

CONTRIBUTIONS REGARDING THE USE OF WHEAT CHAFF AND WHEY IN THE BAKERY PRODUCTS INDUSTRY

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ABSTRACT: The research program done to obtain bakery products with wealthy fibres content was achieved through the use of wheat chaff, secondary product of wheat flour technology.

It was used the whey, secondary product of milk industrialization, for bettering of technological parameters.

KEYWORDS: *whey, wheat chaff, bakery products*

THEORETICAL CONSIDERATIONS

The wheat chaff has a great use in the preparation of dietetic products with increased vegetable fibers content [1]. The wheat chaff addition in the dough kneading process establishes the increase of kneading resistance [2].

The chemical composition of wheat chaff is: proteins 8.5 %, lipids 4 %, vitamins (PP, B complex), and mineral substances [3].

The research about the use of wheat chaff in bakery products constitutes a complex program to obtain bread with increased fibers content and whey [4]. The whey has a positive influence on the technical and economical parameters of the process [5].

MATERIALS AND METHODS

The experimental program was conceived in a centered compound system by second degree, with four independent variables and 31 experiments (table1).

Table 1. Experimental conditions

Independent variables	X _i	Codified values					
		-2	-1	0	1	2	Δx
		Actual values					
Wheat chaff, (%) reported to mixture flour	X ₁	0	3	6	9	12	3
Whey, (%) reported to mixture flour	X ₂	20	25	30	35	40	5
Duration of fermentation, (minutes)	X ₃	56	58	60	62	64	2
Temperature of fermentation, (°C)	X ₄	26	28	30	32	34	2

The raw materials and the conditions used in the program were:

- ✓ Wheat flour type 650;
- ✓ Water and whey, 50 % reported to the whole mixture of wheat flour and wheat chaff;
- ✓ NaCl 1.5 %;
- ✓ Bakery dregs 3 %;
- ✓ Kneading duration of dough, 10 minutes.

The experimental program is reproduced in table 2.

RESULTS AND DISCUSSION

The independent variables were chosen to establish a recipe for obtaining dough with wheat chaff and whey. The interpretation of results was achieved through regression equation particularized of general equation:

$$y = b_0 \pm b_i x_i \pm b_{ij} x_i x_j \pm b_{ii} x_i^2$$

The regression equations are reproduced in table 3.

Table 3. Regression equations for dependent variables at dough fermentation

Dependent variable, y _i	Regression equation
Acidity degree, ml NaOH N/1	$Y = 3.2 - 1.14x_1 + 0.028x_2 + 0.18x_3 + 1.19x_4 - 1.36x_1x_2 - 0.84x_1x_4 + 0.28x_3x_4 - 0.43x_1^2 + 0.15x_2^2$
Dough deformation, %	$Y = 20.14 - 1.76x_1 + 0.07x_2 + 0.43x_3 + 1.04x_4 - 0.23x_1x_2 - 0.34x_1x_3 - 1.14x_1x_4 + 0.46x_2x_3 + 0.82x_1^2 - 0.15x_2^2 + 0.14x_4^2$
Final temperature of fermentation, °C	$Y = 31.12 - 0.03x_1 + 0.15x_2 - 1.28x_3 + 1.12x_4 + 0.65x_1x_2 + 0.14x_1x_4 - 0.43x_1^2 + 1.02x_4^2$
Humidity, %	$Y = 41.2 - 1.14x_1 - 0.15x_2 + 0.02x_3 + 0.72x_4 + 0.12x_1x_2 - 0.48x_1x_4 - 0.43x_1^2 + 1.02x_4^2$
Appearance, marks by 1 to 5	$Y = 2.5 - 0.88x_1 + 0.42x_2 + 0.55x_3 + 1.12x_4 - 1.5x_1x_2 + 0.14x_2x_3 + 0.28x_3x_4 - x_1^2 - 0.43x_4^2$

