ABSTRACT

Wheat is the most important cereal in terms of cultivated areas and production obtained but also high in carbohydrates (in the form of starch) and protein substances.

Wheat seeds, after harvest, generally have a heterogeneous composition, being composed in a mixture formed mostly by basic cereal grains (about 95%), seeds from other crops or weeds (about 2 - 3 %) and impurities of vegetable and mineral nature. Therefore, the properties and structure of wheat seeds, especially moisture, impurity content, glassiness, grain uniformity, etc., determine the choice of processing technology, as well as the optimal operating parameters of machines and installations in the technological line of cleaning, drying and storage.

Preparation of cereal seeds for grinding is a complex process of cleaning and conditioning, being one of the most important phases in the technology of obtaining quality flours.

In order to choose the optimal variant in terms of the technological line and the correct adjustment of the operating parameters of the machines within the processing flow, factors such as the working capacity of the unit, the physico-chemical characteristics of the wheat seed, the productivity of the machinery (required to be 10 … 25% higher than the grinding capacity of the mill), the correct arrangement of the facilities (the unit must have three distinct parts: black cleaning - removal of non-food impurities-; conditioning; white cleaning), the nature of the impurities found in the seed mass; the percentage of foreign bodies in the seed mass, the grinding regime adopted must be taken into account.

The conditioning process consists in the processing of wheat grains by different methods in order to produce mechano - structural and biochemical transformations in the wheat grain or the activity of the ferments, in order to improve the qualitative indices of cereal seeds and baking properties.

Therefore, the purpose of the doctoral thesis was to determine the variations of the qualitative indices of wheat grains depending on the conditioning method and to establish an optimal working regime of the conditioning installation in order to maximize its technological efficiency.

Analyzing the structure of the wheat grain and the chemical composition of its various anatomical parts, it is found that the endosperm layer with the highest concentration of vitamins, enzymes, minerals, nutrients essential for the proper functioning of the human body is the boundary between the endosperm and the aleuronic layer, which is why it is necessary to study the process of seed conditioning.

Therefore, in order to preserve the valuable elements in the wheat grain, the peeling process and the optimal working regime of the peeling machine must be closely monitored in order to obtain a compliant flour.

The main objective of the doctoral thesis is to optimize the work process for the preparation and conditioning of wheat grains for grinding, a study that is carried out with the help of laboratory stands.

In order to achieve the main objective, the following directives have been drawn up:

- design and development of experimental models of machines for performing technological operations of brushing, conditioning and peeling.
- the influence of the operating parameters of the brushing machine on the structure of the wheat grain and the technological indices of baking;
- optimizing the working process of the brushing machine;
- the influence of the physical characteristics of wheat grains on the efficiency of the brushing operation;
- the influence of wheat grain moisture on the technological effect of conditioning;
- the influence of the rest time of wheat grains on the technological effect;
- the impact of wetting methods, temperature and rest time of wheat grains on the technological effect;
- determining the influence of the operating parameters of the wetting stand on the mechano-

structural properties of the wheat grain;

- determination of the constructive characteristics of the wheat grain peeling stand;
- the influence of the different operating parameters of the peeler on the cereal seeds, especially on the wheat husk cover;
- optimization of the working process of the peeling stand;
- optimization of the working process for conditioning the cereal seeds for grinding.

The research used wheat from the Glossa variety from the agricultural production of 2014 in the area of Iaşi county, within the communes of Hălăuceşti and Mogoşeşti-Siret. Prelevation and sampling of wheat was performed using the method listed in SR ISO 13690/2001, the received wheat being standardized and stored in order to conduct research on the working process of the conditioning plant.

The biological material was subjected to the following laboratory determinations: moisture content; hectolitre mass; foreign bodies; wet gluten content; deformation index; protein content; ash content; fall index; acidity.

For the experiments, experimental stands were used, designed and made especially to study the technological operations of brushing, wetting and peeling of wheat grains, as well as for optimizing the constructive and functional parameters of the work process, in order to improve the qualitative indices of wheat seeds. cereals, respectively of the flour obtained after their grinding. The experimental stands were designed and made within the disciplines of Mechanization of Agriculture, from the Faculty of Agriculture.

In order to conduct laboratory experiments on the brushing operation, an experimental stand was built consisting of an active working body represented by a rotor with brushes, arranged inclined to the central axis and a tronconical mantle with perforated orifices of different sizes, the technological effect of of the machine being created by rubbing the grains between the rotor brushes and the perforated sheath, but also by the friction effect produced between the grains during the operation of the installation. Due to the need for remove the dust developed during the process, the machine was equipped with a fan with variable suction flow, effect obtained by inserting a control flap on the path of the air duct. At the same time, by mounting a dumper in the product feed hopper of the machine, the possibility of adjusting the productivity of the machine was created. Also, the electric motor (with a power of 3 kW) that equips the machine was connected to a Moeller brand frequency converter, which allowed the progressive change of the rotor speed and at the same time it provided overload protection of the motor.

