MICROWAVE DRYING OF OAT SEEDS IN VARIOUS CONDITIONS

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Abstract

Experimental work using as dielectric material oat seeds is reviewed in the present study. There were used three samples of seeds that were dried in various conditions using the microwave power. The experiments were divided in three: drying the sample at 0.5W/g, using the power of the microwaves of 0.5W/g with cold air ventilation and finally using 0.5W/g with hot air ventilation. During the process of drying the specific parameters were analyzed and noted. At the end of the experiments the humidity removed from the seeds was calculated and the germination was followed.

Key words: oat seeds, absorbed power, drying, MW, humidity, germination.

INTRODUCTION

The use of microwave energy in the process of drying crops has become nowadays a common procedure. The microwave power not only that brings the seeds to an appropriate level of humidity, but even kills the pests, insects that may effect the quality of the grains during storage. Many industrial installations were created in order to help agriculture in maintaining high quality crops during winter time. The development of these microwave installations lead to the appearance of a real industry aimed on creating high technologies that fulfill the request of agricultures (Nelson, 1996; Varsányi et al., 2001; Vadivambal, 2009).

Microwaves have been used for more than 30 years as an alternative method of killing pests and insects, for sterilizing soils being used radio frequency. Many years ago the solar energy was used as a traditional method of removing the excess of water from the crops. But this method was considered to be old and requiring too much time. Even though the microwave installations were expensive, the higher quantities of grains dried in shorter time represented an important reason for agricultures to use it (Denis, 1998; Manickavasagan et al., 2007).

Song G. and his colleagues present in a recent paper the characteristics of drying corn seeds in microwave field. The experimental data was made on grains having as initial moisture 18.3%, 26.3%, 34.3% and 42.3% and using different power levels: 70W, 175W and 245W for an exposure time of 80 and 120 seconds. The conclusion of the experiments was that a high level of the microwave power decreases the time needed for

drying but affects the quality of the grains, by cracking and reducing the germination percentage (Song et al., 2013).

Hemis M. and his work team studied the effect of microwaves on the wheat seeds. The initial moisture level of grains was 0.18 and 0.29 kg water/kg of dry matter. The exposed time to microwaves was considered to be 180 and 360 seconds. The authors developed a mathematical model by coupling mass and energy balances (Hemis et al., 2011; Hemis et al., 2012).

Ipsita Das and his colleagues presented in there research, data concerning the disinfestations of grains through different methods. They stated that when using conventional methods, hot air at 80 and 100°C the results are satisfactory. The conventional methods are easy to apply and without any chemical residues. Their work also presents the use of dielectric heating: Radio - Frequency (RF) and Microwaves (MW). They stated that RF is better to use when destroying insects because of the energy that penetrates the dielectric material more deeply than microwaves (Das et al., 2013; Gao, 2010; Wang, 2010; Jiao, 2012).

MATERIAL AND METHODS

The conducted work was made using the microwave installation from the University of Oradea, Electrical Engineering Department. The stand offers the possibility of drying grains in the microwave field, using a maximum power of 850W in different ventilation conditions: hot or cold.

The recipient in which the samples are introduced is made of Teflon so it is transparent to microwaves. Due to the fact that during the experiments we couldn't use fresh harvested grains, the oat seeds were rewetted with a day before and than put to rest in proper conditions. In order to find out the percent of humidity removed from the mass of the seeds after drying the weight of the grains was measured before and after the experiment. After each process of drying the samples were put to germination in special conditions.

During the experiments every 30 seconds the next parameters of drying were measured and noted: generated, absorbed and reflected power, the temperature and humidity at the exit, using a special sensor the temperature in the mass of the grains was measured.

The work was divided in three parts: drying the grains using the microwave power level of 0.5W/g without any ventilation, than in order to make a comparison there were dried seeds using 0.5W/g with cold air ventilation and in the end a sample was made using 0.5W/g with hot ventilation of the grains. In the end the parameters of the drying process were noted and the specific comparisons were made.

