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THE ROLE OF THE PARENTAL FACTOR IN THE HERITABILITY OF THE BIOCHEMICAL CHARACTERS OF THE TOMATO FRUIT

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Abstract

The paper presents data on the testing results of 5 F_1 reciprocal hybrid combinations and 7 parental forms of tomato based on the content of dry matter, sugars, acidity, vitamin C, lycopene and β-carotene in fruits. The biochemical analysis of parent varieties and reciprocal F_1 hybrids was differentiated – specific to the genotype, the hybrid, the crossing orientation, the analyzed character. By cluster analysis (k-means) of the tomato F_1 parents and hybrids were identified – Vrojainii, Rufina, Flacara, L 10B, and the hybrid combinations F_1 Flacara x Vrojainii, F1 L 10B x Rufina, F_1 Rufina x L 10B, F_1 Vrojainii x Flacara, F_1 Desteptarea x Flacara, F_1 Flacara x Desteptarea, F_1 Flacara x Rufina, F_1 Rufina x Flacara, F_1 Dolgonosic x Mary Gratefully which are characterized by high indices of the biochemical characters, which provides opportunities for their use in breeding programs in quality of the initial material in improving the quality of tomato fruits. The differences in the manifestation of the characters analyzed in the reciprocal F_1 hybrids demonstrate the involvement of the parental factor in their phenotype.

Key words*: tomato, varieties, hybrids, parental effect, dominance, biochemical characters.*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) fruits are some of the most widely consumed and popular vegetables grown worldwide and particularly profitable for producers (Nasir et al., 2015).

Tomatoes are attractive due to the rich range of flavors, shapes, sizes and colors (Tieman et al., 2017), but also to the high value of the fruits, the various forms of consumption: fresh, mixed with other vegetables, sauces, pots, marinated and pickled tomatoes, stuffed tomatoes, etc., or industrially processed: paste, preserves, juices, etc. (Mihnea, 2016; Li et al., 2018).

The high quality of tomato fruits is one of the basic objectives of the improvement of this culture, being considered as important as the improvement of production characters and other characteristics of the variety. In this context, the wide use of tomato products, the intensification of research for this objective at the national level is fully justified (Mihnea et al., 2022).

The aesthetic and biochemical quality of tomato fruits is often a priority for the middle-income consumer's decision, even more important than the price (Klee & Tieman, 2013). For tomato, taste, appearance, color are decisive for fresh fruit, while consistency, sugar, acidity, dry matter are important in the tomato processing industry.

In the canning industry, varieties with a high content of the dry matter, sugar, vitamins, pigments and other properties are requested, which is often not recorded in the approved varieties (Botnari, 2015). From a biochemical point of view, the fruits must be rich in vitamins, with the tomato having the highest rate of vitamin C. Vitamins, dry matter content, acidity, sugar/acidity ratio determine the taste and aroma of the fruit. The morphological aspects as quality factors are: shape, color and size of the fruits. The shape and color depend on consumer preferences. The high diversity of shapes and colors is an attraction for consumers. Regarding the size of the fruit, the request is determined by the final destination: large fruits are preferred fresh, for the preparation of pasta and juice, and small ones are requested by the sphere of food service and the preservation of fruits in domestic conditions.

Worldwide, tomatoes are an important part of a the diverse and balanced diet (Willcox et al., 2003), providing a wide diversity of nutrients (Ilahy et al., 2016), vitamins, carotenoids and phenolic compounds (Martí et al., 2016; Li et al., 2018). Consumption of carotenoid-rich foods has been associated with decreased mortality and disease risk (Diplock et al., 1998; Giordano & Quadro, 2018). The health benefits of carotenoids are related to their antioxidant properties, being involved in reducing cancer and cardiovascular diseases, improving the immune system and bone health (Eggersdorfer & Wyss, 2018; Rodriguez-Concepcion et al., 2018). In addition, specific benefits for brain development and cognitive functions have been linked to lutein (Giordano & Quadro, 2018; Stringham et al., 2019). Carotenoids and polyphenolic compounds contribute to the nutritional value of tomatoes by improving their functional attributes and sensory qualities, including taste, aroma and texture (Martí et al., 2016).

