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Quality of high-fiber wheat bread improved with rye flour

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Abstract

Cereals have been considered all along the time the most important group of plants for the human existence. Bread products are also the first products included in functional food category; even Hypocrite recommends whole grains bread consumption for its positive effect upon the intestines. Although white flour (refined) obtained products hold the supremacy among consumers' preference, according to the studies that have been carried out lately, we have reached the conclusion that whole grains flours (non-refined) are highly important. The aim of the experiments was to establish the recipes in order to obtain some high nutrition value products also with good volume and porosity using rye flour. The effects of rye flour on the quality and the crumb structure of bread supplemented with 5% to 30% were compared. Using rye flour for replacing 15 % of wheat flour and by optimizing the baking process it is possible to produce good consumer quality wheat bread containing up to 10% dietary fiber.

Keywords: rye, flour, bread, wheat, quality

1. Introduction

Cereals (wheat, rye, oat, corn, sorghum, millet and rice) have been an all times and will always be the most important plant group for the human existence and activity. Some researchers estimated, even from the beginning of this century, the potential advantages of food fibres in preventing some chronic affection. For a healthy person, the recommended fibre ratio is placed at medium value of 30grams fibres/day, half of which must derive from cereals. [7]

Due to the main humankind concerns regarding the increase of population health state in general and obesity control in particular, we may say that the development of some cereal and pseudo-cereal processing technologies becomes of fundamental importance.

The production of no refined based – products is highly necessary especially that lately it has been demonstrated that weight increase is directly related to food ratio from refined cereals [5].

This show how important is for us to make the difference between the products of whole grain and those of refined cereals to help weight control. One way to obtain high-fiber wheat bread is to add rye flour in the bread formulas.

Rye is a good source of fiber, which is especially important for richly endowed with noncellulose polysaccharides, which have exceptionally high water-binding capacity and quickly give a feeling a fullness and satiety, making rye bread a real help for anyone trying to lose weight. A cup of cream of rye cereal provides 17.3% of the daily value for fiber.

Rye and other whole grains are a rich source of magnesium, a mineral that acts as a co-factor for more than 300 enzymes, including enzymes involved in the body's use of glucose and insulin secretion. In addition to its usefulness in weight reduction, fiber, like that found in rye, has been shown to be useful for a number of different conditions.

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One of the most important properties of fiber is its ability to bind to toxins in the colon and then remove them from the body. When it binds to cancer-causing chemicals, fiber helps protect the cells of the colon from damage. This is one reason why a high-fiber diet has been shown to prevent colon cancer. When fiber binds to bile salts in the intestines and removes them from the body, the body is forced to make more bile salts [4].

This is good, because the body must break down cholesterol to make bile. This explains why a good intake of fiber can help to lower high cholesterol levels. Due to their high-fiber content, whole rye foods can help to prevent high blood sugar levels in diabetic patients, thereby helping with blood sugar control [5].

Rye is the key ingredient in traditional rye and pumpernickel breads. Since its gluten is less elastic than wheat's, and it holds less gas during the leavening process, breads made with rye flour are more compact and dense. Since it is difficult to separate the germ and bran from the endosperm of rye, rye flour usually retains a large quantity of nutrients, unlike refined wheat flour [3].

2. Materials and Method

In order to obtain some available experimental data, wheat flour obtaining from *Flamura* wheat variety grinding in Chopin Laboratory Mill was used like control sample.

The technological characteristics of flour are shown in Table 1.

Rye flour was provided by local producers. The analytical flour quality was determined according to the international standard methods (ash content – ICC104/1, wet gluten – ICC105/2, protein content – ICC106/2, hydration capacity with Pharinograph - ICC115/1 and Zeleny index – ICC116/1).

Like raw material I used also compacted fresh yeast (Saccharomyces cerevisiae) from S.C. ROMPAK, Pascani, with 32.5% dry matter and 46.54% protein content (N x 6.25). The recipe used for making breads with different percent of rye flour is shown in table 2.

Table1. Analytical parameters of Control flour

Moisture %	**Ash %**	**Wet gluten %**	**Protein %**	**Hydration capacity %**	**Falling Number sec**
13.42	0.68	31.1	13,3	62.6	329

Table 2. Recipe for high fiber bread with rye flour

Ingredients and technological regime	**UM**	**Quantities**
Raw materials and ingredients		
Wheat flour	grams	500
Rye flour	grams	
Fresh yeast	grams	8
Salt	grams	12
Sugar	grams	5
Water	cm^3	270 to 300
Technological parameters		
Kneading time	min	10-15
Proffer time	min	20-25
Temperature of blanks	^0C	30-32
Baking time	min	30-35
Baking temperature	min	240-260

The Falling Number values for the experimental flours improved with rye flour were determined with AACC/No.56-81 method using a 1500 PERTEN Falling Number System.

