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# Studies regarding the obtaining of some bread varieties with a high content of dietary fiber

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***Abstract***

The Rediscovering the influence of food on health status has led to reorientation of consumer to a rational, healthy nutrition, and the appearance of functional foods as food with prevention and improved properties for different medical affections. Common concern for the development of functional foods generates the need to study and use of new food ingredients with a role in maintaining and improving the health. Starting from these considerations this paper aims to obtain some varieties of bread with increased dietary fiber content (wheat bran, oat bran, rice bran, hemp flour) by adding them to the bread dough. Also, were studied the technological implications which were determined by the addition of dietary fiber and how its influence the quality of the final product.

***Keywords***: bread quality, dietary fiber, bran, chemical composition, rheological properties

## 1. Introduction

Industry of bakery and farinaceous products occupies an important place in the production of market consumption, primarily because the bread is a staple food that is consumed daily. Bakery products and pasta, along with the other foods, provides to the human body a significant proportion of substances which are necessary for vital activity, health status maintenance and preservation of work capacity [1].

In this context, currently there is a growing demand for a new generation of healthier food products which at the same time have excellent sensory qualities [2,4]. Therefore, in the perspective of ensuring a healthy diet, scientists have designed and produced wide varied assortments of bakery products.

The diet of developed countries is at present deficient in fiber, which leads to numerous health complications [3].

Clinical trials conducted worldwide in order to reduce these deficiencies, have highlighted at least two reasons why it is recommended to add dietary fiber in bakery and pastry products, namely: the increase of dietary fiber intake and the decrease of the caloric density of baked goods [4]. At the national level has increased the interest for other bakery or pasta products in the detriment of white classical bread, have been registered a growing interest for other specialties than the local traditional products, and in recent years have been promoted functional foods and organic products [4,5].

Depending on the current market segmentation have been appeared two significant trends: one oriented to "convenient" bakery products type (small and convenient to consumers, often pre-packaged and with more durability) characteristic to nutrition of "fast food" type and the other one, opposite, targeted to bakery products fresh, natural or with health benefits, corresponding to a healthier nutrition, eventually of "slow food" type [4].

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Also, current trends in consumer preferences are oriented to products with high whole fibres. In this context the new technological and ecological solutions have lead to the exploitation of products and cereal by-products such as hemp flour, wheat bran, oats and rice products which have a high content of dietary fibre.

Regarding the nutritional value, it is considered that the bran bread is healthier because it contains more fibre, vitamins, antioxidants and is often richer in iron, folate and magnesium than white bread.

In the production of products enriched with dietary fiber, the recipe usually includes bran or bran products (5 ... 35% reported on flour) [2,6,7], depending on the fiber content and product destination. Can be applied manufacturing processes to dough through monophasic or biphasic method, the bran product always is adding in the dough stage and the manufacturing technology system of rich-fibre bread is similar to that of conventional products.

Simultaneously, can be achieved also protein fortification of bread by adding: soy flour, sunflower meal (max. 3 ... 5% depending on the quality of flour).

Excellent results were obtained on the biological value of proteins from cereals using hemp flour bread (recommended dose - max. 5% reported to wheat flour) [8].

Bran products have a higher granularity than flour and the reddish-copper colour gives a pleasant and appetizing products.

Furthermore, bran products absorb a higher quantity of water in kneading stage, water that by evaporation in baking stage may lead to a good loose crumb and crunchy crust of loaf.

Using low-extraction wheat flour (type 500 or 650) provides a more pleasing aspect of products: light background colour, on which are dragged particles uniform distributed. The packaging of these products contributes to maintaining freshness and crunchiness for a longer period [9,10,11].

Wheat bran is used as a supplemental source of dietary fiber for preventing colon diseases (including cancer), preventing gastric cancer, treating Irritable Bowel Syndrome (IBS), reducing the risk of hemorrhoids and hernia, hypercholesterolemia, hypertension, reducing the risk of breast cancer and gallbladder disease, and type 2 diabetes [12]. Wheat bran helps constipation by speeding up the colon and increasing stool output and bowel frequency. Wheat is an excellent source of iron and phosphorous. The outer layer of the barn provides fiber that gives bulk and regulates the absorption and excretion of nutrients from the body [13,14].

