Inheritance of some pomological traits in Minaret × Betinka apricot progeny

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ABSTRACT: In the years 2005, 2006, and 2007 the described pomological characteristics were evaluated and both heritability and correlation coefficients of the determined characteristics of parents and progeny were estimated for the Minaret × Betinka apricot hybrid population. Estimated heritability of fruit weight, over colour and flesh consistency was approximately 0.9. Heritability of flesh colour, fruit attractiveness and fruit flavour ranged from 0.6 to 0.9. The correlations show a strong dependence of the following characteristics of parent varieties and progeny: over colour and fruit attractiveness. Medium strong dependence was determined in the following characteristics: fruit colour and fruit flavour. Weak dependence was found in the case of fruit size.

Keywords: *Prunus armeniaca* L.; inheritance of pomological traits; progeny

Nowadays, the commercial value of apricots depends mainly on fruit quality. As apricot fruits are mostly consumed fresh, it is necessary to enhance the fruit attractiveness, shade of over colour, flesh firmness and fruit size.

In apricot breeding, improving fruit quality is of utmost importance. Characteristics of fruit quality such as size, firmness, aroma, flavour and sugar content may be enhanced by means of backcrossing, as there is a large diversity of genetic resources for such traits. Nowadays, there are many models which may be relatively easily obtained through purposeful crossing of parent components.

Consumers are very concerned about colour of fruit for direct consumption. They require shining colours, yellow and orange genotypes with red cheeks (Callahan 1995; Moreau-Rio 2006). There is also a wide range of requirements as to the flavour and aroma of the flesh. The market refuses genotypes which do not achieve a standard quality.

Flavour is one of the most important fruit quality aspects. The consumer requires higher sugar content, more intense flavour and flesh firmness.

Requirements for fresh fruit concern mainly fruit size (more than 60 grams), content of sugar and dry matter (over 20% Rf), firm flesh, resistance against cracking, uniform ripening and free stone.

Contemporary European and American breeding programmes focus on the enhancement of fruit quality and resistance against biotic factors. The various pomological characteristics have different heritabilities; however, the majority of characteristics are inherited in compliance with Mendel's laws. In the case of 11 studied pomological and phenological characteristics, Couranjou (1995) estimated high heritability in 10 traits. Skin colour showed medium heritability. This means that the environment had a large impact on the external colour of the studied populations.

Paunović (1987) studied the inheritance of fruit characteristics in several apricot lines, showing that:

– fruit shape was a very stable, heritable character,
– fruit flavour appeared to be a variable character,
– flesh consistency was judged to be a well-inherited character,
– other characters, such as flesh colour, over colour and ease-of-picking, were found to be stable, heritable characteristics,
– fruit weight was judged to be a variable character.

The aim of this study was to evaluate the heritability of several characters of apricot fruits in the Minaret × Betinka progeny.

MATERIAL AND METHODS

This study was carried out on the trial grounds of the Fruit Department in the Faculty of Horticulture in Lednice of Mendel University of Agriculture and Forestry in Brno. Evaluations were conducted on level ground in the orchard adjoining the main road from Lednice to Valtice. Conditions here can be described as suitable for maize-growing, where the 80-year average annual rainfall (1901–1981) is 516.6 mm, and the average annual temperature is 9.1°C. Soil types vary from loess to "degraded chernozem", situated 170 m above sea level.

The hybrid material was produced within the breeding programme of the Fruit-growing Department. The hybrids which form the basis of this study were crossed in 1999. They were produced by crossing Minaret (female parent) and Betinka (male parent).

Minaret, denominated LE-1685, was registered in 2004. It resulted from the hybridization of Velkopavlovická × Stark Early Orange. It flowers later, two days after the Velkopavlovická variety (Krška 1996), is self-fertile with regular high yield, and ripens seven days after Velkopavlovická. Its fruit is of high quality with red-violet cheek, fruit mass being 55 g. It is suitable mainly for direct consumption and has a low susceptibility to pests (Krška et al. 2006).

Betinka, denominated LE-3276, is a result of crossing of Vestar × Stark Early Orange. It has a high level of resistance to *Plum Pox Virus*. It flowers one day before the Velkopavlovická variety and ripens three days after Velkopavlovická. Fruit size is 65 g. It is very attractive with a very tasty flavour and medium yield, and it is especially suitable for direct consumption (Krška et al. 2006). Mean values of parent varieties are shown in Table 1.

