

## *Chaenomeles* sp.

1\*, 2

1, 2, 5600

### Study on the Decorative Effect of Some Genotypes from *Chaenomeles* sp. in the Central Northern Bulgaria

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Original scientific paper

#### SUMMARY

*Chaenomeles* sp. - The shrubs of *Chaenomeles* sp. have a high decorative effect. They are attractive with an extremely large variety in shape and colour, with early and prolonged blossoming. The present study was conducted in the period 2017-2018 in the region of Dryanovo, the Central Northern Bulgaria. The main type of soils is gray forest, and the altitude in the area is from 230 m to 680 m.

During an expedition study on genotypes of Japanese quince (*Chaenomeles* sp.) were found and observed. They were grown without any care for more than 30 years in the outskirts of some neighborhoods of the town of Dryanovo, along rural roads and in the town itself. Five forms were chosen, with a pronounced decorative effect, which are of interest as a genetic resource. The following indicators are monitored: shape, size and colour; duration of blossoming; characteristics of shrubs in individual

L., , , : *Chaenomeles* sp.

genotypes.

**Key words:** *Chaenomeles* sp. L., Japanese quince, genotypes, Bulgaria

## INTRODUCTION

(Mezhenskyj, 2004; Minkov, 2012; Stoyanova et al., 2014; Kikindonov et al., 2017; Kizeková et al., 2017; Martincová et al., 2017).

(*Chaenomeles* sp.)

IX .

*Rosaceae*,  
*Maloideae*,

Weber (1963; 1964),

. *Chaenomeles* sp.

(Mezhenskyj, 2009).

(Mezhenskyj, 2015; Sahin, 2020; Turkiewicz et al., 2020).

(Mezhenskyj, 2004, 2015; Rumpunen, 2010; Nahorska et al., 2014;

- There has been a growing interest  
- in the preservation and study of the gene  
- pool of cultivated and wild, ornamental  
- and medicinal species in recent years, as  
- well as preparing products from them. The  
- study of genotypes of local origin allows  
- the selection of species in order to protect,  
- preserve and enhance the biological  
- diversity of local flora (Mezhenskyj, 2004;  
- Minkov, 2012; Stoyanova et al., 2014;  
- Kikindonov et al., 2017; Kizeková et al.,  
- 2017; Martincová et al., 2017). One of  
- these plants is the Japanese quince  
- (*Chaenomeles* sp.), which was distributed  
- in Europe since the end of the IX century.  
- *Chaenomeles* is a perennial plant in the  
- family *Rosaceae*, subfamily *Maloideae*,  
- which originates from East Asia. Weber  
- (1963; 1964) had a great deal of credit for  
- the botanical study of this plant species.  
- He identified and described significant  
- taxonomic diversity, including four species  
- and four interspecies hybrids. So far,  
- hundreds of described varieties of  
- chaenomeles have been created, used  
- mainly for decorative purposes and  
- bonsai. *Chaenomeles* sp. is widespread in  
- Asia, Europe, North and South America  
- and Australia.

- There is a great variety in colouration  
- among the created cultivars – white, pink,  
- red, yellowish to orange petals  
- (Mezhenskyj, 2009). In Japan, Korea and  
- China, it has been grown and used for  
- centuries as a food, medicine, ornamental  
- plant (Mezhenskyj, 2015; Sahin, 2020;  
- Turkiewicz et al., 2020).

- The fruits have different shapes, weight  
- and are rich in chemical composition.  
- They are used in the food and  
- pharmaceutical industries (Mezhenskyj,  
- 2004, 2015; Rumpunen, 2010; Nahorska  
- et al., 2014; Kaufmane and Ruisa, 2018).

Kaufmane and Ruisa, 2018).

(Mondeshka, 2005). Rumpunen (2010) *Chaenomeles sp.* 6

Mezhenskyj et al. (2019) 10

Mezhenskyj (2009), Rumpunen and Garansson (2003) *Chaenomeles sp.*

*Chaenomeles sp.*

XIX

XX

(Mondeshka, 2005; Mihova, 2016).

*Chaenomeles sp. L.*

Japanese quince is used both in fruit production and in landscape design, for decorative purposes and bonsai.

Shrubs look especially well in the garden during the blossoming period, in early spring, when its branches are strewn with dozens, hundreds of blossoms (Mondeshka, 2005). According to Rumpunen (2010) in *Chaenomeles sp.* up to 6 blossoms can be observed in one flower bud located on two- and three-year-old twigs, while Mezhenskyj et al. (2019) observed up to 10 blossoms. Japanese quince is successfully combined in garden compositions with forsythia, ornamental almonds, ornamental conifers, spirea, mahonia etc. Authors such as Mezhenskyj (2009), Rumpunen and Garansson (2003) have found that the fruits of *Chaenomeles sp.* give very good qualities and are accepted by consumers in various products – ice cream, lemonade, jam etc.

In Bulgaria *Chaenomeles sp.* was widely used as an ornamental plant since the late 19th century and early 20th century, but it has become popular as a fruit crop only in recent years (Mondeshka, 2005; Mihova, 2016).

The objective of the present study was to examine the valuable decorative qualities of some genotypes of *Chaenomeles sp. L.*, distributed in the region of the Central Balkan Mountain in Bulgaria.

## MATERIAL AND METHODS

2017-2018

230

m 680 m.

5

The studies were conducted in the period 2017-2018 on the territory of Dryanovo municipality, Gabrovo region. The region is situated in the Central Northern Bulgaria at an altitude of various terrains from 230 m to 680 m. The main type of soils is gray forest. During an expedition study were found and observed 5 genotypes of *Chaenomeles sp.* in the outskirts of some neighborhoods of the town of Dryanovo and along

*Chaenomeles* sp.  
20

Rumpunen (2002) Mezhenkyj et al. (2019)

- , m<sup>3</sup>,

$$V = 1/12 \cdot \pi \cdot d^3,$$

$$\pi = 3,14; \quad d -$$

- , cm;

- ;

- , cm;

- m.

Lidanski (1998)  
Microsoft Excel.

- rural roads. The plants are of visible age
- over 20 years and have grown without
- agrotechnical events.

The following indicators were observed and described according to Rumpunen (2002) Mezhenkyj et al. (2019):

- Size and volume of shrubs, m<sup>3</sup>, calculated by the hemisphere formula

$$V = 1/12 \cdot \pi \cdot d^3,$$

where  $\pi = 3.14$ ; and d is the average diameter;

- Length of thorns, cm;
- Shape, position and colour of petals;
- Diameter of blossom, cm;
- Number of blossoms per linear m.

The obtained data were processed statistically according to Lidanski (1998) and Microsoft Excel programs.

## RESULTS AND DISCUSSION

- The decorative qualities of chaenomeles are largely determined by the volume of the bush. The density of blossoms and their colour determine the type of their landscape application in small flower areas, rock gardens, green fences.

- During the expedition, five
- genotypes of Japanese quince were
- discovered and described in the Gabrovo region. A large variety of *Chaenomeles* sp. in terms of size and shape of shrubs and fruits were found. A characteristic biological feature of all studied specimens is the presence of thorns.

- Regarding the height of shrubs, significant differences were found in the individual described specimens (Table 1). Genotype No3 (0.86 m) was less than 1 m 0.86 m, followed by No 1 (0.96 m).
- According to the classification proposed by Rumpunen (2002) and supplemented by Mezhenkyj et al. (2019), they could be referred to the group of low height Japanese quinces. The highest shrub was found in No 5 (1.90 m) and No 4 (1.87 m), which belong to the large height Japanese

*Chaenomeles* sp.

( 1). 1 m

3 – 0,86 m, 1 – 0,96 m.

