Nectar production of quince *(Cydonia oblonga Mill.)* cultivars

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Summary: Nectar production of six quince cultivars were measured during three consecutive years. The nectar production of quince can be regarded to be small compared to other temperate zone fruit tree species since quince flowers contained 1.07 ± 0.06 mg of nectar in average. The extreme values, however, ranged between 0.1 and 7.3 mg/flower and this indicated that the nectar production was highly variable. The distribution of the nectar production was definitely skew because low values were definitely much more frequent than the highest ones. Our findings do not corroborate the earlier statements on the high sugar concentration of quince nectar. We found some 21–27% sugar in average, only. The normal distribution of the sugar concentration also indicates that the typical sugar concentration may be between 20–30%. Accordingly, the sugar concentration of quince nectar is rather low compared to other temperate zone fruit tree species (except pear). There was a significant negative correlation between the amount of nectar and its sugar concentration in quince flowers in all of the three years of the study ($r = -0.51$, $n=37$, $p<0.02$ in 1996, $r = -0.57$, $n=28$, $p<0.1$ in 1997, $r = -0.35$, $n=91$, $p<0.001$ in 1998). No definite difference was established between the nectar production of quince cultivars. Nevertheless, one cultivar tended to produce less and two other ones produced somewhat more nectar in average than the rest of the 6 cvs investigated but the extreme values of nectar production of cultivars overlapped in most cages.

Introduction

Very little information is available on the insect pollination of quince. Reviewing the available few publications *McGregor,* (1976) concluded that quince required the contribution of pollinating insects, first of all of honeybees, to set a good crop. No more information is available on this item since than (*Benedek,* 1996). On the other hand, the nectar production of quince was studied from the point of view of honey production (*Simidchiev,* 1967, *Péter,* 1972, 1975) and quince was regarded to be very attractive to honeybees on this basis. In fact, the amount of nectar detected by *Simidchiev* (1967) and *Péter* (1972) was not so much compared to other temperate zone fruit tree species but the sugar concentration of quince nectar seemed to be fairly high (c.f. *Benedek & Nyéki,* 1997).

High sugar concentration should attract nectar gatherer honeybees first of all but *Simidchiev* (1967) stated that most honeybees visiting quince flowers were mixed behaviour foragers collecting both pollen and nectar or pure pollen gatherers and not more than 11 per cent of them gathered deliberately for nectar only. This statement does not seem to be in a good accordance with the high attractiveness of quince nectar to honeybees. So it has been necessary to study the problem.

Material and method

Measurement were made at a 1 ha large quince plantation of 15–18 years old trees at the experimental farm of the Fruit Research Station Újfehértó (Eastern Hungary). The plantation was surrounded by other fruit tree plantations. Quince starts to bloom much later than other temperate-zone fruit tree species and so nothing else but some late sour cherries were in flowers at the neighbourhood (some 20 ha) when the quince was blooming. This is important to mention because 4 to 5 bee colonies were placed in the 1 ha large quince plantation and 30–40 colonies in the 20ha large sour cherry plantation at the vicinity so the area was clearly overpopulated with honeybees.

The quince plantation contains a number of cultivars, five of that were selected for observations (*Angersi, Bereczki, Bereczki bőtermő, Champion, Konstantinápolyi, Mezőtúri).* These are well know quince varieties grow first of all in Europe but also in other areas where quince is grown at all.

The nectar production of quince was studied in three consecutive years, in 1997, 1998 and 1999. The well know capillary tube method was used to sample the nectar production of the flowers. Branches facing to South and to North with some 30–50 flowers were covered with parchment paper bags on two trees per cultivar. Nectar production was measured on the next day in 5 flowers per branch late morning (10–12h) and early afternoon (13–15h). Samples taken were put into a deep freezer and were kept frozen until the laboratory measurements on their weight and on their sugar concentration. Sampling procedure was repeated at least at two but sometimes at as much as six days of the blooming. The amount of nectar (mg) was measured by a analytical balance and the sugar concentration (per cent) was inspected by a table refractometer in the laboratory.

Weather condition were registered during the blooming period of quince. The weather was favourable in all the three years and it favoured bee activity very much.

In 1997: The weather was fairly hot all along the blooming period of quince (*Table 1*). Except the first two day of flowering the daily mean temperatures were around 20 °C and the daily maximums raised up to 30–40 °C each day. There was very little, practically no rain.

