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CHEMICAL COMPOSITION OF FRUITS OF A FEIJOA (F. SELLOWIANA) IN THE CONDITIONS OF SUBTROPICS OF RUSSIA

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ABSTRACT

The feijoa is culture quite widespread on the Black Sea coast of Russia. Difficulties are connected with absence in Russia of grades. All gardens have only the mix of grades, which is grown up from seeds. At institute are going of work on creation of productive varieties, with good quality parameters. Data on chemical and biochemical composition of fruits of high-yielding forms of a feijoa are provided in article. After carried-out selection work we selected a large number of perspective forms of a feijoa (more than 50). However not all of them was repeated by the results on productivity and were excluded from works on further studying. For today after rejection there were no more than two tens perspective forms. They differ from each other on productivity, terms of maturing and quality of fruits. On efficiency the D-1 forms (Dagomys), 0-01 (Country) and 10-22 are allocated - productivity of fruits (on the average in 7 years) made respectively 33.3, 20.1 and 12.4 kg from a bush. The plants are sorted out according to the productivity, ripening terms and fruit quality. It is defined that early ripe grades are characterized by higher activity of oxidizing enzymes (263.1 $mL.O_2.g^{-1}$). In a zone of damp subtropics the grades containing increased quantity of carotinoids are steadier (0.31 $mg.g^{-1}$). The contents in fruits of a feijoa of such substances, as vitamin P, P-active and pectin substances, ascorbic acid, macro and microelements are revealed. Fruits of a feijoa are differed the increased accumulation of sugars, at some forms the content of sucrose prevails over amount of monosaccharide. High accumulation of vitamin C (41.89 - 78.68 $mg.dL^{-1}$) is noted. But we don't confirm the high content of iodine in fruits. Fruits of a feijoa can be considered as potential raw materials for production of canned products with a functional purpose.

Keywords: feijoa; form; vitamin; sugar; catalase; pigment; sugar-acid coefficient

INTRODUCTION

Among the subtropical orchard grows on the Black Sea coast of Russia, a feijoa is conceded to grow only in the area with persimmon. The homeland of a feijoa is the subtropical zone of South America. For the first time plants of a feijoa were described by Otto Carle Berg in 1854 under the name *Orthotemon Sellowianus*. Till then was this sort only identified by R. Brown as a part of *Gentiaceae* family. Berg replaced the name of the sort *Orthotemon* with Feijoa, in honor of the well-known naturalist Joani de Silva Feijoa who became further the director of San Sebastyan`s museum of natural history (Brazil). Subsequently this name (feijoa) was accepted everywhere. Into Russia the culture was introduced for the first time in 1900, and in a subtropical zone of Krasnodar region in 1930 is delivered. In total in damp subtropical areas under this culture about 300 hectares are occupied now. The feijoa is ranked high in decorative gardening that was promoted by its beautiful silvery leaves and unusual bright crimson-red flowers with white-pink fleshy petals. Feijoa perfectly fits in a humid climate of Sochi where are grown 70 – 80-year old plants, which are one of, oldest in country. Usually it grows a bush with 4-6 trunks and approximately 2.5 meters high. The crown expands in width up to 3 meters. In the conditions of subtropics of Russia vegetation begins at a temperature of 10 °C with 200 – 220 days of vegetation period. Unlike metioned above citrus feijoas is rather frost-resistant and maintains temperature fall to -10 °C. It is unpretentious to soil conditions and grows on soils of various types. Near Sochi - feijoa is grown up by nearly 70 thousand gardeners on farmer sites, in the agricultural organizations. Now, all existing plantings of a feijoa in a subtropical zone of Krasnodar region represent mix of hybrid forms which in the biological and morphological relation are characterized by huge variety, differing from each other not only on productivity and frequency of fructification, but also by the size of fruits and their taste.

