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Cynara scolymus L.: an Accurate Method for Determining the Edible Parts

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Summary

For artichoke cultivars grown for the fresh market a sizable "heart" and outer bracts with high contents of inside flesh are potentially favourable characteristics. We suggest a simple and accurate method for determining the edible fractions of artichokes. Edible parts of stem, outer bracts, inner bracts, as well as pappus and receptacle were determined based on partitioning of cooked buds. The heart fraction was calculated as the sum of edible inner bracts, pappus and receptacle divided by the drained weight. The total edible fraction was calculated as the sum of all edible parts divided by the drained weight. Differences in edible fractions were detected between seed artichoke cultivars 'Imperial Star' and 'JW 109'. The method described may contribute to a more detailed quantification of artichoke quality.

Key words. *Cynara scolymus* – edible fraction – bud height – bud diameter – yield

Introduction

When artichokes (*Cynara scolymus* L.) are consumed as a vegetable, the outer bracts of cooked buds are usually peeled off and dipped into a variety of sauces. Then the inside flesh of each bract is eaten by scraping it between the teeth (Rainey and Nyquist 1997). Thereafter, the soft, inner part of the capitulum, formed by the lower parts of inner leaves, pappus and receptacle which is generally known as the 'heart' is eaten with knife and fork. Thus, consumers intending to prepare artichokes as vegetable are satisfied with artichoke heads providing outer bracts with high contents of inside flesh and a sizable heart. For producers who grow artichokes for the fresh market this could be of importance for cultivar choice, especially when direct marketing is possible. However, the edible content of artichoke cultivars is not commonly recorded. In fact, cultivars are reviewed rather with respect to marketable yield, head weight and head size, then with respect to quantification of edible parts. Previously described methods for ascertaining the edible parts of artichokes neglect the outer bracts but focus on the heart (e.g. Halter 2003, Sharaf-Eldin et al. 2003). This mode proved to be suitable and satisfying when artichokes are grown for processing, nonetheless it might underestimate the edible fraction in cultivars with fleshy bracts, which is relevant when artichokes are produced for the fresh market. Thus, we suggest an accurate method for assessing the edible parts using previously cooked artichokes.

Material and Methods

Two cultivars with apparently different habitus were chosen, assuming that the differences in morphology are reflected by differences in the share of edible fractions. Cultivar 'Imperial Star' is a thornless globe artichoke with greyish-midgreen glossy bracts (Schrader and Mayberry 1992) which is well established as a vegetable artichoke for both processing and fresh marketing. Cultivar 'JW 109' is characterized by elongated buds and reddish outer bracts. The latter cultivar is also known as 'A 109' and is assumed to have good quality for fresh market. Both cultivars where grown in two consecutive years (2007 and 2008) on a loamy soil in Hennef/Germany (50° 48' N; 07° 17' E, mean temperature 10.1 °C, mean annual precipitation 750 mm). In both years, 60 t ha^{-1} of farmyard manure were incorporated into the soil before planting. The artichokes were grown from seeds in the greenhouse from early February in both years and transplanted to the field on April 18 in 2007 and April 24 in 2008, respectively for one year production. Plant spacing was 1.0 m x 1.6 m. Plots containing 10 plants each were arranged in a randomized design with four replicates. Sprinkler irrigation was provided throughout the growing period. Buds in marketable quality i.e. undamaged buds with a diameter >9 cm harvested before the bracts spread open were used to assess total fresh matter yield. Harvest period lasted from July to September in both years. For determining the edible parts, only primary buds were used, since they exhibit less variance in their morphology. Twelve primary buds of each cultivar were harvested from previously selected plants between July 18 and July 31 in 2007 and July 6 and July 14 in 2008, respectively. Bud diameter and bud height were recorded. Edible parts were determined as follows: (1) Artichoke buds were cut to a stem length of 6 cm and boiled in water for 30 min. After cooling off and dripping off on a grid for 30 min., drained weight (DW) was measured using a standard laboratory balance. (2) The bottom 5 cm of the stem was removed by using a sharp

knife. The remaining 1 cm stem (S) was cut and weighed. (3) The outer bracts were removed until the pale and soft inner bracts appeared. The soft, edible parts of the outer bracts (OB_{ed}) were scraped off from their inner sides using a customary sharp edged teaspoon, collected and weighed. (4) The upper, partially lignified parts of the inner bracts were removed by using a sharp knife, and then the lower, edible parts of the inner bracts (IB_{ed}) were separated from the receptacle and weighed. (5) The pappus (P) was dissected from the receptacle and weighed. (6) The remaining receptacle (R) was weighed. (7) The heart fraction was calculated as the sum of edible inner bracts, pappus and receptacle divided by the drained weight (equation I):

$$\text{Heart fraction (\%)} = \frac{IB_{ed}(g) + P(g) + R(g)}{DW(g)} \cdot 100 \qquad (I)$$

(8) The total edible fraction was calculated as the sum of all edible parts divided by the drained weight (equation II):

$$\text{Total edible fraction (\%)} = \frac{S(g) + OB_{ed}(g) + IB_{ed}(g) + P(g) + R(g)}{DW(g)} \cdot 100 \qquad (II)$$

Statistical differences between the cultivars were estimated with t-tests ($p<0.05$) using SPSS version 14.0.

