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Influence of strawberry and raspberry consumption on the antioxidant status of human body

Szenthe, A.[1], Stefanovits-Bányai, É.[2], Blázovics, A.[3], Hegedűs, A.[2], Engel, R.[2], Sipos, B. Z.[1], Sárdi, É.[4] & Papp, J.[1]

[1]*Corvinus University of Budapest, Faculty of Horticultural Science, Department of Fruit Science*
[2]*Corvinus University of Budapest, Faculty of Food Science, Department of Applied Chemistry*
[3]*Semmelweis University, Department of Medicine, Budapest*
[4]*Corvinus University of Budapest, Faculty of Horticulture Science, Department of Genetics and Plant Breeding*

Summary: Several parameters influencing the antioxidant capacity were measured in our experiments to compare strawberry and raspberry cultivars. The analysed cultivars were: 'Honeoye', 'Elsanta', 'Onebor' (strawberries) and 'Glen Ample', 'Fertődi zamatos', 'Malling Expoit' (raspberries). Besides the determination of dry matter content the content of glucose, fructose, total phenol and anthocyanine, the reducing power, H-donating activity and total scavenger capacity were measured as well as the compound of mineral nutrients. Among the species and the cultivars, differences were obtained. These results call the attention to the features of cultivars and to count on the antioxidant-capacity describing values in case of consuming these fruits. In early spring and summer the consumption of strawberry and raspberry has a beneficial contribution to the antioxidant status of our body. In this respect these are more valuable than the year-long consumable apple. Accordingly, our measurements showed higher amount of sucrose, phenolic compounds and anthocyanine in raspberries, but strawberries contained more glucose and fructose and had stronger H-donating activity. It is worth to keep in mind that e.g. which cultivar contains more of certain compounds because of the strictly determined allowable dose in some diseases (e.g. diabetes).

Key words: antioxidant capacity, *Fragaria* spp., raspberry, *Rubus*, strawberry

Introduction

Many scientific data support the theory that the conscious consumption of vegetables, fruits, herb- and medicinal plants can improve the quality of life, prevent from diseases due to the special compounds and vitamins accumulating in plant raw materials. Food products contain more or less compounds with antioxidant effect, which play an important role in prevention of diseases. Certain fruit species are known to have diverse physiological effects and curative power. Different plant species and cultivars possess different health effects, and the curative efficiency of these plant materials may also differ from one another in a quite amazing degree.

From overall studies we know that a well composed diet may reduce or eliminate the etiology of certain civilization diseases (*Ames* et al., 1995; *Steinmetz & Potter*, 1996; *Ness & Powles*, 1997; *Lampe*, 1999). Due to the ever increasing amount of environmental stress effects more and more harmful free radicals accumulate in our cells (*Fehér* et al., 1993). Molecules with antioxidant effect can eliminate them. Antioxidant compounds are present in lower concentration as compared to that of the oxidizing molecules, however, they can considerably inhibit or delay the oxidative processes (*Lugasi* et al., 1998). Vitamins A, E and C, carotenoids, flavonoids, phenolic compounds, some sulphur-containing amino acids have antioxidant effect (*Lugasi & Blázovics*, 2004). Human nutritional habit is changing and more attention is paid to fruits, vegetables and some medicinal plants with favourable inner content. Some ingredients in the raw materials of these plants play an indispensable role in health care, prevention of chronic diseases or as a part of the so-called complementary therapy (*Lugasi & Blázovics*, 2004; *Lugasi*, 2004; *Veres* et al., 2004). Not only the bioactive compounds are responsible for the antioxidant capacity but mineral elements also have some modifying effect. Not only their absolute quantity, but also their proportion is important from this respect (*RDA*, 1989; *Szentmihályi & Then*, 1999; *Stefanovits-Bányai* et al., 2005).

Among the fruit, soft fruits have unique and characteristic properties from many aspects (*Papp & Porpáczy*, 1999): they have important curative power, they turn to bearing quickly; their propagation is easy; they can be utilized in many ways and at last but not least berries are known to possess outstanding antioxidative power and thereby having enhanced functional properties (*Connor* et al., 2005; *Hannum*, 2004; *Moyer* et al., 2002).

The aim of our experiments was to compare some soft fruit cultivars from the aspect of antioxidant power. Our experiments were extended to the assay of relationships, which may be beneficial in the course of product-preparation and distribution.

