INFLUENCE OF THE WETTING PROCESS IN THE CONVENTIONAL SYSTEM ON THE QUALITATIVE INDICES OF WHEAT FOR MILLING

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Abstract

The wheat conditioning determines a series of transformations of the mechano-structural and biochemical properties of the grains. Proper wetting of the wheat grain on the outside succeeds in the peeling process in removing the upper layers of its coating without water entering the endosperm, so that in the end high quality flours will be obtained. In this study, two influencing factors were followed: the temperature in the grain mass and the rest time of grains after wetting, finally obtaining a multifactorial experience with 72 experimental variants. The experiments, performed in the present paper, revealed a close connection between the rest time of grains and their humidity after the hydrothermal treatment. Also, the three temperature ranges (10°C - 15°C, 15°C - 20°C and 20°C - 25°C) of the cereal mass for which the study was performed, had a direct influence on the water speed penetration from the outside of the grains to the inside. By establishing individually, the optimal conditioning recipe for each batch of wheat with different characteristics, the wetting period is significantly reduced in the technological process of preparing wheat grains for milling.

Key words: conditioning, wetting, wheat, peeling, flour

The technological operation of conditioning consists in the processing of wheat grains with water or water and heat. Among the operations applied to the mass of cereal seeds before milling, conditioning has the greatest influence on the technological properties of wheat, as well as on the baking characteristics of the resulting flour (Racz I., 2013; Vizitiu D., 2012).

Despite the existing shortcomings in the exact determination of the optimal parameters of hydrothermal treatments, it is unanimously recognized that the conditioning process acts on the properties of wheat grains and flour and directly influences the energy consumption of the grinding section.

So far, researchers have shown that applying the hydrothermal conditioning operation creates a difference in humidity between the coating and the endosperm of the grain, the former becoming more elastic and the latter more friable, which automatically leads to better separation of the bran, obtaining whiter flours and decreasing the ash content. (Dubei T., 2008; Moroz SM *et al*, 2014)

MATERIAL AND METHOD

For this study, wheat from the Glossa variety was used, from the agricultural production of 2014 in the area of Iaşi county, within the communities of Hălăuceşti and Mogoşeşti-Siret. Wheat sampling 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 raw material used was analized at the Feed Quality Control Laboratory from Faculty of Animal Science at "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine of Iasi and it's characteristics were established (*table 1*).

Table 1

Physico-chemical characteristics of the wheat batch used in experimental research

Quality indices		UM	Glossa wheat variety
Humidity		%	13.80
Hectolitre mass		kg/hl	81.60
Foreign impurities	white	%	1.00
	black	%	0.50
Wet gluten		%	24.40
Gluten deformation index		mm	3.50
Protein content		%	11.60
Ash content		%	1.654
Falling number		sec.	312
Acidity		grade	4.00

The methods and apparatuses used for the analysis of wheat samples, before and after their conditioning are presented in *table 2*.

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Table 2

Methods and apparatuses used for wheat analysis (C.N.G.S.C., 2013)

Quality parameters	U.M.	Method	Apparatus
Sensorial characteristics	-	STAS 6253 /1980	-
Humidity	%	SR EN ISO 712:2010	Oven/ Magic FSA device
Hectolitre mass	Kg/hl	SR EN ISO 7971-1:2010	Hectolitre balance/ Magic FSA device
Foreign corps	%	SR ISO 7970/2001	Sieves
Ash content	%	SR EN ISO 2171:2010	Calcinator
Protein content	%	SR EN ISO 20483:2014	Kjeldahl installation
Wet gluten	%	SR EN ISO 21415-3:2007	Oven
Deformation index of gluten	mm	SR 90-2007	Thermostat
Falling number	sec	SR EN ISO 3093/2010	Falling Number tester

In order to optimize the working process for the conventional wetting system for wheat it was used a seed treatment (*figure 1*).

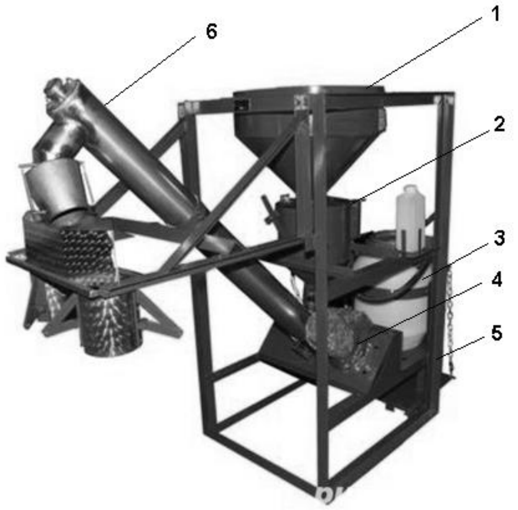

Figure 1 - **Seed treatment device**
1 – row material inlet; 2 - product mixing chamber; 3 – water tank; 4 – electromotor; 5 – Framework; 6 - helical conveyor

In order to obtain the most accurate data, a MAGIC FSA (*figure 2*) type humidometer was used to analyze the wheat before and after wetting.