RESULTS AND DISCUSSION

The results of the experimental data revealed that using ventilation in the whole mass of the seeds more water is being eliminated, so the final humidity content is lower, for a better storage conditions. The humidity eliminated from the grains was calculated with the relation between the initial m_i and final m_u mass of the grains:

$$U\,[\text{Humidity}] = \frac{m_i - m_u}{m_u} \times 100[\%] \quad (1)$$

In fig.1 are being presented the values given by the value of the Humidity for the three samples. Analyzing the values, like we previously stated we can say that when using no ventilation less water is being lost. As expected, the hot ventilation determined the loss of a large quantity of water.

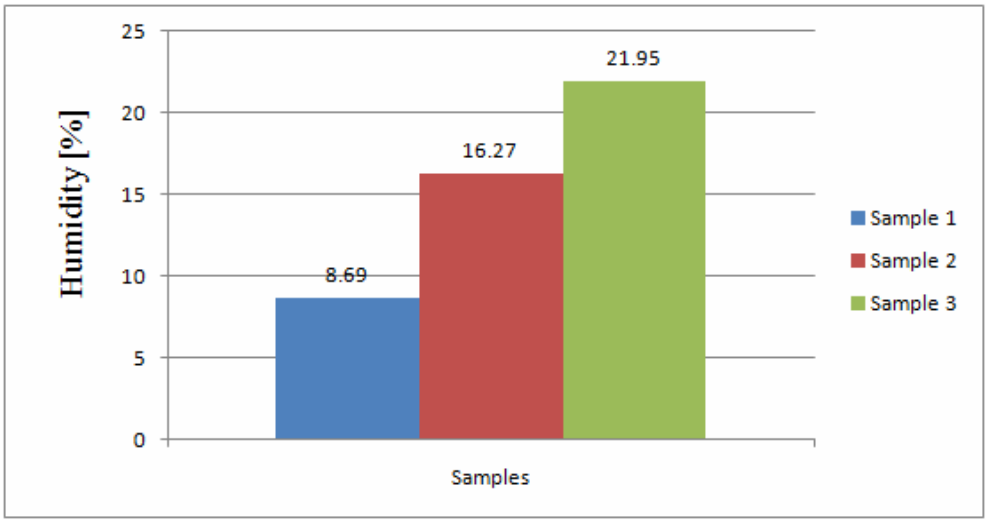

Fig. 1. Humidity evaporated from the grains

When reviewing the variation of the absorbed power (see Fig. 2) we can conclude:

- using only the power of the microwaves the absorbed power has a linear variation until minute 6.5, from which it starts to grow progressively to 45W in minute 10; the explanation to this is that without ventilation, on the surface of the grains a film of water is being formed, which absorbs more and more energy;
- the cold air stream determines a very slow variation of the absorbed energy at the end of the experiment, due to the fact that the water from the dielectric is being lesser so the absorption of microwaves is too;

- when using hot airing the absorbed energy was between 15W and 20W without any significant changes.

