EFFECT OF MICROWAVE ENERGY ON DRYING BARLEY SEEDS

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Abstract

The process of drying Barley seeds using 0.2 W/g microwave energy is being studied in the present work. The experiment included three cases of drying: using hot, cold or no air flow. During the experiments the temperature in the seed bed was measured every 30 seconds and at the end the germination percentage was established and compared with the witness sample.

Key words: barley seeds, drying, microwave energy, temperature, germination.

INTRODUCTION

Microwave energy has become popular in the agricultural industry due to the lower costs of production and the necessity of obtaining a quality product (Ishii, 1995), (Mujumdar, 2006), (Schiffmann, 2001). When using microwave power combined with traditional ways of drying seeds, like air ventilation - hot or cold, the water from the mass of the seeds is being released to the surface of the dielectric material and eliminated by the air flow. In consequence, using both methods leads to a good result (Jayas D.S. and Ghosh P.K, 2006), (Manickavasagan A., 2006).

Song G. and his team followed the drying parameters of corn seeds, using high levels of power energy - 70, 175 and 245 [W] with a processing time of 80 and 120 seconds. The results of their experiment revealed that at higher values of the microwave power - 245 [W], more water is being eliminated from the seeds, but it occurs the cracking and the decreased of the germination percentage (Song G. et al, 2013).

An important issue when talking about microwave drying of dielectric materials is understanding how the material gets heated (Sobol and Tomiyasu, 2002). Das S.K and Chakraverty A. described very well the process of heating dielectric materials using the microwave power. The water from the material absorbs the microwave energy, which will cause a rise of temperature that will lead to the evaporation of water from the material and so the moisture content will be reduced. In order to find out the microwave energy that is being absorbed by the material, the next relation is being used:

$$\frac{P}{V} = 2\pi f\varepsilon' E^2 \quad (1)$$

where: P represents the absorbed power [W], V is the volume's material [m^3], f represents the frequency [Hz],

ε' is the loss factor and E is the electric field strength [V/m] (Das and Chakraverty, 2014).

One of the most important researchers who studied the efect of microwaves on agricultural products and the dielectric properties of those, is S.O.Nelson, from the University of Georgia (Nelson and Trabelsi, 2012), (Nelson and Datta, 2001).

MATERIAL AND METHOD

In order to develop the experiments, was used a microwave installation from the Center of Research and Technological Engineering in Conversion of Electromagnetic Energy, Electrical Engineering Faculty, University of Oradea. In the absence of fresh harvested Barley seeds, the grains were previously moistened, respecting the next procedure: the grains were placed into a glass vessel and water was poured on, over the beans, until the whole quantity was covered. The grains were kept into the water for 2 hours and then were left for 10 hours on towels, the final humidity being 25 %. For each experiment were used 50 g of seeds.

During drying, every 30 seconds was noted the temperature in the seed bed, by introducing a fiber optic sensor (type Pico Power Sens 6) in the mass of the grains. In order to calculate the loss of humidity from the mass of the seeds, it was used the value of the initial quantity - m_1 and final one - m_2 (after the drying process). The relation used is:

$$U[\%] = \frac{m_1 - m_2}{m_2} \times 100 \quad (2)$$

The constant parameters that interfere within the experiments are:

- the quantity of seeds, 50 g;
- the microwave power, which is constant, having the value of 0.2W/g;
- the time dedicated to dry the grains, with the value of 600 seconds.

The experiments were divided as it follows:

- using the microwave power of 0.2W/g without air flow;
- using the microwave power of 0.2W/g with cold air flow;
- using the microwave power of 0.2W/g with hot air flow.

RESULTS AND DISSCUSIONS

The results achieved through experiments are being presented in Table 1. The highest value of the humidity lost from the mass of the seeds is being obtained by the last experiment, U=28.2 [%]. This result was expected because of the use of hot air flow, that fostered the vaporization of water from the grains. The temperature measured in the mass of the grains is an important issue, because a high value could destroy the structure of the seeds. It is observed that when using the microwave energy with no air flow, the value of the temperature reached 88.6 [°C] (see Fig.1). When there is no ventilation in the dielectric material the hot spots appear due to the water that forms at the surface and absorbs a higher quantity of microwave energy.

The use of microwave energy with cold air flow led to a much lower value of the temperature, 35[°C] (Fig.2). The line that describes the flow of temperature for the second experiment (see Fig.2) demonstrates the above stated, regarding the form of water on the surface of the seeds, that is missing in this case, the fluctuation of temperature being almost constant. The same conclusion can be taken for the third experiment, (Fig.3), when using hot air flow. As presented in Table 1, the highest value of the temperature for the third case is 68.4 [°C].

Analyzing the results concerning the germination percentage, next conclusions could be draw:

- a high value of the temperature measured in the mass of the seeds leads to a lower percentage of the germination;
- using cold air flow fosters the rate of germination, due to the lower value of temperature that doesn't destroy the structure of the grains;
- using hot air flow leads to a higher level of humidity lost from the mass of the seeds (see Fig.4) and to an acceptable value of the temperature measured in the grains.
- considering that the rate of germination for the witness sample is 87[%], the germination of the samples is not acceptable.

