Effect of the method of harvesting on the yield and the content of phenolic compounds in artichoke (*Cynara scolymus* L.) herb*

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S u m m a r y

The yield of an artichoke herb depended on number of harvests undertaken. Definitely higher yield of an air-dried herb was obtained from twofold (0.74 $kg \cdot m^{-2}$) and threefold (0.65 $kg \cdot m^{-2}$) harvest in comparison to single one (0.46 $kg \cdot m^{-2}$). The content of polyphenolic acids in herb obtained from threefold harvest (in 1st decade of August, September and October) and from the twofold harvest (in 1st decade of September and October) was over 50% higher than that from the single harvest (1st decade of October). Content of flavonoids, depending on number of harvest, varied from 0.23% to 0.36% in the artichoke herb.

Key words: Cynara scolymus, herb, yield, polyphenolic acids, flavonoids

Artichoke (*Cynara scolymus* L.), a valuable medicinal plant, is found in nature in Meditterean Sea region [1]. The pharmaceutical material consists of dried leaves (*Cynarae folium*) or herb (*Cynarae herba*). Polyphenolic acids and flavonoids were identified, among others, in dry extract of artichoke [2]. Artichoke is a special crop planted for pharmaceutical use [3, 4].

Artichoke can be successfully cultivated in Poland as an annual crop. Effect of the method of harvesting on the yield and the content of phenolic compounds in artichoke herb were evaluated.

*Scientific work financed from budget means of the research in the years 2004–2007 as a research project No. 2 PO6R 095 27.

MATERIALS AND METHODS

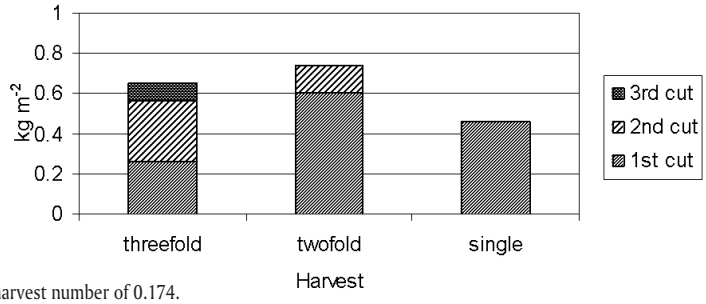
Agrotechnical and laboratory experiments were conducted in the years 2004–2006 in Department of Vegetable and Medicinal Plants in Lublin. The cultivar 'Green Globe' was used. The seeds were sowed in the amount of 0.2 kg·m^{-2} in the 1st decade of May in the seasons 2004–2006 with Use of 0.4 m spacing between rows. A thinning of plants was not carried out. A plot size of each replication was 6.4 m^2.

The dependence between number of cut and yield in artichoke herb was evaluated. The artichoke plants were harvested in vegetative stage. Three different treatments were compared: threefold harvest (with 3 cuttings) carried out in the 1st decade of August, 1st decade of September, and 1st decade of October, twofold harvest (with 2 cuttings) done in the 1st decade of September and 1st decade of October and a single harvest (one cutting) carried out in the 1st decade of October. Each time the herb was harvested from each replication from an area of 1 m^2 which was determined randomly by means of a frame method. In the presented work yield of an air-dry artichoke herb is showed as means from three years (2004–2006). The material was dried in a drying room at a temperature of 40°C.

The chemical analysis of polyphenolic acids and flavonoids content were carried out separately for samples prepared from herb obtained from successive cuts. Chemical analyses were undertaken on a dry plant material in 3 replications. Determining for contents of polyphenolic acids content in the reduction on caffeic acid (%) was done with spectrophotometrical method with use of Arnova reagent, and content of flavonoids (%) was done with Christ-Müller method [5]. The obtained results were statistically evaluated with analysis of variance and Tukey-test at $\alpha=0.05$ level of significance. The content variability of biologically active compounds was proved with coefficient of variation for these parameters (%).

RESULTS AND DISCUSSION

The yield of an artichoke herb depended on number of harvests undertaken (Figure 1). Definitely higher yield of an air-dry herb was collected from plants cut twice (0.74 kg·m^{-2}) and three times (0.65 kg·m^{-2}) in comparison to single harvest (0.46 kg·m^{-2}).



$LSD_{0.05}$ for harvest number of 0.174.

