



INVESTIGATION OF DIMENSIONAL CHARACTERISTICS OF PEA AND MILLET GRAIN

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Abstract

Crop yields have been significantly affected by arid weather over the past five years. They lead not only to a decrease in crop yields, but also to a decrease in the quality of the crop grown. First of all, its grain part includes a considerable amount of soft underdeveloped grain with a total weight reduction of 1000 seeds of the main crop. Post-harvest treatment of the grain part of such a crop is associated with the separation of part of the grain of the main crop into waste fractions. The content of these fractions, after appropriate refinement, can be a valuable component of the feed and feed additives required for the complete feeding of farm animals. To obtain balanced and nutritional nutritious feeds, it is necessary to have finely ground with small particle sizes of all components and their particle size distribution. The process of grinding by rotary shredder is promising. To substantiate the parameters of such shredders and to choose the modes of their operation requires a thorough study of the mechanical and technological properties of all components of the original grain materials, including their size and shape. The variability of grain sizes was estimated by its geometric dimensions: thickness, width and length, their statistical characteristics and equivalent diameter. The sampling volume of each grain was 100 units for reliable results. Separate whole grains of peas and millet and the characteristic halves of peas were studied. Studies of the dimensional characteristics of the grain of the pea of the Motto variety, its halves and the grain of millet Slobozhanske found that their average values of length, width and thickness differ significantly and the standard deviation of their thickness 1.33 mm, width – 1.47 mm, and lengths – 1, 51 mm. The coefficient of variation of the length of the studied grain is 34.40%, width – 39.73%, and thickness – 47.33%. The average equivalent diameter of the studied grain varies from 2.52 mm grains of Slobozhanske millet to 7.20 mm grains of Motto pea. The smallest weight of 1000 pieces also has millet grain – 7.54 g, and the largest – pea grain – 258.77 g.

Key words:

variability of grain size characteristics, width, thickness, length, peas, millet, halves of peas, average equivalent diameter, shape.

Introduction

An important component of increasing both the livestock population and improving their productivity is the formation of a stable forage based on priority feeds based on updated performance criteria (Hnoyevyy *et al.* 2018).

The crop yields of the last five years have been significantly influenced by weather conditions (Kumhalova *et al.* 2008). Thus, the average daily air temperature in the forest-steppe and steppe zones of Ukraine exceeds long-term indicators, and a small amount of rainfall in the autumn-winter period,

prolonged droughts and rainfall in the spring-summer period leads to a lack of productive moisture in the soil. Also, there is a significant increase in the likelihood of hot periods, with temperatures higher than 30 °C, during the growing season of crops.

All this leads not only to a decrease in crop yields, but also to a decrease in the quality of the cultivated crop. First of all, its grain part includes a considerable amount of soft underdeveloped grain with a total weight reduction of 1000 seeds of the main crop. In addition, the drying of inflorescences, spike-lets, beans of plants lead to an increase in their crushed particles, with the dried seeds of the main crop, in the grain part of the crop. In

this case, the grains of the main crop become less resistant to the mechanical impact of the working organs of both harvesting machines and equipment for post-harvest processing of the crop, which increases not only their injury, but also partial grinding, or splitting into halves, for example, pea grains.

Formulation of problem

Post-harvest treatment of the grain part of such a crop, bringing the target fraction to the requirements of state standards for food grain, and even more so for the sowing material, associated with the separation of part of the grain of the main crop to waste fractions. The content of these fractions, after appropriate refinement, can be a valuable component of the feed and feed additives required for the complete feeding of farm animals (Provatorov *et al.* 2007). So, for example, defective crushed pea grains contain from 16 to 36% protein, up to 48% starch, up to 10% sugar, up to 1.6% fat, over 3% ash, and millet starch is more than 80% weight, protein – 12%, and fat – 3.5%. In addition, they include mineral salts of potassium, calcium, sodium, magnesium, as well as vitamins (Khorasani *et al.* 2007; Bingol *et al.* 2008; Wadhwa *et al.* 2007).

To obtain balanced and nutritional nutritious feeds, it is necessary to have finely ground with small particle sizes of all components and their particle size distribution (Wadhwa *et al.* 2007).

Crushing grain with a blow does not fully meet the requirements (Revenko *et al.* 2009; Syrotyuk *et al.* 2004). More promising is the process of grinding by rotary shredders (Nanka *et al.* 2018; Naumenko *et al.* 2019), but to substantiate the parameters of such shredders and the choice of modes of their operation requires a thorough study of the mechanical and technological properties of all components of the original grain materials for grinding, including their size and shape (Tsarenko *et al.* 2003).