Materials and methods

We measured three strawberry (Honeoye, Elsanta and Onebor) and three raspberry (Glen Ample, Fertődi zamatos and Malling Exploit) cultivars, all of them are among the main cultivars recommended for growing in Hungary. Strawberry fruits are from Tahitótfalu (Szentendre island), raspberry fruits from Nagyréde.

Total dry matter content was measured by MSZ 2429–1980, the separation of carbohydrates was carried out by OPLC (Overpressured Layer Chromatography) and their quantity was measured by a densitometer (TLC/HPTLC scanner) (*Sárdi* et al., 1996).

Total quantity of phenols was measured spectrophotometrically (=760 nm), using Folin-Ciocalteu reagent, and expressed in gallic acid equivalents (*Singleton & Rossi*, 1965). Total antioxidant capacity, related to ascorbic acid was determined spectrophotometrically (=593 nm), using the FRAP (Ferric Reducing Ability of Plasma) method (*Benzie & Strain*, 1996). H-donating activity of samples was measured by the modified method of Blois (1958), at =517 nm (Hatano et al., 1988) Total scavenger capacity was measured by a chemiluminescence assay at λ =420 nm (*Blázovics* et al., 1999). The emitted light was measured in 390–620 nm range by scanning. Reaction mixture contained H_2O_2 (0.30 ml, 10^{-4} dilution of 33% H_2O_2), microperoxidase (0.30 ml, of 1 mM) as a catalyst and alkaline luminol solution (pH 9.8) (in 0.050 ml of 0.07mM). The emitted photons were accumulated during a 30 sec of exposure time and are expressed in relative light unit (RLU). The mineral nutrition content was determined by ICP-OES IRIS Thermo Jarrel Ash, Corp., Franklin, MA, USA.

Results

Present study reports on the results of the experiments carried out during the year 2005. Between the strawberry and raspberry species differences could be detected in the dry matter content (*Figure 1*). While this value ranged between 10.1–11.9 % in the strawberry cultivars, it was 14.5–16.6 % in the raspberry cultivars. Raspberry cultivars had higher content in each case.

Phenol and anthocyanine contents (*Figures 2* and *3*) reached quite different levels in fruits of strawberry and raspberry according to the different cultivars. While in the phenol content no considerable differences occurred between the two species, raspberry cultivars possessed higher anthocyanine content compared to that of the strawberry cultivars.

We determined very low (20–170 mg/100g) sucrose content in the strawberry cultivars (*Figures 4* and *5*). In

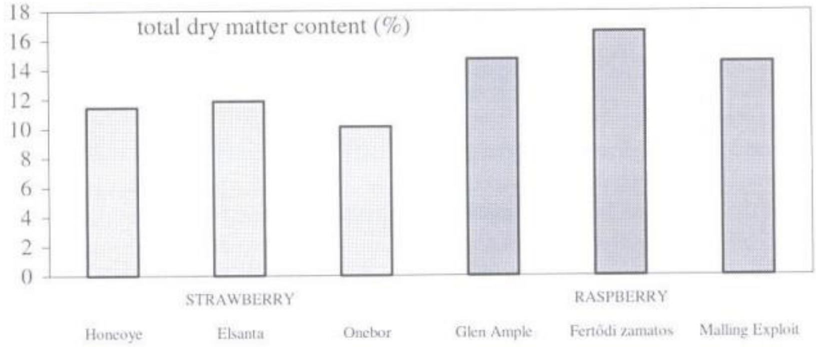

Figure 1 Dry matter content (%) in fruits of strawberry and raspberry cultivars

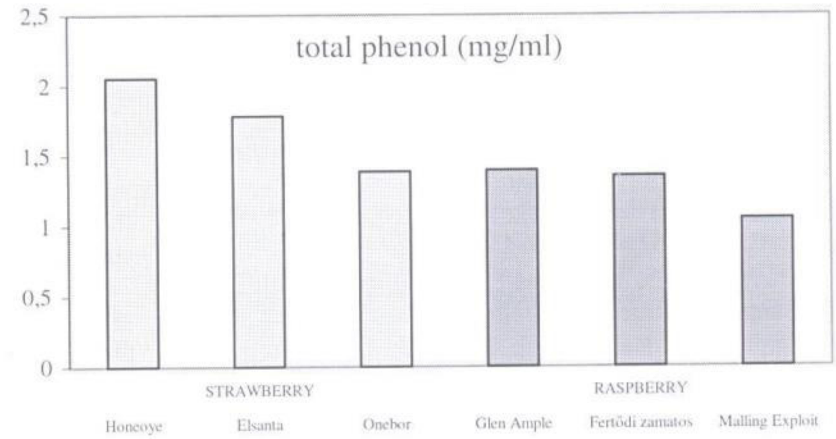

Figure 2 Total phenol content (mg/l) in fruits of strawberry and raspberry cultivars

