

RESEARCH ON THE VARIABILITY OF SOME MORPHOLOGICAL CHARACTERS AND THE BIOMASS OF SEA BUCKTHORN FALSE FRUITS HARVESTED IN ROMANIA

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Key words: *Hippophaë rhamnoides* L., false fruits, average length, average diameter, average biomass

INTRODUCTION

The first research on phenotypic variability of the species *Hippophaë rhamnoides* L. in Romania were conducted by SERVETTAZ (1909). Subsequently, researchers like ȚOPA (1960) ȚOPA E., LEOCOV M. (1981), CIREAȘĂ (1980), CIREAȘĂ V., NĂSTASE M., (1979) BELDEANU (1972) and others performed more in-depth studies on the morphology of the vegetative parts of sea buckthorn in our country.

In the Romanian flora, the species *Hippophaë rhamnoides* L. is represented by 3 subspecies: *rhamnoides* Linné, *carpatica* Rousi and *fluviatilis* Van Soest. In Moldavia, for example, ssp. *rhamnoides* has been reported in Vaslui; ssp. *carpatica* in the counties of Suceava, Neamț, Bacău, Vrancea, Iași and Galați, and ssp. *fluviatilis* in the county of Bacău (CHIFU et al., 2006).

The fruits differ greatly in size, shape, colour, pedicel length, number of fruits on branches, etc. The subspecies *rhamnoides* presents fruits of the largest dimensions, cylindrical in shape and orange-red colour, and the subspecies *fluviatilis* and *carpatica* bear fruits of various forms (from nearly spherical or short elliptical to oblong shape), but never cylindrical and yellow-orange.

MATERIAL AND METHODS

Our research aimed to observe individuals as different as possible in terms of size, shape and fruit colour, aspects eloquent in Figures 1-35, and to highlight significant differences in morphology depending on the region where the plant material was harvested.

The plant material harvested from the culture of FRUCTEX Bacău (six varieties, one biotype) and from the spontaneous flora of the counties of Bacău, Neamț, Vaslui and Vrancea (22 biotypes) was used to investigate the morphological variability of sea buckthorn fruits.

From each variety/biotype there were randomly harvested 100 fruits/individual at different moments of the fruit ripening period. The plant

material from the county of Bacău was collected in the month of October of the years 2008 - 2010. In Vaslui, the fruits were harvested in September 2010 and in Neamț and Vrancea in August 2010.

Since edaphic conditions influence morphological, biochemical and physiological fruit parameters, the samples from the spontaneous flora were taken from different ecosystems: hills (the samples of Cotenii 1-5, Ruginoasa 1-2, Pogana 1-2), the Siret river floodplain terrace (the samples Letea 1-5), the Sușița river floodplain terrace (Vrancea) (the samples Varnița 1-2), the old riverbed of the river Bistrița (the samples Gherăiești 1-6), forest margins (the samples Vaduri 1-3) and forest openings (deforested areas taken over by sea buckthorn) (the samples Câmpuri 1-3).

The biometric measurements aimed to identify the length, width and weight of individual fruits and seeds, the weight of 100 fruits and seeds, the L/wd ratio.

Seed length and width were measured in mm with an electronic calliper (DIGITAL CALIPER 0-150 mm) and the weight in grams, with an analytical balance (ACCULAB). The data obtained were processed in Microsoft Excel and interpreted statistically. There were calculated the following biometrical indices: \bar{x} - the arithmetic mean; s - standard deviation; s% - variation coefficient; sx - standard deviation of the arithmetic mean (arithmetic mean error); sx% - the arithmetic mean standard deviation in percentages (average error in percentages).

