ACTA SCIENTIARUM POLONORUM *Acta Sci. Pol., Hortorum Cultus 11(5) 2012, 67-80*

MORPHOLOGICAL AND QUALITATIVE CHARACTERIZATION OF GLOBE ARTICHOKE (*Cynara scolymus* L.) CULTIVARS 'SYMPHONY' AND 'MADRIGAL' ON DEPENDING OF THE HEADS GROWTH

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Abstract. An artichoke is a commonly cultivated vegetable in the Mediterranean region. It is cultivated for an immature flower head. In Poland the artichoke is cultivated as an annual plant because of its high temperature demands. It is difficult to determine the most optimal harvest stage and the most often it is based on expensive chemical analysis. In the years 2007–2009 there was a research undertaken to specify the most optimal harvest stage of flower heads. In order to determine a development stage of head the height of flower bud in the middle part of the receptacle was measured directly after harvest. The unit weight of each head, the level of bracts deflection, content of dry weight, L-ascorbic acid, raw protein, raw fibre and total sugars in whole heads and their fractions: receptacle and bracts were determined. On the basis of obtained results it was stated that the size of flower buds on an inflorescence axis is a sign of full synchronization of head development and changing environmental conditions during artichoke vegetation. The edible part of artichoke, a receptacle, had more dry weight, total sugars, L-ascorbic acid and raw protein and less raw fibre in comparison to inner bracts. The increase of flower buds height on receptacle was accompanied with the increase of dry weight, raw fibre and total sugars content in heads and its fractions. The longer flower buds in the middle part of inflorescence the lower content of total protein in whole heads and bracts and the higher content of this component in receptacle. It was stated that the size of flower buds was negatively correlated with content of L-ascorbic acid as with the increase of flower buds height in receptacle the content of L-ascorbic acid in whole heads and it's fractions decreased. The obtained results show that the level of bracts deflection may the selection indicator to determine harvest maturity. This feature of artichoke head allows to visually determine its harvest usability. Receptacles of Symphony content more dry matter, total protein and less total sugars than those of Madrigal. Intermediate values were found in Symphony and Madrigal for L-ascorbic acid and crude fibre.

Key words: heads, growth, receptacle, bracts, chemical composition, Symphony, Madrigal

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INTRODUCTION

The artichoke (*Cynara scolymus* L.) is a member of the Asteraceae family. It is a perennial which at the beginning forms rosette of leaves [Bianco 2007].

This vegetable is cultivated for fresh, immature flower head, in practice called artichoke bud or head. It consists of many single florets on flattened receptacle, called artichoke 'heart', surrounded with external bracts. The bracts are hard, fibrous only in lower parts are edible [Foury and Pecaut 1988]. The artichoke is thought to more valuable than other vegetables as its biochemical constituents, particular polyphenolic compounds have an important role from nutritional points of view [Sałata and Gruszecki 2010].

The artichoke is a commonly cultivated vegetable in the South of Europe, in the Mediterranean region [Bianco 2005]. Because of its high thermal requirements it is cultivated in Poland as an annual plant. In the Mediterranean countries artichoke heads are harvested during winter. The early harvest is conducted, depending on the area, from November to December and the late one from January to March [Bucan et al. 2005; Cantore et al. 2005]. Temperature around 10°C during heads growth decide about their high quality. The temperature is a very important factor in artichoke cultivation it regulates proper growth of plant, flower buds development and flowering [Macua et al. 2004; Tesi et al. 2004]. Artichoke plants under high temperature stress mature too quickly and loose consumption value [Schrader 1992; Ierna et al. 2004; Mauromicale et al. 2004].

To determine the most optimal maturity stage of flower heads for harvest, which is not easy, the head size and bracts deflection are taken into consideration [Mauromicale and Raccuia 2000].

Trials to adapt artichoke cultivation for climate conditions of Poland have been undertaken for a few years. The problem to determine the optimal harvest stage of flower heads and its effect on their nutritional value is very interesting and completely not studied in the cultivation conditions of artichoke in Poland, so that explanation of this matter would be valuable from the theoretical and practical point of view.

MATERIAL AND METHODS

The research was undertaken in the years 2007–2009 in the research units of the University of Life Sciences in Lublin. The field experiments were conducted in the experimental centre of the Department of Vegetable Crops and Medicinal Plants in Felin and analysis of edible part of artichoke were done in the Laboratory of Plant Material Analysis of the Department. The experimental material were hybrid plants of artichoke recommended for cultivation from seed 'Symphony F_1' and 'Madrigal F_1' obtained from the Rijnsburg seed company (the Netherlands).