Table 1

Results of the drying process

Air flow	Final Mass [g]	U[%]	Highest Temperature [°C]	Germination [%]
No	45	11.11	88.6	13
Cold	42	19.04	35	55
Hot	39	28.2	68.4	43

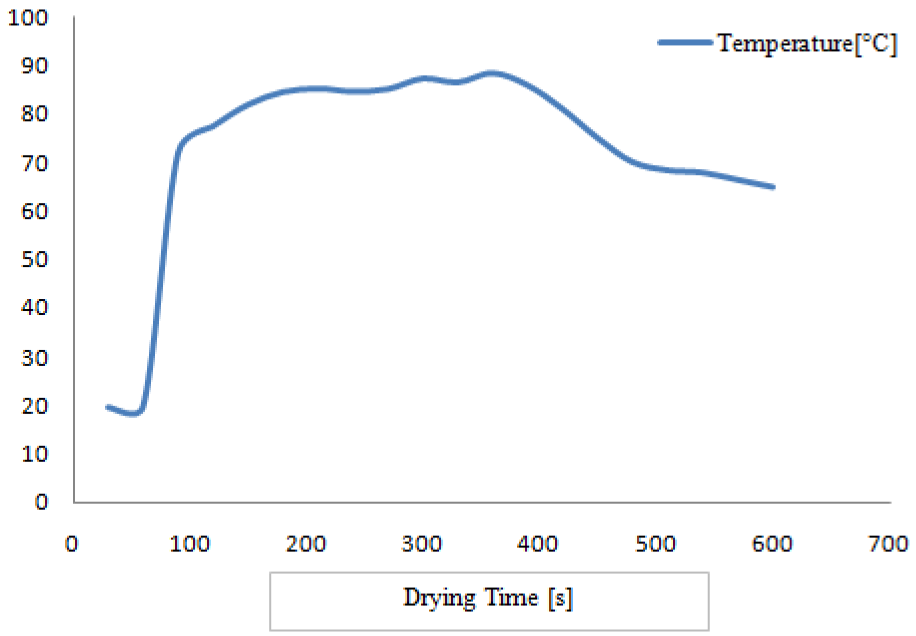

Fig.1 Variation of temperature measured in the mass of the seeds for the first experiment

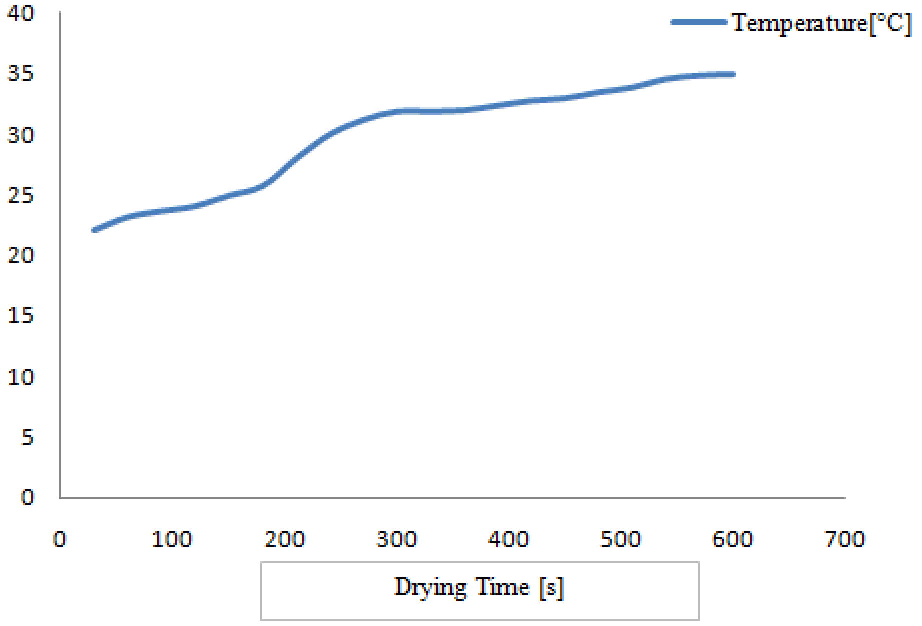

Fig.2 Variation of temperature measured in the mass of the seeds for the second experiment

