# Evaluation of fruit quality parameters of *Rosa* taxa from the Carpathian basin

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***Summary:*** From the wide range of genetic sources available in Hungary, we have chosen as objective the evaluation of those rose taxa, which – on the base of their quality and morphologic features – are suitable for selecting fruit production varieties or parent varieties for further breeding. We examined physical and inner parameters of fruits of *Rosa* taxa, and evaluated the correlations by mathematical statistic methods. Namely, if a correlation can be found between physical and inner parameters, fruit production value can be determined by less examinations in the future. According to our results, there is a large variability in some physical parameters (weight, diameter of fruits; weight, number of achenes) as well as in inner content values (vitamin C, glucose, fructose, K, Ca, Fe, Zn and Cu content) of rosehip, regarding production year, habitat and even the individual of examination. Twice as much ascorbic acid can be found in achene-free fruits, and nearly five times as much in their dry product as in fresh whole fruits. It was established repeatedly, that vitamin C concentrates in fruit flesh, and ascorbic acid content can be preserved better in achene-free flesh. There is no essential difference in citric acid and carbo-hydrate content of whole and achene-free rosehips. However, macro- and microelement content of whole fruits is 30–40% higher than that of achene-free fruit flesh. The connection between fresh weight and diameter, as well as achene number and seed weight of fruits can be described by the function $y=ax^b$. A significant relationship can be found in case of K-Fe, Ca-Mg, Ca-B, Ca-Mn and Zn-Cu, between fresh weight and B content of fruits. According to our examinations, fresh weight of rose species with a higher citric acid content is usually higher, while their Fe content is smaller. Glucose content of fruits of rose species is directly proportional to their Ca and Zn contents. Zn content of rose species with higher fructose content is usually smaller.

***Key words:*** *Rosa* sp., rose-hip, fruit size, vitamin C, inner content of fruits

## Introduction

Production traditions of rose species as ornamental plants go back to millenaries, while the fruit of wild rose species – the rosehip – was used as a medicinal plant already before Christianity (*Koch & Grope*, 1993).

The healing power of rosehip was certified by inner content examinations. There is 300–800 mg/100g vitamin C in fruits of wild species, while in the best cultivated varieties there can be found 3000 mg/100g. Vitamin C content depends on the habitat, the maturity phase of fruits, the weather features, the storage method of fruits and the method of drying and processing (*Keipert* 1981; *Szenes E.-né* 1995; *Buschbeck* 1997; *Brodmann* 1993; *Lenchés & Facsar* in. *Bernáth* 2000).

The rosehip is rich in potassium and magnesium, but has a significant phosphorus, calcium, iron and sodium content as well. It contains twice as much pectine as the currant: 3.5 g/100 g. The fruit flesh of rosehip contains 14 g of sugar, 5 g of malic- and citric acid, 4 g of protein, as well as B-carotene, vitamins B1-, B2-, P-, K-, H- and E in small quantities, flavonoids and anthocyanidins in traces, and tanning materials (*Koch & Grope* 1993; *Buschbeck* 1993; *Stoll & Gremminger* 1986; *Lenchés & Facsar in. Bernáth* 2000; *Keipert* 1981). The achenes contain: much pectine, 0,2–0,3% essential oils, 8% oils, various vitamins, for example vitamin E2, as well as lecithin, vanillin, and sugar (*Rápóti & Romváry* 1990; *Perédi* et al. 1994).

Some characteristics of fruits of cultivated varieties are the large fruit size (2.5–3 × 2–2.5 cm), the heavy fruit weight (3–7 g), the high rate of fruit flesh (70–80%) and the small number of achenes (*Madeleine cit. Porpáczy* 1999; *Müller* 1997; *Anonymus* 1999).

The primary objective of our research program is to choose those taxa from the rich genetic material available in Hungary, which have fruits of favourable physical and inner values, and from which varieties suitable for cultivation as well as parent varieties for further breeding can be selected in the future. The aim of present paper is to evaluate the fruits of examined rose species: demonstrating physical and inner content parameters, as well as exploring statistical relationships between their physical parameters and inner values.

## Material and method

We have chosen for our examination mainly those rose species, which bear rosehips as large as possible, preferably ripening without sepals, whose shrub is of intensive growth, upstanding habit and has a shoot system with as less thorns as possible. Between 1996 and 1999, the fruits of totally 19 species and 3 minor species variations were evaluated *(Table 1.)*. Rosehips were harvested in mid-September, beginning of October, according to the ripening time of wild roses.

For obtaining an average sample characteristic of the certain species, 50–80 fruits were gathered from all parts of the shrub, without selection. Within one weeks after harvest the physical parameters of fresh whole rosehips (fruit flesh + seeds) were measured: diameter, length, weight, flesh weight, achene content. We wanted to determine the weight loss during storage in a 15–20 °C, airy, dry place by a repeated measurement in the end of winter (end of February-beginning of March).

Laboratory measurements were carried out in the Central Laboratory of the Faculty of Food Science in spring of 1997, 1998 and 1999. The following methods were used to determine inner content values: vitamin-$\alpha$, $\alpha$-dipyridile photometric method, organic acid – HPLC (UV), sugar – HPLC (RI), mineral elements – AAS (atomic absorption photometry).

We evaluated the effect of production year and habitat, as well as variability of species (differences between individuals, variations) with the help of Statgraph 5.1 by a two-sample t-test at 95% significance level, while to determine the relationship between morphological features and inner values, regression analysis was used.