RESULTS AND DISCUSSIONS

Regarding the character fruit length, as shown in Table. 1, we find that the analysed individuals can be grouped according to the value \bar{x} , as follows:

- under 6 mm: the variety *Silvia* (5.69);
- 6-7 mm: the variety *Tiberiu*, the biotypes from the spontaneous flora, Gherăiești-1, Gherăiești-3, Gherăiești-5, Ruginoasa-2, Câmpuri-1, Câmpuri-3, Pogana-1;

- 7-8 mm: the *Ovidiu* variety, the biotypes from the spontaneous flora Coteni-1, -2, -5, Gherăiești-2, -4, -6, Ruginoasa-1, Varnița-1, -2, Pogana-2, Vaduri-2 and -3;

- 8-9 mm: the varieties *Auraș* and *Victoria*, biotypes from natural populations Coteni-3, Letea-1, Câmpuri-2, Vaduri-2;

- 9-10 mm: the variety *Serpenta*, the culture biotype Roșu Albastru, biotypes from natural populations Letea-3, -5;

- above 10 mm: the biotypes from the spontaneous flora Coteni-4, Letea-4, Viforeni.

The *Silvia* variety showed the lowest value for the character fruit length (5.69 mm) and the biotype Letea -4 the highest value (10.69 mm).

The values of the variation coefficient of the character fruit length (s%), providing information on the genetic stability of the character (Table 1), show that this parameter has values below 10, which indicates that the fruit length of the analysed varieties and biotypes is a genetically stable character.

The biotype Roșu Albastru from the culture of FRUCTEX Bacău recorded the highest value (10.39), being more liable to environmental factors (average

variability). The lowest values of s% were observed at the fruits of the biotypes from the spontaneous flora (Gherăiești-2 – 5.03; Viforeni – 5.26; Pogana-1 – 5.45; Coteni-1 – 5.62; Pogana-2 – 5.71; Vaduri-2 – 5.74; Vaduri-3 – 5.84; Gherăiești-4 – 5.87).

sx% is a biometric index, which is a relative measure of the reliability of the arithmetic mean. This index should not exceed the value of 3% in order to serve as a basis for interpreting data obtained from biometric measurements. This parameter for the character fruit length recorded values below 3% for all the samples measured (0.50 to 1.03%), which certifies that the statistical values obtained are reliable.

Regarding the studied fruit diameter (width), as shown in Table 2, the parameter values of \bar{x} range between 4.85 mm (Letea-2) and 9.64 mm (the variety *Ovidiu*). High values of this biometric index were recorded for the samples Letea -4 (7.78 mm) and Roșu Albastru (7.39 mm). The other samples highlight values of 6-7 mm for this morphological character.

Table 1. Variation of the character “fruit length” (mm) at *Hippophaë rhamnoides* L. biotypes

