EFFECTS OF THE PUMPKIN SEED ADDITION ON BREAD QUALITY OF WHEAT FLOUR WITH A VERY GOOD QUALITY FOR BREAD MAKING

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Abstract:

The objective of this study was to evaluate the effect of pumpkin seed flour addition at different levels (0, 5, 10, 15 and 20%) in wheat flour 650 type with a very good quality for bread making in order to improve bread quality. The physical characteristics (loaf volume, porosity, elasticity), mechanical textural parameters (hardness, cohesiveness, adhesiveness, viscosity, elasticity, gumminess, chewiness), crumb color (*L, a, b*, Δ*L*, Δ*a*, Δ*b*, Δ*E*), sensorial characteristics (overall acceptability, general appearance, color, flavor, texture, taste, smell, texture) and microstructure were determined in the control sample (0% pumpkin seed flour addition) and supplemented breads. The results highlight that the bread with 10 % pumpkin seed flour addition was rated the most acceptable from the all attributes evaluated.

Key words: pumpkin seed, bread, physical parameters, texture, sensory characteristics, principal component analysis

Introduction

Pumpkin (*Cucurbita sp.)* is a seasonal crop cultivated throughout the world for use as vegetable. Their seeds are uniquely flavored with nutty taste and are eaten as roasted, toasted, salted snack, ground as an ingredient [2] and/or as food additives [14]. Moreover, pumpkin seeds are used as raw material for food application, highly nutritious than cereals, due to its high protein content (37.80–45.40%), oil (25.20–37.00%), dietary fibers (16.84-24.02%) and minerals (4.59%) [1, 15, 22]. Among mineral elements, pumpkin seed contained especially phosphorus, magnesium and potassium [1]. From the point of view of amino acids composition, pumpkin seeds comprise high lysine content that aids in producing high protein bread when incorporated into bakery products [7] and tryptophan, an essential amino acid that is able to increase brain levels of serotonin, known to fight depression [15]. Regarding the lipid content, almost 73.03% correspond to the unsaturated fatty acids where linoleic acid (52.69%) and oleic acid (18.14%) are the dominant fatty acids, while the saturated fatty acid content comprise 27.73% and comprises of palmitic acid (16.41%) and stearic acid (11.14%) occur at lower levels [1, 13]. Also, very high vitamin E content and the main isomers alpha-tocopherol and gamma-tocopherol was found in pumpkin seed oil [3, 13]. The antioxidant properties of tocopherols could play a significant role in the therapeutic effects of pumpkin seed oil [21]. From the therapeutic point of view, pumpkin seeds have several health benefits such as prevention of the growth and reduction of the size of prostate, retardation of the progression of hypertension, mitigation of hypercholesterolemia and arthritis, reduction of bladder and urethral pressure and improving bladder compliance, alleviation of diabetes by promoting hypoglycemic activity, and lowering levels of gastric, breast, lung, and colorectal cancer [21]. Also, they are rich in plant sterols which have recently become of great interest due to the serum cholesterol-lowering effect [16]. Pumpkin seeds have also been used in traditional medicine with combination from several plants and herbs which contain fatty acids and phytosterols and are used in the treatment of benign prostatic hyperplasia [5].

Many studies related the incorporated of various flour from seeds such as sunflower seed, sesame seed, flaxseeds, grape seed [6, 10, 12, 20] into wheat flour in order to improve dough rheological characteristics and nutritional value of bread quality. Pumpkin seeds can be considered a good alternative for the nutritional enrichment of food products [8]. They are recognized as a good source of protein and nutrients for fortification of baked products, especially bread [4, 7], enhancing the texture and flavour of the product [15]. Moreover, pumpkin seed flour has an attractive greenish color and a nutty taste. The addition of pumpkin seeds protein increased the protein content, mineral content and the lysine level [7].

By addition in bread, pumpkin seeds can improve it quality from the nutritional and physical-chemical point of view. However, sensory evaluation also indicated that 5% pumpkin seed flour bread was the most acceptable bread [19]. El-Soukkary F.A.H. (2001) found that sensory properties of bread fortified with pumpkin seed protein level up to 19% indicated no significant differences between the wheat flour bread (control) and breads fortified with pumpkin seeds. Also, the loaf volume of the control was significantly higher than baked with raw pumpkin seeds meal, the loaf volume decreased with increasing level of substitution.

