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The effect of incorporation of red lentil flour on the bread quality

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Abstract

Lentil, part of the *Leguminoseae (Papilonaceae, Fabaceae)* family and originary from Central Asia, has been known as an important food since prehistoric times. According to scientific literature, lentil is a functional food, especially due to its high content in proteins and fibers.
In this paper we aimed to optimize the addition of red lentil flour in white bread with the purpose to fortify this type of bread and improve its sensory properties (colour, taste, flavour, texture). We used three experimental variants introducing red lentil flour in different proportions 12%, 25% and 40%. The sensorial, physical and chemical analyses have noted that content up to 12% of red lentil flour doesn't modify adversely these parameters and does not raise technical issues. This result is in conformity with data found in scientific literature.

Keywords: bread quality, red lentil flour, chemical composition

1. Introduction

Industry of bakery and farinaceous products occupies an important place in the production and market consumption, primarily because the bread is a staple food that is consumed daily [1].

Legume flours, due to their amino acid composition and fibre content, are ideal ingredients for improving the nutritional value of bread and bakery products [2].

There are numerous protein-calorie malnutrition problems over the world. Legumes may be helpful in solving this problem. Legume crops have rich content in essential amino acids, particularly in lysine. It has been demonstrated that legume protein is the natural protein suitable to complement the protein content present in cereals grains and on the other hand, legume grains are an important part of human diet [3]. That legumes are helpful in enhancing the protein content. Legumes have been considered a rich source of protein throughout the world and contain approximately three times more proteins than cereals [4,5]. Legumes represent, together with cereals, the main plant source of proteins in human diet. They are also generally rich in dietary fibre and carbohydrates [6]. Minor compounds of legumes are lipids, polyphenols, and bioactive peptides [7]. Legumes including lentil, beans and chickpea are important crops because of their nutritional quality. They are rich sources of complex carbohydrates, vitamins and minerals [2,8].

Lentils are believed to originate from central Asia, having been an important food since prehistoric times and are one of the first foods to have ever been cultivated.

Lentils are part of the *Leguminoseae (Papilonaceae, Fabaceae)* family, the *Lens* genus and we are encouraged to include them in our nutrition by the Food Guide Pyramid U.S.A. due to their high content in fiber and protein and also because of their functional properties. Seeds can be fried and seasoned for consumption; flour is used to make soups, stews purees, and mixed with cereals to make bread and cakes, and as a food for infants [9].

Lentil (*Lens culinaris* Medik) is one of the most important crops with 4.4% protein, 1.8 oil, 41-50.8%

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carbohydrates, 21.4 % fibers, high percentage of other mineral nutrients and unsaturated linoleic and oleic acid for human consumption [10,11]. Starting from these observations, this paper's goal is to obtain new bakery products, with high nutritional value given by the additions of red lentil flour by two objectives: (1) to establish the optimal recipes of bakery products with addition of red lentil flour and (2) to determine the maximum markups of the new ingredient in different proportions (12%, 25% and 40% red lentil flour) in order to obtain bread with good quality characteristics.

2. Materials and Methods

2.1. Materials. All raw materials used in these experiments have been purchased from markets or specialized stores.

2.2. Chemical determinations of flour. Nitrogen content was determined using Kjeldahl method and was multiplied by a factor of 5.7 to (SR ISO 1871/2002). Moisture content was determined by drying the samples at 105°C to constant weight. All the determinations, moisture, hydration capacity, gluten contents, deformation index, expansion index, acidity degrees, as well as nitrogen were determined according to the official methods (STAS 90-2007).

2.3. Experimental program. For the experimental program, there were done three baking tests and a blank test. The blank test didn't contain red lentil flour, while in the others tests, red lentil flour content grew progressively (as seen in Table 1).

Table 1. Experimental program

Sample	**1**	**2**	**3**	**4**
Red lentil flour (% reported to wheat flour)	0	12	25	40

For each test the following ingredients were maintained constantly:

- flour type 550 – 1000 g;
- compressed yeast - 3 % reported to flour;
- salt – 1,5 % reported to flour;

The straight method, consisting of a single stage, was used for the dough preparation.