The main carotenoids that accumulate in red ripe tomato fruits are lycopene (~90%), *β*-carotene (5-10%), lutein (1-5%) and less than 1% – other carotenoids (Ronen et al., 1999). Lycopene and *β*-carotene are the main pigments responsible for the characteristic color of the ripe fruit. These carotenoids largely determine the perception of the quality of fresh tomatoes, with consumers usually preferring red or deep orange tomatoes. According to some authors (Sahlin et al., 2004), the content of carotenoids in tomatoes largely depends on the genotype, stage of maturity, climatic and growing conditions.

Breeding is a sure way to improve the biochemical composition of tomato fruits – dry matter content, gluco-acidic ratio, sugar, vitamin C, etc. The creation of varieties, hybrids, new lines with a high level of dry matter is one of the main requirements in modern agriculture and the implementation of intensive technologies. Therefore, testing selection material based on this character is very important in improving of the tomato fruit quality (Mihnea et al., 2016).

The lack of fundamental knowledge regarding the peculiarities of the synthesis of valuable biochemical compounds, but also the genes involved in the control or regulation of metabolic pathways often hinders the correct and directed strategy of creating performing tomato genotypes that would maintain the taste and aromatic qualities in the long term after harvesting, which currently presents a major challenge (Moreno et al., 2014).

One of the sources of increasing the variability of the quantitative and qualitative characters of the plans is the parental factor, which at the moment is insufficiently investigated. According to data (Singkaev et al., 2015), cross-pollination in tomato, demonstrated different effects on the number of seeds per fruit, the weight of 1000 seeds, the content of dry matter, the gluco-acidic ratio, the proportions of fructose, glucose and sucrose.

Hybridization methods can be used to improve tomato fruit quality characters. For this purpose, it is necessary to know the peculiarities of their heredity. For example, total dry matter, acidity, vitamin C are under dominant control, and their low heritability indicates the involvement of non-additive interactions. Therefore, due to the low heritability and the lack of high selection potential, hybridization methods and the phenomenon of heterosis can be used in the first generation to improve these characters. On the contrary, the high selection potential for total phenol due to additive genes reveals the opportunity to improve the population by selecting the best genotypes (Randii et al., 2016).

Research on the genetic contribution to the variation of tomato seed quality traits at the transcriptome level demonstrated that the genetic control of plasticity in the regulation of genes expressed in seeds is affected by the maternal nutrient environment (Sterken et al., 2023).

Although the content of lycopene and *β*-carotene varies greatly depending on the environment, there is a high genotypic potential for improving the content of lycopene and *β*-carotene in new tomato cultivars. Real opportunities offer the involvement of the species *S. pimpinellifolium* in crosses (Duduit et al., 2022; Sterken et al., 2023).

The existing assortment of tomatoes in the Republic of Moldova has improved in recent years by introducing varieties and hybrids created in the country or abroad. Taking into

account the great diversity of the use of tomato production, staggering it over as long a period as possible, continuously improving the quality and broadening the current assortment with new varieties and hybrids is a topical objective.
The purpose of the research: elucidation of heritability peculiarities and the parental effect in the new tomato hybrid combinations, and the cluster organization of the F_1 parents and hybrids based on biochemical characters.