Rumpunen (2002)  
Mezhenkyj et al. (2019),

5 – 1,90 m 4 – 1,87 m,

1,5 m) ( 1,0  
2 1,36 m.  
1,20 m 2  
2,05 m 5.  
5, 4 2.

quinces. Genotype No 2 (1.36 m) was classified as medium height (from 1.0 to 1.5 m).

The width of shrubs varied in the range from 1.20 m for genotype No 2 to 2.05 m for No 5. The data analysis shows that the group of No 5 No 4 and No 2 belong to the group of wide chaenomeles shrubs.

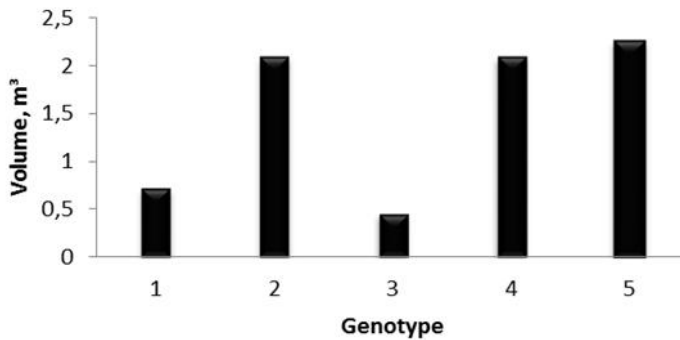
**Table 1. Shrub sizes and length of thorns**

Genotype No	Height of shrubs, m	Width of shrub, m	Length of thorns, cm
1	0,96	1,40	1,14
2	1,36	2,00	1,00
3	0,86	1,20	0,93
4	1,87	2,00	0,95
5	1,90	2,05	1,15

1,15 m 5. 0,93 m 3  
4 5  
1 m<sup>3</sup>  
m<sup>3</sup> – 2, 4 5, ( 1).

Thorns were observed in all five genotypes, as the length of their thorns varied from 0.93 cm in No 3 to 1.15 cm in No 5. The large height of shrubs in genotype No 4 and No 5 makes them suitable for use in landscape design such as hedges and decorative walls or to include them in a selection with such a focus.

The volume of shrubs is an important indicator and is a function of their size. The smallest volume in the 5 studied genotypes, which is less than 1 m<sup>3</sup>, was distinguished in shrubs No 3 and 1, while a volume of more than 2 m<sup>3</sup> was observed in No 2, No 4 and No 5, which defines them as plants with large volume (Figure 1).



**Fig. 1. Volume of the shrub, m<sup>3</sup>**

2.

2

3,

5

1

4.

5

Data on the characteristics of blossoms is presented in Table 2. The petals of No 1 and No 4 were with free position. The petals of genetic types No 2 and No 3 came into contact, while in No 5 they overlapped. The round shape of petals appeared more often, followed by elliptical one. The colour of blossoms ranged from light orange to dark orange, and only in genotype No 5 it had dark pink blossoms.

**2.**

**Table 2. Characteristics of blossoms**

Genotype No	Position of petals	Shape of petals	Colouration
1	free position	elliptical	light orange
2	round	round	light orange
3	in contact	round	dark orange
4	free position	elliptical	light orange
5	overlapping	round	dark pink

2.

The number of blossoms per linear meter is of great importance on the decorative effect of the genotype. Data on this indicator are presented in Figure 2.



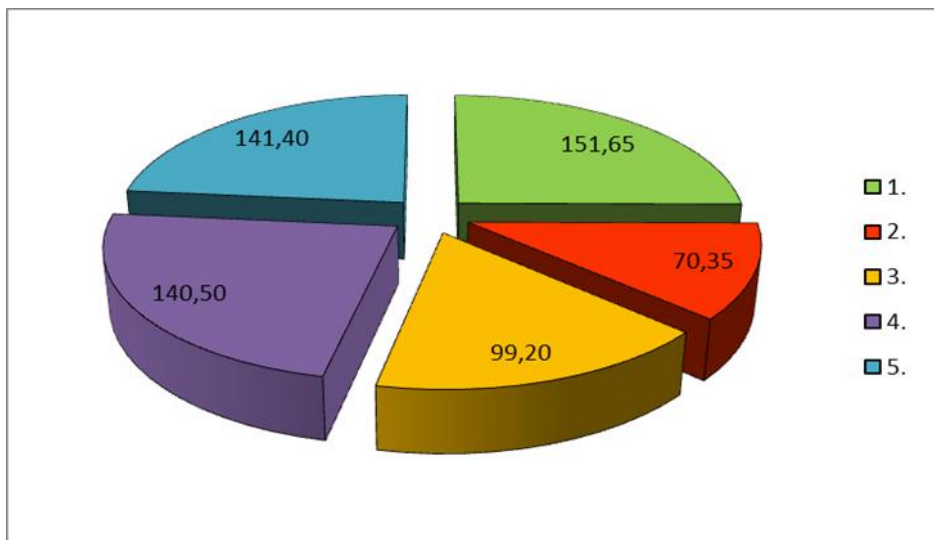
**2.**

**Fig. 2. Colouration of blossoms**

The studied genotypes are characterized by a large number of blossoms per linear meter and vary

1 (151.65),  
5 (141.40) 4 (140.50).  
2 (70.35) ( 3).

widely. The highest number of blossoms was reported in genotype No 1 (151.65), followed by genotypes No 5 (141.40) and No 4 (140.50). The smallest was observed in genotype No 2 (70.35) (Figure 3).



. 3.  
**Fig. 3 Number of blossoms of linear meter**

2 (4.70 cm) Mezhen'skiy et al. (2019) ( 4.5 cm ), 5 (4.23 cm) (4.2 cm) ( 3).

The diameter of blossoms is one of the most important quality characteristics determining the decorative value of a plant. In the study of the five genotypes, the largest blossom diameter was observed in genotype No 2 (4.70 cm) according to Mezhen'skiy et al. (2019) as it belongs to the group of large blossoms (over 4.5 cm in diameter), followed by genotype No 5 (4.23 cm) and a smaller diameter of blossoms (4.2 cm) (Table 3). The other genotypes belong to the group of average-sized blossoms

. 3. , cm  
**Table 3. Average diameter of blossoms, cm**

Genotype N	1	2	3	4	5
Min	3.20	4.40	3.50	3.70	3.80
Max	4.20	5.00	4.30	4.20	4.60
Average	3.78	4.70	3.92	3.97	4.23
SD	0.18	0.16	0.16	0.19	0.25
CV	20.54	28.60	23.82	21.17	17.16

(  
).

*Chaenomeles sp.*

- The described genotypes are characterized by abundant long term blossoming period, demonstrate high decorative value, different colour of petals (light to dark orange, dark pink). They are of interest for a longer study and we recommend that they should be stored in a collection and protected from destruction. They can be included in the species diversity used in urban landscape architecture, achieving maximum aesthetic appearance, with beautiful colors, in homes or in urban environments.

### CONCLUSIONS

- A complex assessment of the decorative qualities of five genotypes of *Chaenomeles sp* was made. A large variety in the shape of blossom, colour and duration of blossoming period in different types of Japanese quince was found. The study of five genotypes of Japanese quince in the Gabrovo region revealed great variability in terms of size and shape of shrubs, diameter of blossoms, colour of petals.

- A characteristic biological feature of all studied specimens is the presence of thorns. The five genotypes studied are of interest for a longer study and should be stored in a collection and preserved. They are of interest for a longer study and we recommend that they should be stored in a collection. They can be used in urban landscape architecture, achieving maximum aesthetic appearance, with beautiful blossoms, in homes or in urban environments.

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## Colour Parameters of Remontant Raspberry Cultivars Stored under Frozen Conditions

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Original scientific paper

### SUMMARY

The impact of the cultivar and the process of storage under frozen conditions of two remontant raspberry cultivar 'Lyulin' and 'Autumn bliss' on the colour stability and quality colour characteristics of fruits were studied.

