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RESULTS AND PROBLEMS OF BREEDING ALTERNATIVE BERRY CROPS IN BELORUSSIA

Anna Batchylo, Maryna Shalkevich, Olga Kamzolova

Belorussian Research Institute for Fruit Growing, Samohvalovci, Belorussia

Introduction

Insufficient supplies of vitamins and antioxidants create an extremely unfavorable situation, which poses a real threat not only to health but also to the survival of tee nation. This insufficiency is of a polyhypovitamin character and persists during the summer and the autumn.

Table 1; Tabela 1

Biochemical composition of alternative berry crops fruits, 1993–1995
Skład biochemiczny owoców alternatywnych roślin jagodowych, 1993–1995

Plant Roślina	Dry soluble substances Suche rozpuszczalne substancje (%)	Acidity Kwasowość (%)	Sugar Cukier (%)	Pectines Pektyny (%)	Ascorbic acid Kwas askorbinowy (mg %)	Carotenoides Karotenoidy (mg %)	P-active substances Substancje P-aktywne (mg %)	Phenolic substances Substancje fenolowe (mg %)
Actinidia kolomicta	11.3	1.3	9.1	1.7	816.4	0.3	375	–
Aronia melanocarpa	18.9	1.2	8.8	0.5	17.4	0.7	2215	667
Berberis vulgaris L.	17.4	5.7	6.6	0.8	12.0	X	600	X
Crataegus sanguinea	15.0	0.6	5.3	0.5	22.0	0.6	X	302
Sambucus nigra L.	11.8	0.6	8.5	0.7	6.5	1.9	220	X
Lonicera edulis L.	10.8	2.2	4.9	0.5	22.2	1.5	700	277
Viburnum opulus L.	12.6	1.5	8.5	0.9	22.9	2.4	400	736
Hippophaë rhamnoides L.	7.8	2.2	3.9	0.5	80.1	5.9	75	700
Ribes aureum Pursh	13.8	1.3	9.3	1.0	73.3	X	X	392
Sorbus domestica L.	15.5	2.0	7.0	0.9	16.5	10.0	X	732
Chaenomeles japonica L.	7.9	5.9	2.6	1.4	15.7	0.4	500	X
Rosa L.	17.9	1.3	6.2	2.6	900.0	13.8	811	1535

According to the scientistific data, children in Belarus experience a shortage of vitamins A and C reaching 50%. Forty per cent of donors suffer insufficiency of unsaturated fatty acids [PHILONOV, MYROH 1997]. Alternative berry crops are a primary source of antioxidants and nutrients, especially vitamin C and carotenoids (Tab. 1).

In the past years, more attention has been paid to of such crops as sorb tree, snowball tree, cornelian cherry tree, sea-buckthorn, etc.

The aim was to estimate morphological and economic features of the alternative plants (*Sorbus domestica* L., *Viburnum opulus* L., *Cornus mas, Elaeagnus multiflora, Actinidia* and *Hippophaë rhamnoides* L.) and to choose the best varieties for cultivation and for breeding in the Republic.

Materials and methods

Nine introduced varieties and 300 hybrids of snowball tree (*Viburnum opulus* L.), 19 introduced varieties of sorb tree (*Sorbus domestica* L.), 5 introduced varieties and 160 seedlings of cornelian cherry tree (*Cornus mas.*), 18 introduced varieties and hybrids and more than 100 male seedlings of sea-buckthorn (*Hippophaë rhamnoides* L.), introduced seedlings of *Elaeagnus* (*Elaeagnus multiflora*) and varieties of *Actinidia* were studied. The investigations were carried out by of generally accepted methods on the experimental plots of the Belarusian Research Institute for Fruit Growing in 1991–1998 [Anonymous 1980].

The thorn capacity of sea-buckthorn was determined as described by Potapov and Borodachev [POTAPOV, BORODACHEV 1980].

The biochemical analysis was made in the laboratory of biochemical valuation, according to the generally accepted methods [ERMAKOV et al. 1987].

The statistical analysis of the data was made using „Dispasn" program.

Results and discussion

A unique collection of alternative barry crops, including more than 20 types, has been gathered at the Belarusian Research Institute for Fruit Growing in the years 1987–1992.

A complex study project on cranberry tree, elaeagnus, honeysuckly, sea-buckthorn, snowball tree, sorb tree, wild rose, etc., was started in 1992.