Table 1 Weather conditions in the blooming period of quince trees in 1997 (Ujfehértó)

Date	Ambient temperature, °C		Rainfall
	mean	maximum	mm
May 8	15.4	23.3	7.8
May 9	12.5	19.4	0.2
May 10	15.4	22.1	0
May 11	19.7	33.0	0
May 12	21.7	33.2	0
May 13	23.6	36.1	0
May 14	24.1	37.5	0
May 15	24.7	38.3	0
May 16	24.8	39.1	0
May 17	23.2	40.3	0.8
May 18	23.8	36.3	0
May 19	22.8	32.0	0
May 20	23.6	33.6	0

Table 2 Weather conditions in the blooming period of quince trees in 1998 (Ujfehértó)

Date	Ambient temperature, °C		Rainfall
	mean	maximum	mm
April 28	16.5	27.8	0
April 29	17.9	29.1	0
April 30	17.2	25.2	0
May 1	14.7	21.2	20.0
May 2	12.1	18.8	14.2
May 3	15.1	23.9	0.6
May 4	12.8	14.8	29.4
May 5	9.6	14.0	4.2
May 6	13.7	21.5	0
May 7	8.3	9.3	0
May 8	19.1	31.1	0.2
May 9	20.6	34.6	0
May 10	21.6	34.4	0
May 11	23.0	34.4	0
May 12	22.6	35.6	0

In 1998: The weather was warm but not so hot as in the previous year (*Table 2*). Daily mean temperatures were around 10 or 20 °C and the daily maximums did not surpassed 30 °C except on three days just after the first half of the blooming period. There were three rainy days at the first quarter of blooming with fairly good amount of precipitation.

In 1999: The weather was warm too but both the daily mean and the daily maximum temperatures remained at a bit lower level than in the previous year (*Table 3*). There were few rainy days and no more than one day produced great amount of precipitation in the first quarter and one other day at the very end of blooming.

Table 3 Weather conditions in the blooming period of quince trees in 1999 (Ujfehértó)

Date	Ambient temperature, °C		Rainfall
	mean	maximum	mm
April 29	14.4	19.9	0
April 30	14.4	20.2	0
May 1	16.4	23.2	0
May 2	14.9	20.6	18.8
May 3	13.8	18.5	0
May 4	14.0	18.8	0.3
May 5	10.2	13.6	0
May 6	9.3	14.8	0
May 7	10.4	16.4	0
May 8	13.4	18.0	0
May 9	13.4	17.0	2.1
May 10	15.4	21.8	0
May 11	17.0	22.6	0.8
May 12	14.5	19.6	5.6

Results

The nectar production of flowers

1997: This year the weather was very hot during quince flowering but the extremely hot weather did not prevent the nectar production of quince. Nectar production was 0.8–0.9 mg/flower in average in all days of the survey (*Table 4*). The mean values of the nectar production, however, varied between 0.3–2.1 of different cultivars on different days. The extreme values of nectar production were between 0.2–2.7 mg/flower. The amplitudes of the extremes were somewhat wider (high values were 9–13 times greater than the low ones) for some cultivars (*Bereczki, Mezőtúri*) than for others varieties (at which high values were not more than 2–3 times higher than low figures).

Some 1/3 of the samples contained such a small amount of nectar that prevented the measurement of their sugar concentration. The sugar concentration of samples measured was at least as variable as the nectar content of the flowers (*Table 4*). Mean values varied between 20–30% and the sugar concentration tended to be somewhat higher on the first day of the survey than on the other two days but the difference was not statistically significant. Extreme values, on the other hand, did not differ so much as the same for the nectar production. Higher values were not more than 1.5–3 times higher than low ones.

Table 4 Nectar production of the flowers of quince cultivars in 1997 (Ujfehértó)

Cultivar	Date	Nectar content mean±standard error (extremes)		Sugar concentration mean±standard error (extremes)	
		n	mg/flower	n	per cent
Angersi	May 13	2	0.4 ± 0.1 (0.2 – 0.5)	1	36.5
	May 14	3	0.3 ± 0.1 (0.2 – 0.6)	1	18.5
Bereczki	May 13	7	0.7 ± 0.2 (0.2 – 1.9)	5	30.0 ± 3.2 (22.5 – 42.0)
	May 14	6	0.4 ± 0.1 (0.2 – 0.9)	4	27.9 ± 5.2 (15.0 – 38.5)
	May 15	4	1.1± 0.5 (0.2 – 2.7)	3	20.3 ± 5.3 (11.0 – 29.5)
Bereczki bőtermő	May 13	5	0.7 ± 0.2 (0.3 – 1.6)	4	31.0 ± 7.3 (15.5 – 47.5)
	May 14	3	0.7 ± 0.03 (0.6 – 0.7)	3	24.0 ± 3.2 (20.5 – 30.5)
	May 15	2	0.5 ± 0.05 (0.4 – 0.5)	1	20.5
Champion	May 13	4	1.5 ± 0.2 (1.1 – 1.9)	4	29.9 ± 3.2 (22.5 – 36.0)
	May 15	2	1.2± 0.9 (0.3 – 2.2)	1	20.5
Konstantinápolyi	May 13	6	1.1± 0.2 (0.3 – 2.4)	5	19.4 ± 3.0 (10.5 – 26.5)
	May 14	4	1.3± 0.5 (0.7 – 2.7)	4	21.8 ± 4.2 (10.5 – 30.5)
	May 15	1	0.2	–	–
Mezőtúri	May 14	1	2.1	1	10.5
Mean of The days	May 13	24	0.9 ± 0.2	19	27.7 ± 2.4
	May 14	17	0.9 ± 0.2	13	22.9 ± 1.8
	May 15	9	0.8 ± 0.2	5	20.4 ± 2.8

The nectar production was fairly similar on the three consecutive days of sampling (*Table 4*) but the sugar concentration of nectars was different. On the first day of sampling it was much higher than on the two other days and the figure of the third day was the smallest.