The studied raspberry cultivars, such as 'Lyulin' and 'Autumn bliss' were grown and provided by a collection plantation of the Research Institute of Mountain Stockbreeding and Agriculture - Troyan.

Storage under frozen conditions -18°C for 12 months and instrumental colour measurement were carried out at the Institute of Food Preservation and Quality - Plovdiv.

It was found that 'Autumn bliss' cultivar had the most stable colour after a 12-month storage during spring-summer fruit-bearing. The storage period did not affect the colour stability of the remontant cultivar. The fruit-bearing period affected the colour characteristics of the fruit.

With statistically indistinguishable values

	Lyulin	utumn bliss	
Lyulin	utumn bliss		
	-18°	12	
utumn bliss		12	

Lyulin

12

are the qualitative indicators of colour saturation and colour tone, as well as the quantitative values of red and yellow colour tone of the fruit.

- 
- The cultivar and storage parameters of fruit did not affect the colour characteristics mentioned above.
- 

'Lyulin' cultivar showed a significant colour difference in fruits stored for 12 months under frozen conditions from the spring-summer fruit-bearing, compared to the fresh raw material. The red and yellow colour tone of fruits reduced significantly during storage from their first fruit-bearing, as the storage period had an impact.

- 
- The changes in the quality colour parameters of fruits from both periods of fruit-bearing were insignificant in terms of colour saturation and colour tone. The data show that in the stored fruits from the second fruit-bearing, the colour brightness increased compared to the fresh fruits.
- The total colour difference in fruits from the second fruit-bearing was smaller, compared to the stability of fruits from the first fruit-bearing of the cultivar. The cultivar with fruit-bearing period had an impact.
- 

**Key words:** colour characteristics, colour tone, raspberries, cultivar, fruit-bearing periods

## INTRODUCTION

There are so-called remontant raspberry cultivars that can bear fruit twice a year, which is a biological feature and depends on the way they are pruned. For one-time fruit-bearing, the harvest is higher during the year and after fruit-bearing in autumn, all shoots are cut to the base. The thinning of new and thin shoots is conducted in spring.

For double fruit-bearing, the period is throughout the summer until late autumn, but the harvest is less.

- The advantage of remontant cultivars is that with pruning to the base of the shoots every year the bushes heal, as there is no accumulation of diseases and pests, as well as frost in winter.

- The study aims to evaluate the quality and stability of colour in remontant raspberry cultivars depending on the cultivar difference and the process of storage in frozen conditions of -18 °C for 12 months.

-18° 12

## MATERIAL AND METHODS

- Two remontant raspberry cultivars were used to reach the objective, such as 'Lyulin' and 'Autumn bliss' grown and provided by a collection plantation of the Research Institute of Mountain Stockbreeding and Agriculture - Troyan. The study was conducted in the period 2019-2020.

Lyulin utumn bliss,

2019-2020

### Raw materials

- 'Lyulin' is one of the most stable Bulgarian cultivars and the most widespread in Bulgaria. It is spread outside Bulgaria - Russia, Serbia, Ukraine. In Russia it has shown high resistance to didymella and medium tolerance to anthracnose, therefore it finds a place in their range.

Lyulin

- Requirements for mechanized harvesting are: the shoots should be upright with firmly attached fruit twigs, and the fruits should be of high density, easy to pick up and relatively uniform ripening (Hristov et al., 1981; Kondakova et al., 2005). About 70% of the costs of growing the plantations are due to manual harvesting.

(Hristov et al., 1981; Kondakova et al., 2005). 70%

- This cultivar is cold-resistant and unpretentious to the soil. Fruit-bearing is twice a year, and in the first period - June 20-25 is much more abundant. In soils more saturated with nutrients, the yield per decare reaches 1200-1600 kg. Harvesting should be conducted carefully and, if possible, in boxes with a capacity of up to 2.5 kg, because fruits are easily

20-25

1200-1600

kg.

2,5 kg,

2-3

Lyulin

3.20-3.70 g

5.64 g.

25

10-15

83-85%

1/3

( )

utumn bliss

1977

(Humer, 1996; Miši and Nikolic, 2003; Georgiev et al., 2007; Petrovic and Lepasovic, 2011).

- injured. It responds well to soil fertilization and regular irrigation, increases yields 2-3 times more than usual and fruits become very large.

- Cultivar characteristics according to the certificate: 'Lyulin' is remontant cultivar, i. e. bears fruit twice a year. The fruit from the large-scale harvests has an average weight of 3.20-3.70 g and the largest are those from the first harvests and reach a weight of 5.64 g. The fruit shape is obtuse-conical and the colour is intense red. They are easily picked without disintegrating into their constituent berries and are suitable for mechanized harvesting. The fruit flesh is relatively dense, juicy, sweet and sour, with good to very good taste and moderate aroma. They begin to ripen on August 25 for summer-autumn fruit-bearing, while the latter ripen till October 10/15, as 83-85% being harvested by the end of September for the Troyan region. The fruits of the summer-autumn harvest are not formed on last year's shoots, but on those grown in the current spring and summer. The fruits of the spring-summer harvest began to ripen in late June, but were smaller and located on looser fruit twigs. Their amount was about 1/3 of the summer-autumn, and often less due to damage to the buds by winter frosts. The fruits of this cultivar are very suitable for single freezing (solo), as well as for processing (compotes); for fresh consumption, etc.

'Autumn bliss' cultivar was created in 1977 in the east of England. It is a classic early ripening raspberry cultivar that is well known for its exceptional characteristics and quality fruit (Humer, 1996; Miši and Nikolic, 2003; Georgiev et al., 2007; Petrovic and Lepasovic, 2011).

The fruits are dark red with excellent taste and aroma. Fruit-bearing begins in mid-June, and the second fruit-bearing begins in September till late autumn.

-18° Premium NoFrost  
Liebherr 12

"Colorgard 2000",  
BYK-Gardner Inc. USA.

CIE Lab.

3

: L, a b; : L -

; + - ; - -

; +b - ; -b -

:

a/b;

$$a^2 + b^2.$$

L, b,

- The cultivar, like most, is self-fertile and does not need pollinators. It is also suitable for container cultivation and does not need a supporting structure to produce quality fruit. Remontant cultivars are often grown for an abundant, autumn harvest, and summer fruits are not so abundant.

- The fruits are large or medium in size, about 3.3 grams, approximately spherical in shape, red to dark red in color, with a pleasant aroma and good taste. Throughout the fruit-bearing period, the fruit size remains almost unchanged.

**Experimental setting:**

Acceptance, storage under frozen conditions and measurement of color parameters were carried out in the Department of Food Technology at the Institute of Food Preservation and Quality - Plovdiv.

Fruits were accepted, sorted and inspected from injured fruits and mechanical impurities, placed in polyethylene packaging and frozen at -18°C in a freezer Premium NoFrost of the company Liebherr for 12 months.

- The quantitative colour indicators are instrumentally measured with a colourmeter "Colorgard 2000", by BYK-Gardner Inc. USA The indicators were reported according to the CIE Lab system. During the measurement 3 colour coordinates were taken: L, a and b; where: L - colour brightness; + a - red colour; -a - green colour; + b - yellow colour; -b - blue colour.

The quality colour parameters are: value of the colour tone or the dominant wavelength represented by the ratio a/b; the colour saturation determined by the values of the index  $a^2 + b^2$ .

- The colour differences between the different fruit cultivars are determined with the values L, a and b, and  $a^2 + b^2$  is a generalized indicator of the final colour difference. The difference in colour

$$E = \sqrt{L^2 + a^2 + b^2}$$

$$L = L_{12} - L_0$$

$$a = a_{12} - a_0$$

$$b = b_{12} - b_0$$

"0" - ( )

"12" - ( )

=1.