Starting from these observations, this paper aim is to obtain new bakery products, with high nutritional properties given by the additions of wheat bran, oats, rice and hemp flour; establishment of optimal recipes of bakery products production with addition of wheat bran, oats, rice and hemp flour and setting maximum markups of new ingredients (wheat bran, oats, rice, hemp flour) that can be added to the bread without affecting their quality.

## 2. Material and methods

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

***2.2. Methods.***

**2.2.1. Analytical methods applied to flours and bran.** Analytical methods used in experiments in order to determine the quality indicators of flour and bran have been the following: *Moisture content, (%) max* - SR 877 – 1996; *Wet gluten, (%) minim* SR EN ISO 21415/1 – 2007; *Water absorption (%)* STAS 90 - 2007; *Deformation index of gluten, (mm)* SR 877 – 1996; *Ash content (%) max* STAS 90 – 2007; *Protein content (%)* – STAS 90 - 2007; *Lipids (%) – STAS 90 - 2007*; *Food fibre (%)* – STAS 90 - 2007; *Carbohydrates (%)* - STAS 90 – 2007.

**2.2.2.Technological process for obtaining fiber *bread.*** The technological process for fibre addition bread obtaining was the common one. The recipe used, was the following one: white wheat flour type 650 - 89%, hemp flour 5%, water - 57%, yeast – 2,5%, salt – 2% and each 6 % for the following bran: wheat bran, oat, rice, also was used in a proportion of 6% a mixture of three types of bran in a rate of 1:1:1. Similarly, a control bread sample without bran addition was performed. After rising, the dough was divided into two equal parts, has been hand-modelled as a loaf and put into tin pans for baking. The optimum parameters of the technological process were: *kneading* 15 minutes/28°C, *fermentation* 40 minutes/35°C, *baking* 20 minutes/220°C and 5 minutes/200°C [1, 6, 15].

**2.2.3.Sensory and physical-chemical evaluation of fiber bread**. Bread samples obtained according to the protocol described in paragraph 2.2.2. were subjected to sensory and physico-chemical examination, aiming: shape, crust aspect, volume, consistence and comparison to mastication, crumb aspect, smell, taste, the product volume, crumb porosity and elasticity, height/diameter ratio, moist and acidity *(according to **STAS 91 -2007** „ Bread, loaf products and bakery specialties. Analysis methods”).*

**2.2.4. Evaluation of rheological characteristics of fiber bread.** From the so obtained bread, a slice of about 3 cm was cut. The slice was cut after 2 hours of room temperature storage. From this slice, samples were taken with a cylinder 3 cm long and 2 cm in diameter. Further, compression tests were performed. For each bread assortment, 3 times each were performed. For the experimental study, a compression JTL Janz apparatus was used. The so obtained samples were compressed with a constant speed to 120 seconds, the compression force being read at every 5 seconds. The obtained data were interpreted in the ORIGINI 7.0. program. Two replicates were analyzed and averaged [1, 6,16,17, 18].

## 3. Results and Discussion

***3.1. Qualiy of wheat flour type 650, of hemp flour and of wheat, oats and rice bran.*** The corresponding values of quality indices and chemical composition of flours and bran used in these experiments are shown in *Tables 1* and 2*:*

***Table 1.*** Chemical composition of wheat flour type 650

| Qualitative indices | Experimental values |
|---|---|
| Moisture, (%) max | 14.2 |
| Acidity, (grade) max | 1.1 |
| Wet gluten, (%) minim | 28 |
| Deformation index of gluten, (mm) | 7 |
| Water absorption (%) | 57 |
| Ash content, (% s.u.) max | 0.64 |
| Protein content, (%) | 11.06 |
| Lipids (%) | 1.3 |
| Carbohydrates (%) | 73.2 |

***Table 2.*** The components with nutritional value of hemp flour and wheat, oats and rice bran

| Components name | Experimental values | | | |
|---|---|---|---|---|
| | Hemp flour | Wheat bran | Oat bran | Rice bran |
| Proteins, (g) | 29.4 | 14.04 | 16.56 | 8.7 |
| Lipids (g) | 8.2 | 4.35 | 6.9 | 2.3 |
| Carbohydrates (g) | 2.2 | 65.06 | 64.20 | 75.1 |
| Fibre (g) | 46 | 12.02 | 16.11 | 7.9 |