## Results and discussion

### *1. Physical parameters of rosehips*

Regarding physical parameters of fruits, many species can be found (*R. sancti-andreae* Det., types of *R. canina* L., *R. elliptica* Tausch., *R. zalana* Wiesb.), which have remarkable fruit already at present *(Table 2.)*, and do not fall much behind cultivated varieties. The fruit weight of the species *R. sancti-andreae* is outstandingly high (4.81 g), but weighty rosehips were collected from two individuals of *R. canina* in Szigetcsép, individual number 1 of *R. zalana* in Szigetcsép and number 3 of *R. zalana* in Szentendre as well.

Fruit flesh rate of *R. kmetiana*, *R. spinosissima*, the mixed thorned variation of *R. canina*, *R. blanda*, *R. rugosa*, *R. canina* (Sz2), *R. x vetvičkae*, *R. sancti-andreae* and *R. canina var. blondeana* (in order of species 89–72%) reaches that of cultivated varieties already at present.

Fruits of the examined rose species contained 2–35 achenes. The less number of achenes (2 and 4 pieces) can be found in fruits of *R. kmetiana*, *R. blanda* and *R. spinosissima*.

The species involved in examination was ranked on the base of joint evaluation of physical parameters. Comparatively high fruit weight and fruit flesh rate, as well as small number of achenes and small weight loss during storage are the characteristics of *R. canina* cv. 'Inermis', *R.*

***Table 1*** Rose species involved in examination

| Species | Frequency of occurence in the Carpathian basin | Place of collection |
|---|---|---|
| | Species native in Hungary | |
| *R. agrestis* Savi | rare | Soroksár |
| *R. canina* L. | common in mountains, rarer on the Great Plain | Soroksár Szigetcsép |
| *R. can. var. andegavensis* (Bast.) Desp. | rare | Soroksár |
| *R. can. var. blondeana* (Rip. ex Dés.) Crép. | rare (sparse) | Soroksár |
| *R. canina* L. cv. *Inermis* | highly propagated | Soroksár |
| *R. corymbifera* Borkh. | common in mountains, rarer on the Great Plain | Soroksár and Szigetcsép |
| *R. deseglisei* Boreau | very rare (sparse) | Soroksár |
| *R. dumalis* Bechst. em. Bouleng. | more frequent in mountains, rarer on the Great Plain | Szentendre |
| *R. elliptica* Tausch | in the Northern and Transdanubian Mountains, moderately common on the Great Plain | Soroksár |
| *R. inodora* Fr. em. Klást. | rare (in flood-basin forests) | Soroksár |
| *R. kmetiana* Borb. | Northern Mountains, generally rare | Soroksár |
| *R. livescens* Bess. | common in some mountain areas, very rare on the Great Plain | Soroksár and Szentendre |
| *R. micrantha* Sm. ex. Borrer in Sow. | moderately common to the west of the Danube | Soroksár |
| *R. obtusifolia* Desv. | rare | Soroksár |
| *R. polyacantha* (Borb.) Degen | Transdanubian Mountains., moderately common on West and South Transdanubia | Soroksár |
| *R. rubiginosa* L. | generally common in Hungary, frequent | Soroksár |
| *R. spinosissima* L. | rare on the Transdanubia and on the Great Plain, common in mountains, native | Soroksár |
| *R. zalana* Wiesb. | common in some places of the Northern and Transdanubian Mountains, generally rare | Soroksár and Szentendre |
| | Non-native species | |
| *R. sancti-andreae* Det. et Trtm. ex Jáv. | protected in the Northern Mountains and on the Great Plain! Cultural relictum! | Soroksár |
| *R. blanda* Alt. | in forestry plantations, in parks of Budapest. Cultural relictum! | Soroksár |
| *R. rugosa* Thunb. | planted in forests, parks and near roads, cultural deserter | Buda Arboretum |
| *R. x vetvickae* Kláštersky | native in Slovakia | Soroksár |

*Table 2* Main physical parameters of fruits of rose taxa (average data of 1996–1999)