In the years 2007–2009 artichoke seeds were sown in a greenhouse in the first decade of March. The seeds were sown into multiple pots filled with peat substrate (54 single pots of 90 cm^3 cubic content each). The emergence of plants were observed 12 days after sowing at the air temperature of 18–20°C. In the 4^{th} week after the emer-

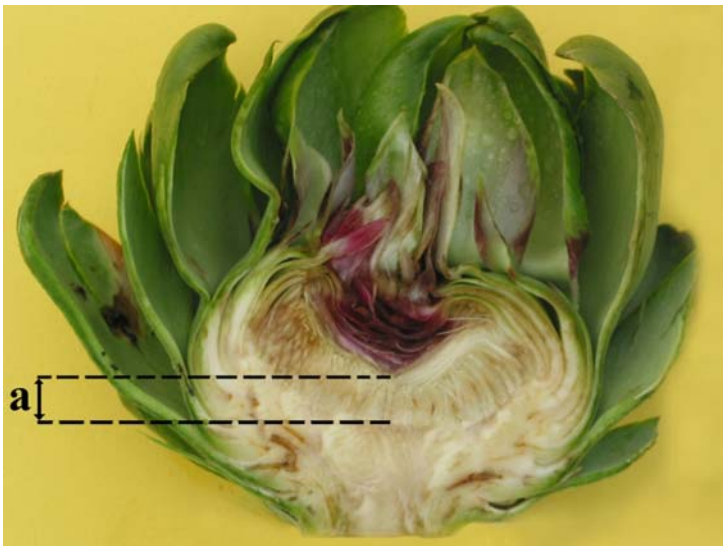


Photo 1. Method carry out of measurement flower bud heigh on the capitulum receptacle of artichoke: a – height of flower bud

Fot. 1. Metoda przeprowadzania pomiaru wysokości pąka kwiatowego w koszyczku karczocha: a – wysokość pąka kwiatowego

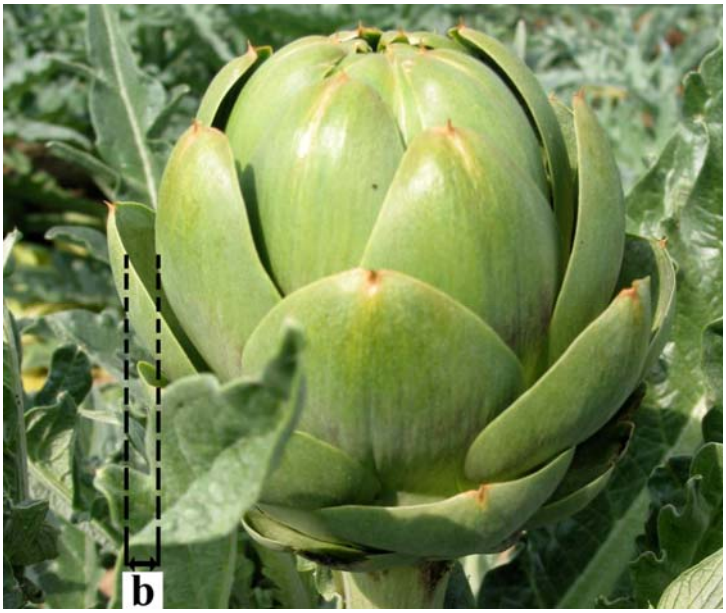


Photo 2. Method carry out of measurement reclinate external bracts from the capitulum of artichoke: b – reclinate external bracts

Fot. 2. Metoda przeprowadzania pomiaru okrywy zewnętrznej koszyczka karczocha: b – odchylenie okrywy zewnętrznej

gence plants were transplanted into 12 cm diameter pots. A few days before planting outdoor plants were fertilized foliarly with 0.1% Florovit and hardened.

Bean was used as a previous crop. In autumn it was harvested and 30 t·ha^{-1} of manure was applied before winter plough in. Organic fertilization was complemented with fertilizer at a rate 80, 150 and 150 kg·ha^{-1} of N, P and K respectively, used in two doses: before seedling planting and a rate 50 kg·ha^{-1} of N as a top dressing nutrition in the 5th week after planting.

The experiment was established according to a randomized blocks method in 4 replications, with 10 plants per replication. Seedling were planted with spacing 1.0 × 0.8 m, the area of each replication plot was 8.0 m^2. In the years of 2007–2009 artichoke seedlings were planted into the field at the same date – 10th of May.

The harvests of flower heads were conducted in August, successively as they grown on the plant. In the year 2007 first harvest was done 31st of July and the last one on the 3rd of September, while in the years 2008 and 2009 they were conducted on the 10th of August and the 10th of September respectively.

Right after harvest the weight of each head was determined. Flower heads were separated into two fractions depending on the level of bracts deflection in the lower part of head, which was measured with calipers (Photo 1). The raw fibre content was then determined in the bracts. After harvest, flower heads were cut in the middle of diameter and the height of flower bud in the central part of receptacle was measured in order to define stage of head development (Photo 2). In the case of heads with adjoining scales the outer inedible part was removed and the receptacle (artichoke 'heart') was separated from the fleshy inner bracts giving two fractions.

Evaluation of chemical content of edible part. Samples from commercial yield were taken randomly for analysis. The analyzed material was an average sample of 5 flower heads harvested in each combination. In the fresh plant material of edible parts: artichoke 'heart' and inner bracts, there was determined the content of the following:

– dry weight (%) with drop-weight method,
– L-ascorbic acid (mg·100 g^{-1} FW.) with Roe method modified by Evelyn,
– total sugars and reducing sugars (g·100 g^{-1} FW) with Luffe-Shorl method,
– total protein (g·100 g^{-1} FW) with Lowry method,
– raw fibre (g·100 g^{-1} FW) with Hennenberg and Stohmann method.