The object of the present study was to analyze not only the impact of pumpkin seeds flour (PSF) replacement (from 0% up to 20%) in wheat flour on bread quality due to it physical-chemical, textural, color profile and sensory characteristics, but also relationships between the bread characteristics evaluated at different pumpkin seeds flour substitution levels.

Materials and methods

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

The **chemical composition** of the flour was determined using the 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). The pumpkin seed was determined for: moisture, protein, fat and ash according to ICC methods (2010).

Bread preparation require following stages: the wheat flour was mixed with varying doses 0% (control sample), 5, 10, 15 and 20% of the pumpkin seed flour (PSF). The composite flours were mixed then with 3% yeast and 1.5% salt reported to the mass of the wheat- pumpkin seeds flour and water according to the wheat flour hydration capacity (56.3%) at 29-30ºC, were kneading in a mixer for approximate 15 min at 28-30ºC and then the modeled samples was proofed for 60 minutes at 30ºC, 85% relative humidity and baked in an electrical bakery convection oven with steam production, ventilation and humidification (Caboto PF8004D, Italy) for 35 min at 180^{o}C.

Physical parameters of bread were determined according to the Romanian standard methods described in SR 91:2007 after cooling the bread for 2 h at room temperature. Loaf specific volume – rapeseed replacement method, porosity and elasticity were measured.

Color analysis of samples wad done using the Konica Minolta CR–400 colorimeter. The color parameters such as luminance (*L*), red saturation index (*a*), and yellow saturation index (*b*) of the samples were evaluated using CIELAB color system measurement. The total color variation or difference (ΔE) was calculated as function of the deviation from *L* (ΔL), *a* (Δa) and *b* (Δb), Equation (1). The color profile analysis values were obtained in triplicate.

$$\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2} \quad (1)$$

The **texture parameters** of bread were measured using the Mesur Gauge software of Mark 10 texturometer. Hardness, cohesiveness, adhesiveness, viscosity, elasticity, gumminess and chewiness values were tested for mechanical textural properties of bread.

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 of the bread samples tasted for the sensory attributes such as: general appearance, colour, flavor, texture, taste, smell and overall acceptability were made by a panel of twenty semi-trained judges. Each sensory attribute was evaluated according to individual preferences on a nine point hedonic scale of 1 as “Dislike extremely”, 5 as “Neither one”, and 9 as “Like extremely”.

The **statistical analysis** was done using the Statistical Package for Social Science (v.16, SPSS Inc., Chicago, IL, USA) and Microsoft Excel 2007. A 5% significance level was used throughout the 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 pumpkin seeds are the fallowing characteristics: 5.4% moisture content, 33.58% crude protein, 29.26% fat content and 5.48% ash content.

Bread physical characteristics. The variation of loaf volume, porosity and elasticity of bread depending on the different quantities of pumpkin seed flour (PSF) added in wheat flour is shows in Figure 1. The results revealed that an increase of the PSF addition in wheat flour increase the loaf bread volume, porosity and elasticity up to 10% and then decrease them at the level of 20% PSF addition.

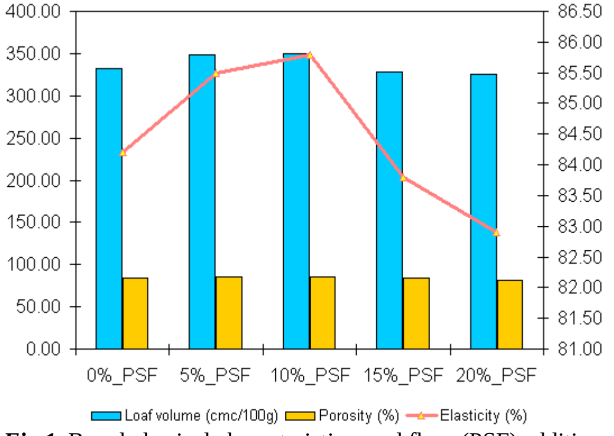


Fig.1. Bread physical characteristics seed flour (PSF) addition

The increase of the bread physical characteristics up to 10% PSF addition may be due to it fat content which wraps around the gas cells and prevent its release from the dough. A similar trend was reported by Meral and Dogan (2013) where the addition up to 15% flaxseed flour showed an increase in loaf volume which decreased with further level of flaxseed. Lower values of the bread physical characteristics may be due to the gluten dilution from the system the wheat-pumpkin seed dough which impaired carbon dioxide retention form during fermentation [9]. Porosity of bread samples decreased with increase in PSF incorporation about 10% (Figure 1). Sample with 20% PSF incorporation was more compact than control sample. The 10% PSF bread had the highest loaf volume as compared to the other samples. A similar observation was reported by Ptitchkina *et al.* (1998) where the addition of pumpkin flour showed a massive increase in loaf volume which decreased with further level of pumpkin flour.