At the beginning of the experiment, the number of hybrids was 143. The planting started in 2001 using own-rooted 2-year old hybrid seedlings. The spacing of the individual hybrids was 1 m × 3 m. The trees were not pruned in order to speed up their life cycle.

Pomological evaluation

Most of the pomological characteristics were evaluated by 9-point scale. For these characteristics the following methodology (Vachůn et al. 1995) was used.

The evaluated characteristics were as follows: average fruit weight, fruit colour, external colour, fruit attractiveness, flesh consistency and fruit flavour.

Calculation of correlation coefficients

In order to determine the dependence of phenotypic manifestation of parents' and F_1 progeny values, correlation coefficients were calculated from three-year data from parents and offspring.

Calculation of heritability coefficient

Values are from 0 to 1, where $h^2 > 0.5$ is considered high; $h^2 = 0.2–0.5$ medium; and $h^2 < 0.2$ low heritability (Rod et al. 1982).

Expression of frequency of inherited traits

The frequency of expression was measured by calculating mean values of the parent trait in studied hybrids during the period of monitoring:

Very stable inherited trait	100–83%
Stable inherited trait	82–66%
Constantly heritable trait	65–50%
Averagely well-heritable trait	49–34%
Variable heritable trait	33–17%
Very variable trait	16–5%
Highly variable trait	4–0%

Table 1. Values of parent varieties

	Minaret	Betinka
Fruit weight	55 g	65 g
Over colour	8 (dark orange)	8 (dark orange)
Flesh colour	7 (orange)	8 (dark orange)
Fruit attractiveness	8 (high)	9 (very high)
Flesh consistency	7 (firm)	8 (firm or very firm)
Fruit flavour	7 (good)	8 (excellent)

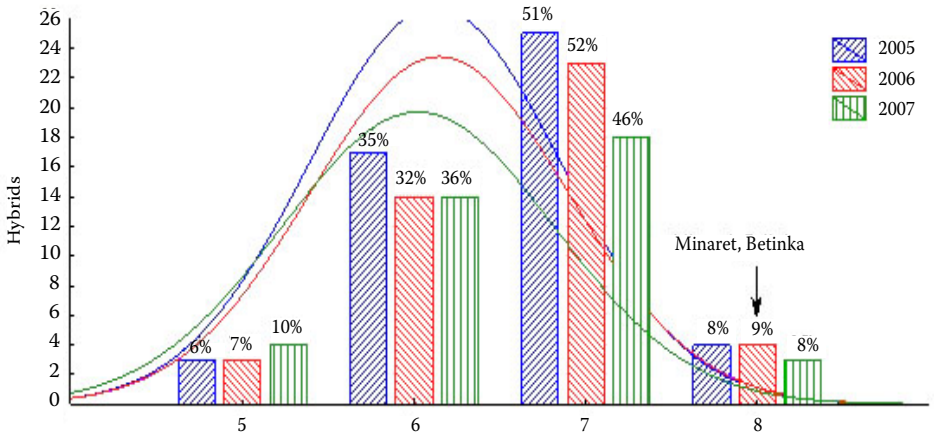

Fig. 1. A survey of heritability of the over colour

RESULTS AND DISCUSSION

Heritability of pomological characteristics

Fruit weight

The average fruit weight of the parent varieties was 65 g in Betinka and 55 g in Minaret.

In the years of monitoring, an average of 10.87% of studied hybrids corresponded to the parent varieties. Fruit weight is a variable characteristic. In every year of monitoring, more than 75% of hybrids in the population had very low average fruit weight.

Over colour

The fruit over colour of both parent varieties goes from dark orange to orange, with a corresponding value of 8 (Vachůn et al. 1995).

In none of the years, a more intense fruit over colour than that of the parent varieties was detected. None of the hybrids was awarded 9 for rich orange colour. Orange to rich orange colour is considered desirable, as it corresponds to an ideal type of apricot fruit. In the years of monitoring, an average of 7.8% of studied hybrids corresponded to the over colour of parent varieties. In spite of the fact that the parental combination was not chosen to increase variability of this characteristic, transgressive segregation was apparent in the progeny. Fruit over colour proved to be a variable characteristic in the population studied (Fig. 1).