| Rose taxa | Length (mm) | Diameter (mm) | Shape index (length/ diameter) | Weight (Oct.) (g) | Weight (March.) (g) | Weight loss* (%) | Fruit flesh rate (%) | Seed weight (g/fruit) | Seed rate (%) | Number of achenes (pieces/ fruit) | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *R. agrestis* | 15.05 | 10.53 | 1.43 | 0.76 | 0.53 | **30.62** | 61.75 | 0.31 | 38.25 | **16.11** | 4 |
| *R. blanda* | 19.25 | 9.27 | 2.08 | 0.54 | 0.25 | 53.48 | **76.26** | 0.11 | 23.74 | **3.27** | 10 |
| *R. deseglisei* | 16.86 | 13.29 | 1.27 | 1.39 | 0.84 | 39.74 | 65.14 | 0.53 | 34.86 | 21.79 | 6 |
| *R. dumalis* (Szentendre) | 19.53 | 12.78 | 1.53 | 1.31 | 0.92 | **29.77** | ~ | ~ | ~ | ~ | ~ |
| *R. inodora* | 17.98 | 11.38 | 1.58 | 1.13 | 0.70 | 37.80 | 61.71 | 0.53 | 38.29 | 27.23 | 16 |
| *R. kmetiana* | 18.13 | 13.69 | 1.33 | 1.43 | 0.66 | 53.88 | **84.68** | 0.16 | 15.32 | **2.13** | 3 |
| *R. micrantha* | 14.05 | 9.79 | 1.44 | 0.70 | 0.43 | 37.59 | 53.17 | 0.31 | 46.83 | 26.35 | 22 |
| *R. obtusifolia* | 16.67 | 13.45 | 1.24 | 1.30 | 0.67 | 48.29 | 59.91 | 0.44 | 40.09 | 20.60 | 17 |
| *R. spinosissima* | 11.56 | 13.98 | 0.83 | 0.87 | 0.55 | 36.01 | **81.46** | 0.16 | 18.54 | **4.45** | 2 |
| *R. polyacantha* | 14.65 | 9.40 | 1.56 | 0.64 | 0.40 | 38.07 | 53.36 | 0.29 | 46.64 | **16.81** | 18 |
| *R. rugosa* | 12.60 | 16.09 | 0.78 | **2.14** | 0.90 | 58.18 | **75.00** | 0.53 | 25.00 | 26.00 | 8 |
| *R. sancti-andreae* | 25.40 | 20.40 | 1.25 | **4.81** | 3.33 | 69.20 | **72.56** | 1.18 | 27.44 | 33.13 | 14 |
| *R. x vetvickae* | 21.85 | 13.20 | 1.66 | 1.23 | 0.78 | 36.59 | **73.17** | 0.40 | 26.83 | **15.40** | 2 |
| *R. canina* (Sz1) | 24.02 | 14.40 | 1.67 | **2.39** | 1.32 | 44.83 | 56.52 | 1.03 | 43.48 | 34.53 | 19 |
| *R. canina* (Sz2) | 22.76 | 14.31 | 1.60 | **2.14** | 1.15 | 46.28 | **74.25** | 0.86 | 25.75 | 29.07 | 9 |
| *R. canina* (hanging bush habit) | 24.63 | 11.37 | 2.17 | 1.57 | 0.91 | 42.04 | **79.62** | 0.40 | 20.38 | 26.90 | 5 |
| *R. canina* (caried fhorned) | 20.47 | 13.90 | 1.48 | **2.05** | 0.94 | 54.04 | 61.38 | 0.68 | 38.62 | 22.24 | 12 |
| R. canina var. andegavensis | 17.76 | 11.75 | 1.51 | 1.13 | 0.75 | 33.91 | 60.25 | 0.46 | 39.75 | 23.29 | 9 |
| *R. canina var. blondeana* | 17.21 | 13.13 | 1.31 | 1.34 | 1.04 | 47.16 | **72.21** | 0.42 | 27.79 | 20.20 | 9 |
| *R. canina cv. Inermis* | 22.21 | 11.06 | 2.01 | 1.37 | 0.72 | **22.49** | 65.85 | 0.43 | 34.15 | **15.54** | 1 |
| *R. corymbifera* 1. | 18.93 | 13.55 | 1.40 | **1.60** | 0.98 | 38.63 | 58.80 | 0.61 | 41.20 | 27.55 | 13 |
| *R. corymbifera* 2. | 15.00 | 12.27 | 1.22 | 1.09 | 0.63 | 42.48 | 63.94 | 0.47 | 36.06 | **19.88** | 11 |
| *R. corymbifera* (Sz3) | 18.59 | 13.40 | 1.39 | **1.73** | 0.99 | 42.81 | 56.41 | 0.76 | 43.59 | 23.55 | 15 |
| *R. elliptica* 1. | 17.31 | 12.31 | 1.41 | 0.91 | 0.59 | 35.16 | ~ | ~ | ~ | ~ | ~ |
| *R. elliptica* 2. | 17.36 | 13.90 | 1.25 | 1.44 | 0.84 | 41.81 | 63.57 | 0.51 | 36.43 | **18.53** | 4 |
| *R. livescens* | 16.35 | 11.25 | 1.45 | 0.99 | 0.83 | **16.16** | 55.56 | 0.36 | 44.44 | **17.80** | 8 |
| *R. livescens* (Szentendre) | 15.93 | 14.34 | 1.11 | 1.44 | 1.08 | **25.00** | ~ | ~ | ~ | ~ | ~ |
| *R. rubiginosa* 1. | 16.80 | 11.96 | 1.41 | 1.12 | 0.65 | 42.01 | 56.73 | 0.50 | 43.27 | 26.96 | 20 |
| *R. rubiginosa* 2. | 18.18 | 12.20 | 1.49 | 1.21 | 0.69 | 43.17 | 57.19 | 0.48 | 42.81 | 26.37 | 20 |
| *R. zalana* 1. | 14.07 | 15.40 | 0.91 | **1.76** | 1.17 | 33.19 | 57.69 | 0.69 | 42.31 | 27.30 | 8 |
| *R. zalana* 2. | 14.97 | 14.04 | 1.07 | 1.50 | 0.91 | 39.11 | 63.80 | 0.51 | 36.20 | 25.46 | 7 |
| *R. zalana* 3. (Szentendre) | 18.18 | 16.08 | 1.13 | **2.05** | 1.40 | **31.71** | ~ | ~ | ~ | ~ | ~ |
| Regression analysis ($LSD_{5\%}$) | ~ | a | ~ | a | ~ | ~ | ~ | b | ~ | b | ~ |

Note: The Arabic numerals beside taxa indicate the different idividuals of examined species. Differentiation of taxa from various habitats: name of taxon (habitat), or name of taxon (initial of habitat + number of individual). „Sz" indicates the habitat in Szigetcsép. In the column marked by * the values of weight loss measured after five month of storage in room temperature are indicated. Significant relationship were found by regression analysis between the parameters indicated by the same letter

*vetvickae*, *R. kmetiana*, *R. elliptica* 2., *R. deseglisei*, *R. zalana* 2. taxa and the pendulous shrub variation of *R. canina*. Although *R. spinosissima* and *R. agrestis* produced rosehips of low weight, they deserve attention because of the fruits' low achene number, their small weight loss during storage, as well as their high fruit flesh rate.

Relationship was found between parameters indicated by the same letter in *Table 2*, using regression analysis. The connection between fresh weight and diameter of fruits of rose species can be described by the function $y=ax^b$. No relationship can be found between fresh weight and fruit flesh rate, as well as between fresh weight and weight loss. Therefore, bigger fruits do not result in a higher fruit flesh rate, and the weight loss during storage is not necessarily higher. A good example to that is *R. canina* (Sz1), because fruit flesh rate of its weighty rosehips is low, and their weight loss after a 5-month storage was relatively high.