Color profile analysis. The color parameters of the breads obtained from wheat-pumpkin seeds flour blends are showed in Table 1.

Table 1. Effect of pumpkin seed flour (PSF) addition on color profile analysis of wheat bread

Sample	*L*	*a*	*b*	*ΔL*	*Δa*	*Δb*	*ΔE*
Control (0% PSF)	74.46	-1.87	13.35	38.64	-15.22	-0.87	41.54
5% PSF	70.28	-1.90	16.89	34.46	-15.05	0.76	37.61
10% PSF	67.03	-1.98	17.50	31.10	-15.27	2.66	34.75
15% PSF	66.92	-2.12	18.61	29.22	-15.52	3.23	33.24
20% PSF	65.04	-2.26	18.95	28.64	-14.94	3.28	32.47

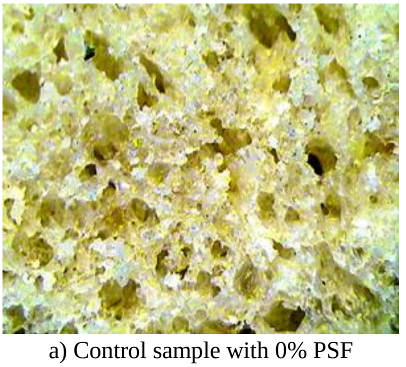
The lightness (*L*-value) of samples decreased when the proportion of the PSF increased in the blends. This is may be due to a darker greener color of PSF, comparatively to white wheat flour. The color *a* values increased when the proportion of PSF was higher at 20% in the blends. For *a* value, 20% pumpkin seed bread was greener than control bread than control bread. The *b* values were all positive indicating yellowish color. The bread with 20% of PSF displayed the highest *b* value.

Textural properties of bread. Crumb texture is an important attribute of bread quality, and the protein fraction plays a key role in the formation of the structure, gas retention, and volume of breads [18]. The results obtained for the bread samples with and without pumpkin seeds addition on mechanical textural properties of bread are shown in Table 2. The hardness, gumminess, and chewiness values increased with the addition of pumpkin seeds flour into bread formulas. This is certainly due to the lack of a coherent and continuous protein matrix that, in wheat-pumpkin flour bread, led to a low dough development significant in determining the crumb structure and, consequently, the mechanical properties of samples. Regarding the elasticity and cohesiveness of breads slower values were recorded for the samples with PSF addition but not with a considerable impact. The higher elasticity values were recorded for the sample with 5% PSF addition and for the texture parameters gumminess and chewiness the maximum values were recorded for the sample with 20% PSF addition in disagreement with the results obtained by Nyam *et al.* (2013) which find that, chewiness of the bread samples was reduced with the addition of pumpkin seeds and pumpkin rind flour [15].

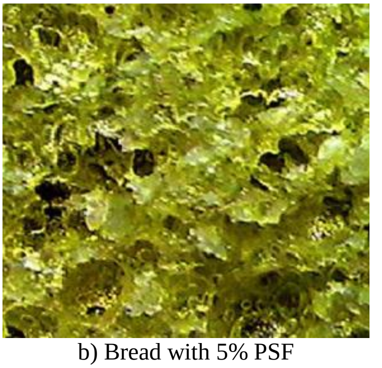
Table 2. Textural parameters of bread samples with different levels of pumpkin seed flour (PSF)

Sample	**Hardness, (N)**	**Cohesiveness**	**Elasticity**	**Gumminess, (N)**	**Chewiness, (N)**
Control (0% PSF)	16.22	0.69	0.82	11.19	9.62
5% PSF	26.62	0. 66	0. 97	16.77	12.83
10% PSF	32.60	0. 64	0. 83	17.28	14.26
15% PSF	32.96	0.53	0. 82	21.81	18.22
20% PSF	49.66	0.51	0. 76	26.32	25.75

Results of **bread microstructure** with increasing level of PSF (Figure 2) highlight that at a high levels of pumpkin seed flour 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 can not retain as well as the control sample the gas formed during fermentation process.



a) Control sample with 0% PSF



b) Bread with 5% PSF

c) Bread with 10% PSF

d) Bread with 15% PSF

e) Bread with 20% PSF

Fig. 2. Crumb structure of bread samples with different levels of pumpkin seed flour (PSF)

Analyses of the control and bread with 5% PSF showed a more discontinuous gluten matrix as compared to the bread with 10% and 15% pumpkin seed flour which have mesh-like structures. The control bread microstructure showed larger spherical air cells as compared to the 15% % and 20% PSF.

