STUDY ON THE EFFECTS OF MICROWAVES ON WATER HEATING AND THEIR INFLUENCE UPON THE GERMINATION PROCESS

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Abstract*: This paper considers an experimental study that considers the effects of heating water in a microwave oven. Thus, we wanted to check how harmful microwave-heated water is, and by extrapolation, how harmful microwave-heated food can be.*

1. INTRODUCTION

In electronics, microwaves work at high frequencies, thus having short wavelengths:

$$\lambda = \frac{c}{f}$$

where:

- *c*, represents the propagation speed specific to electromagnetic waves. When propagating in a free space (vacuum), the speed of electromagnetic waves is $c_0 = 3 \cdot 10^8$ m/s .

As a rule, in the field of microwaves, the wavelengths λ have small values, of the order of millimeters or centimeters, which corresponds to high frequencies, tens of gigahertz. In principle, the microwave field can be defined or has as characteristics the fact that the dimensions of the circuits are almost equal or even greater than the wavelength, the absolute value of the frequency being a secondary characteristic.

With a view to an easier analysis of microwave circuits, specialists in the field have developed certain calculation methods, especially suitable, which allow the determination of the most significant properties of circuits, respectively microwave systems [2].

2. SYSTEMS, CIRCUITS AND ASPECTS OF MICROWAVE PROCESSING TECHNIQUES

They consist of interconnected components/subassemblies. The interconnection element represents the simplest element related to a system. If we talk about low frequencies, the related components of an assembly will be interconnected by metal wires that keep both the voltage and current constant throughout the respective section. In the field of high frequencies, the propagation time relative to the period, which is very short, specific to the signal, cannot be neglected, so the current and voltage are not kept constant along the length of the respective wire. Thus, considering the previously mentioned, these short or long portions of lines are called waveguides. The properties of such a system are dependent on the propagation phenomena along the elements that realize the interconnection and the properties of the component subassemblies.

If we talk about the category of linear circuits, these are all Radio Frequency circuits that work in the range of frequencies corresponding to microwaves and that operate at low signal, such as very low power amplifiers. Electronic circuits are the ones that have brought about the change in the life we live today since the beginning of the 20th century. The digital age was opened, however, with the appearance of the first integrated circuits, followed later by digital computers. But, for electronic circuits that use microwaves, we will talk about a more special category, because high frequencies are circulated here. The specific applications of this field can be found in radio communication equipment, more precisely in satellite communications, television and even the development of the Internet. At high frequencies, more complex microwave circuits in addition to amplification will accurately pick up the signal in noisy conditions. The previously mentioned complex processes will allow the transmission of signals, wirelessly, over very large distances, even if the corresponding stations do not have a fixed point.

In the study presented in this paper, the main element is the microwave oven. From the specialized literature [3] we know that those microwaves are generated by a magnetron, which acts as an emitter for the radiant energy at high frequencies, which will later be transmitted with the help of a tube inside the electronic equipment. The waves are reflected inside with the help of the walls that make up the enclosure, thus a resonance system will be established. The agitator has the role of distributing the microwaves throughout the room. In the case of a 2450 MHz installation (microwaves being the electromagnetic radiation between 300 MHz - 300 GHz) magnetrons are used that have individual powers between 2.5 - 3 kW.

The main elements responsible for the influence of microwave heating are the dielectric properties of food, respectively the thermal and physical properties specific to food. The properties of the microwave source and packaging details should also be mentioned. When food

is placed in a microwave oven, it will absorb the energy of the microwave field. Basically, heating represents an interaction in the created energy that will change the polarity and the elements of which the respective food is made up billions of times per second, thus achieving volume heating. Another property of microwaves is that they can be transmitted, reflected, or absorbed. Food products will be a dielectric material because they are made of carbohydrates, proteins, water, and microwaves will penetrate them without problems, being thus absorbed in a proportion greater than 50% [3].

3. EXPERIMENTAL DETERMINATIONS

The experiment carried out considers the effects of heating water in a microwave oven and the effect upon the germination process of beans.

The experiment wanted to highlight how harmful microwave-heated water is for plants, especially during their germination period and by extrapolation, how harmful microwave-heated food can be for the health of the consumers of food prepared in this way. It is known that this type of heating is based on the "stirring" of the water molecules in the food, by the electromagnetic field of the microwaves. For this reason, materials that do not contain water (or other liquids) are not heated in the microwave oven, they change their temperature only from the transmission of heat from the body to be heated (food, for example) to the vessel in which it is placed.

Description of the experiment. For the experimental part, the following equipment and materials were used: microwave oven (Samsung), two glass containers (370 ml), cotton wool for the germination bed, tap water, beans. Two beans of different varieties were placed in two transparent containers (*figure 1*).

Fig. 1. Experiment preparation

These grains were watered separately, one with tap water (the one labeled "water") and the second with tap water, heated for 2 minutes in the microwave oven, and then cooled (labeled "µwaves").

