

OLD LOCAL APPLE GENOTYPES THREATENED WITH EXTINCTION

Boryana STEFANOVA, Petko MINKOV, Georgi POPSKI

Agricultural Academy, Institute of Mountain Stockbreeding and Agriculture Troyan, 281 Vasil
Levski str., 5600, Troyan, Bulgaria

Corresponding author email: stefanova_b@abv.bg

Abstract

During research expeditions in the Central Balkan Mountain region, trees of late-ripening (mid-October), rare local cultivars, and forms of apples with valuable pomological and biological qualities were marked. In 2021, all marked forms bore abundant fruit. The highest yield (280 kg per tree) was registered in 'Meka Shekerka' cultivar (MS F1). The fruit weight was on average 59.50 g, obloid form, low percentage of dry matter (12%), a high percentage of total sugars (18%), and the highest glucoacidimetric coefficient. BFI was distinguished by yields of 140-150 kg per tree, very good taste of the fruit (lowest acid content 0.27%), attractive appearance (green-yellow with a blush on the sunlit side), white fruit flesh, pleasant taste with a pronounced aroma of green apple, abundant waxy coating, with a mass of 86.17g and globose fruit shape. Our scientific data are compared with the information obtained from the local population on age, origin, fruitfulness, use, and distribution in the region.

Key words: apple, local cultivars and forms, fruit weight, fruit skin colour, chemical composition.

INTRODUCTION

The traditional cultivars of fruit species are the wealth and natural heritage of each country. They are important for economic and biological reasons, especially recently due to the growing interest of consumers in the consumption of fruits produced without the use of chemicals. Many rare and locally distributed cultivars have become extinct and are difficult to find today. Old traditional cultivars (autochthonous and cultural) are almost neglected and represent an important part of Bulgarian natural and cultural heritage. Regardless of that most orchards of old cultivars are neglected. Efforts have recently been made to restore and protect them, as their fruit market is slowly emerging. Traditional cultivars are more resistant to plant diseases, pests, and other forms of abiotic stress.

Long-term research in the region of the Central Balkans has been carried out to establish the type of this region's fruit species and local cultivars and forms and to propose a program for their preservation and renewal. Our previous expeditions in the area of the village of Stanchov Khan and the surrounding villages were described by Dragoyski et al. (2012). Because of the closed nature of municipalities and neighborhoods in the past, the same forms

and primitive local cultivars of apples have been exchanged and propagated among the locals. The gardens are managed only around the few inhabited houses, with trees over 60-70 years old predominating.

These farms have a rich gene pool of unique, endangered cultivars that need to be preserved. Due to their increased resistance to diseases, they can be included in organic fruit orchards, as their production can be successfully used for the preparation of traditional healthy foods such as dried fruits, pestil, marmalades, and fruit brandies typical of the Balkan region. Single trees from the old local apple cultivars, such as 'Kantarka', 'Yovovka', 'Vlashka', and 'Skrinyanka' were found. Old local cultivars of pears 'Summer Pear', 'Vodnik', and others were found in the observed villages.

Many of the collected cultivars can be donors in the selection for disease resistance, high acidity, pectin, and biologically active substances. Their fruits are suitable for fresh consumption and the preparation of traditional healthy foods. Such production could be very attractive for tourists and would help the development of this business in the area. Nesheva et al. (2019) also surveyed this area of the Central Balkan National Park. The total area was approximately 530 ha, at more than 750 m above sea level. During the

investigation, wild apple species *Malus sylvestris* Mill., *M. dasycphylla* Borkh., *M. praecox* (Pall.) Borkh. and wild pear species *Pyrus pyraeaster* Burgsd., *P. amygdaliformis* Vill., *Pyrus nivalis* Jacq. and *Pyrus elaeagrifolia* have been identified.

Due to the preservation of the assortment, the morphological and pomological characteristics of the fruits of the most common traditional apple cultivars from the region of Bjelovar-Bilogora County were studied by Vujević (2016). Based on the study of pomological characteristics were determined cultivars, such as 'Jonatan', 'Kanada', 'Šampanjka', 'Zlatna zimna parmenka', and 'Božićnica'. These cultivars can be recommended for propagation and renewal of the production range in the study area, due to the variety of pomological characteristics, fruit quality, and resistance to adverse abiotic and biotic factors.