Flesh colour

The flesh colour of parent varieties goes from very intense to intense. The Minaret variety influenced the intensity of the strong flesh colour in the progeny. In the years of monitoring, an average of 27% of studied hybrids corresponded to the parent varieties. Flesh colour is a variably inherited characteristic (Fig. 2).

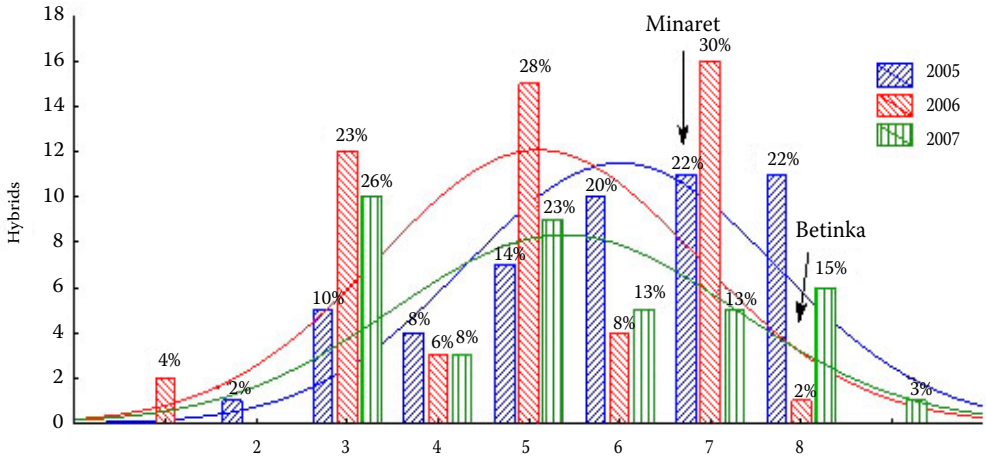

Fig. 2. A survey of heritability of the fresh colour

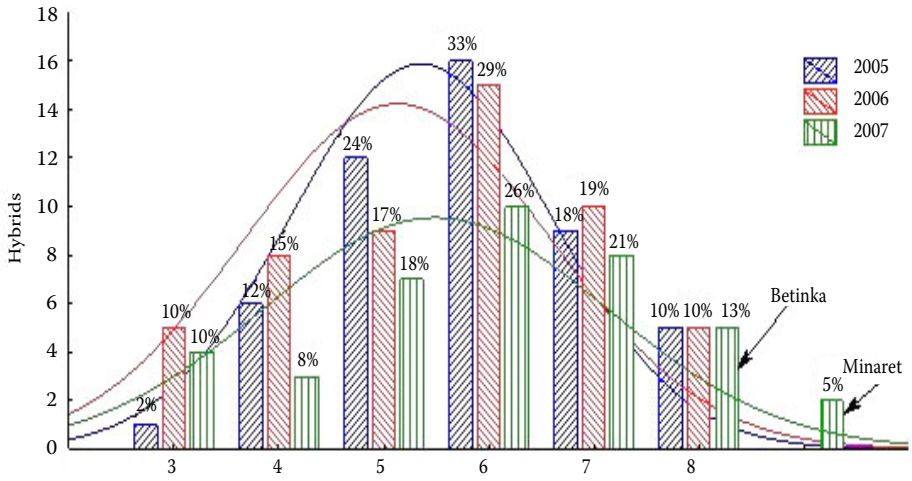

Fig. 3. A survey of heritability of the fruit attractiveness

Fruit attractiveness

Betinka as parent achieved the highest level of fruit attractiveness.

During the three years of monitoring, the fruit attractiveness of majority of hybrids was evaluated with the number 6. In the years of monitoring, an average of 13% of studied hybrids corresponded to the parent varieties. Both parent varieties used can be considered highly attractive. Such a characteristic proved to be variable (Fig. 3).

Fruit flavour

The flavour of Betinka variety ranged from good to excellent, Minaret's flavour was characterized as good.