The same amount of water (10 drops) was put into each vessel at the same time, and the recipients were kept in natural light, in a room with constant temperature of 20 ^{o}C (f*igure 2*).

Fig. 2. Storing pots of beans

The first results of the experiment appeared after five days of watering with the two kinds of water, the grains in the "water" jar sprouted (*figure 3*).

Fig. 3. After 5 days - those watered with tap water sprouted

Those soaked with "microwave" water had no change (*figures 4 - 5*).

Fig. 4. After 5 days - the grains are watered with "microwave" heated water

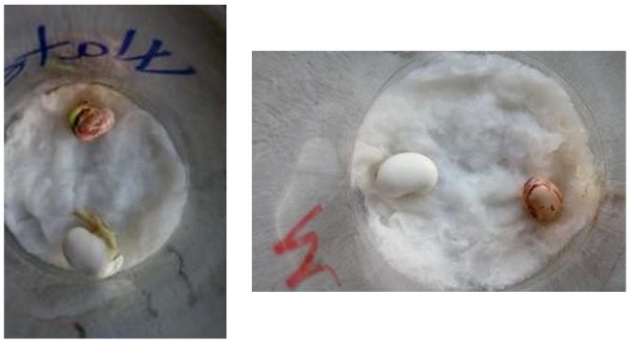

Fig. 5. Day 6 - "µwaves" no change (!)

After seven days, the first green sprout appeared in the vessel in which the plant was watered with "clean" water, while in the other vessel there was no change (*figure 6*). After eight days, the green sprouts continued their growth, but on top of those soaked in microwave water, mold begins to form and, in the end, they rotted (*figures 7 - 8*).

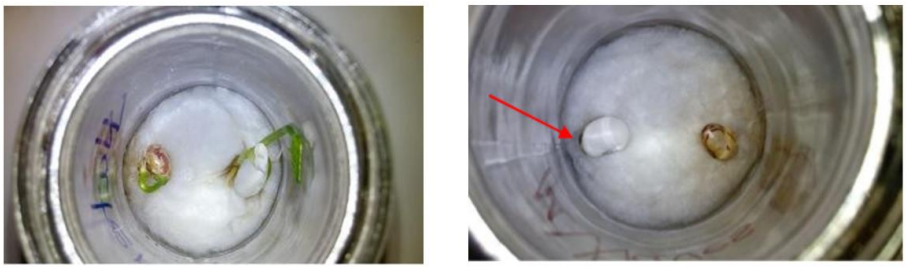

Fig. 6. Day 7. The appearance of mold on the one from the "μwaves"

Fig. 7. Day 8. Plant grows (tap water-left) and mold grows (microwave heated water-right).

Fig. 8. Day 9. The plant watered with "tap water" grows. Mold expands in"μwaves"

On the tenth day, only the "moldy" grain from the "μwaves" jar was watered with 4-5 drops of tap water. The next day it sprouted. Thus, the clean water was beneficial to the vegetal material and the grain recovered (*figures 9 - 10*).

Fig. 9. Day 11. The plant watered with "pure water" grows and the the sprouts with mold recover after they were watered with tap water.

The watering of the grains continued, exactly as at the beginning of the experiment. Those watered with tap water continued to grow, and those that received microwave heated water stopped their evolution (*figure 10*).

Fig. 10. Day 13. The plant watered with tap continues to grow. The grains watered with microwave heated water do not evolve anymore.

4. CONCLUSION

The experiment presented focuses on the effects of heating water in a microwave oven and the germination process of grains. The results indicate that water heated in a microwave oven negatively affects the germination process of grains compared to tap water. This finding raises concerns about the potential harmful effects of microwave-heated water on plants and, by extrapolation, on the health of consumers who use this method of food preparation.

Following the analysis of the results it was found that the grains watered with microwave-heated water had a slower and less efficient germination process compared to those watered with tap water. After five days, the beans watered with regular water began to

germinate, while those watered with microwave-heated water showed no signs of germination. This difference increased over time, and after eight days, the grains soaked in microwaved water developed mold and began to deteriorate, while the others continued to grow healthy. After heating the water in the microwave oven, its properties change and it cannot trigger "life" for some simple plants that, under normal conditions, evolve very quickly. After the tenth day, the water treated with microwaves had no influence on the growth and development of the plants, comparing to the tap water, and in addition it determined the appearance of mold and finally the complete degradation of the plant material. Also, the involvement of mold suggests that this water may create a favorable environment for the growth of harmful microorganisms.

Although the study discusses the process of grain germination and the effects of exposure to microwaves on it, we mention that these results are preliminary and are part of a larger experiment designed to explore the influence of other factors on the experimental results, among which are exposing water samples to electro-magnetic, energetic and radiative fields with varying frequencies, in order to understand the impact of these factors on the process of plant germination, their interaction with the soil, as well as the thermal and chemical effects of different heating methods on the environment, plant health and implicitly human health.

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