

The study of irrigation influence on nutritional value of *Lonicera kamtschatica* – cultivar Gerda 25 and *Lonicera edulis* berries under the Nitra conditions during 2001–2003

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ABSTRACT: Two species of edible honeysuckle were studied in the trial established in the autumn 1994. The spacing used was 2.0 × 1.5 m and the experiment included irrigated as well as non- irrigated variants. The aim of this study was to provide a summary of nutritional values of *Lonicera kamtschatica* and *Lonicera edulis* berries under the Nitra conditions during the period 2001–2003. The berries were examined for the content of dry mater, sugar, organic acids, ascorbic acid, mineral substances – K, Ca, P, Mg, Na and anthocyanins from pomace and juice. The results of our experiments refer to the exceptionally high content of ascorbic acid ranging from 28.56 up to 86.96 mg/100 g, potassium 10,175 to 14,764 mg/kg and anthocyanins from pomace 6.245–17.36 g/kg. The values of ascorbic acid varied and they were statistically significantly depending on the year; similarly, only year can be taken into account as a statistically significant factor for forming content of sugar, magnesium and sodium. The content of dry mater, organic acids, potassium, calcium and anthocyanins in juice was influenced not only by year but also by species. The interaction species – year as a source of statistically significant differences is evident in the case of phosphorus and organic acids. A significant influence of irrigation on all evaluated nutrients was not confirmed.

Keywords: nutritional value of fruits; *Lonicera kamtschatica* (Sevast.) Pojark.; *Lonicera edulis* Turcz. ex Freyn

Edible honeysuckle is a unique member of *Lonicera-ceae* family. Although *Loniceras* are well-known as ornamental shrubs planted for their sweet-scented flowers, several species labeled as “edible” or “blue” honeysuckle have sweet, edible fruits (BARANEC et al. 1998; CAGÁŇOVÁ 1994). Different authors recognized 1 to 17 species of edible honeysuckle. The opinions of authors vary at this point (PLEKHANOVA, STRELTSYNA 1998). Despite of the wide variety of edible honeysuckle, tasty sweet berries with delicious aroma are characteristic only for some of them; out of these tasty varieties similar to blueberry, BURMISTROV (1985) and PETROVA (1987) recommend *Lonicera kamtschatica* and *Lonicera edulis*. These plants originate in the Asiatic part of Russia, on the Pacific coast, on the Kamtschatka peninsula and in the eastern Siberia (PLEKHANOVA 1998). Edible honeysuckle has a lot of positive features – early ripening (2 weeks earlier than strawberry), exceptional

hardiness, no specific demands for soil and climatic conditions (it only requires a lot of moisture), or a low susceptibility to pests and diseases (PLEKHANOVA 1990, 1996). Edible honeysuckle contains a wide range of valuable biologically active substances – especially ascorbic acid and polyphenolic compounds (anthocyanins, rutin, quercetin and isoquercetin). Due to their high content of anthocyanins berries can be utilized for coloring jams and similar food products (MÁRIASSYOVÁ et al. 1999).

MATERIAL AND METHODS

An experimental area for the edible honeysuckle planting was established in the autumn 1994 in Nitra. Two species – *Lonicera kamtschatica* (Sevast.) Pojark., cultivar Gerda 25 and *Lonicera edulis* Turcz. ex Freyn, were planted at spacing 2.0 × 1.5 m using 2-year-old seedlings. The experimental area was

Table 1. The average values of rainfall (in mm) during vegetation in 2001–2003

Month	2001	2002	2003
March	50.9	28.7	2.3
Characterization	very humid	normal	extremely dry
April	20.0	44.5	27.0
Characterization	dry	normal	normal
May	49.1	42.3	44.5
Characterization	normal	normal	normal
June	18.0	38.5	6.5
Characterization	dry	normal	very dry

Table 2. The average values of temperatures (in °C) during vegetation in 2001–2003

Month	2001	2002	2003
March	6.1	6.3	5.1
Characterization	normal	normal	normal
April	10.4	9.9	10.7
Characterization	normal	normal	normal
May	17.8	17.4	18.8
Characterization	very warm	very warm	extremely warm
June	18.0	19.6	18.0
Characterization	normal	extremely warm	normal

covered with black polyethylene mulch. In order to examine the influence of drip – irrigation on the nutritional value of fruit the experiment comprised 2 variants, irrigated and non-irrigated, placed in 2 blocks.

