

COMPARATIVE CHARACTERISTICS OF TWO METHODS FOR POPPING POPCORN

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Topicality. The comparative study on effectiveness of various methods of popping popcorn from *Zea mays L. everta* Sturt. is important and relevant. Technological indicators of popcorn kernels depend on many factors, including the method of popping. **Purpose.** To compare the technological characteristics for popcorn kernels obtained by two methods of popping the grain: frying in a frying pan and heating with air-popping appliances. **Methods.** The initial material for research was kernels of popcorn lines bred by the Laboratory of Maize Breeding for Food Use at SE Institute of Grain Crops of NAAS. According to the first method of popping, one layer of popcorn kernels were placed on an aluminium pan heated to 175 °C and fried without oil, shaking the kernels every 5–6 seconds. For the second popping method, Clatronic PM 3635 electric popcorn maker having a capacity of 1200 W was used. **Results.** In the first method of producing popcorn, the dominant type of popcorn flakes was unilaterally expanded; the average percentage of unpopped kernels was 3.5 %; the coefficient of kernel volume expansion varied from 16.4 to 29.7; and eating qualities were from 3 to 4.5 points. In the second method, the dominant type of popcorn flakes was bilateral expanded; the average percentage of unpopped kernels was 18.2 %; coefficient of kernel volume expansion ranged from 23.4 to 45.2; and eating qualities were from 3.5 to 5 points. For the first popping method, the coefficient of kernel volume expansion had an inverse average correlation with the percentage of unpopped kernels; for the second popping method, it had a direct average correlation with the thousand kernel weight. **Conclusions.** The method of popping popcorn affects the technological indicators of popcorn such as the number, weight and percentage of unpopped kernels; volume and weight of popcorn flakes; coefficient of kernel volume expansion; type of popped flakes and flavour of popcorn. Lines RB 20, RK 1, RK 44, RK 6 with kernel volume expansion coefficient over 40 and popcorn taste qualities of 5 points were selected.

Key words: breeding, line, technological indicators, coefficient of kernel volume expansion, unpopped kernels, type of popped flakes, correlation

Introduction. A characteristic feature of popcorn (*Zea mays everta* Sturt.) is the popping of the kernels with a significant expansion of the volume when exposed to high temperatures. This feature is primarily explained by the structure of the kernel, which has a very hard coat and a horny endosperm that fills the kernel almost completely. The pressure and temperature inside the kernel increase during heating, and under these conditions, the starch gelatinises. When the pressure reaches 930 kPa, the pericarp ruptures and the pressure decreases, and the water transforms into steam, which leads to the stretching of the starch cells, which acquire a loose foamy structure. After rapid cooling, the starch hardens, and as a result, white or creamy, voluminous and crispy "clouds" are formed, i. e. the popcorn is ready [1].

There are several types of popcorn flakes: in the United States, popped kernels of a spherical shape with few small wings are called mushroom. Flakes of irregular shape, with a large

number of wings pointing in different directions are called butterfly or snowflake (if the popcorn is white). Thus, J. C. Sweley and other authors [2] proposed further differentiation of butterfly popcorn depending on the position of the wings: on one side (unilateral), on both sides (bilateral) or multilateral extension.

Based on the results of the research, scientists found that different types of popcorn from the same hybrid differ in volume and have different chemical and flavour properties.

In Ukraine, this trait is determined using the methodology for examining varieties of common maize (*Zea mays* L.) for distinctiveness, uniformity and stability [3]. According to this methodology, there are such flake types as spherical, butterfly and intermediate. We have divided the intermediate flake type into two types – mushroom and rose (Fig. 1).

The shape of the popped kernels is a varietal trait, however, the shape of the flakes can change depending on various factors. Until 1998,

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Fig. 1 Types of popcorn flakes

there were no hybrids in the US that produced 100 % mushroom popcorn, while butterfly popcorn became stable faster [4]. Most often, we have a mixture of different types, so the share of each type needs to be determined separately.

At present, the technological characteristics of popcorn grain are studied in two different ways. The first approach determines an increase in the initial volume of grain after popping, i.e. the popping fold. And the second approach determines the grain volume after popping given a certain grain weight, i.e. the popping expansion of the grain in cm^3/g [5]. Some authors propose other indicators, such as popcorn volume from one kernel [6], or popcorn volume per 1 ha of sown area [7].

