric reducing antioxidant power (FRAP) and DPPH radical scavenging capacity. The methanolic extracts of the aerial parts of 8 varieties of *Matricaria pubescens* were tested. The results indicated that these varieties had strong radical scavenging capacity as well as a strong reducing antioxidant power. The average contents of polyphenols, flavonoids, condensed tannins, hydrolysable tannins and anthocyanins were 1.58 ± 0.33, 38.44 ± 10.77, 0.63 ± 0.2, 1.22 ± 1.55 and 0.39 ± 0.13 mg/g of dry matter, respectively, with the highest contents found in the samples harvested from the region of Ouargla. The Ferric reducing antioxidant power was positively correlated with the contents of hydrolysable tannins which play a major role in the antioxidant properties. Samples were divided into two groups by cluster analysis and variables measured. These results are useful for the selection of varieties and as guidance for their harvest.

Keywords: Cluster analysis; DPPH Radical scavenging capacity; Ferric reducing antioxidant power (FRAP) and phenolic compounds; Matricaria pubescens

I. INTRODUCTION

Recent decades have been marked by the particular interest shown towards the development of medicinal plants as sources of natural bioactive substances. As a result, much research is being carried out to study the therapeutic effects of natural antioxidants. However, this source seems inexhaustible, since only a small part of the 250,000 known plant species have been investigated phytochemically and pharmacologically, and each species may contain thousands of different constituents (Fabricant & Farnsworth 2001; Atanasov *et al.,* 2015). Natural substances derived from plants have multiple interests that are used in cosmetology, dermopharmacy and in the food industry, among these compounds, the secondary metabolites which are particularly illustrated in the therapeutic field (Mushtaq *et al.,* 2018).

Polyphenols are a family of compounds that are ubiquitous in the plant kingdom. The many health-related properties of these compounds, widely described in epidemiological studies, are primarily based on their antioxidant activities;

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they can scavenge free radicals, inhibit enzymes responsible for the formation of free radicals, and are even chelators of some metal ions (Dugas Jr *et al.,* 2000).

Flavonoids represent a remarkable group of secondary plant metabolites and have long been used as traditional medicines with scientifically proven pharmacological benefits. They serve broad medicinal activities that may lead to the discovery of drugs with new and potential therapeutic effects. The latest research mainly amplifies the functional activity of flavonoids as an antioxidant against oxidative stress, it sheds light on the potential role of flavonoids as an antioxidant (Banjarnahor & Artanti 2014; Hussein & El-Anssary, 2018).

Matricaria pubescens is a common plant throughout the northern Sahara corresponding to the regions of Biskra, Figuig, El-Oued, Touggourt, Colomb-Béchar, Ghardaia, El golea, Ouargla, Beni Abbes, and in the central Sahara which includes the regions of Adrar, Tamanrasset, Djanet, Fort-polignac, Fort-flatters, Timimoun, Ain salah (Ozenda 1991).

It is very famous for its aromatic qualities to flavor soups, especially during the month of Ramadan. It is also of great pastoral interest since it is mainly grazed by goats (Ben-Moussa *et al.,* 2020).

Matricaria pubescens is recognised in the traditional Algerian pharmacopoeia for treating various pathologies which is primarily thought to be due to the active substances that it encloses such as flavonoids (Apigenin, luteolin) (Gherboudj *et al*., 2012).

The little work done on this plant, whether for antioxidant activity or the study of phenolic compounds has encouraged us to study it with regard both to its antioxidant power of samples from different regions and to enrich our knowledge on the geographical diversity of the biological activities of this plant.

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II. MATERIALS AND METHOD

A. Plant Material

1. Harvesting the plant

The aerial parts of *Matricaria pubescens* were harvested in dry weather over the period from November 2015 to May 2016 from two regions, during several periods of the year as shown in Table 1. The two regions are M'lili in the Wilaya of Biskra (samples are named M1, M2, M3 and M4) and Taïbat in the Wilaya of Ouargla (samples are named M5, M6, M7 and M8). The plant was identified at the Center for Scientific and Technical Research on Arid Regions of Biskra. The harvested plant was then dried in a cool dry place away from direct sunlight. Once dried, the plant was grounded to a powder using a mortar, and finally set for extraction.