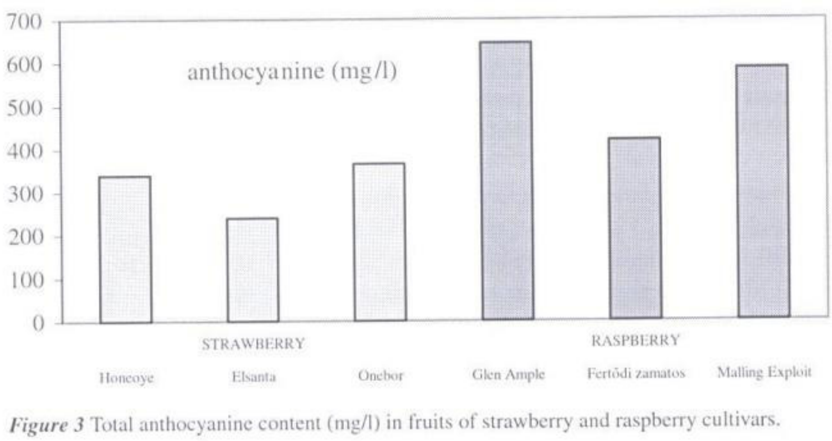

Figure 3 Total anthocyanine content (mg/l) in fruits of strawberry and raspberry cultivars.

raspberry cultivars much higher (210–580 mg/100g) sucrose levels were measured. Honeoye from strawberry cultivars and Fertődi zamatos from raspberry cultivars had the highest sucrose contents, from which, Fertőid zamatos showed almost a three times higher value.

OPLC analysis revealed that fructose and glucose were the most abundant carbohydrate components in both berry species. Our results showed that fructose content exceeded the glucose level. Strawberry cultivars possessed higher glucose and fructose contents than the raspberry cultivars, with the exception of high fructose content in Malling Exploit. In strawberry cultivars the quantities of fructose varied between the thresholds of 780–1000 mg/100g, their glucose content fell between 690 and 910 mg/100g; in case of the raspberry fructose and glucose contents ranged between 540–1070 and 380–670 mg/100g, respectively.

The H-donating activity is a good indicator of the reducing ability of tissue extracts. When samples have proton-donating capability, it means that redox-active compounds are present in fruits which can neutralise the DPPH stabile free radical. Fruits with huge amount of antioxidant compounds are able to eliminate free radicals faster than those which has antioxidants in lower concentrations. Strawberry cultivars did not show any difference in the H-donating activity (*Figure 6*).

Comparing berry species, it was found that raspberry cultivars possessed higher H-donating activity in each cultivar; within these samples, cultivar Fertődi zamatos could be characterized by the most favourable value (*Figure 7*).

Chemiluminescence assay of 1000-times diluted samples did not show relevant differences in scavenger capacity either between species or among the cultivars (*Figure 8*).

Total antioxidant capacity expressed in ascorbic acid equivalents (*Figure 9*) was more favourable in strawberry cultivars than in case of the raspberries. According to our former examinations, these values are much higher than the antioxidant capacity of apple cv. Jonathan (0.436 mmol Ascorbic Acid/L).

We carried out an element analysis but no toxic elements were found in any of the samples, therefore, these elements were omitted from the tables. We classified the elements into two groups: elements playing role in the ion homeostasis (Na, K, Ca, Mg and P) (*Table 1*), and elements influencing the antioxidant defence mechanisms and the integrity of biochemical processes (Al, Cu, Fe, Mn and Zn) (*Table 2*). We expressed data as the amount of a given element in 100 g fresh fruit.

