THE SUPERIOR USE OF CEREAL RESOURCES FOR THE OBTAINING OF THE DIETETIC BAKERY PRODUCTS
Baking of bakery products with barley flour addition

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ABSTRACT: The utilization of a well-proportioned mixture of wheat flour and barley flour, allows the obtaining of dietetic bakery products, with a reduced content of gluten, wealthy in fiber and in B and PP vitamins. The most propitious dough can be obtained of 12 % barley flour of total mixture, when baking temperature is 180 °C and baking time is 35 minutes. In these conditions the acidity degree is 3.8 and the Core / Crust ratio is 1.2.

KEYWORDS: barley flour, bakery products, baking process.

RESUME: L'utilisation d'un mélange bien proportionne de farine de blé et de farine d'orge permet l'obtention des produits de panification diététiques avec une teneur réduite de gluten, riche en fibre et vitamines du complexe B et vitamine PP. Une pâte optimale on peut obtenir par 12 % farine d'orge par mélange total quand la température de cuire est 180 °C et la durée de cuire est 35 minutes. Dans ces conditions le degré d'acidité est 3,8 et le rapport Mie / Croûte est 1,2.

MOTS CLE: farine d'orge, produits de panification, processus de cuire.

THEORETICAL CONSIDERATIONS

The transformation of dough in finite product is the result of a complex process: physical, chemical, and biochemical, colloidal, microbiological and thermal. The transformation of dough in finite product is due to the obtaining of crust and core and to the volume increase and the humidity modification [1].
The superficial layers of dough from which the crust bread is formed, are heated rapidly, exceeding in short time the 100 °C temperature and trying to reach the temperature of oven environment [2].
In dough the humidity is removed by two mechanisms:

- *Spreading*, due to the humidity difference between two neighboring layers and it takes place from the layer with high humidity to the layer with low humidity.
- *Thermo spreading* due to the temperature difference between two neighboring layers and it takes place from the layer with high humidity to the layer with low humidity.

In the baking period the exterior layers of dough lose the water and are transformed in crust [3,4].
The formation of crust is not constant during the baking period. First, when the humidity from external layers migrates to the inside due to the difference of temperature and humidity, the thickness increases. During the baking process the proteins are coagulated due to the breaking of no covalent bond that maintain the wrap up aspect and due to the intermolecular hydrophobic bond. After coagulation the proteins are easily attacked by the action of proteolysis enzymes. The starch jellifies due to heating and to water that is freely from the coagulation of proteins. The jellying is not uniform in the mass of dough. It is produced step by step from the superficial layers to central layers, during heating [5].
In the baking period the features of dough are continuously modified. Beginning with 60 °C the elasticity of dough increases and the compressibility decreases. At this temperature begins the colloidal process that means it is a tight bundle between the temperature and the core. The biochemical process that began in the kneading process continues during the baking [6].

MATERIALS AND METHODS

This program presents the use of barley flour for obtaining bakery products, with dietetic utilizations, especially for persons that have gluten intolerance.
For achievement the research it was used a program in rotator-centered system by second degree with two independent variables that are considered as technological parameters necessary for the baking process:

- X_1 – baking temperature,
- X_2 –baking duration.

During the baking was tested a dough obtained using the following recipe:

- A mixture of wheat flour 800 type (88 %) and barley autumn flour (12 %),
- Water, 50 ml at 100 g mixture,
- Compressed dregs, 5 % mixture,
- NaCl, 2.25 % mixture,

- Kneading duration, 10 minutes,
- Fermentation duration, 35 minutes,
- Fermentation temperature, 35 °C.

The variation of independent parameters is shown in table 1, and the experimental program in table 2.

Table 1. Experimental conditions

Independent variables	x_i	Codified values			
		-1	0	1	Δx
		Real values			
Temperature, °C	X_1	180	200	220	20
Duration, minutes	X_2	32	35	37	2

Table 2. Experimental program for baking dough

No	X_1 Temperature °C		X_2 Duration, minutes		Acidity degree	H/D	Core / Crust	Core / Bread
	Codified	Real	Codified	Real				
1	-1	180	-1	33	3.9	0.34	1.7	0.22
2	-1	180	0	36	4.1	0.42	1.9	0.38
3	-1	180	1	39	4.3	0.37	1.6	0.29
4	0	200	-1	33	4	0.47	2.1	0.42
5	0	200	0	36	4.2	0.48	2	0.30
6	0	200	1	39	4.5	0.39	2.4	0.35
7	1	220	-1	33	4	0.31	2	0.29
8	1	220	0	36	4.2	0.27	1.8	0.27
9	1	220	1	39	4.7	0.25	1.5	0.28