The soil and climatic conditions of the site were as follows: open level, 130 m above sea level, corn processing area, clay-loam – drift, pH 6.4, mould content 3.5%, precrop black fallow, average rainfall 564 mm per year, average temperature during vegetation period 16.3°C. The actual values of average rainfall and temperature in March–June 2001–2003 are given in Tables 1 and 2.

12 shrubs were planted for each variant. The research of the chemical composition of *Lonicera* berries was carried out at the Plant Research Institute in Malanta in 2001–2003. The samples of edible honeysuckle were analyzed for the content of dry matter, sugar, organic acids, ascorbic acid and mineral matters – potassium (K), calcium (Ca), phosphorus (P), sodium (Na), magnesium (Mg) and for the content of anthocyanins from pomace and juice.

In order to determine the content of dry matter, berries were dehumidified until constant weight was reached; organic acids were determined by the NaOH titration according to PRÍBELA (1967) and were calculated on citric acid; the percentage of sugar content was determined by the method of

SOMOGYI; the amount of ascorbic acid was obtained by polarography; mineral matters were identified in ash and the content of mineral substances was determined by atomic spectroscopy (AAS) after drying and burning berries in the drying kiln; the content of anthocyanins was determined by the method of FÜLEKI and FRANCIS (1968). Statistical analyses were conducted using the Statistical Analysis program (SAS)-computer program SAS/STAT. The experimental data were analyzed by the two-factor analysis of variance.

RESULTS

The results of our experiments and their statistical evaluation are given in Tables 3 and 4.

Dry matter

The mean value of dry matter reached 17.39% with standard deviation 0.59. We found statistically significant differences between species and years ($\alpha = 0.01$); however, only little differences were found between irrigated and non-irrigated variants, irrigation thus cannot be considered as a statistically significant factor forming dry matter content. In the case of irrigation applied in 2002, dry matter content increased by 10.5% (*Lonicera kamtschatica*) and

Table 3. The content of the nutrients in the berries of *Lonicera kamtschatica* and *Lonicera edulis* under the Nitra conditions during 2001–2003

Nutrients	2001				2002				2003				Mean value
	L.k.–	L.k.+	L.e.–	L.e.+	L.k.–	L.k.+	L.e.–	L.e.+	L.k.–	L.k.+	L.e.–	L.e.+	
Dry matter (%)	14.42	14.52	16.92	15.54	15.33	17.13	18.54	18.91	19.07	18.54	20.27	19.4	17.39
Sugar (%)	4.3	4.9	5.5	5.8	8.5	9.1	6.4	9.1	12.8	12.00	10.70	10.00	8.26
Organic acids (%)	3.84	3.6	3.52	3.84	3.84	3.52	4.16	4.13	4.1	3.79	5.18	5.25	4.04
Ascorbic acid mg/100 g	63.13	86.95	71.26	85.19	56.70	65.80	53.06	54.30	28.56	32.53	36.21	34.91	55.716
K (mg/kg)	11,575	11,150	10,525	10,175	14,764	13,624	12,723	10,991	12,809	14,084	11,434	12,970	12,235.3
P (mg/kg)	2,050	2,220	2,400	2,350	2,675	2,775	2,050	1,675	2,200	2,100	2,425	2,100	2,251.67
Mg (mg/kg)	751	870	766	687	695	922	952	810	469	524	592	489	710.58
Ca (mg/kg)	1,160	1,390	1,675	1,275	1,053	1,280	1,664	1,416	427	503	663	426	1,077.67
Na (mg/kg)	125	132	117	140	57	55	54	63	89	37	69	63	81.67
Anthocyanins in pomace (g/kg)	–	–	–	–	8.72	15.99	17.7	17.36	8.96	6.245	14.06	9.25	12.28
Anthocyanins in juice (g/l)	–	–	–	–	4.45	6.32	8.98	9.68	0.61	0.785	1.71	2.215	4.34

L.k.– *Lonicera kamtschatica* without irrigation, L.k.+ *Lonicera kamtschatica* with irrigation, L.e.– *Lonicera edulis* without irrigation, L.e.+ *Lonicera edulis* with irrigation

1.96% (*Lonicera edulis*). On the contrary, a negative influence of irrigation on dry matter content was observed in 2003, namely a decrease of dry matter by 2.78% (*Lonicera kamtschatica*) and 4.3% (*Lonicera edulis*).