After the bulk-fermentation period, the dough was divided into two equal parts, it was shaped and baked. The parameters of the technological process were: kneading 10 - 12 minutes/28ºC, fermentation 40 - 60 minutes/30ºC, final proofing 20 - 30 minutes at 30ºC baking 30 - 40 minutes at 200 - 220ºC.

2.4. Bread sensory analysis. The bread obtained after the above described method was submitted to the sensory exam in order to asses the following characteristics: the external appearance, crumb state, aspect, flavor, taste and microbial alteration signs (according to STAS 91 -2007 *„Bread, loaf products and bakery specialties. Analysis methods*") [14].

*2.5. Bread physico-chemical analysis.*In order to establish the optimal conditions for the bread technological process, regarding the lentil flour addition at different levels, it had been studied the following physical-chemical and quality parameters: humidity, [%], elasticity [%], porosity [% vol.], acidity degree, and salt content. The analyses were performed after methods described by STAS 91 - 2007.

3. Results and Discussion

Physicochemical characteristics of flour. The chemical constituents of wheat flour and of flour mixtures obtained by adding red lentil flour (LF1, LF2 and LF3) are shown in table 2.

Table 2. Physicochemical characteristics of wheat flour and wheat-red lentil flour blends

Parameter	Wheat flour	Wheat – red lentil flour blends		
		LF1	LF2	LF3
Moisture,%	13.8	13.2	12.0	11.3
Hydration capacity, %	60.8	60.98	62.57	65.74
Gluten contents, %	35.2	33.6	31.6	29.8
Deformation index, mm	5	5	6	6
Expansion index, cm	30	32	38	45
Acidity degrees	2.2	2.4	2.9	3.4
Crude protein,%	11.5	14.8	15.7	17.9

**Data represent means values for three independent replications*

Table 3. Red lentil flour supplemented bread sensory features

Analysed sensory feature	Recorded sensory features
Aspect	- shiny, developed surface, without flattening, without cracks;
Color	- reddish brown, characteristic to the analyzed assortment;
Appearance to the core	- the crumb is characteristic to the analyzed assortment; - uniform, with fine pores, no gaps greater than 2 × 3 cm; - elastic, when easy pressed accrues to the initial shape, well baked crumb.
Taste and flavor	- pleasant, aromatic, characteristic to well baked product
Microbial alteration signs	- upon bursting no mucilaginous filaments are formed

Red lentil flour supplemented bread physico-chemical evaluation

The results interpretation through graphic representation have permitted to obtain certain information concerning the optimal red lentil flour addition. The experimental influence of lentil flour addition on studied characteristics of bread are graphically presented in figure 1 – for bread humidity, in figure 2 – for bread acidity, in figure 3 4 – for bread elasticity and porosity, and in figure 4 5 for final crude protein.

Figure 1 shows that bread humidity linearly increases with increasing amount of lentil flour added; a good linear correlation (R = 0.9023) between BU (bread humidity) and LF (lentil flour added) was recorded.

$$BU\ (\%) = 40.08 + 0.1282 \cdot LF \qquad (1)$$

Also, by analyzing figure 2, a very good linear correlation (R = 0.9500) between the bread acidity (BA) and the amount of lentil flour added could be observed. The explanation of this behavior derives from the high fiber and mineral contents of the red lentil flour as well as due to unsaturated linoleic and oleic acid also found in this flour. Mathematically, this increasing dependence can be described with the linear function 2:

$$BA\ (\%) = 2.07 + 0.016 \cdot LF \qquad (2)$$

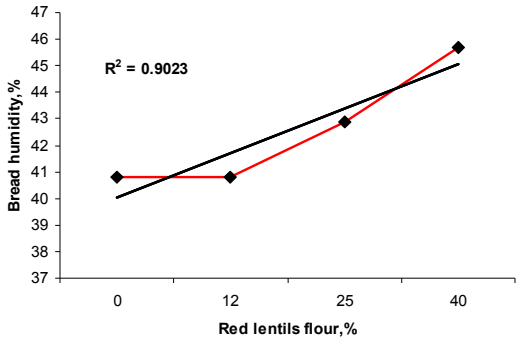

Figura 1. The influence of lentil flour addition on bread humidity.