Statistical analysis. The obtained results were assessed statistically with analysis of variance in SAS software (SAS, 9.1 version), simple classification with the use of Tukey's confidence half interval at the 5% level of significance were computed.

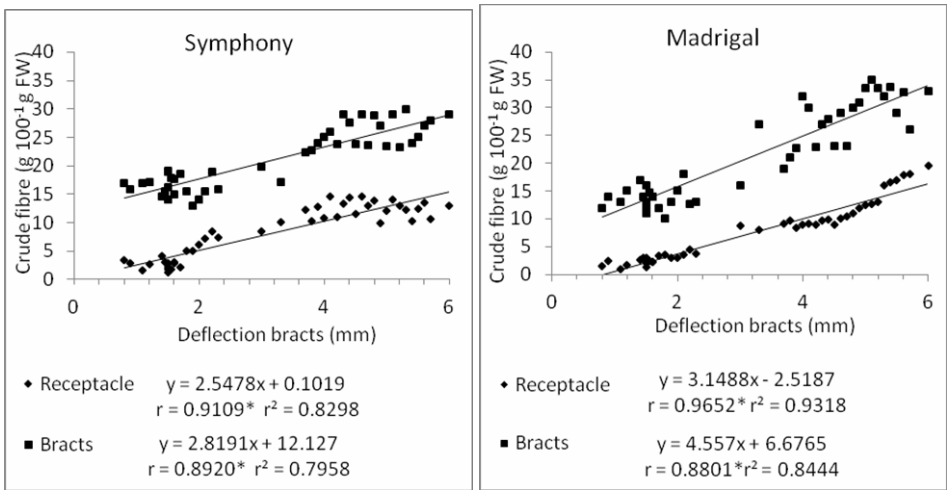
The results were assessed statistically, correlation coefficients were determined for examined features. Additionally with the use of regression analysis the dependence between the level of head outer bracts deflection and the content of raw fibre as well as between height of flower buds in the middle of the receptacle and the content of dry weight, L-ascorbic acid, raw fibre, raw protein and total sugars in the receptacle (artichoke 'heart') and inner bracts were determined.

RESULTS

Results of research presented in this work confirm the influence of weather conditions on content of chemical compounds in artichoke heads (tab. 1, 2). In the year 2008 the content of dry weight, L-ascorbic acid, raw fibre, total protein and total sugars in edible parts of heads of Madrigal and Symphony plants were higher than in the years 2007 and 2009. In comparison to the years 2007 and 2009, the temperature and falls during growth and maturing of heads for harvest (in August) were higher in the year 2008.

Table 1. The total monthly rainfall and an average air temperature during the research
Tabela 1. Suma opadów i średnia temperatur w okresie badań

Year Rok	May Maj		June Czerwiec		July Lipiec		August Sierpień		September Wrzesień	
	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C
2007	80.5	14.9	87.8	18.1	87.0	19.2	37.6	18.4	129.8	12.9
2008	101.6	12.8	25.9	17.7	77.1	18.3	45.0	19.3	102.2	12.6
2009	71.1	13.6	125.5	16.4	57.1	19.9	54.7	19.0	21.0	15.3
Long term Temperatura wieloletnia (1951–2005)	57.7	13.0	65.7	16.2	83.5	17.8	68.6	17.1	51.6	12.6



* significantly at α = 0.05 – istotnie przy α = 0,05

Fig. 1. Relation between deflection bracts on the head and crude fibre content (bracts and receptacle) of two cultivars of globe artichoke
Rys. 1. Zależność pomiędzy odchyleniem okrywy zewnętrznej koszyczka a zawartością włókna surowego (okrywy i dno kwiatostanowe) u dwóch odmian karczocha

Together with the lengthening vegetation period of plants and growing heads on inflorescence stems the tendency to deflect head bracts was observed. The dependence between the level of bracts deflection and content of raw fibre in bracts and receptacle was an increasing linear function (fig. 1). The bigger level of outer bracts deflection the higher content of raw fibre. These correlations were significant for both examined artichoke cultivars. The bracts deflection was caused by increasing content of raw fibre in 80% for Symphony and in 84% for Madrigal cultivars. At the bracts deflection from 1 to 2 mm the content of raw fibre in receptacle was on average 5 $g \cdot 100^{-1}$ of fresh weight, and in bracts 15 $g \cdot 100^{-1}$ of fresh weight, while with bracts deflected from 4 to 6 mm the raw fibre content increased to 10 $g \cdot 100^{-1}$ of fresh weight in receptacle and to 25 $g \cdot 100^{-1}$ of fresh weight in bracts.