Despite the fact that the popping ability of corn kernels is heritable, the value of popping fold depends on many factors, such as grain moisture content, grain maturity, damage to the kernels by pests and diseases, heating temperature, etc. Research conducted by of I. Ye. Ivanov at the All-Union Research Institute of Maize found that the best temperature for the production of popcorn is 175 °C. At a temperature of 150–160 °C, bulk of popcorn kernels don't pop, because the grain gradually dries out before reaching the critical temperature point for kernel popping. As the temperature rises above the

optimum value, the technological characteristics of popcorn deteriorate [8].

Modern popcorn makers are based on three principles: hot air-popping, oil-popping, or using microwave irradiation. Modern popcorn makers are based on three principles: hot air-popping, oil-popping, or using microwave irradiation. For example, C. P. Jele compared the technological characteristics of popcorn from 119 experimental hybrids obtained by using a hot air popcorn maker Samsung SPC 900 model and a microwave oven Defy DMO351 900 W [9]. It was found that the popping method had significant effect on popcorn volume, popping expansion, number of unpopped kernels and kernel size. There was a significant direct correlation between popcorn volume and popping expansion; a weak inverse correlation was observed between popping expansion and number of unpopped kernels; a significant direct correlation was observed between grain size and number of unpopped kernels.

The purpose of the research was to compare the technological characteristics of popcorn grain obtained by two popping methods: heating in a frying pan and with hot air.

The objective of the research was to identify the effect of the popping method on the quality of the finished product.

Materials and Methods. The source material for the research was the grain of the popcorn lines developed in the Laboratory of Maize Breeding for Food Use of the State Enterprise Institute of Grain Crops of NAAS of Ukraine.

In the study, we used lines with different genetic origins: RS 1 and RS 9 were bred on the basis of Snow Puff Popcorn hybrid; RK 1, RK 6 and RK 44 – Creme Puff Corn hybrid; RB 1, RB 4 and RB 20 – Japanese Hulless White Popcorn variety; RP 3, RP 37 and RP 63 – Pick and Pop Popcorn hybrid; RR 3 and RR 5 – Red River Valley Popcorn variety; RV 2 and RV 13 – Wisconsin White Birch Popcorn variety.

The first popping method included heating a single layer of popcorn kernels on an aluminum frying pan heated to 175 °C and frying them without oil. The grain was stirred every 5–6 seconds. The initial and final temperatures at which the grain popping occurred, as well as the duration of this process, were noted.

For the second popping method, Clatronic PM 3635 Electric Popcorn Maker with a capacity of 1200 W was used. The hot air circulating inside the cylindrical container heated the grain, it was popped, and the finished product was discharged by air flow to the outside. To ensure the same temperature conditions, each subsequent sample was poured 15 minutes after the end of the previous popping process.

One self-pollinated ear from each popcorn line was selected to determine the technological parameters of the grain. The grain was threshed from the middle part of the cob and divided into 4 10 ml weightings (2 replications per method). The volume of the initial product was determined using a 25 ml graduated cylinder. The samples were previously weighed and the number of grains in each sample was counted. Then, the volume and weight of the finished popcorn, the number and weight of unpopped kernels, and the taste of popcorn were determined on a 5-point scale, and the samples were analysed by the type of popping. The volume of finished popcorn was measured with a 500 ml graduated cylinder.

The popping fold was calculated using the following formula [10]:

$$K303 = \frac{V - V_0 \times a}{V_0 \times a}$$

where: V – volume of grain; V_0 – initial grain volume; a – yield of popped kernels.

Yield of popped kernels was determined by the formula:

$$a = \frac{N_0 - N_{\#}}{N_0}$$

where: N_0 – number of kernels in weighting, $N_{\#}$ – number of unpopped kernels.

The statistical reliability of the experimental data and correlation coefficients were calculated according to B. O. Dospekhov [11]. Mathematical data processing was carried out using special application programmes Microsoft Excel (Statistica).

