# EVOLUTION OF BIO-ACTIVE SUBSTANCES IN ASPARAGUS AS AFFECTED BY DIFFERENT HARVEST TIMES

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Fresh asparagus is rich in protein, vitamins and minerals with high nutritional value. But nutritional content and composition are affected by the genotype and the harvest time. In our trials at the experimental farm Pallag of Debrecen University 3 asparagus varieties (*Cumulus, Gijnlim, Grolim*) were tested on brown humus sand soil in ridge cultivation. Solids, nutritional fibre, protein, sugar and vitamin-C contents were measured in the white spears at 3 different harvest times (8 May, 24 May, 6 June 2012). Mineral element tests included B, Ca, Cu, Fe, K, Mg, Na, P, S, Zn and sulphate sulphur. Our trials confirmed the strong negative correlation (r = -0.828) between the sugar and vitamin-C content of the spears. This investigation confirm that the variety with higher vitamin-C content has lower flavour materials. On the start of the harvest period we measured higher sugar and lower vitamin-C content in the spears. In our variety comparison trial the variety *Cumulus* had the highest solids (7.1 %), nutritional fibre (4.7 %), protein (2.81 %) and sugar (3.51 %) contents on the brown humus sand. Among the microelements the high Fe content (4.93 – 7.63 mg $kg^{-1}$ fresh weight) deserves attention. Fe is variety dependent at different genotypes. The highest value was found in *Gijnlim* with 7.63 mg $kg^{-1}$ on fresh weight basis. The sulphate-S content is responsible for the special taste and flavour of asparagus. In our trials *Cumulus* had the highest sulphate-S value (279 mg $kg^{-1}$ fresh weight). *Cumulus* also excelled in Mg content (84.10 mg $kg^{-1}$ fresh weight) and *Grolim* in Ca content (27,23 mg $kg^{-1}$ fresh weight). The low Na content of the element composition is essentially favourable. It varied between 17.07 and 27.23 mg $kg^{-1}$ on fresh weight basis in the tested 3 varieties.

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## Introduction

In the development of illnesses and the preservation of health nutrition has a decisive part both from qualitative and quantitative points. In checking civilisation illnesses the consumption of certain vegetables with scientifically proved favourable bio-active effects, play a central part. Such a crop is the asparagus.

Asparagus has considerable vitamin-C contents (9-32 mg 100 $g^{-1}$) which play an important role in Fe incorporation and pholic acid and protein metabolism. The top of the spear contains the highest quantities which decrease towards the base[1]. Different factors such as cultivars, fertilisation and environmental conditions have influence on the quality of white asparagus[2]. Furthermore there are genotypical differences in spear quality such as spear diameter, head tightness and fibrousness[3,4,5]. But information about genotypical differences in the content of inorganic and organic compounds in asparagus spears are limited. It was therefore the aim of this study to determine quality parameters such as the mineral composition in spears of different genotypes.

The special taste of asparagus is caused by sulphur compounds[6]. Asparagus is remarkable for its low Na content and excellent nutrient element composition[7]. The evolution of the minerals is greatly affected by the genotype and the nutrient content and availability of the soil as also indicated by data giving 4500 µg $g^{-1}$ Na quantities[1].

Spears have higher mineral element contents, especially Mn, Cr and K, at the top[8]. Consequently, broken bits of head can play an important part in processing, mostly in producing freshly pressed juice.

During processing mineral element contents are subjected to considerable changes. Lopez and co-workers[9] showed considerable losses in Fe and Mn during cleaning while quantities of Cu and Zn increased. This correlates with the peeling loss. Thicker spears had higher mineral element content and lower cleaning loss.

Nutritive elements – including minerals – are very important as asparagus plays a significant part in the mineral element supply of the human body[10].

The ion ratio of the human body can be characterized by $(Ca^{2+} + Na^{+}) / (Mg^{2+} + K^{+})$ correlation with ~ 1.0 value under optimal conditions but values about 4.0 are often measured. This ratio is very low in vegetables which contributes to equalize the ion balance of the human body[11].

The trials aimed to determine the evolution of bioactive substances during 6-week harvest time at 3 sampling dates.

## Experimental

In our trials at the experimental farm Pallag of Debrecen University 3 asparagus varieties (*Cumulus, Gijnlim, Grolim*) were tested on brown humus sand soil in ridge cultivation.

