SENSORY, COLOUR AND STRUCTURAL PROPERTIES OF PANCAKES PREPARED WITH PEA AND BUCKWHEAT FLOURS

Ilze Beitane[1], Gita Krumina-Zemture[1], Irisa Murniece[2]

[1] *Department of Nutrition, Faculty of Food Technology, Latvia University of Agriculture, 2 Liela Street, Jelgava, Latvia, e-mail: Ilze.Beitane@llu.lv*

[2] *Department of Food Technology, Faculty of Food Technology, Latvia University of Agriculture, 2 Liela Street, Jelgava, Latvia*

Abstract

Pea and buckwheat flours, that are gluten free, possess nutritionally important amino acids, therefore they are useful for people suffering from celiac disease. The treatment of celiac disease is gluten free diet, thus it is important to produce gluten free products with high nutritional value. The aim of the research was to evaluate the effect of pea and buckwheat flour on colour, sensory and structural properties in pancakes. The results showed that during and after frying process pancakes kept their shape when 100% of pea flour was used. The structure of pancakes was changed from harder to the softer and was floury due to the pea flour replacement to the buckwheat flour. When the pancake was prepared with 100% of buckwheat flour, the pancakes fell apart – did not keep the shape properly-during frying. The sensory analysis results showed that pea and buckwheat flour affected pancake colour and taste. When higher amount of buckwheat flour was used in pancake preparation, the colour of pancakes changed to darker, the structure was softer and buckwheat flavour was predominant. The experienced panellists indicated that pancakes with 40% and 60% supplemented buckwheat flour were the most pleasant during sensory analysis. Similar tendency was obtained with results of colour (CIE Lab system) and texture analysis. L* and b* colour indices of pancakes had decreasing tendency when the amount of buckwheat flour was increased.

Keywords: pea flour, buckwheat flour, sensory properties, texture, colour.

Introduction

Celiac disease is one of the most common lifelong disorders, affecting 1% of the population worldwide (Catassi, Yachha, 2009). It is a digestive tract disease that damages the small intestine and interferes with the absorption of nutrients from food (De la Hera et al., 2013).

Gluten is a major protein component of wheat flour which is responsible from dough forming characteristics in bakery industry (Torbica et al., 2010), affects elastic properties of dough and contributes to the overall appearance and crumb structure of many baked products (Torbica et al., 2012). However, gluten must be eliminated from the diet of patients with celiac disease. Therefore it is important to produce gluten free products with high nutritional value. Many researchers have studied the substitution of gluten by ingredients with the similar functional properties (Sciarini et al., 2008). Most of the gluten free products are on starch or rice basis with addition of different types of hydrocolloids (Torbica, 2010).

Legumes have an important place from the nutritive point of view (Kohajdováet al., 2013), they are as good sources of proteins, carbohydrates, several water soluble vitamins (Sreerama et al., 2012) and minerals such as calcium, iron, zinc and magnesium (Kaur et al., 2007; Amarakoon et al., 2012). Legumes have been identified as low glycaemic index foods (Bornet et al., 1997), which proteins can be successfully used in baked products to obtain a protein-enriched product with improved amino acids balance (Mohammed et al., 2012). Legume flours were successfully applied as functional ingredients in cereal based foods such as bread (Hefnawy et al., 2012), cake (Gómez et al., 2008), cracker biscuits (Kohajdová et al., 2013) and spaghetti (Arab et al., 2010).

Field pea is one of the oldest domesticated food crops, which is grown widely as a cool season grain legume (Wang et al., 2011) and which is an excellent source of complex carbohydrates, protein, dietary fibre, vitamins and mineral micronutrients (Wang et al., 2010; Amarakoon et al., 2012). The starch and protein content of peas range between 30–50% and 20–25% of the dry matter, respectively (Simsek et al., 2009; Piecyk et al., 2012). Kohajdová et al. (2013) indicated that inclusion of pea flour to wheat dough resulted in increased water absorption capacity and dough development time, in addition incorporation of higher levels of pea flour (20% and 30%) into crackers significantly reduced volume index, width to spread ratio of final products.

Buckwheat is recognised as an important functional food in some countries such as China, Japan and Taiwan and can be used to replace rice or potatoes in the regular meal (Lin et al., 2009). Buckwheat proteins consisted mainly of globulins (up to 50%) and albumins (about 25%) (Choi et al., 2006), they are known for their well-balanced amino acid content (Ikeda, Asami, 2000) and are particularly rich with essential amino acids as lysine and arginine (Choy et al., 2013) as well as they are gluten free which makes them useful for patients suffering from celiac disease (Ikeda, 2002). In addition, buckwheat was found to be a prebiotic, because the research of Prestamo et al. (2003) showed that buckwheat could increase lactic acid bacteria in rat intestine. In general buckwheat, which is added to food as a supplement, can provide beneficial health effects and prevent food from oxidation during processing (Lin et al., 2009).