The research on the wetting process was carried out in two ways: the first in a conventional system in which the grains were subjected to wetting using a conventional seed treatment plant and the second in an unconventional system through a micro-plant that was performed in the laboratory, thus studying the way of water migration from the outside of the wheat grains to the inside of them.

The peeling process was studied with the help of a machine obtained by replacing the rotor and the drums in the brush machine with two concentrically arranged truncated Eureka wire braid sheaths. The technological effect in the case of peeling is produced by rubbing the grains on the surfaces of the two mantles. One of the studied parameters of the peeling machine was the distance between the two sheaths, which was varied by introducing a translation system of the inner sheath in the direction of the central axis. The speed of the moving drum and the suction flow were adjusted in the same way as in the brushing process, the machine retaining the rest of its constructive characteristics.

To study the influence of the brushing operation on the percentage of broken grains (B_s) and the ash content (C_c), the following experimental factors were varied:

- the type of troconical mantle sieve ($\boldsymbol{F_1}$), a factor that has six graduations, as follows: $\boldsymbol{a_1}$ - perforated sheet with elongated orifices of 1 mm; $\boldsymbol{a_2}$ - perforated sheet with elongated orifices of 1.5 mm; $\boldsymbol{a_3}$ - perforated sheet with elongated orifices of 1.75 mm; $\boldsymbol{a_4}$ - perforated sheet with round orifices of 1 mm; $\boldsymbol{a_5}$ - perforated sheet with round orifices of 1.5 mm; $\boldsymbol{a_6}$ - perforated sheet with round orifices of 1.75 mm.

- Suction air flow ($\boldsymbol{Q_a}$) from the suction system ($\boldsymbol{F_2}$), with tow graduations: $\boldsymbol{b_1}$ - $\boldsymbol{Q_a}$ = 0.15 m^3/s and $\boldsymbol{b_2}$ - $\boldsymbol{Q_a}$ = 0.075 m^3/s.
- Product supply flow ($\boldsymbol{F_3}$), factor that has three graduations: $\boldsymbol{c_1}$ - $\boldsymbol{Q_p}$ = 600 m^3/s; $\boldsymbol{c_2}$ - $\boldsymbol{Q_p}$ = 300 m^3/s; $\boldsymbol{c_3}$ - $\boldsymbol{Q_p}$ = 60 m^3/s.
- Rotor speed ($\boldsymbol{F_4}$), factor with four graduations: $\boldsymbol{d_1}$ - n = 100 rpm; $\boldsymbol{d_2}$ - n = 150 rpm; $\boldsymbol{d_3}$ - n = 200 rpm; $\boldsymbol{d_4}$ - n = 250 rpm.

Experimental research using the wheat brushing plant (IPG) has shown that both the percentage of broken grains and the ash content of processed wheat grains are influenced by the size and shape of the holes in the perforated sieves in the construction of the machine; rotor speed with brushes; the product supply flow and the air flow of the suction system.

The analysis of the experimental data shows that the percentage of broken grains is low, below 0.8%, for nine of the total of 144 experimental variants, respectively for Vp_4, Vp_{10}, Vp_{13}, Vp_{31}, $\mathbf{Vp_{34}}$, $\mathbf{Vp_{37}}$, Vp_{46}, Vp_{125} and $\mathbf{Vp_{136}}$.

For 26 experimental variants out of the 144 performed, the values of the ash content were below 1.5%, compared to the initial ones measured at the control sample (for control sample represented by the wheat not subjected to the brushing operation C_c = 1.654%). Thus, by brushing, a sharp decrease of this indicator of over 0.1% compared to the raw samples was obtained. The experimental variants that recorded C_c values below 1.5% were Vp_7, Vp_{11}, Vp_{20}, Vp_{21},Vp_{24}, Vp_{25}, Vp_{27},Vp_{29},Vp_{30},$\mathbf{Vp_{34}}$, $\mathbf{Vp_{37}}$,Vp_{40}, Vp_{57}, Vp_{62}, Vp_{70}, Vp_{78}, Vp_{79}, Vp_{85}, Vp_{86}, Vp_{93}, Vp_{103}, Vp_{104},Vp_{123},Vp_{134},Vp_{135},$\mathbf{Vp_{136}}$ (*Zăpodeanu Cezara, 2016*).

At the same time, it was found that the mantle of the brush made of sheet metal with elongated orifices allows a better removal of particles of impurities, such as chaff, edges and those smaller than the grain of wheat, compared to that made of sheet metal with circular orifices. Therefore, in order to obtain a low content of broken grains and ash for processed seeds, the best results were obtained for the following three variants: $\boldsymbol{Vp_{34}}$ (where B_s = 0.75%, C_c = 1.4763 %); $\boldsymbol{Vp_{37}}$ (B_s = 0.716%, C_c = 1.4576%) and $\boldsymbol{Vp_{136}}$ (B_s = 0.78% and C_c = 1.4995%).