By comparing the values obtained for the analyzed samples (**wheat flour type 650, hemp flour, wheat bran, oat bran and rice bran**) with quality standards can be observed that these results fit within the limits of admissibility for all samples.
Summarizing the data presented in the two *Tables* (1 and 2) regarding quality indices and chemical composition of wheat flour, hemp flour and of the three types of bran analyzed can be made the following assessments:

- Wheat flour type 650 used in this experiment due to the wet gluten content of 28%, with a rate of deformation of 7 mm, corresponds to the bakery products purposed;
- Type 650 wheat flour mixed in a proportion of 5% with hemp flour (fibre 46g/100 g product) due to the chemical composition can be used to obtain bakery products with high nutritional values;
- Wheat, oat and rice bran analyzed, due to the high carbohydrate content (64.2 ÷ 75.1g/100 g product) and protein (8.7 ÷ 16.56g/100 g product) can be successfully used for baking without reduce the baking properties of these cereal mixtures;
- Wheat bran due to fibre content of 12.02 g, are highly recommended for use in bakery products regarding their influence on the digestion process.

***3.2. Sensory evaluation of fibre bread.*** The use of well-proportioned mixtures of wheat flour type 650, hemp flour and bran has allowed obtaining of breads with optimal sensory characteristics in accordance with *STAS 91-2007*, rich in dietary fibre and low gluten content. Also, experiments showed a possible correlation between the composition of the dough, working technological parameters and qualitative properties of these breads.

***Table 3.*** Sensory characteristics of fibre bread

| Analysed sensory characteristics | Sensory characteristics observed |
|---|---|
| Product form | - volume proportional to mass specific to assortment; |
| Crust: - aspect | - crunchy |
| - colour | - shiny surface, well-developed, thin crust with slight cracks (1-2mm);<br>- uniform golden-brown, darker than the control sample, characteristic to analyzed assortment; |
| Crumb:<br>- aspect in section | - mass with uniform pores, without lumps or traces of unmixed flour; |
| - colour | - crumb color is characteristic of analyzed assortment; |
| - consistence | - elastic, to gently pressing returns to baseline, dry crumb to the touch, ripe; |
| Taste and flavour | - pleasant, aromatic, characteristic of the ripe product, without foreign odor |

Sensory evaluation of the assortment of bread with fiber obtained in the laboratory was performed using the points scale method, whereby, they have obtained the following qualifications:

***Table 4.*** Scores assigned to high-fiber bread

| Sample | Maximum score | Scores obtained |
|---|---|---|
| Control | 18 | good |
| Bread with addition of 6% wheat bran | 18,5 | good |
| Bread with addition of 6% oat bran | 18,3 | good |
| Bread with addition of 6% rice bran | 19,5 | very good |
| Bread with addition of 6% mixture of bran 1:1:1 | 19,6 | very good |

Based on the scores assigned according to Romanian scoring scale of analyzed breads, it can be seen that, all samples fall into the first two quality categories ("very good" and "good"), but as regards of sensory analysis, assortments of bread with addition of 6% rice bran and 6% mixture of bran are the best. In case of bread with addition of 6% oat bran is observed a decrease in the total score (18.3 points), because the product has uniform crumb porosity with up to 4 goals of 1x2 cm in section, as well the appearance of shell with a rough surface, less glossy.

### *3.3. Physical-chemical evaluation of fiber bread*

After baking, to all samples after sensory examination was performed, has determined volume, porosity, elasticity, height/diameter ratio (H/D), acidity and humidity as STAS 91-2007. Experimental results are shown in *Table 5*:

***Table 5.*** Fiber supplemented bread physic-chemical features

| Analysed physic-chemical features | Witness (S1) | 6% wheat bran supplemented bread (S2) | 6% oat bran supplemented bread (S3) | 6% rice bran supplemented bread (S4) | 6% mixture of wheat, oats and rice bran 1:1:1 (S5) |
|---|---|---|---|---|---|
| Product volume ($cm^3$/100 g product) | 294 | 255 | 252 | 265 | 273 |
| Crumb porosity (% volume) | 86.67 | 78.58 | 75.88 | 80.66 | 84.68 |
| Crumb elasticity (%) | 85.33 | 83.16 | 80.9 | 84.4 | 88.95 |
| Diameter/height ratio (cm) | 0.496 | 0.483 | 0.480 | 0.484 | 0.488 |
| Product moist (%) | 42.65 | 42.47 | 42.21 | 41.76 | 41.16 |
| Product acidity (acidity degrees/100g product) | 1.5 | 1.8 | 1.7 | 1.8 | 1.6 |

