INFLUENCE OF THE GOLDEN FLAXSEED ADDITION ON BREAD QUALITY OF WHEAT FLOUR WITH A VERY GOOD QUALITY FOR BREAD MAKING

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Abstract: The aim of this study was to analyze the effect of golden flaxseed addition in different doses (5%, 10%, 15%, 20%) in wheat flour 650 type with a very good quality for bread making in order to improve bread quality. It was analyzed bread physical (loaf volume, porosity, elasticity), textural (hardness, cohesiveness, adhesiveness, viscosity, elasticity, gumminess, chewiness), color profile (*L*, *a*, *b*, Δ*L*, Δ*a*, Δ*b*, Δ*E*), sensorial (for overall acceptability, appearance, color, flavor, texture, taste, smell, texture) and microstructure. The best results were obtained for the bread with 10-15% golden flaxseed flour addition.

Key words: wheat flour, golden flaxseed, bread, textural, microstructure

Introduction

Flax (*Linum usitatissium)* is an important oilseed crop industrial used in especially for it oil content (30÷40%) [Oomah B.D., 2001]. Two types of flaxseed are available in the world which differ in especially by them color namely golden and brown flaxseed [Barthet V.J. et al., 2014]. Almost 48% of its lipid content correspond to the alpha-linolenic acid (ALA) flaxseed being the seed with the highest content in this essential fatty acid [Rubilar M., 2010]. From the two flaxseed variety it seems that the golden one presents a high amount of ALA than the brown one [Sargi S.C. et al., 2013]. Besides ALA flaxseed also contains eicosapentaenoic (EPA) and docosahexanoic acid (DHA) all of them being precursors for producing omega-3 fatty acids type very important from the nutritional point of view [Ganokar P.M. and Jain R.K., 2013]. It appears that these acids are beneficial for preventing heart diseases, arthritis, inflammatory bowel disease, e.g. [Rakcejeva T. et al., 2007]. Also along omega-3 fatty acids flaxseed contain more than 13 % linoleic acid (an omega-6 fatty acid) and natural antioxidants such as chlorogenic acid, caffeic acid, phenolic glycoside-Q and K, kaempferol, quercetin, e.g. [Obranović M. et al., 2015] in a higher content in brown flaxseed variety [Sargi S.C. et al., 2013]. The flaxseed may contain aproximatively 30% dietary fibers [Rubilar M., 2010] from which mucilage (6%) [Mazza G. and Biliaderis C.G., 1989] and insoluble fibers (minimum 18%) in a lower amount in golden flaxseed variety [Epaminondas P.S. et al., 2011]. The flaxseed protein content is about 20% [Rubilar M., 2010] and vary due to genetic and environment conditions. Regarding it amino-acid composition it presents high levels of glutamic acid, leucine, arginine and aspartic acid with slightly higher values for the golden variety comparatively with the brown one [Oomah and Maza, 1993].

Flaxseed can be added in bread in order to improve it quality from the nutritional and physical-chemical point of view. Kaur A. et al (2013) obtained by an addition up to 10% flaxseed in whole wheat bread good results for baking and sensory properties. Also, Rakcejeva T. et al. (2007) found that by an addition of flax seed marc in wheat flour were obtained better results from the sensory point of view than for the control

wheat bread sample and Xu Y. et al. (2014) found that loaf volume of bread made with 6 and 10% flaxseed addition did not differ significantly from the control one.

The object of this study was to analyze the impact of golden flaxseed replacement (from 0% up to 20%) in wheat flour on bread quality due to it physical-chemical, textural, color profile and sensory characteristics.

Materials and methods

Commercial **wheat flour** (harvest 2015) was milled on an experimental Buhler mill from Mopan S.A. (Suceava, Romania) and golden flaxseed was provided by S.C. Enzymes and Derivates Romania. The effect of golden flaxseed ground in a domestic blender was evaluated by the addition of 5%, 10%, 15%, 20% related to the flour weight.