Harvesting year	Name of variety/ biotype	The values of statistical parameters				
		x	s	s%	sx	sx%
2008	<i>Auraș</i>	9,00	0,68	7,55	0,068	0,61
	<i>Ovidiu</i>	7,43	0,74	9,95	0,074	0,99
	<i>Silvia</i>	5,69	0,51	8,96	0,051	0,89
	<i>Serpenta</i>	9,21	0,69	7,49	0,069	0,74
	<i>Tiberiu</i>	6,51	0,61	9,37	0,061	0,93
	<i>Victoria</i>	8,46	0,61	7,06	0,061	0,70
2009	Roșu Albastru	9,43	0,98	10,39	0,098	1,03
	Coteni-1	7,65	0,43	5,62	0,043	0,56
	Coteni-2	7,90	0,51	6,45	0,051	0,64
	Coteni-3	8,04	0,60	7,46	0,060	0,74
	Coteni-4	10,18	0,77	7,56	0,077	0,75
	Coteni-5	7,57	0,64	8,45	0,064	0,84
	Letea-1	8,11	0,57	7,02	0,057	0,70
	Letea-2	6,75	0,60	8,88	0,060	0,88
	Letea-3	9,55	0,75	7,85	0,075	0,78
	Letea-4	10,69	0,65	6,08	0,065	0,60
	Letea-5	9,60	0,57	5,93	0,057	0,59
	Gherăiești-1	6,98	0,48	6,87	0,048	0,68
	Gherăiești-2	7,75	0,39	5,03	0,039	0,50
	Gherăiești-3	6,57	0,46	7,00	0,046	0,70
2010	Gherăiești-4	8,00	0,47	5,87	0,047	0,58
	Gherăiești-5	6,98	0,53	7,59	0,053	0,75
	Gherăiești-6	7,07	0,45	6,36	0,045	0,63
	Vaduri-1	8,68	0,56	6,45	0,053	0,64
	Vaduri-2	7,31	0,42	5,74	0,042	0,57
	Vaduri-3	7,36	0,43	5,84	0,043	0,58
	Ruginoasa-1	7,36	0,50	6,79	0,050	0,67
	Ruginoasa-2	6,54	0,50	7,64	0,050	0,74
	Varnița-1	7,34	0,52	7,08	0,052	0,70
	Varnița-2	8,84	0,55	6,22	0,055	0,62
	Câmpuri-1	6,77	0,53	7,82	0,052	0,78
	Câmpuri-2	8,20	0,63	7,68	0,063	0,76
	Câmpuri-3	6,75	0,40	5,92	0,040	0,59
	Pogana-1	6,60	0,36	5,45	0,036	0,54
	Pogana-2	7,52	0,43	5,71	0,043	0,57

Table 2. Variation of the character “fruit width” (mm) at *Hippophaë rhamnoides* L. populations

Harvesting year	Name of variety/ biotype	The values of statistical parameters				
		x	s	s%	sx	sx%
2008	<i>Auraş</i>	6,87	0,46	6,69	0,046	0,66
	<i>Ovidiu</i>	9,64	0,58	8,35	0,058	0,83
	<i>Silvia</i>	5,64	0,53	9,39	0,053	0,93
	<i>Serpenta</i>	6,49	0,93	14,32	0,093	1,43
	<i>Tiberiu</i>	6,11	0,72	11,78	0,072	1,17
	<i>Victoria</i>	7,13	0,67	9,39	0,061	0,93
2009	Roşu Albastru	7,39	0,81	10,96	0,081	1,09
	Coteni-1	6,47	0,35	5,40	0,035	0,54
	Coteni-2	6,47	0,34	5,25	0,034	0,52
	Coteni-3	6,27	0,37	5,90	0,037	0,59
	Coteni-4	7,24	0,53	7,32	0,053	0,73
	Coteni-5	5,82	0,41	7,04	0,041	0,70
	Letea-1	6,07	0,49	8,07	0,049	0,80
	Letea-2	4,85	0,40	8,65	0,042	0,86
	Letea-3	6,97	0,60	8,60	0,060	0,86
	Letea-4	7,78	0,98	12,59	0,098	1,25
	Letea-5	7,07	0,38	5,37	0,038	0,53
	Gherăieşti-1	6,70	0,45	6,71	0,045	0,67
	Gherăieşti-2	6,38	0,28	4,38	0,028	0,43
	Gherăieşti-3	5,65	0,32	5,66	0,032	0,56
2010	Gherăieşti-4	7,31	0,40	5,47	0,040	0,54
	Gherăieşti-5	7,01	0,46	6,56	0,046	0,65
	Gherăieşti-6	6,93	0,39	5,62	0,039	0,56
	Vaduri-1	6,93	0,39	5,62	0,039	0,56
	Vaduri-2	5,94	0,37	6,22	0,037	0,62
	Vaduri-3	6,71	0,37	5,51	0,037	0,55
	Ruginoasa-1	6,87	0,41	5,96	0,041	0,59
	Ruginoasa-2	6,52	0,31	4,75	0,031	0,47
	Varniţa-1	6,80	0,41	6,02	0,041	0,60
	Varniţa-2	6,78	0,59	8,70	0,059	0,87
	Câmpuri-1	6,23	0,43	6,90	0,043	0,69
	Câmpuri-2	6,46	0,34	5,26	0,034	0,52
	Câmpuri-3	6,65	0,41	6,16	0,041	0,61
	Pogana-1	6,45	0,34	5,27	0,034	0,52
	Pogana-2	6,87	0,47	6,84	0,047	0,68

