

Studies on the aspects of commercial quality of bell peppers (*Capsicum annuum* L. var. *grossum*) landraces from western Romania

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Abstract The aim of the studies was to evaluate some characteristics of fruit quality in a collection of 23 landraces of bell peppers (*Capsicum annuum* L. var. *grossum*) from the western part of Romania. The study of landraces was carried out in field conditions, a period of two years in extensive technological conditions. In the mature fruits, were observed the pericarp of the fruit (thickness, weight, carbohydrate content) and the quantity of seeds in the fruit. The experimental data obtained were processed by determining the statistical indices of intrapopulation variability. The fruits of the landraces studied were very different in terms of pericarp thickness, but only three landraces had thicker pericarps than the control variety. The percentage of pericarp in fruit weight was over 80% in only five landraces, but opposite the average value of the control were several of the landraces studied. Were also reported landraces with high carbohydrate content in the pericarp, many being superior to the control. Among the genotypes studied, the Vinga landrace was noted, which had a thick pericarp with a high content of carbohydrates. Regarding the production of fruit seeds, it was found that the landraces had more fruit seeds compared to the 'Cristal' variety, for the most part, the number of seeds being over 200. From the studied collection can be found valuable genotypes regarding the quality of the fruit, which should be recommended as initial material in the process of improvement or even for promotion in culture.

Key words

bell pepper, variability, fruit quality, landraces

Studies for the recovery of local germplasm in peppers are multiple. In western Romania, such assessments were carried out following field collections. Most research has focused on the manifestation of morphological characteristics that contribute to the production of the plant. They found that there is great variability from this point of view and the local germplasm is useful for breeding programs. The productive characterization must be completed as quality studies. The quality elements can be morphological or biochemical. The morphological elements are the easiest to study, including the characteristics of the pericarp [5].

The quality of the pepper from a commercial point of view is given by some characteristics of the fruit. Are appreciated the big fruits, with thick pericarp, with a high percentage of pericarp in fruit weight and intense coloration of mature fruit. The old varieties and landraces may have such characteristics, while being tolerant of some stressful conditions. Compared to the old forms, the hybrids are superior in terms of the

weight of the edible part of the fruit, but they are also demanding on the cultivation technology [2].

The study of large collections of peppers in terms of quality traits, shows that there is great genetic potential. Studies conducted in Brazil have focused on fourteen morphological and biochemical characteristics that may influence the quality of paprika fruit. Very valuable forms have been found for all characters, many genotypes having fruits with large weight and size, rich in pericarp, with a high content of dry matter or vitamin C. The consumer demands can be met by using the material from such collections in breeding programs [8].

Genetic resources can be capitalized superiorly by inbreeding. In the case of bell peppers, such studies have been carried out and established that there are some links between morphological characteristics and aspects of quality. The length of the fruit has a positive influence on the production of fruit per plant but a negative one on the sugar content in the pericarp. Another negative correlation was found between fruit production and chlorophyll content in

green fruits, carotene content in mature fruit, or vitamin C content. The inbreeding also highlights some unknown genes, especially in warm regions, where the degree of allogamy is higher and inbreeding is more effective in breeding [11].

In testing the fruit quality of bell peppers, an attempt was made to correlate the quality elements with other aspects of plant growth, such as the precocity of flowering or the precocity of maturation. In general, more flowering forms can provide higher yields if fruit ripening takes place over a longer period of time [10].

The production and quality of bell peppers are also dependent on the technology applied. Some experiments show that planting distances influence plant vigor, fruit size, fruit production per plant, but do not affect the thickness of the pericarp [4].

The new genotypes introduced into culture are thoroughly tested, the statistical techniques and methods are becoming more precise and elaborate. In addition to testing in different climatic and soil conditions, the software extrapolation can help reduce the cost of testing before a new genotype is introduced into crops. However, the direct field testing is also mandatory [1].

Some of the qualities of quality are of interest not only from a food or commercial point of view but also for industrialization. The carotenoids are a very valuable natural food coloring. The potential of carotenoids in bell peppers is underlined by their structure and stability. The analysis of these compounds must be standardized in order to make the selection more efficient from this point of view [7].

Bell pepper is a fruit appreciated by consumers due to its variations in color, size, aroma and taste. The important amount of polyphenols, carotenoids and ascorbic acid contributes to these. All these qualitative properties are found in the pericarp of the fruit. Classically, the pericarp assessments are done visually or by analysis, but modern electronic evaluation systems are being tried to study the dynamics of fruit ripening. The computerization of the observations ensures the application of the selection much faster and more efficiently for the quality elements to the bell pepper [12].