The **bread sensory characteristics** are shown in Figure 3. Bread consisting of 10% PSF had the highest score from the point of view of overall acceptability, taste, texture and appearance, indicating that panelists preferred bread samples added with pumpkin seed flour. The addition of higher levels of PSF caused an unpleasant aroma and taste. Bread with 20% pumpkin seeds flour was the least preferred bread among all bread samples. Also the panelists preferred the greenish brighter crumb color; the sample with 10% PSF addition was the best evaluated. Increase in replacement level of wheat flour with PSF beyond 10% reduced the likeness of bread with color point of view as the color became gradually darker with increase in replacement level.

From the point of view of smell and flavor the best evaluated was the sample with 10% PSF addition. Flavor likeness in sample with replacement level beyond 10 % was reduced as there was increase in oily flavor. The sensory score for texture decreased gradually with increase in addition level of PSF. As the level of addition was increased from 5% to 20%, the texture of the bread became inferior due to the gradual increase in hardness.

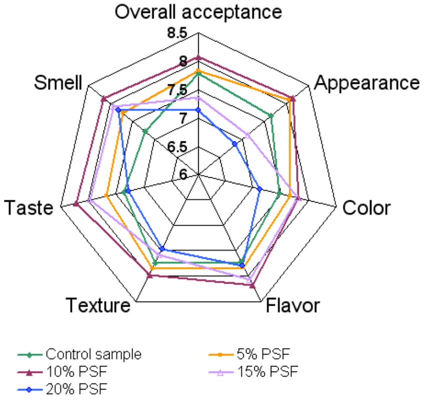


Fig. 3. The bread sensory characteristics

Relationship between the bread characteristics at different pumpkin seed flour addition levels. The principal component analysis (PCA) was used 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 PSF in wheat flour 650 type. The first two principal components explain 89.88% of the total variance PC1 = 56.65% and PC2 = 33.23%), Figure 1. Regarding the first principal component PC1, one can notice that there is a very good correlation between the colour parameters (L, ΔL, ΔE, b, Δb) and textural characteristics (hardness, elasticity, chewiness and gumminess). These parameters are strongly associated with the first component PC1. The textural parameter elasticity is opposed to chewiness and gumminess parameters. The second principal component, PC2 distinguishes the loaf volume and the cohesiveness, which are opposed. An inverse high correlation between loaf volume and cohesiveness ($r = -0.913$, $p < 0.05$) was found. In regard to the PC2 axis, the physical parameters loaf volume, porosity, elasticity and sensorial characteristics appearance. Color, texture and overall acceptability are placed on the left of the graph, which shows that these contribute to a larger extent to the evaluation of bread in comparison to the variables on the right. A good correlation ($r > 0.70$) between sensorial characteristics smell, taste and flavour was found. PC2 axis distinguishes between sensorial characteristic taste and textural parameter cohesiveness ($r = -0.838$, $p < 0.05$). Sensorial characteristic color is directly correlated with colorimeter parameter a ($r = 0.751$, $p < 0.05$).

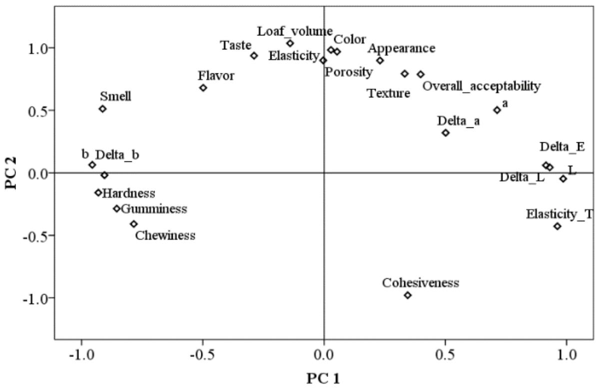


Fig. 4. Principal component analysis for the bread characteristics

Conclusions

Pumpkin seeds flour can be added into bakery products to enhance the nutritional value and overall acceptability of the food product. It appears appropriate to incorporate up to 10% of pumpkin seed flour into wheat flour bread from the point of physical, textural, sensorial and microstructural properties of bread. The experimental bread formulation resulted in a novel product which is considered beneficial to human health.

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