(Excel).

CIE Lab

1, 2, 3, 4 5.

-18°

-18°

12

-18°

( > 0.05).

( < 0.05).

-18°

12

( 1 2).

change **E** is calculated based on the colour differences of brightness, red colour tone and yellow colour tone:

(1)

where:

$$L = L_{12} - L_0$$

$$a = a_{12} - a_0$$

$$b = b_{12} - b_0$$

"0" - raw material (standard)

12 "12" - frozen fruit after a 12-month storage

For visual non-perception of the colour difference, the value =1 is assumed.

- The values of the measured colour indicators at the indicated coordinates are arithmetic mean of three parallel measurements. One-way and two-way analysis of variance (Excel) were applied to process the obtained results.

## RESULTS AND DISCUSSION

The values of CIE Lab colour coordinates of fruits of the selected raspberry cultivars are presented in Figures 1, 2, 3, 4 and 5.

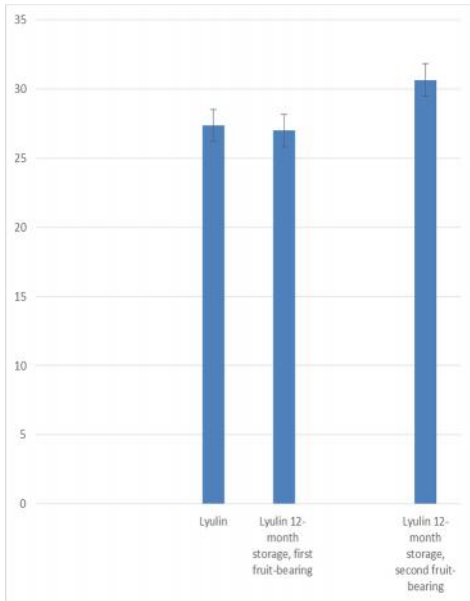
- The first value is the raw material on the day of receipt, the second value is the remontant cultivars of raspberries stored at -18°C on spring-summer fruit-bearing, and the third value is the remontant cultivars of raspberries stored at -18°C on summer-autumn fruit-bearing.

- For both studied cultivars, the measured values of brightness did not differ significantly from the day of receipt of the raw material compared to 12-month storage at -18°C of the first fruit-bearing ( $P > 0.05$ ). The provided and frozen samples from the second fruit-bearing for both cultivars showed a statistically significant increase in colour brightness, which is due to the time of cultivar fruit-bearing ( $P < 0.05$ ). Storage at -18°C for 12 months affected only the fruits of the second fruit-bearing (Figures 1 and 2).

12

( > 0.05).

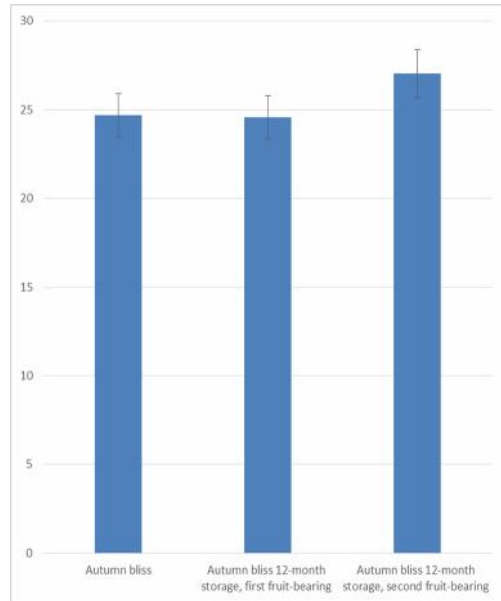
It was confirmed that storage under frozen conditions did not affect fruit colour brightness at a 12-month storage from the first fruit-bearing (P> 0.05).



. 1.

Lyulin

12



. 2.

Autumn bliss

12

Fig. 1. Colour brightness of 'Lyulin' cultivar, depending on fruit-bearing, during a 12-month storage

Fig. 2. Colour brightness of 'Autumn bliss' cultivar, depending on fruit-bearing, during a 12-month storage

3

Autumn bliss.

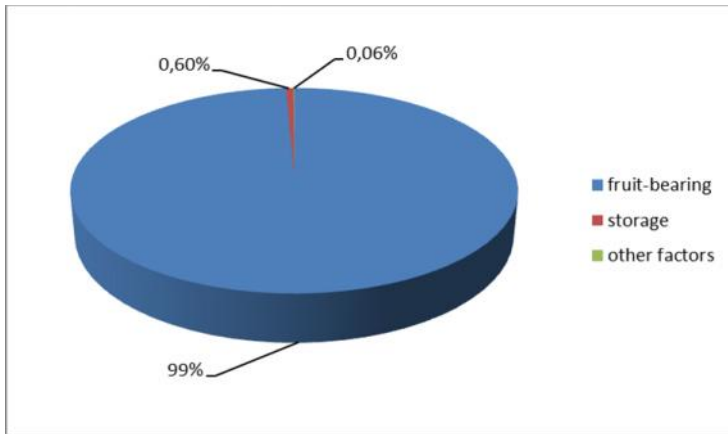
-

(99%).

Figure 3 shows the impact of factors on colour brightness index in 'Autumn bliss' cultivar.

Cultivar fruit-bearing (99%) had the highest percentage of impact on fruit brightness.



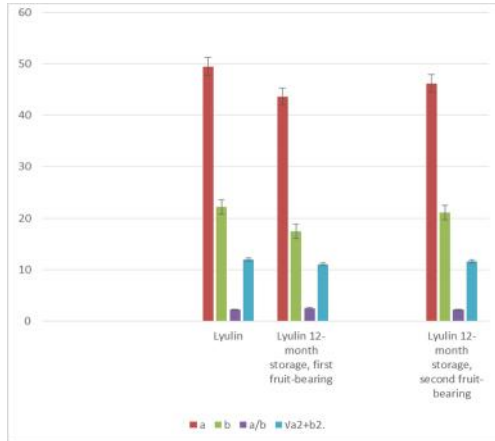


3. autumn bliss  
**Fig. 3. Impact of the factors on fruit colour brightness of 'Autumn bliss'**

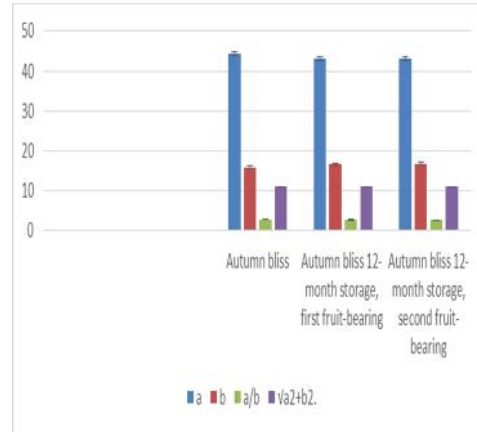
4 5  
 Lyulin  
 ( < 0.05).  
 ( > 0.05).  
 ( < 0.05).  
 12  
 ( < 0.05).  
 12  
 ( > 0.05).  
 ( < 0.05).  
 Lyulin ( > 0.05).

Figures 4 and 5 show the quantitative and qualitative colour parameters of the studied cultivars during their storage.

- The red colour tone of 'Lyulin' raspberries in both fruit-bearing decreased during storage compared to the raw material on the day of receipt ( $P < 0.05$ ). In fruits of both fruit-bearings no statistically significant difference was found in the red colour tone ( $P > 0.05$ ).
- The values of this indicator are influenced by the storage period of the fruits compared to the day of their receipt ( $P < 0.05$ ). The value of the yellow component decreases statistically distinct in fruit from 12-month storage from the first fruit-bearing ( $P < 0.05$ ).
- Statistically indistinguishable are the values of yellow colour from the second fruit-bearing of fruits stored for 12 months compared to raspberries on the day of their receipt ( $P > 0.05$ ). The values of this indicator are influenced by the storage period of fruits from the first fruit-bearing compared to the day of their receipt ( $P < 0.05$ ).
- Qualitative indicators of colour saturation and colour tone are statistically indistinguishable values in 'Lyulin' ( $P > 0.05$ ).