Results and Discussion. The analysis of the data showed that in the first popping method, the temperature of the pan at the beginning of the popping process was on average 241 °C, and at the end it was 264 °C. The popping process itself lasted from 28 to 63 seconds.

According to Table 1, the number of kernels in a 10 ml weighting varies depending on the original lines. The minimum value of this indicator was 51 kernels in lines RK 1 and RK 6, and the maximum value was 112 kernels in line RR 3.

The kernel weight in the 10 ml weightings ranged from 6.85 to 8.61 g and averaged 7.91 ± 0.06 g. In this popping method, the number of unpopped kernels was insignificant. The grains of RS 1 and RR 3 lines were characterised by 100 % popping, and the largest number of unpopped kernels was in samples of RB 20 and RP 63.

The volume of the finished popcorn varied from 165 ml (RR 5) to 305 ml (RV 305) and was on average 233.7 ± 11.9 ml. Given the origin of the lines, it should be noted that the largest average volume (282.5 ml) with this method of popcorn preparation was produced by the progeny of the Snow Puff Popcorn hybrid and the Wisconsin White Birch Popcorn variety, and the smallest (180 ml) by the lines produced from the Red River Valley Popcorn variety. The weight of the finished popcorn also varied, with the highest value of 7.32 g in the RK 44 line with a popcorn volume of 275 ml.

The analysis of popcorn by the type of flakes showed that the mushroom type prevailed, its percentage in the samples ranged from 47 to 97 %. Spherical type of flakes was not characteristic for any line, while mushroom, rose and butterfly flakes were observed in seven lines, mushroom and rose – in five, mushroom and butterfly – in three.

According to the second popping method,

Table 1. Technological indicators of popcorn lines in the first popping method

Line	Initial grain sample of 10 ml volume		Unpopped kernels		Finished product		Distribution by type of popcorn flakes, %		
	number, pcs	weight, g	number, pcs	weight, g	volume, ml	weight, g	mush room	rose	butter-fly
RS 1	56	7.46	0	0	290	6.68	59	26	15
RS 9	68	7.76	1	0.05	275	6.79	79	21	–
RK 1	51	8.24	4	0.57	215	6.64	88	12	–
RK 6	51	8.41	3	0.40	215	6.94	97	3	–
RK 44	63	8.39	1	0.09	275	7.32	84	11	5
RB 1	62	7.86	4	0.40	220	6.56	75	5	20
RB 4	71	8.12	2	0.21	245	6.98	59	3	38
RB 20	97	8.61	6	0.44	230	7.19	78	9	13
RP 3	81	8.04	5	0.34	200	6.75	89	–	11
RP 37	52	8.45	4	0.58	220	6.87	96	–	4
RP 63	52	7.74	6	0.71	195	6.08	90	–	10
RR 3	112	6.85	0	0	195	6.04	96	4	–
RR 5	64	7.16	4	0.26	165	5.88	88	12	–
RV 2	88	7.50	1	0.04	305	6.70	47	15	38
RV 13	78	8.09	1	0.04	260	7.03	80	13	7
Average	69.5 ± 1.20	7.91 ± 0.06	2.5 ± 1.14	0.27 ± 0.12	233.7 ± 11.9	6.69 ± 0.10	–	–	–

the kernels began to pop after 55-100 seconds and lasted on average 30 seconds, which is 12 seconds less compared to heating in a pan. Table 2 shows that while the average parameters of the samples, i.e., the number and weight of kernels in 10 ml weighting, were similar for both popping methods, other parameters differed significantly.

The average number of unpopped kernels was 5 times higher than in the previous study and was 12.7 ± 2.56 pieces. The largest number of unpopped kernels (41 pcs) was in the line RR 3, which had the lowest grain weight.

The difference between the minimum and maximum volume of the finished product was much larger than in the previous popping method, and the average value was 300.7 ± 14.5 ml. The largest volume of popcorn (380 ml) was recorded for the grain of the RK 6 line, and the smallest (155 ml) for the RR 5 line, which had 37 % of unpopped kernels.