MATERIALS AND METHODS

As initial material for the intended research, 5 reciprocal F_1 hybrid combinations were used: Dolgonosic x Mary Gratefully/Mary Gratefully x Dolgonosic, Flacara x Vrojainii/ Vrojainii x Flacara, Flacara x Desteptarea/ Desteptarea x Flacara, L 10B x Rufina/ Rufina x L 10B, Rufina x Flacara/Flacara x Rufina and 7 parental forms: Rufina, Dolgonosic, Flacara, L 10B, Vrojainii, Mary Gratefully, Desteptarea.
The experiments were carried out under laboratory and field conditions. Tomatoes were grown by seedling culture in three repetitions according to the standard method (Ershova, 1978).
The dry matter was determined by drying (Murashev, 2007), the content of sugars – by the anthrone method (Severin & Solovyova, 1898), vitamin C in fruits and acidity – according to the standards in force (GOST 24556-89, 2003; GOST 25555.0-82, 2010).
The amount of carotenoids in fruits was determined by spectrophotometric method (Trineeva & Slivkin, 2016; Golubkina et al., 2017).
The degree of dominance (h_p) was calculated according to the formula proposed by Brubaker (1966):
$h_p = F_1 - 0.5 (P_1+P_2)/ Hp - 0.5 (P_1+P_2)$,
where:
F_1 – the average value of the character in the F_1 generation;
P_1, P_2 – the average value of the character in the parental forms;
H_p – the average value of the character evaluated at the best parental form.
The reciprocal effect (r_e) was calculated according to the formula: $r_e = (b - a)/(B - A)$, where A and B – character values for the parental forms involved in crossing; a – for the ♂A x ♀B hybrid; b – for the reciprocal hybrid ♂B x ♀A. The positive value r ($r > 0$) signifies the paternal effect, and the negative ($r < 0$) – maternal, the absolute value r ($|r|$) shows the relative appreciation of these effects in units, equal to the differences in the values of the character in the parental forms (B - A) (Reinhold, 2002).
Cluster analysis of tomato genotypes based on biochemical characters – dry matter content (%), sugar (%), acidity (%), sugar / acidity index, vitamin C (mg/%), licopene, mg/100 g, *β*-carotene, mg/100 g was performed according to the iterative algorithm for constructing dendrograms and the *k*-means centroid method – methods successfully used in genetics and breeding research (Lupaşcu et al., 2019; Kanavi et al., 2020).
The obtained data were statistically processed in the STATISTICA 7 software package.

RESULTS AND DISCUSSIONS

The biochemical data of the characters under study for parent cultivars and F_1 reciprocal hybrids of tomato depended a lot on the parent, F_1 hybrid, crossing orientation, analyzed character – dry matter, sugars, acidity, vitamin C, lycopene and *β*-carotene (Table 1).
Dry substance. It was found that in the fruits of the parental forms, the dry matter content varied within the limits of 6.0-7.4%, and of the hybrid combinations – 7.2-8.4%. It should be noted that for all hybrid combinations, the index recorded higher values than the best parent, except for the combination Flacara x Desteptarea which was at the level of the maternal form. Differences between mutual analogues were found in the combinations Desteptarea x Flacara, Flacara x Rufina, Dolgonosic x Mary Gratefully.

Table 1. Variability of fruit biochemical characters in the parental forms and F_1 hybrids of tomato

No.	Variety, F_1 hybrid	Dry substance, %	Sugar, %	Acidity, %	Sugar/acidity index	Vitamin C, mg/%	Lycopene, mg/100 g	β-carotene, mg/100 g
1	Rufina	7.2	6.9	0.59	11.7	30.1	0.67	3.93
2	Flacara	7.2	6.6	0.66	10.0	29.5	0.38	3.39
3	L 10B	7.4	6.6	0.53	12.5	34.0	0.19	0.71
4	Vrojainii	7.3	6.8	0.57	11.9	33.5	0.07	0.63
5	Mary Gratefully	6.7	6.0	0.57	10.5	25.8	1.22	1.38
6	Desteptarea	6.2	5.5	0.54	10.2	28.5	1.71	1.44
7	Dolgonosic	6.0	4.2	0.38	11.1	23.1	0.55	1.8
	$x \pm m_x$	6.86± 0.21	6.09± 0.37	0.55± 0.03	11.13± 0.36	29.21± 1.48	0.68± 0.22	1.90± 0.49
	σ	0.57	0.97	0.09	0.94	3.91	0.59	1.28
8	F_1 Flacara x Vrojainii	7.7	6.6	0.60	11.0	33.5	1.6	1.73
9	F_1 Vrojainii x Flacara	7.8	7.3	0.61	12.0	31.5	1.37	1.78
10	F_1 Desteptarea x Flacara	7.6	6.8	0.71	9.6	29.6	1.56	1.92
11	F_1 Flacara x Desteptarea	7.2	6.7	0.70	9.6	30.1	1.49	1.7
12	F_1 Flacara x Rufina	8.0	5.8	0.68	8.5	31.5	0.53	3.66
13	F_1 Rufina x Flacara	7.5	5.7	0.61	9.3	30.3	0.52	3.89
14	F_1 Dolgonosic x Mary Gratefully	7.8	5.3	0.53	10.0	31.3	1.37	2.73
15	F_1 Mary Gratefully x Dolgonosic	8.4	6.1	0.59	10.3	27.3	1.48	2.82
16	F_1 L 10B x Rufina	7.9	5.8	0.53	10.9	33.8	2.15	2.0
17	F_1 Rufina x L 10B	8.2	5.6	0.58	9.7	32.6	2.07	1.94
	$x \pm m_x$	7.81± 0.11	6.17± 0.20	0.61± 0.02	10.09± 0.32	31.15± 0.61	1.41± 0.17	2.42± 0.26
	σ	0.35	0.64	0.06	1.00	1.94	0.54	0.82