In the conditions of damp subtropics of Russia there are special conditions for cultivation of many subtropical cultures that influences the biochemical structure of their fruits. The Black Sea coast of Krasnodar region is the most northern border of subtropics, which begins from the southern border of the Tuapse area in the north to frontier with Abkhazia (river of Psou) in the south. Damp and rather warm climate of this zone is caused by existence of the mountain ridges reaching around Sochi 3000 - 3500 m, playing a role of a barrier to penetration of cold winds. At the same time they detain on the coast warmly and moisture, creating high humidity of air and abundance of a

precipitation. So, the quantity them in Sochi make 1534 mm, in Tuapse - 1264 mm. The vegetative period here is shorter (185 - 200 days), it is less and the sum of temperatures (3000 - 3300 °C against 4100 °C in Anaseuli, Georgia). In Krasnodar region during the droughty period the maximum daily temperatures in the soil in the horizon 20cm reach 32°C. In the territory of Krasnodar region January is coldest month. However negative average monthly temperatures here happen seldom. One of important conditions for studied cultures is repeatability of temperature minima and their duration. Rather severe winters on the Black Sea coast of Krasnodar region repeat on the average each 12 - 15 years. At the same time, according to **Gutiyev et al. (1977)**, in Sochi winters with snow cover are quite rare, it low-power and sticks on the average to 8 - 10 days in a year. And studying of biochemical structure of fruit plants in such unique conditions is actually. Difficulties are connected with absence of grades in Russia. All gardens have only the mix of grades, which are grown up from seeds. Inspection of a plantation of institute (area of 1. 2 hectares) showed that among of 739 bushes of a feijoa, which were planted in 1978, 1.7% is high-yielding plant, 50.3% - low-yielding and 48% of plants have single fruits. Similar results were made for others a plantation of the feijoas, which are available around Sochi (state farms at Matsesta, Adler, etc.). There is carrying out a work on creation of productive varieties, with good quality parameters at the institute.

Early researches on studying of a chemical composition of feijoa fruits were conducted by the staff of laboratory of biotechnology, physiology and biochemistry of plants in the 80th years of the XX. century **(Koval et al., 1984; Voronzov et al., 1950)** that became a basis for allocation of the most perspective forms. However these works weren't completed.

In recent years at institute a large number of forms (more than 50), which differ in efficiency, were selected. Among them is perspective the forms of D-1 (Dagomys), 0-01 (Dachnaja) and 10-22 which on the productivity (on the average in 7 years) are made respectively 33.3, 20.1 and 12.4 kg. The form of D-1 differs not only in the general efficiency, but also in the mass of a fruit reaching in separate years (differences were 150 - 160 g). All forms, which allocated on terms of ripening, were divided on early-ripening (ripening in 2-3 decade of September - 1 decade of October), mid-season (2-3 decades of October - 1 decade of November) and late-ripening forms (November - the beginning of December). The more earlier are forms 8-10 (September) and 0-01 (Dachnaja). Fruits which are characterized by maturing in the first decade of September are preferred by reason of more simply realization of harvesting, absence of autumn rains and frosts, production has a trade appearance and better transportationmiss.

MATERIAL AND METHODOLOGY

Objects of researches were 18 of the most perspective forms of the feijoa, differed on terms of ripening, productivity and mass of fruits. Definition of biochemical indicators was carried out by the conventional techniques. Control is the grade of Superba, which is considered as the best grade. Fruits of this grade can reach 200g. Adult plants maintains to -12 frost degrees. Feijoa fruits used for experiments were in the period of a technical maturity (10-20 November). Studied biochemical parameters: dry matter - by drying samples to constant weight at t = 100 °C **(Gunar, 1972)**; content of sugars (glucose, sucrose, fructose) by methods of Bertrand **(Voznesensriy et al., 1962)**; content of ascorbic acid (vitamin C) - iodine's method **(Pochinok, 1976)**, total acidity - titration with 10 N NaOH **(Pochinok, 1976)**. For physiological researches were selected leaves at a stage of a physiological maturity. Objects of physiological researches were only grades of a feijoa of Superb (control), D-1 (Dagomys) and 8-10 (September). We studied enzymes from oxidation-reduction group (catalase) and the contents of photosynthetic pigments. Activity of catalase enzyme was studied by the gasometrical method made by **Gunar, (1972)**, content of chlorofills and carotinoids - of method by **Shlyk, (1971)** in extract for 100% acetone.

Statistical analyze of results of researches - methods of the correlation and cluster analysis, applying a package of the statistical programs Statgraphics Centurion XV.