Table 1. Locations and periods of the harvested sample

Sample number	Region of harvest	Local coordinates	Date of harvest
M1	M'lili Biskra	34° 48′ 21 East	13/01/2016
M2	M'lili Biskra	34° 48′ 21 East	20/02/2016
M3	M'lili Biskra	34° 48′ 21 East	12/03/2016
M4	M'lili Biskra	34° 48′ 21 East	30/04/2016
M5	Taybat Ouargla	33° 05′ 02″ East	07/01/2016
M6	Taybat Ouargla	33°05′ 02″ East	13/02/2016
M7	Taybat Ouargla	33° 05′ 02″ East	16/03/2016
M8	Taybat Ouargla	33° 05′ 02″East	20/04/2016

2. Chemicals

Methanol, Sodium hydroxide, Folin-ciocalteu Reagent, Gallic Acid, Quercetin, Potassium Ferricyanide, Iron Trichloride, Iron Sulphate, Mono Hydrogenated Sodium Phosphate, Ascorbic Acid, 2,2 Diphenyl -1-Picryl Hydrazyl (DPPH), proanthocyanidin, tannic acid and sodium carbonate were obtained from the company Sigma (St. Louis, MO, USA). Hydrochloric acid, butanol, trichloroacetic acid and tween 80 were supplied by Biochem Chemopharma (Line, COSNE, France). Sodium nitrate was obtained from Fluka. Aluminium trichloride was obtained from Panreac (Spain). Potassium iodate was obtained from Prolabo (Sion, Valais Switzerland). All other chemicals were of analytical grade.

B. Preparation of Samples

1g of each plant powder pf *Matricaria pubescens* was macerated in 25 mL of absolute methanol for 48h. The

macerate obtained was filtered on a Büchner funnel then transferred to flasks initially weighing P_o. After evaporation under vacuum using a rotary evaporator, the filtrates were then dried in an oven (45 °C.) for 24 h. After cooling, the flasks were weighed again (P_f).

The yield of extraction was calculated by the following formula (Stanojević *et al.,* 2009)*:*

$$R = (P_f / P_o) * 100$$

Where:

R : Extraction yield (%).

P_f : Weight of the flask after extraction (g).

P_o : Weight of the empty flask (g).

A volume of 5 ml of methanol was added to the flasks to recover the extract, the flask was then dried in an oven, cooled and weighed to calculate the concentration of the extract recovered in the 5 ml of methanol (Mamyrbekova-Bekro *et al.,* 2013).

1. Determination of total phenolic compounds

The determination of the concentrations of total polyphenols in the crude extract was carried out using the method of Folin-Ciocalteu (FC) (Cheok *et al.,* 2013).

A volume of 200 µL of each extract (diluted to 1/50) was introduced into a test tube, 1 mL of Folin-Ciocalteu reagent (diluted to 1/10) was added to it. After incubation at room temperature for 5 min, 800 µL of sodium carbonate solution (Na_2CO_3 7.5%) was added. The final solution was mixed well and kept in a water bath away from light for 30 min. The absorbance was measured at 765 nm against a blank using a spectrophotometer. A calibration curve was produced under the same operating conditions using gallic acid as standard at different concentrations (0.5, 1, 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20 µg / mL of gallic acid). The concentration of total polyphenols was expressed in milligrams of gallic acid equivalent per gram of dry matter (mg EAG / g DM) (Hatami *et al.,* 2014).

2. Determination of total flavonoids

The total flavonoid content was carried out by the method of (Zhishen *et al.,* 1999). In a flask, 250 µL of the extract (diluted 1/50) were mixed with 1 ml of distilled water, then 75 µL of a solution of $NaNO_2$ (5%) were introduced. After 5 minutes, 75 µl of $AlCl_3$ (10%) were added. After 6 minutes, 500 µL of NaOH (1N) and 600 µL of distilled water was added and the mixture was stirred immediately. The absorbance was measured at 415 nm against a blank using a spectrophotometer. A calibration curve was prepared under the same operating conditions using quercetin as standard at different concentrations (10, 20, 30, 40, 50, 60, 70, 80, 101, 110 and 120 µg / mL of quercetin). The concentration of total flavonoids was expressed in milligrams of quercetin equivalent per gram of dry matter (mg EQ / g DM) (Bouayed *et al.,* 2011).