**Table 6.** Characteristics of samples from the control bread, bread with wheat bran, oats, rice and bran mixture calculated from compression curves

| Proba | $\varepsilon_E$ | E (kPa) | Firmness (kPa) | L ($J \cdot m^{-3}$) | ρ ($kg \cdot m^{-3}$) |
|---|---|---|---|---|---|
| Control bread | 0.140 | 53.89 | 9.00 | 1457 | 346 |
| | 0.104 | 26.64 | 4.68 | 689.6 | 391 |
| | **0.122±0.025** | **40.27±19.27** | **6.84±3.05** | **1073.3±542.6** | **368.5±31.8** |
| Bread with wheat bran | 0.188 | 19.18 | 4.47 | 617.0 | 381 |
| | 0.106 | 13.21 | 2.80 | 378.9 | 333 |
| | **0.147±0.058** | **16.20±4.22** | **3.64±1.18** | **498.0±168.4** | **357±33.9** |
| Bread with oat bran | 0.139 | 28.62 | 5.52 | 811.8 | 372 |
| | 0.117 | 23.72 | 4.63 | 685.5 | 399 |
| | **0.128±0.016** | **26.17±3.46** | **5.08±0.63** | **748.7±89.3** | **385.5±19.1** |
| Bread with rice bran | 0.172 | 8.44 | 1.96 | 259.4 | 362 |
| | 0.155 | 21.27 | 4.12 | 584.0 | 345 |
| | **0.164±0.012** | **14.86±9.07** | **3.04±1.53** | **421.7±229.5** | **353.5±12.0** |
| Bread with 6% addition of bran mixture 1:1:1 | 0.132 | 17.97 | 3.45 | 488.4 | 384 |
| | 0.164 | 11.73 | 2.61 | 357.7 | 353 |
| | **0.148±0.023** | **14.85±4.41** | **3.03±0.59** | **423.1±92.4** | **368.5±21.9** |

Centralizing the obtained data, we can say that, regardless of bran added, the products obtained were proportional, specific the assortment, volume - visual appreciated - was lower than in case of control sample. Volume of all samples with bran was lower compared with that of control sample, due to low gluten protein content in the dough and implicitly reducing the capacity of dough to withhold the fermentation gases. Another reason for the volume of bread with bran is lower is because the gluten proteins are not hydrated enough, so that the gluten network is formed to a smaller proportion.

Also, the shell coloration is uniform, golden brown – more darkness by the control sample, which has golden yellow shell, due to *Maillard* compounds, but without dark spots caused by burning.

The bread was good increased, without flattening, form was well defined, undistorted, shell surface did not present cracks. The crumb was no crumbly, well-bred, porous (porosity value of bread with bran samples had values between 75.88 % and 84.68 % towards control sample which had a porosity value of 86.67%), unmoist. Regarding the elasticity of crumb samples analyzed *(table 5.),* it was lower for all samples with addition of bran (being between 80,9% and 88,95%) compared to the elasticity of control sample (85,33%), as a result of chemical processes that occur in the dough, and lower protein content, respectively of gluten.

For values of the H/D ratio between 0.4-0.5 it is considered that the volume and shape of bread are corresponding, above 0.5 bread is bulging, and under 0.4 flattened. One can say that by adding bran, bread volume decreased, samples having values in the range 0.480-0.488 cm compared with the control sample (0,496 cm), so however H/D ratio for all samples with addition of bran bread fall within the limits provided by STAS.

The humidity of all samples with addition of fiber was invariably lower than that of control sample, ranging from 42.65% to control sample until 41.16% to sample with addition of 6% mixture of bran, the difference being determined by lower hydration of gluten proteins.

### *3.4. Bread rheological features evaluation*

The bread assortments with added wheat bran, oats and rice and their mixture 6% were submitted to compression tests.

As follows, the tests applied on the various bread assortments, are presented. Experimentally, for the compression, the dependence F =f(t) was obtained. in order to calculate the rheological features of the bran supplemented bread, this dependence was transformed into $\tau$ =f(ε) [16,17].

The graphical $\tau$ =f(ε) is not a linear dependence, but in the small deformations domain, the dependence is linear, and from its slope, the compression modulus was calculated [6, 16, 18].