The average weight of the finished product when making popcorn in the Clatronic PM 3635 was 0.81 g less than in the pan, while the weight of unpopped kernels increased by 0.89 g. Regarding the second popping method, the largest average popcorn volume (256 ml) was characteristic of the progeny of the Creme Puff Corn hybrid, and the smallest, as in the previous experiment, belonged to the lines bred from the Red River Valley Popcorn variety (175 ml).

The analysis according to the type of flakes showed that there were no samples with the spherical type among the presented lines. The butterfly type was present in all lines, and the number of such kernels varied from 7 to 100 %. The kernels of RR 5 line provided 100 % butterfly type of flakes, RS 1, RK 1 and RK 6 lines provided 3 types – mushroom, rose and butterfly, and all other lines provided 2 types – mushroom and butterfly. So, in the second popping method, the butterfly type of popping prevailed in 87 % of the lines.

As shown in Fig. 2, a significant, direct and strong correlation was observed between the weight and the number of unpopped kernels ($r = 0.91 \pm 0.08$) and average correlation between the weight and the volume of popcorn ($r = 0.58 \pm 0.15$). At the same time, the volume of popcorn had an inverse correlation of average strength with the number of unpopped kernels ($r = -0.63 \pm 0.15$) and the weight of unpopped kernels ($r = -0.58 \pm 0.15$). A direct significant correlation was found between the popcorn weight and the initial kernel weight ($r = 0.79 \pm 0.12$) and an inverse average correlation between the weight of unpopped kernels and the initial number of kernels ($r = -0.42 \pm 0.17$).

In contrast to the first, the second popping method was characterised by more significant correlations. A direct strong correlation was ob-

Table 2. Technological indicators of popcorn lines in the second popping method

Line	Initial grain sample of 10 ml volume		Unpopped kernels		Finished product		Distribution by type of popcorn flakes, %		
	number, pcs	weight, g	number, pcs	weight, g	volume, ml	weight, g	mush room	rose	but-terfly
RS 1	56	7.45	3	0.31	335	6.31	34	7	59
RS 9	70	7.75	5	0.50	345	6.40	25	-	75
RK 1	50	8.26	6	0.92	370	6.44	4	10	86
RK 6	51	8.43	9	1.34	380	6.07	48	45	7
RK 44	61	8.31	16	2.01	320	5.37	14	-	86
RB 1	62	7.89	5	0.50	310	6.55	23	-	77
RB 4	72	8.13	23	2.22	245	5.34	24	-	76
RB 20	96	8.49	12	0.87	365	6.61	8	-	92
RP 3	81	8.08	7	0.66	295	6.54	17	-	83
RP 37	52	8.54	5	0.53	335	7.02	43	-	57
RP 63	54	7.83	11	1.24	285	5.69	19	-	81
RR 3	111	6.92	41	2.1	155	4.02	-	-	100
RR 5	64	7.28	18	1.72	195	4.83	16	-	84
RV 2	91	7.7	25	1.78	255	4.94	12	-	88
RV 13	78	8.11	9	0.81	320	6.10	12	-	88
Average	69.8 ± 1.74	7.94 ± 0.03	12.7 ± 2.56	1.16 ± 0.28	300.7 ± 14.5	5.88 ± 0.25	-	-	-

Trait	Initial number of grain	Initial weight of grain	Number of unpopped kernels	Weight of unpopped kernels	Popcorn volume	Popcorn weight
Initial number of grain **	1	- 0.38 ± 0.18	*0.65 ± 0.14	0.28	*- 0.49 ± 0.17	*- 0.44 ± 0.17
Initial weight of grain	- 0.33 ± 0.2	1	*- 0.51 ± 0.16	-0.23	*0.75 ± 0.13	*0.65 ± 0.14
Number of unpopped kernels	- 0.22	0.33 ± 0.18	1	*0.85 ± 0.10	*- 0.81 ± 0.11	*- 0.91 ± 0.08
Weight of unpopped kernels	*-0.42 ± 0.2	0.40 ± 0.17	*0.91 ± 0.08	1	*- 0.65 ± 0.14	*- 0.86 ± 0.10
Popcorn volume	0.05	0.13	*- 0.63 ± 0.15	*-0.58 ± 0.15	1	*0.84 ± 0.10
Popcorn weight	- 0.03	*0.79 ± 0.12	- 0.23	- 0.21	*0.58 ± 0.15	1

Note: * P < 0.05;

**

	The first popping method
	The second popping method

Fig. 2. Correlation between traits of popcorn lines.

served between the number and weight of unpopped kernels ($r = 0.85 \pm 0.10$); between the volume and weight of popcorn ($r = 0.84 \pm 0.10$); between the volume and initial weight of popcorn ($r = 0.75 \pm 0.13$).