Purpose of research

Investigate the variability of grain size of peas and millet, which is separated into the waste fraction when preparing the conditioned seed.

Research results and discussion

Grain mixtures of the motto of the Motto variety and the Slobozhanskemillet were investigated, which were separated into the waste fractions during the preparation of the seed material on the grain processing lines.

The variability of grain sizes was estimated by its geometric dimensions: thickness, width and length, their statistical characteristics and equivalent diameter. The sampling volume of each grain, for reliable results (Tsarenko *et al.* 2003), was taken by 100 pieces. Separate whole grains of peas and millet and the characteristic halves of peas were studied.

The dimensions of each grain were measured separately with a microscope with an accuracy of 0.01 mm. The results of measurements of grain sizes, in the form of variation rows, are given in Tables 1...3 and the variation curves in Fig. 1.

Whole grain pea has the greatest dispersion of thickness (Table 1, Fig. 1a), and the least - millet grain. The thickness of whole grain peas varies from 1.89 mm to 6.45 mm, and its halves from 1.44 to 3.79 mm. The scattering thickness of the Slobozhanske millet grain varies only from 1.75 to 2.31 mm.

Millet grain also has the lowest average thickness. It is 1.98 mm. The average width of the pea halves is more than 0.13 mm of the average thickness of the millet. The largest value of the average value of the thickness of a whole pea. It is 2.20 times larger than average thickness of millet grain, 2.06 times larger than average thickness of half peas and is 4.35 mm.

Table 1. Variation series of grain thickness

Interval limits, mm	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-5.5	5.5-6.0	6.0-6.5
Frequency, %	The pea of "Motto" variety										
			4	5	9	23	15	15	12	11	5
Frequency, %	The half of peas of "Motto" variety										
	4	44	36	10	4	2					
Frequency, %	Millet of Slobozhanske variety										
	2	61	37								

Table 2. Variation rows of grain width

Interval limits, mm	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-5.5	5.5-6.0	6.0-6.5	6.5-7.0	7.0-7.5	7.5-8.0
Frequency, %	The pea of "Motto" variety												
				5	7	15	19	15	14	11	9	4	2
Frequency, %	The half of peas of "Motto" variety												
		6	12	37	31	12	2						
Frequency, %	Millet of Slobozhanske variety												
	1	73	26										

By the size of scattering, the width of the peas grains of the motto of the motto is much greater than the scattering of the width of its halves, and even more so - the grains of millet Slobozhanske. Thus, the width of the pea grains varies from 3.20 to 7.63 mm, and the width of the millet grains - only from 1.86 to 2.69 mm (Table 2, Fig. 1b).

The average values of the width of the studied grain also differ significantly. The largest average value is the width of pea grains (5.29 mm) and the smallest – 2.38 mm width of millet grains (Table 4). The average width of the pea halves is less than the average of the whole grain by only 1.54 times.

Table 3. Variation series of grain length.

Interval limits, mm	1.5-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	4.0-4.5	4.5-5.0	5.0-5.5	5.5-6.0	6.0-6.5	6.5-7.0	7.0-7.5
Frequency, %	The pea of "Motto" variety											
				4	7	18	20	22	13	8	4	4
Frequency, %	The half of peas of "Motto" variety											
		15	41	34	10							
Frequency, %	Millet of Slobozhanske variety											
	18	80	2									

Table 4. Statistical indicators of variability of grain sizes

Agrarian culture Indicators	The pea of "Motto" variety	The half of peas of "Motto" variety	Millet of Slobozhanske variety	The average value of the dimensions, mm	The standard deviation of the dimensions, mm	Coefficient of variation of sizes, %
Minimum grain thickness, mm	1.89	1.94	1.75			
Maximum grain thickness, mm	6.45	3.79	2.31			
The average value of grain thickness, mm	4.35	2.11	1.98	2.81	1.33	47.33
Minimum grain width, mm	3.20	2.21	1.86			
Maximum grain width, mm	7.63	4.78	2.69			
Average value of grain width, mm	5.29	3.44	2.38	3.70	1.47	39.73
Minimum grain length, mm	4.13	3.04	2.72			
Maximum grain length, mm	8.14	4.78	3.49			
The average value of grain length, mm	6.07	3.95	3.15	4.39	1.51	34.40

The average value of the width of the test grain is 3.70 mm, which is 0.89 mm more than the average value of its thickness. In general, the pattern of variability in the width of the test grain is almost indistinguishable from the variability of its thickness. By absolute values of the mean values, the largest difference in width and thickness are half the pea grains. It is 1.33 mm. Whole pea grains have a difference of 0.94 mm, while millet grains have a

difference of only 0.4 mm. The scattering of the length of whole grains of peas of the motto of the motto significantly exceeds the scattering of the length of its halves and grains of millet Slobozhanske. Thus, the scattering of the length of pea grains varies from 4.13 to 8.14 mm, its halves - from 3.04 to 4.78 mm, and millet grains – from 2.72 to 3.49 mm (Table 3, Table 4, Fig. 1, c).