A significant part of the diversity in the area of the forest park of Starčevica, Banja Luka, was studied by Antić et al. (2021). Analysis of the site and related tree species in the community was performed based on representative samples belonging to the wild relatives of the cultivated species, wild cherry (*Prunus avium*), wild apple (*Malus sylvestris*), wild pear (*Pyrus communis*). For each fruit species, abundance and degree of presence were determined, and a map was created based on GPS coordinates collected from the field. A total of 1059 trees at 37 landfills were inventoried, of which 39 were wild apple trees, 27 wild pears, and 118 wild cherries. Other trees of other forest species are mostly hornbeam (*Carpinus betulus*), beech (*Fagus sylvatica*), and oak (*Quercus petraea*). The presence of wild fruit trees in the Starčevica forest park was noted at an average value of 2 by the Braun-Blanquet method and the abundance of 10-25% of fruit trees in the study area compared to the presence of other forest species.

Extensive research were done by Ghosh et al. (2012) given the high genetic diversity in the genus *Malus*. The age of the plants varied between 13 and 70 years, and the yield potential varied from 650 to 1,085 kg/tree. The fruit weight varied between 130 and 225 g, the dry matter content (Brix) varied between 15.0 and 18.4°, the acidity 1.7 to 4.6%, and the total sugar content varied between 5.1 and 14.3%.

For the region of Apriltsi, Marishnitsa, near the town of Troyan, Vitkov (2015) marked, described, and studied 38 apple cultivars and forms and their reproductive characteristics. The fruits of most of them have an attractive appearance, rich skin color, juicy and tasty fruit flesh, a rich chemical composition, valuable nutritional and dietary qualities, and good storage in ordinary home conditions.

With the extinction of old cultivars of trees, Bulgarian natural and cultural heritage, genetic diversity is lost, and those cultivars that have adapted to local agroecological conditions over the years might be at the heart of organic fruit growing (Janjić, 2016).

The fruits of the traditional old apple cultivars from the Topusko region were studied by Babojelić et al. (2014). They differ significantly in quality and physico-chemical characteristics. Given the many benefits of growing traditional cultivars, it is important to preserve them, because the extinction of old trees of certain cultivars and the loss of a significant source of genetic resources, impoverishes the assortment of apples on the market.

The present work aims to study the pomological characteristics of old local cultivars and forms of endangered apples.

MATERIALS AND METHODS

During the research period, research expeditions were conducted in the Central Balkan Mountains region (Stoynovska neighborhood) and trees of late-ripening (mid-October), rare local cultivars and forms of apples with valuable pomological, and biological qualities were marked.

The marked trees were in abandoned orchards, in depopulated villages and neighborhoods and were not maintained and applied agricultural techniques, so they were introduced into alternative fruiting. They were over 100 years old, with damaged trunks, and falling bark, but still show high yields (good reproductive performance in a full fruit-bearing year), which does not significantly interfere with the size of the fruit.

To be protected from wild animals and unfavorable climatic conditions, the trees were grafted by cuttings over 1.5 m high from the soil surface, the diameter of the trunk is over 2

meters, the crowns are free-growing, erect, tall (12-15 m and more), globular in some and pyramidal (Figure 1).

Individual single trees of these shapes were found in different neighborhoods in the region of Troyan. The most important thing was to preserve and reproduce them because they are a valuable genetic resource.



Figure 1. Old apple tree

A visual assessment of the attitude of the observed cultivars and forms to the economically significant diseases, such as scab and powdery mildew on leaves and fruits was performed. Slight susceptibility based on single spots or no spots of scab on the leaves and fruits was reported, and no symptoms of powdery mildew were found.

Monitored indicators

Vegetative - diameter of the trunk (m); size and shape of the crown (m);

Reproductive - yield (kg/tree), fruit weight (g), fruit size, and stalk (mm);

Chemical composition of the fruit at the ripening stage:

- Dry matter in refractometrically (%)
- Sugars (%) (total, invert and sucrose) - according to Schoorl and Regenbogen method, (Donchev et al., 2000)
- Organic acids (malic, citric) (%) -by titration with 0.1N NaOH (Donchev et al., 2000)
- vitamin C (mg/%) to Tilman method (Donchev et al., 2000)
- Pectin (%) extraction of pectin substances to calcium pectate (Melitz)

Chemical composition of the fruit after a month after fruit harvesting:

