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Amino acid profile of organically grown alternative agricultural products

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Abstract. Human nutrition recently has mainly focused on animal products; particularly processed products with large amounts of various synthetic additives. The benefit of fruits and vegetables for human health has been already shown and consumer interest in organic food products has increased. Therefore the main aim of this research work was to determine the amino acid content of the following organically grown raw alternative products: the pumpkins *Cucurbita maxima* Duchesne – 'Stofuntovaja', 'Bambino', 'Kroška'; *Cucurbita moschata* (Duchesne) Duchesne ex Poir. – 'Žemčiužina'; *Cucurbita pepo* L. – 'Miranda', 'Golosemiannaja', 'Herakles' and Jerusalem artichokes (*Helianthus tuberosus* L.) – 'Swojecki', 'Rubik', 'Albik'.After harvest they were analyzed in order to estimate their amino acid composition. Amino acids were separated by the method of ion-exchange chromatography and detected photometrically with an automatic analyzer of amino acids Mikrotechna AAA 339. The amount of essential amino acids was highest in Jerusalem artichokes. The largest concentration of individual essential amino acids, depended on cultivar, was arginine 8.41 to 9.57 g kg $^{-1}$ in Jerusalem artichokes; while in pumpkins this was leucine, which ranged from – 3.6–1.09 g kg $^{-1}$. The pumpkin 'Bambino' cv. had the highest content of all essential amino acids compared with other pumpkins. Jerusalem artichokes of the 'Albik' cv. were exceptionally high in amounts of nonessential glutamate and pumpkins of 'Golosemiannaja' cv. in aspartate amino acid, respectively 11.09 and 12.99 g kg $^{-1}$. The essential to total amino acids ratio is higher in Jerusalem artichoke tubers compared with pumpkin pulp.

Key words: amino acids, pumpkins (*Cucurbita*), Jerusalem artichoke (*Helianthus tuberosus* L.)

INTRODUCTION

Reviews of the literature have demonstrated few and inconsistent differences in the nutrient composition of organically produced foods compared to foods that have been produced by conventional methods (Woese et al., 1997; Bourn & Prescott, 2002).

There are indications that many organic food varieties have a lower nitrate content (Worthington, 2001; Bourn & Prescott, 2002) and higher vitamin C, iron, magnesium, and phosphorus contents compared to their conventional counterparts. There were nonsignificant trends showing less protein but protein of better quality, and higher contents of nutritionally important minerals with, lower amounts of some heavy metals in organic crops compared to conventional ones (Worthington, 2001). Consideration of the impact of organic growing systems on nutrient bioavailability is an important direction for future research.

Proteins are a particularly important material of human cells and play an important role in human nutrition. The amino acid content, their proportions and digestibility by humans define protein's biological value (Joint FAO/WHO/UNU, 1981). Proteins consist of 20 amino acids, but the most important are essential amino acids which the human body needs to gain from food.

According to Aboul-Nasr (1997) and Tarek (2001) the amounts of amino acids in plants depend not only on plant species, the generative or vegetative portions, but also from the soil, climatic conditions and the vegetative period. Pumpkin (*Cucurbita*) and Jerusalem artichoke (*Helianthus tuberosus* L.) are alternative, not very widespread, agricultural products containing components important for human nutrition. Scientists have proved the suitability of pumpkins and their products for curing various diseases. This vegetable is valued not only for its nutritious and medicinal qualities but also for simple cultivation. Of all the known cultured plants, in comparison with other vegetables, pumpkins produce the highest yields (Brecht, 1999). The Jerusalem artichoke originated in the American continent and has been first, a source for human food, and secondly, a source of animal food (Ben Chekroun et al., 1996). The main component of tubers' dry matter content are carbohydrates and the greatest part of these consist of water soluble inulin (concentrations ranges between 49.5 to 56.4% of dry matter) (Praznik et al., 1998).

In pumpkin pulp the amount of protein is negligible – on average 0.8–1.0% (Anon, 1976), but they contain almost all the essential and nonessential amino acids (Duke, 1998).

The protein content of Jerusalem artichoke varies from 2 to 3% (Tchoné, 2003). There is very little data known about the amino acid composition of Jerusalem artichoke tubers. Cieslik (1998) reports that Jerusalem artichoke contains all the essential amino acids in almost ideal proportions.

Despite the small amounts of proteins in pumpkins and Jerusalem artichokes the amino acids contained are beneficial for human nutrition. The main aim of this research work was to determine the amino acids contained in organically grown raw alternative products.

MATERIALS AND METHODS

Plant material

The following pumpkin and Jerusalem artichoke cultivars were selected for the investigations: *Cucurbita maxima* Duchesne – 'Stofuntovaja', 'Bambino', 'Kroška'; *Cucurbita moschata* (Duchesne) Duchesne ex Poir. – 'Žemčiužina'; *Cucurbita pepo* L. – 'Miranda', 'Golosemiannaja', 'Herakles'; *Helianthus tuberosus* L. – 'Swojecki', 'Rubik', and 'Albik'.