1998: Nectar production of the quince flowers was 0.3–0.8 mg/flower in average, less than in the previous year (*Table 5*). The mean nectar production varied between 0.1-1.3 mg/flower in the case of different cultivars on different days of the survey. The extreme values of individual measurements were between 0.1–2.4 mg/flower (*Table 5*) and so this amplitude was fairly similar to the same in the previous year. The amplitude of the extreme values was wider at some instances (e.g. *Bereczki bőtermő* on May 3, *Bereczki* on May 7) but the same was much more narrow for the same cultivars on the other days and for other cultivars on the same days. Accordingly, the nectar production of flowers was rather variable. Nevertheless, some cultivars tended to produce somewhat more nectar (*Champion, Bereczki bőtermő*) and others tended to produce less (*Bereczki, Angersi*) than the average of the cvs but the difference was not too large and the daily figures were greatly changeable for all cvs altogether.

We got much less data on the sugar concentration of nectars because a good number of the samples contained so small amount of nectar that was not enough to measure its sugar concentration. The samples measured for sugar concentration contained rather little amount of sugar since most of the figures were around 20–25% and not more than a few figures were round or up to 30–35% (*Table 5*). The available data show variable pictures on the sugar concentration. Some of the cultivars (*Bereczki bőtermő, Mezőtúri*) seems to have lower sugar concentrations than the other ones but, in fact, there are no consequent differences among them. The extreme values for sugar concentration do not show as wide amplitudes as the extremes of the nectar production of the flowers, higher figures are not more than 1.2–1.5 times higher than the low ones.

The mean nectar production of quince flowers was somewhat different on the consecutive days of sampling (*Table 5*). It was somewhat greater on the first and on the third sampling day but no relationship could be discovered between the weather (*Table 2*) and the daily nectar production of flowers (*Table 5*) since the weather was evenly warm and sunny during the whole blooming period. Even rains failed to have an impact on nectar production on the day of precipitation or on the following days. The mean sugar concentration was somewhat different on the days of sampling but it seemed to be dependent on the amount of nectar production instead on the weather conditions. Namely, the sugar concentration was definitely higher when the amount of nectar was low and the reverse was true for higher daily nectar productions.

1999: More nectar was measured in quince flowers than in the pervious two years. Mean values were between

Table 5 Nectar production of the flowers of quince cultivars in 1998 (Ujfehértó)

Cultivar	Date	Nectar content mean±standard error (extremes)		Sugar concentration mean±standard error (extremes)	
		n	mg/flower	n	per cent
Angersi	May 1	3	0.4 ± 0.2 (0.2 – 0.5)	–	–
	May 3	4	0.5 ± 0.2 (0.2 – 0.9)	1	27.5
	May 6	3	0.5 ± 0.3 (0.2 – 0.7)	–	–
	May 7	3	0.4 ± 0.1 (0.1 – 0.4)	–	27.5
	May 8	3	0.7 ± 0.4 (0.3 – 1.4)	1	–
Bereczki	May 3	4	0.6 ± 0.1 (0.4 – 0.9)	2	32.3 ± 2.3 (29.0 – 35.5)
	May 4	5	0.3 ± 0.1 (0.1 – 0.6)	–	–
	May 7	6	0.3 ± 0.2 (0.1 – 1.2)	1	20.5
	May 8	4	0.3 ± 0.1 (0.1 – 0.7)	1	35.0

Table 5 Nectar production of the flowers of quince cultivars in 1998 (Ujfehértó)