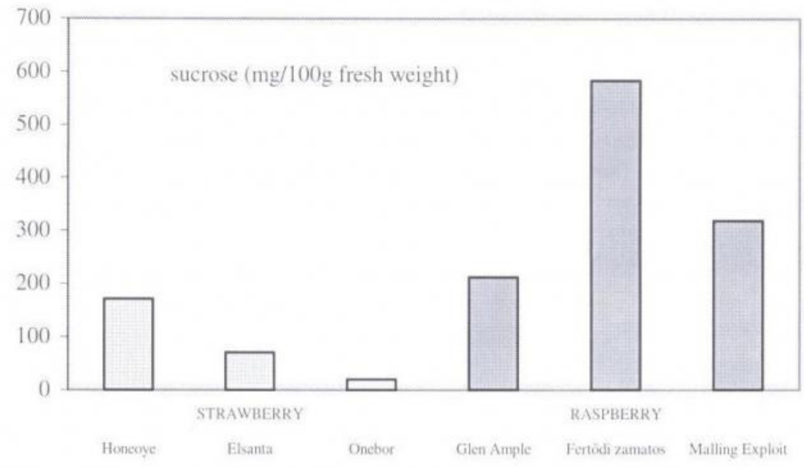

Figure 4 Sucrose content in fruits of strawberry and raspberry cultivars (mg/100g fresh weight)

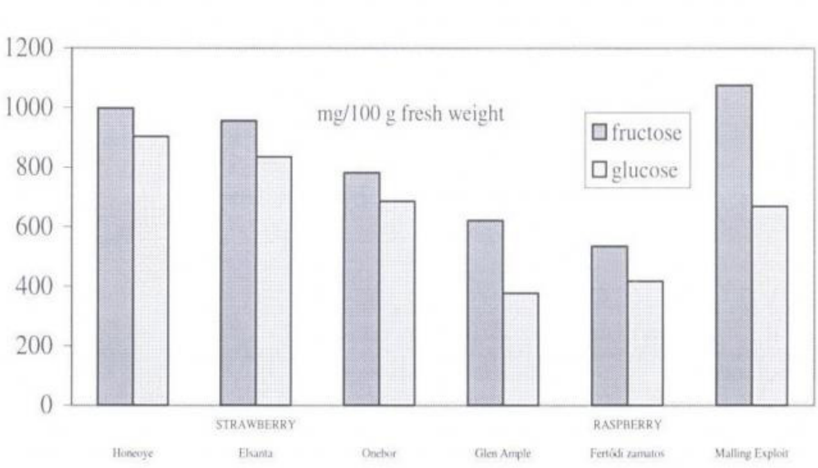

Figure 5. Glucose, fructose content in fruits of strawberry and raspberry cultivars (mg/100g fresh weight)

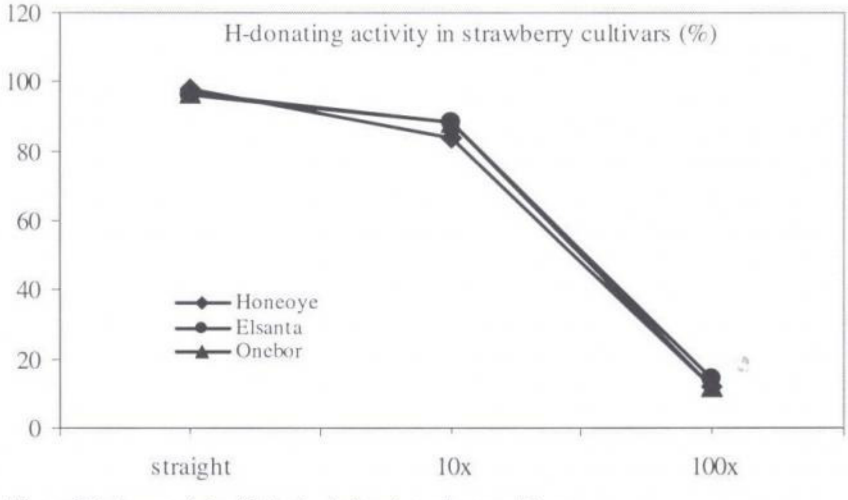

Figure 6 H-donor activity (%) in the fruits of strawberry cultivars.