Results

'Imperial Star' produced a total marketable yield between 1030.7 and 551.3 g m^{-2} (2007 and 2008) whereas 'JW 109' produced a total marketable yield between 760.2 and 475.6 g m^{-2} (2007 and 2008). In 2007 mean primary bud height was 9.9 cm (s.e. 0.3) in 'Imperial Star' and 9.1 cm (s.e. 0.2) in 'JW 109', which was a statistically significant difference (t-test, $P<0.05$). Bud diameter was 9.5 cm on average in both, 'Imperial Star' and 'JW 109' (s.d. 0.8 and 1.0, respectively). In 2008 no significant differences were observed (t-test, $P<0.05$): Mean primary bud height was 9.4 cm (s.e. 0.2) in 'Imperial Star' and 9.9 cm (s.e. 0.2) in 'JW 109'. Bud diameter was 9.6 cm on average in 'Imperial Star' and 9.2 cm 'JW 109' (s.d. 0.2 and 0.3 respectively). The investigated primary buds exhibited statistical differences concerning the total percentage of edible parts (Table 1). In 2007 we found the share in pappus, receptacle and heart fraction to be higher in 'JW 109' than in 'Imperial Star'. In 2008 there was a higher share in the edible parts of outer bracts in 'Imperial Star' than in 'JW 109'.

Discussion

Annual production of seed artichoke is a promising growing practise in areas where cold winters are limiting the change to successfully grow artichokes as a biannual crop (Halter et al. 2005). In our field trial, total marketable yield in both cultivars was markedly lower in 2008 than in 2007. This result is related to a severe root vole infestation in the latter year. The suggested method for determining the edible parts proved to be simple and less time consuming than expected: each bud was analysed in approximately 10 min (time for cooking and cooling off excluded). The total edible fraction of 'Imperial Star' as determined by the suggested method was within the range revealed by Sharaf-Eldin et al. (2003), based on an investigation on uncooked heads. The share of edible parts in artichokes may vary markedly between different cultivars. In 2007 'JW 109' produced higher edible contents in pappus and receptacle and a higher heart total edible fraction. We have to take into consideration that many consumers may despise stem and pappus, which will result in a potential divergence between the effectively consumed edible content and the total edible content as shown in Table 1. However, this uncertainty refers to a comparatively small part of the total edible fraction. In 2008 the differences revealed in the previous year were not confirmed. These results are supposedly linked to the unfavourable growing conditions in 2008, resulting in reduced total marketable yield and potentially also diminishing possible differences in the share of edible parts between the cultivars. Furthermore, artichokes are known to yield highly variable populations of plants (Baggett et al. 1982), especially when grown from seeds. However, a statistical difference in the edible

Table 1. Total drained weight (g) and percentage of total drained weight (%) of different fractions of edible parts in two artichoke cultivars. Standard errors are shown in parentheses. Differences between cultivars were estimated with t-tests. Sig. = Significance.

Year	2007			2008		
Edible fraction	'Imperial Star' (n=11)	'JW 109' (n=11)	Sig.	'Imperial Star' (n=12)	'JW 109' (n=12)	Sig.
Total drained weight [g]	305.8 (15.2)	267.9 (18.2)	n.s.	290.5 (14.7)	253.4 (18.3)	n.s.
Stem [%]	1.9 (0.2)	2.3 (0.1)	n.s.	1.9 (0.1)	2.0 (0.2)	n.s.
Outer bracts [%]	7.5 (0.5)	9.1 (1.0)	n.s.	12.8 (1.5)	9.7 (0.8)	*
Inner bracts [%]	12.8 (1.5)	12.8 (1.3)	n.s.	10.4 (0.7)	11.1 (1.4)	n.s.
Pappus [%]	1.7 (0.1)	2.3 (0.3)	*	2.9 (0.2)	2.7 (0.3)	n.s.
Receptacle [%]	7.5 (0.5)	9.8 (0.6)	**	8.1 (0.4)	8.3 (0.5)	n.s.
Heart fraction [%]	21.9 (1.2)	24.9 (1.2)	*	21.4 (0.6)	22.2 (1.0)	n.s.
Total edible parts [%]	31.3 (1.2)	36.3 (1.6)	**	36.1 (1.4)	33.8 (1.6)	n.s.

*: P<0.1, **: P<0.05, n.s.: not significant

fraction of outer bracts indicates that our method might also be useful to identify cultivars with a high content of flesh in the outer bracts – an attribute that is sometimes used to advertise new cultivars (e.g. PAPALINI 1997) but has not been quantified so far. Probably, more pronounced differences in the edible contents would have been revealed between genetically more separated cultivars, including asexually propagated genotypes. Another aspect that needs attention in future investigations is possible differences between primary buds and secondary or auxiliary buds that were not taken into account in this study. The investigated cultivars had apparently different properties regarding the share of fibre tissue in the stem. Variations in the consistency of artichokes have been described previously: ALMELA et al. (2007) found significant differences regarding texture and moisture as well as glucidic content and browning capacity between different cultivars, which provided information on the potential use for industrial applications or fresh consumption. In 'JW 109' even in the uppermost stem fibres were present, provoking some inconvenience when chewing it. In 'Imperial Star' fibre content was lower: the stem had a fine texture down to 5 cm distance from the bud. We did not record the fibre content in stems nor the sensory quality of the edible parts. However, we assume that these parameters could be important parameters for quantifying the quality of artichokes.

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