

Grapes as a Valuable Source of Nutrition and Health

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ABSTRACT

Grapes is a valuable crop; it is not only an important nutritional source but also a product of multiple therapeutic characteristics. There are only 4 varieties of grapes adapted and officially approved for the Tambov region. Despite the narrow choice these varieties while being cultivated according to the covering system, can significantly extend the assortment of grapes, improve product quality and extend the consumption period. The berries of this culture in the Tambov region accumulate a sufficient amount of sugars and taste good.

Key words: Grape, New varieties, Quality of berries, Sugars, acids.

INTRODUCTION

The origin of the ampelotherapy (gr. Ampelos - grapes, therapeia - treatment), the treatment using the grapes, is dating back to the ancient times. Scientifically, the efficiency of this type of treatment was proved during the second half of the XIX century by the experimental studies of fresh grapes and their chemical composition products, as well as their therapeutic properties in clinical settings.

The products of this culture are successfully used while treating nephritis, nephrosis, gastritis, pulmonary tuberculosis, the colitis, chronic bronchitis, pleurisy, asthma; cardio-vascular diseases, gout, whooping cough, sore throat, neurasthenia, psycho-asthenia, urinary sand, kidney stones, anemia, etc. All these knowledge are necessary and important for the modern population of Russia, where the majority of the male population lives out only up to the age of 60!

The berries of fresh grapes contain up to 30% of easily digestible sugars: glucose, fructose, and small amounts of sucrose. Fructose is absorbed by the human body without the pancreas

participation, which is important while preventing the diabetes.

The fresh grapes also contain a large range of organic acids: malic, tartaric, citric, succinic, gallic, formic, oxalic, salicylic, and others. Grapes are rich in mineral salts: potassium (235 mg), calcium (45 mg), sodium (26 mg), phosphorous (22 mg), manganese, cobalt and iron. One hundred grams of fresh grapes provides 4% of daily intake of calcium, 1.6 of magnesium, 0.12 of phosphorus, 16.4 of iron, 2.7 of copper, and 16.6 of manganese. The grape peels are rich in colorants (pigments), complex tanning compounds, waxes, consisting of a mixture of fatty acids and glycerides.

Grapes are also rich in vitamins groups, such as: A, C, P, B (B2, B6, B12, etc.), and vitamin PP. The juice of berries contains thiamin (B1), pantothenic (B3) and nicotinic (PP) acids, pyridoxine (B6), and inositol⁸.

Knowing the importance of this crop, I.V. Michurin paid a great attention to the grapes during his research. "In fact, currently viticulture can be considered as one of the most solid foundations of agricultural welfare of the people who practice it. But hitherto all these benefits could only be used

by people living in warmer countries, while we, the inhabitants of the Northern and Central Russia, with its harsh climate, could not even think of breeding the grapes with industrial purpose⁴⁵.

Using the methods of outbreeding hybridization and re-crossing, Michurin obtained some series of winter-hardy grape varieties: Buytur, Russkiy Konkord, Korinka Michurina Arctic, Metallicheskiy, and others. A great contribution into the breeding of new grape varieties after I.V. Michurin's discoveries was made by the following scientists: I.S. Gorshkov, I.M. Fillipenko, L.T. Shtin, and etc. They have obtained more than 50 varieties, which are even nowadays considered to be the prominent ones. Currently, the State Register of breeding achievements in the Tambov region permits using only three varieties. These I.V. Michurin Central Genetic Laboratory's varieties are: Korinka Russkaya, Krasa Severa (Olga), and Neptune.

Recently, due to climate change and the emergence of new varieties, the interest of gardeners-amateurs to cultivated grapes has significantly increased. A survey conducted on the gardening plots of viticulturists-amateurs in the Tambov region (Tambov, Bondarsky District; Michurinsk and its surroundings) showed a significant increase in grape varieties assortment². As a result, in addition to the three mentioned above varieties, others were identified in the private gardens and kailyards. For example:

- White table grapes: Augustine, Alexa, Aleshinkin, Arcadia, Vostorg, Laura, Russkiy yantar, Tambovskiy beliy, Tuzlovsky velikan, Rafinad;
- Dark table grapes: Vostorg krasniy, Kodryanka 218, Krasa Severa, Nizina, Nina, Stashenskiy, Rusven, Favor;
- Seedless grapes : Korinka russkaya, Kishmish krasniy muscat, Kishmish Kluchekova, Kishmish lychistiy, Rusbol uluchshenniy, Bessemyanniy cherniy zimostoykiy ;
- Universal grapes: Vostorg muscatniy, Kristal, Platovskiy;
- Technical grapes: Amurskiy Potapenko – 2, Bianka, Bruskam.

