

THE USE OF THE NEW APPLE HYBRIDS FRUITS WITH RED PULP IN THE FOOD INDUSTRY

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Abstract: Juice, compote, fruit chips, obtains from hybrids apple fruits was made and analyzed. Juice from red-flesh apples has attractive anthocyanin color, high content of antioxidants and a higher acidity. Stewed fruit of red-apple apples fully corresponds to the necessary indicators for organoleptic and chemical composition, but it has an unusual color for apple compote. Chips from red-flesh apples are the most promising type of products. Along with the conservation of anthocyanin in the drying process, they have a perfectly acceptable sugar-acid index and a high content of anthocyanins.

Keywords: *acidity, anthocyanins, apple hybrids, juice, natural dyes, processing, soluble dry matter, vitamin C*

INTRODUCTION

Fruits and berries are the most valuable raw material for the production of food products for therapeutic and prophylactic purposes, which have high antioxidant activity [1, 2].

One of the most interesting varieties for technological processing could be "apples with red flesh" apple varieties that have in their genotype the apple tree of Niedzwiecki (*M. niedzvetskiana*). Apple tree cultivars, in the origin of which the Apple Nedzwecki participated, are distinguished by the red flesh of fruits of varying intensity, and are a source of high content of ascorbic acid and polyphenolic compounds, including anthocyanins [3 – 11].

One of the first in the world and the first in Russia apples with red flesh apple varieties received in the early twentieth century I.V. Michurin. Initially, they were Rubinovoe and Yakhontovoe (*Y.Nedzvetsky* x Antonovka), and then the Red Standard (Pepin Shafrannyi x Rubinovoe), Komsomolets (Belfler - Chinese x Rubinovoe), Belfler Red and Belfler Record (Belfler-Chinese x Yakhontovoye) [3].

In the 30s - 50s it was planned to widely use them in the processing and confectionery industry (natural dyes), and thoughts were expressed about their "curative" value.

In many countries interest in apples with red flesh apple varieties as a source of anthocyanins and other antioxidants in fruits have increased again [12 – 17]. Fruits of such varieties could serve as a rich source of anthocyanins for the food and pharmaceutical industries.

Slightly grown clonal rootstocks of apple trees, obtained in the Michurinsk State Agrarian University as a result of long-term selection work, are interspecies hybrids of the genus *Malus* Mill. and possess a number of valuable features. They synthesized about 9 species of apple, 17 varieties, more than 10 rootstocks of domestic and foreign origin, as well as hundreds of hybrids of the first and third generations [1, 6]. Most of them have anthocyanin color of pulp of varying intensity [Figure 1 – 5].

Currently, as a result of a multi-year survey of the hybrid fund, we have identified the forms whose fruits can be promising for the production of various types of processed products, including those with a functional purpose.

MATERIALS AND METHODS

From fruit of 6 perspective apples with red flesh of hybrid forms juice of direct extraction, compote, fruit chips (infra-red drying) was made.

All the forms studied are matched to late maturity dates (August 15 - 30) and have anthocyanin color of flesh of different intensity. Organoleptic evaluation of processed products was carried out on a 10-point scale, such indicators as external appeal, color, taste, aroma, transparency, typical taste were taken into account.

The content of sugars was determined by Bertrand method, ascorbic acid in stained plant extracts using the iodometric method. Determination of the amount of soluble dry matter in the fruit was performed according to the refractometric method. P-active substances according to the method proposed [18, 19]. Experimental data were processed by variance analysis at the B. A. Dospheov [20] G. N. Zaitsev [21] using the software EXCEL (Microsoft Office Professional Plus 2010 license number 60788903).

RESULTS AND DISCUSSION

According to the organoleptic evaluation of juices from the fruits of forms 87-3-2, 69-4-450, Pomegranate exceeds the juice of Antonovka vulgaris according to this indicator. The highest organoleptic estimate of juice is the Granatnoe form (8.76 points on a 10-point scale).

In specially conducted hedonic tests (pleasurable tests) with a group of children, it was found those juices and their mixtures containing the highest concentrations of anthocyanins, for example a mixture of red grape juice and blueberry, were the most preferred [17] (Table 1).

Table 1. Chemical composition of juice from fruits of red apple hybrids

No.	Hybrids and varieties	Soluble dry matter [%]	Acidity total [%]	Sugar total [%]	Saccharic Acid Index	Vitamin C [mg/100 g]	Anthocyanins [mg/100 g]
1.	67-5(28)	14.3	1.07	12.59	11.8	5.9	12.8
2.	69-4-450	12.0	1.27	12.98	10.2	5.0	27.7
3.	82-26-2	14.6	1.06	12.90	12.2	6.3	11.8
4.	87-3-2	13.0	1.40	11.35	8.1	7.8	46.6
5.	88-5-110	15.8	1.10	11.93	10.9	8.9	13.5
6.	Granatnoe	15.8	2.2	13.60	6.1	6.2	64.0
7.	87-3-2 + Pamyat Yakovlevu	14.8	0.77	11.9	15.5	4.2	26.6
8.	Antonovka	10.8	1.1	9.6	8.7	5.1	-

One of the indicators determining the nutritional value of juice is the content of soluble dry matter (RSV). In accordance with GOST 656-79 (standard of the Russian Federation) of the highest and first grades of apples of summer varieties, there should be no less than 10.0 and 9.0 % RSV, respectively. In juice from the fruits of the studied forms, the content of RSV exceeds this index by 2.0 - 5.8 %.