3. Determination of the condensed tannins

The proanthocyanidin content was determined by the method of Scalbert (Scalbert *et al.,* 1989). A volume of 200 µl of the extracts (diluted 1/10) was added to 2 ml of an acidic ferrous solution (77 mg of $FeSO_4.7H_2O$ dissolved in 500 ml of HCl / BuOH (2/3)). The solution was incubated for 15 min in a water bath. The absorbance was measured at 530 nm against a blank using a spectrophotometer. The concentration was expressed in milligrams of cyanidin equivalent (CyaE) per gram of dry matter (mg CyaE / g MS). The content of condensed tannins was calculated as follows:

$$mg\ CyaE\ /\ gMS\ = \frac{Abs\ \times\ V\ \times\ D\ \times\ M\ \times\ V2}{l\ \times\ \varepsilon\ \times\ v\ \times\ m}$$

Where:

Abs is the absorbance of the sample at 530 nm;

V is the total reaction volume (ml);

D is the dilution factor;

M is the molar mass of cyanidin ($g.mol^{-1}$);

V2 is the volume of the extract before dilution (ml);

L is the path length (cm^{-1});

ε is the molar extinction coefficient (34,700 L $mol^{-1}.cm^{-1}$)

v is the volume of the extract diluted 10 times

m is the dry weight mass of the dry matter (g) (Scalbert, Monties *et. al.,* 1989; Naima *et al.,* 2015).

4. Determination of hydrolysable tannins

The content of hydrolysable tannins was determined by the method of (Bossu *et al.,* 2006). A volume of 500 µL of the extract (diluted 1/50) was added to 2.5 mL of a KIO_3 solution (2.5%) and left to react for 2 min in a water bath at 30°C. The absorbance was measured at 550 nm against a

blank using a spectrophotometer. A calibration curve was carried out under the same operating conditions using tannic acid as standard at different concentrations (0, 100, 200, 400, 600, 800 and 1000 µg / mL of tannic acid). The concentration of hydrolysable tannins was expressed in milligrams of tannic acid equivalent per gram of dry matter (mg EAT / g DM) (Bossu *et. al.,* 2006; Naima *et al.,* 2015).

5. *Determination of anthocyanins*

The quantification of total anthocyanins was evaluated by the pH differential method (Bossu *et al.,* 2006). For the determination of our extracts, two solutions were prepared, one at pH 1.0 using potassium chloride buffer (0.03 M), and the second at pH 4.5 using sodium acetate buffer (0.4 M).

A volume of 2 mL of each buffer solution was mixed with 1 mL of each extract (diluted 1/50). The solutions were then incubated for 15 min in the dark, then the absorbance was measured at two wavelengths of 510 nm and 700 nm against a blank using a spectrophotometer. The absorbance was calculated as follows:

$\mathbf{Abs} = (\mathbf{Abs}_{\lambda 510} - \mathbf{Abs}_{\lambda 700})_{pH=1} - (\mathbf{Abs}_{\lambda 510} - \mathbf{Abs}_{\lambda 700})_{pH=4.5}$ (Giusti & Wrolstad 2001; Bouayed *et al.,* 2011).

The concentration of anthocyanins expressed in mg/L was calculated as follows.

$$mg\ /\ l\ = \frac{Abs\ x\ PM\ x\ FD\ x\ 1000}{\varepsilon x d\ Where}$$

Abs is the absorbance;
MW is molecular weight (g/mol) = 449.2 g/mol for cyanidin 3 glucoside;
FD is the dilution factor (FD = 10);
ε is the extinction coefficient for cyanidin 3-glucoside (ε = 26900 $L.mol^{-1}.cm^{-1}$) and
d is the thickness of the tank **(d** =1cm).

6. *Radical scavenging activity (DPPH)*

The antioxidant power of methanolic extracts from both plants have been tested by the method which uses DPPH (1,1-diphenylpicrylhydrazyl) as a relatively stable free radical (Blois, 1958; Sharma & Bhat, 2009).

In this test, the purple-coloured DPPH was reduced to a yellow compound, diphenylpicrylhydrazine, the colour intensity of which is inversely proportional to the reducing capacity of the antioxidants present in the medium (Kiers *et. al.,* 1976; Sanchez-Moreno, 2002).

The reaction was carried out in a total volume of 2.5 ml containing 2 ml of 0.1 mM DPPH dissolved in methanol. The extracts were prepared by dissolution in absolute methanol, these stock solutions were then diluted to obtain the final concentrations (Dehpour *et. al.,* 2009; Amarti *et. al.,* 2011; El Youbi *et. al.,* 2012; Huang *et al.,* 2016).

Ascorbic acid was used as a reference antioxidant, a stock solution of 0.05mg/ml was prepared, this solution was diluted to obtain final concentrations of 1 to 10 µg / ml.