Table 2. Experimental program for dough fermentation

No.	X ₁ = wheat chaff %		X ₂ = whey ml		X ₃ = duration minutes		X ₄ = temp. °C	
	Codi- fied	Real	Codi- fied	Real	Codi- fied	Real	Codi- fied	Real
1	-1	3	-1	25	-1	58	-1	28
2	1	9	-1	25	-1	58	-1	28
3	-1	3	1	35	-1	58	-1	28
4	1	9	1	35	-1	58	-1	28
5	-1	3	-1	25	1	62	-1	28
No.	X ₁ = wheat chaff %		X ₂ = whey ml		X ₃ = duration minutes		X ₄ = temp. °C	
	Codi- fied	Real	Codi- fied	Real	Codi- fied	Real	Codi- fied	Real
6	1	9	-1	25	1	62	-1	28
7	-1	3	1	35	1	62	-1	28
8	1	9	1	35	1	62	-1	28
9	-1	3	-1	25	-1	58	1	32
10	1	9	-1	25	-1	58	1	32
11	-1	3	1	35	-1	58	1	32
12	1	9	1	35	-1	58	1	32
13	-1	3	-1	25	1	62	1	32
14	1	9	-1	25	1	62	1	32
15	-1	3	1	35	1	62	1	32
16	1	9	1	35	1	62	1	32
17	-2	0	0	30	0	60	0	30
18	2	12	0	30	0	60	0	30
19	0	6	-2	20	0	60	0	30
20	0	6	2	40	0	60	0	30
21	0	6	0	30	-2	56	0	30
22	0	6	0	30	2	64	0	30
23	0	6	0	30	0	60	-2	26
24	0	6	0	30	0	60	2	34
25	0	6	0	30	0	60	0	30
26	0	6	0	30	0	60	0	30
27	0	6	0	30	0	60	0	30
28	0	6	0	30	0	60	0	30
29	0	6	0	30	0	60	0	30
30	0	6	0	30	0	60	0	30
31	0	6	0	30	0	60	0	30

The value of average square deviation $\sigma = 0.15$ justifies the correctness of research program (fig. 1 - 9).

The acidity degree depends on the wheat chaff adding and whey. It increases until 4.5 – 5 when the whey adding is 40 % and wheat chaff adding is 6 – 9 % (fig. 1 - 3).

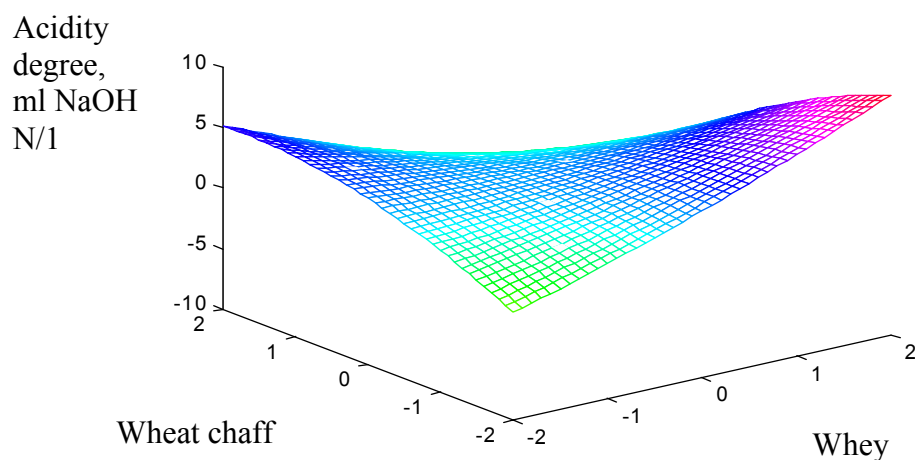


Fig.1. Acidity degree variation of dough made of wheat flour and wheat chaff mixture and whey, when the temperature and duration are constantly in central domain (30 °C, 60 minutes)

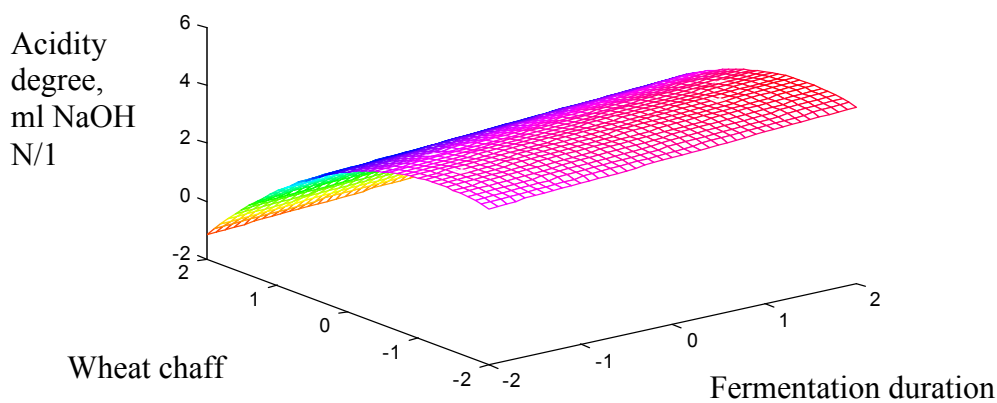


Fig.2. Acidity degree variation of dough made of wheat flour and wheat chaff mixture and whey, when whey adding and temperature are constantly in central domain (30 %, 30 °C)