4. **Lyulin**  
**Fig. 4 Colour parameters of 'Lyulin' raspberry cultivars**



5. **utumn bliss**  
**Fig. 5. Colour parameters of 'Autumn bliss' raspberry cultivars**

utumn bliss

12

( > 0.05).

( > 0.05).

1

The measured quantitative values of red and yellow colour tone in 'Autumn bliss' fruits for both fruit-bearings during the 12-month storage did not differ significantly in the values ( $P > 0.05$ ).

The calculated quality indicators of colour tone and colour saturation are statistically indistinguishable and this shows that the fruits of this cultivar and the storage process do not affect the above indicators ( $P > 0.05$ ).

Table 1 presents the data on the colour differences of both cultivars during storage depending on fruit-bearing.

1. **Lyulin** **utumn bliss**  
**Table 1. Colour differences of raspberries of 'Lyulin' and 'Autumn bliss'**

/ Sample	L		b	
Lyulin 12	-0,38	-5,88	-4,69	7,53
Lyulin 12-month storage, first fruit-bearing				
Lyulin 12	3,29	-3,29	-1,06	4,77
Lyulin 12-month storage, second fruit-bearing				
utumn bliss 12	-0,1	-1,34	0,8	1,56
Autumn bliss 12-month storage, first fruit-bearing				
utumn bliss 12	2,36	-1,42	0,93	2,91
Autumn bliss 12-month storage, second fruit-bearing				

Lyulin 12  
 12  
 ( < 0.05).  
 autumn bliss  
 ( > 0.05).  
 autumn bliss ( < 0.05).  
 3  
 autumn bliss 12  
 12

Lyulin autumn bliss

- In the case of colour differences of fruits during storage only in terms of colour brightness, the fruits from the first fruit-bearing had low values compared to fruits from the second fruit-bearing during their storage. In the other colour indicators the differences dominate and are statistically significant (P <0.05). These parameters are influenced by cultivar fruit-bearing (P <0.05).

- The generalized colour difference gives information about the colour stability of the studied cultivars. 'Lyulin' had the highest generalized colour difference and the largest colour change after 12 months of storage at the first fruit-bearing, followed by the harvest after 12-month storage from the second fruit-bearing (P <0.05).

- Data of colour differences of 'Autumn bliss' fruits between the first and second fruit-bearing show that in red and yellow colour tone the differences are statistically indistinguishable (P > 0.05).

- The fruits from the first fruit-bearing of 'Autumn bliss' were with significant and low colour differences according to brightness (P <0.05).

- Figure 3 shows what causes this difference and what influences it.

- The fruits of 'Autumn bliss' cultivar had the most stable colour after 12-month storage from the first fruit-bearing, followed by those after 12-month storage from the second fruit-bearing.

## CONCLUSIONS

- The impact of cultivar and technological parameters were studied during storage of two raspberry cultivars, such as 'Lyulin' and 'Autumn bliss', on their quality indicators.

- For both varieties it was found that in terms of color brightness, the period of storage of the fruit does not affect the values of the fruits of the first fruiting. For

		-	fruits from the second fruit-bearing, the values of colour brightness increased during storage, as the period of their fruit-bearing had an effect.
	Lyulin, utumn bliss		Quantitative values of red colour tone significantly decreased in fruits of 'Lyulin' cultivar during the storage period, while the values between the first and second fruit-bearing were approximately the same for 'Autumn bliss' fruits.
	Lyulin,	-	The yellow colour component increased in fruits from the second fruit-bearing in 'Lyulin', in the other tested samples it was stable.
bliss	Lyulin utumn	-	Qualitative indicators of colour saturation and colour tone are statistically indistinguishable values in 'Lyulin' ( $P > 0.05$ ).
	utumn bliss		The fruits of 'Autumn bliss' cultivar had better colour characteristics during storage under frozen conditions compared to 'Lyulin'.
	Lyulin.	-	The most stable colour was observed in fruits of 'Autumn bliss' from the first fruit-bearing, and the most unstable was in raspberries of 'Lyulin' from the first fruit-bearing.
	utumn bliss		
	Lyulin		

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## Malus sp.

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# Valuable Local Large-sized Apple Fruit Cultivars and Genotypes of Genus Malus in the Region of Troyan Balkans

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Original scientific paper

### SUMMARY

Malus sp. - The local plant resources of Malus sp. in the Fore Balkan region of Troyan town – the villages Beli Osam, Shipkovo, Chiflik were studied. The more widespread cultivars and forms of apples were established: Canadian Reinette, Yellow Belle Fleur, Winter green, forms of the groups of Perusha, Shekerka, Belurka, Tziganka, Troyanka.

5

- The main morphological characteristics of the fruits of 5 selected large-fruited genotypes from deserving greater attention were studied: weight, shape, colouration, pedicel length and palatability of fruits. Most of them have increased resistance of the main apple diseases, which allows their cultivation without applying plant protection and make them suitable for organic fruit production.

- The main morphological characteristics of the fruits of 5 selected large-fruited genotypes from deserving greater attention were studied: weight, shape, colouration, pedicel length and palatability of fruits. Most of them have increased resistance of the main apple diseases, which allows their cultivation without applying plant protection and make them suitable for organic fruit production.

**Key words:** large-fruited apples, apple cultivars, apple genotypes, genetic resources, morphology, biochemical analysis

## INTRODUCTION

(Vieira et al., 2009; Kikindonov et al., 2017; Kizeková et al., 2017; Martincová et al., 2017).

(Pereira-Lorenzo et al., 2018; Bozovic et al., 2013; Dzhuvinov et al., 2016; Ferreira et al., 2016; Kumar et al., 2019).

70 %  
1/3  
(Ivanova et al., 2009; Dimkova et al., 2018).

(Vieira et al., 2009; Minev et al., 2011; Dragoyski et al., 2014; Wagner et al., 2014; Dimkova, 2015).

In recent years, there has been a growing interest in the preservation and study of gene pool of cultivated and wild fruit species, as well as products from them. The study of genotypes of local origin allows the selection of species in order to preserve, keep and enhance biodiversity of local flora (Vieira et al., 2009; Kikindonov et al., 2017; Kizeková et al., 2017; Martincová et al., 2017). In response to the increased demand for organic fruits, fruit growers are looking for alternative technologies for their efficient production. One of the most important stages is the use of the rich gene pool of local genetic resources (Pereira-Lorenzo et al., 2018; Bozovic et al., 2013; Dzhuvinov et al., 2016; Ferreira et al., 2016; Kumar et al., 2019).

In the past, fruit growing was the main means of livelihood of the population of the Central Balkan Mountain region. Due to the rough terrain, the main part of the arable land was occupied by orchards with plums, apples, pears. Over 70% of the apple trees were planted before the establishment of the cooperatives. About 1/3 of them are designated as orchards (Ivanova et al., 2009; Dimkova et al., 2018).

Common large-sized forms and cultivars, which found suitable soil and climatic conditions for cultivation, appreciated by the local population and well accepted in the studied areas are: 'Winter Green', 'Troyanka', 'Tsiganka', 'Canadian Reinette', 'Limonki', 'Perusha' and a number of other local forms. They were and still are the basis of the local processing industry for making dried fruits, marmalades, juices, brandy, pectin, vinegar etc. (Vieira et al., 2009; Minev et al., 2011; Dragoyski et al., 2014; Wagner et al., 2014; Dimkova, 2015).