There are 100 species of snowball tree in the world, 5 of them found in Belarus. *Viburnum opulus* L. is the most widely distributed species. Snowball tree is appreciated as a food, medicinal and ornamental plant.

It was introduced in Russia in the mid 20th century. The first varieties (Ylgen, Souzga, Zarnitsa, Toyoznue rybinu, Zolobovskaya, Shykshinskaya) were selected at the M.A. Lisavenko Research Institute of Horticulture [SMIRNOW 1991].

At the Belarusian Research Institute for Fruit Growing, the study on *Viburnum* started in 1989. Nine introduced varieties and 300 seedlings selected on the basis of open pollination of Kievskaya sadovaya and *V. opulus* L. were tested.

High winter-hardiness, drought-resistance, early cropping, high yield (25 t·ha^{-1}) pest and disease resistance, and fruit quality, are the technological qualities of snowball tree.

It was found that varieties Tayoznue rybiny Ylgen, Krasnaya grozd are the most valuable in Belarus, as thesy produced stable yield (21–25 t·ha^{-1}), of good value, multipurpose fruit and are winter-hardy.

As a result of the breeding, 5 forms were selected (Tab. 2).

Table 2; Tabela 2

Yield and yield components of introduced varieties and hybrids of snowball tree, 1990–1996

Plon i składniki plonu wprowadzonych odmian i mieszańców kaliny koralowej, 1990–1996

Variety Odmiany	Number of berries per one bunch Liczba jagód w gronie	Weight of 100 berries Masa 100 jagód (g)	Yield; Plon	
			kg per tree w kg z drzewa	t·ha^{-1}
Ylgen	43	72.3	6.8	15.1
Tayoznue rubinu	61	51.8	7.8	17.3
Kievskaya sadovaja N 1	51	80.9	9.9	21.8
N 15	56	68.7	17.8	39.6
N 16	46	61.6	12.4	27.6
2-30 M	40	107.4	11.8	26.2
2-45 M	52	102.6	11.4	25.3
2-46 M	55	101.3	11.0	24.4

The investigated forms have fruit of different colours (from orange-red to ruby), crown shape (from rounded to flat-pyramidal); fruit shape (from rounded to elongated-oval), fruit mass (0.68–1.07 g).

Fruit of the selected forms has sour-sweet, bitter taste and multipurpose value.

Thanks to the investigations it was possible to create the initial material and real possibilities of breeding in Belarus new varieties with a complex of features. Sorb tree is a rich source of carotenoids, sorbite, vitamins, pigments, etc. [POPLAVSKAYA 1995].

The studies on 19 introduced varieties of *Sorbus domestica* L. made it possible to choose the most valuable forms for further breeding work and for production tests (Tab. 3).

Table 3; Tabela 3

Yield and yield components of *Sorbus domestica* L. varieties, 1991–1995

Plon i składniki plonu odmian *Sorbus domestica* L., 1991–1995

Variety Odmiany	Number of berries per one bunch Liczba jagód w gronie	Weight of 100 berries Masa 100 jagód (g)	Yield per one tree Plon z drzewa (kg)		Yield Plon (t·ha^{-1})
			average średnia	lim wartości graniczne	
Granatnaya	28	88	18.4	11.6–30.8	21.0
Koncentra	75	68	10.1	7.9–17.0	11.5
Moravskaya	121	82	18.5	11.0–23.1	21.1
Nevezinskya	146	72	8.5	5.9–11.0	9.7
Rosyna	116	104	5.8	4.3–7.6	6.6
Tytan	33	107	11.3	6.7–15.8	12.9
N 10	38	114	4.9	3.2–10.7	5.6

The following varieties singled out:
For yield: Granatnaya (18.4–21.0 t·ha^{-1}), Alaya krypnaya (18.5–21.1 t·ha^{-1})
For fruit weight: Alaya krupnaya, Tytan, Rosyna, N 10
For ripening: Koncentra (early), Granatnaya (late).

It is necessary to continue breeding work to select varieties with stable annual yielding and high content of biologically active substances.

Studies on cranberry tree as a new plant began in 1995. There are 5 introduced varieties and 160 hybrids of Far East origin in the collection.

As a result of the study on hybrids, the difference in yield, fruit shape and colour, winter-hardiness, ripening term were found.

It was established that weight and size of fruit varied during the years of investigations. But these differences among the hybrids were of a regular character. We did not find any periodic pattern of fruiting, although this character varied during the years.