The relationship between the achene number and seed weight of fruits can also be described by the function $y=ax^b$, which means that rose species with higher seed weight have more achenes.

The difference between physical parameters of fruits of rose taxa characterized in details in literature, and physical parameters indicated by us can derive from several factors. According to our examinations, the weight of freshly harvested fruits can vary by years and shrubs. Diverse drying circumstances (e.g. temperature of storage room, relative humidity) can also cause different dry weights after storage. Seed weight and achene number of rosehips vary yearly as well. No factors modify the fruit length of a certain species, but the diameter can vary by individuals.

## 2. *Inner content values of rosehips*

The most important and most valuable factor is vitamin C. A maximum vitamin C content of 873 mg/100 g (*R. blanda*) and a minimum of 266 mg/100 g (*R. kmetiana*) was measured in fruits of examined rose species in 1997 and in 2000 *(Table 3)*. The results of these two years correspond to former literature publications (*Keipert* 1981; *Szenes E.-né* 1995; *Lenchés & Facsar* in *Bernáth* 2000). The extremely low values measured by us in 1998 can definitely be counted to the fact, that preparation of samples was carried out with metal tools, in the other two years of examination a modifying factor could be at some species for example the different maturity of fruits. Our results confirm the statements of *Facsar* (1993) as well, that types referred to as mountain roses (with upstanding residual calix) always contain more vitamin C, than rose species of plain areas (*R. elliptica*>*R. agrestis*, *R. rubiginosa* >*R. micrantha*).

The fruit flesh rate of freshly harvested rosehips is 50–80% depending on the species, which necessarily decreases during storage. *Lenchés & Facsar* in *Bernáth* (2000) mention among others, that vitamin C concentrates essentially in fruit flesh, furthermore, vitamin C can be preserved more effectively in achene-free dried rosehips, than in whole dried fruits.

Carbohydrate and citric acid content of species examined by us *(Table 3)* have not differed significantly from literature data. In literature, authors mention carbohydrate values between 10–20 g/100 g, and we measured approx. 624 g/100 g carbohydrates, with glucose values of 2–11 g/100 g and fructose values of 3–13 g/100 g in it. For citric and malic acid content of species, values between 1.5 g/100 g and 5 g/100 g are known. We expressed the acid content in citric acid in our measurements, the values varied between 0.03 and 1,94 g/100 g in the samples.

***Table 3*** Vitamin C, citric acid and carbohydrate content of fruits of rose taxa (laboratory data from 1997–2000, referring to fruit stored for 5 months)

