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SEED DRYING INSTALLATION WITH LOW ELECTRICITY CONSUMPTION

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Annotation. This paper is devoted to the efficiency of the drying process of agricultural seeds by the suspended layer treatment method. To solve this problem, a seed drying plant was developed and the research was carried out. Convection and SHF were used as suspended layer treatment sources.
Keywords: drying plant, seed treatment, suspended layer, process efficiency.

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УСТАНОВКА ДЛЯ СУШКИ СЕМЯН С НИЗКИМ ПОТРЕБЛЕНИЕМ ЭЛЕКТРОЭНЕРГИИ

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Аннотация. Работа посвящена изучению эффективности процесса сушки семян сельскохозяйственных культур методом обработки во взвешенном слое. Для решения этой проблемы была разработана установка для сушки семян и проведены исследования. В качестве источников воздействия на взвешенный слой использовались конвекция и СВЧ.

Ключевые слова: сушильная установка, обработка семян, взвешенный слой, эффективность процесса.

Introduction. Currently, the rise in energy prices makes it imperative to improve the efficiency of primary agro-food processing technologies. Efficient management of the agro-industrial complex can be ensured both by upgrading existing technologies and by developing and implementing new processing methods [7, 9, 11].

Thus, the effort of researchers in the field is particularly directed towards reducing electricity consumed and processing costs, increasing machine productivity and product quality [2–5].

Currently, one of the main problems of electrical seed drying technologies is the long process time and the essential consumption of electricity [1, 3–6, 10, 12]. The given problem is exacerbated in the case of oilseed drying, which is rich in unstable vegetable fats in heat treatment processes [4–8]. Therefore, in order to identify solutions in this direction, a suspended layer seed drying plant was developed.

Research has confirmed that the application of the experimental plant, on the example of grape seeds, increases the speed of the process and reduces the duration of heat treatment, helping to ensure the quality of the seeds for subsequent use in the food industry, medicine, cosmetology, pharmaceuticals, etc. Moreover, the installation developed allows a reduction in electricity consumption and overall processing costs.

Material and method. The research was carried out on three types of oilseed: grape seed, linseed and white buckthorn seed. These types of seeds were selected for research because at present their drying is a problem and they have a valuable potential for the industry of food, medicine, cosmetology, pharmaceuticals, etc.

The experimental installation, developed for the research, on seed drying in a suspended layer is shown in Fig. 1. On the basis of this installation, the efficiency of the suspended bed drying process was estimated and the results were compared with those obtained by the classical dehydration method.

The suspended layer drying installation consists of the following components: On the casing *1* is mounted the wind tube and the control panel *3*, which operates the inverter *2* and the fan *4*; The fan draws in air at a flow rate of 430 m^3/h through filter *11* and is operated by motor *13* model C 15/2 T with a power of 0.16 kW; The microwave generator *15* with drying chamber *14* is also mounted on the housing; The fan *4* is connected with the tube 6, to which the supply bank *5* is attached; The tube *6* vertically intersects the drying chamber *14*, which is mounted on the support *8*, and is fixed by the fixing-adjusting levers *12* to the guides *7*; At the top of the tube *6* is mounted the product outlet pipe *9*, and the perforated receiver 10.

The CPS-AM50 anemometer with ±1.5 % accuracy, TESTO 400 hot wire thermometer with ±1 % accuracy was used to measure air velocity, air flow and temperature.

Results and discussions. As a result of the research on the drying process of the three types of oilseeds (grape seed, linseed and white buckthorn seed), the following was determined for each type in particular: speed of moisture reduction in the seeds, duration of the drying process and electricity consumption.

The results obtained by the suspended layer drying method were compared with those obtained by the classical drying method.

Fig. 2 shows, as an example, the moisture reduction curves for drying grape seeds in a suspended layer with SHF application.

Using the suspended layer treatment method, the seeds were dried to the optimum moisture level of 10.3 % and as a result of examining 5 treatment regimens: 200 W, 300, 450, 600, 750 W, the duration of treatment for each regime was determined, respectively: 103 minutes, 76, 53, 43, 33 minutes.

Following the seed drying process, the kinetics of the process were determined and the results obtained from the suspended layer drying method were compared with those obtained by the classical drying method.