The samples were then left in the dark for 60 minutes, and the discolouration against the negative control containing only the DPPH solution was measured at 515 nm. Antioxidant activity was estimated using the following equation:

$$AA = ([Abscontrol - Abstest] / Abscontrol) \times 100$$

AA: antioxidant activity, Abs: absorbance at 515 nm.

7. *Ferric Reducing Antioxidant Power (FRAP)*

The reducing power of iron (Fe^{3+}) in the extracts was determined according to the method described by (Oyaizu, 1986; Bougandoura & Bendimerad, 2013). The method of iron reduction was based on the reduction of ferric iron to iron salt (Prussian blue) by the antioxidants which give the colour blue. One millilitre of the extract at different concentrations was mixed with 0.5 mL of 0.2 M phosphate buffer solution (pH 6.6) and 0.5 mL of a ferricyanide solution of potassium $K_3Fe(CN)_6$ at 1%. The whole was incubated in a water bath at 50 ° C for 20 min and then left to cool. 0.5 ml of 10% trichloroacetic acid was added to stop the reaction. The tubes were centrifuged at 3000 rpm for 10 min. An aliquot (0.5mL) of supernatant was combined with 0.5ml of distilled water and 0.1mL of an aqueous solution of $FeCl_3$ (Ferric chloride) at 0.1%. The absorbance of the reaction medium was read at 700 nm against a similarly prepared blank, replacing the extract with distilled water which made it possible to calibrate the UV-VIS spectrophotometer ((Jasco V-530 UV/VIS Spectrophotometer, France). The positive control was represented by a standard of an antioxidant; ascorbic acid, the absorbance of which was measured under the same

conditions. An increase in absorbance corresponded to an increase in antioxidant activity (Ghaisas *et al.,* 2008).

The reducing power of iron was expressed as IC50, which corresponded to the concentration of the sample giving an absorbance of 0.5.

C. Statistical Analyse

All the experiments were carried out in triplicate and the results were expressed as mean±SD. Experimental data were analysed using analysis of variance (ANOVA) and significant differences between the means of the triplicate analyses at p = 0.05 were determined by Duncan's multiple range test using the statistical product and service solution.

III. RESULTS AND DISCUSSION

A. Results of the Tests

The methanolic extraction yields are expressed as the mass percentage of dry plant material. The results of the yields are displayed in Figure 1. The yield recorded for *Matricaria pubescens* from Ouargla is higher than that of Biskra with a statistically significant difference (p = 0.016).

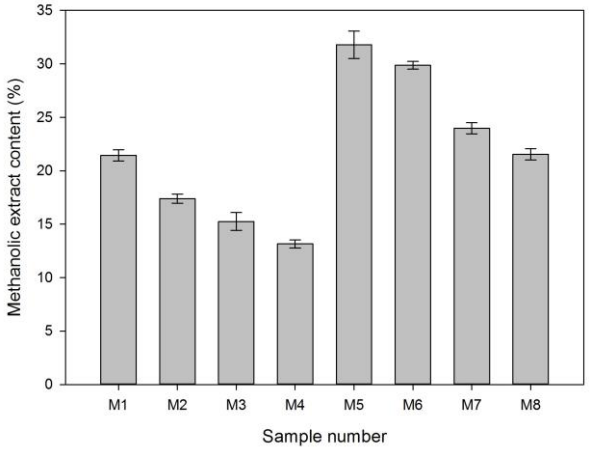

Figure 1. Methnolic extract yield results for *Matricaria pubescens* (Desf.) Schultz

In the study of Maja Molnar, on Matricaria chamomilla, the highest yield was obtained with the hydroalcoholic mixture (22.30 0.77%) (Molnar *et al.,* 2017) and in the study of Zarrour's study, on Matricaria pubescens, the highest yield was obtained with the hydroalcoholic mixture (23.22%) followed by the aqueous extract (21.98%) and the hydroacetone extract (19. 07%) (Zarrour, 2012).

In Metrouh's work, the highest yield for Matricaria pubescens was obtained with hydroalcoholic extract (34.68%) followed by hydro-acetone extract (34, 44%) and acetone extract (5.02%) (Metrouh-Amir *et al.,* 2015).