Material and Method

The studies aimed to evaluate the quality of fruit in a collection of local populations of bell peppers (*Capsicum annuum* L. var. *grossum*), by observing the characteristics of the pericarp of the fruit and the quantity of seeds in the fruit.

The biological material consisted of 23 landraces of bell peppers collected by collecting expeditions in the western part of Romania. The comparison was made with the old Romanian variety 'Cristal'.

The study of landraces was carried out in the field for a period of two years. As the quantities of seed purchased were small, the experiment was placed in a single repetition, the plot comprising 40 plants for each genotype. The applied technology was extensive, without the addition of chemical fertilizers, with the application of watering at critical times. The crop was established by planting seedlings. When the fruits have reached maturity, were performed biometric measurements on the plant productivity and quality elements. Regarding the quality elements, were determined: the thickness and weight of the fruit pericarp, the percentage of pericarp in the weight of the fruit, the number and weight of the seeds in the fruit.

The experimental data obtained were statistically processed, being determined the estimated values of the average (\bar{x}), the standard deviation of the average (s_x) and the coefficient of variability ($s\%$) [3].

Results and Discussions

The thickness of the pericarp is a component of quality, because this part of the fruit is the one consumed. There are no very pronounced differences between the studied genotypes, the extreme limits being 0.34 cm in the population of 'Belinț I' (it also has the smallest fruits in weight) and 0.71 cm in the population of 'Vinga'. The control variety had a pericarp thickness in the middle of this interval, but was exceeded by only three of the landraces. This character showed a moderate variability within the populations (Table 1).

In correlation with the previous character, the weight of the pericarp is found. This was between 23.93 g in the landrace with the lightest fruits ('Belinț I') and 94.17 g in the landrace with the heaviest fruits ('Temerești I'). Compared to the control variety, 14 landraces showed higher amounts of pericarp, although its thickness was not greater. This situation is due to the fact that the fruits of the landraces were longer and larger in diameter. The weight of the pericarp is a character with moderate variability in the populations, in some being a reduced variability (Table 1).

Among the biochemical compounds that contribute to the achievement of taste, in bell peppers, an important place is occupied by carbohydrates. The determinations were made on ripe fruit when it was bright red. The determinations were made using a manual refractometer. For bell peppers, carbohydrates accounted for a percentage of the juice obtained from the pericarp of the fruit, between 6.46% (in the 'Aldești' landrace) and 9.83% (in the 'Pordeanu' landrace). They also presented very sweet fruits, and the 'Ohaba Lungă' and 'Vinga' landraces. Compared to the control variety, only two landraces showed less sweet fruit. The variability of this trait within populations was very low (Table 1).

Table 1.

Results regarding the amount of characters involved in the development quality at bell pepper

No.	Genotype	Pericarp thickness (cm)		Pericarp weight (g)		Carbohydrate content (%)	
		$\bar{X} \pm S_x$	S%	$\bar{X} \pm S_x$	S%	$\bar{X} \pm S_x$	S%
1.	Cristal (control)	0.55±0.14	25.96	44.90±9.30	20.72	7.67±0.28	12.37
2.	Gelu	0.47±0.11	23.60	45.7±12.67	27.57	7.01±0.32	12.19
3.	Aldești	0.52±0.06	12.16	62.29±5.60	8.99	6.46±0.24	12.01
4.	Seleus	0.48±0.08	17.11	38.59±10.12	26.23	6.98±0.29	10.52
5.	Cutina	0.48±0.10	21.51	71.73±13.34	18.60	6.51±0.21	9.41
6.	Șimian	0.40±0.05	13.18	53.27±8.62	16.18	7.21±0.20	8.92
7.	Altringen	0.51±0.07	14.57	58.03±4.55	7.84	7.58±0.21	9.36
8.	Satchinez	0.40±0.06	15.81	31.47±7.89	25.06	6.98±0.64	22.57
9.	Temeresti I	0.61±0.11	18.95	94.17±23.33	24.78	6.65±0.26	9.73
10.	Temeresti II	0.45±0.08	18.59	50.56±6.92	13.68	7.26±0.18	6.13
11.	Julita	0.46±0.05	11.06	52.91±7.50	14.18	7.03±0.24	8.39
12.	Siria	0.45±0.05	12.17	72.42±7.32	10.11	7.81±0.22	6.93
13.	Girisu de Cris	0.53±0.05	9.68	38.25±11.22	29.35	7.38±0.43	14.42
14.	Fizis	0.48±0.04	8.44	58.36±5.76	9.87	7.40±0.14	4.75
15.	Tomnatic	0.46±0.05	11.06	61.62±9.14	17.71	7.93±0.29	9.08
16.	Rinei I	0.48±0.04	8.44	56.82±6.48	11.38	7.21±0.29	9.16
17.	Ceica	0.38±0.04	10.65	34.27±18.18	12.47	7.60±0.17	5.64
18.	Cenad	0.44±0.05	12.07	44.60±6.95	14.78	7.55±0.28	9.31
19.	Belinț I	0.34±0.05	16.10	23.93±3.35	14.01	8.53±0.54	15.66
20.	Belinț II	0.41±0.09	23.59	35.84±4.98	13.89	7.38±0.33	11.26
21.	Tagadau	0.63±0.10	16.30	57.62±6.75	11.72	8.81±0.38	10.67
22.	Ohaba Lunga	0.41±0.04	9.79	28.94±5.89	20.63	9.71±0.37	10.26
23.	Vinga	0.71±0.11	16.31	63.64±14.42	22.66	9.72±0.71	16.48
24.	Becicherecu Mic	0.63±0.08	12.89	61.67±9.82	15.93	8.71±0.37	10.55
25.	Buteni	0.48±0.07	15.57	42.79±9.64	22.54	8.10±0.60	18.26
26.	Pordeanu	0.44±0.06	17.19	26.43±5.85	18.31	9.83±0.77	19.23
27.	Dudești Vechi	0.46±0.10	18.59	34.64±5.23	17.77	8.63±0.19	5.61
28.	Chesinti	0.65±0.17	18.32	38.62±5.55	13.70	8.15±0.24	7.47
29.	Rieni II	0.39±0.05	19.79	27.90±5.19	19.63	7.70±0.64	20.38