Fig. 1. Effect of the method of harvesting on the yield of air-dry artichoke herb (kg·m-2).

Figure 1 presents share of yield from each cut in total yield obtained with threefold, twofold and a single harvest, according to the method. The yield from 2nd cut – threefold harvest (0.3 kg·m^{-2}) and from 1st cut – twofold harvest (0.6 kg·m^{-2}) had the highest share in total yield. The yield from 3rd cut – threefold harvest (0.09 kg·m^{-2}) had the lowest share in total yield.

An artichoke herb is a rich source of polyphenolic acids [6]. In the presented work a content of polyphenolic acids in herb obtained from threefold harvest (in 1st decade of August, September and October) and from twofold harvest (in 1st decade of: September and October) was over 50% higher than that from single harvest (1st decade of October). Literature reports confirm that content of polyphenolic acids depends on phase of artichoke growth and it becomes higher with plants' age [7, 8].

Table 1.

Content of polyphenolic acids in an artichoke herb (%).

number of harvest	cut number	2004	2005	2006	mean
threefold	1	0.75	0.41	0.46	0.54
	2	0.73	0.46	0.50	0.56
	3	0.45	0.85	0.91	0.73
twofold	1	1.25	0.87	0.97	1.03
	2	0.51	0.96	1.02	0.83
single	1	1.53	0.64	0.71	0.96
coefficient variation (%)					37.9

More polyphenolic acids were determined in the herb in 2004 than in 2005–2006. The value of a coefficient of variation of polyphenolic acids content was high (37.9%). On the ground of obtained results and literature data it can be stated that course of weather in the vegetation period is a deciding factor over accumulation of biologically active compounds in the artichoke herb [2, 8].

Content of flavonoids, depending on number of harvest, varied from 0.23% to 0.36% in the artichoke herb. The coefficient of variation of flavonoids content value was high (38.2%). Dependence between these biologically active compounds and method of artichoke herb harvest cannot be unambiguously proved.

Table 2.

Content of flavonoids in an artichoke herb (%).

number of harvest	cut number	2004	2005	2006	mean
threefold	1	0.20	0.26	0.29	0.25
	2	0.45	0.15	0.11	0.23
	3	0.27	0.24	0.26	0.25
twofold	1	0.40	0.26	0.29	0.31
	2	0.20	0.26	0.29	0.25
single	1	0.57	0.27	0.25	0.36
coefficient variation (%)					38.2

Results of these research trials show that in respect to higher yield of air-dry herb with higher content of polyphenolic acids in material, from twofold harvest (in the 1st decade of: September and October) and threefold harvest (in the 1st decade of August, September and October) should be practiced.

CONCLUSIONS

1. The yield of an artichoke herb depended on number of harvests undertaken. Definitely higher yield of an air-dry herb was collected from plants with twofold and threefold harvest in comparison to single one.
2. Content of polyphenolic acids in herb obtained from twofold and threefold harvest was over 50% higher than those from single harvest.
3. Content of flavonoids, depending on number of harvest, varied from 0.23% to 0.36% in artichoke herb.

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WPŁYW METODY ZBIORU NA PLON I ZAWARTOŚĆ ZWIĄZKÓW FENOLOWYCH W ZIELU KARCZOCHA (*CYNARA SCOLYMUS* L.)

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Streszczenie

Wielkość plonu ziela karczocha zależna była od liczby przeprowadzonych zbiorów. Zdecydowanie większy plon powietrznie suchego ziela uzyskano z roślin, z których ziele zbierano dwukrotnie (0.74 $kg \cdot m^{-2}$) i trzykrotnie (0.65 $kg \cdot m^{-2}$) w porównaniu ze zbiorem jednokrotnym (0.46 $kg \cdot m^{-2}$). Zawartość polifenolokwasów w zielu uzyskanym ze zbioru przeprowadzonego trzykrotnie (w 1. dekadzie: sierpnia, września i października) oraz dwukrotnie (w 1. dekadzie: września i października) była większa o ponad 50% w porównaniu z zawartością oznaczoną w zielu ze zbioru jednokrotnego (w 1. dekadzie października). Zawartość flawonoidów w zielu karczocha w zależności od liczby przeprowadzonych zbiorów wynosiła 0.23–0.36%.

Słowa kluczowe: Cynara scolymus, ziele, plon, kwasy polifenolowe, flawonoidy