Sugars. In F_1 varieties and hybrid populations, differences were also established based on the sugar content in the fruits, which varied within the limits of 4.2-6.9% and 5.3-7.3%, respectively. The highest sugar content was recorded in the varieties Rufina, Flacara, Vrojainii, L10B and in the reciprocal combinations Flacara x Vrojainii/Vrojainii x Flacara and Desteptarea x Flacara/Flacara x Desteptarea (Table 1).

Sugar/acidity ratio. Of particular importance for the variety's performance is the sugar/acidity ratio, on which the taste properties of the fruit depend a lot. A variability was found within the limits of 10.0-12.5 for parents and 8.5-12.0 – F_1 hybrids. Based on this character, the varieties L 10B (12.5), Rufina (11.7), Dolgonosic (11.1), Vrojainii (11.0), and the hybrid combinations Vrojainii x Flacara (12.0) were highlighted, Flacara x Vrojainii (11.0). No differences were recorded between mutual analogues for the combinations Desteptarea x Flacara, Dolgonosic x Mary Gratefully.

Vitamin C. Ascorbic acid content is also important for fruit quality. The index registered a high variability in the researched varieties: 23.1 mg/% (Dolgonosic) –34.0 mg/% (L 10B), and in the hybrid combinations – between 27.3 (F_1 Mary Gratefully x Dolgonosic) and 33.8 F_1 L 10B x Rufina (mg/%).

Lycopene varied within the limits of 0.07-1.71 mg/100 g (Vrojainii, Desteptarea), 0.52-2.15 mg/100 g – F_1 hybrids (Rufina x Flacara, F_1 L 10B x Rufina), and *β*-carotene – in wider limits than lycopene: 0.63-3.93 mg/100 g (parents Vrojainii, Rufina); 1.28-3.89 mg/100 g – hybrids F_1 Flacara x Vrojainii, F_1 Rufina x Flacara. It should be noted that the average of the indices for the examined characters was higher in the case of F_1 hybrids, higher exceedances of the parental group being recorded for the content of lycopene and *β*-carotene: + 107.4% and +27.4%, respectively, which denotes the pronounced heterosis effect for these tomato fruit quality traits.

The correlational analysis (r) of the quality character indices of tomato fruits demonstrated that, based on the material under study, new tomato genotypes can be obtained with a successful association of the characters dry matter – vitamin C, sugar – acidity, sugar – vitamin C , for which there was a significant dependence: 0.49*-0.67* ($p < 0.05$). It should be noted that between the sugar/acidity index and β-carotene content, the dependence was inversely proportional: (-0.51*, $p<0.05$) (Table 2).

Table 2. Correlational dependencies (r) between indices of biochemical properties of tomato fruits

Dry substance, % – Vitamin C, mg/%	0.59*
Sugars,% – Acidity, %	0.67*
Sugars, % – Vitamin C, mg/%	0.49*
Sugar/acidity ratio – β-caroten, mg/100 g	-0.51*

*-p<0.05.

The distribution dendrogram of the parents and the F_1 hybrids taken together, demonstrates the existence of significant similarities or differences based on a complex of characters – dry matter content (%), sugar (%), acidity (%), sugar/acidity index, vitamin C (mg/%), licopene, mg/100 g, β-carotene, mg/100 g taken as classification criteria (Figure 1).