- Total Soluble Solids (%)
- physical - density (firmness) of fruit flesh (kgf/cm^2) - determined with a digital penetrometer FHT-15 (3.5 mm), by measuring on both sides of 25 randomly selected fruits. Fruit skin of measured fruit was removed.
- pomological characteristics - taste, aroma, color (SC-30, Colorimeter for color difference)

RESULTS AND DISCUSSIONS

Vegetative indicators

The crowns of all the described shapes were free-growing. Forms SF 1 was with the slightest growth, whose trunk circumference had 64 cm, a spherical crown with an average diameter of 5 m and a height of 5.5 m, and SF 2, which had a larger trunk circumference and wider and a high spherical crown. MS F1 had a trunk circumference of over 2 m, over 10 m of tree height, the crown was upright, free-growing with an average diameter of 6-6.5 m. MSF2, KS, BF1, and BF2 also had the largest sizes.

The skeletal branches of BF forms (1, 2, 3) were firmly connected to the guide, and the angle of deviation from the stem is 45° . In other forms of 'Shekerka', the overgrown wood was more upright (with a sharper angle to the stem).

Reproductive indicators

Form BF 1 was characterized by a fruit weight of 86.17 (g) and a globose fruit shape (UPOV 2005), followed by SF 1 and SF 2 with a fruit weight of 83.17 and 81.67 (g, respectively). The exception was 'Newtown Pippin' with 101 (g) (Table 1). BF 1 also had the largest fruit height (53.37 mm) and diameter sizes (60.34-63.89 mm), followed by BF 2 (height - 51.13 mm; diameters 58-60 mm).



Figure 2. Apple fruit Momina Cheska

The average diameter of the fruit was the largest in the 'Newtown Pippin' (61.55-64.68 mm). The smallest were the fruits of 'Momina cheska' (average diameter 50.85 mm), with a yield of 130 kg of wood.

The fruits ripened a little earlier than other cultivars, fall off, but remained for a long time without damage and rot. They were suitable for processing (Figure 2).

Table 1. Biometric indicators of fruit

	Yield (kg/tree)	Fruit weight (g)	Height (mm)	Average Diameter (mm)	Fruit stalk length (mm)
BF 1	140	86.17	53.37	62,12	13.11
BF 2	165	78.13	51.13	59,50	11.26
BF 3	150	70.67	49.51	57,00	9.89
MS F1	280	59.50	46.54	53,60	11.28
MS F2	260	56.17	44.71	52,21	11.62
KS	200	62.00	46.79	53,06	14.12
'Zimna koravka'	210	76.33	44.84	58,62	9.57
'Newtown Pippin'	120	101.00	50.53	61,10	14.93
SF 1	85	83.17	49.06	58,74	16.71
SF 2	65	81.67	47.79	59,22	12.38
'Karastoyanka'	110	65.67	42.48	55,78	6.47
'Momina cheska'	130	52.67	42.89	50,82	10.75
<i>LSD 0,05</i>		11.12	3.27	2.31	2.87
<i>St Dev</i>		19.16	4.14	3.99	3.44

Chemical composition at the time of fruit ripening included the content of dry matter (%), total sugars and acids (%), and pectin (%) (Table 2). The highest percentage of dry matter was in the variety "Zimna koravka" at 18%, while the forms of 'Korava Shekerka' and SF 1 had 17%.

Forms BF 1, 2, 3 had a very low dry matter content of 11.5-12.5%, but their pectin content was 1.0-1.17%, the highest for the group.

Regarding the total sugars 'Karastoyanka' and 'MS F1' contained 18.05% each, followed by

'Korava Shekerka' with 15% and 'SF1' with 14.5%. 'MS F1' was characterized by the highest content of sucrose (5.32%), and there were cultivars and forms without sucrose, which was an extremely important indicator determining the consumption of these fruits by people with high blood sugar.

These were 'BF 3', 'Newtown Pippin' and 'Momina cheska'. The lowest pectin content was registered in 'Momina cheska' and 'SF 2' (0.22-0.26%).