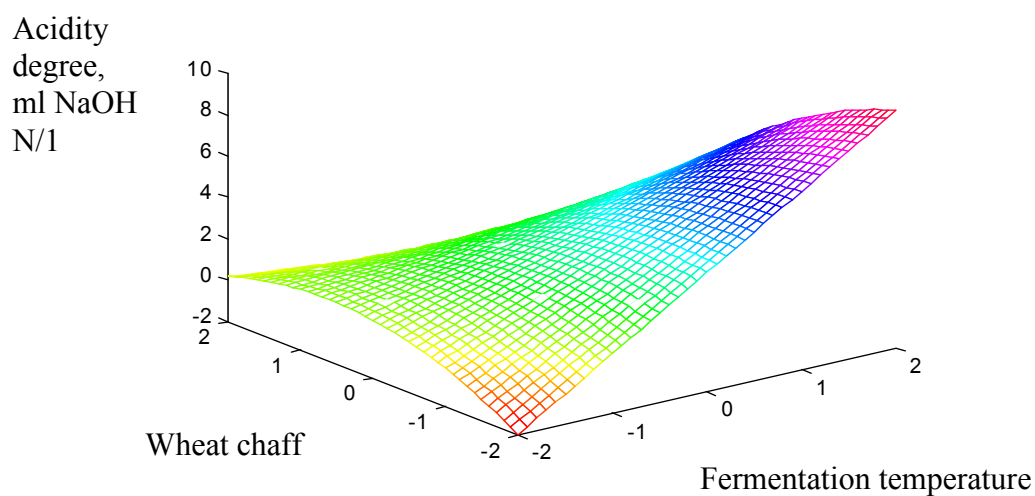


Fig.3. Acidity degree variation of dough made of wheat flour and wheat chaff mixture and whey, when whey adding and duration are constantly in central domain (30 %, 60 minutes)

In the same technological conditions is remarkable the dough growth until 25 – 26 % (fig. 4, 5).

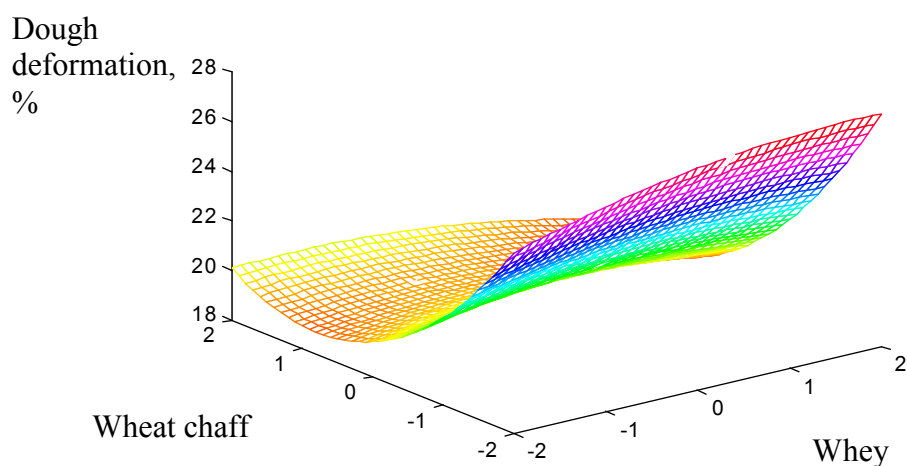


Fig.4. Dough deformation variation of dough made of wheat flour and wheat chaff mixture and whey when the temperature and duration are constantly in central domain (30 °C, 60 minutes)