1. Results of the determination of total polyphenols

The concentrations of the total polyphenols are expressed in mg/g of dry plant matter. The total phenols of the methanolic extracts of the eight samples are presented in Figure 2. The content of total polyphenols for *Matricaria pubescens* is 1,58 ± 0.33 mg/g of dry matter, The concentrations recorded for *Matricaria pubescens* from Ouargla are higher than that of Biskra but with a statistically insignificant difference (p = 0.771). The calibration equation of total polyphenols is as follows:

$y = 0.0958x \quad R^2 = 0.9995$

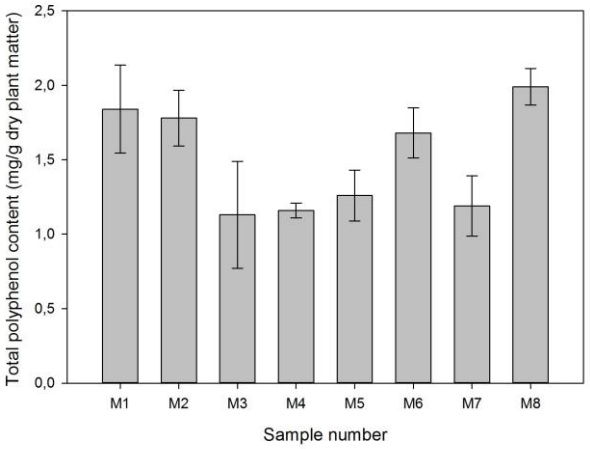

Figure 2. Results of the concentrations of total polyphenols in the samples of *Matricaria pubescens* (Desf.) Schultz

These total polyphenol contents are higher than those of ethanolic extracts of leaves and flowers of some Asteraceae species (Anvari & Jamei, 2018). The total polyphenol contents of some species of the Asteraceae family reported in the work of Beata Ulewicz-Magulska & Marek Wesolowski are higher between 97.2–253.5 (mg EQ/ g Extract) (Ulewicz-Magulska & Wesolowski, 2019).

2. Results of the determination of total flavonoids

The concentrations of total flavonoids are expressed in mg/g of dry plant matter.

The amount of flavonoids in the methanolic extracts of the eight samples are presented in Figure 3. The flavonoid content for *Matricaria pubescens* is 38.44 ± 10.77 mg/g of dry matter, The flavonoids content is significantly higher in samples of Ouargla compared to those of Biskra (p = 0.045). The equation of calibration of total flavonoids is as follows:

$y = 0.0016x - 0.0022$ $R^2 = 0.9934$

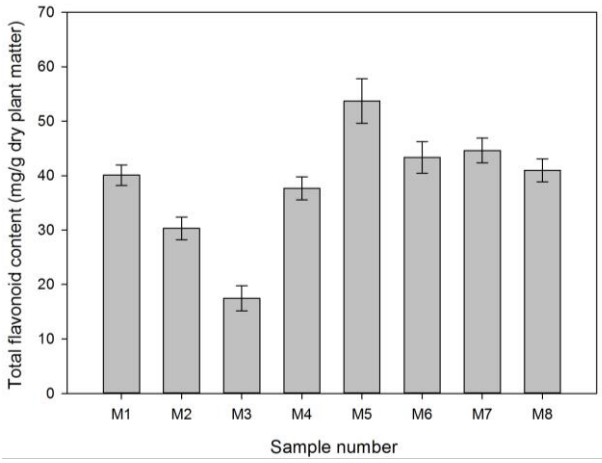

Figure 3. Results of total flavonoid concentrations in samples of *Matricaria pubescens*

The flavonoid content of Matricaria pubescens obtained in our study is higher than those of ethanolic extracts of leaves and flowers of some Asteraceae species the maximum 0.0169 ± 0.07 (mg EQ/ g Extract) (Anvari & Jamei, 2018). The results recorded in the study of Salachna *et al.* (2021) are close to results with contents (40.57 mg EQ/g) are those of Centaurea orientalis, (28.57 mg EQ/g) of Centaurea nigra and (24.92 mg EQ/g) of Centaurea phrygia.

3. Results of the determination of the condensed tannins

The concentrations of the condensed tannins are expressed in mg/g of dry vegetable matter.

The condensed tannins of the methanolic extracts of the eight samples are presented in Figure 4. The content of condensed tannins for *Matricaria pubescens* is 0.63 ± 0.20 mg/g of dry matter. The content in condensed tannins obtained from samples of *Matricaria pubescens* from Ouargla is higher than that from Biskra with a statistically insignificant difference (p = 0.49).