Soil analysis data are summed up in Table 1. Data show satisfactory P and K supplies. Soil compactness, Ca and N supply were suitable for asparagus production.

The trials aimed to determine the evolution of bioactive substances during a 6-week harvest time at 3 sampling dates. Laboratory measurements at 3 different dates (8 May, 24 May, 6 June 2012) included:

- solids content (%) - gravimetric method MSZ ISO 6496:2001
- nutritional fibre content (%) - enzymatic determination by Codex Hungaricus 3-2-2008/1
- protein (%) - Kjeldahl method MSZ 08-1783-6:1983
- sugar (%) - by Luff-Schorl MSZ 6830-26:1987
- vitamin-C (mg $100g^{-1}$ fresh weight) iodometric titration titrimetric method, MSZ ISO 6557-2:1991
- mineral elements (mg $kg^{-1}$ fresh weight) - B, Ca, Cu, Fe, K, Mg, Na, P, S, Zn – Codex Hungaricus-08-1783:1985 by ICP, PERKIN ELMER Optima 3300 DV

**Table 1.** Soil analysis results

| | |
|---|---|
| pH | 6.25 |
| pH( in distilled water) | 6.88 |
| $K_A$ (compactness by Arany) | 25 |
| Water-soluble total salt content | 0.013 % |
| Conductivity | 384 µS |
| Calcium carbonate content | 0.884 % |
| Humus content | 1.05 % |
| KCl solution soluble nitrite and nitrate N-content | 28.9 mg $kg^{-1}$ |
| AL*-soluble P-content as $P_2O_5$ | 463 mg $kg^{-1}$ |
| AL*-soluble K-content as $K_2O$ | 617 mg $kg^{-1}$ |

*AL – ammonium-lactate

Meteorological data of the location are shown in Fig. 1. The harvest periods were rich in natural precipitation (> 30 mm).

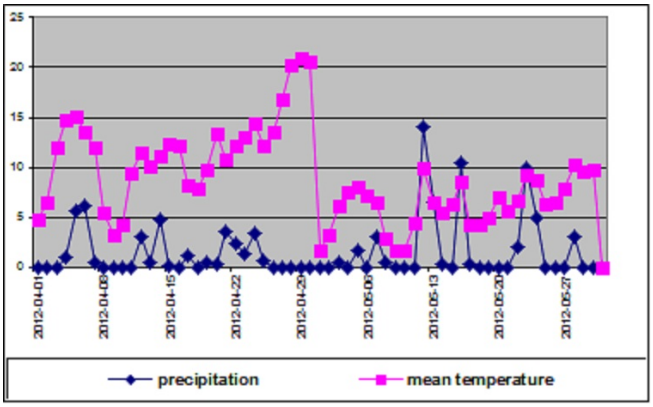


**Figure 1.** Precipitation (mm) and mean temperature (°C) distribution, Debrecen-Pallag 2012

## Results and discussion

Solids, nutritional fibre, protein and sugar are important nutritive elements. Beside production conditions the genetical traits of the variety are also involved. Data can be seen in Fig. 2. showing 6-7 % variations in the solids content on the mean of harvest dates. The variety *Cumulus* had the highest values in solids as well as in nutritional fibre, protein and sugar. The statistically significant difference indicates the high quality of this genotype under our production conditions.

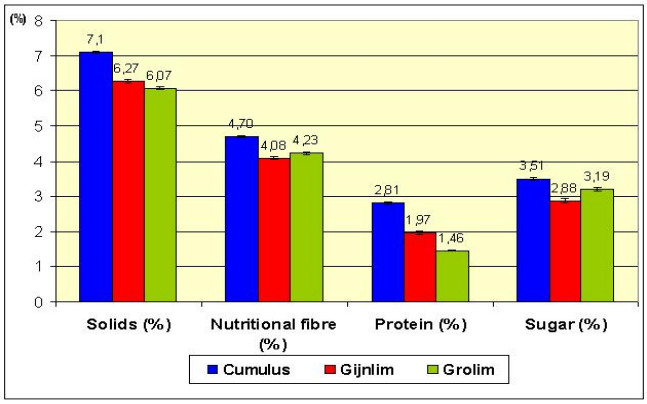


**Figure 2**. Evolution of nutrient elements in the varieties on the mean of harvest dates

In consumption vitamin-C and sugar play an important part as freshly pressed asparagus juice. In this case vitamin-C and the agreeable taste are desired features. In our experiment *Gijnlim* had the highest vitamin-C content (11.7 mg 100 $g^{-1}$) (Fig. 3.) but the lowest sugar content (2.88 %).