The experiments were carried out on a limnoglacial loam on a moraine loam, a carbonate deeper gleyic luvisol (*Calearie Luvisol*) at the Experimental Station of the Lithuanian University of Agriculture. Pumpkin and Jerusalem artichoke were grown in the soil which had the following characteristics: slightly neutral and neutral, medium humus content, phosphorus-rich and potassium-rich. In the experimental area the soil was drained with a drainage system, the relief was artificially levelled.

The plants were cultivated as follows: pumpkins – interlinear – 2 m, distance between plants – 2 m, Jerusalem artichokes – interlinear – 0.7 m, distance between plants – 0.3m.

Pumpkins and Jerusalem artichokes were grown in certificated organic fields where the soil richness was known to be adequate for the plants' needs, and for this reason the plants were not given additional fertilizer. The pumpkins were harvested in the last week of September and Jerusalem artichokes in the first week of November. After harvesting amino acid analyses were performed.

Analytical methods

Amino acids were separated by the method of ion-exchange chromatography and detected photometrically by absorbance at 570 nm with an automatic analyzer of amino acids, Mikrotechna AAA 339, using a glass column (∅ 0.37 × 45 cm) filled with ionite Ostion LGANB. Hydrolysis of the sample was performed in the presence of 6 M HCl at 105°C for 24 h. The concentrations of the essential amino acids: threonine, valine, methionine, isoleucine, leucine, phenylalanine, histidine, lysine and arginine, and the nonessential amino acids: aspartic acid, serine, glutamic acid, glycine, alanine, tyrosine were determined (Technical regulation of amino acids ..., 2003).

Statistical analysis

The investigation data were evaluated by the method of dispersion analysis (ANOVA) using the computer programme STATISTICA. All determinations were made in triplicate. Arithmetical means and standard errors of the experimental data were calculated. Statistical reliability among data was evaluated according to the Fisher LSD test. Differences were statistically significant when $P < 0.05$ (Sakalauskas, 2003).

RESULTS AND DISCUSSION

Practically all the essential and nonessential amino acids were found in pumpkin pulp as also found by Duke (1998). Fujihara et al. (2001) determined that the total amount of amino acids in*Cucurbita maxima* D. pumpkin pulp was 4.90 g $100g^{-1}$. Caili et al. (2007) identified 18 amino acids in pumpkin pulp, with a total amount of 7.4 g kg^{-1}. The amino acids in the highest amounts were of alanine, glutamic acid and serine. In our investigated pumpkin pulp the highest amounts of the essential amino acids were of leucine 1.09–3.6 and valine – 0.90–2.83 g kg^{-1}, and the leastwas of methionine – 0.16–0.94 g kg^{-1} (Fig. 1).

Off all nonessential amino acids the highest amount was of glutamic – 4.82–12.96 and aspartic acids – 3.7–12.99 g kg^{-1}, the least of tyrosine – 0.66–2.35 g kg^{-1} (Fig. 2).

Comparing the amounts of amino acids in various pumpkins cultivars the highest amounts of essential and nonessential amino acids was found in the 'Bambino' pumpkin pulp. The least amounts of essential amino acids were found in Miranda' and 'Žemčiužina' pumpkin pulp, respectively 14.89 and 13.53 g kg^{-1} less than in 'Bambino' pumpkins. The least nonessential amino acid amounts were found in 'Žemčiužina' and 'Stofuntovaja' pumpkin pulps, respectively 23.29 and 21.40 g kg^{-1} less compared with the 'Bambino' pumpkin pulp (Figs 1–2).

