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RESEARCH REGARDING THE USAGE INFLUENCE OF SOYA FLOUR AND FOOD ADDITIVES ON BREAD QUALITY

Monica MARIN, Georgeta DINIȚĂ, Elena POGURSCHI, Carmen Georgeta NICOLAE, Daniela IANIȚCHI

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: marin_monica_zoo@yahoo.com

Abstract

The use of soy flour in bakery products improves the handling of the dough, the bread core is lighter in color and softer. In these conditions, the research carried out aimed to test the possibility of replacing a part of the wheat flour with enzymatically active soybean meal, associated with ascorbic acid (0.005% of the amount of flour) and sodium stearoyl-2-lactate (0.4%), as stabilizer and emulsifier. During the experimental period, 4 recipes were made for bread making, respectively a control sample and 3 experimental samples, in which different quantities of enzymatically active soybean meal (5%, 10%, 15%) were introduced. There was an improvement in the hydration capacity of the dough, in proportion to the amount of the added soy flour. As a result, it can stated that soybean meal increases the absorption capacity of the water and increases the durability of bread freshness.

Key words*: active enzymatic soy flour, alimentary additives, bread.*

INTRODUCTION

The introduction of enzymes in bakery products began in 1886, the purpose being to improve the rheological qualities of bread (Mizrahi, 1967).
One source of bread enzymes was the enzyme-activated soy flour containing lipoxygenase. The purpose of adding the soybean meal was to whiten the flour and respectively the breadcrumbs, to increase the tolerance to mixing and to improve the bread volume and internal structure (Johnson and Myers, 1995).
In soy there are two types of enzymes, respectively type I (optically active at pH 9; thermally stable at 69°C for 25 minutes and inactive with linoleic acid ester and carotenoids) and type II (optically active at pH 6.5, active against linoleic acid ester). Only type II contributes to the improvement of the bakery features. The soybean enzyme called lipoxidase II has been identified as the isoenzyme responsible for the bleaching of carotene (Doxastakis et al., 2002).
The second function of lipoxygenase in the dough is to improve the mixing tolerance and the processing properties of the dough (Ribotta et al., 2005).
Sanful and Darko (2010) investigated the effects of enzymatically active soybean meal and found that it greatly increased the tolerance to chewing.
This capacity was dependent on the quality of the substrate that depended on the amount of fat in the flour.
A more important practical effect of the action of lipoxygenase is to improve the rheology of the dough, to strengthen it during baking and in the oven, resulting in an improved bread volume (Shafali and Sudesh, 2004).
Tripathi et al. (2019) appreciated that both lipids and oxygen were needed to improve the volume of bread.
The action of lipoxygenase can lead to unwanted flavors in bread (Johnson and Myers, 1995).
The purpose of the paper was to test the possibility of using the enzymatically active soybean meal in order to replace the wheat flour from the technological process of bread making to reduce the gluten content.
Soya flour is quite often used in the bakery industry, but in Romania it has not been legally established the recommended quantity to be used.

MATERIALS AND METHODS

The main raw materials used were wheat flour type 650, soybean meal, baker's yeast, additives that were used during the experimental period.
As food additives, ascorbic acid 0.005% of flour and sodium stearoyl-2-lactate (E481) 0.4% were used as stabilizer and emulsifier.
During the research, 4 bread recipes were analyzed, namely a control sample and 3 experimental samples, in which different quantities of enzymatically active soybean meal, ascorbic acid and sodium stearoyl-2-lactate were introduced.
In general, the following ingredients were used for the fabrication of bread:
-1.5 kg of flour for leaven and 1.5 kg of flour for dough, obtaining a total of 3 kg destined for each of the three samples, as well as for the control sample;
- water in the amount of 0.830 l in leaven and 0.830 l in dough;
- yeast 45 g in leaven for each sample;
- salt 45 g in dough.
Soybean flour was not added to the control batch, while in the experimental batches the soybean meal was replaced by 5% wheat in experimental batch I, 10% in batch II and 15% in batch III. To the experimental batches were added food additives, respectively ascorbic acid in the proportion of 0.005% of the amount of flour and stearoyl-2-sodium lactate in proportion of 0.4% of the flour.
On each experimental batch, 6 loaves were obtained, on average, which were obtained by the indirect process. The experiment was repeated 2 times.
The main phases of the technological process are the following:
- preparation and dosing of raw materials;
- preparation of the dough by the two-phase method with leaven and dough. The kneading time of the leaven was of 4 minutes, and the fermentation time of the leaven was of 120 minutes;
- the kneading of the dough aims to obtain a homogeneous mixture of the raw materials and at the same time a dough with good rheological properties. Kneading the dough took 4 minutes. The appreciation of the end of the dough kneading is made organoleptic, respectively the well kneaded dough is homogeneous, consistent, dry when kneaded, elastic and easily separates from the kneader's arm;
- fermentation of the dough, during which a series of physico-chemical, biochemical and microbiological transformations take place, which have an important influence on the physico-mechanical and technological properties of the dough; fermentation time of 40 minutes for the control sample, and in the other samples of 30 minutes;
- the repetition of dough kneading aims to eliminate part of the carbon dioxide accumulated in the dough, which slows the activity of the yeasts and the pressure of the gas bubbles, increasing the breaking resistance of the dough. The duration of kneading repetition in our case (protein surplus flour) is of maximum 1 minute;
- dividing the dough consists of dividing the dough into pieces;
- the preparation of the predrying dough pieces has the role to restore the physical properties of the dough partially destroyed during the division; takes 3-5 minutes;
- modeling the dough aims to give a shape of the dough that the bread has to have;
- the final drying is done in a warm and humid environment, the temperature being of 30-35°C, and the relative humidity of the air of 75-85%, conditions that prevent the surface drying, the formation of an unwanted crust that leads during the baking to the cracking of the surface and enhanced fermentation. The final drying is done in specially arranged rooms or in rake depots (wooden boards). The determination of the end of the fermentation was made organoleptic (soft, raised, elastic, and after a finger press on the surface, it gradually returns to the original form);
- the baking was done for 25 minutes for the experimental samples, as well as for the control sample at a temperature of 230-240°C;
- the storage of the bread is done in order to cool the bread in optimum conditions and to maintain its quality during storage.
The obtained bread was packed, after 3 hours since removing it from the oven, in closed polyethylene bags.
In order to determine the quality of the used flour, moisture (SR90:2007), crude protein (SR 91:2007) and crude ash (ISO 2171:2010) were determined.

