

# Experimental study of bakery products obtained in electrical resistance heated ovens

I.R. Șugar<sup>1</sup>, B.S.Săsăran<sup>1</sup>, M. Banica<sup>1</sup>, L.Giurgiulescu<sup>2</sup>

<sup>1</sup>Department of Engineering and Technologic Management, Faculty of Engineering, North University Center of Baia Mare, Technical University of Cluj Napoca, Victor Babes 62A, 430083, Baia Mare, Romania

<sup>2</sup>Department of Chemistry-Biology, Faculty of Science, North University of Baia Mare Center, Technical University of Cluj Napoca, Victoriei Street 76, 430082, Baia Mare, Romania

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## Abstract

The quality of bakery products is a complex system because it must fulfill several conditions: the amount of food harmlessness, the sensory quality and the presentation of the product. Due to continuous trend of increasing quality demands appeared and maintaining the demands in good features and economic performance appeared due to the continuous trend of increasing quality.

**Keywords:** hardness, crust oven, thermal

## 1. Introduction

The construction and operation of furnaces used in bakery have an important role in the quality of the final products.

Electric heating has some advantages over heating with gas: the ability to adjust fast, precise and easy manual or automatic energy input and temperature of the heated area; the ability to develop heat in the desired location; direct heating of the heated area without contamination; energy high efficiency and constructive simplicity of ovens, etc. [1,4].

The appearance and the consistency of bread crust, baking and oven regime used in the process, play a very important role. Due to the shape and construction of ovens, bread subjected to experiments can go through various stages in consistency of the crust: the half-soft crust to hard or very hard crust [2].

## 2. Material and Methods

The rudimentary baking regime is given by earth kilns which work on the basis of heat accumulation in the walls and furnace of the furnace and which

gradually cool down due to the low conductivity of the material from which they are made.

The baking regime is characterized by high initial temperatures, intense heating of the dough at the beginning and a long asymptotic baking end.

The humidity of the environment is very small at first and increases as products lose moisture [5].

If there is no balance between the dough weight and the heating intensity, the defect in the figure may appear when the dough under the internal pressure is expelled outwardly (figure 1).

Where:

- $\Theta_v$  is temperature of the fireplace;
- $\Theta_p$ -temperature of the walls;
- $\Theta_{me}$ -temperature of the cooking environment;
- $\Theta_{cm}$ -temperature from the center of bread;
- $\Theta_c$ -temperature of the peel;
- W%-relative humidity of the cooking environment.

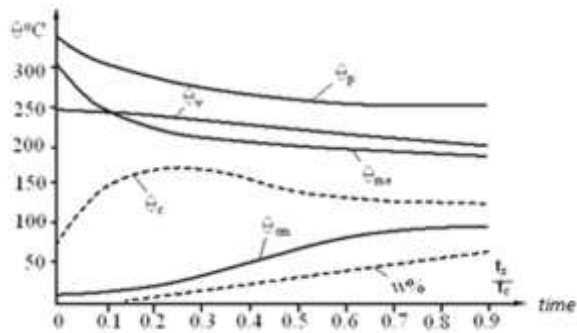


Figure 1. Diagram of the rudimentary baking regime

In the modern baking mode, the first step of the baking process involves steaming the products (steam jet spraying) without irradiation, heating the upper surface by only the heat of condensation of the water vapor.

At this stage, the temperature of the baking medium is  $\Theta_{me}=160\div 180^{\circ}\text{C}$ , and the heater temperature is high, the products receive the heat through the bottom.

After the first 3 minutes, the temperature of the upper shell is relatively small due to the condensation evaporation, keeping it plastic, deformable without cracks or cracks.

On the way the temperatures increase, and in the end the heating is reduced and the formed shell decreases its temperature.

The following pictures show Innovatest Impact TH-1100 hardness testing device and its components [5,6].

The tests were carried out on a sample of two loaves of bread, wheat flour, white baked in both the electric furnace and the traditional furnace, and measurements were made at every 60 minutes for 24 hours, using a hardness tester, Innovatest Impact TH-1100, a portable digital tester, operating in accordance with the method of rebound, standardized according to ASTM A956.

The characteristics of TH-1100 Hardness Impact Innovatest are shown in the following chart.

It's compact design enables easy testing on component surfaces which are difficult to transport or difficult to access by other hardness tester.

This tester operates on different hardness scales such as Rockwell, Brinell, Vickers, Shore, Leeb's and the test results appear directly on the screen.

Also, testing may be performed at any angle, even in difficult positions.

Other benefits include: LCD screen, battery capacity on the screen, Li-Ion rechargeable battery, simple handling without wires, reduced testing costs.



Figure 2. Tester, Innovatest Impact TH-1100

Table 1. The characteristics of Innovatest Impact TH-1100 hardness tester

Nr. Crt.	Characteristics	Values
1	Measuring range	190~960 HLD
2	Measuring direction	360°
3	Hardness scales	HL, HB, HRA, HRB, HRC, HV, HS
4	Display	112x48 dot matrix LCD
5	The range of impact	1~9 (optional)
6	Charger	6V/400mA
7	Time of work	>8 h
8	Charging time	2~3 h
9	Power	3,7 W
10	Dimensions	145x35x30 mm
11	Mass	130 g.

### 3. Results and discussion

For testing, the hardness testing device has been set on Brinell hardness scale, one of the most common hardness testing methods used for testing materials with hardness below 350 HB. It was determined the hardness of the upper crust bread baked in a electrical oven and traditional oven too. Test results are shown in Table 2.

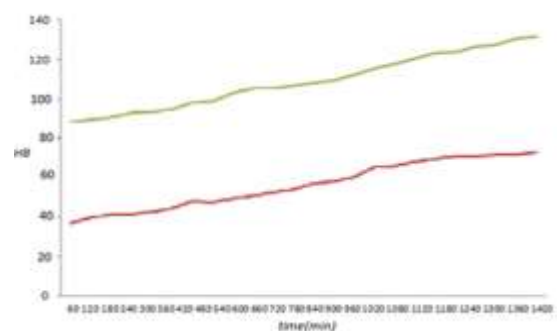


Figure 3. Shows the evolution of bread crust hardness make in electric oven and traditional oven

Table 2. The final experimental results

Nr. crt.	Time (h)	HB Electrical oven	HB Traditional oven
1	60	37	88,5
2	120	40	89,5
3	180	41	90,5
4	240	41,5	93
5	300	42,5	93,5
6	360	44,5	95
7	420	48	98
8	480	47,5	99
9	540	49,5	103
10	600	51	105,5
11	660	52,5	105,5
12	720	54	106,5
13	780	57	108
14	840	58	109,5
15	900	60,5	112
16	960	65,5	115,5
17	1020	66	117,5
18	1080	68	120,5
19	1120	69,5	123
20	1180	71	123,5
21	1240	71	126,5
22	1300	71,5	127,5
23	1360	72	130,5
24	1420	73	131,5

#### 4. Conclusions

As expected, the crust hardness of bakery products obtained in resistance heated electric stoves is lower than the products obtained in a traditional oven.

Ovens heated with electric resistance, due to the possibility of controlling the temperature and steam system, will lead to obtaining higher quality bakery products being substituted for other types of furnaces.

When using these layered wall ovens efficiency will increase depending on the number of layers and materials in construction [3].

**Compliance with Ethics Requirements.** Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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