The results of the experimental researches carried out with the help of the IPG wheat brushing installation, led to the establishment of an optimal operation regime for the following conditions: the mantle made of perforated sheet with elongated orifices, with their dimensions of L x L = 20 mm x 1.75 mm; suction system to operate with air flow Q_a = 0.075 m^3/s; rotor speed with brushes n = 100 rpm; respectively n = 250 rpm and product feed rate Q_p = 600 kg/h.

Taking into account the results of the analysis and statistical interpretation of the experimental data results a ***very significant degree*** for variants $\boldsymbol{Vp_{25}}$ and $\boldsymbol{Vp_{37}}$, a ***distinct significant degree*** for variants $\boldsymbol{Vp_{40}}$, $\boldsymbol{Vp_{31}}$, $\boldsymbol{Vp_{34}}$, a ***significant degree*** for variant $\boldsymbol{Vp_{46}}$, and for variants $\boldsymbol{Vp_{43}}$ and $\boldsymbol{Vp_{28}}$ the results are ***insignificant***.

In the doctoral thesis, ***research on the process of hydro-thermal treatment on wheat grains, in a conventional and unconventional system*** were conducted.

The experimental researches regarding the unconventional hydro-thermal treatment process were carried out within the Research Institute for Agriculture and Environment, from the "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine from Iaşi, with the help of a micro laboratory station. Thus, in order to determine the optimal hydrothermal treatment regime for wheat grains, a multifactorial experiment was designed, in which the following influencing factors varied: the temperature in the water bath (from 20° to 80°C) and the rest time of wheat (1, 2 and 3 hours, respectively). In order to optimize the working process for wheat wetting in a conventional system, a seed treatment plant was used. Regarding the results of experimental research on the process of hydro-thermal treatment of wheat, in the conventional system, we mention that the grains intended for grinding must meet certain requirements, namely that their average humidity before the first grinding must be 16 – 17%, with the distribution of water differently in the structure of the seeds, the moisture of the coating must be

60 – 80% higher than the endosperm.

From the point of view of the degree of wetting, the best results were obtained in the experimental variants: V_{u1}, V_{u2}, V_{u3}, V_{u4}, V_{u5} (the water temperature having values of 20°C and 30°C, and rest time was 1, 2 or 3 hours). In these cases, it was found that the water penetration process was performed only in the outer layers of the wheat grain, this being one of the criteria imposed prior to the grinding process.

Correlating the research results on the variation of grain moisture and the variation of the degree of wetting depending on the water temperature and their standing time, it can be said that good results are recorded in the operation of the hydro - thermal treatment plant at water temperature of 20°C and 30°C.

In order to study the peeling process, the grains were previously brushed and moistened in a conventional system. In order to achieve the experiences regarding the process of peeling the wheat seeds, an original experimental stand was used, designed and realized within the disciplines of Mechanization of agriculture from the Faculty of Agriculture.

In order to optimize the peeling process, the following working indices were taken into account: the percentage of broken grains, the ash content and the amount of coating removed, depending on the distance between the trocnonical mantles of the peeling machine (6, 8, 10 and 12 mm) and rotor speed (100, 150, 200 and 250 rpm).

A first aspect that was observed after the peeling process is that the percentage of broken grains and the ash content are influenced by the two constructive and functional parameters of the peeling machine, namely the distance between the two truncated mantles and the speed of the inner drum. It can be stated that the percentage of broken grains is directly proportional to the speed of the inner mantle and inversely proportional to the distance between the two truncated drums of EUREKA wire cloth.

Unlike the variation of the content of broken grains, the percentage of ash of the peeled seeds obtained after the experimental tests does not have a constant variation curve depending on the rotor speed and the distance between the peels of the peeler.

With regard to the percentage of peeling, it is directly proportional to the increase in rotor speed and inversely proportional to the distance between the tronconical mantles of the machine.

Correlating the values of the contents of broken grains, the percentage of ash and the amount of cover removed, recorded after peeling wheat seeds, it is found that the optimal operating variants of the machine are obtained for the following working parameters: the distance between the truncated mantles of 10 mm and rotor speeds of 150 rpm and 250 rpm.

The statistical interpretation of the research results on the process of peeling wheat seeds showed a ***very significant degree*** for variants V_{d2}, V_{d3}, V_{d4}, V_{d8}, V_{d9} , V_{d15}, V_{d13}, V_{d14}, V_{d16}, a ***distinctly significant degree*** for variants V_{d1}, V_{d10}, and for V_{d5}, V_{d6}, V_{d7}, V_{d12} variants the results are ***insignificant***.

The doctoral thesis has 193 pages and is made in two parts, containing eight chapters, 129 figures, 61 tables and a number of 161 bibliographic references.