RESULTS AND DISCUSSIONS

For obtaining a recipe necessary for the baking of dough with an addition of barley flour the acidity was chosen as independent variable. The acidity is formed of initial acidity of raw materials and the acidity gained in the biochemical reactions. The interpretation of results was realized in the graphical shape by particularization of the general regression equation.

$$y = b_0 + b_1x_1 + b_2x_2 + b_{12}x_1x_2 + +b_{11}x_1^2 + b_{22}x_2^2 \quad (1)$$

Table 3. Regression equations for dependent variables

Dependent variable	Regression equation
Acidity, degree	$Y = 4,2+0,1x_1+0,26x_2+0,075x_1x_2-0,03x_1^2-1,3x_2^2$
Ratio H/D	$Y = 0,36-0,05x_1-0,01x_2-0,022x_1x_2-0,12x_1^2+0,26x_2^2$
Ratio core /crust	$Y = 1,8+0,016x_1-0,05x_2-0,1x_1x_2-0,41x_1^2-0,02x_2^2$

In the programming of experiences was determined the square average deviation σ = 0.15, admitted in appreciation of central system. In the figures 1, 2, 3, 4, was represented the acidity variation of core, the core / crust ratio, the core / bread ratio and height / diameter ratio. For dough with 12 % addition of barley flour the parameters that influence the quality of the finished product, are the temperature and the duration of baking. That explains that the core acidity is maxim for dough with 12 % addition of barley flour, duration of 35 minutes and a temperature of 180 °C. It is enough for the achieving of a complete baking process.

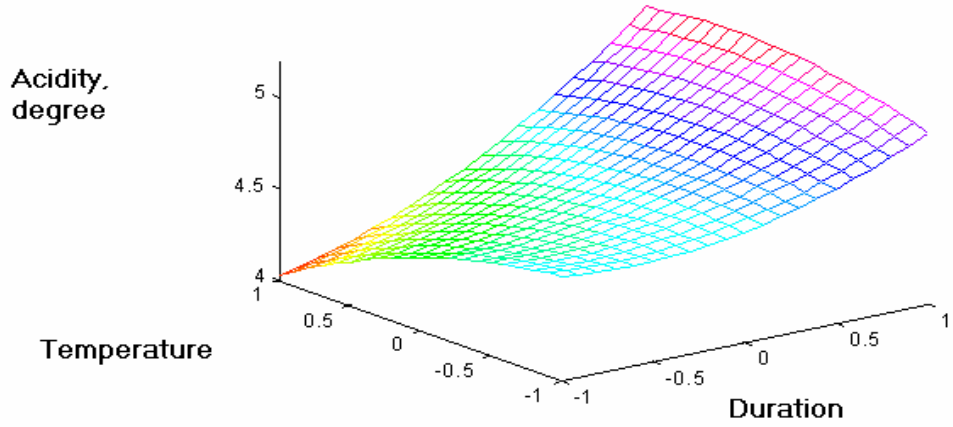

Fig.1. The variation of core acidity at the bread with barley flour addition, after baking, depending on the temperature and the baking duration.

At a dough with 12 % addition of barley flour, when the temperature increase from 180 °C to 220 °C, the acidity core decrease until to 4-grade acidity (Figure 1).
When the baking temperature of dough with barley flour addition has a value of 220 °C, the height / diameter (H/D) ratio is minimum. A maximum value is obtained in the conditions of 12 % barley flour addition (Figure 2).
The core / crust ratio decreases when the temperature and baking period increase. The increase of baking temperature to 220 °C will negatively influences the core content (Figure 3).
When the baking temperature is 200-220 °C and the baking duration is 35 minutes the core / bread ratio is minimal (Figure 4).

