RESEARCHES REGARDING THE OPTIMIZATION OF THE OPPERATING PROCESS OF WHEAT DEBRANNING FOR GRINDING

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Abstract

Debranning is an operation which removes parts or the entire outer layer of wheat seeds, resulting in the removal of dust particles adhering to the surface of the grain and it also clears the wheat kernels hair. The debranning operation of cereals has a large influence on the grinding work process, on the content of minerals of the flour, on germs separation and broken kernels content; for these reasons the purpose of this paper is to optimize the constructive and functional parameters of the wheat debranning installation, namely to maximize the technological work process. In order to achieve the objective of this paper, a test rig was designed and built in order to study and optimize the operating process for wheat kernels debranning; the technological line consists of: horizontal debranning machine with frusto active bodies made of Eureka type braided wire and an aspiration system. In order to study the influence of debranning operation on the quality indices of wheat seeds, several structural and functional parameters of the machine were varied and the variations of the following indices were observed: broken kernels content, ash content and the amount of peeled coating. As a result of the laboratory investigations it was found that the percentage of broken grains, the ash content and the amount of peeled coating varies with the rotor speed and the distance between the two frusto jackets. The percentage of broken grains is directly proportional to the inner jacket speed and inversely proportional to the distance between the two conical drums made of braided wire. The experimental tests showed that the percentage of ash was affected by the rotor speed and the distance between the two drums of the debranning machine. Corroborating the results regarding the content of broken grains, percentage of ash and the amount of peeledcoating led us to the conclusion that the optimum operating regime of the machine was obtained when the distance between the tapered drums was d = 10 mm, the rotor speed was 150 rev/min and 250 rev/min respectively.

Key words: wheat, debranning, conditioning

By studying the operation of conditioning, researchers have tried to determine the influences of this process on wheat kernels and flour made from them, but until this moment they were not able to determine the exact recipe of wheat conditioning (Cozma D., Țenu I., 2014).

Modern technologies of processing wheat in market economy conditions involve better use of raw materials in order to obtain products with high nutritional value at the lowest possible production costs. (Iorga L, Câmpeanu G., 2004).

Analyzing the structure of wheat grain and chemical composition of various anatomical parts of it, it appears that the endosperm layer with the highest concentration of vitamins, enzymes, minerals and nutritional components essential for the proper functioning of the human body is the boundary between endosperm and aleurone layer; which is why it is necessary to study the process of conditioning (Wheat Quality & Carbohydrate Research, 2015).

In conclusion to preserve valuable elements from whole wheat, the working procces of the pelling machine and its optimal working regime must be followed closely in order to obtain a flour in line with market requirements (Brătucu G., 2009).

MATERIAL AND METHOD

The Glossa wheat variety from Hălăuceşti, Iaşi was used for this study. Grain sampling was conducted using the method stated in ISO 13690/2001. In order to carry out the researches on the work process of the wheat brushing machine, the grain was received, homogenized and stored.

For the experiences was used an experimental stand, designed and built in order to study the debranning process of wheat kernels and to optimize its constructive and functional parameters, in order to improve the quality indices

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of cereal seed respectively of the flour obtained after milling.

For the design of experimental stand were taken into account primarily the conditions it must fulfill:

• to process small portions of the product;
• allow changing various process parameters which influence the technological effect of operation;
• simple construction;
• must be made of demountable assemblies to enable to easily change components in order to modify the working parameters;
• the machine must be equipped with an engine aviable to modify the rotor speed;
• the form of the tapered drums must be tronconical in order to ensure the transportation of the product from the inlet to the point of discharge;
• machine drums must be concentric to ensure uniformity of debranning process;
• must offer the possibility of changing the distance between the tapered drums;
• in order to remove dust from the grain mass and to ensure that the mineral particles will not be released into the environment, the machine must be connected to a suction system.

The technological scheme of the device used in the experiences is shown in figure 1 and in figure 2 is presented the debranning laboratory stand.