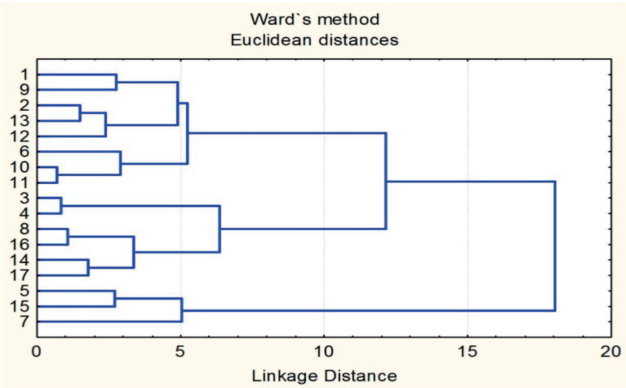

Figure 1. Distribution dendogram of F_1 tomato varieties and hybrids based on the biochemical characters 501 – Rufina, 502 – Flacara, 503 – L 10B, 504 – Vrojainii, 505 – Mary Gratefully, 506 – Desteptarea, 507 – Dolgonosic, 508 – F_1 Flacara x Vrojainii, 509 – F_1 Vrojainii x Flacara, 510 – F_1 Desteptarea x Flacara, 511 – F_1 Flacara x Desteptarea, 512 – F_1 Flacara x Rufina, 513 – F_1 Rufina x Flacara, 514 – F_1 Dolgonosic x Mary Gratefully, 515 – F_1 Mary Gratefully x Dolgonosic, 516 – F_1 L 10B x Rufina, 517 – F_1 Rufina x L 10B

For a more accurate identification of tomato F_1 parents/hybrids with valuable complex traits, the *k*-means cluster method was applied. The data obtained show that the clustering into 4 groups of similarity was more successful based on 2 characters – the content of vitamin C and β-carotene, demonstrated by the fact that the intercluster variance was much higher than the intracluster one, the ratio between them being 8.08 and 3.16, respectively (Table 3).

Table 3. Inter- and intracluster variance analysis for parent cultivars and F_1 hybrids of tomato

Quality index	Interclusterian variance (1)	df	Intraclusterian variance (2)	Ratio	df	F	p
Dry substance	2.909	3	3.815	0.76	13	3.304	0.054
Sugars	2.844	3	6.545	0.44	13	1.892	0.181
Acidity	0.040	3	0.059	0.68	13	2.921	0.074
Sugar/acidity ratio	7.464	3	11.281	0.66	13	2.867	0.077
Vitamin C	125.543	3	15.540	8.08	13	35.009	0.000
Licopen	1.880	3	5.007	0.38	13	1.628	0.231
β-carotene	12.909	3	4.081	3.16	13	13.707	0.000

It should be mentioned that the 7 parent varieties were distributed in different clusters, thus demonstrating differences according to the indices of the characters under study. Reciprocal hybrids, with the exception of F_1 Dolgonosic x Mary Gratefully/F_1 Mary Gratefully x Dolgonosic, were located together in the same cluster and also shared with both parents. This denotes the lack of differences between the reciprocal F_1 hybrids according to the whole complex of investigated characters. Regarding the content of vitamin C and β-carotene, as properties that showed the highest ability to differentiate varieties and hybrids, it can be observed that clusters 2, 3, 4 are characterized by high indices of vitamin C content – 28.9-33.2 mg/%, and cluster 2 (Rufina, Flacara, F_1 Rufina x Flacara, F_1 Flacara x Rufina, F_1 Dolgonosic x Mary Gratefully) records a high average: 30.54 mg/%, and 3.52 mg/100 g, respectively, of vitamin C and β-carotene content (Table 4).