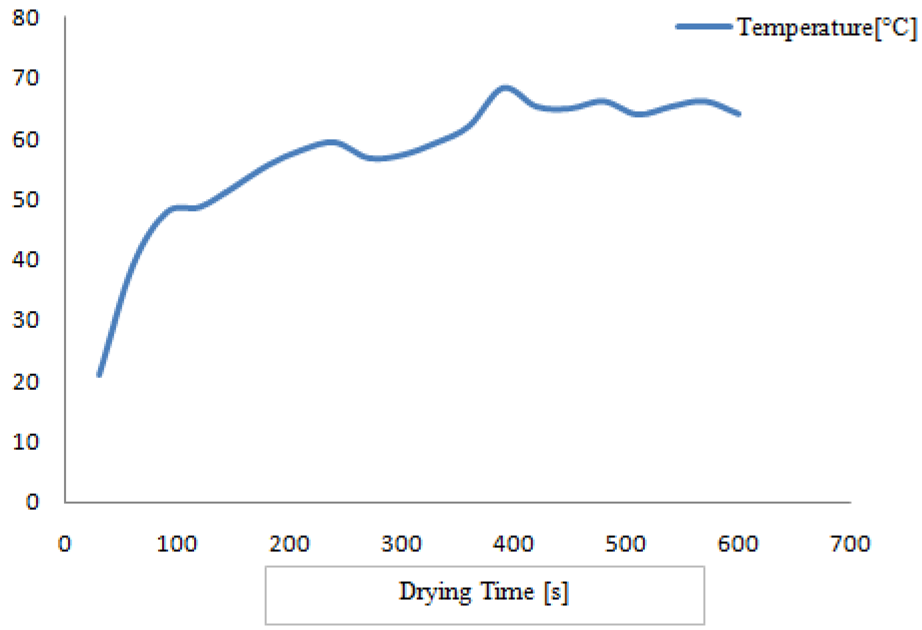

Fig.3 Variation of temperature measured in the mass of the seeds for the third experiment

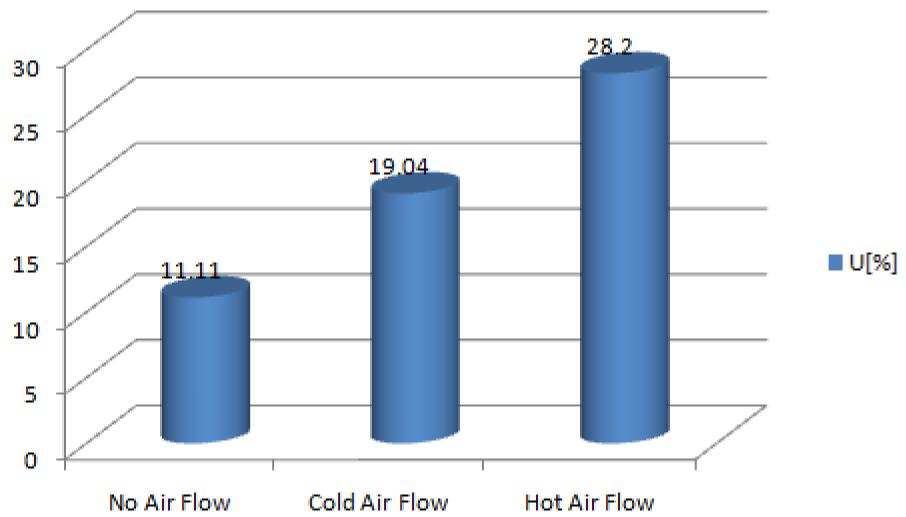

Fig.4 Rate of humidity lost from the mass of the seeds

CONCLUSIONS

Studying the efect of microwaves on agricultural products has become nowadays very important, due to the need to store in proper conditions the grains. Fresh harvested seeds have a high value of the humidity content, which has to be reduced to an acceptable level in order to be able to store them. The present experiment showed the study of drying Barley seeds using a constant microwave power of 0.1W/g without air flow, with cold or hot air flow. The results revealed that using air flow, especially cold, leads to a good result of the lost humidity from the seeds and an acceptable one for the germination percentage. As a consequence, it may be said, that using a power of 0.1W/g is not enough to dry the Barley seeds and obtain a good result of the germination percentage.

REFERENCES

1. Das S.K., Chakraverty A., 2014, Grain Drying Systems, Handbook of Industrial Drying - Fourth Edition, CRC Press, pp. 138-166
2. Ishii T.K., 1995, Microwave Engineering, Second Edition Oxford, Oxford University Press, UK
3. Jayas D.S., P.K. Ghosh, 2006, Preserving quality during grain drying and techniques for measuring grain quality, 9th International Working Conference on Stored Product Protection, Quality in Grain Drying, pp. 969-980
4. Manickavasagan A., D.S. Jayas, N.D.G. White, 2006, Non-uniformity of surface temperature of grains after microwave treatment in an industrial microwave drier, Drying Technology, pp.1559-1567
5. Mujumdar A.S., 2006, Handbook of Industrial Drying, Third Edition, Editura CRC Press
6. Nelson S. O., S.Trabelsi, 2012, Factors Influencing the Dielectric Properties of Agricultural and Food Products, Journal of Microwave Power and Electromagnetic Energy, 46 (2), pp. 93-107
7. Nelson S.O., A.K. Datta, 2001, Dielectric properties of food materials and electric field interactions, Handbook of Microwave Technology for Food Applications, pp.69-107
8. Schiffmann R.F., 2001, Microwave Processes for the Food Industry, Handbook of Microwave Technology for Food Applications, pp. 298-337
9. Sobol H., K. Tomiyasu, 2002, Milestones of Microwaves, IEEE Transactions on Microwave Theory and Techniques, Vol. 50, No. 3
10. Song G, Ruplal Choudhary, Dennis G. W., 2013, Microwave drying kinetics and quality characteristics of corn, IJABE, Vol.6, No.1, pp. 90-99