In the three years, the flavour of the other hybrids ranged from good to acceptable. In the years of monitoring, an average of 30% of studied hybrids corresponded to the parent varieties. Heritability of the fruit flavour thus proved to be variable. Majority of offspring reached 5 points. It is probably due to a common ancestor (cultivar Stark Early Orange with medium taste) in both parents (Fig. 4).

Flesh firmness

The flesh firmness of Betinka variety goes from very firm to firm, Minaret's flesh firmness is characterized as firm.

In each year of monitoring, there was a high number of hybrids with medium flesh firmness. Flesh firmness ranging from very firm to firm is considered to fulfil the breeding aims. In the years of monitoring, an average of 37% of the studied hybrids corresponded to the parent varieties. Heritability of the flesh firmness proved to be an averagely well-heritable trait (Fig. 5).

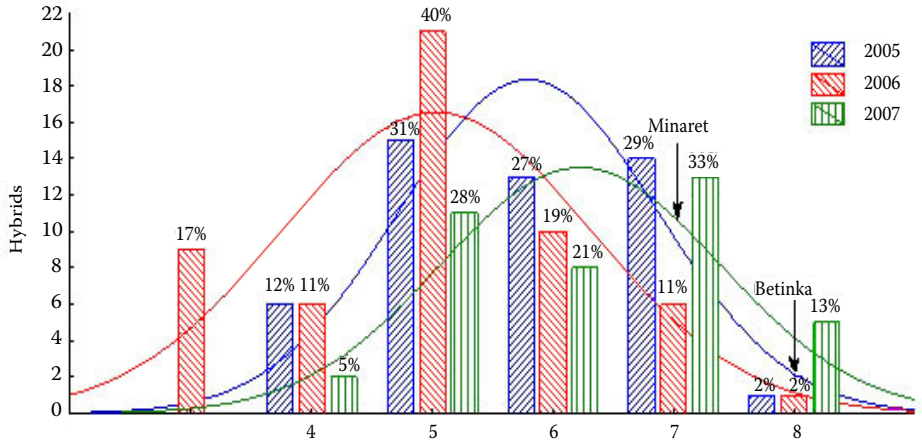

Fig. 4. A survey of heritability of the fruit flavour

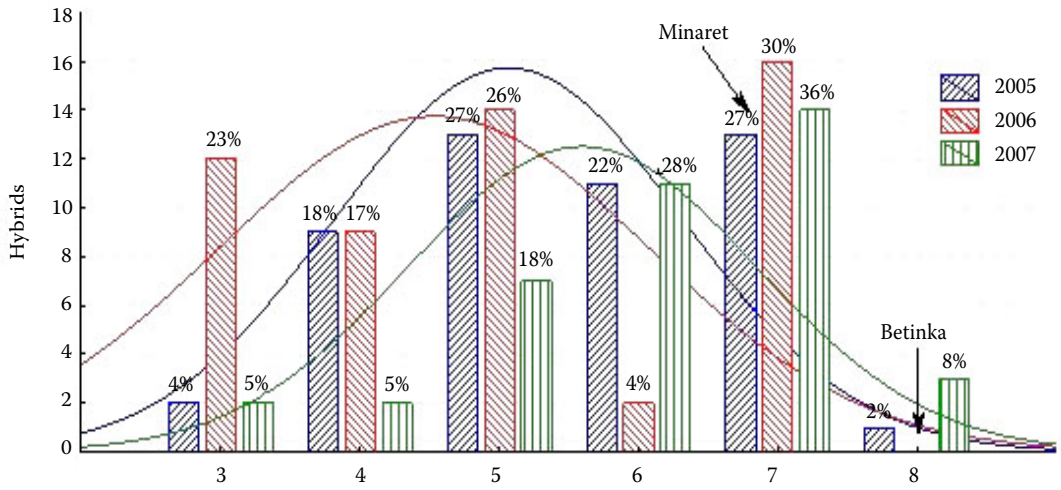

Fig. 5. Heritability of the flesh firmness

Significance of the environmental impact on final variability

The influence of environment on the total variability was analyzed by the *F*-test. Following studied characteristics: fruit shape, over colour, fruit colour, fruit attractiveness, flesh firmness, free stone and fruit flavour, were not influenced significantly ($P < 0.05$) by the environment. The veracity of such a statement is not probable in practice; the environment influences also pomological traits (Table 2).

