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The Evaluation of Dandelion (*Taraxacum officinale*) Properties as a Valuable Food Ingredient

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Abstract

The qualities of dandelion (Taraxacum officinale), a plant of the spontaneous flora of Romania and the possibility of using it in food were highlighted. Currently used only for consumption as medicinal tea with beneficial effects on the body, dandelion has a chemical composition that allows its use in dairy products, pastries, desserts, etc. In this study were determined the content of mineral elements of plant using ICP-MS spectrometer, antioxidant activity was determined by the DPPH method, the vitamin C was determined by HPLC and the carotene and chlorophyll was determined by spectrophotometric measurements. All parts of the plant, roots, leaves, stems, flowers in fresh state were analyzed. The results demonstrate that the plant can be used throughout the year, so the production does not become a seasonal one because all its component parts have special qualities in terms of chemical composition, both fresh and frozen.

Keywords: *antioxidants, carotenes, chlorophyll, minerals*

1. Introduction

Fruits and vegetables have an important role in human nutrition because they contain constituents that have health benefits and anti-disease factors, such as antioxidants and polyphenols. These components are known to scavenge harmful free radicals that are capable of attacking the healthy cells of the body, causing them to lose their structure and function. Cell damage caused by free radicals appears to be a major contributor to aging and to degenerative diseases of aging such as cancer, cardiovascular disease, cataracts, immune system decline, and brain dysfunction (OZGUR & al. [1]; PERCIVAL [2]). Antioxidants have also been used in food industry to prevent deterioration, nutritional losses and off-flavoring in various foods, especially those containing polyunsaturated fatty acids. Recently, interest has increased considerably in finding naturally occurring antioxidants for use in foods because of their potential in health promotion and disease prevention, and their high safety and consumer acceptability (KRATCHANOVA & al. [3]). Various herbs and spices have been reported to exhibit antioxidant activity, including *Ocimum sanctum, Piper cubeba Linn, Allium sativum Linn., Terminalia bellerica* (Gaertn.) Roxb., *Camellia sinensis Linn., Zingiber officinale Roscoe* and several Indian and Chinese plants (KHALAF & al. [4]). Dandelion (*Taraxacum officinale L.,*) is found in all parts of the North Temperate Zone, in pastures, meadows and on waste ground, and is so plentiful that farmers everywhere find it a troublesome weed, contains an abundance of terpenoid and sterol bitter principles (principally taraxacin and taraxacerin), equally distributed in the roots, leaves, and flowers. Traditionally *Taraxacum officinale* has been used as a remedy for jaundice and other disorders of the liver and gallbladder, and as a remedy for counteracting water retention. *Taraxacum officinale* is a rich source of a variety of vitamins and minerals, including beta carotene, nonprovitamin A carotenoids, xanthophylls, chlorophyll, vitamins C and D, many of the B-complex vitamins, choline, iron, silicon, magnesium, sodium, zinc, manganese, copper, and phosphorous (FAZILI & al. [5]; AMIN & al. [6]). The present research work was carried out about the antioxidant potential and mineral content of dandelion and the possibility of its use in dairy products such as hard cheese or fresh cheese, pastries or confectionery.

2. Materials and Methods

Sampling and preparation of plant

The antioxidant capacity, vitamin C, chlorophyll, carotenoids and mineral content of common dandelion (*Taraxacum officinale, Weber*) were determined in this study. Plants were collected during flowering and before being analyzed were washed and dried. Every part of the dandelion plant, flowers, leaves, stems and roots were analyzed. For each sample several plants were used and all were collected from the same area of Suceava county-Romania.

Determination of antioxidant activity

For the determination of antioxidant capacity, the method of DPPH was used. DPPH (2, 2-diphenyl-1-picrizilhidrazil) is one of the most stable organic nitrogen radicals with a maximum absorption in the UV-VIS at 517 nm. At the time of reduction the solution is decolorized and the antioxidant capacity of a system can be monitored spectrophotometrically (GÜLCIN & al. [7]). Plant extraction was performed with methanol using an ultrasonic bath at a temperature of 40 °C and frequency of 25 kHz. Samples (0.5 ml) were mixed with 2.5 ml DPPH solution $6 \cdot 10^{-5}$ M. The waiting time for readings at spectrophotometer was 5 min. (MARINOVA and BATCHVAROV [8]; LACHMAN & al. [9]; TABART & al. [10]; ASAN-OZUSAGLAM and KARAKOCA [11]). A spectrophotometer with optic fiber from Ocean Optics was used.

$$DPPH\ scavenging\ effect\ (\%) = A_0 - A_P/A_0 \times 100, \qquad (1)$$

where A_0 was the absorbance of the control and A_P was the absorbance in the presence of the sample (VAMANU [12]).