| Rose taxa | Vitamin C content (mg/100 g) | | | Two-sample t-test ($SD_{5\%}$) | Citric acid (g/100 g) | | Two-sample t-test ($SD_{5\%}$) | Glucose (g/100 g) | | Two-sample t-test ($SD_{5\%}$) | Fructose (g/100 g) | | Two-sample t-test ($SD_{5\%}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ápr. 1997 | Ápr. 1998 | Ápr. 2000 | | 1997 | 1998 | | 1997 | 1998 | | 1997 | 1998 | |
| *R. agrestis* | 446 | 19 | ~ | ~ | 1.08 | 0.72 | ~ | 4.05 | **6.58** | ~ | 4.90 | **8.77** | ~ |
| *R. blanda* | **873** | ~ | **800** | ~ | 0.03 | ~ | ~ | 3.04 | ~ | ~ | 3.68 | ~ | ~ |
| *R. deseglisei* | 305 | 32 | **582** | ~ | 0.98 | 1.04 | ~ | 2.36 | 5.17 | ~ | 3.63 | 5.84 | ~ |
| *R. dumalis* (Szentendre) | 328 | ~ | ~ | ~ | 1.01 | ~ | ~ | 3.86 | ~ | ~ | 5.39 | ~ | ~ |
| *R. inodora* | 399 | 13 | ~ | ~ | 1.27 | 0.45 | ~ | 4.85 | 2.84 | ~ | 3.50 | 3.50 | ~ |
| *R. kmetiana* | 266 | ~ | ~ | ~ | 1.25 | ~ | ~ | **5.94** | ~ | ~ | **7.30** | ~ | ~ |
| *R. livescens* | ~ | 10 | ~ | ~ | ~ | 0.96 | ~ | ~ | 2.58 | ~ | ~ | 4.38 | ~ |
| *R. livescens* (Szentendre) | 282 | ~ | ~ | ~ | 0.85 | ~ | ~ | 4.33 | | ~ | 5.58 | ~ | ~ |
| *R. micrantha* | 402 | 13 | ~ | ~ | 0.62 | 1.26 | ~ | 4.12 | **6.46** | ~ | 4.23 | **7.30** | ~ |
| *R. obtusifolia* | ~ | 40 | 362 | ~ | ~ | **1.56** | ~ | ~ | 4.65 | ~ | ~ | 6.71 | ~ |
| *R. spinosissima* | 290 | ~ | ~ | ~ | 0.21 | ~ | ~ | **7.23** | ~ | ~ | **7.00** | ~ | ~ |
| *R. polyacantha* | ~ | 23 | 395 | ~ | ~ | 0.92 | ~ | ~ | 2.84 | ~ | ~ | 3.79 | ~ |
| *R. sancti-andreae* | **647** | ~ | ~ | ~ | 0.72 | ~ | ~ | **11.11** | ~ | ~ | **13.42** | ~ | ~ |
| *R. x vetvickae* | ~ | ~ | **752** | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ |
| *R. canina* (Sz2) | 270 | 20 | 485 | c. f | 0.72 | 1.76 | ~ | 2.31 | 5.06 | a | 5.08 | 8.21 | ~ |
| *R. canina* (hanging bush habit.) | ~ | ~ | **640** | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ |
| *R. canina* (caried fhorned) | ~ | 36 | 477 | d. e. f | ~ | **1.63** | ~ | ~ | **6.35** | ~ | ~ | **7.91** | ~ |
| *R. canina var.andegavensis* | ~ | 16 | 562 | a. d | ~ | 0.82 | b | ~ | 4.56 | ~ | ~ | 6.79 | b |
| *R. canina var. blondeana* | 483 | 37 | 527 | a. b. c | 0.57 | 0.75 | a | 4.25 | 4.81 | ~ | 3.73 | 6.79 | a |
| *R. canina* cv. Inermis | 466 | 20 | ~ | b. e | **1.66** | **1.94** | a. b | **4.53** | **7.75** | a | **5.00** | **9.05** | a. b |
| *R. corymbifera* 1. | 347 | 20 | 511 | ~ | **1.05** | **1.31** | ~ | 3.56 | 4.56 | b | 6.51 | 6.51 | ~ |
| *R. corymbifera* 2. | ~ | 14 | 465 | g | ~ | 1.06 | ~ | ~ | 2.84 | b. c | ~ | 5.84 | ~ |
| *R. corymbifera* (Sz3) | ~ | 28 | 513 | g | ~ | **1.37** | ~ | ~ | 4.81 | c | ~ | 7.64 | ~ |
| *R. elliptica* 1. | **738** | ~ | ~ | f | 0.56 | ~ | ~ | 4.12 | ~ | ~ | 3.92 | ~ | ~ |
| *R. elliptica* 2. | **585** | 52 | **597** | f | 1.36 | 0.83 | ~ | 4.50 | 4.81 | ~ | 5.00 | 5.84 | ~ |
| *R. rubiginosa* 1. | 492 | 56 | **689** | g | 1.10 | 0.69 | ~ | 3.36 | 3.62 | ~ | 3.73 | 3.79 | ~ |
| *R. rubiginosa* 2. | 331 | 47 | **600** | g | 1.00 | 0.95 | ~ | 4.43 | 4.39 | ~ | 3.83 | 4.38 | ~ |
| *R. zalana* 1. | 403 | ~ | ~ | ~ | 1.30 | ~ | ~ | **4.46** | ~ | ~ | **5.60** | ~ | ~ |
| *R. zalana* 2. | 334 | 29 | 567 | ~ | **1.02** | **1.29** | ~ | **4.86** | **5.82** | ~ | **5.75** | **7.64** | ~ |
| *R. zalana* 3. (Szentendre) | 334 | ~ | ~ | ~ | 1.02 | ~ | ~ | **4.72** | ~ | ~ | **6.09** | ~ | ~ |
| Two-sample t-test ($LSD_{5\%}$) | a, b | a, c | b, c | ~ | ~ | ~ | ~ | d | d | ~ | e | e | ~ |
| Regression analysis ($LSD_{5\%}$) | a, ba, bb,bc, bd | *a, b, be, bf, bg | *b | ~ | e, f, *c | b, d, n, o, p,*k, *p | ~ | g, h, i, j, k, l | c, q, r, *v | ~ | a,m | c, d, s, t, *i, *q, *w | ~ |

Note: Standing small letter(s) were used to indicate significantly different parameters during two-sample t-test ($SD_{5\%}$), as well as to indicate significantly related parameters in regression analysis.

Till present only few authors tried to describe in details the several macro- and microelements found in rosehip. Most of our values *(Table 4.)* are closer to examination results of *Szentmihályi* et al. (1999) based on the evaluation of native *Rosa* taxa, but do not differ significantly from literature containing foreign examination results (*Brodmann* 1993). However, differences can be shown between values measured by us and data of the above mentioned authors in case of Na, Ca, K, Cu, and Zn.

Besides laboratory examination of whole rosehips, inner content values of freshly harvested rosehips, as well as achene-free rosehips of some valuable rose taxa were examined after 5 months of storage. *Table 5* shows the positive or negative differences between inner content results of achene-free fruits and those of whole fruits indicated in *Tables 3 and 4*.

According to our results, nearly twice as much vitamin C can be found in freshly harvested, halved fruits compared to whole fruits, while nearly 5 times as much in achene-free dried rosehips. Citric acid and carbohydrate content of whole and achene-free rosehips do not vary from each other significantly *(Tables 3 and 5)*.

Mineral content of dried whole fruits is higher, than that of achene-free died fruits: their phosphorus-, nitrogen- and zinc content is about two and a half times, their iron- and copper content twice, their magnesium-, manganese- and boron content one and a half times higher in most species *(Tables 4 and 5)*. Literature data also confirm, that there are various materials in the achenes, for example different types of oils, sugar and minerals (*Brodmann* 1993, *Rápóti a*nd *Romváry* 1990; *Perédi* et al. 1994). Materials of the achenes can be dissolved during sample preparation, therefore presence or lack of achenes can change the inner content parameters of whole and halved fruits.