The **chemical composition** of the flour was determined according to international standard methods: moisture (ICC 110/1), ash content (ICC 104/1), protein content (ICC 105/2), falling number (ICC 107/1) wet gluten content (ICC 106/1) and gluten deformation index (SR 90:2007). Golden flaxseed chemical composition: moisture, protein, fat, ash was determinate according to ICC methods (2010).

The baking test was performed after the fallowing protocol: wheat flour, golden flaxseed flour in different doses (0% - control sample, 5%, 10%, 15%, 20%), 3% yeast and 1.5% salt reported to the mass of the wheat-flaxseed flour and water according to the wheat flour hydration capacity (56,3%) at 29-30^{o}C were kneading in a mixer for approximate 15 minutes at 28-30^{o}C and then the modeled samples was proofed for 60 minutes at 30^{o}C, 85% relative humidity and baked for approximately 30 minutes in an electrical bakery convection oven with steam production, ventilation and humidification (Caboto PF8004D, Italy).

Physical parameters of bread (specific volume – rapeseed replacement method, porosity, elasticity) were determined according to the Romanian standard methods described in SR 91:2007 after two hours of cooling.

Color profile analysis wad done using the Konica Minolta CR–700 colorimeter. The color measurement was made by CIE Lab color system measurement. *L*, *a*, *b* values, the deviations from *L*, *a*, *b* (ΔL, Δa, Δb) and the total color difference (ΔE) were obtained, in triplicate. ΔL, Δa, Δb are deviations from *L*, *a*, *b* values and ΔE is the total color difference. The color profile analysis values were obtained in triplicate.

The **textural properties** of bread were measured using an electronic texture analyzer Mark-10-ESM301. The textural characteristics of bread were hardness, cohesiveness, adhesiveness, viscosity, elasticity, gumminess, chewiness.

The bread microstructure was analyzed using the MoticSMZ–140 stereo microscope with the 20x objective to a resolution of 2048 x 1536 pixels.

Sensory evaluation for overall acceptability, appearance, color, flavor, texture, taste, smell, texture was made by a panel of twenty semi-trained judges using a preference method of nine points hedonic scale.

The **statistical analysis** was done using the Statistical Package for Social Science (v.16, SPSS Inc., Chicago, IL, USA) and Microsoft Excel 2007. A confidence interval of 95% was used in this study.

Results and Discussion

Analytical characteristics. The chemical composition of the wheat flour indicated the following values: 0.65% ash content, 14.5% water content, 12.6% crude protein, 8 mm deformation index, 2.3 acidity and 380 s for falling number. The golden flaxseed presents the fallowing characteristics: 5.6% moisture content, 20.85% crude protein, 41.12% fat content and 3.41% ash content.

Bread physical characteristics. Figure 1 shows the variation of loaf volume, porosity and elasticity of bread depending on the different quantities of golden flaxseed (GFS) added. It is shown that an increase of the golden flaxseed flour addition in wheat flour increase the loaf bread volume, porosity and elasticity up to 15% and then decrease them at the level of 20% GFS addition.

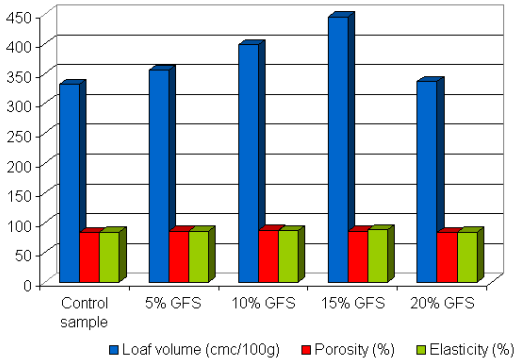


Fig.1. Bread physical characteristics

The increase of the bread physical characteristics up to 15% flaxseed addition may be due to it fat content which wraps around the gas cells and prevent its release from the dough [Meral and Dogan, 2013]. Lower values of the bread physical characteristics may be due to the gluten dilution from the system the wheat-flaxseed dough is being no longer able to retain the gas form during fermentation [Sivam et al., 2010].