*Figure 2 - **MAGIC FSA humidometer***

This computerized grain moisture analyzer with integrated hectoliter mass determination system has also features for as infrared temperature scanning / compensation function. First-class accuracy, classification class A, being the only one on the market that measures humidity at a precision of 0.01, while scanning the temperature without coming into contact with the sample. The accuracy of the hectoliter mass is 0.1 Kg/hectoliter.

The experimental protocol used to study the working process of the hydrothermal treatment plant for wheat grains in a conventional system consisted in designing a multifactorial experiment, in which the following influencing factors varied: grain mass temperature (F1) and wheat rest time (F2). In order to analyze the influence of the functional parameters of the humidification installation on the grain moisture and to establish the way of water migration into the grain, a number of 72 variants were performed (table 3), as follows:

3 (temperature ranges) x 24 (resting times) = 72 (experimental variants)

Table 3

Experimental variants performed on the humidifier

Nr. var.	**Influence factors**		**Nr. var.**	**Influence factors**		**Nr. var.**	**Influence factors**	
	F_1 [˚C]	**F_2** [ore]		**F_1** [˚C]	**F_2** [ore]		**F_1** [˚C]	**F_2** [ore]
V_{u1}		1	V_{u25}		1	V_{u49}		1
V_{u2}		2	V_{u26}		2	V_{u50}		2
V_{u3}		3	V_{u27}		3	V_{u51}		3
V_{u4}		4	V_{u28}		4	V_{u52}		4
V_{u5}		5	V_{u29}		5	V_{u53}		5
V_{u6}		6	V_{u30}		6	V_{u54}		6
V_{u7}		7	V_{u31}		7	V_{u55}		7
V_{u8}		8	V_{u32}		8	V_{u56}		8
V_{u9}		9	V_{u33}		9	V_{u57}		9
V_{u10}		10	V_{u34}		10	V_{u58}		10
V_{u11}		11	V_{u35}		11	V_{u59}		11
V_{u12}	10 ÷ 15	12	V_{u36}	15 ÷ 20	12	V_{u60}	20 ÷ 25	12
V_{u13}		13	V_{u37}		13	V_{u61}		13
V_{u14}		14	V_{u38}		14	V_{u62}		14
V_{u15}		15	V_{u39}		15	V_{u63}		15
V_{u16}		16	V_{u40}		16	V_{u64}		16
V_{u17}		17	V_{u41}		17	V_{u65}		17
V_{u18}		18	V_{u42}		18	V_{u66}		18
V_{u19}		19	V_{u43}		19	V_{u67}		19
V_{u20}		20	V_{u44}		20	V_{u68}		20
V_{u21}		21	V_{u45}		21	V_{u69}		21
V_{u22}		22	V_{u46}		22	V_{u70}		22
V_{u23}		23	V_{u47}		23	V_{u71}		23
V_{u24}		24	V_{u48}		24	V_{u72}		24

RESULTS AND DISCUSSIONS

Because an industrial wheat seed treatment plant was used in the research, the outdoor temperature could not be strictly controlled, so the temperature in the grain mass could not be adjusted exactly. Thus, the conducted experiments were performed in three temperature ranges from the grain mass, namely 10°C ÷ 15°C, 15°C ÷ 20°C and 20°C ÷ 25°C. Measurements of grain mass temperature were performed hourly over 24 hours for all the 72 experimental variants, the results being shown in *figure 3*.