The average length of whole grains of peas is also

the largest and is 6.07 mm. Halves average less than 1.54 times the length of a whole pea, but 1.11 times longer than the length of a millet grain. The slight difference in the mean values of the thickness, width and length of the test grain indicates the similarity of its spherical shape.

The average value of the length of the test grain is

4.39 mm and only 0.69 mm more than the average width value, and 1.58 mm average value of its thickness. On the whole, the smallest dispersion of all sizes has millet grain, and the largest – whole pea grain. It should be noted that the size of peas is much larger than millet grains.

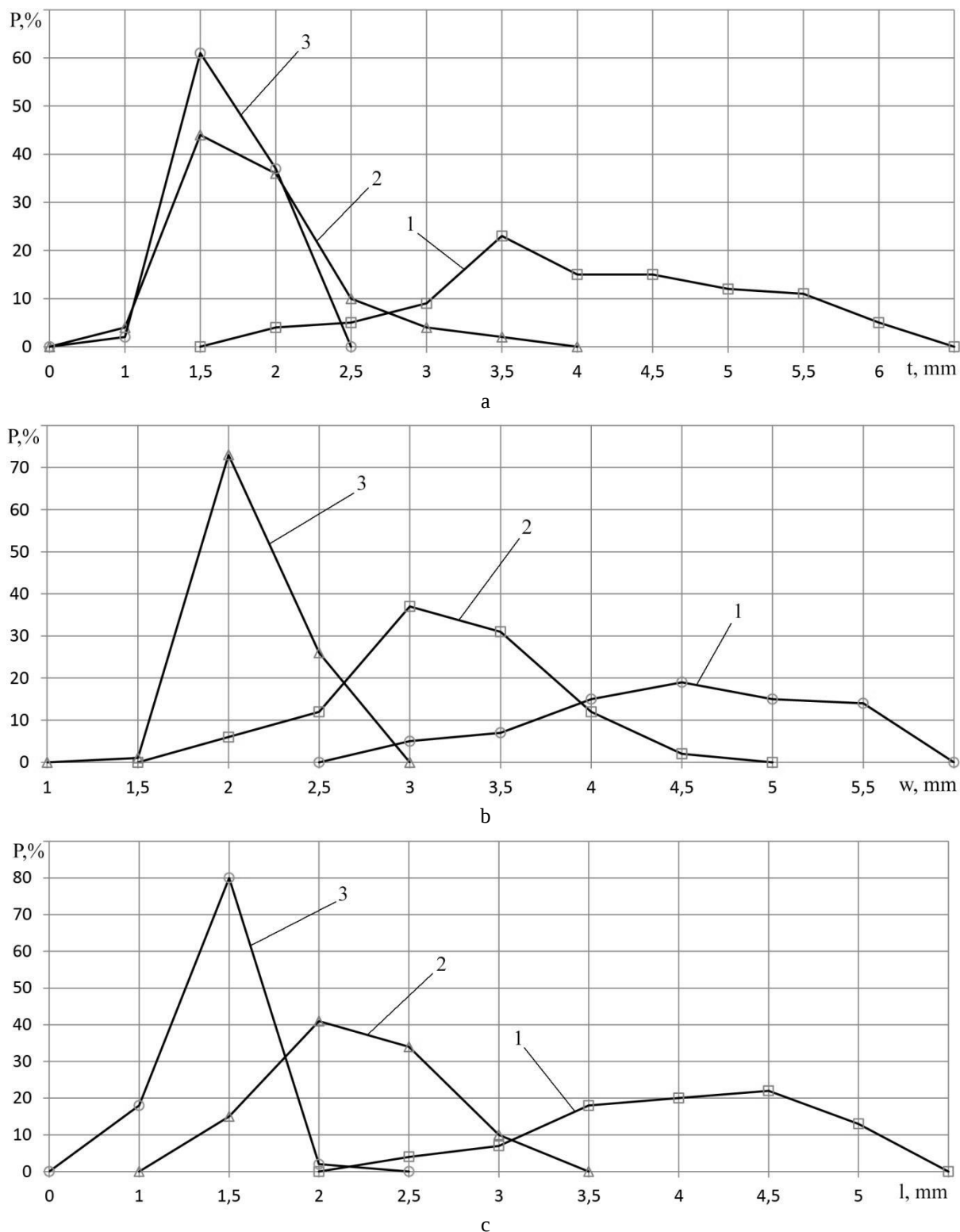


Figure 1. Variation curves of grain size characteristics: a – thickness, b – width, c – length; 1 – peas of the motto of the motto; 2 – half of peas of the motto of the motto; 3 – Slobzhanske millet.

Thus, the average thickness of pea grains is 2.20 times greater than the average thickness of millet grains, the average width is greater by 2.22 times, and the average length is greater by 1.93 times the average length of millet grains. The average size of a whole pea is also much larger than the corresponding size of its halves. Therefore, the standard deviations of the average sizes of the studied grain are significant in magnitude and vary from 1.33 mm for grain thickness, 1.47 mm for width and 1.51 mm for length. This determines the variation of the coefficients of variation of the average size of the studied grain from 34.40% for length, 39.73% for width and up to 47.33% for thickness (Table 4), which must be taken into account when adjusting the shredders to obtain homogeneous composition of all feed components.

To estimate the variety of forms of pea grains, their

halves and millet grains when grinding them into animal feed, as for other agricultural crops, we take the equivalent grain size as the diameter of a ball whose volume is equal to the actual grain volume (Tsarenko *et al.* 2003).

To ensure the accuracy of the grain volume, we first determine the quantity of grain and its total volume in a 100 ml flask (Tsarenko *et al.* 2003). To this end, the grain filled flask was supplemented with water from the measuring beaker, determining its volume. The difference between the volume of the flask and the refilled water is the total volume of grain in the flask. By dividing it by the amount of grain in the flask, we determined the average volume of one grain. By equating it to the volume of a ball, the average equivalent diameter of the test grain was determined (Tsarenko *et al.* 2003). The results are shown in Table 5.