Table 5 continued

Cultivar	Date	Nectar content mean±standard error (extremes)		Sugar concentration mean±standard error (extremes)	
		n	mg/flower	n	per cent
Bereczki bőtermő	April 30	2	0.7 ± 0.3 (0.4 – 0.9)	1	23.0
	May 1	2	0.4 ± 0.4 (0.1 – 0.8)	1	25.0
	May 3	4	1.0 ± 0.5 (0.1 – 2.2)	3	21.7 ± 1.9 (18.5 – 25.0)
	May 6	5	0.4 ± 0.1 (0.2 – 0.5)	–	–
	May 7	4	0.4 ± 0.1 (0.1 – 0.7)	–	–
	May 8	4	0.3. ± 0.1 (0.1 – 0.8)	–	–
Champion	April 30	1	0.6	–	–
	May 1	4	0.7 ± 0.3 (0.2 – 1.3)	2	23.0 ± 2.1 (20.0 – 26.0)
	May 3	4	1.1 ± 0.3 1.2 (0.7 – 2.2)	3	25.2 ± 3.3 (20.5 – 31.5)
	May 6	6	0.3 ± 0.1 (0.1 – 0.9)	1	34.5
	May 7	3	03 ± 0.3 (0.1 – 0.9)	1	30.5
	May 8	1	0.28	–	–
Konstantinápolyi	May 1	2	0.1 ± 0.1 (0.1 – 0.3)	–	–
	May 3	4	1.1 ± 0.4 (0.1 – 1.7)	3	26.3 ± 1.9 (24.0 – 30.0)
	May 6	7	0.5 ± 0.1 (0.1 – 0.9)	1	26.0
	May 7	8	04. ± 0.1 (0.1 – 0.9)	1	38.5
	May 8	4	0.6 ± 0.1 (0.3 – 0.9)	1	28.5
Mezőtúri	April 30	7	0.7 ± 0.1 (0.4 – 2.4)	2	20.3 ± 0.9 (19.0 – 21.5)
	May 1	4	0.4 ± 0.2 (0.4 – 1.1)	1	22.5
	May 3	5	0.2 ± 0.1 (0.4 – 0.9)	1	20.0
	May 6	5	0.3 ± 0.1 (0.2 – 0.5)	–	–
	May 7	4	0.4 ± 0.1 (0.3 – 0.5)	–	–
Mean of The days	April 30	10	0.7 ± 0.2	3	21.2 ± 1.2
	May 1	15	0.4 ± 0.1	4	29.4 ± 3.2
	May 3	25	0.8 ± 0.1	13	25.9 ± 1.4
	May 4	5	0.3 ± 0.1	–	–
	May 6	26	0.4 ± 0.05	2	30.2 ±
	May 7	27	0.4 ± 0.1	3	29.8 ±
	May 8	16	0.4 ± 0.1	3	30.3

0.6–5.4 mg/flower that was much higher than in the two other years (*Table 6*).

No much difference could be found between cultivars. One cultivar (*Konstantinápolyi*) tended to produce definitely more nectar than others (except May 6) and another cvs (*Angersi*) tended to produce less (*Table 6*). Other cultivars

Table 6 Nectar production of the flowers of quince cultivars in 1999 (Ujfehértó)

Cultivar	Date	Nectar content mean±standard error (extremes)		Sugar concentration mean±standard error (extremes)	
		n	mg/flower	n	per cent
Angersi	May 1	4	0.7 ± 0.3 (0.3 – 1.4)	1	22.5
	May 2	8	1.1 ± 0.2 (0.3 – 2.5)	4	27.3 ± 3.0 (20.5 – 35.0)
	May 3	8	1.1 ± 0.1 (0.3 – 2.0)	4	25.9 ± 2.2 (21.5 – 32.0)
	May 4	5	0.9 ± 0.2 (0.4 – 1.8)	1	19.5
	May 5	1	0.9	–	–
Bereczki	May 1	2	4.6 ± 1.7 (2.9 – 6.4)	2	19.3 ± 0.2 (19.0 – 19.5)
	May 2	8	2.0 ± 0.6 (0.9 – 5.5)	6	24.7 ± 2.1 (17.5 – 33.0)
	May 3	8	3.0 ± 0.5 (0.4 – 2.7)	5	19.2 ± 3.1 (12.5 – 27.5)
	May 4	4	08. ± 0.2 (0.4 – 1.6)	1	27.5
Bereczki bőtermő	May 2	5	2.9 ± 1.3 (0.6 – 7.5)	2	23.5 ± 1.5 (22.0 – 25.0)
	May 3	8	2.4 ± 0.4 (0.6 – 4.7)	7	25.4 ± 4.3 (16.5 – 46.0)
	May 4	8	1.3 ± 0.7 (0.4 – 6.0)	2	20.0 ± 4.5 (15.5 – 24.5)
Champion	May 1	1	0.5	–	–
	May 2	8	2.4 ± 0.7 (0.4 – 3.7)	6	22.2 ± 1.6 (17.5 – 27.0)
	May 3	8	2.4 ± 0.4 (1.4 – 5.0)	8	22.2 ± 2.0 (12.0 – 29.0)
	May 4	8	2.6 ± 0.6 (0.4 – 5.6)	6	25.2 ± 1.6 (20.5 – 31.0)
	May 6	4	1.1 ± 0.3 (0.8 – 1.9)	2	21.8 ± 3.7 (18.0 – 25.5)
Konstantinápolyi	May 1	2	5.4 ± 0.1 (5.3 – 5.4)	2	15.3 ± 2.7 (12.5 – 18.0)
	May 2	8	4.3 ± 0.7 (1.3 – 6.7)	8	16.3 ± 1.4 (9.0 – 21.0)
	May 3	4	3.1 ± 1.2 (1.1 – 6.6)	4	25.4 ± 3.3 (19.5 – 32.5)
	May 4	8	3.3 ± 0.7 (1.2 – 6.5)	7	22.6 ± 1.8 (15.0 – 29.5)
	May 5	4	2.7 ± 0.3 (2.3 – 3.2)	4	16.3 ± 1.3 (12.5 – 18.0)
	May 6	6	0.9 ± 0.3 (0.3 – 1.8)	2	20.0 ± 0.5 (19.5 – 20.5)
Mezőtúri	May 2	7	1.2 ± 0.4 (0.5 – 2.9)	2	21.5 ± 2.0 (19.5 – 23.5)
	May 3	4	1.1 ± 0.4 (0.3 – 2.2)	1	27.0
	May 4	6	2.6 ± 0.7 (1.0 – 5.0)	4	28.3 ± 2.8 (21.5 – 34.5)
	May 5	5	0.5 ± 0.2 (0.2 – 1.1)	–	–
Mean of The days	May 1	9	2.6 ± 0.8	5	30.5 ± 1.6
	May 2	44	2.5 ± 0.3	28	21.8 ± 1.1
	May 3	40	1.9 ± 0.2	29	23.6 ± 1.4
	May 4	39	1.7 ± 0.3	17	23.6 ± 1.2
	May 5	6	0.7 ± 0.1	–	–
	May 6	10	1.1 ± 0.2	4	20.9 ± 1.6