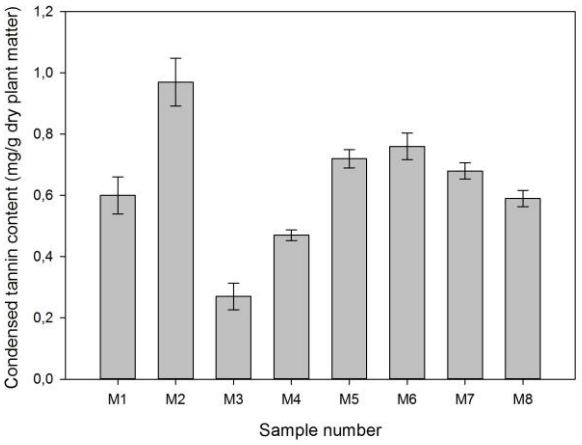

Figure 4. Results of concentrations of condensed tannins in samples of *Matricaria pubescens*

According to the study by Metrouh *et al.* (2015) the results showed that the contents of condensed tannins in the various extracts of *Matricaria pubescens* are lower ranging from 0.029 mg/g to 0.054 mg/g. On the other hand, the work of Dehimat *et al.* (2013) recorded a high content of 435.55 ± 7.2 mg/g.

4. Results of the determination of the hydrolysable tannins

The concentrations of the hydrolysable tannins are expressed in mg/g of dry vegetable matter, The hydrolysable tannins of the methanolic extracts of the eight samples are presented in Figure 5, The content of hydrolysable tannins for *Matricaria pubescens* is 1,22 ± 1.55 mg/g dry matter. The condensed tannin content obtained from samples of *Matricaria pubescens* from Ouargla is higher than that of Biskra with a statistically insignificant difference (p = 0.183). The equation of calibration of hydrolysable tannins is as follows:

$y = 0.0025x + 0.0978$

$R^2 = 0.9939$

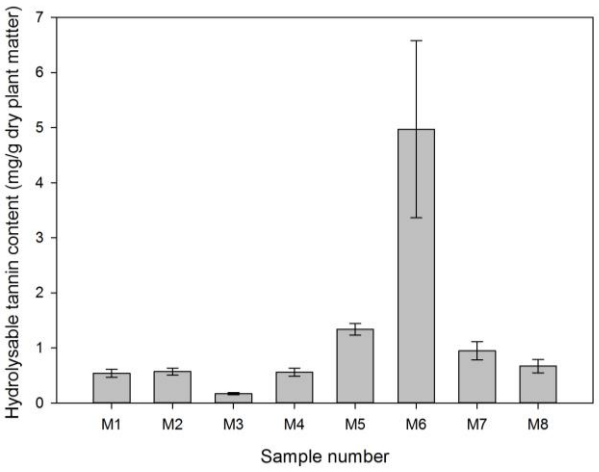

Figure 5. Results of the concentrations of hydrolysable tannins in samples of *Matricaria pubescens*

5. *Results of the determination of total anthocyanins*

The concentrations of the anthocyanins are expressed in mg/g of dry vegetable matter.

The anthocyanins of the methanolic extracts of the eight samples are presented in Figure 6. The anthocyanin content for *Matricaria pubescens* is 0.39 ± 0.13 mg/g dry matter. The condensed tannin content obtained from samples of *Matricaria pubescens* from Ouargla is higher than that of Biskra with a statistically insignificant difference (p = 0.258).

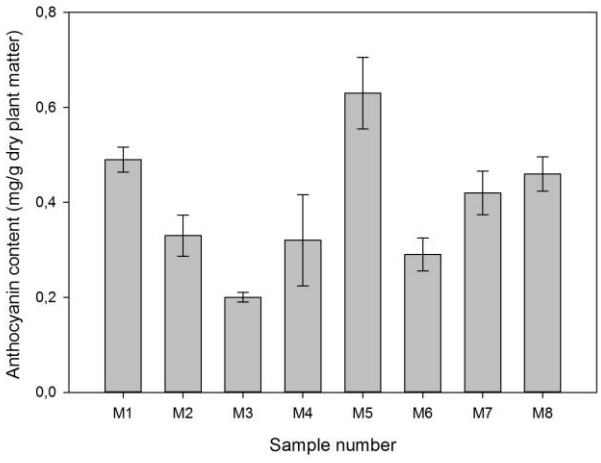

Figure 6. Results of the concentrations of total anthocyans in samples of *Matricaria pubescens*

6. *DPPH*

The anti-radical activities of the methanolic extracts are expressed in µg/mL. The anti-radical activities by DPPH of the eight samples are presented in Figure 7. The average results of the anti-radical activity is 181.79 ± 55.35 µg/mL for the methanolic extract of *Matricaria pubescens*. The IC50 of ascorbic acid by DPPH is 3.94.