Sugar

Mean value of sugar represented 8.26% with standard deviation 0.82. During 2001–2003 the increasing tendency of sugar content was noticed. Annual increase in sugar content was positively associated with the increase of dry matter content. A maximum content of sugar was recorded in the case of non-irrigated variant of *Lonicera kamtschatica* in 2003 (12.8%). The sugar content was statistically significantly influenced only by year ($\alpha = 0.01$).

Differences between irrigated and non-irrigated variants were not so dramatic and thus the influence of the irrigation is questionable; sugar content had an increasing tendency due to irrigation only in 2001 and 2002, in 2003 the irrigation had a negative effect on sugar content.

Organic acids

Organic acids reached the mean value 4.04% with standard deviation 0.17. During 2001–2003 organic acid content had an increasing tendency, which positively corresponded with dry matter and sugar content. Regardless of irrigation *Lonicera edulis* had a higher content of organic acids (4.3%) on average in comparison with *Lonicera kamtschatica* (3.78%). In the case of organic acids we can find statistically significant differences between species ($\alpha = 0.01$), year ($\alpha = 0.05$), and interaction year and species ($\alpha = 0.01$). On the whole, organic acids content varied from 3.52% (non-irrigated variant of *Lonicera edulis* in 2001) to 5.25% (irrigated variant of *Lonicera edulis* in 2003). Irrigation positively contributed to the content of organic acids only in the case of *Lonicera edulis* (increase by 8.3% in 2001, by 7.6% in 2002, by 1.33% in 2003). On the contrary, in the case of *Lonicera kamtschatica* an evident decrease of organic acids was observed by 6.25%, 8.3%, and 7.8% in 2001, 2002 and 2003, respectively.

Ascorbic acid

The mean value of ascorbic acid was 55.716 mg per 100 g with standard deviation 5.7. The highest value of ascorbic acid (86.95 mg/100 g) was

Table 4. Testing of the significance of differences in nutrition value between *Lonicera kamtschatica* and *Lonicera edulis*

Nutrients	Species	Year	Irrigation	Species × year
Dry matter	++	++	–	–
Sugar	–	++	–	–
Organic acids	++	++	–	++
Ascorbic acid	–	++	–	–
Potassium	+	+	–	–
Phosphorus	–	–	–	++
Calcium	+	++	–	–
Magnesium	–	++	–	–
Sodium	–	++	–	–
Anthocyanins in pomace	–	–	–	–
Anthocyanins in juice	++	++	–	–

+ Significant differences at the significance level $\alpha = 0.05$

++ Significant differences at the significance level $\alpha = 0.01$

measured in the case of irrigated variant of *Lonicera kamtschatica* in 2001, the lowest (28.56 mg/100 g) in the case of non-irrigated variant of *Lonicera kamtschatica* in 2003.

The variability of ascorbic acid content was statistically significantly influenced by year at the significance level $\alpha = 0.01$. In terms of two species and two variants of the treatment the highest values of ascorbic acid contents were noticed in 2001 (with the mean value 76.63 mg/100 g), which might be caused by increased average annual rainfall that year – especially in March. On the contrary the lowest content of ascorbic acid in 2003 (with mean value 33.025 mg/100 g) can result from a long rainless period during flowering stage (Table 1). The results of analysis of variance expressed that there were no significant differences between *Lonicera kamtschatica* and *Lonicera edulis*. Despite the fact that irrigation had a positive effect on the content of ascorbic acid it was not marked as statistically significant. The most considerable influence of irrigation was noticed in 2001 (among irrigated variants values of ascorbic acid increased by 27.3% in the case of *Lonicera kamtschatica*, and by 16.35% in *Lonicera edulis*).