The number of seeds in the fruit is an element that can be important in the production of seed. The production of a large number of seeds is a specific element of wild species and rustic forms. This fact is also found in the studied material. The 'Cristal' variety produced the lowest number of seeds in the fruit (an average of 161 seeds). The vast majority of the landraces bore more than 200 seeds, the highest value being 333.28 seeds in the 'Cenad' landrace. The number of seeds in the fruit is a character with moderate to large variability within populations (Table 2).

Along with the number of seeds, their weight can also be important for seed production. The extreme limits are present in other variants, because the weight of the seeds depends not only on their number, but also on their size. The limits of variability in the evaluated collection for this character were 0.82 g in the 'Altringen' landrace and 1.86 g in the 'Simian' landrace. Intra-population variability for fruit seed weight is moderate (Table 2).

The percentage of pericarp in the fruit is an element of quality that expresses the degree of capitalization of the fruit. It is desirable that the pulp should represent as much of the weight of the fruit as possible. For bell peppers, the percentage of pericarp was between 5.11% in the 'Chesinți' landrace and 92.61% in the 'Tomnatic' landrace, followed by the 'Vinga' landrace with a percentage of 91.04. In the 'Vinga' landrace this percentage is due to the thickness of the pericarp (being the largest in the collection), but in the 'Tomnatic' landrace, the thickness of the pulp is in the middle of the variability range. In these, were important, the size of the fruit and a smaller volume of the fruit spine (peduncle and receptacle). The differences from the 'Cristal' control variety (which showed a pericarp percentage of 75.29%) are very important. Five other landraces have a percentage of pericarp over 80%, which makes them remarkable as sources of initial material for the improvement process (figure 1).

Table 2.

Results regarding the amount of characters involved in the production of seed at bell pepper

No.	Genotype	Seeds number in the fruit		Seeds weight in the fruit (g)	
		$\bar{X} \pm S_x$	S%	$\bar{X} \pm S_x$	S%
1.	Cristal (control)	161.00±56.33	66.04	1.01±0,65	64.10
2.	Gelu	171.42±77.55	45.24	0.89±0,55	61.49
3.	Aldești	232.90±57.87	24.84	1.50±0,35	23.36
4.	Seleus	166.12±56.27	33.87	1.21±0,48	40.29
5.	Cutina	294.60±87.92	29.84	1.81±0,39	21.86
6.	Șimian	285.09±76.47	26.82	1.86±0,60	32.92
7.	Altringen	204.00±40.82	20.01	0.82±0,43	53.21
8.	Satchinez	214.66±60.03	27.96	1.46±0,52	35.78
9.	Temeresti I	238.66±24.81	10.39	1.48±0,38	25.53
10.	Temeresti II	201.66±56.57	28.05	1.28±0,33	26.07
11.	Julita	216.16±24.14	11.16	1.29±0,32	25.50
12.	Siria	273.83±38.84	14.18	1.40±0,21	15.27
13.	Girisu de Cris	195.66±60.90	31.12	1.03±0,31	30.69
14.	Fizis	241.60±95.22	39.41	1.44±0,58	40.59
15.	Tomnatic	209.66±76.35	36.41	1.46±0,52	35.59
16.	Rinei I	218.33±66.30	30.36	1.18±0,40	34.57
17.	Ceica	235.00±35.32	15.03	1.37±0,46	33.78
18.	Cenad	333.28±44.47	13.34	2.19±0,33	15.38
19.	Belinț I	223.20±27.23	12.17	1.10±0,43	39.22
20.	Belinț II	229.83±36.95	15.08	0.94±0,18	19.67
21.	Tagadău	220.00±43.52	17.76	0.97±0,35	36.66
22.	Ohaba Lunga	235.66±26.03	11.04	1.48±0,43	29.66
23.	Vinga	279.80±47.43	16.95	1.68±0,36	21.44
24.	Becicherecu Mic	247.33±22.12	8.94	1.47±0,16	11.08
25.	Buteni	182.40±65.04	35.65	1.01±0,38	37.75
26.	Pordeanu	231.20±24.45	18.17	1.13±0,45	37.29
27.	Dudeștii Vechi	228.85±26.83	14.13	1.04±0,38	20.67
28.	Chesinti	212.00±33.42	19.76	0.87±0,34	30.06
29.	Rieni II	225.66±23.03	19.04	1.38±0,23	28.67