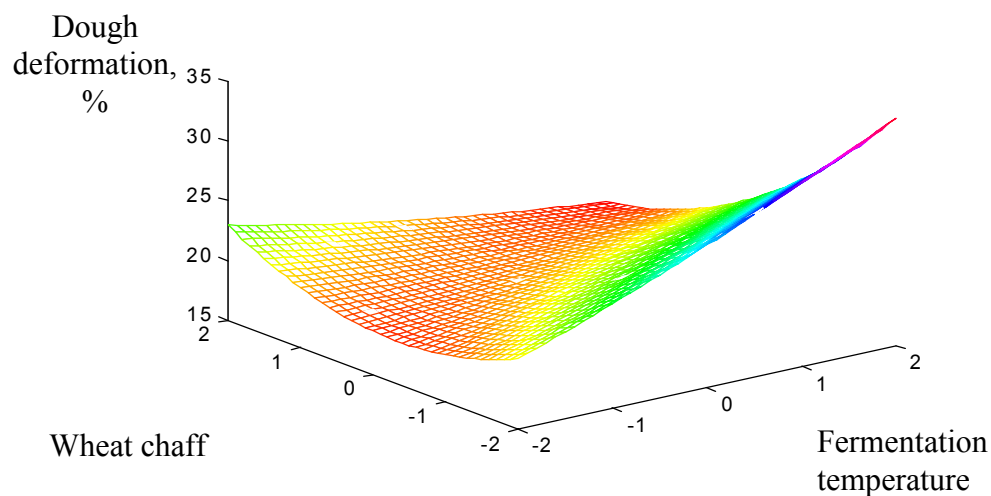


Fig.5. Dough deformation variation of dough made of wheat flour and wheat chaff mixture and whey, when the whey adding and duration are constantly in central domain (30 %, 60 minutes)

Also, the humidity content is 40 – 41 % and the final temperature of fermentation is 32 – 36 minutes. This value has constant limits for whey and fermentation duration.

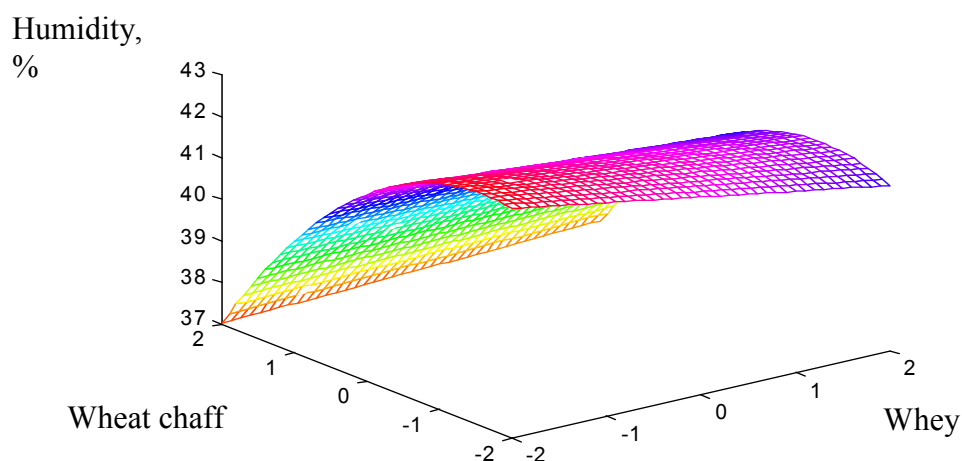


Fig.6. Humidity variation of dough made of wheat flour and wheat chaff mixture and whey, when duration and temperature are constantly in central domain (60 minutes, 30 °C)

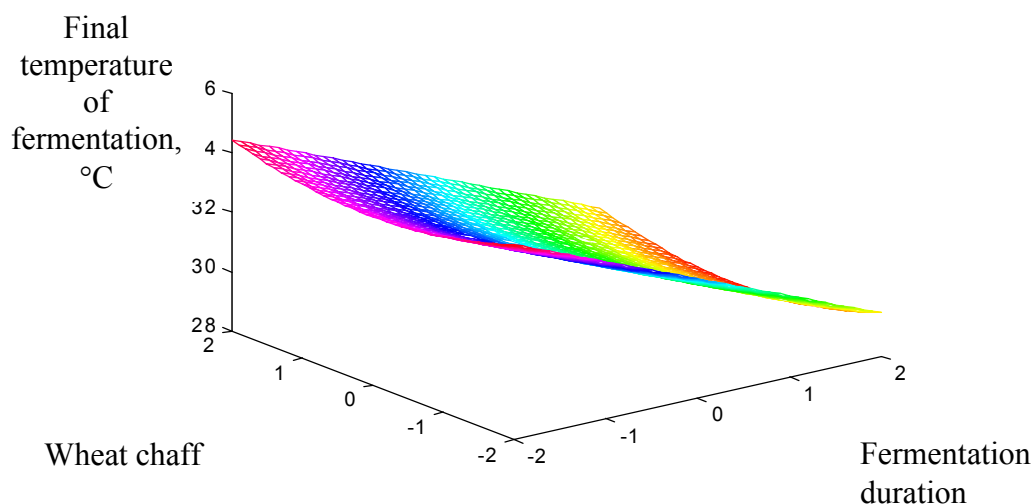


Fig.7. Final temperature variation of dough made of wheat flour and wheat chaff mixture and whey, when the temperature and whey adding are constantly in central domain (30 °C, 30 %)

The dough appearance is reproduced through marks (table 4).