*Table 6* shows the flowering and ripening time of examined cultivars. Beginning and length of flowering

***Table 4*** Mineral content of fruits of rose taxa
(laboratory data from 1997–1998, referring to dried fruit stored for 5 months)

| Rose taxa | Macroelements (mg/100 g) | | | | | | | | | | Microelements (mg/100 g) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P | N | K | | Ca | | Mg | | Na | Two-sample t-test ($SD_{5\%}$) | Fe | | Mn | | Zn | | Cu | | B | | Two-sample t-test ($SD_{5\%}$) |
| | 1998 | 1998 | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 | 1997 | | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 | |
| *R. agrestis* | 170 | 330 | 460 | 560 | 202 | 150 | 134 | 170 | 16 | ~ | 8.24 | 7.33 | 1.66 | 3.12 | 0.47 | 1.11 | 0.14 | 0.56 | 1.45 | 1.63 | ~ |
| *R. blanda* | ~ | ~ | **890** | ~ | **230** | ~ | **180** | ~ | ~ | ~ | **7.76** | ~ | **3.66** | ~ | **1.36** | ~ | **0.78** | ~ | **1.06** | ~ | ~ |
| *R. deseglisei* | **220** | **420** | **460** | **710** | **450** | **210** | **166** | **140** | **18** | ~ | 9.77 | 6.03 | 1.19 | 2.93 | 0.82 | 0.97 | 0.19 | 0.57 | 2.62 | 1.06 | ~ |
| *R. dumalis* (Szentendre) | ~ | ~ | 430 | ~ | 219 | ~ | 128 | ~ | 7 | ~ | 7.76 | ~ | 2.24 | ~ | 0.59 | ~ | 0.14 | ~ | 1.37 | ~ | ~ |
| *R. inodora* | 170 | 360 | 420 | 580 | 158 | 300 | 127 | 170 | 12 | ~ | **10.30** | **6.03** | **2.64** | **3.96** | **0.50** | **0.72** | **0.15** | **0.56** | **1.61** | **2.00** | ~ |
| *R. kmetiana* | ~ | ~ | **660** | ~ | **160** | ~ | **180** | ~ | ~ | ~ | **6.89** | ~ | **3.76** | ~ | **0.89** | ~ | **0.56** | ~ | **1.25** | ~ | ~ |
| *R. livescens* | **140** | **510** | ~ | **730** | ~ | **280** | ~ | **160** | ~ | ~ | ~ | 6.65 | ~ | 2.37 | ~ | 0.81 | ~ | 0.50 | ~ | 1.13 | ~ |
| *R. livescens* (Szentendre) | ~ | ~ | 440 | ~ | 228 | ~ | 119 | ~ | 7 | ~ | 7.48 | ~ | 6.00 | ~ | 0.65 | ~ | 0.12 | ~ | 1.29 | ~ | ~ |
| *R. micrantha* | **220** | **370** | **450** | **880** | **309** | **230** | **162** | **160** | **13** | ~ | **8.41** | **6.03** | **3.70** | **4.59** | **0.68** | **1.14** | **0.16** | **0.70** | **1.65** | **1.81** | ~ |
| *R. obtusifolia* | 170 | 400 | ~ | 690 | ~ | 240 | ~ | 290 | ~ | ~ | ~ | **5.32** | ~ | **2.57** | ~ | **1.08** | ~ | **0.71** | ~ | **1.38** | ~ |
| *R. spinosissima* | ~ | ~ | 720 | ~ | 100 | ~ | 90 | ~ | ~ | ~ | 6.21 | ~ | 1.70 | ~ | 0.69 | ~ | 0.53 | ~ | 0.31 | ~ | ~ |
| *R. polyacantha* | 160 | 470 | ~ | 650 | ~ | 210 | ~ | 140 | ~ | ~ | ~ | **6.90** | ~ | **3.27** | ~ | **0.92** | ~ | **0.49** | ~ | **1.56** | ~ |
| *R. sancti-andreae* | ~ | ~ | 1050 | ~ | 80 | ~ | 80 | ~ | ~ | ~ | 5.77 | ~ | 1.13 | ~ | 0.81 | ~ | 0.28 | ~ | 0.81 | ~ | ~ |
| *R. canina* (Sz2) | 140 | 200 | 440 | 1190 | 197 | 110 | 150 | 110 | 7 | d. e. f. g | 9.04 | 4.88 | 1.75 | 1.39 | 0.89 | 1.33 | 0.17 | 0.57 | 1.92 | 0.88 | ~ |
| *R. canina* (kevert tüsk. vált.) | **220** | **340** | ~ | **880** | ~ | **180** | ~ | **140** | ~ | d. h. i. j | ~ | 4.31 | ~ | 2.39 | ~ | 0.92 | ~ | 0.63 | ~ | 1.75 | ~ |
| *R. canina var.andegavensis* | **200** | **420** | ~ | **680** | ~ | **260** | ~ | **180** | ~ | a. b. e. h | ~ | **5.60** | ~ | **2.73** | ~ | **1.42** | ~ | **0.85** | ~ | **1.88** | ~ |
| *R. canina var. blondeana* | 150 | 330 | 440 | 480 | 260 | 240 | 153 | 180 | 7 | b. c. f. i | 7.11 | 6.90 | 1.14 | 2.54 | 0.51 | 1.08 | 0.13 | 0.56 | 1.88 | 2.01 | ~ |
| *R. canina* cv. Inermis | 180 | 330 | 450 | 750 | 189 | 150 | 166 | 160 | 11 | a. c. g. j | 6.65 | 5.77 | 1.77 | 2.63 | 0.31 | 0.67 | 0.11 | 0.49 | 1.17 | 1.03 | ~ |
| *R. corymbifera* 1. | **150** | **620** | **460** | **770** | **370** | **240** | **161** | **180** | **18** | k. l | **9.79** | **3.45** | **2.70** | **3.96** | **0.71** | **1.00** | **0.18** | **0.70** | **1.69** | **1.00** | ~ |
| *R. corymbifera* 2. | 140 | 380 | ~ | 630 | ~ | 190 | ~ | 150 | ~ | k. m | ~ | 6.21 | ~ | 3.60 | ~ | 1.19 | ~ | 0.35 | ~ | 0.56 | ~ |
| *R. corymbifera* (Sz3) | 140 | 580 | ~ | 790 | ~ | 150 | ~ | 90 | ~ | l. m | ~ | 4.81 | ~ | 1.65 | ~ | 1.03 | ~ | 0.49 | ~ | 1.13 | ~ |
| *R. elliptica* 1. | ~ | ~ | **480** | ~ | **266** | ~ | **138** | ~ | **18** | ~ | 7.80 | ~ | 1.56 | ~ | 0.47 | ~ | 0.14 | ~ | 1.13 | ~ | ~ |
| *R. elliptica* 2. | 130 | 260 | 430 | 610 | 240 | 280 | 134 | 150 | 13 | ~ | 7.41 | 7.32 | 2.26 | 4.10 | 0.53 | 0.83 | 0.15 | 0.54 | 1.37 | 1.63 | ~ |
| *R. rubiginosa* 1. | **180** | **430** | **440** | **740** | **240** | **210** | **132** | **140** | **18** | n | 9.30 | 6.66 | 1.67 | 2.52 | 0.62 | 1.22 | 0.12 | 0.63 | 1.37 | 1.01 | ~ |
| *R. rubiginosa* 2. | 170 | 190 | 450 | 750 | 200 | 140 | 135 | 150 | 19 | n | 9.11 | 7.10 | 1.23 | 2.68 | 0.44 | 1.08 | 0.13 | 0.51 | 1.61 | 1.19 | ~ |
| *R. zalana* 1. | ~ | ~ | **460** | ~ | **234** | ~ | **154** | ~ | **14** | o | 7.94 | ~ | 2.28 | ~ | 0.65 | ~ | 0.09 | ~ | 1.33 | ~ | a |
| *R. zalana* 2. | **170** | **280** | **450** | **740** | **285** | **240** | **154** | **160** | **13** | ~ | 9.41 | 4.74 | 1.88 | 2.20 | 0.52 | 0.86 | 0.12 | 0.56 | 1.53 | 1.63 | ~ |
| *R. zalana* 3. (Szentendre) | ~ | ~ | 450 | ~ | 367 | ~ | 137 | ~ | 3 | o | **7.66** | ~ | **7.74** | ~ | **0.78** | ~ | **0.09** | ~ | **1.33** | ~ | a |
| Two-sample t-test (LSD5%) | ~ | ~ | f | f | g | g | ~ | ~ | ~ | ~ | h | h | | | i | i | j | j | k | k | ~ |
| Regression analysis (LSD5%) | ap | ~ | ba, aa, ab, ac | be, n, *m, *r, ab | g, *d, *h, ae, af aa, ad, | q, s, ad, ae, af | h, *e, ad | o, ad, ao | aj | ~ | bb, e, i, ab,ag, ah, ai, an | bf, p, *s, ab | af, ag, aj | *t, af | bc, f, j, m, *f, *i, ah, ak, al | r, t, al | k, ai, al, am | *n, al, ao, ap | bd,l,*g *j, ac, ae, ak, am, an | bg, *o, ae | ~ |