It could be explained by the different climatic conditions and by the plant age.

Actinidia is a new crop in Beloruss. Two species (*A. colomicta* and *A. arguta*) are of a greatest interest.

High content of ascorbic acid (816.4 mg %) is the main merit of plant fruit (Tab. 1).

The first varieties were selected in New Zeland. I.V. Michurin began breeding actinidia in 1909. He selected 6 varieties, two of which (Ananasnaya and Klara Tsetkin) have been preserved [TIKHONOV 1995]. All the tested cultivars of actinidia were pest and disease resistant. Depending on a variety, yield varied from 0.3 to 5 kg per plant.

The main task of breeding is to select more winter-hardy and high-yielding varieties.

The studies on *Elaeagnus multiflora* began in 1992. Winter-hardiness, yield, size, shape and taste of fruits introduced seedlings were estimated.

As a result of this work, 2 seedlings (E-2 and E-89) were selected. Fruits of the seedlings are different in shape (elongated-oval and cylindrical). Fruit mass varied from 0.7 to 2.1 g. Seed mass amounts to 12–15% from fruit mass. These seedlings can be used for further breeding work.

It is necessary to select high-yielding and more winter-hardy varieties and to study the biochemical content of fruit.

Long experience in the introduction of sea-buckthorn demonstrated the potential value of this crop in Beloruss. The results of investigations (1976–1992) on 30 varieties and hybrids showed that the best adapted cultivars were those selected on the basis of Baltic climate, e.g. Botanitcheskaya, Otradnaya, Podarok sadu etc. [GARANOVICH 1977; RADUK 1996].

Since 1992 a complex study of new varieties and hybrids of different origin has continued. The aim of the work is to estimate and choose the best forms as initial material and for cultivation.

The need for these investigations is explained by a limited assortment of the crop, absence of varieties of early and late ripening absence of pollinators, some defects of sea-buckthorn e.g. high growth, thornbush, etc.

The results of the winter-hardiness study confirmed that the best adapted varieties were those selected on the basis of Baltic climate.

Thornbush is one of the primary defects of sea-buckthorn. Hybridization of

thorny forms gives the same progeny [PANTELEEVA 1993]. We were unable to find thornless varieties among the ones we studied (Tab. 4). Botanitcheskaya, Lomonosovskaya, Mariya, Podarok sadu were the best in terms of this feature.

Table 4; Tabela 4

Comparative characteristics of the sea-buckthorn varieties, 1995–1998
Porównanie cech odmian rokitnika, 1995 – 1998

Varieties Odmiany	Thorn value Stopień ciernistości	Yield Plon ($t \cdot ha^{-1}$)	Biochemical composition of the sea-buckthorn fruits Skład biochemiczny owoców rokitnika					
			acidity kwasowość (%)	sugar cukier (%)	ascorbic acid kwas askorbinowy (mg %)	carotenoids karotenoidy (mg %)	oil olej (%)	phenolic substances substancje fenolowe (mg %)
Botanitcheskaya	1	14	1.2	2.9	57	5.3	4.7	303
Vorob`jovskaya	2	20	2.0	3.2	65	12.7	3.8	309
Lomonosovskaya	1	7	2.1	3.8	45	8.8	3.8	309
Mariya	1	4	1.6	2.8	92	8.8	4.3	408
Mendelejevskaya	2	7	2.8	2.7	52	4.7	3.7	350
Nivelena	2	18	2.7	2.9	68	4.9	2.8	354
Otradnaya	2	16	1.6	2.8	68	12.8	4.9	32
Podarok sadu	1	15	2.3	3.6	51	12.8	3.8	31
Priokskaya	1	5	1.8	4.1	82	8.2	3.2	376
Trophimovskaya	2	15	2.3	3.5	62	7.1	5.0	337
10/86	1	3	1.6	3.8	36	12.7	3.9	362
4/87	1	5	1.4	4.0	100	12.5	4.9	369
15/88	1	3	1.8	3.7	66	12.3	3.9	352
20/88	1	2	2.1	3.1	63	10.3	3.6	366
29/88	2	16	1.7	3.8	86	12.9	4.5	341
$HCP_{0.5}$	–	8	0.5	–	9.0	3.5	0.9	73

High yield is one of the main parameters of a cultivar. The results of our studies showed a high difference between the varieties. Moscow`s cultivars (exception Lomonosovskaya and Mendelejevskaya) had high (11–15 kg per plant) and very high (>15 kg per plant) yield. The parameter depended on climatic conditions, plant age and genetic characters of a variety. As sources of high yield, the following cultivars were determined: Vorob`jovskaya (20 $t \cdot ha^{-1}$), Nivelena (18 $t \cdot ha^{-1}$), Otradnaya, 29/88 (16 $t \cdot ha^{-1}$, Podarok sadu (15 $t \cdot ha^{-1}$), Botanitcheskaya (14 $t \cdot ha^{-1}$).