Table 4. Dough appearance

Qualities assessment of dough	Marks
<ul style="list-style-type: none"> ▪ sticky, ▪ non-homogeneous, ▪ non-uniform pores, ▪ unspecified smell 	1.0 – 2.0
<ul style="list-style-type: none"> ▪ homogeneous, ▪ elastic, ▪ normal firmness 	2.0 – 3.0
<ul style="list-style-type: none"> ▪ homogeneous, ▪ elastic, ▪ non-sticky, ▪ specified smell 	4.0 – 5.0

The influence of conditions about dough appearance is reproduced in figures 8, 9. Dough with a good appearance can be obtained when wheat chaff adding is 6 – 9 % and whey adding is 40 %.

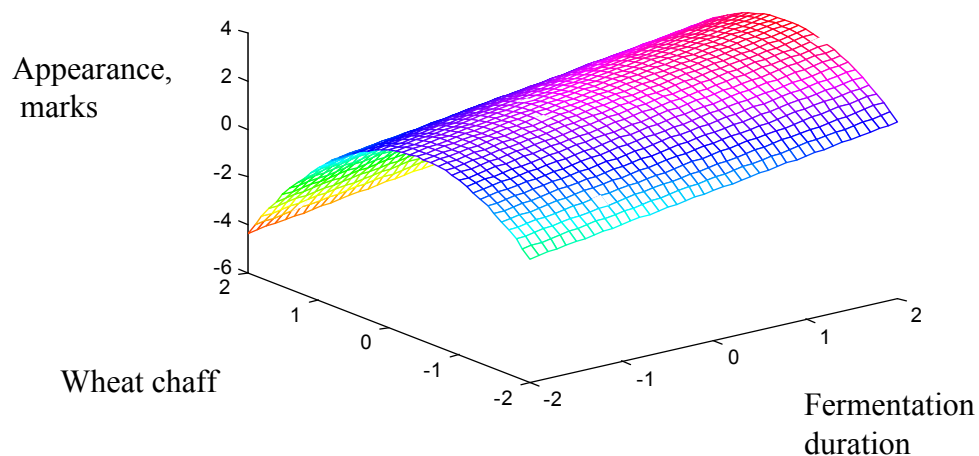


Fig.8. Appearance variation of dough made of wheat flour and wheat chaff mixture and whey, when the whey adding and temperature are constantly in central domain (30 %, 30 °C)

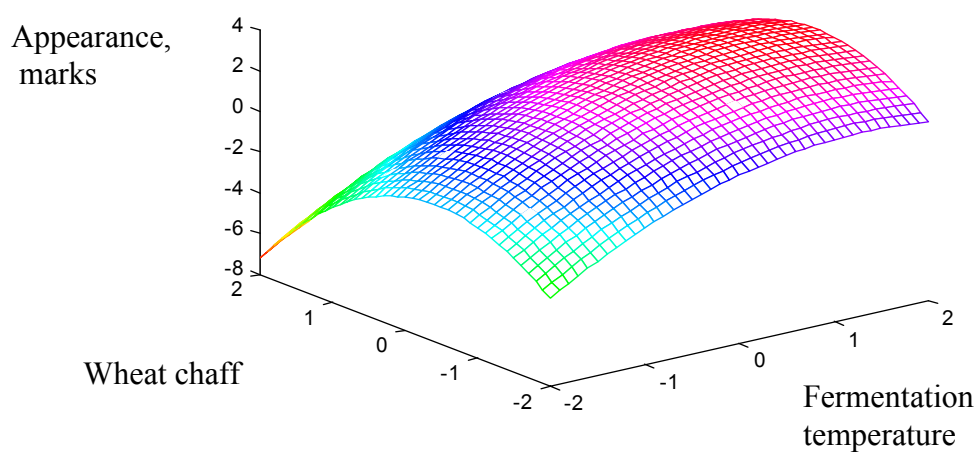


Fig.9. Appearance variation of dough made of wheat flour and wheat chaff mixture and whey, when the whey adding and duration are constantly in central domain (30 %, 60 minutes)

CONCLUSIONS

A 6 – 9 % wheat chaff adding and 40 % whey adding contributes to obtain dough suitable with the standards for bakery products.

Also, the fermentation duration of dough is 62 – 64 minutes and fermentation temperature is 32 – 36 °C.

The whey adding has a positive influence about dough quality and a technical and economical efficiency through substituting water with whey, secondary product of milk industry.

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