Mineral substances

Mineral substances also play an important role in nutritional value of berries. When the amount of mineral substances was taken into account, potassium (K) predominated, followed by phosphorus (P), calcium (Ca) and magnesium (Mg); on the contrary, the lowest content was that of sodium (Na).

The potassium content ranged from 10,175 mg/kg (irrigated variant of *Lonicera edulis* in 2001) to 14,764 mg/kg (non-irrigated variant of *Lonicera*

kamtschatica in 2002). Species and year were identified as statistically significant factors for the potassium content; on the other hand it was not significantly influenced by different modes of irrigation.

A significant position among the evaluated mineral matters was occupied by phosphorus (P). The mean value of phosphorus was 2,251.67 mg/kg with standard deviation 8.609. As regards the variants, the highest value (2,775 mg/kg) was observed in the case of irrigated variant of *Lonicera kamtschatica* in 2002; on the contrary, the lowest value (1,675 mg/kg) was recorded in the case of irrigated variant of *Lonicera edulis* in 2002. The values of phosphorus content significantly differed according to the interaction of year and species at the significance level ($\alpha = 0.01$).

Calcium and magnesium are present in a lesser amount. As for Ca, the highest content (1,675 mg/kg) was recorded in non-irrigated variant of *Lonicera edulis* in 2001, whereas the lowest (426 mg/kg) in irrigated variant of *Lonicera edulis* in 2003. Comparison of Ca contents indicated statistically significant differences caused by year ($\alpha = 0.01$) and species ($\alpha = 0.05$). The calcium content had a decreasing tendency. Regardless the influence of irrigation, the mean values of all evaluated variants of *Lonicera edulis* show a higher content of Ca (1,186.5 mg/kg) in comparison with *Lonicera kamtschatica* (968.8 mg per kg).

As for magnesium, the lowest values of all evaluated variants were noticed in 2003 (the mean of all observed variants was recorded as a 38.6% decrease). The highest value of magnesium was recorded in non-irrigated variant of *Lonicera edulis* (952 mg/kg), the lowest (469 mg/kg) in non-irrigated variant of *Lonicera kamtschatica* in 2003. As a result of statistical evaluation we observed significant differences

between years ($\alpha = 0.01$). A little higher values of magnesium were recorded in *Lonicera edulis* but differences cannot be considered as statistically significant.

The least significant representative of mineral matters was sodium, amount of which reached on average 81.67 mg/kg with standard deviation 10.5. The greatest increase in sodium values was observed in 2001; the highest value was noticed in the case of irrigated variant of *Lonicera edulis* (140 mg/kg). On the contrary, the lowest value of sodium 37 mg/kg was evident for the irrigated variant of *Lonicera kamtschatica* in 2003. As a result of the statistical evaluation we can claim statistically significant differences only in the case of year at the significance level $\alpha = 0.01$. It was also confirmed in our experiment that sodium and potassium are antagonistic.

Anthocyanins

Anthocyanins reached a higher concentration in pomace (12.28 g/kg) than in juice (4.34 g/l) during 2001–2003. The anthocyanins content was higher in *Lonicera edulis* (in pomace 9.25–17.7 g/kg, in juice 1.71–9.68 g/l) in comparison with *Lonicera kamtschatica* (in pomace 8.72–15.99 g/kg, in juice 0.61–6.32 g/l). We observed statistically significant differences between years ($\alpha = 0.01$) and species ($\alpha = 0.01$) only in the case of juice extract.

The results of our experiments showed that from the variants examined for the pigment production the most suitable variant was non-irrigated *Lonicera edulis*.

DISCUSSION

The results obtained in our study are generally in agreement with previous findings in Russia (PETROVA 1987; PLEKHANOVA 1998).