Correlation between sugar and vitamin-C of the spears is found in Fig. 4. On the mean of varieties data show a close reverse correlation between the two contents (r = -0.823) which means that varieties of higher vitamin-C content are pour in taste.

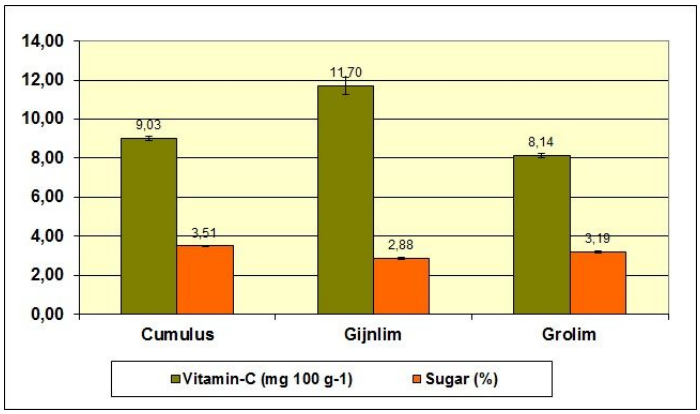


**Figure 3**. Vitamin-C sugar contents on the mean of sampling

Among the microelements Fe is especially important as it plays part in numerous biochemical processes. In our measurements (Fig. 5.), *Cumulus* appeared with 7.63 mg $kg^{-1}$ (121.7 µg $g^{-1}$ on dry matter basis) which is higher than the corresponding value given in literature (86.8-98.3 µg $g^{-1}$)[12]. No considerable differences were found in Zn, Cu and B content of the varieties.

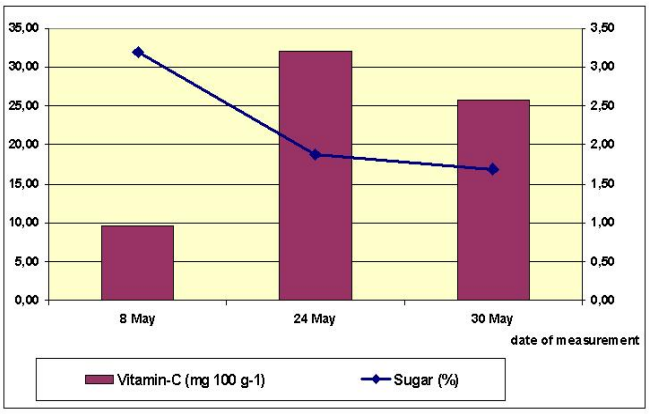


**Figure 4**. Correlation between vitamin-C and sugar contents

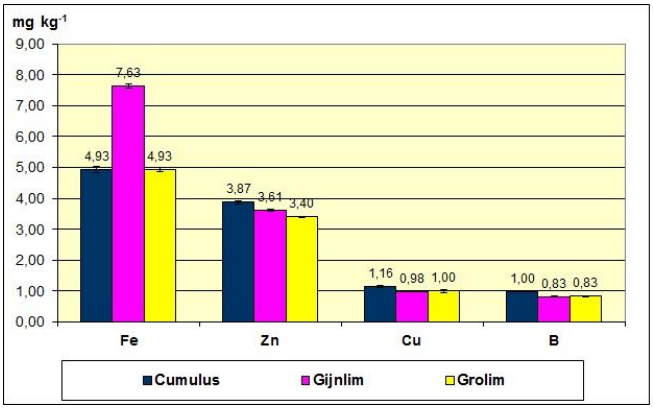


**Figure 5.** Microelement content of asparagus on the mean of harvests

Besides macroelements (K, P, S) Sulphate-S was also measured and shown in Fig. 6. K content of asparagus varied between 1344 – 1562 mg kg$^{-1}$ depending on variety and location. Certain literary data give much higher values[5]. The sulphate-S content must be mentioned as it is responsible for the special asparagus taste and flavour. In our trials *Cumulus* had the highest sulphur-S content (279 mg kg$^{-1}$).