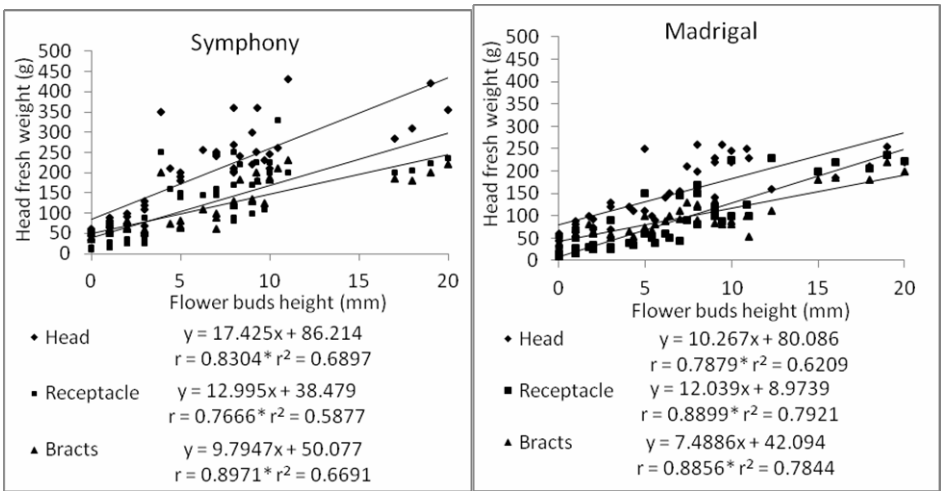


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Fig. 2. Relation between flower buds height on the receptacle and head fresh weight (head and its fractions: inner bracts and receptacle) of two cultivars of globe artichoke

Rys. 2. Zależność pomiędzy wysokością pąka kwiatowego na dnie kwiatostanowym a masą koszyczka (koszyczek i jego frakcje: okrywy wewnętrzne i dno kwiatostanowe) u dwóch odmian karczocha

On the basis of obtained results it was stated that together with the growth of flower buds in the receptacle weight of single heads was increasing (fig. 2). The increase of weight of whole heads and separate fractions: receptacle and head bracts, was characterized with increasing linear function. Faster increase of head weight was observed at Symphony in comparison to Madrigal. Heads harvested from Symphony plants when the height of buds in receptacle was 8 mm had weight of 350 g, while those harvested from Madrigal at the same height of flower buds weighted 150 g. The share of each head fractions was correlated with the size of flower buds in receptacle. For Symphony when the height of bud was ≤ 2.5 mm the share of bracts was higher than receptacle. The longer flower buds (≥ 2.5 mm) the share of receptacle was bigger and the share of

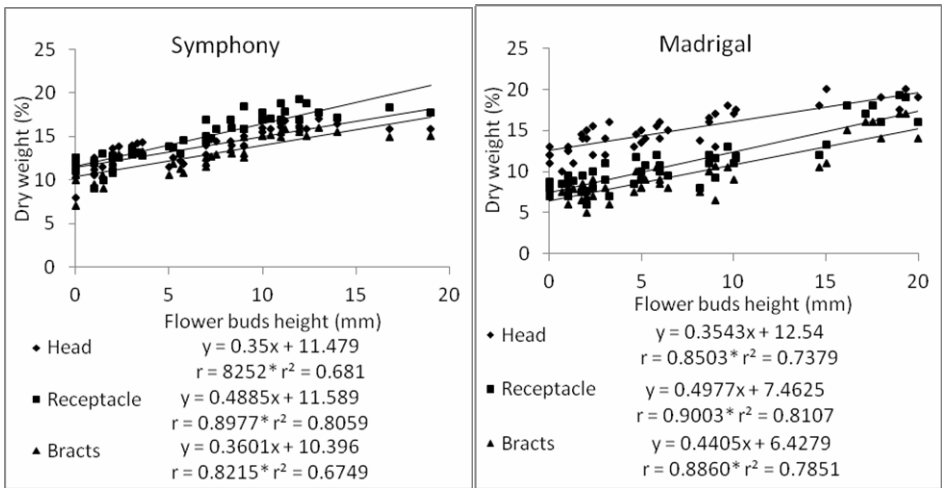
bracts was lower. Similar growth of heads was observed for Madrigal, while the change of head structure was observed when height of flower buds was 5 mm.

Table 2. The content of dry weight, in %, and chosen organic component, in g·100 g^{-1} FW, in bracts and receptacle of artichoke depending on the cultivar (years 2007–2009)

Tabela 2. Zawartość suchej masy w % i związków organicznych w g·100 g^{-1} św.m. w okrywach i dnie kwiatostanowym karczocha w zależności od odmiany (2007–2009)