Table 2. Chemical composition of fresh fruit (2021)

	Dry matter (%)	Total sugars (%)	Inverted sugars (%)	Sucrose (%)	Acids (%)	vit. C (mg%)	Pectin (%)
BF1	12.00	10.05	6.65	3.23	0.27	17.60	1.17
BF 2	12.50	13.45	10.90	2.42	0.40	17.60	0.63
BF 3	11.50	11.75	11.75		0.34	14.08	1.00
MS F1	12.00	18.05	12.45	5.32	0.27	17.60	0.61
MS F2	11.50	14.30	11.75	2.42	0.47	14.08	0.57
'Korava Shekerka'	17.00	15.15	12.60	2.42	0.34	17.60	0.72
'Zimna Koravka'	18.00	13.45	12.45	0.50	0.27	12.32	0.47
'Newtown Pippin'	14.00	13.45	13.45		0.40	17.60	0.73
SF 1	17.00	14.50	13.45	1.00	0.40	14.08	0.41
SF 2	16.00	13.45	10.90	2.42	0.20	15.84	0.26
'Karastoyanka'	15.50	18.05	13.45	4.37	0.34	12.32	0.39
'Momina cheska'	15.50	13.45	13.45		0.34	15.84	0.22
<i>St Dev</i>	2.40	2.27	1.91	1.50	0.07	2.10	0.28

After one month of fruit storage, the value of soluble solids increased by 1 to 4%, as form BF1 from 11.50% (Table 2), reached 15.20%

(Table 3). In 'Zimna koravka', the value of soluble solids during the harvest period was 18%, and a month later 21.8%. Most likely, this

was the reason for the long period of storage of this form (May-June next year). The forms with green-coloured skin, covered with abundant wax, thin and strong, such as BF 1, 2, 3, had white fruit flesh, juicy, and slightly sour, pronounced apple flavor and were suitable for consumption in the ripening stage. The density of the fruit flesh was on average 8.5 kgf/cm². MS F1, 2 were similar in description, but without a pronounced aroma, they were significantly sweeter and preferred by certain consumers. These forms could also be preserved (Table 3). The presence of abundant wax deposits increased storage time in ditches covered with ferns.

Cultivars and forms with red skin color and green fruit flesh were suitable for processing and consumption after storage and resistant to long-term storage. Form SF1 was on an intermediate position in the present study, whose fruits were suitable for consumption at the ripening stage and then subject to long-term storage. The density of the fruit flesh was 8 kgf/cm². The density of the fruit flesh of all the described forms was from 7.02 to 13.06 (kgf/cm²) (Table 3). 'Zimna Koravka' had the densest fruit flesh (13.06 kgf/cm²), followed by SF2 with 12.45 kgf/cm², and 'Karastoyanka' with 11.27 kgf/cm² (Table 3).

Table 3. Pomological and physical characteristics of the fruit

	Fruit skin	Fruit flesh	Fruit flesh density (kgf/cm ²)	Soluble Solids (%)
BF 1	Green, red on the sunlit side, with white dots. Oily, covered with abundant wax, thin, strong	White, soft, juicy, slightly sour, with a pronounced apple aroma	8.24	15.00
BF 2	White-green, with blush on the sunlit side, covered with abundant wax, thin	White, juicy, sour with aroma	8.76	13.20
BF 3	Light green, on red clouds on the sunlit side, with abundant waxy coating, tender, thin	White, soft, juicy, not coarse, sour, with a pronounced aroma	10.90	15.20
MS F1	Main colour - yellow-green, covered almost entirely with discontinuous and continuous red stripes, thin, tough	White, soft but not floury, slightly dry, sweet, odourless	7.62	13.80
MS F2	Green with blush on the sunlit side, with darker red stripes, thin, strong	White, soft, juicy, sweet, tender, odourless	7.40	12.80
'Korava Shekerka'	Green, covered with red discontinuous and continuous stripes, thick but not coarse	Green, soft, dry, sweet	7.90	17.00
'Zimna koravka'	Green, with blush, thick, firm	Green, slightly coarse, without stony cells, juicy, sweet, odourless	13.06	21.80
SF 1	Dark red, slim but tough	White to creamy, grainy, tender, juicy, slightly sour, slight aroma	8.00	19.80
SF 2	Green, with broken red stripes on the sunlit side, firm but not thick	Green, slightly coarse, juicy, sour, with aroma	12.45	18.60
'Karastoyanka'	Reddish in stripes, firm, tough	Greenish, juicy, firm, slightly sour with aroma	11.27	18.80
'Newtown Pippin'	Dark green with rust, thick, firm	Green, firm, to slightly coarse, fibrous, highly sour with aroma	9.27	18.00
'Momina cheska'	Dark red, firm, tough	White, soft, dry, without a pronounced aroma	7.02	15.00
<i>St Dev</i>			2.07	2.85

CONCLUSIONS

In 2021, all marked forms bore abundant fruit. BF1 was distinguished by yields of 140-150 kg per tree, very good taste of the fruit, attractive appearance (green-yellow with a blush on the

sunlit side), white fruit flesh, pleasant taste with a pronounced aroma of green apple, abundant waxy deposit, with a weight of 86.17 (g) and a globose fruit shape.