The main rheological characteristics of the dough were determined with the help of the farinograph, respectively the hydration capacity, the development of the dough, the stability of the dough, the elasticity of the dough in Brabender units (Bu), the softening of the dough in Brabender units (Bu), the power of the flour.
The physical-chemical indicators of the bread obtained during the experimental period were determined according to the standard SR 91:2007.
In order to assess the results obtained, the Student's test was used to assess the significance of the differences between the average values, and the analysis of the variant was done with the ANOVA program.

RESULTS AND DISCUSSIONS

The flour quality indicators used to obtain the bread analyzed during the experimental period are presented in Table 1.

Table 1. Flour quality indicators used in experiments

Indicators	M.U.	Wheat flour	Soy flour
Humidity	%	10.81	11.05
Crude protein	% SU	9.95	31.96
Ash	% SU	0.65	2.73

Following the analysis carried out on the flour samples, the following quality indicators were obtained:
- the humidity ranged between 10.81% for the wheat flour and 11.05% for the soy flour, being located between the nominal values;
- the proportion of ash related to the dry matter was of 0.65% for the wheat flour and 2.73% for the soybean flour, which is a source of mineral elements;
- the protein content related to the dry substance was of 9.95% in the wheat flour, and in the soybean one was of 31.96%, which is also an important source of lysine for the human consumer.

The rheological indicators of the dough made during the experimental period are presented in Table 2.
The hydration capacity of the dough was of 58.4% in wheat flour, and the addition of soy flour resulted in an increase in values, proportional to the added quantity, the differences being significant for the experimental batch 3 ($P < 0.05$).
The dough development took place in 2-3 minutes for the control batch, the values remainning close to the experimental batch (2.1-2.2 minutes).
The stability of the dough was of 4.2 minutes for the control batch, the addition of soy flour causing an increase of this rheological indicator.
The elasticity of the dough registered the value of 138 Brabender units, and the softening degree of the dough of 110 Brabender units, both parameters being influenced in an increasing way by the addition of soy flour.
The power of the flour was between 35-39, values that were within appropriate limits, which allowed the experience to unfold.
The physical-chemical indicators of the bread obtained by the baking samples, after 3, 24, 48 and, respectively, 72 hours after the exit from the oven, are presented in Table 3.
Bread volume. At 3 hours after baking, the lowest value is bread from the experimental batch E1 (312.27 cm^3/100 g product), using 5% soybean meal and food additives. Sample 2, which used 10% soybean meal and food additives, has the highest value (355.32 cm^3/100 g product).