Pea and buckwheat flours, that are gluten free, possess nutritionally important amino acids, therefore they are useful for people suffering from celiac disease. Choy et al. (2013) incorporated buckwheat flour into noodle formulation instead of wheat flour in order to analyse

the colour of final products. They found that the brightness of noodles was low that can be regard to brownish colour. Lin et al. (2009) indicated that buckwheat enhanced wheat bread exhibited lower brightness and higher redness and yellowness.

The above mentioned research findings showed that pea and buckwheat possess unique nutritional properties and in the development of new products, the addition of pea and buckwheat flour would enrich nutritional composition of the product and thus would be beneficial for our health. However, replacement of wheat flour with pea and buckwheat flour would lead to some changes on rheological and sensory properties. Therefore, the aim of the research was to evaluate the effect of pea and buckwheat flour on colour, sensory and structural properties of pancakes.

Materials and Methods

Materials

Pea flour (PF) and buckwheat flour (BF) were purchased from Fasma, Lithuania. Sugar, baking powder, milk with fat content 2.5% and refined rapeseed oil for dough preparation of pancakes were obtained from the local food market.

The procedure of pancake preparation

At the beginning of pancake preparation, 100% of pea flour (PF) was used and then pea flour was replaced by buckwheat flour (BF) in following PF : BF ratios: 80 : 20, 60 : 40, 40 : 60 and 20 : 80. Because of radical changes in structural properties of the final product, pancakes prepared with 100% of buckwheat flour were excluded in this research.

In the preparation of the dough, all ingredients were mixed to reach smooth dough consistency; then dough was kept for 20 min (resting time) then fried for 8±1 min on frying pan where oil temperature was adjusted to 150±2 °C. Pancakes were served at 65 ±2 °C to determine sensory properties.

According to the added amount of pea and buckwheat flour, the following abbreviations for the samples in current research were used:

- 100% PF – pancakes with 100% of pea flour;
- 80% PF+20% BF – pancakes with 80% of pea and 20% of buckwheat flour;
- 60% PF+40% BF – pancakes with 60% of pea and 40% of buckwheat flour;
- 40% PF+60% BF – pancake with 40% of pea and 60% of buckwheat flour;
- 20% PF+80% BF – pancake with 20% of pea and 80% of buckwheat flour.

Sensory evaluation of pancakes

In order to evaluate differences among pancakes prepared with different amount of buckwheat flour, sensory assessment was performed. Eight experienced staff members from Latvia University of Agriculture Faculty of Food Technology (females between 33–62 years old) were selected. They were selected according to their willingness, availability, motivation and previously demonstrated capability to work as a member of a sensory panel.

Five sensory properties – aroma, taste, colour, hardness and structure were analyzed using a line scale (ISO 4121:2003). Pea and buckwheat aroma, pea and buckwheat taste, yellow and grey colour was followed from ‘not perceptible’ to ‘strongly perceptible’. Hardness was defined from ‘soft’ to ‘strong’ and structure expressed from ‘porous’ to ‘dense’.

In the second part of sensory analysis, the ranking test (ISO 8587:2006) was used with the aim of ranking pancake samples in the following order: the most pleasant – the worst.

Colour measurement

Colour measurements of pancakes were carried out in quintuple using CIE Lab system. The obtained results were expressed in terms of CIE L*, a* and b* values. L* indicates brightness, *a** represents red to green coordinates and b* represents blue to yellow coordinates of a product.

Structure analysis

Texture analyzer “TA.XT.plus Texture Analyser” (Stable Micro Systems Ltd., Surrey, UK) with a Warner–Bratzler shear blade with guillotine probe was used. The cut was performed perpendicularly to the main axis of the pancake until completely breaking. The peak force obtained was taken to be the result from the test (N). The cutting parameters: pre-test speed 1 mm s^{-1}; test speed 3 mm s^{-1}; post test speed 10 mm s^{-1}; cutting distance of 25 mm into the pancake sample. The maximum force required for sample cutting was calculated as an average of six measurements. Obtained data were processed in the Texture Exponent 32 programme.

Statistical analysis

The results were analyzed using one way and two way analysis of variance (ANOVA). T-test was applied to compare the mean values, and p-value at 0.05 was used to determine the significant differences. The correlation analysis was performed in order to determine the relationship between results of sensory analysis and measurements of colour and structure.

Results and Discussion

It is known that consumer behaviour about food choice is determined not only by nutritional value and healthy properties but also sensory evaluation of particular food product. Good quality pancake should possess pleasant pea or buckwheat taste and aroma as well as soft and porous structure. The changes of sensory properties of pancakes with pea flour to buckwheat flour ratios were shown in Figure 1.