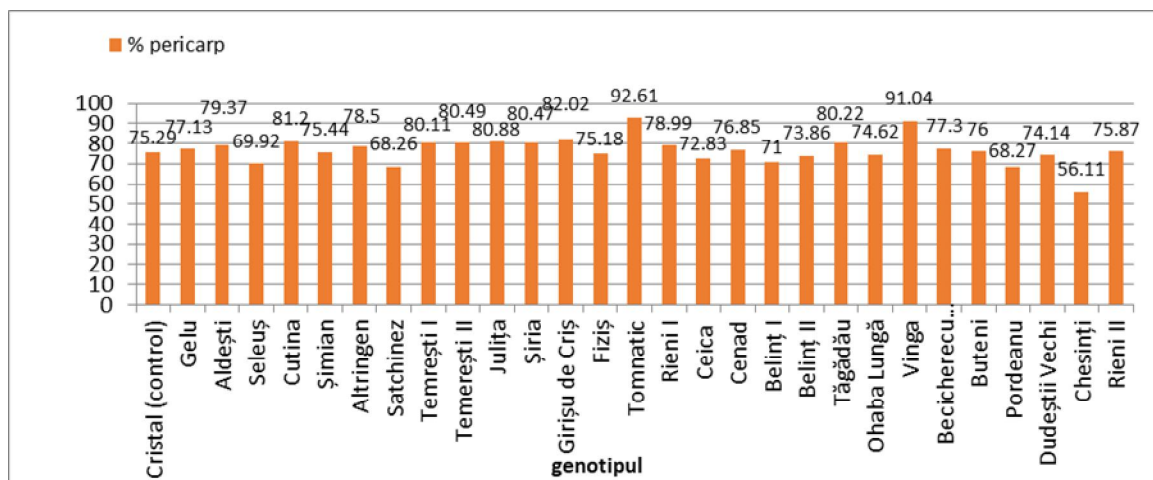


Figure 1. Percentage of pericarp in bell pepper fruits

The pepper has a pronounced natural variability. The landraces are a source of lost variability, being replaced in culture by modern genotypes. In terms of commercial quality, the study of

some fiber peppers landraces showed that they are valuable in terms of the thickness of the pericarp and the percentage of pericarp in the weight of the fruit. This motivates their use in breeding programs [9].

In all countries of the world, ancient genotypes are searched for use. The cultivation of peppers is practiced from the plain areas to the mountainous regions. The varieties from less favorable regions are the most valuable for obtaining new varieties for organic farming. Studies need to be extended to establish productive and qualitative performance in the area of origin or in other areas [6].

Conclusions

The thickness of the pericarp is a component of quality, because this part of the fruit is the one used. There are no very pronounced differences between the studied variants, the highest value being presented to the Vinga landrace.

The percentage of pericarp expresses the degree of capitalization of the fruit. It is desirable that the consumable part represents as much of the weight of the fruit as possible. In the case of bell peppers, the highest percentage of pericarp was presented by the 'Tomnatic' and 'Vinga' landraces. In another five landraces, the pericarp has presented over 80%, which makes them remarkable as sources of initial material for the improvement process.

Among the biochemical compounds that contribute to the achievement of taste, in fat peppers, an important place is occupied by carbohydrates. The determinations made highlight the landraces of 'Pordeanu', 'Ohaba Lungă' and 'Vinga', as having the sweetest fruits

Making a large number of seeds is a specific element of rustic forms. The 'Cristal' variety produced the lowest number of seeds in the fruit, the vast majority of the local populations presented in the fruit over 200 seeds.

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