Determination of mineral

Determination of minerals was performed by coupled plasma-mass spectrometer (ICP-MS), 7500cs Series Agilent Technologies. The sample to be analyzed (5 g) was calcined to constant weight after which mineralized with HNO_3. Double deionized water (18 MΩ cm resistivity) obtained by using a water purification system ThermoFisher- Germany was used to prepare solutions.

Determination of total carotenoids and total chlorophylls

Carotenoids and chlorophylls from the leaves, stems and flowers of dandelion were extracted from 0.5g of fresh sample homogenized with 5 ml of 80% aqueous acetone for 2 min, followed by a centrifugation at 4500 rpm for 10 minutes (GUAN & al. [13]). The supernatant was diluted 10 times using 80% aqueous acetone and measured at 460, 647 and 664 nm (figure 1).

Carotene and chlorophyll was calculated using these equations (LICHTENTHALER [14]):

$$Total\ chlorophylls = 7.15A_{664} + 18.71A_{647} \quad (2)$$

$$Total \cdot carotenoids = \frac{(1000A_{460} - 1.82C_a - 85.2C_b)}{198} \quad (3)$$

where: A = absorbance. C_a (chlorophyll a) = $12.25A_{664} - 2.79A_{647}$; C_b (chlorophyll b) = $21.50A_{647} - 5.10A_{664}$;

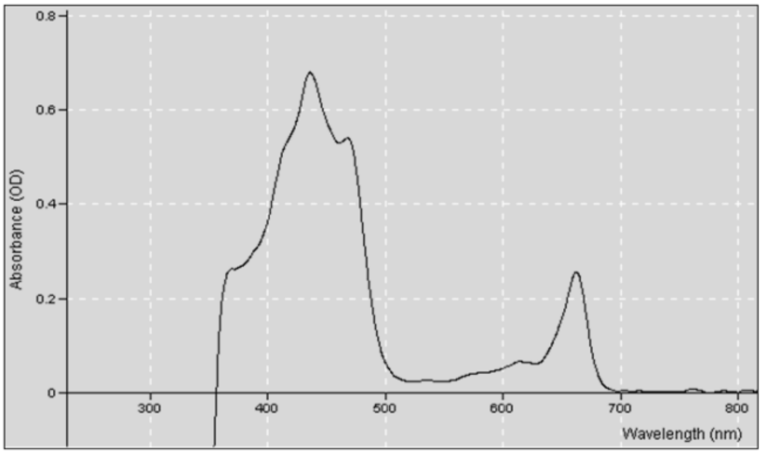

Figure1. Chlorophyll absorption spectra of dandelion

Determination of vitamin C

Vitamin C content of the dandelion samples was determined by HPLC method using a liquid chromatograph equipped with an auto injector along with a UV/VIS detector (DAD) and 4.6 x 250 mm, 5 µm column, the flow rate was maintained at 0.6 ml/min and mobile phase was a 100% solution of phosphate. For sample preparation 4 g of dandelion (leaves, stems, flowers and roots) with 12 ml acid solution (10% perchloric acid and 1% ortho-phosphoric acid) were mixed and quantitatively transferred into a 50 ml volumetric flask. The mixture was stirred for 2 minutes and added up to the mobile phase (0.02 mol/L monopotassium phosphate acidified to pH=3.5 with 10% ortho-phosphoric acid) until the flask's mark was reached. After stirring, the resulted solution was filtered through paper and 1 ml of filtrate was analyzed (DRANCA and OROIAN [15]).

Reagents

All reagents (DPPH, acetone, methanol, HNO_3) were purchased from Sigma Aldrich (Germany).