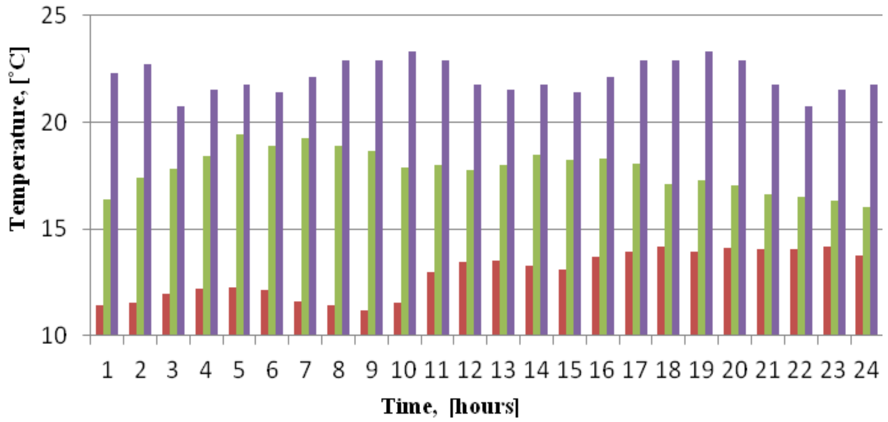

Figure 3 - **Temperature of wheat seeds during wetting process**

After each experimental variant, a sample was taken and analyzed with the Magic FSA humidometer. The humidity value was recorded hourly during the rest period and the data obtained is highlighted in *figure 4.*

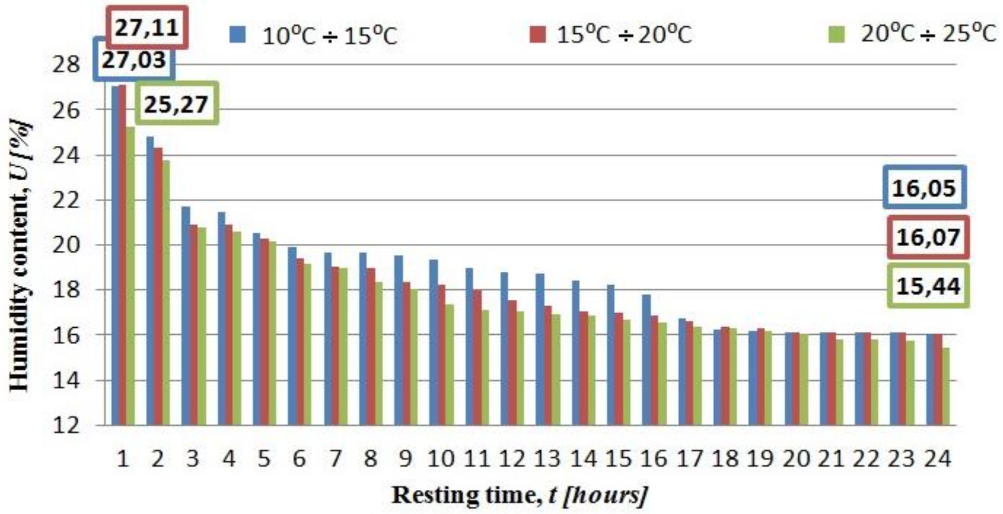

Figure 4 - **Variation of humidity depending on the rest time and temperature of the grain mass**

The research shows that after the first rest hour grain humidity reaches values of 25-27%, because water is concentrated on the outside of the particles. With the increase of the grain resting time, there is a sharp decrease in the humidity percentage, about 2-3% per hour in the first three hours of rest, for all temperature ranges in the grain mass. Starting with the fourth hour of rest, the percentage of humidity shows a slow decrease, about 0.2-0.3% per hour, and after 8-9 hours of rest, the humidity stabilizes for the temperature range 15°C ÷ 20°C respectively 20°C ÷ 25°C. For the temperature range of 10°C ÷ 15°C in the grain mass, the wheat humidity uniformity occurs after about 17 hours of rest, much later than the other two studied temperature ranges, a phenomenon explained by the fact that the water speed penetration, from the outside to the inside of the particles, is directly influenced by the temperature in the grain mass. Thus, as the grain temperatures increase, the speed of water migration also increases. At the same time it is observed that after 10 hours for the temperature range between 20°C ÷ 25°C (**V_{u58}**), after 13-14 hours for the temperature range between 15°C ÷ 20°C (**V_{u37}**, **V_{u38}**) and after 17 hours for the temperature range between 10°C ÷ 15°C (**V_{u17}**) the wheat humidity percentage is stabilized, which means that the water must have penetrated into the grain cover, and the resting process for cereals must be interrupted by introducing the raw material into the next processes from technological flow (peeling, grinding).