Local cultivars and forms differ significantly in terms of their resistance to extreme cold and heat, low humidity and

(Minev et al., 2011).

2018-2020 .

500-800 m,

772.03 mm.

(Nedev et al., 1979).

(mm); (g); (mm); ;

(%) - ; , -

0.1 N NaOH; (mg/%) ; (mg/%) - ; Stanchev et al. (1958).

(Lidanski, 1998) Microsoft Excel.

large temperature fluctuations in late winter and early spring (Minev et al., 2011).

The aim of the present work is to search for large-sized old, endangered local cultivars and forms of apples and to study their reproductive characteristics.

## MATERIAL AND METHODS

The current study was conducted during the summer-autumn period of 2018-2020. A number of expeditionary studies on the apple cultivars and forms were carried out in the area of the villages of Balkanets, Beli Osam, Chiflik, Terziysko and their adjacent neighborhoods. The villages are located on the northern slopes of the Central Balkan Mountain, along the Beli Osam River and its tributaries. The trees are grown at an altitude of 500-800 m, in non-irrigated conditions and without any plant protection measures. The soils are gray, dark gray forest. The average annual precipitation for the study period was 772.03 mm.

The biological and morphological features of fruits were established according to the methodology for studying plant resources in fruit growing (Nedev et al., 1979). Their size (mm) was determined; weight (g); fruit stalk length (mm); colouring of fruit skin; taste qualities; Their main biochemical composition was studied: dry matter (%) - refractometrically; total, invert sugar and sucrose by the method of Shoorl. The organic acid content was determined by titration with 0.1 N solution of NaOH; Ascorbic acid (mg/%) ; Pectin (mg/%) - according to Melitz; The sugar-acid index was calculated by Stanchev et al. (1958).

The obtained data were statistically processed by analysis of variance (Lidanski, 1998) and Microsoft Excel Programs.

## RESULTS AND DISCUSSION

Many of the old endangered species of *Malus sp.* could be found in the area of the villages of Balkanets, Terziysko, Beli Osam, Chiflik and their adjacent neighborhoods. During the expeditionary research in the region, a large number of local forms and cultivars were found and studied, from which 16 large-sized forms weighing over 100 g were selected. They occur as single trees or in mixed plantations. Most often they were grafted on a seed rootstock, leading to strong growth and formation of trees with large crowns and thick trunks.

The morphological characteristics of fruits were made on the selected forms and cultivars and their qualities were determined. They are late ripening as their fruits reach harvest maturity in late September or mid-October. Some of them, such as 'Tsiganka', 'Troyanka', 'Winter green', 'Perusha', 'Limonki', are distributed in all parts of the surveyed area, while others, such as 'Belurka', 'Shekerki' have a specific, local distribution in some localities (in the area of the village of Balkanets).

The fruit size is a hereditary feature of fruit species, cultivars, forms (Stoichkov et al., 1968). The size and color of the fruit in the study varied in a wide range.

The main fruit colour is a characteristic feature of the individual cultivars, but is also influenced by the location of the fruit in the crown and the sunlit side. The studied cultivars are mainly green in colour and shades of yellow and red to dark red.

Under the same conditions, the fruits of some of them are large, up to very large, while others are medium-sized. In order to give a more accurate comparative estimate of fruit size grown in a given habitat, the classification of Nedev et al was used (1979).



:  
 - 50 g;  
 51 100 g;  
 101-150 g;  
 - 151 200 g  
 201 g ( 1).  
 : -  
 . . - 259 g;  
 (247g).  
 5 , 31%  
 163 - 200 g.  
 (8 )  
 103 148 g  
 50%  
 ( 1).  
 ( 1  
 cm) -  
 1, ,  
 -1, .  
 - 10 20 mm  
 7 ( ,  
 , , ,  
 2, , ).  
 - 20  
 mm - , 1,  
 1, -  
 . . (26,22 mm).  
 -  
 1 (79,82  
 mm) , (75,00 mm).  
 70,00 mm . .  
 ( 1).  
 51,76 mm ( )  
 62,65 mm ( ).

Under the same physical characteristics, apple cultivars grown under the same conditions are grouped into five categories: very small with a weight less than 50 g; small with a weight variation from 51 to 100 g; medium-sized with a weight of 101-150 g; large - from 151 to 200 g and very large - over 201 g (Table 1). According to the classification, the large-sized fruits of apple cultivars and forms studied in the present work are referred to as follows: the highest average weight of one fruit was registered in 'Belurka FB.'cultivar with 259 g; and 'Tsiganka' (247g). The second group includes 5 forms, constituting 31% of the total number. Their weight varies in the range of 163 - 200 g. The most numerous (8 forms) belong to the group with medium-sized fruits from 103 to 148 g in 'Perusha'. The latter group makes up 50% of the total team (Figure 1).

Very short fruit stalks (less than 1 cm) were noticed in four local forms - Form 'Troyanka Chiflik 1', 'Perusha', Form 'Terziysko-1', Korava Shekerka. The group with medium length of fruit stalks, from 10 to 20 mm, includes 7 forms (Form 'Winter green', 'Troyanka', 'Belurka', 'Limonka', 'Chiflik F 2', 'Yellow Belle Fleur', 'Tziganka'). Five of the studied cultivars and forms had fruits with a pedicel length over 20 mm: 'Canadian Reinette', 'Balkanets F1', 'Chiflik F 1', 'Koravka' and with the longest stalk is 'Belurka FB' (26.22 mm).

'Terziysko 1' form (79.82 mm) was distinguished by the highest fruit height of the cultivars studied, followed by 'Tziganka' (75.00 mm). With over 70.00 mm are also 'Belurka FB' and 'Yellow Belle Fleur' (Table 1). The other examined cultivars and forms varied in the range of 51.76 mm (for 'Limonkata') to 62.65 mm ('Troyanka').

1.

**Table 1. Morphological characteristics, colour, taste qualities of fruit in the studied apple forms and cultivars**

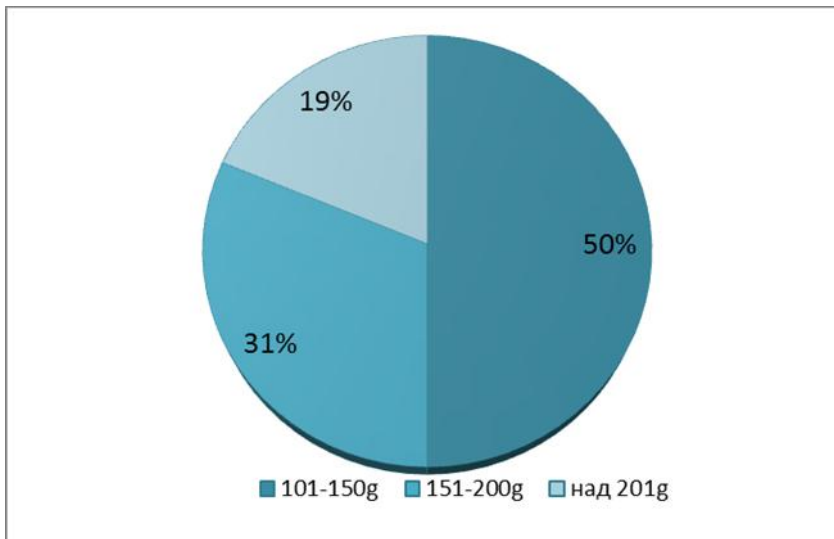
Cultivar, Form No	Weight, (g)	Fruit sizes			Height/diameter	Fruit colour, taste qualities
		Fruit stalk length (mm)	Height (mm)	Average diameter (mm)		
<b>Balkanets 1</b>	122	22,00	57,00	65,00	0,88	
<b>Belurka</b>	165	12,32	58,55	78,68	0,74	light yellow with predominant blush, fruity flesh-yellowish green, relatively tender, sweet sour with a slight aroma
<b>Belurka FB</b>	259	26,22	74,20	88,44	0,84	Light green to white with blush, white fruit flesh, juicy, slightly sour (5-6),
<b>Yellow Belle Fleur</b>	177	17,69	72,40	75,72	0,96	White, green to yellow with a red cover on the sunlit side. pronounced ribs on the upper and the lower sides (5-6), covered with wax. White fruit flesh, tender, slightly sour with aroma
<b>Canadian Reinette</b>	133	20,46	53,02	70,28	0,75	Fruit skin colour: thick, yellow with blush. Fruit flesh: coarser, dense, dry, slightly sour.
<b>Korava shekerka</b>	118	9,28	52,58	64,75	0,81	Fruit skin colour from green to yellow with rust, white fruit flesh, coarser, dry
<b>Koravka</b>	112	25,38	54,67	64,81	0,84	Fruit skin colour: intense red. Fruit flesh: soft, floury, dry, odorless.
<b>Limonka</b>	103	14,38	51,76	69,59	0,74	Colouring, thick fruit skin, red with darker stripes of fruit flesh - dry, sour, not coarse, floury
						Fruit skin colour from yellow to orange, fruit flesh-rough, firm, juicy, sour