We use a Chopin Alveograph (AACC/No.54-30A, ICC121, and ISO 5530/4) to determine the relationship between elasticity of the dough and rising power in order to analyze the rheological characteristics of tested flours.

After baking, the samples were cooled 6-8 hours in controlled atmosphere (UV lamps). In order to be scoring (after 24 hours), the samples were sliced for packed in plastic bags. Crumb structure was determined after 24 hours of cooling by means of a Stereomicroscope. The experiments are made in the research laboratory of "Ştefan cel Mare" University of Suceava, Faculty of Food Engineering.

3. Results and discussion

In order to obtain some available data we made the following mixture of wheat flour and rye flour:

C - Control Flour: only wheat flour
P1- 5 % rye flour and 95% wheat flour
P2- 10 % rye flour and 90% wheat flour
P3- 15 % rye flour and 85% wheat flour
P4- 25 % rye flour and 80% wheat flour
P5- 30% rye flour and 70 % wheat flour

Evaluation of analytical parameters of flour samples

First of all it was study how will affect the rye flour add the analytical parameters of flours. Flour quality parameters are determined by standard methods after mixing Control flour with rye in different percents reported to basic flour are shown in Table 3.

Table 3. Analytical parameters of tested flours

Type of Flour	Moisture %	Ash %	Wet gluten %	Protein %	Hydration capacity %	Falling Number sec
Control	13.98	0.68	31.1	13,3	62.6	329
P1: Control + 5% rye flour	13.93	0.71	29.94	12.81	59.68	328
P2: Control + 10 % rye flour	13.92	0.74	28.97	12.38	61.79	328
P3: Control + 15% rye flour	13.92	0.75	28.00	11.97	62.34	328
P4: Control + 25% rye flour	13.97	0.81	22.25	9.51	62.91	328
P5: Control + 30 % rye flour	14.01	0.97	18.64	8.2	63.97	328

As it could be seen, the analytical parameters of tested flour are drawn into the normal value for a high-fiber mixture: the wet gluten percent decrease and in the same time the hydration capacity increase because the pentosanes from rye. From the point of view of volume and aspect of loaf the optimal mixture could be P3: Control + 15% rye flour, but if we want a higher level of fibres we could use P4: Control + 25% rye flour

But, it was necessary to take into consideration that an excessive rye ads can yield doughs that show decreased optimum water levels, stickiness and slackness. The resulting bread may have reduced loaf volume with inferior grain and texture. That's why the experiments were continued with Chopin Alveograph tests. The recording results are shown in Table 4.

Table 4. Average values of alveograph evaluations

Type of Flour	P, mmH_2O	L, mm	G	P/L
Control	86	48	19	1.79
P1: Control + 5% rye flour	85	48	19	1.77
P2: Control + 10 % rye flour	80	46	18	1.73
P3: Control + 15% rye flour	79	44	18	1.79
P4: Control + 25% rye flour	70	36	16	1.94
P5: Control + 30 % rye flour	72	38	14	1.89

Analyzing the data recording by alveograph it could be observe an interesting situation. From the point of dough quality, the best behavior was obtaining from Control flour improved with 10% rye flour. The dough based on P2 mixture had a better extensibility in correlation with a superior resistance/stability to stretching.

In case of P3 mixture we also obtain a good workability of dough, in correlation with a good resistance to stretching. In correlation with Falling Number evolution it could be say that both samples P2 and P3 could constitute a proper manner to enrich our Control flour with fiber in correlation with dough good for baking.

Evaluation of breads quality

Next step was to make baking tests and to evaluate the quality of breads (Table 5)

Table 5. Quality of breads after 24 hours after baking

Type of Flour	Volume, $cm^3/100g$	Height, cm	H/D	Porosity (Crumb structure), %	Elasticity, %	Moisture, %
Control	271	8.5	0.53	77	97	43.8
P1: Control + 5% rye flour	269	7.8	0.48	76	94	49
P2: Control + 10 % rye flour	268	7.3	0.45	75	91	49
P3: Control + 15% rye flour	268	7.3	0.45	75	89	49
P4: Control + 25% rye flour	257	6.7	0.41	74	82	49.3
P5: Control + 30 % rye flour	257	6.7	0.41	74	76	49.3

The obtaining scores are almost similar for samples with rye flour add, that's why became very important to correlate the practical results with price and the crumb structures.

Regarding the evolution of crumb all the breads obtaining from all mixture samples were scoring and analyze with a Stereomicroscope. Te picture recording are shown in figure 1.