Cultivar Odmiana	Year Rok	Dry weight Sucha masa		L-ascorbic acid Kwas L-askorbinowy		Crude fibre Błonnik		Total protein Białko ogółem		Total sugars Cukry ogółem	
		r	b	r	b	r	b	r	b	r	b
Symphony	2007	12.56 c*	11.32b	11.98c	9.45c	7.45c	19.63bc	18.95b	14.96c	25.56b	4.29c
	2008	17.34a	14.55a	16.95a	13.18a	9.56ab	22.78a	21.34a	18.73a	29.22a	7.82a
	2009	14.65b	12.20b	14.68b	11.29b	8.45bc	21.25ab	20.86a	16.48b	28.65a	6.54ab
	mean średnio	14.85A	12.69A	14.54A	11.31A	8.49A	21.22A	20.38A	16.72A	27.81B	6.22A
Madrigal	2007	9.40c	8.35b	14.68c	5.26b	6.78b	18.45b	17.28b	12.86b	29.65b	3.78b
	2008	12.28a	11.35a	16.89ab	7.36a	10.12a	22.56a	20.33a	17.75a	33.24a	6.83a
	2009	10.80b	9.39b	15.90b	6.76ab	7.49b	20.33b	17.18b	16.45a	30.78b	6.83a
	mean średnio	10.83B	9.70B	15.82A	6.46B	8.13A	20.45A	18.26B	15.69B	31.22A	5.81A

*mean in the columns followed by the same letters do not differ significantly at α = 0.05
r – receptacle; b – bracts
*średnie w kolumnach poprzedzone tymi samymi literami nie różnią się istotnie przy α = 0,05
r – dno kwiatostanowe; b – okrywy



* significantly at α = 0.05 – istotnie przy α = 0,05

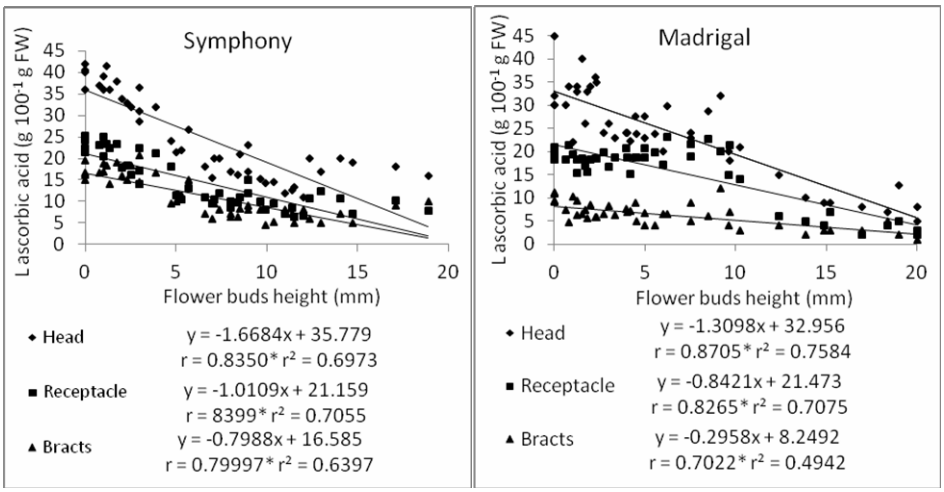
Fig. 3. Relation between flower buds height on the receptacle and dry matter content (head and its fractions: inner bracts and receptacle) of two cultivars of globe artichoke

Rys. 3. Zależność pomiędzy wysokością pąka kwiatowego na dnie kwiatostanowym a zawartością suchej masy (koszyczek i jego frakcje: okrywy wewnętrzne i dno kwiatostanowe) u dwóch odmian karczocha

The chemical content analysis of immature artichoke heads showed differentiated content of compounds depending on cultivar, head fractions, stage of growth and stage of head development. Heads of Symphony and Madrigal cultivars had on average 12.84% of dry weight in receptacle and 11.19% in head bracts (tab. 2). Significantly more dry weight occurred in Symphony heads receptacles (14.85%) and bracts (12.69%) than in Madrigal. The increase of flower buds height in a receptacle was accompanied by increase of dry weight in receptacle and head bracts and this feature was statistically significant for both cultivars (fig. 3).

The mean content of L-ascorbic acid in a receptacle for Madrigal was 15.82 g·100 g FW, and for Symphony 14.54 g·100 g FW. Head bracts of Symphony cultivar had more L-ascorbic acid by 4.85 g·100 g FW than Madrigal (tab. 2). For cultivars examined the correlation between the size of flower buds and content of L-ascorbic acid in whole heads and in edible parts – receptacle and its coats, was negative (fig. 4). It means that each increase in height of flower buds by 1 mm caused significant reduction of L-ascorbic acid content. Significant values of this coefficient for examined correlation were observed in both artichoke cultivars.