(not counting *Konstantinápolyi*), on the other hand, produced more nectar than others on some days (e.g. *Bereczki* on May 1, 2, *Bereczki bőtermő* and *Champion* on May 3, *Champion* and *Mezőtúri* on May 4) but on the other days the same produced less amounts than others.

The extreme values were also higher than in the previous years, being between 0.2–7.5 mg/flower. Interestingly, some high extremes of some cultivars (*Bereczki bőtermő, Bereczki*) well approached or surpassed the highest figures for the cvs *Konstantinápolyi* that one produced the highest amount of nectar in average (*Table 6*). The higher extremes were 3–10 times greater than the low ones at most occasions, but the difference sometimes was as much as 12–15-fold between the low and the high extremes (*Bereczki bőtermő* on May 2, 4, *Champion* on May 4). On the other hand, the higher figures were not more than 0.1–5 times larger than the low ones sometimes even for those cultivars, too, the amplitudes of whose extremes were very wide at other cases (see *Champion* on May 3, 6, for example). This means that the differences found in some cases were not consequent at other instances.

Most samples could be well measured for sugar concentration for the highest amount of nectar in the flowers. In fact, the sugar concentration of quince nectar tended to contain less sugar (*Table 6*) than in the previous two years when the flowers produced less nectar in average. The cultivar, *Konstantinápolyi*, that tended to produce more nectar than others had lower sugar concentration in its nectar. Other cultivars, on the other hand, produced fairly similar mean sugar concentrations but the concentrations were different on consecutive days (*Table 6*). The higher concentrations sometimes were 1.5 times larger than the lower ones for individual cultivars. The amplitudes of the extreme values of individual measurements were somewhat wider (higher extremes were 2.3–2.8 times greater than the low ones) at some cases (*Bereczki bőtermő* on May 3, *Champion* on May 3, *Konstantinápolyi* on May 2) but the difference was not more than 1.1–1.5-fold at most cases (*Table 6*). This means that the sugar concentration of nectar was not so much changeable as the amount of nectar produced per flower.

The daily mean nectar production was somewhat different on the sampling days (*Table 6*). Somewhat more nectar was found in flowers in the first two sampling days and the mean amount decreased gradually on the following days. This tendency seemed to be proportional with the air temperature that gradually became lower on the consecutive sampling days (the daily mean being 14.9 °C on the first day of sampling and it went down gradually to 9.3 °C till the last day of sampling). There was a substantial rain on the second sampling day but no effect of that could be observed on the amount of nectar produced. The mean sugar concentration of nectar was also the highest at the first sampling day when the highest amount of nectar was measured in the flowers. The mean concentration was much lower on the other days but no definite tendency could be observed in that (*Table 6*).

The distribution of the nectar production and the sugar concentration of nectar

The amount of nectar in quince flowers failed to show a normal distribution in no one of the years of the experiment (*Figure 1*). The distribution was definitely skew, since the low values were definitely much more frequent than the high ones. The frequency of low and high values, however, greatly differed in different years of the study. In 1997 and 1998 when the mean nectar production was much lower than in 1999 the frequency of very low values was conspicuously much higher and the frequency of higher values was definitely much lower than in 1999 when the mean nectar production of flowers was definitely higher. In the latter year also more low values were detected than higher ones but the decrease of the number of samples from low to high nectar production was not so sharp, on the contrary, it was rather gradual. This was the result of higher frequency of high values in this year than in others. This year also the highest extremes were much better represented and much more scattered than in the two previous years mentioned. The major tendency, however, was the higher frequency of low values compared to higher ones in all the three years of the survey. This shows that variability of the amount of nectar seems to tend rather towards the small than towards the high values.

The distribution of the sugar concentrations in quince nectar produced a completely different picture. Namely, the distribution of the sugar concentration was definitely very close to normal in all the three years of the study (*Figure 2*).