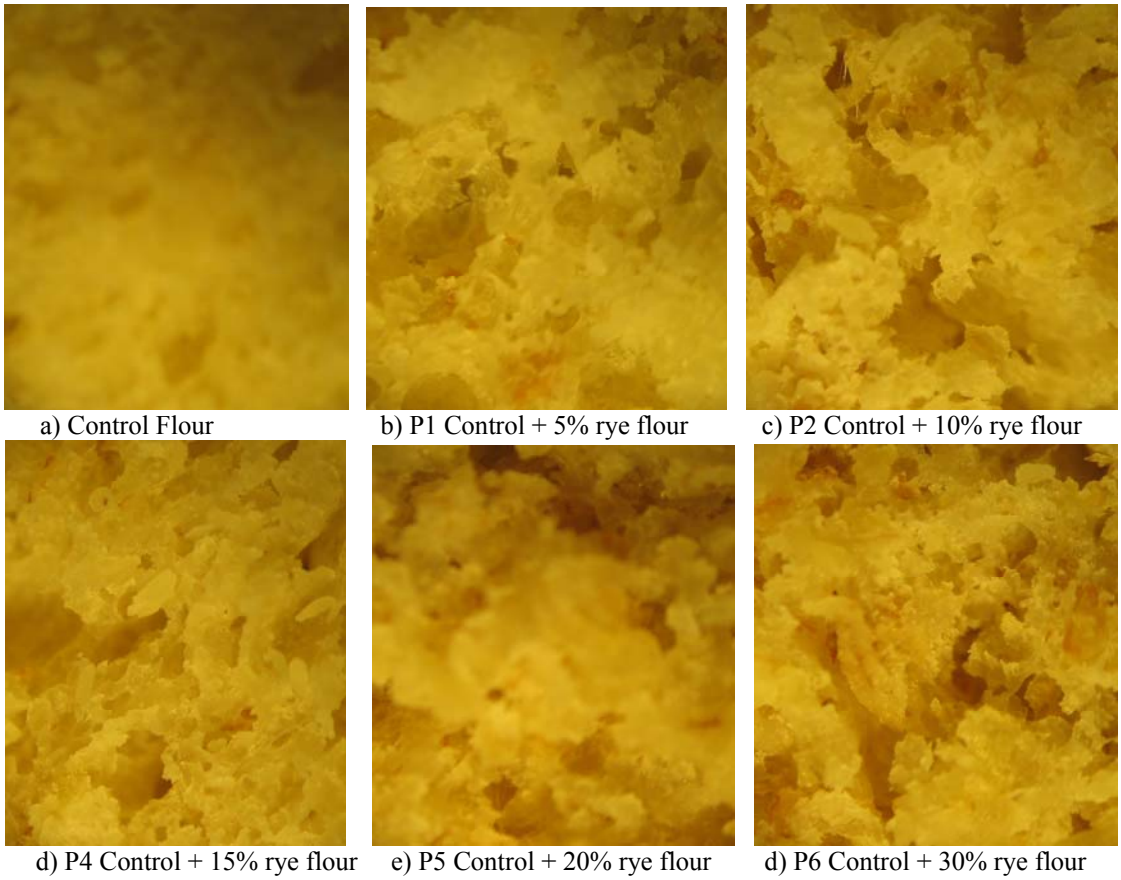
As it could be seen, the crumb structure was various because special characteristics of rye flour which is a little beet different against wheat flour. Rye flour contain gliadin and glutenin but not with the same properties like in the wheat flour.

That's why in dough doesn't exist a continuous glutenic network. Responsible for this it is possible to be the higher content in pentosanes witch absorbs water quiqly than proteins.

At backing, starch and pentosanes provide very concentrated gels so the final crumb structure will be based on incondensable polysaccharides gel not on gluten network like in wheat flour case.

In figure 1 it could be observe that the bread crumb with Control Flour had a

normal gluten network and a clear starch gel. When the rye percent increase, the gluten network converted to curdy proteins and the starch gel had a lower importance against incondensable polysaccharides gel.



a) Control Flour b) P1 Control + 5% rye flour c) P2 Control + 10% rye flour

d) P4 Control + 15% rye flour e) P5 Control + 20% rye flour d) P6 Control + 30% rye flour

Figure 1. The bread crumb evolution in correlation with rye flour percent add

4. Conclusions

Analyzing the obtained results the following conclusions were dropped:

- Using rye flour between 5% and 15% in mixture with wheat flour could be a possibility to improve the bread quality and fibers content;
- Amounts over 15 % (P5 Control + 20% rye flour and P6 Control + 30% rye flour) could increase the fibres content but, in the same time could decrease the sensorial quality of bread. The volume will be worst and porosity closed because these percent of rye will action like a ballast for gluten network of wheat;
- The best behaviour it was recording in case of P3 mixture: Control + 15% rye flour. The dough had almost the same property like in case of pure wheat flour, and the resulting bread had a good volume and an open porosity. In this case we could obtain a good consumer quality bread containing up to 10% dietary fiber.

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