Table 4. Descriptive cluster analysis

Cluster	Quality index	x	σ	Genotype
1	Dry substance, %	6.35	0.50	Mary Gratefully, Dolgonosic
	Sugars, %	5.10	1.27	
	Acidity, %	0.48	0.13	
	Sugar/acidity ratio	10.8	0.42	
	Vitamin C, mg/%	24.45	1.91	
	Licopen, mg/100 g	0.89	0.47	
	β-carotene, mg/100 g	1.59	0.30	
2	Dry substance, %	7.54	0.13	Rufina, Flacara, F_1 Flacara x Rufina, F_1 Rufina x Flacara, F_1 Dolgonosic x Mary Gratefully
	Sugars, %	6.06	0.44	
	Acidity, %	0.61	0.00	
	Sugar/acidity ratio	9.90	1.40	
	Vitamin C, mg/%	30.54	0.71	
	Licopen, mg/100 g	0.69	0.15	
	β-carotene, mg/100 g	3.52	0.21	
3	Dry substance, %	7.35	0.92	Deșteptarea, F_1 Desteptarea x Flacara, F_1 Flacara x Desteptarea, F_1 Mary Gratefully x Dolgonosic
	Sugars, %	6.28	0.60	
	Acidity, %	0.64	0.08	
	Sugar/acidity ratio	9.93	0.38	
	Vitamin C, mg/%	28.88	1.25	
	Licopen, mg/100 g	1.56	0.11	
	β-carotene, mg/100 g	1.97	0.60	
4	Dry substance, %	7.72	0.33	L 10B, Vrojainii, F_1 Flacara x Vrojainii, F_1 Vrojainii x Flacara, F_1 L 10B x Rufina, F_1 Rufina x L 10B
	Sugars, %	6.45	0.64	
	Acidity, %	0.57	0.03	
	Sugar/acidity ratio	11.33	1.01	
	Vitamin C, mg/%	33.15	0.94	
	Licopen, mg/100 g	1.24	0.91	
	β-carotene, mg/100 g	1.47	0.62	

The analysis of the obtained results demonstrates that the varieties and hybrid combinations evaluated differ essentially also based on the content of lycopene and carotene. If in varieties the lycopene content fell within the limits of 0.10-1.71 mg/100 g, then in reciprocal hybrids – between 0.53-2.15 mg/100 g wet mass. The highest lycopene content was recorded by the varieties Mary Gratefully, Desteptarea and most of the reciprocal combinations except for the mutual combination Flacara x Rufina/ Rufina x Flacara where the lycopene content was 0.53 and 0.52 respectively. The varieties Rufina, Flacara and the mutual combinations Flacara x Rufina and Dolgonosic x Mary Gratefully stood out for their high β-carotene content, which recorded the highest values.

The research of the manifestation of the genetic factors involved in the manifestation of biochemical characters at the level of F_1 reciprocal hybrids, demonstrated that the degree of dominance of biochemical characters varied within wide limits – from positive overdominance to negative overdominance (Table 5), which denotes that the inheritance of biochemical characters it depends on the combination and can be dominant or recessive.

Table 5. The influence of the parental factor on the degree of dominance of biochemical indices in tomato fruits

Hibrid F_1	Dry substance	Sugars	Acidity	Vitamin C	Licopene	β-carotene
Flacara x Vrojainii	+5.0	-1.0	-0.5	+1.0	+9.7	-0.2
Vrojainii x Flacara	+11.0	+6.0	-0.25	0.0	+8.1	-0.2
Desteptarea x Flacara	+1.8	+1.4	+1.8	+1.2	+0.8	-0.5
Flacara x Desteptarea	+1.0	+1.2	+1,7	+2.0	+0.7	-0.7
Flacara x Rufina	0.0	+6.3	+1.7	+5.7	0.0	0.0
Rufina x Flacara	0.0	-7.0	-0.8	+1.7	0.0	+0.9
Dolgonosic x Mary Gratefully	+4.1	+0.2	+0.6	+5.2	+1.5	+5.4
Mary Gratefully x Dolgonosic	+5.9	+1.1	+1.2	+2.2	+1.8	+5.9
L 10B x Rufina	+6.0	-6.3	-1.0	+0.9	+7.2	-0.2
Rufina x L 10B	+9.0	-7.7	+0.7	+0.3	+6.8	-0.2

Notes: $-0.0<h_p<-1$ – negative overdominance; $-1<h_p<-0.5$ – negative dominance; $-0.5<h_p<+0.5$ – intermediate dominance; $+0.5<h_p<+1$ – positive dominance; $+1<h_p<+0.0$ – positive overdominance (Bryubeyker, 1966).