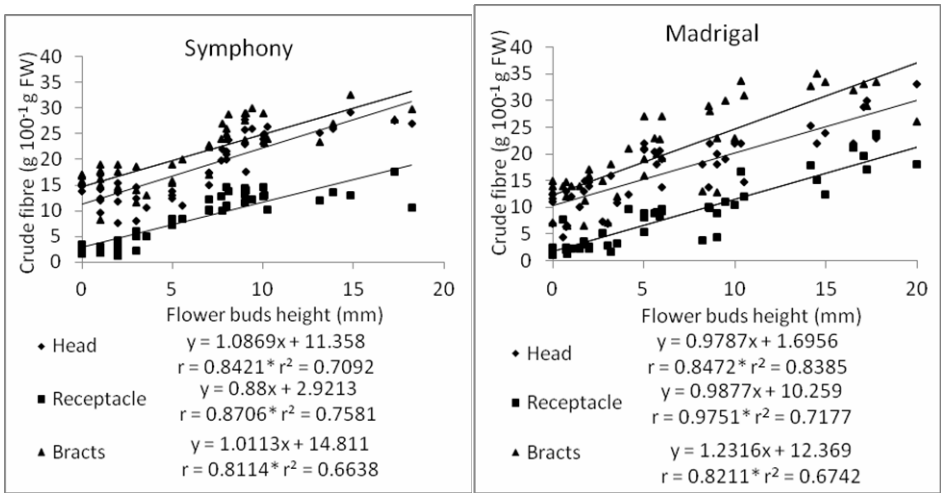
Plants of both cultivars accumulated much more raw fibre in head coats than in receptacle of immature heads, for Symphony the difference was 12.73 g·100 g FW, for Madrigal it was 12.32 g·100 g FW (tab. 2). The size of flower buds was positively correlated with raw fibre content in heads and inner coats (fig. 5). Together with extend vegetation period of plants and lengthening flower buds on inflorescence axis the content of raw fibre increased, the most in coats and whole heads and less in receptacle.



* significantly at α = 0.05 – istotnie przy α = 0,05

Fig. 4. Relation between flower buds height on the receptacle and L-ascorbic acid content (head and its fractions: inner bracts and receptacle) of two cultivars of globe artichoke

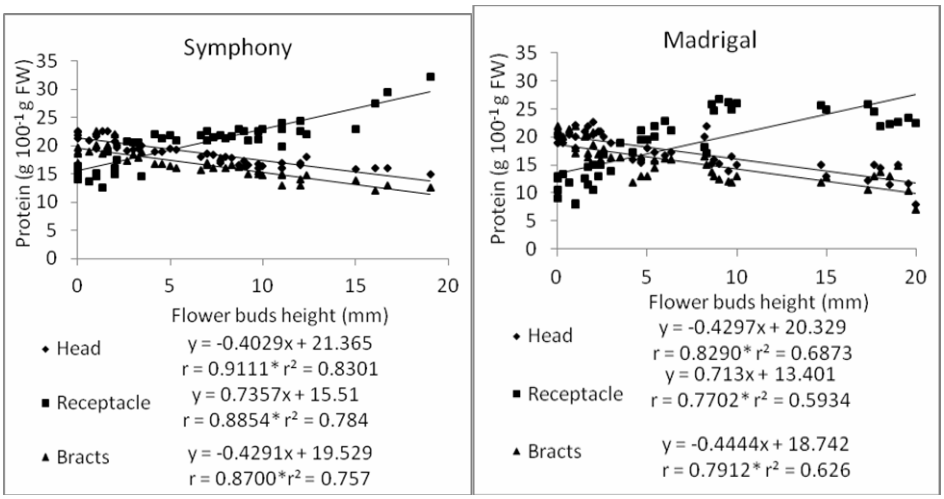
Rys. 4. Zależność pomiędzy wysokością pąka kwiatowego na dnie kwiatostanowym a zawartością kwasu L-askorbinowego (koszyczek i jego frakcje: okrywy wewnętrzne i dno kwiatostanowe) u dwóch odmian karczocha



* significantly at α = 0.05 – istotnie przy α = 0,05

Fig. 5. Relation between flower buds height on the receptacle and crude fibre content (head and its fractions: inner bracts and receptacle) of two cultivars of globe artichoke

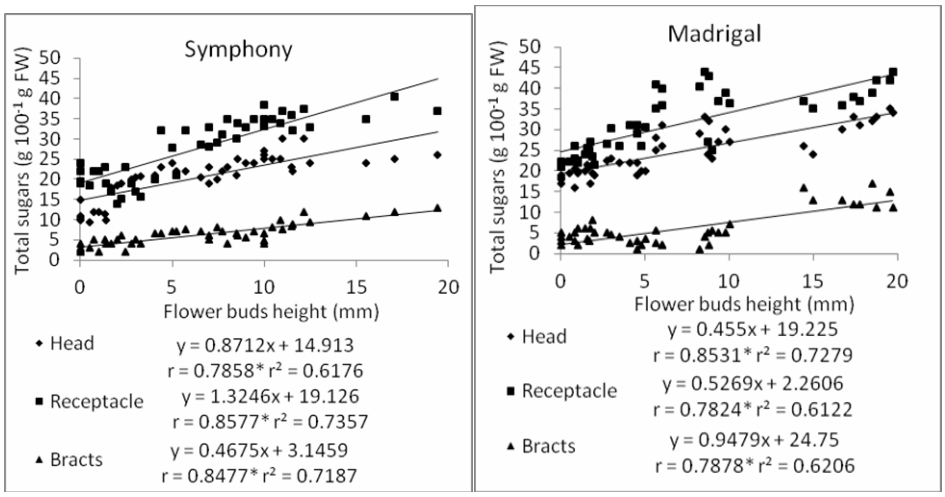
Rys. 5. Zależność pomiędzy wysokością pąka kwiatowego na dnie kwiatostanowym a zawartością włókna surowego (koszyczek i jego frakcje: okrywy wewnętrzne i dno kwiatostanowe) u dwóch odmian karczocha