Unfortunately, not all of the mentioned varieties fulfill the requirements of neither phytosanitary conditions nor productivity ones. Thereby the goal of the research was set. It was to carry out the economic and biological evaluation of new grape varieties and highlight the most prominent ones; those with elevated levels of agronomic and biological characteristics, as well as resistance to biotic environmental factors.

MATERIALS AND METHODS

The objects of the research were the following grape varieties: Arcadia (Nastya), Agate Donkoy, Bessemyanniy cherniy zimostoykiy (Pamyat Dombkovskoy), Beliy ranniy, Vostorg ovalniy, Vostorg krasniy, Kishmish luchistiy, Korinka russkaya, Kodryanka 218, Krasa Severa, Krystal, Liberty, Laura, Muscat yantarniy, Nizina, Russkiy yantar', Rusven, Tambovskiy beliy, Favor. The planting process of seedlings grown from shank was held in spring 2007 in the Tambov region on the territory of Michurinsk State Agrarian University Pedagogical Institute agrobiostation. The observations were held during 2009-2012 years.

The cultivation of grapes was carried out on the four wire trellis. The bottom wire was located at a height of 50 cm from the soil surface. The remaining ones were placed with the interval of 50 cm from one another. The layout of the vines was 3 x 2.5 m.

A vine forming was done according to the fan four sleeves forming method. The repetition was 6-10 folds. Each separate plant was considered as a repetition.

While studying the annual cycle of grape variety, we used the methods of field, vegetation and vegetative field research of the North Caucasian Zonal Research Institute of Horticulture and Viticulture⁷. The observations were done by 6-10 vines of each variety.

The level of leaves and fruits damage by mildew and powdery mildew was determined by eye and were evaluated according to the following scale:

Damage for 75 – 100%	- 5 points
-/ 50 – 74	- 4 points
-/ 25 – 49	- 3 points
-/ 5 – 24	- 2 points
-/ single and less than 5 %	- 1 point
No damage	0 points

The fruiting coefficient was determined by dividing the number of bunches by the total number of developed shoots. The percentage of the productive shoots was determined by dividing the number of productive shoots by the total number of shoots. The fruitfulness coefficient was determined by the number of inflorescences per productive shoots.

In order to estimate the yield of the studied varieties, the preliminary (biological) account was provided. Firstly, the number of bunches of all the bushes was counted. Secondly, the average number of bunches per plant was calculated. And thirdly, the calculation of the biological yield using the data of average weight and the average number of the bunch was accomplished.

In order to determine the mass of grapes, the bunches were collected from the different sides of the bush, they were weighed and the result was divided by the number of bunches. To obtain the mass of the berries, 500 of them were collected from the different parts of a bunch, weighed, and the obtained result was divided by the total number of berries.

RESULTS AND DISCUSSION

A study of the fruiting features of grape varieties is crucial for the cultivation and the development of high-quality farming. The determination of fruiting varieties nature depends on the ratio of fertile shoots to their total number, as well as the number of bunches per productive shoot and their total number.

On average, during 4 years of observations, the percentage of fruit-bearing shoots, depending on the varieties was ranged from 45.0% for Tambovskiy beliy variety to 78.3% for Agate Donskoy. The average indicator for the majority of the varieties was in between 60 and 70%.

The analyses of the fruitfulness coefficient shows that on average, the majority of varieties during 4 years had 1.2 - 1.5 bunches per productive shoot. Slightly higher coefficient (1.5) was obtained for Arcadia, Vostorg oval'niy varieties; while the coefficients 1.7 and 1.8 were obtained for Muscat yantarniy and Pamyat Dombkovskoy varieties. 2.2 bunches per productive shoot were observed for Liberty variety.

The fruiting coefficient (0.8 - 0.9) was obtained for Kodryanka 218, Muscat yantarniy, and Liberty varieties. The greater fruiting coefficient (1.1 - 1.6) during the three years of research was common for varieties with a high fruitfulness coefficient (Beliy ranniy - 1.1; Vostorg ovalniy - 1.1; Krystal – 1.1; Pamyat Dombkovskoy – 1.2; Muscat yantarniy - 1.4; Liberty - 1.6).

High yields and good quality fruits are the necessary conditions for successful cultivation of grapes in the northern regions.

According to Y.I. Potapenko⁶, by the 4th year of vines growth the average yield for Seedling Malengra, Malengrr ranniy, Calabria, Shassla rozoviy varieties is 4-6 kg per vines. So if the planting density is 2,500 vines per hectare, the yield of 100 centners per hectare is attainable. Having such yields, according to Y.I. Potapenko, the development of industrial viticulture in the central Russia becomes reasonable.