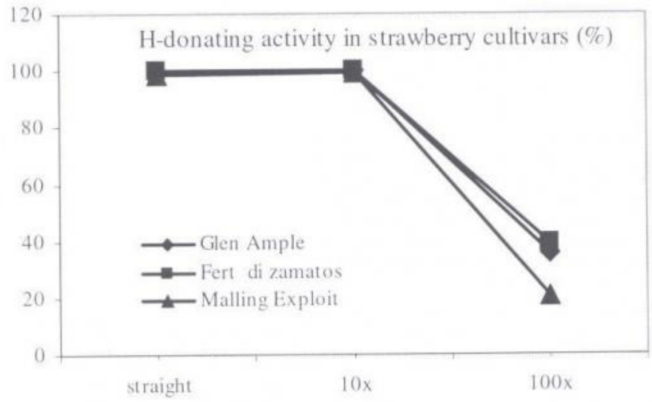

Figure 7 H-donor activity (%) in the fruits of raspberry cultivars.

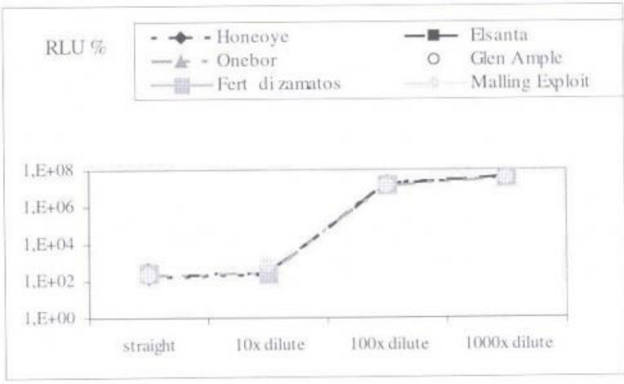

Figure 8 Comparison of strawberry and raspberry cultivars by chemiluminescent assay (% of relative light unit).

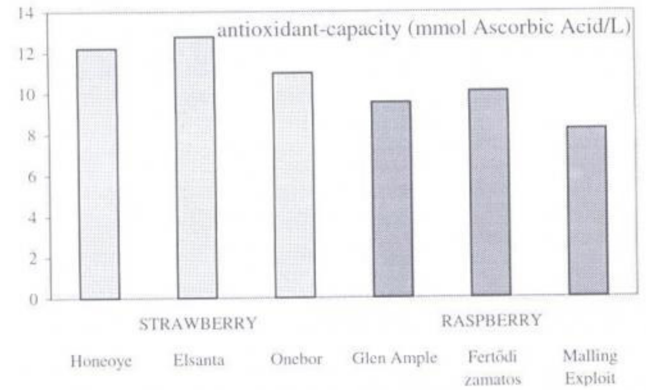

Figure 9 Total antioxidant capacity (mM Ascorbic Acid/L) in fruits of strawberry and raspberry cultivars.

Table 1 Na, K, Mg, Ca and P element content (mg/100g fresh weight) in the fruits of strawberry and raspberry cultivars.

Species/Cultivars	Mineral elements (mg/100g)				
Strawberry	Na	K	Mg	Ca	P
Honeoye	3.75	172.32	13.35	21.59	23.29
Elsanta	3.41	146.52	13.26	17.35	20.57
Onebor	3.85	149.31	11.56	18.29	21.12
Raspberry	Na	K	Mg	Ca	P
Glen Ample	1.49	209.56	19.61	34.30	38.82
Fertődi Zamatos	1.33	180.89	23.23	35.74	27.48
Malling Exploit	2.00	241.09	18.62	32.97	35.75

Strawberry cultivars contained more sodium and less potassium, indicating a potentially unfavourable effect on the ion homeostasis. Consumption of raspberry cultivars could be more favourable because of the elevated intake of magnesium, calcium and phosphorus. In *Table 2* besides the elements involved in the antioxidant protection we also showed the amount of aluminium, because in some neurological disorders (Alzheimer and Parkinson diseases) intake of aluminium must be prevented. Raspberry cultivars contained considerably less aluminium than strawberries but much more from other elements.

Table 2 Al, Cu, Fe, Mn and Zn content in the fruits of strawberry and raspberry cultivars (mg/100g fresh weight).

Species/Cultivars	Mineral elements (mg/100g)				
Strawberry	Al	Cu	Fe	Mn	Zn
Honeoye	0.656	0.057	0.355	0.339	0.095
Elsanta	0.660	0.073	0.230	0.294	0.083
Onebor	0.639	0.073	0.229	0.277	0.067
Raspberry	Al	Cu	Fe	Mn	Zn
Glen Ample	0.470	0.090	0.438	0.477	0.225
Fertődi Zamatos	0.565	0.141	0.640	0.596	0.210
Malling Exploit	0.367	0.129	0.360	0.417	0.193

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