* significantly at α = 0.05 – istotnie przy α = 0,05

Fig. 6. Relation between flower buds height on the receptacle and protein content (head and its fractions: inner bracts and receptacle) of two cultivars of globe artichoke

Rys. 6. Zależność pomiędzy wysokością pąka kwiatowego na dnie kwiatostanowym a zawartością białka (koszyczek i jego frakcje: okrywy wewnętrzne i dno kwiatostanowe) u dwóch odmian karczocha



* significantly at α = 0.05 – istotnie przy α = 0,05

Fig. 7. Relation between flower buds height on the receptacle and total sugars content (head and its fractions: inner bracts and receptacle) of two cultivars of globe artichoke

Rys. 7. Zależność pomiędzy wysokością pąka kwiatowego na dnie kwiatostanowym a zawartością cukrów ogółem (koszyczek i jego frakcje: okrywy wewnętrzne i dno kwiatostanowe) u dwóch odmian karczocha

In heads of both cultivars of artichoke receptacle was more richer in total protein than bracts (tab. 2). Significantly more total proteins were in edible parts and coats of Symphony (respectively 20.38 and 16.72 g·100 g FW) than Madrigal (18.26 and 15.69 g·100 g FW). Course of linear functions relating to correlations between height of flower buds and content of total protein for single fractions of head was different (fig. 6). In general it was observed, that together with increasing buds height the content of total protein increased in receptacle and decreased in whole heads and bracts at the same time. Statistically significant values of coefficient for examined feature were observed for both cultivars. The effect of extend of vegetation period (stage of flower buds height > 5 mm) could be seen as more than twice higher content of total protein in receptacle in comparison to head coats.

More total sugars were in receptacle of Madrigal cultivar (31.22 g·100 g FW) than in edible parts of heads of Symphony cultivar (27.81 g·100 g FW). The content of sugars in receptacle of both cultivars was higher than in head coats: for Symphony by 4.5 times and Madrigal by 5.4 times (fig. 7). Correlation between height of buds and total sugars content were positive. The higher buds the more total sugars in receptacle, whole heads and coats could be observed.

DISCUSSION

On the basis of obtained results it was stated that the higher flower buds the larger head weight. The increase of weight of whole heads, as well as its fractions, receptacle and bracts was a positive linear function. It shows that heads growth and flowers development are interdependent and run evenly. Flower buds size on inflorescence axis is a sign of full synchronization between artichoke head development and changing climate conditions during vegetation [Foury 2003]. During carried out harvests a mean weight of Symphony flower head was 196 g, while for Madrigal it was 260 g. In research of Bonasia et al. [2010] mean head weight of Madrigal was 292.9 g.

More interesting for estimation of the best stage of flower heads harvest seems determination of correlation between content of raw fibre in outer bracts and the level of their deflection. In the case of Symphony and Madrigal cultivars correlation between level of bracts deflection and content of raw fibre in receptacle and coats was significant and positive. Obtained results show that level of bracts deflection might be a selection index to determine degree of ripeness for harvest. This part of artichoke's head structure allows to estimate its harvest maturity.

It is difficult to determine the optimal stage of harvest heads from artichoke plants and the most often it is based on chemical analysis, which are expensive. It is possible to use correlations occurring between morphological features and chemical content. Similar positive correlation was observed in previous research conducted by Mauromicale et al. [2000].

Edible part of artichokes, receptacle, had more dry weight and contained more total sugars, L-ascorbic acid, total protein and less raw fibre in comparison to inner coats of head. Much more dry weight and total protein was in edible parts of heads harvested from Symphony plants than from Madrigal. Heads harvested from Madrigal contained more total sugars in comparison to heads obtained from Symphony plants.

Examined cultivars characterized with very profitable for human health content of chemical compounds in edible parts of heads as the dominating ones were total sugars, protein and raw fibre. An edible part had on average 27.81 g·100 g FW of Symphony plants and 31.22 g·100 g FW for Madrigal. Content of these chemical compounds were similar at other authors [Di Venere et al. 2005; Raccuia et al. 2004]. There is information in literature that high biological value of artichokes depends on high content of inulin which constitutes 75% of total sugars [Melilli et al. 2004].

Increase of flower buds height in receptacle was accompanied by increase of dry weight, raw fibre and total sugars in whole heads and its fractions: in edible parts – receptacle and inner bracts of head. Differentiated contents of total protein were observed in heads of Symphony and Madrigal. Lengthening of flower buds in middle part of inflorescence was accompanied by decrease of total protein content in whole heads and bracts of heads and increase of this compound in receptacle. It was stated that size of flower buds was correlated negatively with content of L-ascorbic acid as it was observed that the higher flower buds in receptacle the lower content of L-ascorbic acid in whole heads and its fractions. Results are converge with those described by other authors [Rangarajan et al. 2000; Arce et al. 2004; Esteva et al. 2004; Ferreyra et al. 2005]

and allow to state that content of chemical compounds in artichoke heads is proportional to plants growth intensity.