The changes of sensory properties of pancakes were affected by the amount of buckwheat flour replaced with the pea flour. By increasing the amount of buckwheat flour the structure of pancakes became softer and denser, colour became darker and buckwheat taste as well as aroma – predominant.

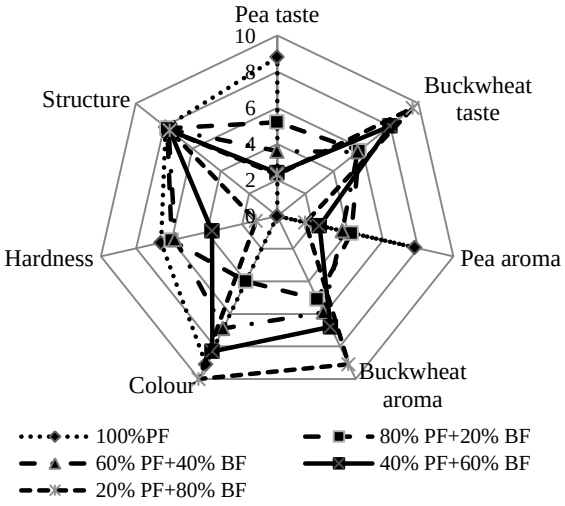

Figure 1. Intensity of sensory properties of pancakes prepared with different ratios of pea flour to buckwheat flour

Evaluation of sensory properties of pancakes with pea and buckwheat flour showed that there were significant differences in intensity of pea and buckwheat taste and aroma, in addition to colour and hardness ($p<0.05$), but there was no significant difference in their structures ($p>0.05$). Pancake samples prepared with 100% PF had significant difference in terms of intensity of pea taste and aroma ($p<0.05$) when compared to other pancakes. The intensities of buckwheat taste and aroma, colour and hardness exhibited significant differences ($p<0.05$) when the pancakes produced with the highest amount of buckwheat flour (20% PF+80% BF). The structure of the same sample was softer and colour much darker when compared to the lightest grey colour obtained with the sample of 80% PF+20% BF.

Focusing on the results of structure, pancake sample having 40% PF+60% BF ratio had significant difference ($p<0.05$) when compared to other samples in term of its soft consistence.

Sensory analysis showed that buckwheat flour addition into the pancake formula caused decreasing of pea taste and aroma, in other words, predominance of pea taste and aroma felt by experts was not so acceptable. Similar conclusions were reported by Kohajdová et al. (2013) in which higher levels of pea flour caused significant reduction in taste, odour and overall acceptance of final crackers due to higher intensity of leguminous taste and odour.

The sensory analysis of ranking showed that the most pleasant pancake samples were obtained with 40% PF+60% BF and 60% PF+40% BF and they were significantly different from other pancake samples ($p<0.05$).

In evaluation of the colour changes in pancake samples with different buckwheat flour supplementation ratio, sensory experienced staff determined similar results. When the buckwheat flour addition was increased in pancake preparation by replacing pea flour, the brightness (L*) of pancake decreased apparently (Fig.2). Similar results were obtained in the study of Lin at al. (2009) by substituting 15% of wheat flour with buckwheat flour in wheat bread preparation. It was the fact that buckwheat flour exhibited beige colour. Choy et al. (2013) and Chillo et al. (2008) reported that the L* values of instant noodles and spaghetti containing buckwheat flour significantly decreased when compared with control samples.

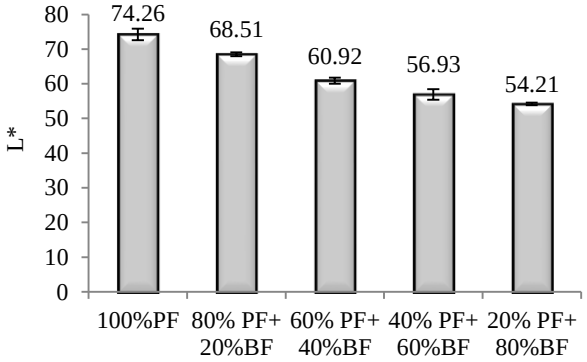

Figure 2. Lightness of pancakes prepared with different ratios of pea flour to buckwheat flour

Decreasing of lightness in 20% PF+80% BF pancake preparation was more than 25% when compared with 100% PF pancake formulation. Pancake samples became much darker when buckwheat flour incorporation increased. On the other hand, Lin et al. (2009) reported that the dark colour of buckwheat incorporated wheat bread might be noticeable to attract consumer's attention.

The correlation was found as very close ($r=-0.995$) between the lightness measurements and experts assessments related to colour intensity in pancake samples.