Color profile analysis. Effect of golden flaxseed flour addition in wheat flour is shown in Table 1. As we can see from the Table 1, the *L* value for the control sample is higher. In general, the brightness values *L* decrease with increasing dose of golden flaxseed in bread. Similar results were also obtained by Kaur A. et al. (2013). This is may be due to a darker color of golden flaxseed flour, comparatively to white wheat flour. Compared with the control sample the value the bread with golden flaxseed flour turn presents positive values, heading to the red color. Coordinate *b* of the color system method CIE Lab color indicates positive values for all the samples evaluated with the increase value proportional with the increase level of golden flaxseed addition.

Table 1. Effect of golden flaxseed addition on color profile analysis of wheat bread

Sample/Golden flaxseed (GFS) addition	***L***	***a***	***b***	***ΔL***	***Δa***	***Δb***	***ΔE***
Control	74,46	-1,87	13,35	38,64	-15,22	-0,87	41,54
5% GFS	68,51	0,01	14,07	32,69	-13,35	-0,17	35,31

Sample/Golden flaxseed (GFS) addition	*L*	*a*	*b*	*ΔL*	*Δa*	*Δb*	*ΔE*
10% GFS	66,46	0,17	15,14	30,60	-13,18	1,52	33,27
15% GFS	66,43	0,33	15,75	30,50	-13,03	0,91	33,25
20% GFS	66,32	0,55	17,06	28,64	-12,80	2,84	31,49

Textural properties of bread. The results obtained for the samples with and without golden flaxseed addition on textural properties of bread are shown in Table 2. The hardness of bread enriched with 20% golden flaxseed flour was approximately 3 times higher than the control one in agreement with the results obtained by Conforti F.D. and Davis S.F. (2006). This may be due to the lower water available for gluten network formation caused by the soluble fibers from the golden flaxseed according to Costa et al. (2012). Regarding the cohesiveness slower values were recorded for the samples with golden flaxseed addition but not with a significant impact.

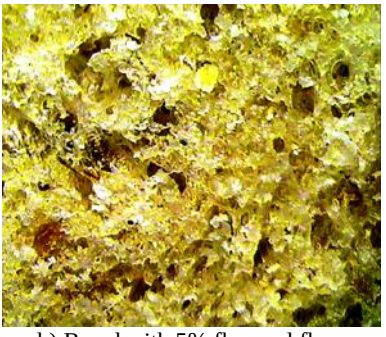
Table 2. Textural parameters of bread samples

Sample/Golden flaxseed (GFS) addition	Hardness, (N)	Cohesiveness	Elasticity	Gumminess, (N)	Chewiness, (N)
Control	16,22	0,69	0,82	11,19	9,62
5% GFS	11,52	0,65	0,86	7,59	6,59
10% GFS	19,48	0,66	0,87	12,89	11,28
15% GFS	30,36	0,65	0,82	19,76	16,27
20% GFS	37,08	0,61	0,83	22,78	18,94

The higher elasticity values were recorded for the sample with 10% flaxseed addition and for the texture parameters gumminess and chewiness the maximum values were recorded for the sample with 20% golden flaxseed addition in agreement with the results obtained by Kaur A. et al. (2013).