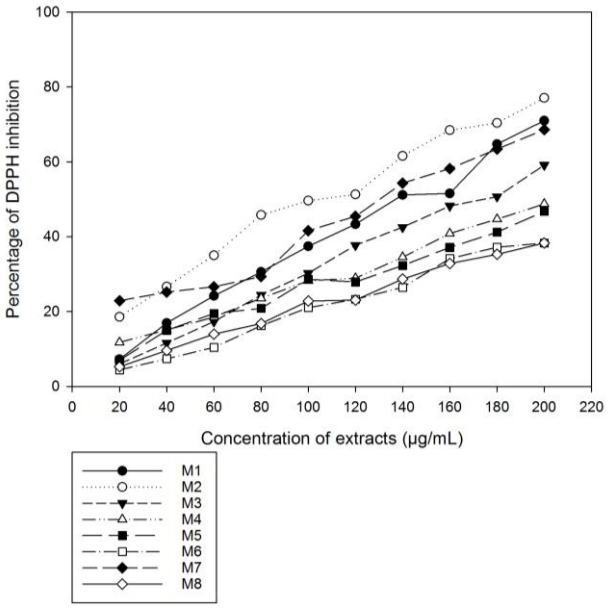

Figure 7. Results of IC 50 by DPPH of methanolic extracts of *Matricaria pubescens*

The methanolic extracts of *Matricaria pubescens* from Biskra have a higher anti-radical power than that of *Matricaria pubescens* from Ouargla with a difference statistically not significant (p = 0.204),

7. *FRAP*

The iron reducing activities of the methanolic extracts are expressed in µg/mL. The results of the iron reducing activities of the eight samples are shown in Figure 8. The average of the iron reducing activity results is 45.97 ± 11.55 µg/mL for the methanolic extract of *Matricaria pubescens*, IC 50 of ascorbic acid measured by FRAP is 4.70.

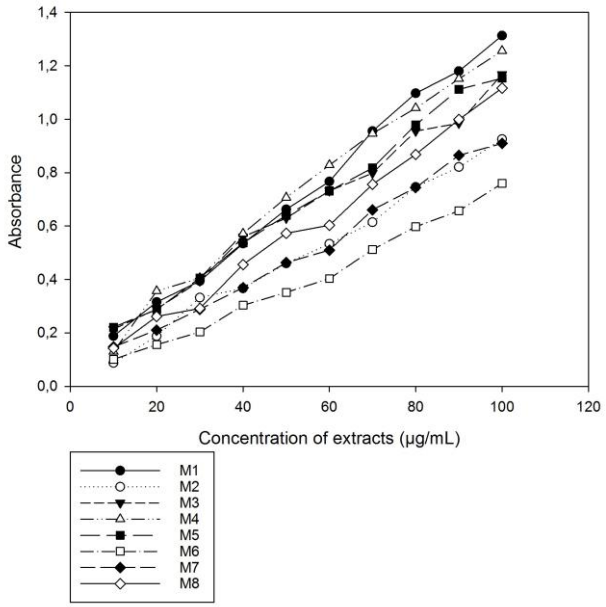

Figure 8. Results of IC 50 by FRAP of methanolic extracts of *Matricaria pubescens*

The methanolic extracts of *Matricaria pubescens* of Biskra have a higher iron reducing power than that of *Matricaria pubescens* of Ouargla with a statistically insignificant difference (p = 0.255).

B. Correlation Analysis of The Phytochemical Content With The Antioxidant Activity

According to Table 2, the FRAP test has a high specificity to distinguish the different active constituents of the methanolic extracts from different samples. There is a strong correlation between the yields of the methanolic extracts Flavonoids (r = 0.780 with p = 0.022) and also with hydrolysable tannins r = 0.649, the anthocyanins and the condensed tannins r = 0.45, but with insignificant differences.