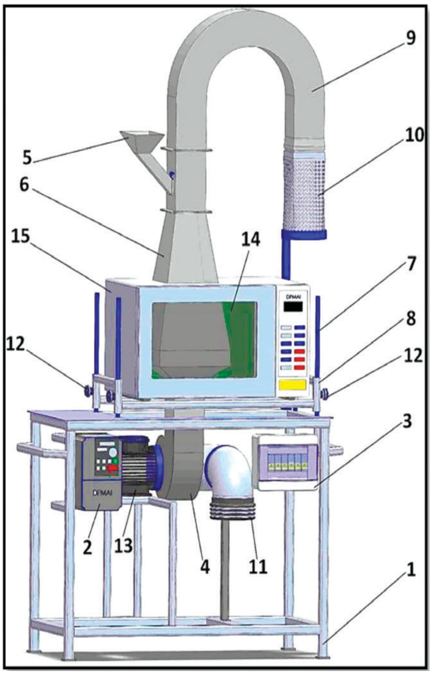

Fig. 1. Experimental plant developed for seed drying in a suspended layer

Table shows, as an example, the comparison of the results obtained for drying by the methods analyzed, for grape seeds, for a treatment source power of 450 W.

Analyzing the results of drying with SHF application, we observe that the drying time is 41 minutes shorter for the suspended layer than for the classical drying method.

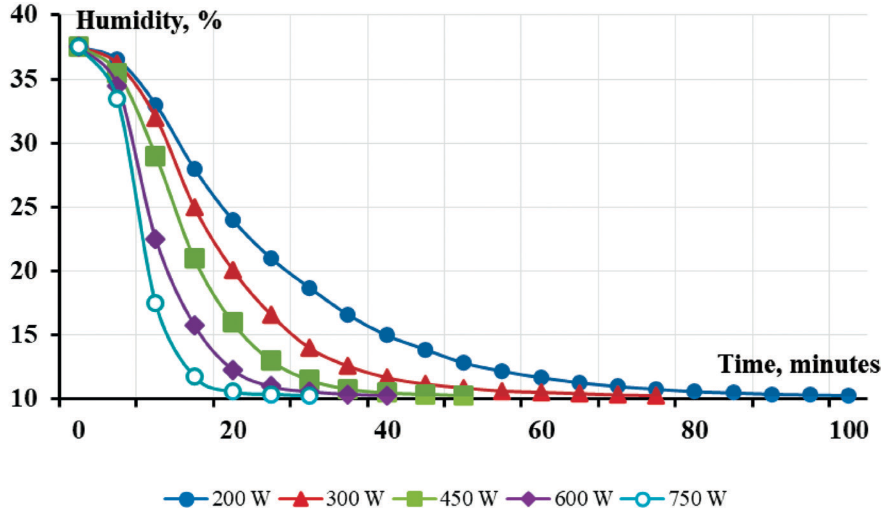

Fig. 2. Moisture reduction curves of dry seed in suspended layer with SHF application

Seed drying results by methods examined

Treatment source applied to drying	Drying process parameters	Drying method	
		Classical drying method	The suspended layer drying method
Convection	Drying speed, %/minute	0,71	0,97
	Drying time, minutes	244	183
	Electricity consumption, kWh	1,83	1,37
SHF	Drying speed, %/minute	1,41	1,76
	Drying time, minutes	94	53
	Electricity consumption, kWh	0,71	0,39

Also the drying speed, with the application of SHF in a suspended layer, is 0.35 %/minute higher than with the application of SHF by the classical method.

The results confirm that, even when drying these seeds by convection in a suspended layer, the drying time is 61 minutes shorter than when drying by convection using the classical method. The speed of convection drying in the suspended layer is also 0.26 %/minute higher than in the classical drying method.

It was found that when drying these seeds in a suspended layer with the application of SHF, electricity consumption is lower than when drying with SHF by the classical method by 0.32 kWh.

Also for convection drying in a suspended layer, the electricity consumption is lower than for convection drying by the classical method by 0.46 kWh.

Comparing both drying methods, based on the applied treatment source, it is recommended to use the suspended bed drying with SHF application. This method is characterized by increased drying speed and reduced drying time for all three types of seeds examined: grape seed, linseed and white buckthorn seed.

For quality analysis, dried seeds were analysed microscopically. Fig. 3 shows, as an example, the microscopic analysis of grape seeds, which were dried by the classical method.

From this figure it can be seen that micro cracks have formed on the surface of seeds dried by the classical method.

This is because in this method, in the drying process, the seeds are subjected to mechanical action, which causes cracks to appear on their surface. These micro-cracks negatively influence the stability of the seeds in the drying process and reduce quality. This is explained by the fact that the vegetable fats in the seed are more sensitive to contact with oxygen in the air. Thus, through cracks in the conventional drying process, oxidation of the fats occurs and the quality of conventionally dried seed is reduced.

Fig. 4 shows the microscopic analysis of the seeds, which were dried in a suspended layer.