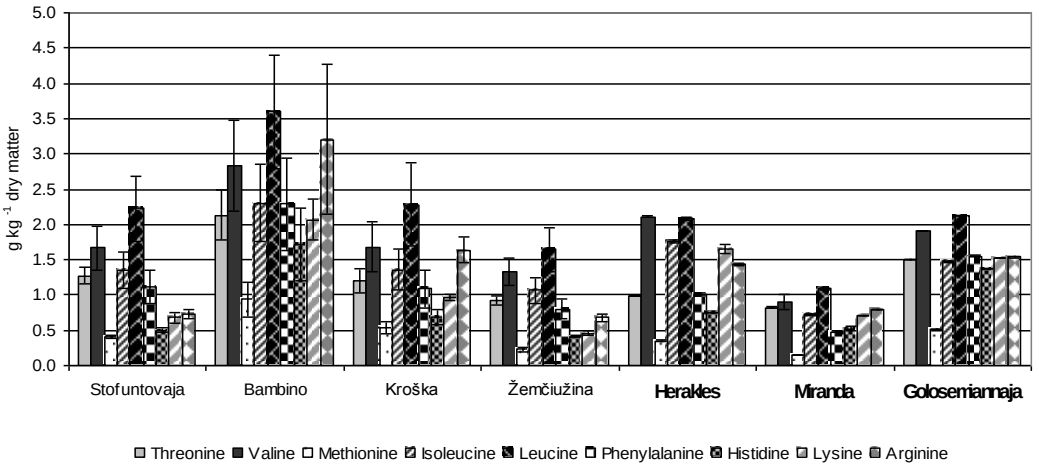

Fig. 1. Amounts of essential amino acids in pumpkin pulp, g kg $^{-1}$ dry matter.

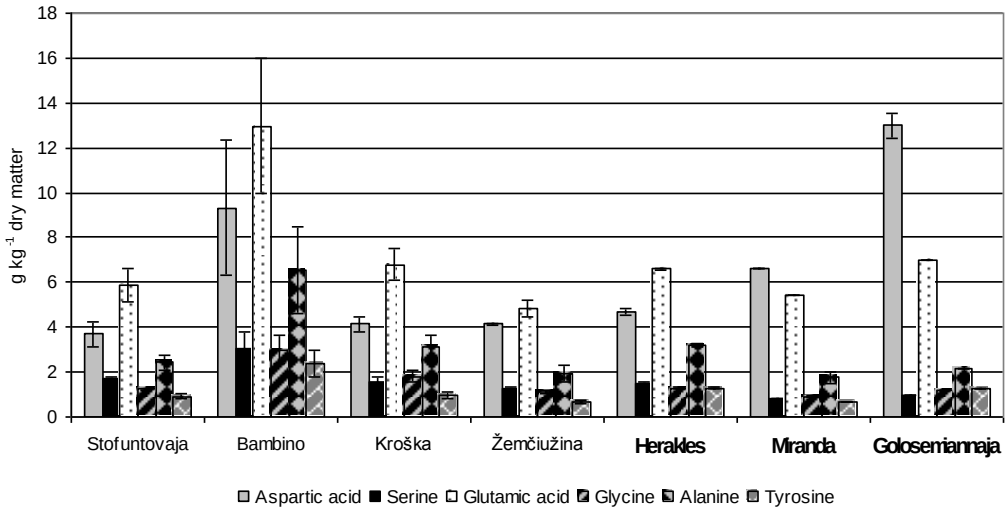

Fig. 2. Amounts of nonessential amino acids in pumpkin pulp, g kg $^{-1}$ dry matter.

According to the literature the largest amounts of essential and nonessentials amino acids were in pumpkin flesh fertilized with complex fertilizers – 0.24 g kg^{-1} of essentials and 1.02 g kg^{-1} of nonessentials compared with those grown using organic cultivation methods (Paulauskiene, 2007). Similar results were obtained from pumpkin seeds fertilized with complex fertilizers and grown organically (Kulaitiene, 2009).

Arginine was the most prevalent among all essential amino acids in the tubers of the Jerusalem artichoke. The amount of arginine was almost four times larger any of the other essential mino acids (Fig. 3).

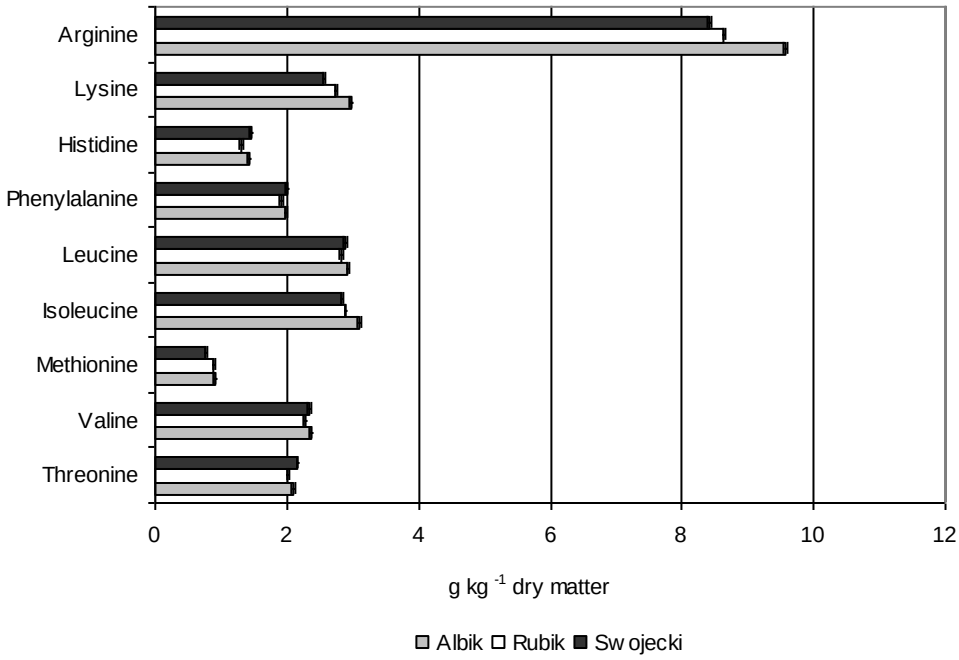

Fig. 3. Amounts of essential amino acids in Jerusalem artichoke tubers, g kg $^{-1}$ dry matter.