Statistical analysis

An analysis of variance (ANOVA) test ($\alpha = 0.05$), with the least significant testing difference (LSD) was carried out using the Statgraphics Centurion softwere XVII. Principal components analysis (PCA) was performed using Unscrambler 9.7 (CAMO Process AS, Oslo, Norway). Principal Components Analysis (PCA) was applied to describe the relationship between elements of the composition and the analyzed plant.

3. Results and Conclusions

Determination of Antioxidant Activity using the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) Radical Scavenging Method. The DPPH method was evidently introduced nearly 50 years ago by Blois and it is widely used to test the ability of compounds to act as free radical scavengers or hydrogen donors, and to evaluate antioxidant capacity (GENOVA & al. [16]). Analysis of dandelion (*Taraxacum officinale*) root show the highest antioxidant capacity by an average of 80.664% inhibition of DPPH solution, other plant parts (flower, leaves and stems) with a capacity of inhibition of DPPH solution of about 69 % (figure 2).

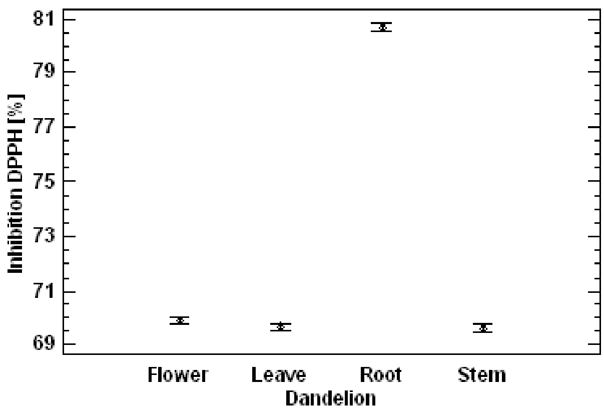

Figure 2. Antioxidant activity of dandelion

Following the analysis of variance a significant difference between the antioxidant capacity of dandelion root and the other plant parts analyzed was observed, F = 6469.37***and P <0.001 (Table 1).

Table 1. Antioxidant activity of dandelion measured by DPPH method

	Sample	Inhibition DPPH [%]	Coefficient of variation [%]	F-Ratio
Dandelion	Flower	$69.876^{b} \pm 0.10841$	0.1551	6469.37^{***}
	Leave	$69.640^{b} \pm 0.01248$	0.0179	
	Root	$80.664^{a} \pm 0.15877$	0.1968	
	Stem	$69.612^{b} \pm 0.00029$	0.0004	

Note: NS – not significant (P > 0.05), * P < 0.05, ** P < 0.01, *** P < 0.001, a, b–statistical groups, Mean value ± standard deviation (n=3)

Determination of total carotenoids, total chlorophylls and vitamin C

The highest amount of vitamin C (121 mg / kg), chlorophyll (450 mg / kg) and carotene (206 mg / kg) is found in the leaves of dandelion than other plant parts analyzed P <0.001 (Table 2).

The amount of vitamin C in dandelion leaves (121.862 mg/kg) determined by this HPLC method correspond to the quantity determined by *Mueeay and Stratton* (0.19 mg/g, 0.12 mg/g, 0.15 mg/g) (MUEEAY and STRATTON [17]), Vitamin C is a electron donor and therefore a reducing agent and a powerful water-soluble antioxidant (PADAYATTY & al.

[18]). Carotenoids and chlorophylls form one of the most important classes of plant pigments and play a crucial role in defining the quality parameters of fruit and vegetables (ELDAHSHAN and SINGAB [19]).

Table 2. The amount of vitamin C, chlorophyll and carotenoids in leaves, stems, flowers and roots of dandelion

Sample	Vitamin C [mg kg $^{-1}$]	F-Ratio	Total chlorophylls [mg kg $^{-1}$]	F-Ratio	Total carotenoids [mg kg $^{-1}$]	F-Ratio
Flower	$61.938^{c} \pm 2.566$	1931.97***	0^{c}	16581.3***	$41.919^{b} \pm 0.714$	107901.68***
Leave	$121.862^{a} \pm 0.720$		$450.784^{a} \pm 4.162$		$206.429^{a} \pm 0.208$	
Root	$17.098^{d} \pm 0.260$		-		-	
Stem	$108.528^{b} \pm 1.497$		$87.62^{b} \pm 1.828$		$20.5^{c} \pm 0.148$	