It should be noted that there were significant differences in the degree of dominance of biochemical indices in all reciprocal hybrids. For example, for the dry matter, vitamin C and lycopene characters, dominance and positive superdominance were recorded, and mutual combinations differed only based on values.

Both reciprocal combinations Flacara x Rufina/Rufina x Flacara did not record higher or lower values than one of the parents for dry matter and lycopene content. As for the sugar and acidity content, the mutual combinations differed both based on the values of the degree of dominance and its orientation.

For example, in the hybrids Flacara x Vrojainii and Rufina x Flacara h_p = - 1.0; -7.0, respectively, and for their counterparts – h_p = + 6.0; +6.3, denoting that the change in crossing direction determined the dry matter content. Differences between the homologous hybrids were also observed based on the acidity content. No differences were recorded based on the β-carotene character in the homologous hybrids Flacara x Vrojainii/ Vrojainii x Flacara and L 10B x Rufina/ Rufina x L 10B. Positive overdominance was found in the reciprocal combination Dolgonosic x Mary Gratefully/Mary Gratefully x Dolgonosic.

Based on the data obtained, we can mention that the F_1 combinations Flacara x Rufina, Dolgonosic x Mary Gratefully, Mary Gratefully x Dolgonosic, which showed incomplete dominance of the parent with high values or positive overdominance of the evaluated characters, are promising and through repeated selections can be obtained lines with high taste properties.

Calculation of the reciprocal effect demonstrated its dependence on the combination and the analyzed character. Thus, significant paternal influence on: i) the content of dry matter, sugar, lycopene was found in Flacara x Vrojainii hybrids; ii) dry substance content, vitamin C – Desteptarea x Flacara; iii) acidity, β-carotene – Flacara x Rufina; iv) dry matter content, sugar – Dolgonosic x Mary Gratefully. A strong influence of the maternal parent was recorded in the case of vitamin C content in the combinations Flacara x Vrojainii, Flacara x Rufina, Dolgonosic x Mary Gratefully (Table 6).

Table 6. Reciprocal effect for some biochemical characters of tomato fruits

Reciprocal hybrid F_1	Dry substance	Sugars	Acidity	Vitamin C, mg/%	β-carotene	Licopene
Flacara x Vrojainii	+1.00	+3.50	-0.11	-0.50	-0.02	+0.82
Desteptarea x Flacara	+4.00	-0.09	-0.08	+0.50	-0.11	+0.21
Flacara x Rufina	0.0	-0.33	+1.00	-2.00	+0.43	-0.03
Dolgonosic x Mary Gratefully	+0.86	+0.44	+0.32	-1.48	-0.21	+0.16
L 10B x Rufina	-1.5	-0.67	+0.05	+0.31	-0.02	-0.17

Study of a the complex of valuable biochemical characters of the fruit in some parent varieties and reciprocal tomato hybrids demonstrated their genetic determinism, the influence of the parental factor on the degree of dominance in the F_1 generation, the cluster organization of genotypes, the differentiated role of maternal and paternal factors in the phenotypic manifestation of quality attributes.

CONCLUSIONS

Research on the quality characteristics of tomato fruits – dry matter content (%), sugar (%), acidity (%), sugar / acidity index, vitamin C (mg/%), lycopene (mg/100 g), β-carotene (mg/100 g) in 7 parent varieties and 10 reciprocal F_1 hybrids demonstrated the dependence of the indicators on the plant genotype.

Through cluster analysis (dendrogram, *k*-means) the distribution of parents and F_1 hybrids was established in clusters according to the degree of similarity/difference of the indicators, and the high capacity of vitamin C and β-carotene for their differentiation was identified. The cluster formed by Rufina, Flacara, F_1 Rufina x Flacara, F_1 Flacara x Rufina, F_1 Dolgonosic x Mary Gratefully recorded an average of 30.54 mg/% and 3.52 mg/100 g, respectively, of vitamin C and β-carotene content.

The choice of hybridization components as maternal or paternal parent influenced the degree of dominance of dry matter content, sugar, acidity, sugar / acidity index, vitamin C content in most F_1 tomato hybrids. The paternal factor was more important for the content of dry matter and sugar, and the maternal factor – for the content of vitamin C.

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