RESULTS AND DISCUSSION

The biochemical structure of fruits is formed under the influence of the sheet device. It is known that the metabolism in leaves is made with the participation of a number of enzymes. According to some authors **(Chirkova, 2002; Golodriga et al., 2002**) activity of a catalase depends on vegetation phases a little, thus, positive correlation between activity of a catalase and duration of the vegetative period is noted. By us it is shown that at an early ripe grade of 8-10 (September) activity of enzyme is less, than at late-ripening grades of D-1 (Dagomys) and Superb.

Except ferment`s systems and the pigment`s system of a leaf participates in processes of assimilation of biochemical components. The content of chlorophyll *a* and *b* would be an indirect indicator of photosynthetic activity of plants. It is established that content of a chlorophyll at a grade of 8-10 (September) is significantly higher, than at other studied grades that defines more active synthetic processes at this grade. Unlike chlorophyll carotinoids not only characterize photosynthetic activity, but also take part in protection of a plant against influence of abiotic stressor. We defined that grades of 8-10 (September) and Superb are steadier against adverse factors of a zone of damp subtropics of Russia, namely – a drought. The content of carotinoids in leaves of these grades is significantly higher, than at a grade of D-1 (Dagomys). Therefore, we can recommend these grades for cultivation in our climatic conditions of subtropics of Russia.

Results of long-term monitoring of biochemical structure of fruits of the allocated forms of a feijoa are presented in Table 2. In feijoa fruits at forms 8-20, 10-6 and 8-10 (September) had the greatest accumulation of dry matter. Fruits of forms 4-3 and 8-10 (September) differ in increased accumulation of sugars, and, at forms 4-3, 6-3, 8-10 (September), 10-11 and 10-21 content of sucrose prevails over amount of monosaccharide. Parameters of the general acidity are in studied fruits ranging from 0.94%

(form 11-8) to 2.47% (form 8-20). The ratio of content of sugars and the general acidity is important because defines optimum flavoring features of fruits and is classified as sugar-acid coefficient. The most harmonious combination of sugar and acids is noted at forms 4.3, 6-3, 12-5, 11-8 and 8-10 (September) as this indicator in their fruits is 1.3 - 1.7 times more than control (sugar-acid coefficient is equal to 4.0 relative units).

Also the value of fruits of a feijoa is connected with the content of vitamin C, which is ranging from 41.89 to 78.68 mg.dL^{-1}. that is equally to the contents of this important component in a citrus, wild strawberry or cabbage. And in 10 forms among investigated the amount of vitamin C is more than 50 mg.dL^{-1}.

Except the biochemical analysis of forms of the feijoas, which are grown up on a plantation of institute, we investigated the general chemical composition of fruits. The contents in fruits of a feijoa of such valuable substances, as vitamin P, P-active and pectin substances, ascorbic acid, macro and microelements are important (Table 2). The analysis showed existence in fruits of a large number of phenolic connections, among them - catechins and leucoanthocyan, that impacting to fruits knitting relish, but they are containing mostly in a peel.

Fruits of a feijoa are attractive to the consumer not so much thanks to specific taste and aroma of fruits, but because of very high content of a digestible form of iodine **(Melkadze, 2007)**. According to **Sergeyev (1934)** content of iodine in fruits are about 3 mg.dL^{-1}.that much more surpasses the content of iodine in foodstuff rich with iodine both vegetable, and an animal origin. However the author notes that these plants grew in a seaside zone, the soil about them were in addition covered with seaweed and probably these factors led to increase the content of iodine in fruits. At the same time, in the fruits, which have been grown up in the Batumi botanical garden, researchers didn't establish existence of a large amount of iodine. An

Table 1 Physiology and biochemistry characteristic of leaves of perspective grades of a feijoa

Forms	Activity of a catalase ml O_2.g^{-1}	C a+b mg.g^{-1}	C car. mg.g^{-1}
Superb (control)	362.0±13.5	1.00±0.07	0.31±0.02
D-1 (Dagomys)	298.6±50.3	1.16±0.09	0.26±0.02
8-10 (September)	263.1±28.0	1.29±0.01	0.31±0.08
The smallest distinction at 95 % level	90.79	0.15	0.08