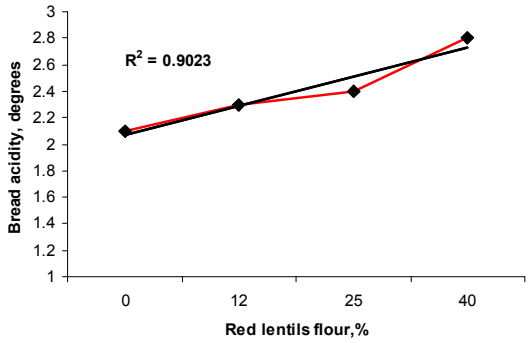

Figura 2. The influence of lentil flour addition on bread acidity

It can be observed from figure 3 that the lentil flour addition has a negative influence on the bread's crumb elasticity; also, the crumb porosity is uneven, decreasing in parallel with raising the lentil flour addition.

Very good linear correlations (R = 0.9530) for porosity (P), (R = 0.9159) and for elasticity (E) with the amount of lentil flour added (LF) were found; these correlations are described by equations 3 and 4:

$$P\ (\%) = 70.1022 - 0.6780 \cdot LF \quad (3)$$

$$E\ (\%) = 97.2501 - 0.3753 \cdot LF \quad (4)$$

In figure 4 it can be observed that the crude protein increases with lentil flour addition. Also a good linear correlation (R = 0,9538) between crude protein content (CP) and the amount of lentil flour added (LF) was found:

$$CP\ (\%) = 12.4367 + 0.1928 \cdot LF \quad (5)$$

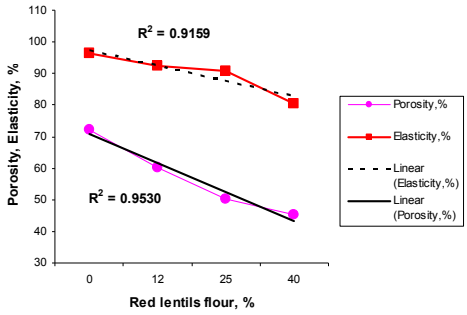

Figura 3. Relationship between bread's elasticity, porosity and lentil flour content

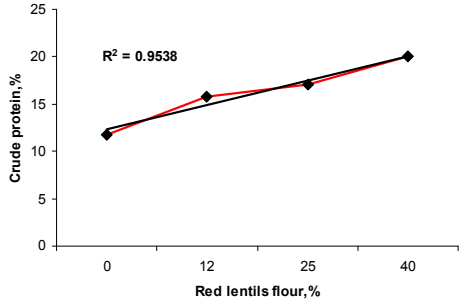

Figura 4. The influence of lentil flour addition on crude protein

4. Conclusion

Lentil flour is a common and important ingredient of a new generation of healthy food products. Lentil flour increases the nutritional value of bread but at the same time alters rheological properties of dough and, finally, the quality and sensorial properties of bread.

The sensorial, physical and chemical analyses have noted that content up to 12% of red lentil flour doesn't modify adversely these parameters and does not raise technology issues.

The recommended recipe following the observations drawn from this study is: 88% wheat flour, 12% red lentil flour, 3% addition of yeast and 1,5% NaCl (relative to the total amount of flour), kneading duration 10 minutes, fermentation time of 60 minutes at 30 °C, the dough baking: 40 minutes, the dough baking temperature: 220° C.

Also, by correlating the results obtained it can be appreciated that established recipe from this study can be successfully applied on an industrial scale, therefore achieving valuable products in terms of both nutrition and technology.

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 and/or animal subjects (if exists) respect the specific regulations and standards.

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