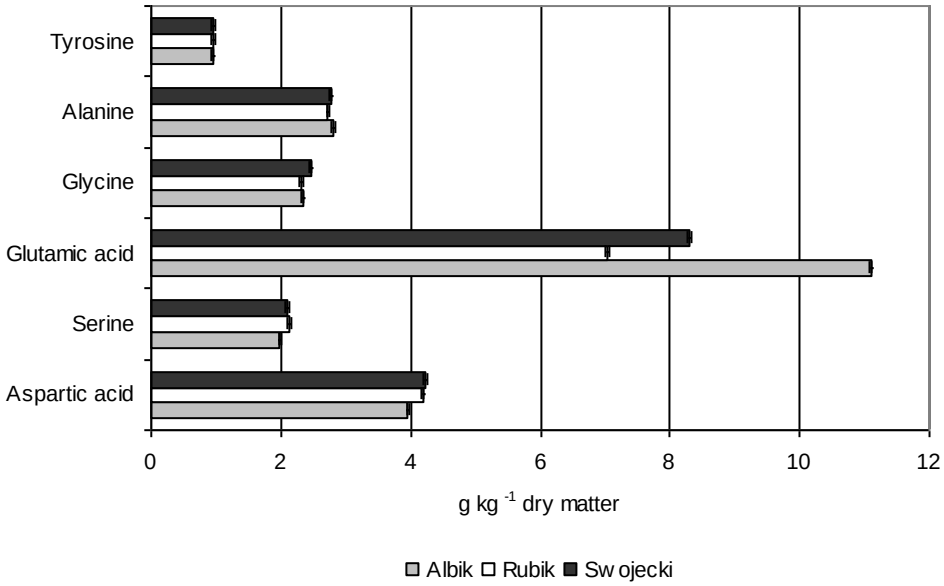

Fig. 4. Amounts of nonessential amino acids in Jerusalem artichoke tubers, g kg $^{-1}$ dry matter.

Comparing amounts of essential amino acids in different Jerusalem artichoke cultivars tubers, the 'Albik' cultivar tubers were higher in the content of essential amino acids , although in both 'Rubik' and 'Swojecki' tubers the amounts of these amino acids were only 1.82–1.90 g kg^{-1} less than in 'Albik' (Fig. 3).

The largest amount of all nonessential amino acids was found in the 'Albik' cultivar tubers (Fig. 4). The prevalent nonessential amino acid in Jerusalem artichoke tubers was glutamic acid, and its amount, compared with other nonessential amino acids was 4–5 times higher. The least amount was found for tyrosine. In the 'Albik' cultivar tubers the amount of glutamic acid was 11.09 g kg^{-1}, while in 'Rubik'– 7.03 g kg^{-1} dry matter (Fig. 4).

Total amounts of amino acids were higher in Jerusalem artichoke tubers compared to pumpkin pulp. In Jerusalem artichoke tubers it ranged from 50.43 to 44.83 g kg^{-1} dry matter, while in pumpkin pulp from 58.32 to 21.50 g kg^{-1} dry matter, depending on the cultivar (Figs 1,2,3 and4).

The ratio of essential to total amino acids in Jerusalem artichoke tubers was higher than given in the recommendations, which are 33,9%(FAO, 1991). This ratio in the tubers of the 'Albik' cultivar was 54.15%, 'Rubik' – 56.86% and 'Swojecki'– 54.95% (Figs. 3 and4).

The ratio of essential to total amino acids in pumpkin pulp depended on the cultivar and the greatest value was for the cultivars 'Herakles' – 39.54% and 'Stofuntovaja' – 38.63% and the least for 'Miranda'– 27.62% (Figs 1 and 2).

CONCLUSIONS

1. 'Bambino' pumpkin pulp is exeptionally high in amounts of essential amino acids compared to nonessential amino acids. The prevalent essential amino acid in pumpkin pulp is leucine.
2. In 'Albik' cultivar Jerusalem artichoke tubers the amount of essential amino acids were slightly higher thanthe tubers of other cultivars .
3. The ratio of essential to total amino acids is higher in Jerusalem artichoke tubers compared to pumpkin pulp.

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