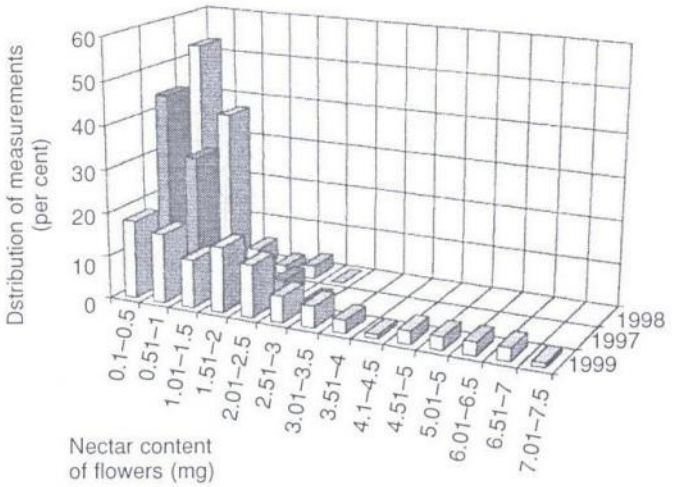

Figure 1 Distribution of nectar content of quince flowers (Ujfehérhó, 1997–1999)

Low sugar concentrations (values below 20%) were as rare as the high figures (higher than 30%). Most values of sugar concentration were between 20–30% showing that the typical sugar concentration of quince nectar can be somewhere among these values.

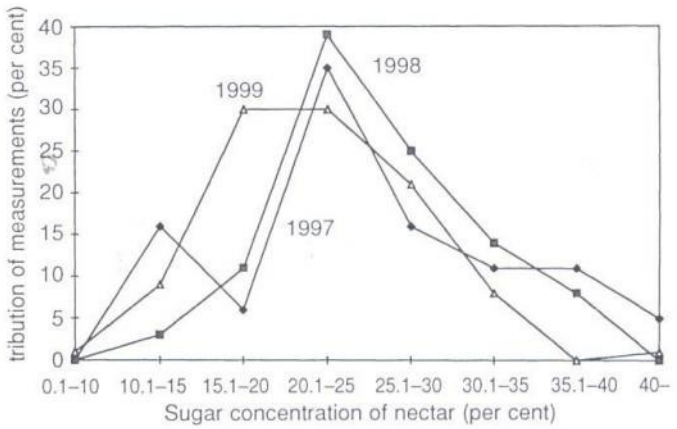

Figure 2 Distribution of the sugar concentration in quince nectar (Ujfehértó, 1997–1999)

Differences between cultivars

Nectar production and its sugar concentration was rather variable on different days of the survey in all the three years of the study (*Tables 4–6*). The comparison of the cultivars, however, shows that slight differences can be found between cvs. Namely, *Angersi* seems to produce less nectar than others because its values for the nectar production of flowers were usually lower than of the rest of the cultivars (*Table 7*). The mean value for the nectar production of this cultivar seems to be significantly different compared to the mean production of *Champion* and *Konstantinápolyi*. At the same time, no significant different could be established between *Angersi* and *Bereczki*, *Bereczki bőtermő* and *Mezőtúri* in their nectar production (*Table 7*). In fact *Konstantinápolyi* tended to produce more nectar but the higher mean values of its nectar production did not differ at all from the other cultivars from the statistical point of view. Also *Champion* produced somewhat more nectar than others (except *Konstantinápolyi*) but the difference was not significant, too. The highest extremes of nectar production were extremely variable (*Table 8*). Though the mean nectar production of *Konstantinápolyi* and *Champion* was higher than the same of another cultivars this tendency was not reflected in the highest extreme values for nectar production at all. The highest extremes of all cultivars were more ore less overlapped and the highest figures for some other cvs surpassed the same of the mentioned two cultivars with higher mean nectar production. There was a single cultivar, *Angersi*, the extreme nectar production of that was different of the others. Namely, the extreme figures of this were ranging at a lower level and the very highest figure of that was much smaller than the same of the others.

Relationship between the amount of nectar and its sugar concentration

In spite of the fact that the distribution of the amount of nectar and its sugar concentration is clearly different (*Figures 1–2*) definitely negative correlation was detected between the amount and the sugar concentration of nectar in quince flowers (*Table 9*). All those measurements were used to make this calculation of that both the values of the amount and the sugar concentration had been available. The coefficient of correlation was significant in all of the three years of the study, however, the level of significance was

Table 7 Comparison of the nectar production of flowers of quince cultivars in consecutive years (Ujfehértó 1997–1999)