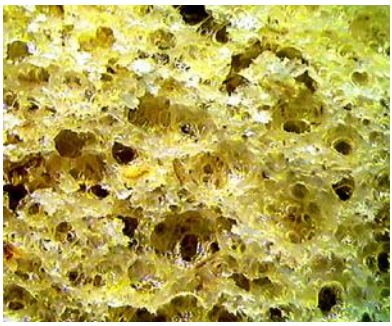
The ***bread microstructure*** is shown in Figure 2. It may be seen that a high levels of golden flaxseed addition the porosity does not present such homogeneity like the control one. This may be due to weaker dough due to a low content of gluten which cannot retain as well as the control sample the gas formed during fermentation process.

a) Control sample

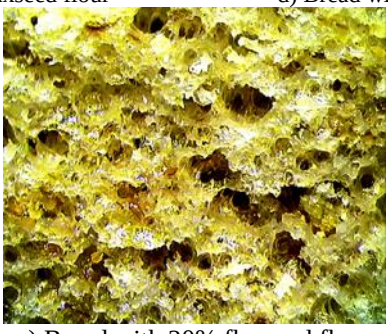


b) Bread with 5% flaxseed flour

c) Bread with 10% flaxseed flour



d) Bread with 15% flaxseed flour



e) Bread with 20% flaxseed flour

Fig. 2. Bread microstructure

The ***bread sensory characteristics*** are shown in Figure 3. It may be seen that the best overall acceptability received the sample with 10% GFS addition. Also the sample with 10% GFS addition was the best evaluated from the point of view of color, taste texture and appearance. From the point of smell and flavor the best evaluated was the sample with 15% GFS addition.

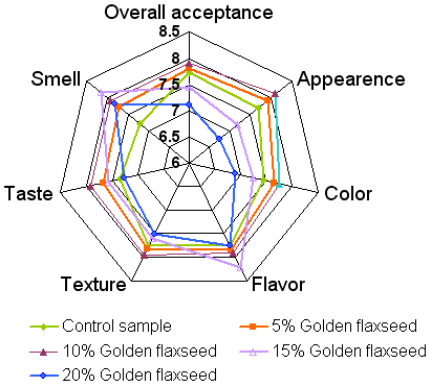


Fig. 3. The bread sensory characteristics

Relationship between the bread flour characteristics at different golden flaxseed flour substitution levels. In order to identify the type of association between

the physical, colour, textural, sensory characteristics recorded at different substitutions levels of 0, 5, 10, 15 and 20% of GFS in wheat flour 650 type, the principal component analysis (PCA) was used. The obtained data showed that the first two principal components (Fig. 4) are responsible for 85.70% of the total variance (PC1 = 56.35% and PC2 = 29.35%).

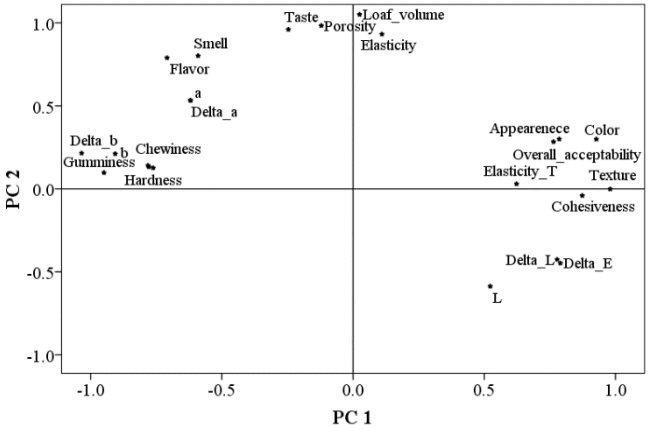


Fig. 4. Principal component analysis for the bread characteristics

The first principal component PC1 is strongly correlated with textural characteristics chewiness, gumminess, hardness ($r = 0.987$, $p < 0.01$) and cohesiveness and elasticity and sensorial characteristics appearance, colour ($r = 0.993$, $p < 0.05$) and overall acceptability ($r = 0.993$, $p < 0.05$). The second principal component PC2 shows a good correlations between colour parameters L, ΔL, ΔE, between b, Δb ($r = 0.956$, $p < 0.05$) and a, Δa and sensory characteristics smell and flavor ($r = 0.759$, $p < 0.05$).

