STUDIES REGARDING THE INFLUENCE OF THE DRYING PROCESS TECHNOLOGICAL PARAMETERS ON THE CORN SEED QUALITY

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Abstract

In some special harvesting conditions of corn grains, the seeds have humidities between 25% ... 30%, and they are subjected to the drying operation in order to be safetly stored. Corn seeds subjected to drying, behave differently according to their condition and the operation parameters of the drying technology. Corn seeds do not support aggressive drying conditions characterized by non-uniform temperatures and rates of the drying agent, when passing through the product layer.

The purpose of the paper is to establish the optimal operating parameters for the drying process to maximize the technological effect and to conserve the quality of the corn seeds. In the investigations, corn seeds with four initial humidities were dryed in a layer thickness of 150 mm. During the investigations, was studied the influence of the drying agent's velocity and temperature on the protein content and germination of the seeds. The drying process for corn seeds was carried out using four velocities and five temperatures of the drying agent. To achieve the goal, a laboratory dryer for agricultural products was designed and built.

Experimental research results show that both the protein content as well as the germination capacity of corn seeds were affected by temperatures of the drying agent higher than 50°C. The optimal drying variant of corn seeds, regardless the initial moisture content, was obtained for the drying agent's velocity of 2.5 m/s and the temperature of 50°C. For temperatures of the drying agent higher than 50°C, the protein content and seed germination capacity decreased up to 5.46% and 88%, respectively.

Key words: corn seed drying, protein content, germination capacity

The grain is a living organism in which occur different biochemical processes whose intensity depends on the drying and storage conditions. During the storage, the seed humidity should not overcome 13% - 14% for cereal seeds and 7% - 8% for technical plant seeds.

In the moist grain the breathing process intensifies, this leading to the water and carbonic acid elimination. During the breathing process of the grain a certain quantity of heat is released which depends on the storage conditions. The temperature increase contributes to the enhancing breath (Hefnia and Witthöftb, 2012).

As a result of the temperature influence, the cereal seeds suffer qualitative changes; the drying systems at high temperatures prevent the seed biological activity, diminish the growing power and at exceedingly high temperatures partial or even total losses of the germination power may occur.

After the drying process, grain seeds for consumption or for animal feeding, are able to be stored and to respond properly to processing and handling.

Corn seeds do not support aggressive drying conditions characterized by non-uniform temperatures and rates of the hot air when passing through the product layer (Qiang *et al*, 2011).

In the past, efforts have been made to experimentally study the drying process of corn seed.

Currently, for drying the corn seeds, convective dryers are used worldwide, vertical and horizontal with continuous and discontinuous function, which do not solve the problem of the distribution's uniformity of temperature and velocity in the drying seed layer.

The corn seeds, which are subjected to the technological drying operation, behave differently depending on the physicochemical characteristics.

The purpose of the paper is to establish the optimal operating parameters for the drying process to maximize the technological effect and to conserve the quality of the corn seeds (protein content and germination capacity).

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MATERIAL AND METHOD

The main objective of the experimental researches consisted in the study of the drying process of corn seeds, aiming the optimized drying.

The targets of the experimental researches in this study were corn seeds, collected at different stages of ripeness, at four predetermined humidities, which were submitted to the drying process by means of an installation for dehydration in laboratory conditions (*figure 1*).

The temperatures during the drying process were 40ºC, 50ºC, 60ºC, 70ºC and 80ºC, and the velocity values of the thermal agent were 1 m/s, 1.5 m/s, 2 m/s, and 2.5 m/s. Each sample of material, regardless the initial humidity, had the same volume.

The experimental investigations were conducted in the laboratory of food industry and agricultural mechanization from the University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad", Iaşi.

For these experiments, a rectangular drying box has beed built (*figure 2*). It was provided with three layers of seeds, next to each other and well delimited, each of them 50 mm thick.

The parallelepiped shaped box has been made according to the current drying conditions and technologies.