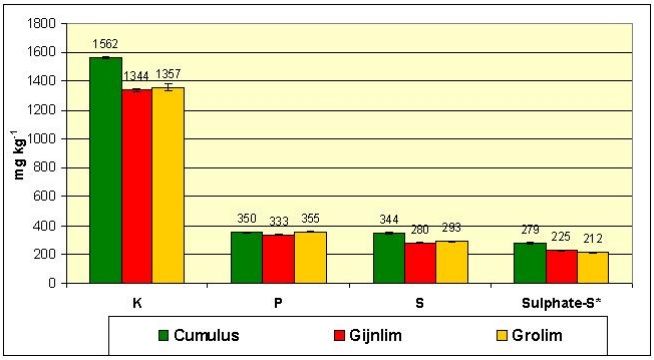


**Figure 6.** Macroelement content of asparagus on the mean of harvests

Beside K, Ca, Mg and Na amounts are also involved in the ion-balance of the human body. Data are found in Fig. 7. *Cumulus* appeared in Mg content (84.10 mg kg$^{-1}$) and *Grolim* in Ca content (27.23 mg kg$^{-1}$). In the element composition of asparagus the low Na content is especially favourable. It varied between 17.07 and 27.23 mg kg$^{-1}$ in the tested 3 varieties.

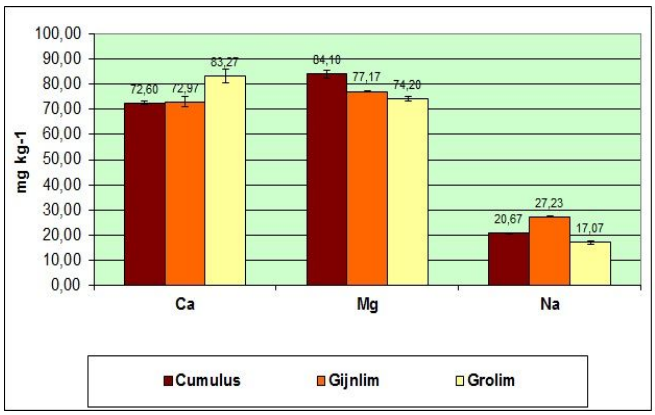


**Figure 7.** Ca, Mg and Na contents of asparagus varieties on the mean of harvests

Table 2 represents the mineral element contents of asparagus on the mean of 3 varieties and 3 harvest dates. The comparison containing our own measurements and literary data[13] indicate that the mineral element content of asparagus is considerably affected by the genotype, production methods and conditions which explain the important differences in K content.

Our measurements give value of 1420 mg kg$^{-1}$ of K on the mean of varieties and samples while Rodler[13] found 2400 mg kg$^{-1}$. Even more spectacular is the difference in the case of Na. We measured nearly the tenth (21.66 mg kg$^{-1}$) of the value given by Rodler (200 mg kg$^{-1}$) and Moreno[1].

**Table 2.** Mineral element content (mg kg$^{-1}$ fresh weight) of asparagus on the mean of varieties based on our own measurements and literary data

| Mineral elements | our own measurements | Rodler[13] |
|---|---|---|
| B | 0.89±0.10 | - |
| Ca | 76.28±6.06 | 70 |
| Cu | 1.05±0.10 | 1.75 |
| Fe | 5.83±1.56 | - |
| K | 1420±122 | 2400 |
| Mg | 78.49±5.08 | 70 |
| Na | 21.66±5.15 | 200 |
| Zn | 3.63±0.23 | 3.3 |
| P | 346.00±11.29 | 400 |
| S | 305.56±33.89 | - |
| Sulphate-S | 238.67±35.84 | - |

Consequently, the nutritional element contents of this excellent vegetable can only be evaluated by testing samples, that is, tabulated data do not give exact information of the nutrient element contents of asparagus in every case. Our investigations confirm that the mineral element content of spear showed differences between cultivars. To produce good quality product it is essential to choose proper variety for the given condition. In our growing conditions *Cumulus* proved to produce the best quality.

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