An inverse strong correlation was found between the number of unpopped kernels and the volume and weight of popcorn ($r = - 0.81 \pm$

0.11 and $r = - 0.91 \pm 0.08$); between the weight of unpopped kernels and the popcorn weight ($r = - 0.86 \pm 0.10$). There was a direct effect of the average strength between the initial number of kernels and the number of unpopped kernels ($r = 0.65 \pm 0.14$) and an inverse correlation between the number of unpopped kernels and the volume and weight of popcorn ($r = - 0.49 \pm 0.17$

and $r = - 0.44 \pm 0.17$). As the first popping method, the second one was characterised by an inverse average correlation between the popcorn volume and the weight of unpopped kernels ($r = - 0.65 \pm 0.14$) and a direct correlation between the popcorn weight and the initial grain weight ($r = 0.65 \pm 0.14$). However, in contrast to the first method, the inverse correlation of the average strength between the number of unpopped kernels and the initial grain weight ($r = - 0.51 \pm 0.16$) was observed.

To compare the two popping methods, we used the following technological indicators: percentage of unpopped kernels, popping fold, type of flakes and popcorn taste. Table 3 shows that the 1000 seed weight of the popcorn lines varies from 61.9 to 165.2 g. The coefficient of variation for this trait was significant and reached 51.3 %, i.e. a wide range of variability of the initial forms was observed in the study.

When making popcorn in a frying pan, the share of unpopped kernels was insignificant and averaged 3.5 %, while when using the Clatronic PM 3635, this indicator increased by 5.2 times. For all the lines, an increase in the percentage of unpopped kernels was characteristic, which va-

ried from 1 to 36.5 %. This is due to the design of the popcorn maker, namely, part of the kernels are blown out with the finished product. In the first popping method, a direct average correlation ($r = 0.47 \pm 0.16$) was observed between the 1000 seed weight and the percentage of unpopped kernels, while in the second method, the correlation was inverse ($r = - 0.34 \pm 0.18$) (Fig. 3). Consequently, large kernels popped worse in the frying pan due to uneven heating, and better in the popcorn maker because they were not blown out.

The popping fold was calculated by the formula considering the number of unpopped kernels, therefore, it objectively characterised both the popping methods for the same sample. Table 3 shows that the average value of the popping fold for the first popping method was 23.3 ± 0.96 , and for the second – 35.1 ± 1.13 , while the coefficient of variation was average, which allowed the selection of the best genotypes. No line had a popping fold ≥ 30 in the first method, while in the second method, lines RB 20, RK 1, RK 44, RK 6 showed a popping fold of 40.5, 41.1, 41.9, and 45.2.

The largest difference in the popping fold

Table 3. Comparative characteristics of two popping methods

Line	1000 seed weight, g	Unpopped kernels, %		Popping fold			Predominant type of popcorn flakes		Taste qualities, points	
		1 method	2 method	1 method	2 method	difference	1 method	2 method	1 method	2 method
RS 1	133.1	0.0	4.5	28.0	34.1	6.1	M, R, B*	B, M, R	3.5	4.0
RS 9	112.4	0.7	6.4	26.7	35.9	9.2	M	B	3.5	4.0
RK 1	165.0	7.0	12.1	22.1	41.1	19.0	M	B	3.5	5.0
RK 6	165.2	4.9	17.6	21.6	45.2	23.6	M	M, R, B	4.0	5.0
RK 44	134.7	1.6	25.5	26.9	41.9	15.0	M	B	3.0	5.0
RB 1	127.1	5.6	7.3	22.3	32.5	10.2	M	B	4.5	5.0
RB 4	114.7	2.1	32.5	24.1	35.2	11.1	M, B, R	B	4.0	4.0
RB 20	88.9	5.7	12.0	23.4	40.5	17.1	M	B	4.5	5.0
RP 3	100.1	5.6	8.1	20.2	31.1	10.9	M	B	3.0	3.5
RP 37	163.3	7.7	8.7	22.8	35.8	13.0	M	B, R	3.0	4.0
RP 63	148.3	11.7	20.6	21.1	34.9	13.8	M	B	3.0	4.0
RR 3	61.9	0.0	36.5	18.5	23.4	4.9	M	B	4.0	4.5
RR 5	113.7	5.5	27.5	16.4	25.8	9.4	M	B	4.0	4.5
RV 2	85.0	0.5	27.5	29.7	34.2	4.5	M, B, R	B	4.0	5.0
RV 13	103.8	0.6	11.0	25.2	35.0	9.8	M	B	3.5	5.0
Average	121.1±1.39	3.5	18.2	23.3±0.96	35.1±1.13	-	-	-	3.67±0.31	4.50±0.22
V, %	51.3	-	-	23.3	23.2	-	-	-	-	-