Cultivar	Nectar production of flowers in three consecutive years: means ± standard errors (extremes)							
	1997		1998		1999		Mean	
	Nectar content: mg/flower	Sugar concentration: per cent	Nectar content: mg/flower	Sugar concentration: per cent	Nectar content: mg/flower	Sugar concentration: per cent	Nectar content: mg/flower	Sugar concentration: per cent
Angersi	0.34 ± 0.09 (0.2 – 0.6) n=5	27.5 ± 9.0 (18.5 – 36.5) n=2	0.43 ± 0.08 (0 – 1.4) n=16	20.25 ± 0.9 (19.5 – 32.0) n=2	0.93 ± 0.12 (0.3 – 2.5) n=28	25.44 ± 1.58 (19.5- 35.0) n=10	**0.73 ± 0.12** n=49	**26.27 ± 2.76** n=14
Bereczki	0.73 ± 0.16 (0.2 – 2.7) n=17	26.8 ± 2.89 (11.0 – 42.0) n=12	0.38 ± 0.1 (0 – 1.2) n=19	30.0 ± 3.5 (20.5 – 35.5) n=4	2.39 ± 0.38 (0.4 – 6.4) n=22	22.14 ± 1.58 (12.0 – 33.0) n=14	**1.26 ± 0.21** n=58	**25.08 ± 1.87** n=30
Bereczki bőtermő	0.63 ± 0.11 (0.3 – 1.6) n=10	27.06 ± 3.87 (15.5 – 47.5) n=8	0.57 ± 0.1 (0 – 2.2) n=21	22.6 ± 1.2 (18.5 – 25.0) n=5	2.19± 1.49 (0.4 – 7.5) n=21	24.05 ± 2.8 (14.0 – 46.0) n=11	**1.21 ± 0.19** n=52	**24.75 ± 1.82** n=24
Champion	1.43 ± 0.27 (0.3 – 2.2) n=6	28.0 ± 3.12 (20.5 – 36.0) n=5	0.6 ± 0.22 0.7 (0 – 2.2) n=19	26.64 ± 2.14 (20.0 – 34.5) n=7	2.21 ± 0.26 (0.4 – 5.6) n=29	22.9 ± 1.29 (12.0 – 31.0) n=23	**1.68 ± 0.13** n=54	**23.76 ± 1.61** n=35
Konstanti-nápolyi	1.11 ± 0.25 (0.3 – 2.7) n=11	20.44 ± 2.36 (10.5 – 30.5) n=9	0.55 ± 0.1 (0 – 1.7) n=25	28.67 ± 2.16 (24.0 – 38.5) n=6	3.12 ± 0.95 (0.3 – 6.7) n=32	19.48 ± 1.05 (9.0 – 32.5) n=27	**1.96 ± 0.32** n=68	**21.0 ± 1.31** n=42
Mezőtúri	2.1 n=1	10.5 n=1	0.5 ± 0.12 (0.2 – 2.4) n=25	20.75 ± 0.8 (19.0 – 22.5) n=4	1.43 ± 1.02 (0.2 – 5.0) n=22	26.15 ± 1.7 (19.5 – 34.5) n=7	**1.14 ± 0.13** n=48	**23.04 ± 1.05** n=12
Mean	**0.9 ± 0.2 n=50**	**25.1 ± 1.9 n=37**	**0.5 ± 0.1 n=123**	**26.1 ± 1.0 n=28**	**1.8 ± 0.1 n=158**	**22.5 ± 0.6 n=83**	–	–

Table 8 Highest extremes of nectar production in quince flowers 1997–1999 (Ujfehértó)

Cultivar	Year	Highest nectar content: mg/flower	Highest sugar concentration: per cent
Angersi	1997	0.6	36.5
	1998	1.4	27.5
	1999	2.5	32.0
Bereczki	1997	2.7	42.0
	1998	1.2	35.5
	1999	6.4	33.0
Bereczki bőtermő	1997	1.6	47.5
	1998	2.2	25.0
	1999	7.5	46.0
Champion	1997	2.2	36.0
	1998	2.2	31.5
	1999	5.6	31.0
Konstantinápolyi	1997	2.7	30.5
	1998	1.7	30.0
	1999	6.7	32.5
Mezőtúri	1997	2.1	10.5
	1998	2.4	21.5
	1999	5.0	34.5

different in consecutive years. It was the lowest for 1998 when the less pairs of data were available and the highest for 1998 when the number of pairs of data was the highest. The constant values (A) of equations show that the sugar concentration of quince nectar normally can not be very high (maximum 26.6–33.9%) but the slope values (B) are different for the years of the study (*Table 9*). It was extremely precipitous (–6.7, –6.8) in the years when the nectar production of the flowers was rather low and the same was close to 45° (–1.3) when the amount of nectar was greater in the flowers. This means that the sugar concentration always decreases with the increase of the nectar production of flowers in some years. This tendency can be extremely strong and so the decrease of the sugar concentration can be very sudden parallel with the increase of the nectar production in some years but the same can decrease much slower in other years.