Opinion that in process of flower buds differentiation there are transformations of chemical compounds in artichoke inflorescence is common. Rate of flowers development and transformations depend mainly on temperature. In conditions of high temperature bracts of coats deflect fast, heads lose their usability stage and commercial value [Mauromicale et al. 2000]. Ierna et al. [2004] observed in Sicily during harvest of artichoke (from March to May) premature flowering of plants and decrease of yield. In the opinion of the authors high temperature had major effect on growth and yield of artichoke.

CONCLUSION

It was stated that the higher flower buds the larger head weight. It shows that heads growth and flowers development are interdependent and run evenly. Obtained results show that level of bracts deflection might be a selection index to determine degree of ripeness for harvest. Increase of flower buds height in receptacle was accompanied by increase of dry weight, raw fibre and total sugars in whole heads and its fractions: in edible parts – receptacle and inner coats of head. Lengthening of flower buds in middle part of inflorescence was accompanied by decrease of total protein content in whole heads and bracts of heads and increase of this compound in receptacle. It was stated that size of flower buds was correlated negatively with content of L-ascorbic acid as it was observed that the higher flower buds in receptacle the lower content of L-ascorbic acid in whole heads and its fractions. Receptacles of Symphony content more dry matter, total protein and less total sugars than those of Madrigal. Intermediate values were found in Symphony and Madrigal for L-ascorbic acid and crude fibre. However, head chemical composition of the two cultivars of globe artichoke confirmed the good nutritive characteristics of this vegetables, particularly as regards total protein, sugars and fibre content.

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MORFOLOGICZNA I JAKOŚCIOWA CHARAKTERYSTYKA KOSZYCZKÓW KARCZOCHA (*Cyanara scolymus* L.) ODMIAN 'SYMPHONY' I 'MADRIGAL' W ZALEŻNOŚCI OD ICH WZROSTU

Streszczenie. Karczoch jest powszechnie uprawianym warzywem w rejonie śródziemnomorskim. Warzywo to uprawia się dla świeżego nierozwiniętego koszyczka. Ze względu na wysokie wymagania termiczne karczoch w Polsce uprawiany jest jako roślina jednoroczna. W latach 2007–2009 przeprowadzono badania dotyczące określenia optymalnej dojrzałości koszyczków do zbioru. Bezpośrednio po zbiorze w celu określenia fazy rozwojowej koszyczka mierzono wysokość pąka kwiatowego na dnie kwiatostanowym w środkowej jego części. Określano masę jednostkową każdego koszyczka, stopień odchylenia listków okryw zewnętrznych, zawartość suchej masy, kwasu L-askorbinowego, białka ogółem, włókna surowego i cukrów ogółem w całych koszyczkach i jego frakcjach: dnie kwiatostanowym i okrywach koszyczka. Stwierdzono, że wielkość pąków kwiatowych na osi kwiatostanowej koszyczka jest związana z rozwojem rośliny oraz ze zmieniającymi się warunkami środowiska. Część jadalna karczochów, dno kwiatostanowe zawierało więcej suchej masy i było zasobniejsze w cukry ogółem, kwas L-askorbinowy, białko ogółem a mniej zasobne we włókno surowe w porównaniu z okrywami wewnętrznymi koszyczka. Wzrostowi wysokości pąków kwiatowych na dnie kwiatostanowym towarzyszył wzrost zawartości suchej masy, włókna surowego oraz cukrów ogółem w koszyczkach i jego frakcjach. Wydłużaniu pąków kwiatowych w środkowej części kwiatostanu towarzyszyło zmniejszanie się zawartość białka ogólnego w całych koszyczkach oraz w listkach okryw koszyczka przy jednoczesnym wzroście zawartości tego składnika w dnie kwiatostanowym. Stwierdzono, że wielkość pąków kwiatowych skorelowana była ujemnie z zawartością kwasu L-askorbinowego, gdyż wraz ze wzrostem wysokości pąków na dnie kwiatostanowym zmniejszała się zawartość kwasu L-askorbinowego w całych koszykach i jego frakcjach. Otrzymane wyniki wskazują, że stopień odchylenia listków okryw koszyczka może być wskaźnikiem selekcyjnym w określaniu dojrzałości do zbioru. U odmiany Symphony dno kwiatostanowe koszyczka zawierało więcej suchej masy, białka ogółem oraz mniej cukrów ogółem niż u odmiany Madrigal. Koszyczki odmiany Symphony i Madrigal były zasobne w kwas L-askorbinowy i włókno surowe.

Słowa kluczowe: koszyczki, wzrost, dno kwiatostanowe, okrywy, skład chemiczny, Symphony, Madrigal

Accepted for print – Zaakceptowano do druku: 26.06.2012