Conclusions

By using golden flaxseed flour in wheat flour it can be obtain a bread improved nutritional and of an acceptable quality. The best results was obtained up to a level of 10-15% golden flaxseed addition in wheat flour from the point of physical, textural, color profile, sensorial and microstructure properties of bread.

Acknowledgements

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References

1. **Barthet V.J., Klensporf-Pawlik, D. & Przybylski, R.**, Antioxidant activity of flaxseed meal components, *Canadian Journal of Plant Science*, 93:593-602, (2014).
2. **Conforti, F,D &Davis, S,F.**, The effect of soya flour and flaxseed as a partial replacement for bread flour in yeast bread, *International Journal of Food Science Technology*, 41, 95–101, (2006).

3. **Costa, A, Barauna, A.C., Bertin R.L. & Tavares, L.B.B**, Flaxseed flour addition on fatty acid profile and sensory properties of Brazilian cheese roll, *Ciencia Agrotecnology* 36:431–438, (2012).
4. **Ganokar, P.M. & Jain, R.K.**, Flaxseed-a nutritional punch, *International Food Research Journal* 20 (2): 519-525, (2013).
5. **Epaminondas, P.S, Araujo, K.L.G.V., de Souza AL, Silva, M.C.D., Queiroz N., Souza A.L., Soledade L.E. B., Santos, I.M.G. & Souza A.G.** Influence of toasting on the nutritious and thermal properties of flaxseed, *Jorunal of Thermal Analysis and Calorimetry*, 106, 551–555, (2011).
6. **Kaur, A., Sandhu, V. & Sandhu K. S.**, Effects of flaxseed addition on sensory and baking quality of whole wheat bread, *International Journal of Food Nutrition and Safety*, 4(1), 43-54, (2013).
7. **Mazza, G. & Biliaderis, C. G.**, Functional properties of flax seed mucilage, *Journal of Food Science*, 54: 1302–1305, (1989).
8. **Meral, R. &Dogan I.S.** Quality and antioxidant activity of bread fortified with flaxseed, *Italian Journal of Food Science*, 25, 51-56, (2013).
9. **Obranović, M., Škevin, D., Kraljić, K., Pospišil ,M., Neđeral, S., Blekić, M. & Putnik P.**, Influence of climate, variety and production process on tocopherols, plastochromanol-8 and pigments in flaxseed oil, *Food Technology and Biotechnology* 53 (4): 496-504, (2015).
10. **Oomah, B.D. & Maza G.**, Flaxseed proteins – a review, *Food Chemistry*, 48, 109-114, (1993).
11. Oomah, B. D., Flaxseed as a functional food source, *Journal of the Science of Food and Agriculture*, 81, 889-894, (2001).
12. **Rakcejeva, T., Skudra, L., Strautniece, E.**, 2013, Sensory evaluation of wheat bread with flax seed marc additive, *Maisto chemija ir technologija*, 41 (2): 58-62, (2007).
13. **Rubilar, M., Gutiérrez, C., Verdugo, M., Shene, C. & Sineiro J.**, Flaxseed as a source of functional ingredients, *Journal of Soil Sicence and Plant Nutrition*, 10 (3): 373 – 377, (2010).
14. **Sargi, S.C., Silva, B.C., Santos, H.M.C., Montanher, P.F. & Boeing, J.S., Santos Junior O.O., Souza, N.E., Visentainer J.V.**, 2013, *Antioxidant capacity and chemical composition in seeds rich in omega-3: Chia, flax, and perilla*, Food Science and Technology, 33: 541–548.
15. **Sivam, AS, Sun-Waterhouse, D, Quek, & S, Perera**, Properties of bread dough with added fiber polysaccharides and phenolic antioxidants: a review, *Journal of Food Science*, 75, 163-174, (2010).

Xu, Y., Hall, C.A. & Manthey F.A. Effect of flaxseed flour on rheological properties of wheat flour dough and on bread characteristics, *Journal of Food Research*, 3 (6), 83-91, (2014).