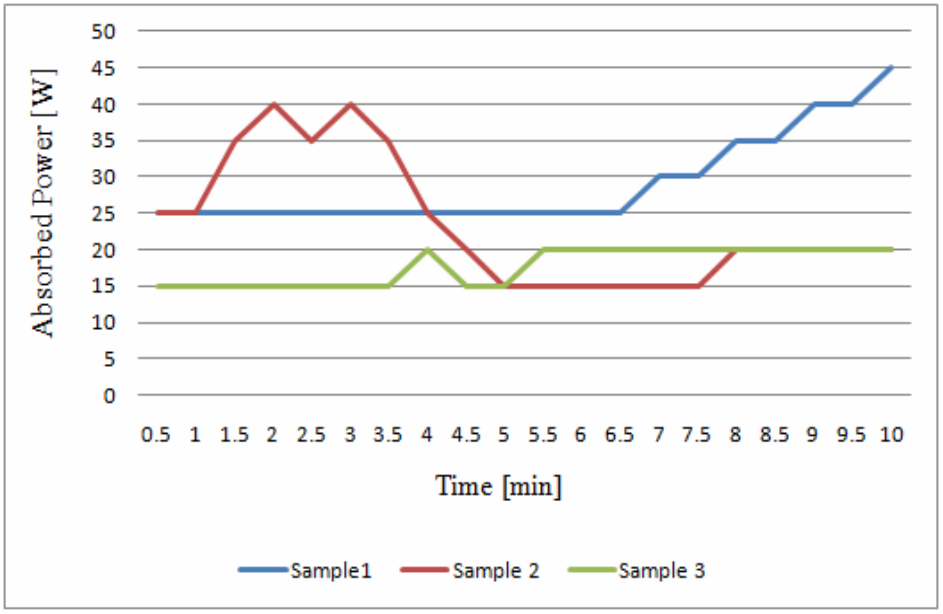

Fig. 2. Values of the absorbed energy

The temperature measured in the mass of the grains during the process of drying and at the end of it is very important when analyzing the quality of the seeds. A high temperature of 70-80°C destroys the kernel and the quality parameters of the oat seeds. Although a high variation of the temperature during drying is bad for the grains (Manickavasagan et al., 2006; Vicaş, Mintaş, 2011).

In the case of the first sample we observed a high variation of the temperature measured in the grains, varying from 19-37.3 and 76.3°C (see Fig. 3). For the second sample, when using cold airing the temperature had a slow, constant growth, without significant changes, with values starting from 23-28.7°C. When using hot airing the variation is the same like in the previous sample, with a constant growth, from 20.1 to 42.9°C.

At the end of the experiment the samples were checked for its germination achieving the next results: sample 1 - G= 25%, sample 2 - G= 80%, sample 3 - G=76% and for the witness sample - G=93%.

The result for the first sample was an expected one, taking into consideration of the variation of the temperature and absorbed power, that destroyed the structure of the grains. Even though the percentage is low, the germinated seeds had a nice growth.

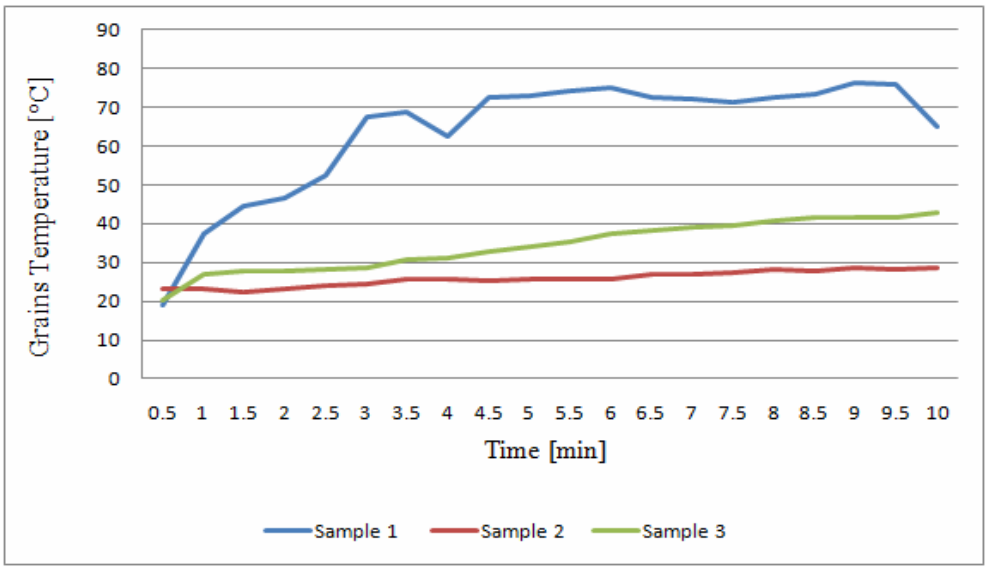

Fig. 3. Grains temperature variation

CONCLUSIONS

In order to conclude at the above experiments it may be said:

- the use of hot airing with 0.5W/g is a good solution in order to achieve a quality product, with a final humidity proper for storage and a satisfactory percentage of the germination;
- it is important to analyze all the parameters that interfere in the process of drying grains, in order to get a final product that satisfies the needs and expectations of agricultures.

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