Note: same as at Table 3.

***Table 5*** Inner value differences of achene-free fruits compared to results of whole fruits*

| Rose taxa | Vitamin C (Apr. 1998) mg/100 g | Vitamin C (Nov. 1999.) mg/100 g | Citric acid (Apr. 1998) g/100 g | Glucose (Apr. 1998) g/100 g | Fructose (Apr. 1998) g/100 g | Macroelements (Apr. 1998) (mg/100 g) P | N | K | Ca | Mg | Microelements (Apr. 1998) (mg/100 g) Fe | Mn | Zn | Cu | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *R. canina* (Sz2) | +137 | +259 | +0.07 | +1.23 | +0.18 | –92 | –24 | +325 | +146 | –38 | –0.97 | –0.36 | –0.91 | –0.337 | +0.37 |
| *R. corymbifera* 1. | +245 | +110 | +0.83 | +2.14 | +3.66 | –74 | –346 | +147 | +110 | +75 | –0.59 | +0.84 | –0.37 | –0.104 | +0.31 |
| *R. corymbifera* 2. | +93 | +292 | +0.25 | +2.9 | +1.1 | –71 | –227 | +229 | –14 | –20 | –1.44 | 0 | –0.41 | –0.082 | +0.537 |
| *R. elliptica* 2. | +176 | +637 | –0.23 | –1.3 | –2.15 | –69 | –180 | –141 | –111 | –75 | –3.88 | –1.95 | –0.473 | –0.296 | –0.78 |
| *R. inodora* | +6 | – | +0.15 | +1.83 | +2.07 | –90 | –298 | +97 | –122 | –72 | –2.32 | –1.47 | –0.402 | –0.341 | –0.58 |
| *R. micrantha* | +21 | – | –0.85 | –4.52 | –5.25 | –175 | –342 | –530 | –96 | –108 | –4.82 | –3.2 | –1.02 | –0.603 | –1.19 |
| *R. rubiginosa* 1. | +132 | +379 | –0.34 | –1.8 | –1.8 | –108 | –303 | –167 | –76 | –92 | –5.38 | –1.76 | –0.98 | –0.464 | –0.65 |
| *R. rubiginosa* 2. | +153 | +447 | –0.4 | –1.85 | –1.74 | –162 | –131 | –86 | –6 | –91 | –5.53 | –1.75 | –0.84 | –0.336 | –0.7 |
| *R. zalana* 2. | +194 | +268 | +0.1 | +1.54 | –0.2 | –40 | –142 | +71 | +36 | –14 | –1.19 | –0.3 | –0.426 | –0.113 | –0.01 |
| Two-sample t-test ($LSD_{5\%}$) | a | b | ~ | ~ | ~ | c | d | ~ | ~ | e | f | g | h | i | j |

Note: *: + or – values in the Table = data of achene-free fruits converted to whole fruits – data of whole fruits.
Standing small letters were used to indicate significantly different parameters during two-sample t-test (SD 5%).