The genetic stability of this parameter is high for individuals from the spontaneous flora, for which s% recorded values ranging between 4.38 (Gherăieşti-2) and 8.65 (Letea-2). The index s% for individuals from the culture of FRUCTEX Bacău recorded values below 10 for the varieties *Auraş*, *Ovidiu*, *Silvia*, *Victoria* and above 10 for the varieties *Serpenta* (14.32), *Tiberiu* (11.78), the biotypes Roşu Albastru (10.96). From the samples of the spontaneous flora, only the biotype Letea-2 recorded the value of 12.59 (over 10) for the s% index, indicating an average variability of the character fruit width. The statistical index sx% for individuals harvested from wild populations showed values between 0.43 (Gherăieşti-2) and 1.25 (Letea-4); for individuals collected from FRUCTEX Bacău, the values of this index ranged between 0.66 (the variety *Auraş*) and 1.43 (the variety *Serpenta*). The index sx% recorded, for the varieties and biotypes analysed morphologically, values below 3%, so the arithmetic mean values are reliable.

A very important character at this species is the biomass/fruit or the biomass/100 fruits. Our investigations revealed the fact that the individuals Coteni-5 (spontaneous flora) and the variety *Victoria*

(culture) yield fruits with the lowest (15.32 g / 100 fruits), respectively the highest (44.50 g / 100 fruits) average biomass among the varieties and biotypes analysed (Table 3).

The fruit biomass of the biotypes from FRUCTEX Bacău is high, with values ranging between 20.74 g / 100 fruits (the variety *Silvia*) and 44.50 g / 100 fruits (the variety *Victoria*). Regarding the character “fruit biomass”, we found that the sea buckthorn individuals harvested from the spontaneous flora can be grouped according to the average weight of 100 fruits, as follows:

- under 15 g / 100 fruits: the biotype Gherăieşti-3;
- 15-20 g / 100 fruits: the biotypes Coteni-5, Letea-2, Vaduri-2, Ruginoasa-2, Câmpuri-1, -3, Pogana-1;
- 20-25 g / 100 fruits: the biotypes Coteni-1, -2, -3, Letea-1, Gherăieşti-1, -2, -5, -6, Vaduri-3, Ruginoasa-1, Varniţa-1, Câmpuri-2;
- 25-30 g / 100 fruits: Vaduri-1, Varniţa-2, Pogana-2;
- 30-35 g / 100 fruits: Coteni-4, Letea-5, Gherăieşti-4;
- 35 g / 100 fruits: Letea-3, -5.

The character shows low variability (the value of s% is less than 10) in most biotypes; a low to medium variability for the biotypes Pogana-2, Câmpuri-3, Varnița-2, Ruginoasa-2, Vaduri-1, Vaduri-2, Letea-2, Letea-3 (s% 10.38 – 11.73).

The Roșu Albastru culture biotype, the biotypes from the spontaneous flora Coteni-3, -4, -5, Letea-1, -4, Gherăiești-1, Ruginoasa-1 and the varieties *Auraș*, *Ovidiu* and *Serpenta* reveal values of s% ranging between 12.40 and 18.50. It was found that the biotypes grown at FRUCTEX Bacău show greater variability than those harvested from the wild flora.

Even if the variability of the character “fruit biomass” is greater than the variability of the characters “fruit length” and “fruit width”, the values of \bar{x} are reliable because sx% has values below 3% for all the studied biotypes (Table 3).