The experimental compression curves and linear specific deformation upon which, sample ruptures are initiated, for the control bread samples and bread samples with 6% bran addition, compressed with a constant speed to $\gamma_c$ = 0,4 - 0,6 , are shown in *Figures 1-9.* For the same bread assortments, *Table 6* presents the values of the compression modulus, values calculated from the compression curves.

In *Figures 1÷ 5* are graphic presented the compression curves for all types of studied breads. Can be observed low values of deformation (**ε**<0.15 – 0.2), deformation is linear, i.e. to small deformations the crumb behave as ideal elastic material. By exceeding the linear domain of elasticity the linear dependence $\tau = f(\varepsilon)$ turns into a non-linear dependence. For $\tau = E \cdot \varepsilon$ (ie in the field of nonlinear elasticity) due to compression the air bubbles walls in crumb start snapping, also begins to change the crumb texture.

Because the two compression curves are not identical to any sort of bread, except bread samples with rice bran (*Figure 4*) means that the crumb analyzed is non-homogeneous.

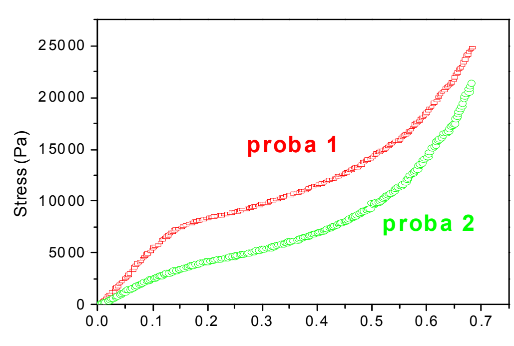


***Figure 1.*** Compression curves for control bread (without bran)

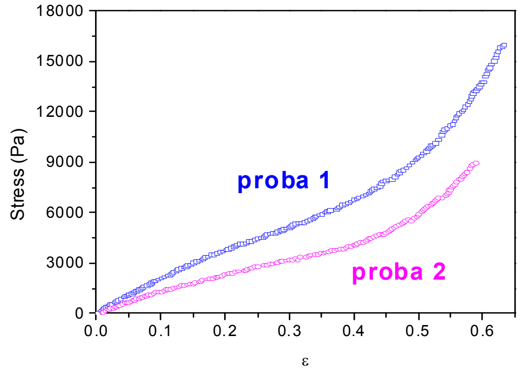


***Figure 2.*** Compression curves for bread samples with wheat bran

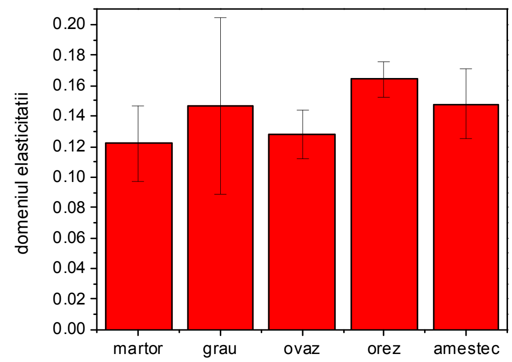


***Figure 6.*** Influence of additions on the domain of linear elasticity of bread samples

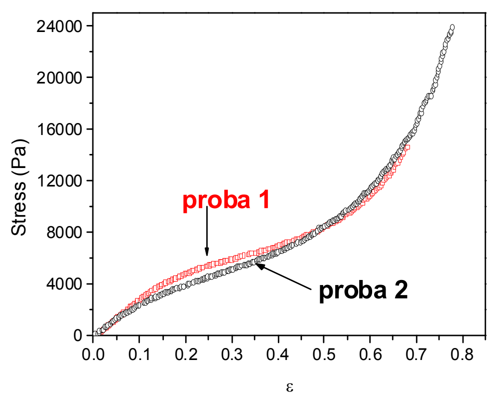


***Figure 3.*** Compression curves for bread samples with oat bran

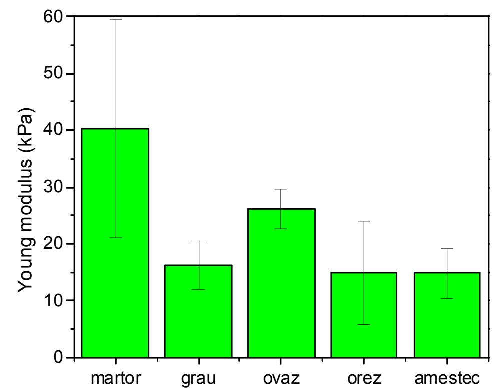


***Figure 7.*** Influence of additions on Young's modulus of bread samples

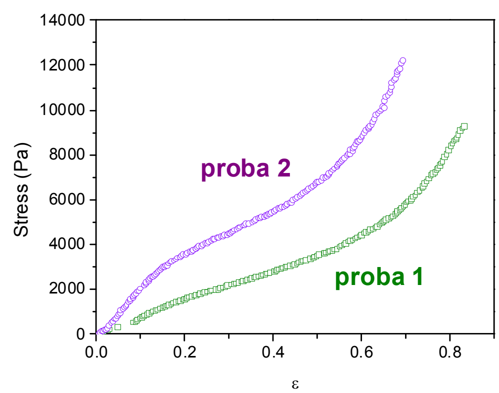


***Figure 4.*** Compression curves for bread samples with rice bran

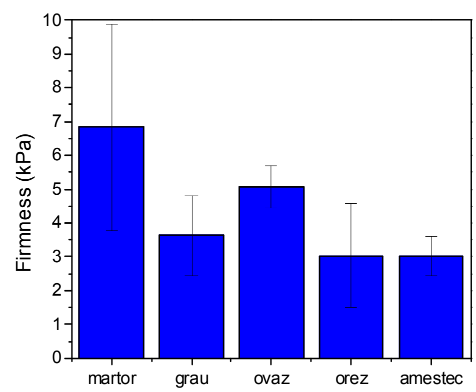


***Figure 8.*** Influence of additions on Young's modulus of the bread samples

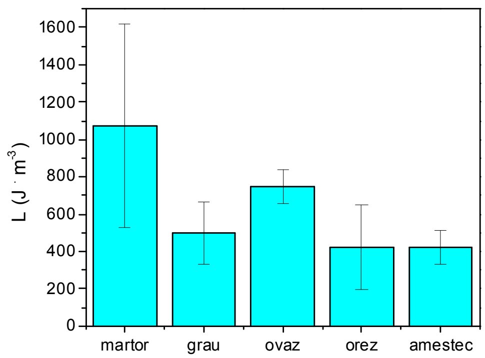


***Figure 9.*** Influence of additions on mechanical work required for 25% compression of bread samples

Dependence between compression module and content of bran in *Figure 7* reveals that a content of 6% rice bran and 6% mixture of bran (the lowest values of the Young's modulus is 14.85 kPa and 14.86 kPa), ensure the best elasticity for bread crumb.