<b>Perusha</b>	200	5,00	57	72	0,79	Greenish colour, sweet sour to sour fruit flesh, tender, medium juicy, with a slight aroma.	
<b>Terziysko-1 Form</b>	-1	195	8,38	79,82	76,96	0,89	Fruit skin colour: yellow-red in stripes. Fruit flesh: firm, rougher, juicy, sweet.
<b>Troyanka</b>		148	12,23	62,65	70,53	0,80	Reddish fruit skin, firm fruit flesh, rougher, sweet sour to sour.
<b>1 Troyanka Chiflik 1 Form</b>		176	3,69	61,42	75,04	1,04	Fruit skin: red in stripes. Fruit flesh: rougher with a grainy structure, slightly sour, juicy, white
<b>Winter green Form</b>		133	12,09	55,88	69,64	0,82	Fruit skin colour: dark green; Fruit flesh rougher, juicy, sour, with a slight aroma
<b>Tsiganka</b>		247	19,00	75,00	84,00	0,89	Colouring dark red, fruit flesh-sour, juicy.
<b>Chiflik F 1</b>	1	163	23,94	60,61	74,17	0,82	Fruit skin: thick, dark red, with a waxy coating; Fruit flesh tender, sweet, not very juicy, odorless
<b>Chiflik F 2</b>	2	105	15,69	54,31	62,46	0,87	Cherry red colour, white fruit flesh, juicy, tender, slightly sour.

62,46 mm  
 2 88,44 mm  
 (84,00 mm),  
 (78,68 mm),  
 (76,96 mm).  
 6  
 (Minev et al., 2011; Vitkov, 2015).

Fruit diameter varied in a wide range from 62.46 mm for 'Chiflik F2' to 88.44 mm for 'Belurka F.B'. With a relatively large fruit width were 'Tziganka' (84.00 mm), 'Belurka' (78.68 mm), Form 'Terziysko-1' (76.96 mm). 6 of the studied forms had an average diameter (over 60 mm).

The taste qualities of fruit flesh are formed complexly by the density, consistency, juiciness and its chemical composition (sugars, acids, aromatic substances, etc.). The high altitude and the associated cooler climate, high humidity and high amplitude in the daytime temperatures during fruit ripening are the reason why the majority of the surveyed cultivars and forms have fruits with firm, juicy flesh with a refreshingly sour taste and very strong apple aroma (Minev et al., 2011; Vitkov, 2015). 'Yellow Belle Fleur', 'Koravka', 'Canadian Reinette' and 'Korava Shekerka' are distinguished by pronounced and softer fruit flesh. With a sour taste were 'Tziganka', 'Koravka', 'Limonka', 'Winter green', 'Troyanka'.



1. (g)  
 Fig. 1. Percentage share of large-sized apple forms in groups in relation to weight (g)

The dry matter content in fruits varied in the range from 11.50% ('Chiflik F1' form) to 17.0% ('Balkanets F1') (Figure 2).

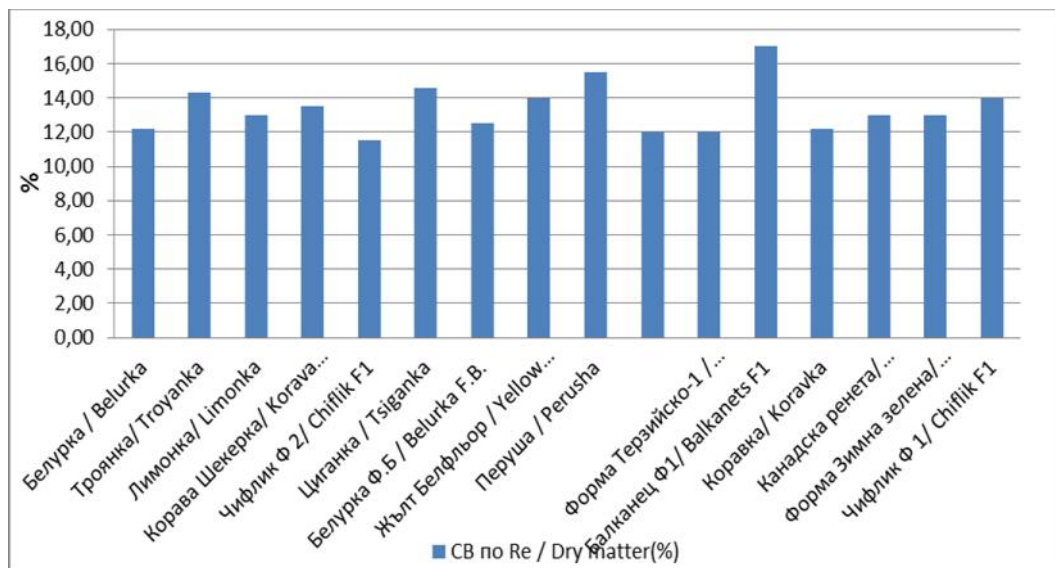
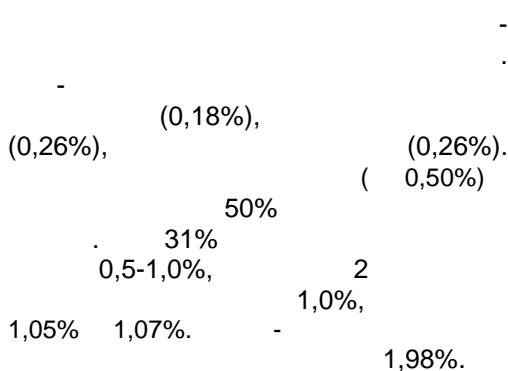


Fig. 2. Dry matter refractometrically (%) of apple forms and cultivars



The pectin content was in a wide range. The lowest was observed in 'Yellow Belle Fleur' (0.18%), 'Canadian Reinette' (0.26%), form 'Winter green' (0.26%). Low pectin content (up to 0.50%) was reported in 50% of the studied forms. Values between 0.5-1.0% were reported in 31% of them. 'Chiflik F2' and 'Troyanka' had indicators over 1.0%, 1.05% and 1.07%, respectively. 'Perusha' had the highest amount of pectin with 1.98%.