Table 2. The rheological indicators of the dough made during the experimental period

Indicators	M.U.	Batch			
		control	E1	E2	E3
Hydration capacity	%	58.4±2.05	63.4±3.12	66.7±2.89	68.1±1.96
Dough development	Minutes	2.3	2.2	2.1	2.1
Dough stability	Minutes	4.2	4.7	5.1	5.3
Dough elasticity	Bu	138±7.32	1198.05±	139±7.58	156±6.26
Softening dough	Bu	110±5.14	115±7.29	121±8.45	127±6.74
The power of flour	-	37	39	37	35

Table 3. Physical-chemical indicators of the bread obtained during the experimental period

Physico-chemical indicator	Baking time (hours)	Control batch	E1 batch	E2 batch	E3 batch
Volume cm^3/100 g product	3	335.12	312.27	355.32	336.24
	24	330.34	296.16	332.51	325.62
	48	310.07	309.27	327.16	310.46
	72	326.21	309.52	334.29	325.58
	3-72	325.43	306.80	337.32	324.47
Height (H), cm	3	10.31	10.11	10.97	10.42
	24	10.24	10.20	10.43	9.89
	48	9.83	10.43	10.31	9.97
	72	9.67	10.32	10.43	10.10
	3-72	10.01	10.26	10.53	10.09
Diameter (D) cm	3	15.55	15.41	15.53	15.57
	24	15.50	15.12	15.26	15.21
	48	15.22	15.19	15.19	15.14
	72	15.01	15.29	15.21	15.17
	3-72	15.32	15.25	15.30	15.27
H/D	3	0.66	0.66	0.71	0.67
	24	0.66	0.67	0.68	0.65
	48	0.64	0.69	0.68	0.66
	72	0.65	0.67	0.68	0.66
	3-72	0.65	0.67	0.69	0.66
Porosity, %	3	81.32	76.11	79.35	78.75
	24	80.89	78.25	81.14	79.27
	48	79.65	78.44	81.07	79.36
	72	81.02	78.89	80.65	80.42
	3-72	80.72	77.92	80.55	79.45
Elasticity, %	3	93.12	95.32	95.24	93.56
	24	90.64	89.52	92.18	91.19
	48	91.35	90.12	92.22	91.31
	72	92.71	96.31	96.15	94.10
	3-72	91.95	92.82	93.95	92.54
Humidity, %	3	42.24	40.84	40.81	40.55
	24	42.10	41.24	41.32	42.05
	48	42.34	40.77	41.37	41.48
	72	42.22	41.69	41.91	41.63
	3-72	42.22	41.14	41.35	41.43

At 24 hours, the volume of all samples decreased, the bread from the experimental batch 1 having the smallest volume 296.16 cm^3/100 g product, and the bread from group E2 had the highest volume (332.51 cm^3/100 g product).
At 48 and 72 hours after baking, it is found that the largest volume is the one of the breads used in which have been added food additives and 10% soybean meal.
As a mean value, it is observed that the largest volume was the one of the breads from the experimental batch E2, which were used food additives and soybean meal 10%, the increase compared to the control being of about 3.52%.
Bread height. It was observed that at 3 hours after baking, the height of the control sample was of 10.31 cm, being an average value. An increase in bread height was observed for the experimental batch E2, and the lowest one was for the batch E1. After 24 hours of baking, batch E2 had the highest height, while the breads in the batch E3, the lowest one.
The same situation is observed after 48 hours and 72 hours after baking: sample no.4 increases the most (by 0.9%), the highest breads being those obtained by adding additives and soy flour 10%.
Bread diameter. There is a decrease in the bread diameter as several hours pass from baking, the values recorded being relatively close and statistically insignificant (P>0.05).
Height/diameter ratio. The highest value of the ratio was registered for the experimental batch E2, but, on average, the differences between the average values were insignificant (P>0.05).
The *porosity of the bread* varied within relatively narrow limits in the control and experimental batches E2, decreasing in the experimental batch E3 by 1.57% and in the experimental batch E1 by 3.47% compared to the control batch.
Bread core elasticity has the highest values for the experimental batch E2 (93.95%), to which 10% soybean flour was added.
The humidity of the bread obtained from wheat flour with the addition of soybean flour and additives decreased compared to the control batch (by 2.56% in batch E1, 2.06% in batch E2 and by 1.87% in batch E3).
Otegbayo et al. (2018) stated that soy enrichment of bread creates a dense food nutrient that is important for health. By adding 5% soy flour in the produced bread, it has a greater nutrient value, similar to the one of wheat flour, being liked by consumers. The 5% soy flour addition is benefic for nutritional value and increases the consumer acceptability through its sensory properties. Also, the bread had a decreased anti-nutritients level, being safe for the consumer.
Sana et al. (2012) advised to replace the wheat flour with a proportion of soybean flour that is greater than 7% in order to obtain a high nutritional bread with sensorial qualities.

CONCLUSIONS

Enzymatically active soybean meal which contains lipoxygenase can be used as a substitute for a portion of wheat flour, provided that an additive of food additives (ascorbic acid 0.005% and stearoyl-2-sodium lactate 0.4%) is used.
The hydration capacity of the dough was improved by the addition of soybean meal which caused an increase in values, proportional to the added quantity.
The stability, elasticity and softening of the dough have been influenced in an increasing way by the addition of soybean meal and food additives.
The highest volume, the best ratio of bread height and diameter, porosity, elasticity were positively influenced by the use of 10% soybean meal with an addition of food additives.
In all the samples with the addition of soybean meal, the humidity was diminished, favoring the preservation of the bread for a longer time.

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