The obtained results (Table 1) show that the cultivation of new grape varieties can considerably increase the yield. It is important to underline that the main components of the yield are the number of bunches per vines as well as the weight of the bunch.

Thus, despite a sufficiently great number of bunches for Korinka Russkaya (36), their weight was only 84 grams (Table 1). So the yield was 3.24 kg per vines or 43.2 centners per hectare. At the same time the varieties Tambovskiy beliy, Liberty, Muscat yantarnyy and Pamyat Dombkovskoy, having lighter bunches but greater number of them, provided 114.6; 115.1; 118.2, and 191.6 centners per hectare, respectively. The relatively low yield (58.7 centners per hectare) was observed for Agate

Donskoy. This fact can be explained by a small number of bunches per vines, although the weight of the bunch was up to 280 g. 4 years average yield for Krasa Severa (Olga) variety was 80.4 centners per hectare. The average weight of this variety bunch was 243 g.

Slightly better yield than from Krasa Severa was obtained from Russkiy yantar (103.4 centners per hectare) and Krystal (126.6 centners per hectare) varieties. These varieties are characterized by the significant number of bunches and weight: 314 and 354 g.

The higher average biological productivity (276.3 centners per hectare) was observed for Arcadia. A characteristic feature of this variety is the formation of a large amount of bunches with an average weight of 657 g per bunch. The most significant weight was observed for the following varieties: Laura (916 g), Favor (796g), and Arcadia (657g). The average biological yield of Laura variety during 4 years was 172.1 centners per hectare.

The consumer demand depends not only on the yield of vines, but also on the weight, size, and attractiveness of bunches.

The varieties Laura, Favor, Nizina, Nina, Arcadia, Kodryanka 218 had the biggest and the heaviest berries. Thus, when having the size of 29 x 34 mm, the average weight of Laura berries was 10.3 g; Favor berries were 24 x 30 mm with a weight of 8.9 g; Nizina and Arcadia berries' weight was within 6.4 – 8.5 g. They contain sugars and organic acids which could be used for technical processing.

The researchers and manufacturers are very interested in the nature of sugars accumulated in grapes. It is well known that fructose is sweeter than the other sugars. Thus, a 15% fructose solution gives the same sweetness as 22.8% glucose or 17.8% sucrose solutions⁹. Therefore, the selection of fructose predominating forms of grapes becomes an important factor while breeding the early table grape varieties or those ones which will be cultivated in more northern areas.

Table. 1: 4 years average biological yield of grape varieties, planted 2.5 x 3 m (1333 vines per hectare)

Variety	Weight of bunch, g.	Weight of yield per vines, kg.	Productivity, centners per hectare
Agat donskey	280.0	4.302	58.7
Arcadia	657.0	20.72	276.3
Beliy ranniy	493.0	18.84	250.0
Besemyanniy cherniy zimostoykiy (BCHZ)	341.0	14.37	191.6
Vostorg ovalniy	338.0	12.31	164.0
Ovalniy krasniy	431.0	7.73	103.1
Kishmish luchistiy	412.0	9.78	130.4
Korinka russkaya	84.0	3.24	43.2
Kodryanka 218	437.0	11.48	153.1
Krasa Severa	243.0	6.03	80.4
Krystal	354.0	9.50	126.6
Liberty	130.0	8.64	115.1
Laura	916.0	12.91	172.1
Nizina	671.0	14.46	192.8
Nina	612.0	15.14	201.8
Russkiy yantar	314.0	7.75	103.4
Tambovskiy beliy	225.0	8.60	114.6
Favor	796.0	22.02	293.5
Muscat yantarniy	183.0	8.87	118.2

In addition to monosaccharides the grapes accumulate the small amounts of sucrose. The sucrose level can be considered as an indicator of physiological ripeness of the grapes.

Grapes also contain considerable quantities of organic acids. The bulk of tartaric and malic acids are about 90%. Moreover, the low concentrations of oxalic, glycolic, succinic, citric acids are also detected. The dynamics of the total amount of acid is opposite to the sugars one; the total amount of acid is decreasing while the berries are getting ripen.

The content of sugars, acids, and sugar/acid ratio (index of sugar and acid) in the berries depends on numerous factors. The most important of them are the biological features of a variety growth environment. For example: the duration and intensity of the sun, the total amount of heat, soil conditions, latitude and altitude, agricultural machinery, and others.

The identification of new varieties with a high content of biologically active substances,

sugars and a harmonious ratio of organic acids for a particular growing area is getting more and more important.