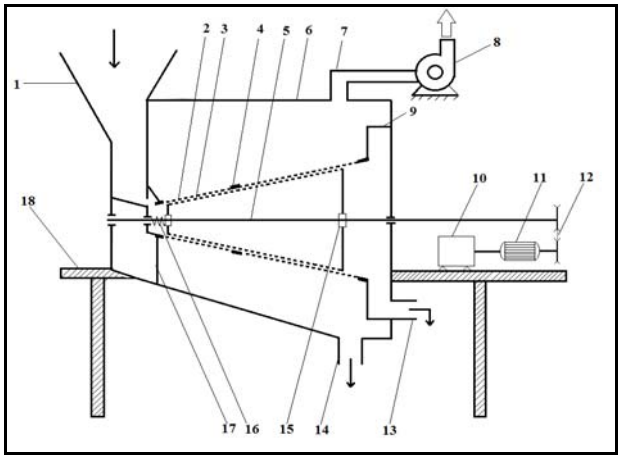
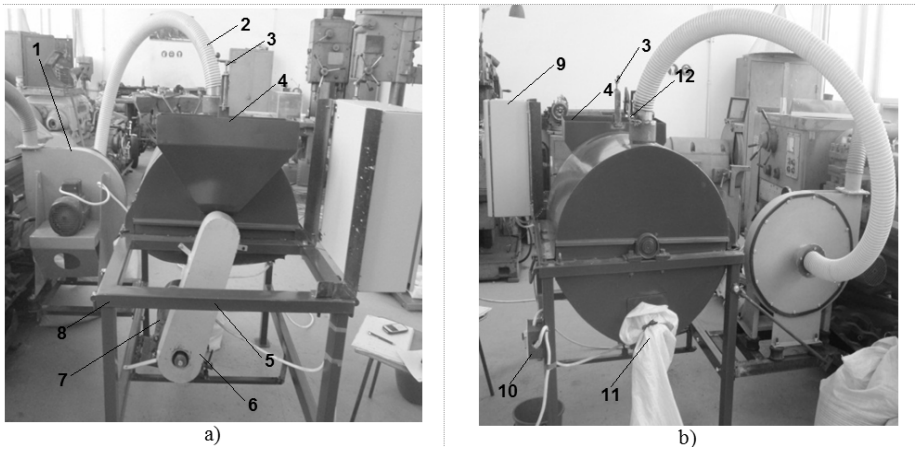


Figure 1 **Technological scheme of the debranning machine:** 1 - inlet; 2 - fixed braided wire jacket; 3 - rotative braided wire jacket; 4 - metal rings; 5 - shaft; 6 - casing; 7 - suction channel; 8 - fan; 9 - evacuation area for debranned seeds; 10 - speed converter; 11 - electric motor; 12 - belt transmission; 13 - debranned seeds outlet; 14 - impurities outlet; 15 - mounting flange; 16 - helical spring; 17 - fixing system for the outer jacket; 18 - frame.



a) b)

Figure 2 **Wheat debranning machine**: a) Left view; b) Right view
1 - fan; 2 – suction tube; 3 - bolt for adjusting the feed rate; 4 - hopper; 5 - frame; 6 - belt transmission; 7 - electric motor; 8 - frame; 9 - frequency converter; 10 - switch; 11- outlet for debranned seeds; 12 - device for regulating the suction flow in the system

To study the influence of the debranning operation on the percentage of broken grains (B_s), ash content (C_c) and the amount of the removed pelled coating (C_i) were varied two experimental factors: the distance between the conical drums (d) and the rotor speed (n). Table 1 presents the experimental variations conducted in the laboratory with the factors graduations.

Table 1

Experimental variants performed on the debranning machine

Nr. var.	Rotor speed, n [rpm]	Distance between drums, d [mm]
V_{d1}	100	6
V_{d2}	150	6
V_{d3}	200	6
V_{d4}	250	6
V_{d5}	100	8
V_{d6}	150	8
V_{d7}	200	8
V_{d8}	250	8
V_{d9}	100	10
V_{d10}	150	10
V_{d11}	200	10
V_{d12}	250	10
V_{d13}	100	12
V_{d14}	150	12
V_{d15}	200	12
V_{d16}	250	12
VdM	-	-

RESULTS AND DISCUSSIONS

After the technological operations of cleaning and conditioning carried out on wheat kernels for milling, a certain percentage of broken grains was obtained, which negatively impacts both the grinding process itself and the quality of the finished product (Panțuru D., Bârsan I., 1997).

In order to determine the structural and functional parameters of the debranning machine that influence the quality indices of wheat, were taken samples from all the 16 experimental variants. After that, was determined the percentage of broken kernels, ash and the amount of debranned coating.

Table 2 shows the percentage of broken grains, ash content and amount of peeled coating, results obtained from laboratory tests conducted on the debtanning machine by using different distances between the drums and various rotor speed.