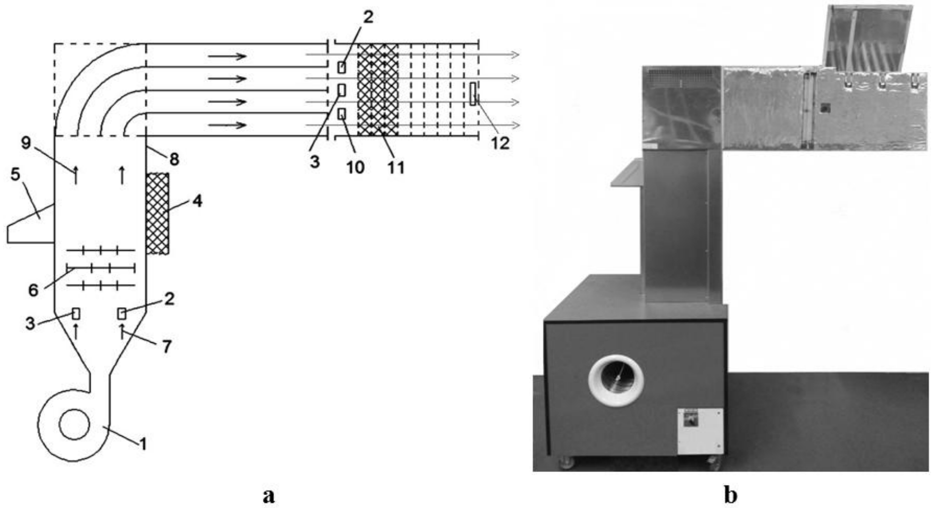

Figure 1 **Laboratory dryer scheme with rectangular box**: **a** – functional scheme; **b** – general view; 1 – fan; 2 – temperature sensor; 3 – humidity sensor; 4 – isolating layer; 5 – control panel; 6 – electrical resistances; 7 – cold air; 8 – body; 9 – hot air; 10 – velocity sensor; 11 – drying cells; 12 – humidity sensor for the used drying agent.

Throughout the research, a special watch was attributed to the influence of the constructive and functional parameters of the dehydration installation on the variation of the humidity and temperature in the three layers of seeds up to the point of reaching the conservation humidity. The drying time, the protein content of the corn seeds and the seed germination have also been recorded.

By varying the velocity and temperature of the hot air between 1 m/s and 2.5 m/s and between 40°C and 80°C were studied a total of 20 experimental variants for each initial moisture content.

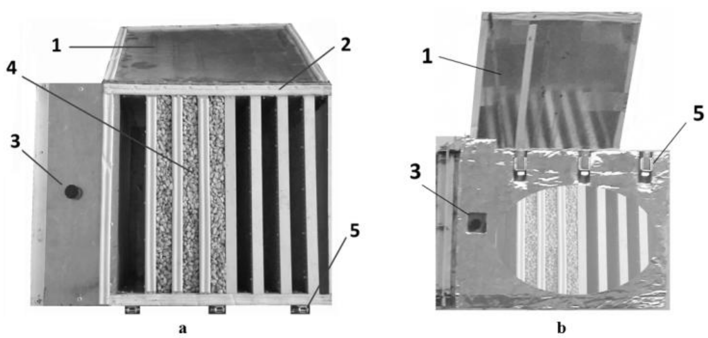

Figure 2 **Rectangular galvanized box and stainless steel sieves used for seed drying:** **a** – view from above; **b** – side view; 1 – cover; 2 – seals; 3 – opening for measuring; 4 – drying cells separated with stainless steel sieves; 5 – sealing cap system.

RESULTS AND DISCUSSION

In order to achieve those proposed, corn seeds were subjected successively to be dried in the three adjacent cells, starting from four humidities of 25%, 22%, 19% and 16%. The initial protein contents were 9.53%, 9.73%, 9.78%, 9.81% and the initial germination capacities were 93%, 93%, 95% and 96%.

The results regarding the protein content of the dried corn seeds are presented in *table 1*.

For the air temperatures of 40°C and 50°C there were no significant changes in terms of protein content. Since the air temperature rises above 50°C, the protein content decreases up to 5.46%. The most affected protein content was obtained after drying corn seeds at the air temperature of 80°C and the air velocity of 1.5 m/s.

Table 1

The results regarding the protein content of dried corn seeds

No.	Drying agent velocity (m/s)	Drying agent temperature (°C)	Initial moisture content (%)			
			25	22	19	16
			Protein content (%)			
1.	1	40	9.54	9.71	9.78	9.82
2.		50	9.53	9.78	9.74	9.81
3.		60	9.31	9.69	9.60	9.63
4.		70	9.27	9.55	9.52	9.49
5.		80	9.01	9.30	9.23	9.24
6.	1.5	40	9.52	9.76	9.85	9.82
7.		50	9.53	9.74	9.83	9.83
8.		60	9.33	9.51	9.57	9.61
9.		70	9.29	9.44	9.49	9.61
10.		80	**9.00**	9.17	9.22	9.34
11.	2	40	9.50	9.69	9.68	9.80
12.		50	9.52	9.69	9.78	9.79
13.		60	9.33	9.53	9.58	9.61
14.		70	9.30	9.50	9.54	9.56
15.		80	9.03	9.45	9.36	9.32
16.	2.5	40	9.54	9.74	9.76	9.81
17.		50	9.53	9.71	**9.86**	9.79
18.		60	9.34	9.62	9.65	9.53
19.		70	9.35	9.61	9.68	9.60
20.		80	9.13	9.33	9.37	9.38