2009 and 2010 are the most informative years because the weather conditions were the most dramatically different during all 4 years of research. The year 2009 had relatively soft and close to the average conditions of the growing season, while the year 2010 had hot and dry ones.

The capacity of solids, sugars, and vitamin C accumulation is the important characteristics of grape varieties. It should be mentioned that the highest content of soluble solids (SS) in 2009 was detected in the following varieties: Muscat yantarniy (22.4%), Korinka russkaya (20.5%), Tambovskiy beliy (20.5%), Belyi ranniy (19.5%).

Relatively high content of soluble solids was detected in the technical varieties Liberty and BCHZ (Bessemeyanniy cherniy zimostoykiy, Pamyat' Dombkovskoy). Favor (11.4%) and Agate donskey (13.2%) had accumulated less soluble solids than other varieties.

Table. 2: Characteristics of bunches and berries of grape varieties, average over 4 years

Variety	Weight bunch, g	Weight berry, g	Weight crest, g.	Number berry, unit.	Weight 1 berry, g	Width berry, mm	Length berry, mm
Agat donskey	280.0	261.0	19.0	63	4.4	15	20
Arkadia	657.0	642.0	15.0	76	8.4	21	29
Belyi ranniy	493.0	468.0	25.0	204	2.3	19	21
BCHZ	341.0	332.0	18.0	218	1.5	12	15
Vostorg ovalniy	338.0	315.0	22.0	62	5.1	19	23
Ovalniy krasniy	431.0	414.0	17.0	147	2.8	18	22
Kishmish luchistiy	412.0	390.0	22.0	178	2.2	14	22
Korinka russkaya	84.0	66.0	18.0	144	0.5	9	10
Kodryanka 218	437.0	425.0	12.0	93	4.6	17	32
Krasa Severa	243.0	222.0	21.0	111	2.0	15	18
Krystal	354.0	336.0	18.0	147	2.3	16	19
Liberty	130.0	118.0	12.0	141	0.8	14	15
Laura	916.0	897.0	19.0	87	10.3	29	34
Nizina	671.0	648.0	23.0	87	7.4	25	28
Nina	612.0	587.0	25.0	91	6.5	23	26
Russkiy yantar	314.0	300.0	14.0	90	3.3	14	15
Tambovskiy beliy	225.0	202.0	23	67	3.0	12	16
Favor	796.0	777.0	19	87	8.9	24	30
Muscat yantarniy	183.0	169.0	17	84	2.0	17	19

The varieties having the largest and the most attractive fruits, such as: Arcadia, Kodryanka 218, Laura, and seedless Kiqhmish luchistiy, had occupied the intermediate position of the soluble solids content. They had accumulated 16-18% of soluble solids.

The following large-fruited varieties: Nina, Nizina, Favor, and Agate donskoy contained less soluble solids; they had lower level of sugars, higher content of acid, and consequently, they had lower ISA (index of sugar and acid).

According to K.D. Stoev⁹, each change of the temperatures sum on about 200°C, the grapes sugar content also changes on about 1%. This regularity was also determined while providing the sugar content analyses of the grapes collected in 2010, and comparing them to the results of 2009.

The highest accumulation of vitamin C during 2009 vegetation year was observed for the following varieties: Belyi ranniy, Korinka russkaya, Kodryanka 218, Russkiy yantar, Muscat yantarniy, Laura, Liberty, and Krystal. Whereas, in

2010 the varieties: Vostorg krasniy, Muscat yantarniy, Laura, Krasa Severa, BCHZ, Vostorg oval'niy, and Liberty had the highest accumulation of vitamin C. However, the total vitamin C content, for the majority of varieties, in 2010 decreased, comparing to the 2009 one.

At the same time the homeostasis of this indicator depended on the particular features of the variety. Thus, the greatest variability should be pointed out for Belyi ranniye (22 mg% and 8.4 mg%), Korinka russkaya (21.5 mg% and 11.4 mg%), Kodryanka 218 (19 mg% and 9.7 mg%).

Much less pronounced response to the changing weather conditions was observed for Muscat yantarniy, BCHZ, Vostorg ovalniyl, Kishmish luchistiy, Liberty, Laura, Nizina, and Nina. In 2010 the variety Krystal had a slight increase in the content of ascorbic acid, 13.2 mg% comparing to 12.3 mg%, in 2009.