CONCLUSIONS

The barley flour with reduced gluten content is a solution for obtaining dietetic bakery products with a great content of fibers. The persons with gluten intolerance use it.
The following recipe is necessary in order to obtain the bakery products with functional qualities: wheat flour type 800, 94 – 97 %, barley flour, 3 – 6 %, fermentation duration 35 minutes and fermentation temperature 30 – 35 °C. When the temperature increases

from 180 °C to 220 °C the acidity core decreases for dough with 12 % barley flour. The acidity core decreases when the fermentation duration increases from 32 to 37 minutes. The core / bred ratio is maximal when the temperature and the baking duration are minimal, respectively: 180 °C and 32 minutes. We consider necessary the impact studies for person's response at this agglutinin dietetic product.

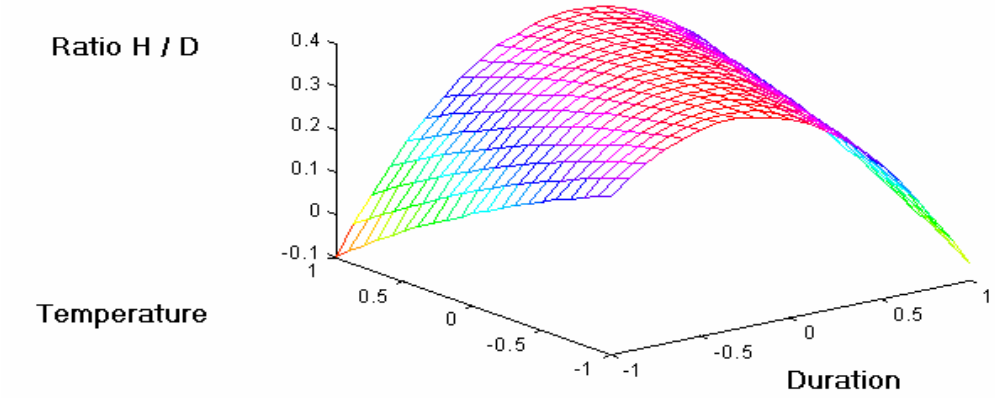

Fig.2. The variation of height / diameter (H/D) at the bread with barley flour addition, after baking, depending on the temperature and the baking duration

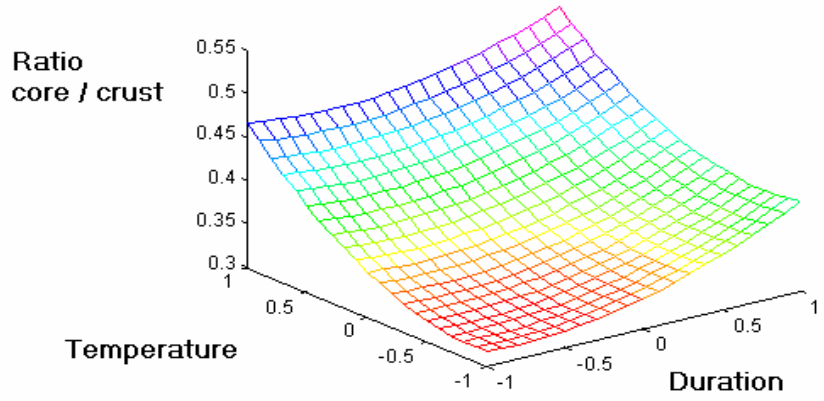

Fig.3. The variation of core / crust ratio at the bread with barley flour addition, after baking, depending on the temperature and the baking duration.

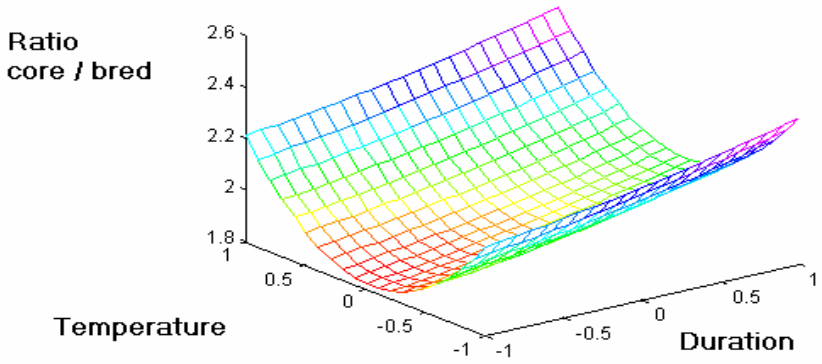

Fig.4. The variation of core / bred ratio with barley flour addition, after baking, depending on the temperature and the baking duration

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