Table 5. Average equivalent diameter of the test grain

Grain variety Indicators	The pea of “Motto” variety	The half of peas of “Motto” variety	Millet of Slobozhanske variety	Average value
Average volume of grain, mm ³	195.52	92.96	8.39	98.96
Average equivalent diameter, mm	7.20	5.62	2.52	5.11
Weight of 1000 grains, g	258.77	127.32	7.54	131.21

A significant excess of the size of a pea grain determines a significant excess of its average volume, average equivalent diameter and weight of 1000 grains of the corresponding indicators of both half peas and millet grains. Thus, the average volume of whole grain peas of the Motto variety is 195.52 mm³, its halves - 92.96 mm³, and the grain of Slobozhanske millet - only 8.39 mm³. The average volume of such grains is 98.96 mm³.

Based on the average volume obtained, we determined the value of the equivalent grain diameter as the diameter of the sphere of the resulting volume. The largest average equivalent diameter of the grain has a pea of the motto of the motto – 7.20 mm, the diameter of its halves is 5.62 mm, and the smallest diameter of the grains of the millet Slobozhanske only 2.52 mm. In this case, the average value of equivalent diameters of the studied grains is 5.11 mm.

By weight of 1000 seeds the grains of the motto pea variety – 258.77 g, its halves are more than twice as heavy, and the weight of 1000 grains of Slobozhanske millet is only 7.54 g. 131,21 g, which must also be taken into account when adjusting the shredders to obtain homogeneous components of feed mixtures.

Conclusions

Investigations of the dimensional characteristics of the pea grain Motto, its halves and grain millet Slobozhanske, which are separated in the waste fraction in the preparation of conditioned seed on grain-cleaning units from seed mixtures grown in arid conditions under

shortage the average values of length, width and thickness differ significantly and the standard deviation of their thickness is 1.33 mm, width – 1.47 mm, and length – 1.51 mm. The coefficient of variation of the length of the studied grain is 34.40%, width – 39.73%, and thickness – 47.33%.

The average equivalent diameter of the studied grain varies from 2.52 mm grains of Slobozhanske millet to 7.20 mm grains of Motto pea.

The smallest weight of 1000 pieces also has millet grain – 7.54 g, and the largest – pea grain – 258.77 g.

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