Note: * M – mushroom, R – rose, B – butterfly.

Indicator	1000 seed weight	PUK ** (1 method)	PUK (2 method)	PF *** (1 method)	PF (2 method)	Taste (1 method)	Taste (2 method)
1000 seed weight	1						
PUK (1 method)	*0.47 ± 0.16	1					
PUK (2 method)	- 0.34 ± 0.18	- 0.24	1				
PF (1 method)	0.00	*- 0.49 ± 0.16	- 0.20	1			
PF (2 method)	*0.58 ± 0.15	0.16	- 0.28	*0.41 ± 0.17	1		
Taste (1 method)	- 0.34 ± 0.18	- 0.11	0.14	- 0.09	- 0.12	1	
Taste (2 method)	- 0.01	- 0.08	0.11	0.12	0.37 ± 0.18	0.40 ± 0.17	1

Note: * $P < 0.05$; ** PUK – percentage of unpopped kernels; *** PF – popping fold.

	direct average correlation		inverse average correlation
	direct weak correlation		inverse weak correlation

Fig. 3. Correlation between two popping methods.

between the first and second popping methods was for the RK 6 line – 23.6, and the smallest – for the RV 2 line – 4.5. Analysis of the sample origin revealed significant variability in the value of the popping fold. Taking into account the average value of this trait, the first place was taken by the lines bred on the basis of the Creme Puff Corn hybrid with an index of 42.7, the second – by the progeny of the Wisconsin White Birch Popcorn variety – 36.1, and the last – by the lines from the Red River Valley Popcorn variety – 24.6.

The correlation analysis shows that there is a significant direct correlation of average strength ($r = 0.41 \pm 0.17$) between the popping fold obtained by the first and second popping methods. The percentage of unpopped kernels in both methods had a negative effect on the value of the popping fold, which was significant and of average strength ($r = - 0.49 \pm 0.16$). At the same time, the correlation coefficient between the 1000 seed weight and the popping fold was medium and positive ($r = 0.58 \pm 0.15$) in the second method, in contrast to the lack of any correlation between the 1000 seed weight and the popping fold in the first method. Consequently, in the first method, the popping fold significantly depended on the percentage of unpopped kernels, and in the second method – on the 1000 seed weight. The popping method determined not only popcorn volume but also the type of flakes. In view of the fact that the kernels of most lines did not have the same type of flakes, we introduced the concept of predominant flake type (75 per cent or more of the popped kernels of such type). Table 3 shows

that mushroom type prevailed in the first popping method, and butterfly type in the second. In both the first and the second cases, only the grain of the RS 1 line produced a mixture in which the proportions of each type were almost equal.

The taste of popcorn was evaluated on a five-point scale, where 5 is the highest point. During the degustation, the texture, consistency, presence and size of husks in the finished product, taste and smell were evaluated. According to the data in Table 3, the use of the Clatronic PM 3635 had a positive impact on the taste of popcorn, with an average of 4.5 points. While the taste of the finished product obtained on the frying pan was rated between 3 and 4.5 points, the popcorn maker provided 3.5 to 5 points. The highest score was given to popcorn made from grains of the following lines: RK 1, RK 6, RK 44, RB 20, RB 2, and RB 13. Fig. 3 shows that any of the traits had no significant effect on the taste. However, for the first popping method, an insignificant inverse correlation of average strength was observed between taste and 1000 seed weight, and for the second method, a direct correlation of average strength was observed between taste and popping fold. Therefore, when popcorn was cooked in a pan, smaller kernels had better taste, and in the popcorn maker, lines with high popping fold had better taste.