The sugar and acid index characterizes the taste of juice. The sugar and acid juice index of the Antonovka common fruit is 8.7. To this value, the sugar-acid juice index of the form 87-3-2 (8.1) is closest. Juice from the fruits of this form is advisable to blend with the juice of the more sweet varieties.

The juice from the fruits of form 69-4-450, 67-5 (28) and 88-5-110 over the sugar-acid index exceeds the juice from Antonovka ordinary (10.2, 11.8 and 10.9 %, respectively) and is found by this indicator at the juice level from such varieties as Veteran, Orel winter, Rossoshan delicious [5]. The highest content of anthocyanins is characterized by forms 87-3-2 (46.6 mg/100 g) and Granate (64 mg/100 g). The high content of anthocyanins correlates with high acidity, low sugar index and, as a result, an excessively sour taste.

The same chemical composition and taste have juices obtained from foreign apple varieties abroad. So, according to the data of German researchers [10], the sugar acidity index of the juice from the fruits of the German red-cheeked variety Weirouge was 7.1,

the total titrated acidity was 1.2 %.

To increase the sugar-acid index to acceptable taste values, we attempted to blend apples with red flesh of apple juice with fruit juice from the Pamyat Yakovlevu. As a result, the acidity was reduced to 0.77 and the sugar index was increased to 15.5, although anthocyanins decreased from 46.6 mg/100 g to 26.6 mg/100 g against this background. And although the taste of the juice was improved, other organoleptic parameters were lower than in other variants, and the total organoleptic evaluation of the juice was 87-3-2 + Pamyat Yakovlevu was the lowest (8.04 points).

When studying the technological characteristics of varieties, such a product as compote is considered to be the most indicative, since it preserves the shape and size, color, taste, aroma of fresh fruits to the greatest extent [2]. After making compotes of 6 samples, their organoleptic evaluation was carried out.

In accordance with the existing standards for the production of compote, varieties with a weak or uncoated colour are preferred. If the fruits have a bright integumentary color, then, as a rule, they become unattractive in compote because of the destruction of pigments during heat treatment, which affects the tasting evaluation even with a good taste of the product [5].

Table 2. *The chemical composition of compote from the fruits of red apple hybrids*

No.	Hybrids and varieties	Soluble dry matter [%]	Acidity total [%]	Sugar total [%]	Saccharic Acid index	Vitamin C [mg/100 g]	Anthocyanins [mg/100 g]
1.	67-5(28)	25.5	0.74	17.85	24.12	3.5	8.35
2.	69-4-450	20.5	1.13	15.38	13.6	4.4	15.7
3.	82-26-2	25.6	1.01	20.48	20.28	3.0	7.8
4.	87-3-2	20.8	1.17	14.56	12.44	4.4	26.00
5.	88-5-110	26.4	0.67	18.48	27.58	2.6	19.00
6.	Granatnoe	20.0	1.70	14.11	8.3	5.3	40.00
7.	Antonovka	21.2	1.20	14.84	12.36	4.4	2.05

It should be noted that all the hybrids fruits studied in the work are characterized not only by the intensive covering color of the skin, but also by the colored pulp of varying intensity, which can reduce the organoleptic evaluation of compotes from them in accordance with existing standards.

None of the samples studied surpassed the control variant by the organoleptic parameters (Antonovka).

The highest values of the overall organoleptic evaluation of products are characterized by samples from the forms 87-3-2 and Granate (9.49 and 9.21, respectively). At the same time, these samples surpassed the control variant for aromaticity (1.95 and 1.80, respectively). Perhaps, this may indicate their more rich and diverse chemical composition. (Table 2, Table 3).