Table 2 Biochemical composed of a feijoa

Forms	Dry matter, %	Ascorbic acids, mg.dL^{-1}	Acidity, %	Sucrose, %	Monosaccharide,%		Sugar-acid coefficient
					fructose	glucose	
Superb (control)	16	48.12	1.75	3.03	2.8	1.17	4.0
0-01 (Dachnaja)	12	50.51	2.30	2.69	2.16	1.11	2.6
D-1 (Dagomys)	17	42.62	1.87	4.02	2.69	1.47	4.3
8-10 (September)	22	50.46	1.41	4.41	2.3	1.47	5.8
3-3	17	48.58	1.99	3.34	3.02	0.83	3.6
4-3	23	53.13	1.75	5.9	3.39	0.41	5.5
6-3	17	48.92	1.54	4.28	2.94	0.8	5.2
6-24	16	51.04	2.26	2.9	2.8	0.75	2.9
8-20	20	59.58	2.47	2.91	1.4	1.14	2.2
8-24	19	49.62	1.84	2.15	2.22	0.99	2.9
9-3	19	54.74	1.92	3.72	4.32	0.16	4.3
10-6	22	43.21	1.63	3.36	2.12	1.06	4.0
10-11	17	54.21	1.39	4.21	3.6	0.07	5.7
10-21	17	50.51	1.88	4.02	2.97	0.23	3.8
10-22	12	49.72	2.1	3.23	2.83	0.34	3.0
11-8	16	41.89	0.94	3.23	1.87	1.33	6.8
12-5	15	75.68	1.43	3.17	2.87	1.13	5.0
12-8	18	52.19	1.7	3.53	2.23	0.95	3.9

Table 3 Chemical composed of a feijoa (at 100 g)

Parameters	A peel	A fruit pulp
Vitamins (mg.dL^{-1})		
Ascorbic acids	47.2	37,1
β-carotene	0.66	0,32
P-active substances (mg.dL^{-1})		
Catechine	153.0	81,0
Leucoanthocyan	109.8	69,6
Nutrient (mg.dL^{-1})		
Potassium	100.0	
Sodium	13.8	
Calcium	17.5	
Magnesia	8.2	
Iron	0.5	
Iodine (mkg %)	0.34	

increase of the content of this element in fruits contactsonly with proximity to the sea **(Voronzov et al., 1950)**.

Earlier biochemical analyses of fruits of the feijoas which have been grown up on a plantation of all-union scientific research institute of floriculture and subtropical cultures which is located in 500-700 meters from the Black Sea, showed that the accumulation of iodine in a feijoa is small **(Omarov et al., 2003)**. Our last researches confirmed these data. The content of iodine in feijoa fruits is a small and makes about 0.34 mkg % (Table 3).

CONCLUSION

Thus, researches showed that the forms allocated by us are differed in high productivity and high quality of fruits. As a result of physiological researches is defined perspective for cultivation in climatic conditions of subtropics of Russia of the grade (Superb and Dagomys), characterized by the raised contents in leaves of carotinoids that defines their resistance to a drought. As a result of biochemical researches the chemical composition of forms of a feijoa, which are growing at the institute, is established that shaped features cause them. And, feijoa fruits, possessing high biological value thanks to presence of β-carotene, vitamin C, R-active agents and a complex of valuable macro elements, can be considered as potential raw materials for food of guests, inhabitants of the resort and production of canned food of a functional purpose. Chemical composition of a feijoa forms macro - and micronutrients. The content of solids varies from 12% (form 10-22) to 23% (form 4-3). Generally for fruits of a feijoa the content of the sugar presented by fructose and glucose is characteristic low (no more than 4,28%). In the conditions of damp subtropics of Russia fruits of a feijoa differs by the low acidity, which is in limits 0,94% (form 11-8) - 2,47% (form 8-20). Availability of pectin gives a feijoa preventive effect caused by good solidification of a product for production of configure and jam. In a feijoa are the complex of phenolic connections (catechins and leucoanthocyan) which cause P - vitamin activity and gives the fruit an astringent taste In studied group of forms of a feijoa the amount of catechins varies from 81 mg (in pulp) to 153 mg/100g (peel). The contents of leucoanthocyan are 1.2 times lower than the content of catechins.

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