As for the mean values of all evaluated variants in 2001–2003, compared with PETROVA (1987), we can claim a higher accumulation of dry matter (14.42–20.27%), organic acids (3.52–5.25%), ascorbic acid (28.56–86.95 mg/100 g), anthocyanins in pomace (6.25–17.7 g/kg) and a comparable content of sugars (4.3–12.8%). These differences could be explained mainly by the introduction of into new climatic conditions, very different from the original conditions in the Kamtschatka peninsula and eastern Siberia. Edible honeysuckle can be planted on every soil type; it only requires humid conditions (KOLBASINA et al. 1984). Considering this fact, Nitra is an atypical locality for the edible honeysuckle planting because of rainfall deficiency. Another reason caus-

ing the differences in mean values might be the selection of evaluated cultivars of *Lonicera kamtschatica* and *Lonicera edulis*. While the results of PETROVA'S (1987) experiments include a wide range of *Lonicera kamtschatica* and *Lonicera edulis* cultivars coming from all parts of Russia, our experiments evaluated only cultivar Gerda 25 of *Lonicera kamtschatica* and 2-year-old seedlings of *Lonicera edulis* from the experimental area in Nitra.

As regards dry matter content we recorded statistically significant differences between species and years, which is in agreement with the experimental results of PLEKHANOVA (1990) and PETROVA (1987). A greater discrepancy between the results of PETROVA (1987) and the results of our experiments was in sugar content. We found only subtle differences between *Lonicera kamtschatica* and *Lonicera edulis* values that cannot be considered as statistically significant. Organic acids and ascorbic acid content in our experiments is higher in colder and wetter weather (Tables 1 and 2); a positive relationship between climatic condition and the content of organic acids and ascorbic acid is also evident in the studies carried out with edible honeysuckle in Russia (PLEKHANOVA, STRELTSYNA 1998; PLEKHANOVA 1990). As it is shown in Table 1, rainfall was regular except for extremes in March 2001 (a very humid month) and 2003 (an extremely dry month). Therefore we can assume that the natural soil moisture is sufficient and irrigation does not play a significant role in formation of nutritional value of fruit. This fact was confirmed for all evaluated nutrients.

The results of the experiment of PLEKHANOVA (1998), in which *Lonicera edulis* and *Lonicera kamtschatica* are hardly distinguishable in terms of dry matter, organic acids, sugars, ascorbic acid and polyphenolic compounds, were confirmed only partially in the case of sugars and ascorbic acid (procedure ANOVA). The content of anthocyanins in our experiments is comparable with the elderberry (cultivar Hasberg) and chokeberry (cultivar Nero) as previously determined by MÁRIASSYOVÁ et al. (1999).

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Štúdium vplyvu závlahy na nutričnú hodnotu plodov *Lonicera kamtschatica* – kultivar Gerda 25 a *Lonicera edulis* v podmienkach Nitry počas rokov 2001–2003

ABSTRAKT: Dva druhy jedlých zemolezov boli študované v pokuse založenom v roku 1994 so sponom 2,0 × 1,5 m. Experiment zahŕňal zavlažované a nezavlažované varianty. Cieľom štúdia je podať súhrn o nutričnej hodnote plodov *Lonicera kamtschatica* a *Lonicera edulis* v podmienkach Nitry v rokoch 2001–2003. Bobule boli študované z hľadiska obsahu sušiny, sacharidov, organických kyselín, vitamínu C a minerálnych látok – K, Ca, P, Mg, Na. Výsledky našich experimentov poukázali na vysoký obsah vitamínu C, pohybujúci sa od 28,56 do 86,96 mg/100 g, draslíka od 10 175 do 14 764 mg/kg a antokyanínov z výliskov od 6,245 do 17,36 g/kg. Hodnoty vitamínu C boli variabilné a boli štatisticky ovplyvnené ročníkom. Podobne iba ročník môžeme považovať za štatisticky významný činiteľ formujúci obsah sacharidov, horčička a sodíka. Obsah sušiny, organických kyselín, draslíka, vápnika a antokyanínov v štave bol ovplyvnený nielen ročníkom, ale aj druhom. Interakcia druh – ročník je zdrojom štatisticky významných rozdielov v prípade fosforu a organických kyselín. Štatisticky významný vplyv závlahy sa nepotvrdil z hľadiska všetkých hodnotených nutričných látok.

Kľúčové slová: nutričná hodnota plodov; *Lonicera kamtschatica* (Sevast.) Pojark.; *Lonicera edulis* Turcz. ex Freyn

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