The least affected protein contents were obtained at higher air velocities and lower air temperatures. It was also observed that the longer the drying process takes, the more affected is the protein content.

This means the lower the initial humidity is, the higher the protein content remains after drying.

At temperatures higher than 50°C, the germination capacity varies inversely with temperature, but at the same time it varies directly proportional to the air velocity. The high temperatures strongly affect the germination capacity up to 88%, as it can be seen in *figure 3*.

According to the graphic, the germination capacity decreased slightly for the dried corn seeds with the initial moisture contents of 25% and 22%, even at low temperatures. As in the case of the protein content, for a low initial humidity, the drying process takes less and that means less protein loss.

The optimal drying variant of corn seeds, regardless the initial moisture content, was obtained for the drying agent velocity of 2.5 m/s and the temperature of 50°C.

For these parameters the seed quality was not affected and more than that, the seed layers temperatures and humidities varied close to each other.

These facts conclude to a uniform seed drying in all the three layers.

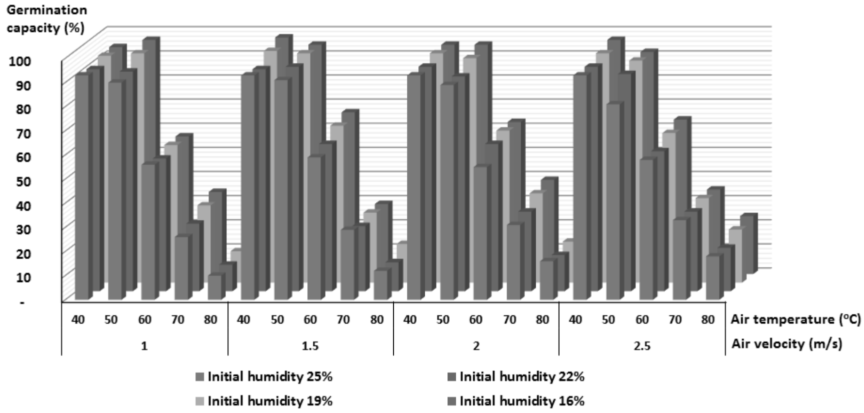

Figure 3 **The variation of germination capacity for the dried corn seeds**

The statistical analysis (*table 2*) regarding the protein content variation for dried corn seeds showed that at different air velocities there weren't any significant differences for the protein content, because the test conditions are not fulfilled (p < 0,05 și F > Fcrit). However, for different air temperatures, significant protein content differences were obtained.

For different air velocities there were also no significant differences obtained regarding the germination capacity. Significant differences were obtained for different air temperatures, because the test conditions were satisfied.

In conclusion, the *temperature* variable had the only influence on both protein content and germination capacity.

Table 2
ANOVA test results with two variables for corn seeds

Analysis	Variables	
	Velocity	Temperature
protein content	ns	*
germination capacity	ns	*

* – P<0,05; ns – not significant.

For the air temperatures of 40^{o}C and 50^{o}C there were no significant changes in terms of protein content. Since the air temperature rises above 50^{o}C, the protein content decreases up to 5.46%.

At temperatures higher than 50ºC, for the germination power of the seeds the values obtained vary inversely proportional to the temperature, but at the same time, vary directly proportional to the thermal agent velocity. The germination capacity decreased up to 88%.

After the statistical analysis, significant differences for the protein content and the germination capacity of dried corn seeds were obtained for the air temperature variation.

CONCLUSIONS

Analyzing the results of the physical parameters obtained throughout the experiments, one can conclude that the best results concerning the protein content and the germination power of corn seeds have been recorded for the variants in which the drying process was done by using high air velocities and low air temperatures.

From the point of view of the uniform drying of corn seeds the final humidity values in the seed layers were also closer at the maximum velocity used of the drying agent and at low working temperatures.

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