To make an assessment of the general shape of fruits, we calculated the length/width ratio

(diameter). As shown in Table 3, the ratio L/wd has values ranging between 0.98 (Gherăiești-5) and 1.90 (Letea-4), therefore from biotypes with relatively round flattened shape of the fruit to biotypes with oblong, cylindrical fruit shape.

Depending on the value of this ratio, we may classify the analysed biotypes into two groups: a) cylindrical fruits, the biotypes Letea-4, Coteni-3, -4, all the biotypes from the population Letea, Varnița-2, Roșu Albastru, etc. with values of the L/wd ratio above 2; b) with round fruits, the biotypes Gherăiești-1, -5, -6, Ruginoasa-2, Câmpuri-3, Pogana-1, and the varieties *Ovidiu* and *Tiberiu*, with the value of the L/wd ratio close to 1.0 (Table 3).

In our study, we found a great variability of fruits in terms of shape, colour and weight, ranging from very small fruits (less than 0.2 g/100 fruits) to large fruits (above 0.5 g / 100 fruits), with colours from light yellow to orange-red.

Table 3. Variation of the character “fruit biomass” (g) at *Hippophaë rhamnoides* L. populations

Harvesting year	Name of variety/biotype	The values of statistical parameters					Weight 100 fruit	L/W ratio (mean)
		x	s	s%	sx	sx%		
2008	<i>Auraș</i>	0,3778	0,05	13,23	0,005	1,32	37,7881	1,31
	<i>Ovidiu</i>	0,3830	0,05	13,05	0,005	1,30	38,2184	1,07
	<i>Silvia</i>	0,2070	0,02	9,64	0,002	0,96	20,7476	1,01
	<i>Serpenta</i>	0,3586	0,05	13,94	0,005	1,39	35,8683	1,55
	<i>Tiberiu</i>	0,2157	0,02	9,27	0,002	0,92	21,5762	1,07
	<i>Victoria</i>	0,4450	0,04	8,98	0,004	8,98	44,5049	1,19
2009	Roșu Albastru	0,2762	0,04	14,48	0,004	1,44	32,6525	1,28
	Coteni-1	0,2392	0,02	8,36	0,002	0,83	23,9740	1,18
	Coteni-2	0,2265	0,02	8,83	0,002	0,88	22,6571	1,22
	Coteni-3	0,2161	0,03	13,88	0,003	1,38	21,6171	1,28
	Coteni-4	0,3179	0,05	15,72	0,005	1,57	31,7900	1,40
	Coteni-5	0,1532	0,02	13,05	0,002	1,30	15,3229	1,30
	Letea-1	0,2126	0,03	14,11	0,003	1,41	21,2653	1,34
	Letea-2	0,1716	0,02	11,65	0,002	1,16	17,1661	1,39
	Letea-3	0,3589	0,04	11,14	0,004	1,11	36,8969	1,37
	Letea-4	0,4158	0,05	12,02	0,005	1,20	41,5867	1,90
	Letea-5	0,3122	0,03	9,60	0,003	0,96	31,2213	1,35
2010	Gherăiești-1	0,2250	0,04	17,77	0,004	1,77	22,5090	1,04
	Gherăiești-2	0,2066	0,02	9,68	0,002	0,96	20,6690	1,21
	Gherăiești-3	0,1450	0,02	13,79	0,002	1,37	14,5070	1,16
	Gherăiești-4	0,3073	0,03	9,76	0,003	0,97	30,7380	1,09
	Gherăiești-5	0,2419	0,03	12,40	0,003	1,24	24,1959	0,98
	Gherăiești-6	0,2154	0,02	9,28	0,002	0,92	21,5467	1,02
	Vaduri-1	0,2696	0,03	11,12	0,003	1,11	26,6900	1,25
	Vaduri-2	0,1784	0,02	11,21	0,002	1,12	17,8402	1,23
	Vaduri-3	0,2243	0,02	8,91	0,002	0,89	22,4313	1,09
	Ruginoasa-1	0,2370	0,03	12,65	0,003	1,26	23,7040	1,07
	Ruginoasa-2	0,1880	0,02	10,63	0,002	1,63	18,8061	1,00
	Varnița-1	0,2461	0,02	8,12	0,002	0,81	24,6161	1,08
	Varnița-2	0,2556	0,03	11,73	0,003	1,17	25,5620	1,30
	Câmpuri-1	0,1923	0,01	5,20	0,001	0,52	19,2300	1,08
	Câmpuri-2	0,2390	0,01	4,18	0,001	0,41	23,9019	1,27
	Câmpuri-3	0,1925	0,02	10,38	0,002	1,08	19,2510	1,01
	Pogana-1	0,1825	0,02	10,95	0,002	1,09	18,2521	1,02
	Pogana-2	0,2502	0,02	7,99	0,002	0,79	25,0232	1,09