Table 2

The variation of broken wheat kernels percentage, ash content and peeled coating

Nr. Var.	Ash content, C_c [%]	Broken kernels content, B_s [%]	Debranned coating amount, C_i [%]
Vd_1	1.520	22.16	0.76
Vd_2	1.563	23.68	0.81
Vd_3	1.636	26.92	0.96
Vd_4	1.569	27.3	1.42
Vd_5	1.542	7.74	0.35
Vd_6	1.525	8.86	0.42
Vd_7	1.647	9.32	0.63
Vd_8	1.565	10.02	0.97
Vd_9	1.616	2.51	0.12
Vd_{10}	1.589	2.98	0.18
Vd_{11}	1.599	3.45	0.28
Vd_{12}	1.596	3.86	0.32
Vd_{13}	1.601	2.05	0.1
Vd_{14}	1.551	2.49	0.1
Vd_{15}	1.586	2.68	0.1
Vd_{16}	1.566	2.92	0.1
VdM	1.654	1.6	0

From the experimental researches carried out on the laboratory stand it has been found that the percentage of broken grains is directly proportional to the rotor speed and inverse proportion to the distance between the two frusto jackets. The most pronounced degree of broken wheat kernels was recorded at a distance of 6 mm between the two drums. This high percentage of broken seeds was maintained for all the four rotor speed variants used in the laboratory tests.

At 8 mm spacing between the two jackets it was observed a decrease in the content of broken grains of more than 60% of the variants in which it was used a distance of 6 mm between the drums. Although in this case it was observed a significant reduction in the percentage of

damaged wheat seeds, the values obtained for the content of broken grains were still high: from 7.74% in the case of setting the rotor speed at 100 [rpm] and at over 10% for the rotor speed set at 250 [rpm].

The lowest values of the percentage of broken grains were recorded at distances of 10 and 12 mm betweed the braided wire jackets at all rotor speeds used in trials.

The lowest content of broken wheat kernels was recorded in the experimental variant V_{d13}, where it was used a 12 mm distance between the drums and a rotor speed of 100 [rpm].

The specific ash content of wheat is between 1.5% and 2.00%, of which about 0.35% is found in the endosperm and the rest in the aleurone layer, germ and pericarp. In the laboratory analysis of the witness sample, represented by wheat seeeds that have not been subjected to the debranning operation, it resulted an ash content of 1.654%.

The experimental tests carried out on the debranning machine revealed that in all 16 variants studied, the percentage of ash content has lower values than the witness sample.

Most frequently the lowest ash content was registered at low rotor speeds, namely at 100 and 150 rpm, and at distances between the jackets of 6 and 8 mm. At the same distances between the two drums, but at the rotor speed of 200 rpm were found the highest values of ash content.

Giving the variation of peeled coating quantity, the tests performed on experimental stand found that when adjusting the distance between the machine drums at 12 mm, respectively variants V_{d13}, V_{d14}, V_{d15}, V_{d16}, technological effect on grain seeds subjected to the debranning process was nonexistent. On the other hand, the variants V_{d1}, V_{d2}, V_{d3} and V_{d4}, respectively at a distance of 6 mm between drums generators, were obtained high values of peeled coating content: up to 1.42%.

CONCLUSIONS

The percentage of broken grains, ash content and debranned wheat kernel coating are influenced by the distance between the two frustoconical jackets and the speed of the inner drum.

Percentage of broken grains is directly proportional with inner jacket speed and inversely proportional to the distance between the two frustoconical braided wire drums. Unlike the variation of broken grains content, the percentage of ash obtained from experimental tests has a curve of constant variance depending on the rotor speed and the distance between the two frusto jackets. The percentage of peeled coating increases in direct proportion with the value of the rotor speed and it increases inversely proportional with the distance between the machine drums.

Although the variants V_{d1}, V_{d2}, V_{d3} and V_{d4} recorded high percentages of peeled coating, they can not be considered optimal for the machine operation because these variants revealed a high degree of broken wheat seeds, between 22 and 27%, which lead to large losses of product.

Also high disposal of debranned coating of wheat kernels was recorded in the variants V_{d5}, V_{d6}, V_{d7} and V_{d8}, but even these may not consider to be the optimum solutions for the debranner because in these experimental variants was obtained an increased degree of damaged seeds (broken grain content was between 7.7% and 10%).

Correlating values of broken grains content, ash percentage and the amount of peeled coating recorded as a result wheat kernels debranning, it appears that the optimum operating regime of the machine is obtained by adjusting the distance between the drums at 10 mm and the rotor speed at 150 or 250 rpm (V_{d10} and V_{d11}).

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