In *Figures 6. ÷ 9* graphical is presented the influence of bran additions on the characteristics calculated from compression curves.

From *Figure 6*. it appears that the additions of bran increases the linear elasticity and Young's modulus is lower in the presence of these added materials (*Figure 7*). Additions of bran have the same effect of reducing the rigidity value (*Figure 8*) as well as unknown mechanical work of compression.

Following the rheological studies performed can appreciate that the bread with 6% rice bran and 6% mixture of bran addition has the best rheological characteristics compared to other studied types of bread with oats and wheat bran. On the opposite side stands the bread sample with the addition of 6% oat bran, which has the weakest rheological characteristics (the highest value of Young's modulus - 26.17%).

## 4. Conclusions

Dietary fiber is a common and important ingredient of a new generation of healthy food products demanded more each day by customers. Dietary fiber increases the nutritional value of bread but usually at the same time alters rheological properties of dough and, finally, the quality and sensorial properties of bread.

Dietary fiber additions, in general, had pronounced effects on dough properties yielding higher water absorption, mixing tolerance and tenacity, and smaller extensibility in comparison with those obtained without fiber addition (in the control bread). Regarding the effect on bread properties, the fiber always enhanced the shelf life, as textural studies revealed.

The recommended recipe following the observations drawn from this study is: 89% wheat flour 650.5% hemp flour, 6% bran, 3% addition of yeast and 2% NaCl (relative to the total amount of flour), kneading duration 15 minutes, fermentation time of 40 minutes at 35 °C, the dough baking: 25 to 30 minutes, the dough baking temperature: 200-220 ° C.

Also, by correlating the results obtained can be appreciated that established recipes from this study can be successfully applied on an industrial scale, thereby achieving valuable products both nutritionally and in terms of technological requirements quality.

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