Mariya and Priokskaya were singled out as a source of early ripening and Mendelejevskaya as a late one.

Sea-buckthorn berries are among the most nutritious and vitamin rich fruit known. Great variation of biochemical content was found both between varieties and within. This fact could been explained by different climatic conditions, plant age, genetic peculiarities, etc.

High acidity (1.6–2.8%) and low level of sugar is a main problem in sea-buckthorn. Priokskaya and 4/87 hybrid were the best.

Hippophaë rhamnoides L. is a valuable source of vitamin C and carotenoides.

Priokskaya, 4/87 and 29/88 had the best vitamin C content and Vorob`jovskaya, Otradnaya, Podarok sadu, 4/87, 29/88 had the best content of carotenoides.

Sea-buckthorn is a source of oil. The content of oil varied from 2.8% to 5%. The best varieties were Trophimovskaya, Otradnaya, Botanitcheskaya, 29/88 and 4/87.

Mariya has the highest level of phenolic substances (408 mg%).

Sea-buckthorn is a dioecious plant and a pollinator influences yield and fruit quality. Therefore the necessity of male plant breeding is obvious.

Seedlings 16.01.95 and 04.17.96 were singled out based on complex features (winter-hardiness, number of buds per 10 cm of one-year shoot, high pollen germination).

In summary, the sources of the main valuable features of sea-buckthorn were found. New material (more than 3000 hybrids of the best varieties and selected male seedlings) was obtained, which is being studied at present.

Conclusions

1. Introduction of new polyvitamin plants will enlarge raw material supplies for food industry and will make it possible to solve the problem of vitamin shortages in Beloruss.
2. On the basis of the investigations on introduced varieties and hybrids, the following were selected for breeding and farm tests:
   Eleaegnus multiflora: E-4 and E-89; Sea-buckthorn: 29/88; Podarok sadu, Otradnaya: 16.01.95; 04.17.96; Snowball tree; Tayznue rubinu, Ylgen, Kievskaya sadovaya N 1, and 5 perspective seedlings; Sorb tree: Granatnaya, Alaya krypnaya, Koncentra, Rosyna, Moravskaya.

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Key words: *Sorbus, Viburnum, Cornus, Elaeagnus, Actinidia, Hippophaë*

Summary

Economical features (yield, fruit weight, winter-hardiness, disease and pests resistance) and biochemical composition of fruits of alternative berry crops (*Sorbus domestica* L., *Viburnum opulus* L., *Hippophaë rhamnoides* L., *Cornus mas*, *Elaeagnus multiflora*, and *Actinidia*) were studied at Belorussian Research Institute for Fruit Growing in 1990–1998. The best introduced varieties and hybrids were selected for breeding work and cultivation in Belorussia.

WYNIKI I PROBLEMY PRAC HODOWLANYCH NAD ALTERNATYWNYMI ROŚLINAMI JAGODOWYMI W BIAŁORUSI

Anna Batchylo, Maryna Shalkevich, Olga Kamzolova
Białoruski Naukowy Instytut Upraw Roślinnych, Samohvalovci

Słowa kluczowe: *Sorbus, Viburnum, Cornus, Elaeagnus, Actinidia, Hippophaë*

Streszczenie

W latach 1990–1998 w Białoruskim Instytucie Naukowych Upraw Roślinnych badano cechy ekonomiczne (plon, masa owoców, zimoodporność, odporność na choroby i szkodniki) oraz biochemiczny skład owoców alternatywnych roślin jagodowych (*Sorbus domestica* L., *Viburnum opulus* L., *Hippophaë rhamnoides, Cornus mas, Elaeagnus multiflora* i *Actinidia*). Najlepsze wprowadzane odmiany i mieszańce wybrano do dalszych prac hodowlanych i uprawy w Białorusi.

Mgr Anna **Batchylo**
Belorussian Research Institute for Fruit Growing
Samohvalovci
BELORUSSIA