Note: NS – not significant (P > 0.05), * P < 0.05, ** P < 0.01, *** P < 0.001; Mean value ± standard deviation (n=3) a, b, c, d –statistical groups

Determination of minerals

The mineral content of the samples analyzed using the ICP-MS shows high concentrations of: Ca, Mg, In, Mn, Zn, Fe, Na, Cu. The scores and correlations of principal component analysis (PCA) are presented in the figure 3 and 4 and the two main components (PCs) explain 99% of variation in the data set. PC1 explained 80% of the variation and PC2 19%. PCA analysis showed clear differences between plant parts, figure 3.

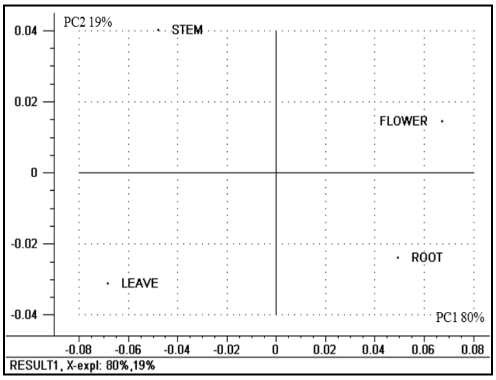

Figure 3. PCA scores of plant samples

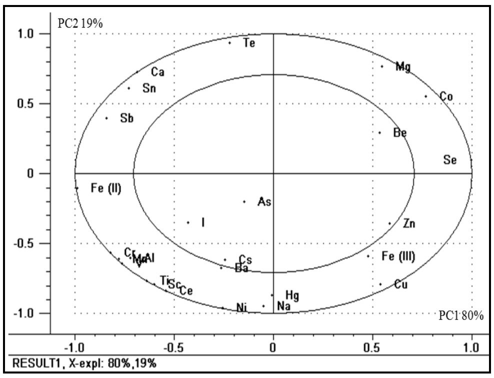

Figure 4. PCA loadings of plant samples

Minerals in the center of the ellipse (figure 4) Ba, Be, As, Zn, Cs, I have a less influence on differentiation of the analyzed samples, while those of the exterior (As, Se, Mg, Na, Cu, Mn, Fe, Sc, Cr) have a greater influence. Dandelion contain a significant amount of calcium leaves contain 499.7 mg/Kg, stems 375 mg/Kg, root 399.700 mg/Kg and flowers 375 mg/Kg; the amount of selenium ranges between 199.941 mg/Kg in root and 120 mg/Kg in stems, Selenium being a powerful antioxidant. Sodium is found also in considerable amount 15.986 mg/Kg in leaves, 14.986 mg/Kg in root, the stems contain 5 mg/Kg and the flowers 6 mg/Kg. According to *Escudero* (ESCUDERO & al. [20]) 100 g of dandelion leaves contain 15.48 g proteins, 58.35 total carbohydrates, 14.55 g ash and 47.80 g total dietary fiber and the content of vitamin C (121 mg/Kg) chlorophyll (450.784mg/Kg) carotene (206.429 mg/Kg) antioxidants and minerals (499.7 mg/Kg Ca, 149.941 mg/Kg Se, 6.299 mg/Kg Mg) determined in this study makes any part of dandelion (leaves, flowers, stems or root) a valuable ingredient usable in food industry not only in traditional medicine. The European scientific cooperative on Phytotherapy (ESCOP) recommends dandelion root for the restoration of liver function, to treat stomach upset, loss of appetite and the traditional Chinese medicine promotes dandelion as a nontoxic herb with exceptional values for its choleretic, diuretic, antirheumatic and anti-inflammatory properties (BEREZI & al. [21]).

4. Conclusions

Dandelion root has a significant antioxidant capacity with the largest capacity of inhibition of DPPH solution, dandelion leaves are rich in vitamin C, chlorophyll and carotenoids. Physico-chemical and sensory qualities of dandelion recommend to use its leaves as fresh salad, flowers and roots in acidic dairy or cheese for the content in carotenoids, chlorophyll and fiber that raise the nutritional value and appearance of products. The results of this study show that the *Taraxacum officinale* can be used as easily accessible source of natural antioxidant and minerals for human nutrition.

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