'Meka Shekerka' (MS F1) had the highest yield (280 kg per tree). The average fruit weight was

59.50 g (Table 1), obloid shape, a low percentage of dry matter (12%), high percentage of total sugars (18%).

'Korava Shekerka' (KS) with a fruit weight of 62.00 g, SF 1 with a weight of 83.17 g were characterized by dense fruit flesh and thick skin, which prolongs the storage period. They can be consumed till May next year.

'Newtown Pippin' and 'Momina cheska' and BF 3 were sucrose-free forms, which makes them suitable for diabetics.

Due to the variety of pomological characteristics, fruit quality and resistance to adverse abiotic and biotic factors, it is important to preserve traditional apple cultivars as a source of genetic diversity in the area where they grow. The described cultivars and forms should be preserved and propagated because of their suitability for fresh consumption and processing and their inclusion in selection programs.

Our scientific data were compared with the information obtained from the local population on age, origin, fertility, use and distribution in the region. It is advisable to create small, sustainable, orchards from the local forms of apples.

REFERENCES

- Antić, M., Đurić, G. & Bosančić, B. (2021). Wild fruit trees in the Forest Park of Starčevica, Banja Luka, Bosnia and Herzegovina. *Acta Hort.*, 1308, 13-18 DOI: 10.17660/ActaHortic.2021.1308.3 (<https://doi.org/10.17660/ActaHortic.2021.1308.3>)
- Babojelić, M. S., Korent, P., Šindrak, Z., & Jemrić, T. (2014). Pomološka svojstva i kakvoća ploda tradicionalnih sorata jabuka. *Znanstveni rad. glasnik zaštite bilja*, 3, 20-27
- Donchev, H., Zlateva, D., & Pashova, S. (2000). Commodity science of food products. part II, 61-63, *University Press Varna University of Economics*
- Dragoyski, K., Minev, I., Hristov, S., Stoyanova, T., Dinkova, H., Stefanova, B., & Marinov, Y. (2012). Results of an Expedition Investigation on The Biodiversity of Fruit Species and Cultivars in the Territory of The "Balgarka" National Park. *Journal of Mountain Agriculture on the Balkan*, 15(1), 226-240.
- Ghosh, S.N., Banik, A.K., Banik, B.C., Bera, B., Roy, S. & Kundu, A. (2012). Conservation, Multiplication and Utilization of Wood Apple (*Feronia limonia*) - A Semi-Wild Fruit Crop in West Bengal (India). *Acta Hort.*, 948, 279-283 DOI: 10.17660/ActaHortic.2012.948.32 (<https://doi.org/10.17660/ActaHortic.2012.948.32>)
- Janjić, V. (2016). Possibilities of preservation and revitalization of orchard with old apple cultivars at a Rehabilitation Center 'Ozalj. *Graduate thesis*, Faculty of Agriculture, Zagreb (<https://www.bib.irb.hr/889695>)
- Nesheva, M., Marinov, Y. & Bozhkova, V. (2019). Study of natural habitats of fruit species in the region of the village Stančov Han, Northern Bulgaria. *Acta Hort.*, 1259, 7-12 DOI: 10.17660/ActaHortic.2019.1259.2 (<https://doi.org/10.17660/ActaHortic.2019.1259.2>)
- UPOV, (2005). International Union for the Protection of New Varieties of Plants. Geneva (<https://www.upov.int/edocs/tgdocs/en/tg014.pdf>)
- Vitkov, V. (2015). Reproductive manifestations of some apple cultivars and forms from the local gene pool in the region of the town of Apriltsi. *Journal of Mountain Agriculture on the Balkans*, 18(1), 112-136. (http://rimsa.eu/images/perennial_plants_vol_18-1_2015.pdf)
- Vujević, B. (2016). Pomological characteristics of fruits of old apple cultivars from the area of Bjelovar-Bilogora County. *Biotechnical Sciences. Agronomy. Fruit Growing* (<https://core.ac.uk/display/197876141?recSetID=>