CONCLUSIONS

The sea buckthorn biotypes investigated showed differences in the aspect (architecture) of plants, arrangement of fruits on branches, fruit shape, size and colour. The average fruit length fluctuated between 5.69 mm (the variety *Silvia*) and 10.69 mm (the biotype Letea -4), the average fruit diameter between 4.85 mm (the biotype Letea-2) and 9.64 mm (the variety *Ovidiu*), and the average biomass of 100 fruits ranging between 14.50 g (the biotype Gherăiești-3) and 44.50 g (the *Victoria* variety).

The characters "fruit length" and "fruit diameter" generally showed low variability, whereas "fruit biomass" presented average variability.

ABSTRACT

In Romania, the species *Hippophaë rhamnoides* L. confirms the genetic variability of the genus *Hippophaë* and it highlights biotypes with fruits of various sizes, colors spreaded throughout the country. This study aimed some aspects of sea buckthorn cultivars and biotypes phenotypic variability collected from some districts of Moldova region. We targeted that each individual plant undergoing morphological observations to be different in terms of size, shape and color of the false fruit, in order to highlight significant differences between morphology and the area where the plant material was harvested. We analyzed the length, diameter and biomass of false fruit of *Hippophaë rhamnoides* L. and the values obtained were statistically interpreted. The average length of false fruits oscillated between 5,69 mm (*Silvia* cultivar) and 11,67 mm (Delta 60 M biotype), the average diameter of false fruits between 4,85 (Letea-2 biotype) and 9,64 mm (*Ovidiu* cultivar) and average biomass of 100 false fruits registered values between 14,50 g (Gherăiești-3 biotype) and 44,50 g (*Victoria* cultivar).

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Fruit appearance of some of the sea buckthorn biotypes investigated from Neamt, Vaslui and Vrancea County



Fig. 1. Biotype Gherăiești-1



Fig. 2. Biotype Gherăiești-2



Fig. 3. Biotype Gherăiești-4



Fig. 4. Biotype Gherăiești-5



Fig. 5. Biotype Gherăiești-6



Fig. 6. Biotype Ruginoasa-1



Fig. 7. Biotype Ruginoasa-2



Fig. 8. Biotype Vaduri-1



Fig. 9. Biotype Vaduri-2

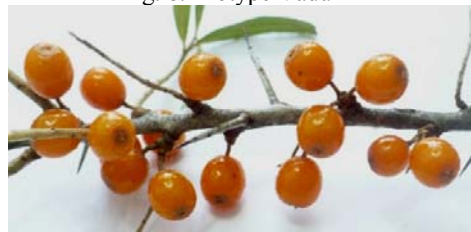


Fig. 10. Biotype Vaduri-3



Fig. 11. Biotype Varnița-1



Fig. 12. Biotype Varnița-2



Fig. 13. Biotype Câmpuri-1



Fig. 14. Biotype Câmpuri-2



Fig. 15. Biotype Câmpuri-3



Fig. 16. Biotype Pogana-2