In order to determine the influence of the grain mass temperature and the resting time upon the quality indices of wheat, the hectolitre mass characteristic was followed through this study. The results regarding the variation of the hectolitre mass in the conventional hidrothermal treatment are presented in *figure 5.*

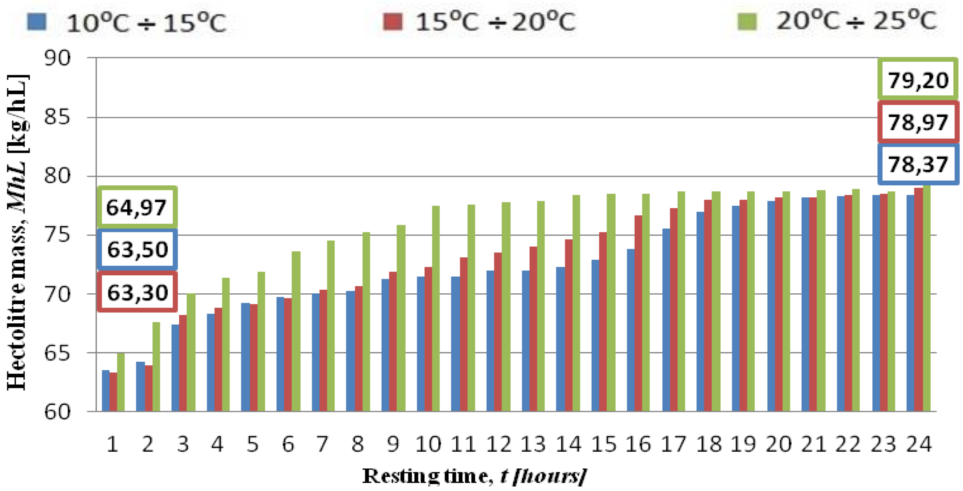

Figure 5 - **Variation of the hectolitre mass depending on the resting time and the grain mass temperature**

Regarding the hectolitre mass of the wetted grain seeds, it can be seen that during the early hours of rest this quality index of grains had values of 63.30 kg/hL (for the temperature range between 15°C and 20°C), 63.50 kg/hL (for the temperature range between 10°C and 15°C) and 64.97 kg/hL (for the temperature range between 20°C and 25°C). The values resulted from the experiments revealed a decrease of the hectolitre mass index in the first hours of rest by up to 18% compared to the control sample (the hectolitre mass in the case of non-moisted wheat was 81.6 kg/hL). The study also revealed that the temperature of the grains influences the hectolitre mass. At higher temperatures the hectolitre mass index reaches early the values imposed by the national standards for wheat of first and second grade in the temperature range between 20°C and 25°C compared to the other two temperature ranges studied (according to Romanian National Commission for Grading Seeds for Consumption first grade wheat must have the hectolitre mass index of 77 kg/hL and second grade at least 75 kg/hL).

CONCLUSIONS

The researches carried out established the exact moments in witch humidity has stabilized, for each temperature range studied. The current paper made possible to identify the time required for moisten the grain cover and also the period after which the migration of water from the coating to the endosperm begins. If the water penetrates into the endosperm of the wheat kernel peeling can no longer properly remove the outer layers of the coating and in the end poor quality flours will be obtained, with a high ash index.

Because the value of the hectolitre mass index is closely related to the extraction coefficient of wheat flour, the quality index must remain at values above 75 kg/hL after wetting.

Analyzing and correlating the results obtained for humidity percent and hectolitre mass index from these experimental researches, choosing the parameters indicated by the variants: $\mathbf{V_{u58}}$ for the mass grain temperature range between 20°C ÷ 25°C, $\mathbf{V_{u63}}$ or the mass grain temperature range between 20°C ÷ 25°C and Vu_{17} for the mass grain temperature range between 10°C ÷ 15°C, the wheat wetting process in the conventional system was optimized.

REFERENCES

C.N.G.S.C., 2013 - *Comisia Naţională de Gradare a Seminţelor de Consum*. Retrieved 2013, from:http://domino.iqm.ro/gradare/home.nsf/Produse/grau.

Cozma D., Tenu I., Zăpodeanu C.V., 2014 – *Influence of Hydrothermal Treatment on Wheat for Milling*. Applied Mechanics and Materials Vol. 659 pag. 511-514, doi: 10.4028/www.scientific.net/AMM.659.511.

Vizitiu D., 2012 – „*Cercetări privind asigurarea indicilor calitativi optimi ai făinurilor pentru câteva grupe de produse de panificaţie şi patiserie în cazul variaţiei calitative a loturilor de grâu procesate la unitatea de morărit*". Teză de doctorat, Universitatea „Lucian Blaga" din Sibiu.

Zăpodeanu C.V., 2020 – *Research regarding optimization of working process of wheat conditioning for milling*, PhD Thesis, "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine from Iasi.