***Table 6*** Flowering order, ripening time of rose species in Soroksár Botanic Garden (1997–2000)

| Rose species | Flowering time | Beginning of flowering | Ripening time |
|---|---|---|---|
| *R. blanda* Ait. | early | about 15th May | end of Aug. |
| *R. spinosissima* L. | | | end of Aug. |
| *R. canina* L. (kevert tüsk. vált.) | | | middle-end of Sept. |
| *R. deseglisei* Boreau | | | middle-end of Sept. |
| *R. livescens* Bess. | middle early | about 20th May | middle-end of Sept. |
| *R. obtusifolia* Desv. | | | beginning-middle of Sept. |
| *R. x vetvičkae Klášterský* | | | middle of Sept. |
| *R. zalana* Wiesb. | | | end of Sept. |
| *R. canina var. andegavensis* (Bast.) Desp. | | | end of Sept. |
| *R. canina var. blondeana* (Rip. Ex. Dés.) Crép. | | | end of Sept. |
| *R. canina* L. *cv. Inermis* | middle | about 25th May | middle of Sept. |
| *R. corymbifera* Borkh. | | | middle-end of Sept. |
| *R. kmetiana* Borb. | | | beginning-middle of Sept. |
| *R. agrestis* Savi | | | end of Sept. |
| *R. polyacantha* (Borb.) Degen | middle late | about 28th May | end of Sept. |
| *R. rubiginosa* L. | | | middle-end of Sept. |
| *R. elliptica* Tausch. | | | middle-end of Sept. |
| *R. inodora* Fr. em. Klást. | late | about 01st June | end of Sept. |
| *R. micrantha* Sm. ex. Borrer in Sow. | | | end of Sept. |

varies yearly, but on the base of more years of examination, flowering groups can be formed. No statistically verifiable connection was found between flowering time, ripening time and vitamin C content indicated in *Table 3*, which means, that these factors determine the characteristics of species as independent genetic facilities.

During statistical evaluation of data we found, that rosehips from individuals of a given species show measurable variability mostly in their diameter, fresh weight and vitamin C content, and less frequently in their macroelement content. *Keipert* (1981) emphasises the difference between vitamin C content of fruits caused by habitat.

Significant relationship can be found between fresh weight and B content of fruits in case of K-Fe, Ca-Mg, Ca-B, Ca-Mn and Zn-Cu. According to our examinations, fresh weight of rose species containing more citric acid is higher, while their Fe content is lower. Glucose content of fruits of rose species is directly proportional to their Ca and Zn content. Zn content of rose species with a higher fructose content is lower.

## References


**Anonymus (1999):** Beschreibende Sortenliste Wildobstarten: Rosa-Fruchtrose. Herausgegeben vom Bundessortenamt. Hannover: Landbuch-Verlag, 121–138.

**Brodmann, S. (1993):** Die Apfelrose als obstbaulicher Forschungsgegenstand. Anbau und Verwertung von Wildobst. Berlin: Bernhard Thalacker Verlag Braunschweig, 111–121.

**Buschbeck, E. (1993):** Nutzung, Gewinnung und Erhöhung des inlandischen Aufkommens an Hagebutten. Anbau und Verwertung von Wildobst. Berlin: Bernhard Thalacker Verlag Braunschweig. 122–127.

**Facsar G. (1993):** Magyarország vadontermő rózsái. Budapest: Kertészeti és Élelmiszeripari Egyetem. Candidate thesis. 142.

**Keipert, K. (1981):** Gattung *Rosa*- Rosen, Hagebutten. Beerenobst. Eugen Ulmer GmbH & Co. 290–295.

**Koch, H. & Grope, J. L. (1993):** Die Bedeutung der Fruchtrosen als Obstraucher. Anbau und Verwertung von Wildobst. Berlin: Bernhard Thalacker Verlag Braunschweig. 107–120.

**Lenchés O. & Facsar G. (2000):** *Rosa* ssp. – vadrózsafajok. 497–502. In Bernáth J. *Gyógy- és aromanövények*. Budapest: Mezőgazda Kiadó.

**Porpáczy A. (1999):** A rózsa termesztése. 222–225. In: Papp J., Porpáczy A. (szerk.) Szeder, ribiszke, köszméte, különleges gyümölcsök. Budapest: Mezőgazda Kiadó,

**Müller, K. D. (1997):** Wilfruchtarten für Biotopverbundsysteme. Beitrage gehalten anlässlich der 1. Internationalen Wildfruchttagung. Humboldt-Universitat zu Berlin. 177–182.

**Perédi J. et al. (1994):** Examination on the seed oils of some wildrose species in central Europe. III. International Conference on New Industrial Crops and Products. Sept. 25–30. Catamarca, Argentina. 14.

**Rápóti J. & Romváry V. (1990):** Gyógyító növények. Budapest: Medicina, 111–116, 247.

**Stoll, K. & Gremminger, U. (1986):** Wilde Heckenrose und andere Rosen-Arten. Besondere Obstarten. Eugen Ulmer GmbH & Co. 81–85.

**Szenes E-né. (1995):** Gyümölcsök tartósítása kisüzemben és a háztartásban. Budapest: Integra-Projekt Kft., 38.

**Szentmihályi K. et al. (1999):** A csipkebogyó (*Rosa canina* L. áltermés) elemtartalmának vizsgálata a fitoterápiás felhasználás szempontjából. Fitoterápia, 4: 104–107.