Correlation analysis

Such values are applied for the assessment of interdependence of the traits monitored in parents and their progeny.

Strong dependence was determined in the following traits: flesh colour, fruit attractiveness. Medium strong dependence was determined in fruit over colour and fruit flavour. Weak dependence was identified in the case of flesh firmness (Table 3).

Heritability of monitored traits

High heritability was assessed for fruit weight, fruit colour, over colour, fruit attractiveness, flesh firmness and fruit flavour.

The above-mentioned results show that the genotype had a large influence in the case of the monitored traits (Table 4).

Better knowledge of heritability and inheritance of the individual traits and characteristics would make the selection of parental combinations easier, which would simplify and accelerate the total breeding process.

Heritability of the individual traits was expressed by means of a proportion of the genetic variability component and total variability. In the described population of Minaret × Betinka, the heritability coefficients ranged from 0.640 to 0.959; with high heritability estimated in all traits monitored. Couranjou (1995), who estimated the heritability between 6 parent varieties and their progeny, found high heritability for 11 traits monitored, and medium heritability for the over colour. When high heritability is demonstrated, strong influence of

Table 2. Results of the variation analysis; importance of the environmental impact on the total variability of the set of traits at the 0.05 level of importance

Trait	*F* value	*P*	Statistical difference
Over colour	0	0.906	non-significant
Flesh colour	1	0.260	non-significant
Fruit attractiveness	1	0.304	non-significant
Flesh firmness	1	0.295	non-significant
Fruit flavour	1	0.284	non-significant

Table 3. Correlation dependence between the mean values of parents and their F_1 progeny

Trait	Correlation coefficients	Significance	Dependence
Fruit weight	0.25	n.s.	weak
Over colour	0.42	n.s.	medium strong
Flesh colour	0.75	*	strong
Fruit attractiveness	0.62	n.s.	strong
Flesh firmness	0.33	n.s.	weak
Fruit flavour	-0.53	n.s.	medium strong

n.s. – non-significant; *siginificant

Table 4. Heritability of traits monitored in apricot progeny

Character	Variance		Variability		Heritability coefficient
	Minaret	Betinka	phenotypic	genetic	
Fruit size	12.25	17.60	189.43	174.47	0.92
Over colour	0.25	0.20	0.62	0.40	0.64
Flesh colour	0.30	0.25	3.50	3.22	0.92
Fruit attractiveness	0.33	0.92	2.66	2.03	0.76
Flesh firmness	0.00	0.20	1.55	1.45	0.96
Fruit flavour	0.30	0.30	1.32	1.02	0.77

genotype on the trait manifestation is considered; phenotype gives a good idea of the genotype.

Correlations showed a strong dependence between the parent varieties and progeny in the case of the following traits: over colour and fruit attractiveness. Medium strong dependence was shown in the case of following traits: fruit colour and fruit flavour. The dependence of fruit weight and flesh firmness was weak. Strong correlation between parents and progeny was also confirmed for fruit attractiveness in the study of 13 populations of apricots (Krška 1996); medium strong dependence was found in the case of fruit flavour (r = 0.891), not just in populations in which Hungarian Best – Velkopavlovická variety was one of the parents.

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Dědičnost některých znaků v populaci meruněk Minaret × Betinka

ABSTRAKT: V hybridní populaci Minaret × Betinka byly v letech 2005–2007 hodnoceny popisované pomologické znaky, koeficient heritability a korelace daných znaků mezi rodiči a potomky. Dědičnost jednotlivých sledovaných vlastností byla vyjádřená pomocí koeficientu heritability a četnosti zděděných vlastností k rodičovským odrůdám. Odhadnutá heritabilita pro hmotnost plodu, krycí barvu a konzistenci dužiny byla okolo 0,9. Pro barvu plodu, atraktivnost, chuť plodu, byla heritabilita mezi 0,6–0,9. Z korelací vyplynula silná závislost mezi rodičovskými odrůdami a potomky u znaků: krycí barva a atraktivnost. Středně silná závislost se projevila u znaků: barva plodů a chuť plodů. Slabou závislost měla velikost plodů.

Klíčová slova: *Prunus armeniaca* L.; dědičnost pomologických znaků; potomstvo

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