One of the indices determining the nutritional value of compote is the content of soluble dry substances (RSV) in it (Table 2). The nutritional value of compote from apples is due, first of all, to easily assimilated carbohydrates, organic acids, and P-active substances (anthocyanins). In accordance with the standard, there are three commodity

varieties of compotes - the highest, the first and the table (GOST 816-91), which differ in organoleptic characteristics, as well as the mass share of the RSV. Concentration of soluble dry substances in compotes of higher and first class must be at least 16 %. [5]. According to the content of RSV in syrup, all samples of compotes studied can be classified as higher or first grade. The high content of RSV (soluble dry substances) in the compote of the studied hybrids to a certain extent allows reducing the consumption of sugar in its production and, in the long term, due to this, it will increase profitability. The sample from the hybrid 87-3-2 was characterized by the closest index of the sugar-acid index to the value of the control variant (12.44 and 12.36, respectively). The sulfuric acid compote index from Garnet grade is inferior to control (8.7 and 12.36, respectively) and has a high enough for compote acidity (1.7). The sulfuric acid compote index of forms 67-5 (28) and 88-5-110 is almost 2 times higher than control and has a too sweet, unharmonic taste for apple compote.

Apple compote is a source of P-active substances - the most important antioxidants. Compotes from apples with red flesh are especially rich in anthocyanins. The highest content of anthocyanins was observed in samples from the Granatum and 87-3-2 forms (40.00 and 26.00 mg/100 g, respectively).

Apples with a high content of soluble dry matter are an excellent raw material for making dried fruits and apple chips. To date, one of the most popular types of dried products is fruit chips (snacks).

Prior to drying, apples are usually treated with a special solution that prevents oxidation and loss of fruit color. The most relevant and promising at the moment is drying with the use of infrared radiation. Infrared drying of food products, as a technological process, is based on the fact that infrared radiation of a certain wavelength is actively absorbed by the water contained in the product, but is not absorbed by the tissue of the dried product, so moisture removal is possible at a low temperature (40-60 °C) that almost completely preserves vitamins, biologically active substances, natural color, taste and aroma of the products undergoing drying.

Of the fruits of 6 apples with red flesh apple forms we made apple chips using infrared drying technology. Fruits were not treated with antioxidant solutions (ascorbic acid, etc.). The task was to establish not only the degree of change in the chemical composition of the product obtained, but also the resistance to oxidation and, as a consequence, to the preservation of the natural anthocyanin color of apples with red flesh-apple chips.

The highest organoleptic evaluation is characterized by chips from the fruits of forms 87-3-2 (9.65 points), practically at the level of the control variant (Antonovka - 9.64 points), and Granatnoe (8.58 points). Form 87-3-2 has the maximum values for taste (4 points) and color (0.5 points) (Table 3).

When removing moisture during the drying process, as one would expect, the content of sugars increased, along with the total content of soluble dry matter, while the acidity increased, but not so much. Thus, the sugar-acid index was from 9.4 (in Granatnoe to 17.93 in 67-5 (28)). An increase in the concentration of anthocyanins (by 1.5 - 2 times) was also observed, with the highest content of 87-3- 2 (181 mg/100 g) and Granatnoe (417 mg/100 g).

Table 3. Chemical composition of fruit chips from fruits of red apple hybrids

No.	Hybrids and varieties	Total acidity [%]		Sugar total [%]		Saccharic Acid Index		Anthocyanins [mg/100 g]	
		Fresh fruits	Chips	Fresh fruits	Chips	Fresh fruits	Chips	Fresh fruits	Chips
1.	67-5(28)	0.85	3.0	11.96	53.8	14.1	17.93	42.5	51.00
2.	69-4-450	1.70	4.0	9.40	42.3	5.5	10.58	94.3	122.60
3.	82-26-2	0.91	3.3	12.1	54.4	13.2	16.48	40.2	49.45
4.	87-3-2	1.40	4.3	11.56	52.8	8.3	12.30	159.5	181.00
5.	88-5-110	1.03	3.5	11.10	53.6	10.8	15.30	54.0	70.21
6.	Granatnoe	1.80	6.0	10.70	56,3	5.9	9.40	220.0	417.00
7.	Antonovka	1.00	2.5	10.1	18.6	10.1	7.40	-	17.50

Thus, the apples with red flesh of Michurinsky GAU breeding are promising raw materials for the production of various types of processed products with a functional orientation. Such products are characterized by a high content of antioxidants, especially anthocyanins, which are largely preserved by heat treatment.

CONCLUSIONS

Juice from apples with red flesh has anthocyanin coloration, confirmed by tests conducted abroad, high antioxidant content, but has an acidity that is high for apple juice, so it must be blended with sweet juices. Attempting to blend with pear juice slightly reduced acidity, but also significantly reduced the overall organoleptic evaluation. In this direction, more comprehensive research is needed, since the fruit and berry juice industry is the leading in the processing industry and the juice from apples with red flesh can be a very promising component in the blended juices.

Compote of apples with red flesh quite corresponds to the necessary indicators for organoleptic and chemical composition, but it has an unusual color for apple compote, which can create difficulties in selling products, in this direction, marketing research is needed.

Chips from apples with red flesh sabuyayutsya are the most promising in our opinion the kind of products. Along with the conservation of anthocyanin in the drying process, they have a perfectly acceptable sugar-acid index and a high content of antioxidants (anthocyanins).

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