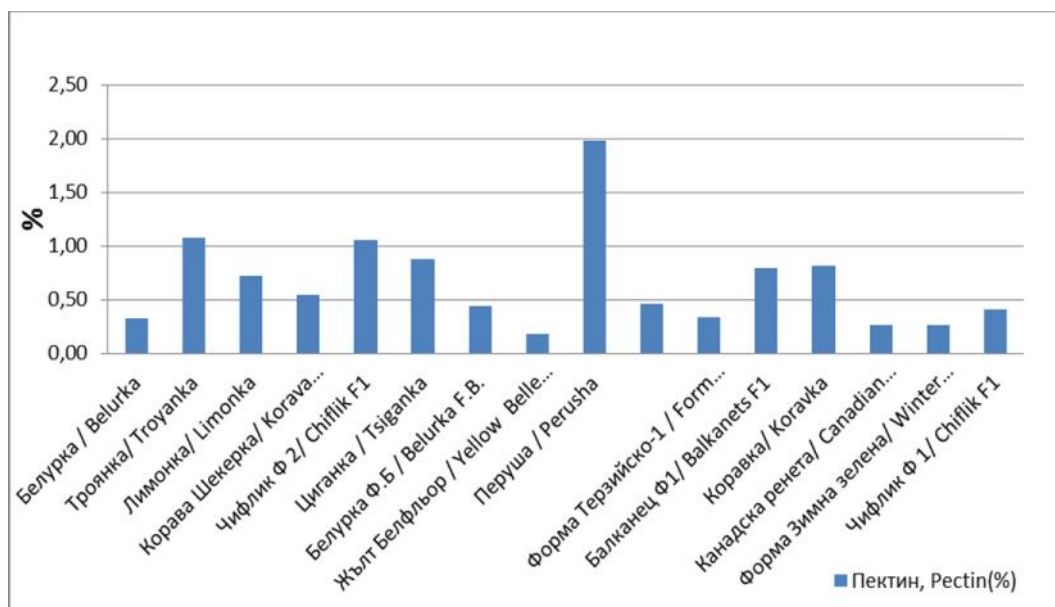


Fig. 3. Pectin (%) in apple forms and cultivars

4.70 %  
 12.95  
 35.20 mg%,  
 (24.75 mg/%)  
 (24.64 mg/%) (

The amount of the main biochemical ingredients determines the fruit taste. To a large extent, they also determine their suitability for processing. In the studied apple cultivars the total sugars varied from 4.70% in 'Belurka' to 12.95% in 'Chiflik F1'. The highest amount of vitamin C was found in apple fruit of 'Balkanets F1' (35.20 mg%), followed by 'Belurka FB' (24.75 mg /%) and 'Terziysko 1' form (24.64 mg /%) (Table 2).

## 2.

Table 2. Biochemical analysis of fresh fruit

Cultivar, form	Total sugars, (%)	Inverted sugar, (%)	Sucrose, (%)	Organic acids (%)	Vit. C (mg/%)
<sup>1</sup> Balkanets F1	10,75	7,70	2,90	0,77	35,20
/Belurka	4,70	4,70	-	0,38	14,08
Belurka F.B	9,20	6,85	2,23	0,64	24,75
Yellow Belle Fleur	9,20	4,70	4,28	0,57	10,56
Canadian reinette	10,75	6,00	4,51	0,60	12,32
Korava Shekerka	6,65	6,00	0,62	0,31	14,08
/Koravka	10,75	8,55	2,09	0,64	17,60
/Limonka	6,35	6,35	-	0,44	17,60
/Perusha	9,40	5,00	4,18	0,64	14,08
<sup>-1</sup> Terziysko-1 Form	10,40	8,70	1,64	0,4	24,64
/Troyanka	4,85	4,85	-	0,57	22,88
-1 ( -1)	9,55	7,20	2,23	0,60	14,08
Troyanka Chiflik 1 Form					
Winter green Form	10,75	6,00	4,51	0,60	12,32
/Tsiganka	9,20	5,85	3,18	0,83	12,32
1/Chiflik F 1	12,95	6,50	6,13	0,40	15,84
2/Chiflik F 2	7,70	7,70	-	0,31	17,60

-  
(Vieira et al., 2009).  
,  
,  
1 (32,38).  
-  
-1 (26,00),  
20  
(21,45).  
2 (24,84),

The sugar-acid index is responsible for the taste and aroma of fruit (Vieira et al., 2009). Apples that taste sweet do not necessarily have high sugar content, but have a lower amount of organic acids.

'Chiflik F1' form (32.38) had high values. The most balanced with values close to index 20 are 'Terziysko-1' form (26.00), 'Chiflik F2' (24.84), 'Korava Shekerka' (21.45).

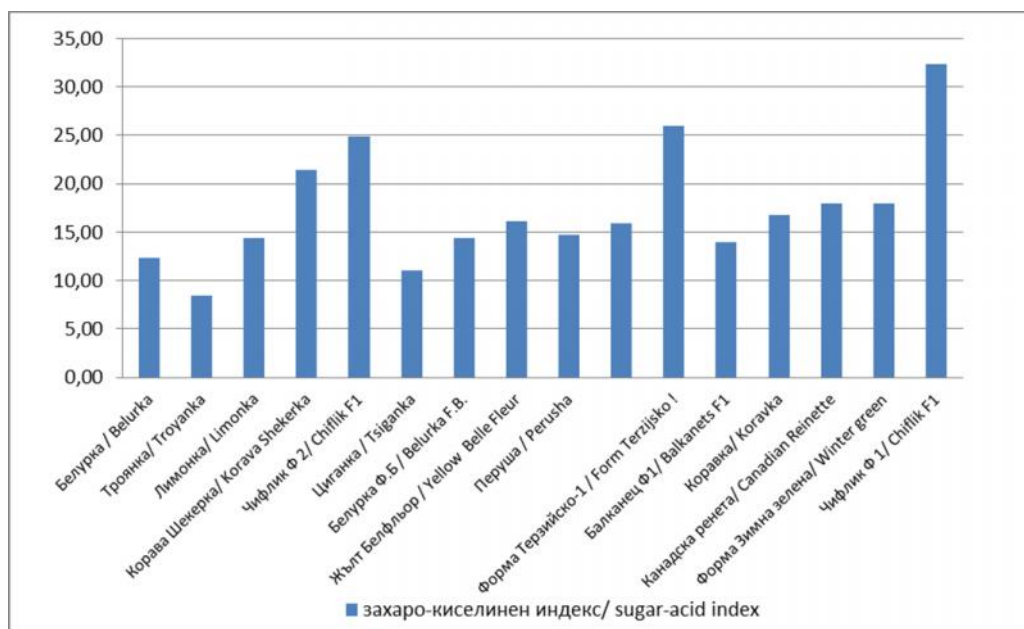


Fig. 4. Sugar acid index in apple forms and cultivars

The results in the present study show that 16 apple cultivars and forms are very diverse in terms of fruit skin colour, dry matter content, total sugars, pectin and organic acids.

This may be due to the specific geographical nature and different climatic characteristics. Most of them have increased resistance to the main diseases in apples, which allows their cultivation without the application of plant protection and makes them suitable for organic fruit production and selection.

## CONCLUSIONS

Based on the present study, it was found that the areas of the villages Balkanets, Chiflik, Beli Osam, Terziysko are characterized by a wide variety of large-sized apple fruit of local cultivars and forms.

The fruits have an attractive appearance, juicy and tasty fruit flesh, have good storage and have a rich biochemical composition. Forms, such as



(1,07%),	(1,98%),	'Perusha' (1.98%), 'Troyanka' (1.07%),
	2 (1,05%)	'Chiflik' F2 (1.05%) have a high content of pectin and could be an important raw material for its extraction.
		-
		-
		-
	9.20%,	Of interest for further research is 'Belurka FB', which has an interesting shape, attractive appearance, good taste, values of total sugars (9.20%), vitamin C (24.75 mg%) and weight (259) g.
24.75 mg%	259 g.	

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