Table 9 Relationship between the nectar production of quince flowers and its sugar concentration

Year	Coefficient of correlation	No. of data and probability	Equation
1997	–0.51	n=37 p<0.02	y= 32.5 – 6.8x
1998	–0.57	n=28 p<0.1	y= 33.9 – 6.7x
1999	–0.35	n=91 p<0.001	y= 26.6 – 1.3x

Discussion and conclusions

Nectar content of quince flowers have been estimated between 0.8–1.6 and 0.4–2 mg in the literature by those authors who made several measurements at different cultivars (*Simidchiev,* 1967, *Péter,* 1972, 1975). *Weryszko-Chmielewska at al.* (1997) stated that quince flowers produced 3.43 mg nectar during their life. This fairly corresponds with the statements cited because individual flowers are open for some three days. We found similar mean values, however, the amplitude of extremes was much wider in this survey (*Table 4–8*) than in the previous studies made by the authors cited. The highest extremes sometimes were as high as 5–7.5 mg/flower (*Table 8*). *Péter* (1972) stated that the weather affected the nectar production of quince flowers very much. No doubt that the weather is known to have a strong influence on the nectar production of fruit tree species but this seems to be less important of quince since it blooms much later than other fruit tree species and so the weather is not so extremely variable during its flowering period. Thus not so strong effect of weather was found during the three consecutive years of this study.

The grand mean of the nectar production of quince flowers was 1.07 ± 0.06 mg/flower in this study and the extremes were 0.1–7.5 mg/flower. The mean figure very well fits to the statement of *Péter* (1972) who has expressed that quince flowers can produce some 1.0 mg nectar/flower in average in May under favourable weather.

This mean that the nectar production of quince can be regarded to be small compared to other temperate zone fruit tree species because other species produce much more nectar (c.f. *Benedek & Nyéki,* 1994, 1997). Even the mean nectar production of peach and nectarine is two times more, however, its flowers produce somewhat less nectar than plum and apple and much less than apricot and sour cherry (*Benedek & Nyéki,* 1997).

Our findings, on the other hand, do not corroborate to the earlier statements on the high sugar concentrations of quince nectar. We found much less sugar, some 21–27 per cent in average only (*Tables 4–7*) instead of 40–50 or 25–60 % as stated earlier by *Simidchiev* (1967) and *Péter* (1972). *Weryszko-Chmielewska at al.* (1997) found much less sugar in quince nectar, since its concentration was 36.9 per cent in their study. We found that the sugar concentration of quince nectar is variable, since the amplitude of the extreme values were ranging between 9–47.5% (*Tables 4–6*) but we did not found as high value as 60% as *Péter* (1972). The normal distribution of the sugar concentration in quince nectar (*Figure 2*) also indicates that the typical concentration can be rather low, it may be between 20–30% instead of as high as stated earlier. Accordingly, the sugar concentration of quince nectar is rather low compared to other temperate zone fruit tree species (c.f. *Benedek & Nyéki,* 1997). It is not so low as of pear (that is usually less than 20%) but seems to be very similar to apricot and somewhat less than of peach and nectarine (30.5%) and much less than plum (33.1%) apple (36.2%) or sour cherry (43.0%). Since the sugar concentration of nectar seems to be the major attractive factor of fruit tree nectars to honeybees instead of its amount (*Benedek & Nyéki,* 1997) it is very important that quince blooms later than the other fruit tree species producing more attractive nectar to honeybees with higher sugar concentrations. This fact can promote very much

that quince is visited by honeybees *en masse* as stated by *Simidchiev* (1967).

The sugar concentration of quince nectar seems to be rather low related to its small amount. This fact corroborates our earlier statement that the amount of nectar and its sugar concentration is not proportional at the level when different fruit tree species are compared to each other because some fruit tree species produce little amount of nectar with low sugar concentration and others produce much larger amount with higher sugar concentration (*Benedek & Nyéki,* 1997).

On the other hand, the amount of nectar and its sugar concentration is know to be negatively correlated to each other at the level of some fruit tree species (see for example *Mommers*,1966 and *Benedek & Nyéki,* 1996 for apple). This relationship, however, has not been investigated for quince so for. Based on the measurements made in three consecutive years we found a definitely negative correlation between the amount of quince nectar and its sugar concentration. The coefficient of correlation was significant in all the three years of our studies. This means that the sugar concentration always decreases with the increasing amount of the nectar produced in quince flowers. The slope values of the equations, however, were different in consecutive years. It was extremely precipitous when the mean nectar production of flowers was rather low and the same was much less so when the amount of nectar was higher in the flowers. Accordingly, the decrease of the sugar concentration can be very sudden with the increasing amount of nectar in some years but the same can be much more gradual in other years. This can influence the attractiveness of quince nectar to honeybees because the sugar concentration is responsible for this in fruit tree nectars instead of its amount in the flowers (*Benedek & Nyéki,* 1997).

Nectar production of quince flowers was rather variable and so not more than some slight differences have been detected between cultivars. No more than a single one of the six cultivars investigated tended to produce less nectar than others (*Angersi*). This difference was significant when the nectar production of the cvs in question was related to some of the cultivars but no significant difference was detected at the same time when the relevant figures were related to other cultivars. There were two varieties (*Konstantinápolyi, Champion*) that tended to produce somewhat more nectar than others but the difference was not significant at all (except when related to the cvs with the lowest nectar production as mentioned above). Accordingly, no consequent difference can be established between the nectar production of flowers of quince cultivars but it is a major question whether slight differences are enough to influence the bee visitation and consequently the bee pollination of the quince flower. This question needs further research.

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