CHEMICAL COMPOSITION OF *Cynara scolymus* LEAVES

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Globe artichoke (*Cynara scolymus* L.) is a perennial herbaceous plant of the Asteraceae family and a cultivated leafy vegetable. A complex of biologically active compounds is responsible for its medicinal properties.

We have previously reported results of qualitative and quantitative studies of the principal groups of biologically active compounds in leaves of *C. scolymus* [1].

Herein we report the amino-acid and mineral composition of components of *C. scolymus* cultivated in the Caucasus at Mineral′nye Vody.

The qualitative composition of the free amino acids in the studied raw material was determined by ascending chromatography [2]. The analysis identified six free amino acids: threonine, valine, glutamic acid, isoleucine, arginine, and methionine.

The amino-acid composition was studied in further detail as before [3]. The qualitative composition of amino acids was determined from retention times. The internal standard was a standard mixture of 18 amino acids. Colored complexes that were formed by reaction with ninhydrin were measured colorimetrically at 570 nm. Peak areas of identified acids were used for quantitative determination (automatically).

A total of 15 amino acids were found in *C. scolymus* leaves (Table 1). Nine of these were essential: valine, threonine, methionine, isoleucine, leucine, lysine, phenylalanine, histidine, and arginine. The total content of essential amino acids was 4.71% (or 58.29% of the total amino acids).

One of the tasks was to compare the composition of phenolic compounds in *C. scolymus* leaves with the aqueous dry extract in order to standardize them.

The qualitative and quantitative compositions of phenolic compounds were studied by HPLC on a Gilson chromatograph (model 305, France) with a Rheodyne 7125 manual injector (USA). The content was calculated by absolute calibration using the Multichrom program for Windows. The mobile phase was CH_3OH:H_2O:H_3PO_4 (400:600:5); flow rate, 0.5 mL/min; sample volume, 20 μL. The analysis was performed at room temperature for 170 min. The stationary phase was a Platinum EPS C18 100 metallic column (4.6 × 250 mm); particle size, 5 μm. A Gilson UV/VIS model 151 UV detector at wavelength 254 nm was used with data collection at 19 and 42 points per second without medial filtration and with manual recording.

The extract was prepared by extracting *C. scolymus* leaves (0.1 g accurate weight) with ethanol (70%, 250 mL) on a boiling-water bath for 1 h. An alcoholic solution of the extract was prepared by dissolving the dry aqueous extract from *C. scolymus* leaves (0.02 g accurate weight) in ethanol (70%, 100 mL) in an ultrasonic bath at 50°C. A series of reference solutions in ethanol (70%, 0.05%) was prepared in parallel. The studied and reference solutions were injected (20 μL) into the chromatograph. Table 2 gives the results.

Thus, the study of the phenolic compounds of *C. scolymus* leaves and the dry aqueous extract enabled the leaves to be standardized for total phenolic compounds calculated as cynaroside or caffeic acid; the dry aqueous extract, for chlorogenic or gallic acid.

The macro- and microelement compositions of *C. scolymus* leaves were determined by semi-quantitative spectral analysis. The method was based on full evaporation of an analytical portion from the well of a carbon electrode (50 elements) in a AC electric-arc plasma (DG-2). A DFS-8-1 spectrograph was used to obtain the spectra.

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TABLE 1. Amino Acid Composition of Proteins from *Cynara scolymus* Leaves

Amino acid	Amino acid content		Amino acid	Amino acid content	
	g, %	g/kg		g, %	g/kg
Aspartic acid	0.52	5.21	Isoleucine	0.49	4.88
Threonine	0.61	6.14	Leucine	0.77	7.71
Serine	0.6	5.96	Tyrosine	0.33	3.34
Glutamic acid	0.95	9.51	Phenylalanine	0.63	6.32
Glycine	0.42	4.17	Histidine	0.32	3.19
Alanine	0.55	5.50	Lysine	0.72	7.18
Valine	0.66	6.57	Arginine	0.50	4.99
Methionine	0.01	0.15	Total amino acids	8.08	80.84

TABLE 2. Phenolic Compounds from Raw Material and Extracts of *Cynara scolymus*

Compound	Content, % of total phenolic compounds		Compound	Content, % of total phenolic compounds	
	leaves	extract		leaves	extract
Flavonoids			Coumarins		
Luteolin-7-glycoside (cynaroside)	35.19	6.03	4-Hydroxycoumarin	0.88	-
Luteolin	-	-	Phenolic acids		
Rutin	0.08	6.33	Gallic	-	23.48
Quercetin	-	-	Salicylic	-	-
Dihydroquercetin	0.91	-	Chicoric	-	5.86
Vitexin	5.31	-	Hydroxycinnamic acids		
Orientin	0.46	-	Chlorogenic	0.10	23.79
Hyperoside	0.01	7.47	Neochlorogenic	6.88	2.38
Apigenin	-	0.89	Caffeic	38.55	6.30
Hesperidin	2.33	-	Ferulic	-	5.54
Robinin	-	1.27	Phenolic glycosides		
			Arbutin	9.31	-

The method could determine 21 elements in the leaves, of which 5 were macroelements (mg %) Na (2070), K (690), Ca (690), Mg (207), P (207) and 16 were microelements Cu (0.345), Zn (0.414), Ag (0.0007), Mo (0.035), Li (0.207), Pb (0.069), Co (0.007), Ni (0.021), Ti (1.380), V (0.021), Cr (0.041), Fe (20.7), B (2.07), Al (13.8), Si (34.5), Mn (2.07). The data indicated that *C. scolymus* leaves accumulate actively such important biogenic elements as Na, K, Ca, Mg, P, Fe, B, Mn, Zn, and Cu. It was noted that toxic elements (Bi, As, Sb, Cd, Tl, lanthanides, and actinides) did not accumulate in the plant.

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