Table 2. Pearson correlations between total phenols, flavonoids, tannins condensed, tannins hydrolysable and anthocyanins

Parameters		**DPPH**	**FRAP**
Yield	Pearson correlation	**0.266**	**0.407**
	Sig, (bilateral)	0.524	0.317
Total polyphenols	Pearson correlation	**0.309**	0.089
	Sig, (bilateral)	0.457	0.834
Flavonoids	Pearson correlation	**0.262**	0.1 30
	Sig (bilateral)	0.531	0.758
Condensed tannins	Pearson Correlation	-0.241	0.599
	Sig (bilateral)	.566	0.117
Hydrolyzable tannins	Pearson Correlation	**0.501**	**0.766***
	Sig (bilateral)	0.206	**0.027**
Anthocyanins	Pearson Correlation	-0.015	-0.304
	Sig (bilateral)	0.972	0.465

Following the correlation analysis of IC50 values of the radical scavenging activities of the extracts; the level of hydrolysable tannins showed a strong correlation with the FRAP tests as shown in Table III. There is a positive correlation between DPPH and hydrolysable tannins (0.501), total polyphenols (r = 0.309), flavonoids (r = 0.282), and between FRAP and Tannins condensed (r = 0.599). However, these correlations are not significant. The results indicate that hydrolysable tannins are the main contributors to the antioxidant and free radical scavenging activities of methanolic extracts, which underlines the importance of these phenolic compounds of *Matricaria pubescens*.

Table 3. Pearson correlations between total phenolic compounds (TP) and flavonoids (F), condensates, hydrolysable tannins and anthocyanins and antioxidant capacity, measured by the FRAP and DPPH assays

Parameters		DPPH	FRAP
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	Sig (bilateral)	0.972	0.465

C. Cluster Analysis (CA)

The average of each value is chosen as an index for the cluster analysis. The results indicate that eight samples of *Matricaria pubescens* could be classified into two groups as displayed in Figure 9 at different scales when the horizontal distance is 25. The first group includes M1, M4, M3, M5 and M8; the second includes M2, M7 and M6. These results can be used as new guidelines for the selection and production of Matricaria *pubescens*. In addition, the content of hydrolysable tannins was the most important factor for the separation of clusters.

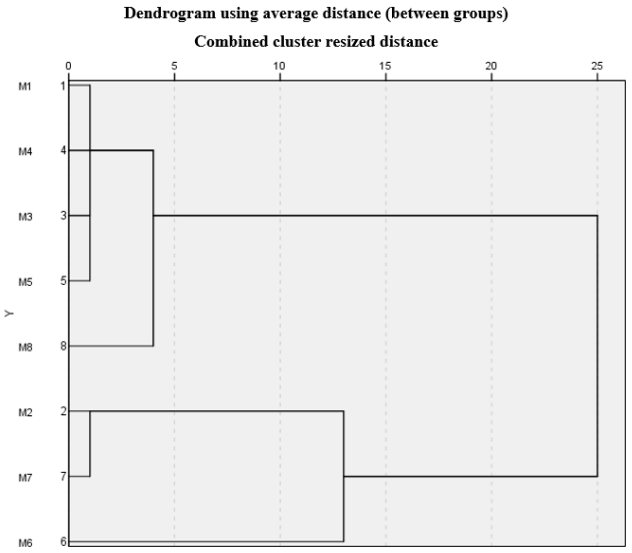

Figure 9. Analysis of clusters based on the content of hydrolysable tannins, anthocyanins and FRAP antioxidant activities of eight samples divided into different clusters

IV. CONCLUSION

The content of active components and antioxidant capacities of the methanolic extracts of *Matricaria pubescens* collected from the two regions: M'lili in the Wilaya of Biskra (the samples were named M1, M2, M3 and M4), and Taïbat in the Wilaya of Ouargla (the samples are named M5, M6, M7 and M8). They were examined to determine the phenols responsible for the increase in antioxidant activity, the methanolic extracts of this plant were tested for the total content of phenols and their antioxidant activity was examined using FRAP and DPPH. All provenances were divided into two groups. The group containing M1, M3, M4, M5 and M8 exhibited the highest antioxidant activities, which may be due to their high amount of phenols and other antioxidants such as condensed tannins.

The study could provide a new guideline for the selection of *Matricaria pubescens* based on the antioxidant compounds rather than appearance or yield. Interactions between different antioxidant products and other important bioactive components of different varieties could be identified. The specific effective components of *Matricaria pubescens* in each sample are to be investigated in the near future.

V. ACKNOWLEDGEMENT

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VI. CONFLICT OF INTEREST

The authors declare that they have no competing financial interests or known personal relationships which could have seemed to influence the work reported in this article

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