It can be seen that no micro cracks have formed on the surface of the dried seed in the suspended layer. This is due to the fact that, by this method, the seeds are not subjected to negative mechanical actions, as by the classical method, and this fact prevents the appearance of cracks or other defects on their surface. The suspended

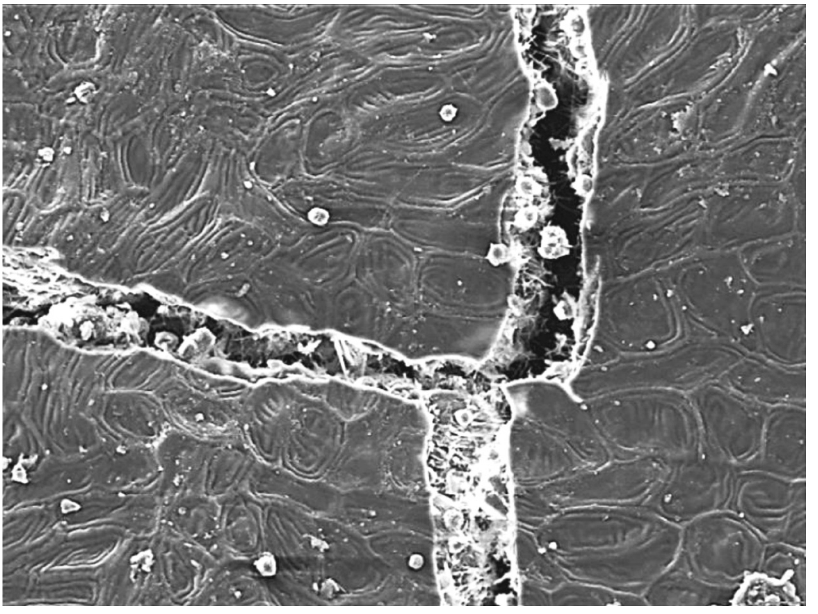

Fig. 3. Microscopic analysis of dried seeds by the classical method

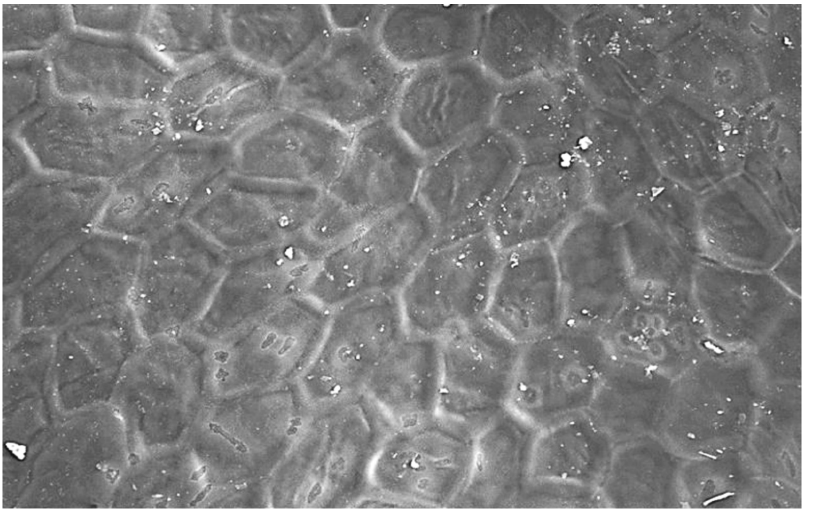

Fig. 4. Microscopic analysis of dried seeds in suspended layer

layer drying method therefore excludes the appearance of micro cracks and prevents oxidation of the vegetable oil in the seeds.

Thus, the results of the research confirmed that the application of the experimental installation significantly increases the speed of the drying process and reduces the heat treatment time, contributing to the increase of the process productivity.

Moreover, electricity consumption is significantly reduced in the application of the suspended layer drying compared to the classical method, and these are the basic technological parameters for a drying process with low electricity costs and high productivity.

Research has shown that the seeds are not subjected to mechanical action during the drying process and the risk of cracks on the seed surface or other defects is absolutely excluded. The risk of oxidation of the vegetable fats in the oilseed content, which can occur through these cracks when in contact with oxygen, is therefore also excluded. This is quite important for the preservation of the quality of seeds rich in vegetable oils for further use in the food industry, medicine, cosmetology, pharmaceuticals, etc.

Conclusions. The installation developed for the drying of seeds in a suspended layer allows increasing the speed of the drying process, to reduce the duration of the process and the consumption of electricity for all three types of seeds examined: grape seeds, linseed and white hawthorn seeds.

The drying in suspended layer does not allow defects to appear in the drying process of the seeds and ensures the preservation of their quality for further use in the food industry, medicine, cosmetology, pharmaceuticals, etc.

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