Conclusions. The research has shown that the popping method affects such technological parameters of the popcorn grain as the number, weight and percentage of unpopped kernels; volume and weight of the finished product;

popping fold; type of popcorn flakes and taste of popcorn. In the first popping method, the predominant type of popcorn flakes was mushroom, the average percentage of unpopped kernels was 3.5%, popping fold ranged from 16.4 to 29.7, and taste qualities were from 3 to 4.5 points. In the second popping method with Clatronic PM 363, the predominant type of popcorn flakes was butterfly, the average percentage of unpopped kernels was 18.2 %; popping

fold ranged from 23.4 to 45.2; and taste qualities were from 3.5 to 5 points. In the first popping method, the popping fold had an inverse average correlation with the percentage of unpopped kernels, and in the second method, a direct average correlation with the 1000 seed weight. The popping fold over 40 and taste qualities of 5 points were observed in the lines RB 20, RK 1, RK 44, RK 6, three of which were developed on the basis of the Creme Puff Corn hybrid.

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Черчель В. Ю., Купріченко Д. С. Порівняльна характеристика двох способів одержання попкорну із зерна розлусної кукурудзи. Grain Crops. 2023. 7 (1). 19–27.

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Актуальність. Є декілька способів одержання попкорну із зерна розлусної кукурудзи (*Zea mays* L. *everta* Sturt.), тому порівняння їх результативності є важливим і актуальним. Визначення технологічних показників зерна розлусної кукурудзи залежить від багатьох чинників, серед яких і спосіб розлуснення. **Мета.** Порівняти технологічні показники зерна ліній розлусної кукурудзи, отриманих за допомогою двох способів розлуснення: смаження зерна на пательні та нагрівання його гарячим повітрям. **Матеріали та методи.** Вихідним матеріалом для проведення досліджень було зерно ліній розлусної кукурудзи, створених у лабораторії селекції кукурудзи харчового напрямку використання Державної установи Інститут зернових культур НААН України. Перший спосіб одержання попкорну полягав у тому, що зерно розлусної кукурудзи одним шаром розміщували на розігріту до 175 °С алюмінієву пательню і смажили без олії, струшуючи зерно кожні 5–6 с. За другого способу розлуснення зерна використовувався електричний апарат Clatronic PM 3635 потужністю 1200 Вт. **Результати.** Показано, що за першого способу одержання попкорну переважаючим типом розлуснення був «гриб»; середній відсоток нерозлуснених зерен дорівнював 3,5 %; величина коефіцієнта збільшення об'єму зерна змінювалася від 16,4 до 29,7; а смакові якості – від 3 до 4,5 балів. За другого способу – переважаючим типом розлуснення був «метелик»; середній відсоток

нерозлуснених зерен дорівнював 18,2 %; величина коефіцієнта збільшення об'єму зерна коливалася від 23,4 до 45,2; а смакові якості – від 3,5 до 5 балів. Коефіцієнт збільшення об'єму зерна, за першого способу розлуснення, мав обернений середній кореляційний зв'язок із відсотком нерозлуснених зерен, а за другого способу – прямий середній зв'язок із масою 1000 зерен. **Висновки.** Спосіб одержання попкорну впливає на такі технологічні показники зерна розлусної кукурудзи, як кількість, маса і відсоток нерозлуснених зерен; об'єм і маса готового продукту; коефіцієнт збільшення об'єму зерна; тип розлуснення та смак попкорну. Виділено лінії РБ 20, РК 1, РК 44, РК 6, які мають коефіцієнт збільшення об'єму зерна понад 40 та смак попкорну 5 балів.

***Ключові слова:** селекція, лінія, технологічні показники, коефіцієнт збільшення об'єму зерна, нерозлуснені зерна, тип розлуснення, кореляція*