Thus, in different weather conditions during the observation period, the highest content of soluble solids and sugars was detected for the

Table 3. Biochemical composition of grapes, average over 4 years

Variety	SS %	Total sugars, %			Titre acids %	ISA	Vit C. mg/%
		Mono-	Di-	Sum			
Agat donskoy	14.0	10.7	0.3	11.0	1.11	10.3	9.7
Arkadia	15.6	13.3	0.6	13.9	0.41	35.0	9.7
Belyi ranniy	19.4	17.2	0.6	17.8	0.33	52.0	15.2
BCHZ	19.5	15.8	0.3	16.1	0.75	21.4	13.7
Vostorg ovalniy	18.4	14.6	1.8	16.4	0.41	42.3	13.1
Vostorg krasniy	19.1	17.8	0.8	18.6	0.40	45.1	15.1
Kiqhmish luchistiy	17.6	15.9	1.0	16.9	0.44	38.2	13.2
Korinka russkaya	21.6	17.2	1.1	18.3	0.52	35.2	16.6
Êodryanka 218	16.9	13.7	0.7	14.4	0.45	31.1	14.8
Êrasa Severa	19.2	16.6	1.2	17.8	0.50	35.6	16.1
Êrystal	17.5	15.0	1.3	16.3	0.62	26.3	12.6
Liberty	22.4	17.2	1.5	18.7	0.71	26.3	14.7
Laura	16.6	14.7	1.1	15.8	0.7	22.6	15.3
Nizina	15.7	11.0	1.0	12.0	0.63	19.0	11.4
Nina	14.2	12.1	0.8	12.9	0.75	17.2	12.2
Russkiy yantar	18.8	17.5	0.8	18.3	0.42	43.8	14.7
Tambovskiy belyi	21.5	17.8	1.8	19.6	0.5	39.2	12.2
Favor	11.7	9.5	0.3	9.8	0.7	14.0	9.3
Ïónêàò ÿìàðíúé	22.6	19.5	0.9	20.4	0.45	45.3	16.5

Those changes caused negative impacts on the plants world, and the grapes are not exceptions. Nowadays we observe the loss of grapes stability toward the meteorological changes, pests and diseases; especially towards the mildew and oidium, most common diseases in Chernozemye. According to our observations, due to the appearance of the new, more adaptive varieties, it is possible to cultivate the grapes with good marketable qualities, while decreasing the quantity of chemical products. One of the objectives of our research was to study the grape varieties resistant to mildew and oidium, the most common diseases.

During 2010 vegetation season the most vulnerable varieties towards mildew were Tambovskiy beliy and Korinka russkaya. In 2009 the resistance of these vines was obtained only after 5-times spraying them with oksihom and Bordeaux mixture 1%. Whereas in 2009, the other varieties were treated with oksihom only twice.

The foliage of the vines sprayed twice with oksihom was damaged by mildew according to 5 and 4 points, while the berries were damaged only to 3 points. Significantly larger lesions by mildew and oidium were observed during 2011 vegetation season.

The damages caused by the mentioned diseases were observed for all the varieties, but the degree of the damage was different. As well as in 2010, the greatest damage by mildew (4.5-5 points) was observed for Korinka russkaya, Tambovskiy beliy, and Krasa Severa. It is also important to mention that the fruits of Tambovskiy beliy and Korinka russkaya were severely damaged

(3.5 – 4 points), while the fruits of Krasa Severa were damaged less (1.8 points).

Among the varieties which were damaged by mildew according to 3 – 3.5 points are: Agate donskoy, Rusven, Pamyat' Dombkovskoy. The varieties damaged to 2 – 2.5 in 2011 points are: Belyi ranniy, Vostorg ovalniy, Vostorg krasniy, Kodryanka 218, Nina, Nizina, Muscat yantarniy, Russkiy yantar, and Favor.

In 2010 there were no berries damaged by oidium, but in 2011 the damages of 1.5 – 2 points were observed for Korinka russkaya and Krasa Severa.

Thereby, the most resistant varieties against mildew and oidium are: Arkadia, Belyi ranniy, Vostorg ovalniy, Kodryanka 218, Krystal, Liberty, Laura, and Favor. The cultivation of the mentioned varieties not only allows to reduce the production cost and the labor time, but also to protect the fertility of the soil as well as the environment of the garden agroecosystems.

The results of this research show that in the Tambov region, while practicing the covering system, it is possible to successfully cultivate new promising large-fruited and large bunched grape varieties for table or technical purposes and to obtain the yield of up to 20 – 22 kg per vine (more than 200 centers per hectare). The correct selection of the varieties permits to reduce the pesticide pressure to the plants adapted to more northern territories (the pesticide pressure will be significantly more important if to cultivate those varieties more south) and to obtain environmentally cleaner grapes.

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