Buckwheat flour incorporation in pancake preparation resulted an increase in a* values from -3.58 to 2.27 (Fig. 3).

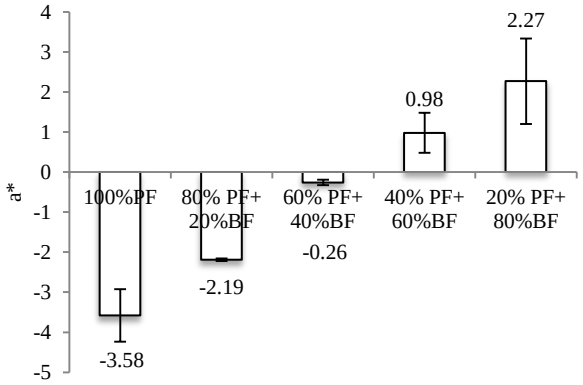

Figure 3. The a* value intensity of pancakes prepared with different ratios of pea flour to buckwheat flour

Similar findings were reported by Choy et al. (2013) where a* value changed from negative to positive value in instant noodles by increasing the buckwheat

amount. Lin et al. (2009) determined similar results like an increase of redness value in wheat bread with the addition of buckwheat flour. In addition, differences were determined between unhusked and husked buckwheat supplemented wheat bread.

The correlation analysis showed that there was close correlation (r=0.998) between measurements of a* value and results of sensory analysis.

In evaluation of the b* value intensity in pancake samples, there was concluded that buckwheat flour significantly affected b* value by decreasing yellowness value in pancakes (Fig. 4). Similar conclusions were indicated by Torbica et al. (2012). In their research related to cookie production with rice and buckwheat flour, yellowness values slightly decreased by increasing the amount of buckwheat flour in cookie formulation.

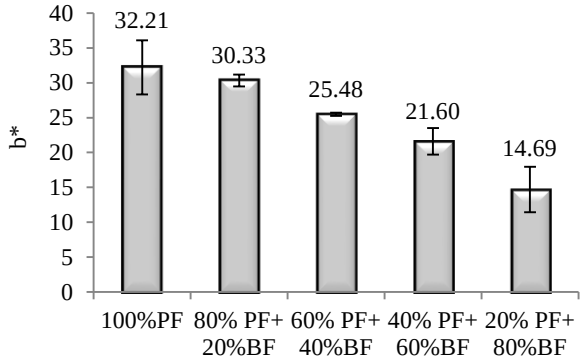

Figure 4. The b* value intensity of pancakes prepared with different ratios of pea flour to buckwheat flour

When the 100% PF pancake sample was compared with the 20% PF+80% BF pancake sample, an increased amount of buckwheat flour caused more than 50% decrease on yellowness. Furthermore, close correlation (r=-0.974) was determined between measurement of b* value and expert's assessment of colour intensity for pancakes prepared with pea and buckwheat flour.

The results of colour measurements showed that the increased amount of buckwheat incorporation in pancake formulation significantly ($p<0.05$) affected L*, a* and b* values.

The hardness results of pancakes prepared with different ratios of pea flour to buckwheat flour were given in Figure 5. The adding of buckwheat in concentrations of 60% and 80% significantly decreased hardness values of pancake samples when compared to other samples. It was observed that an increase of buckwheat flour incorporation caused a decrease on hardness values of pancake samples. Choy et al. (2013) indicated that incorporating buckwheat flour significantly affected hardness of instant noodles which became softer.

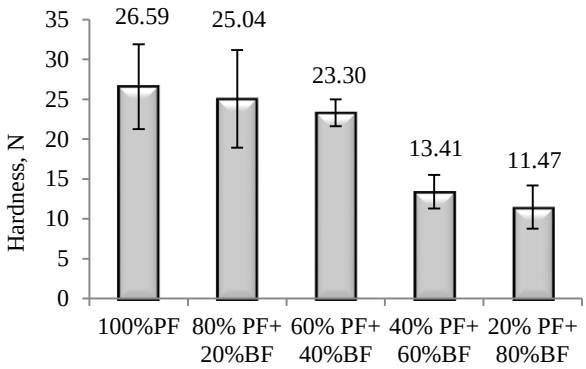

Figure 5. Hardness of pancakes prepared with different ratios of pea flour to buckwheat flour

Whereas Kahajdová et al. (2013) established that addition of pea flour concluded in increased hardness of crackers. Therefore, it could be concluded that addition of buckwheat flour provided softer structure of pancakes. These changes were observed by experts too. The results of sensory analysis and structure analysis exhibited close correlation (r = 0.951).

Conclusions

The sensory properties were affected by the amount of added buckwheat flour in pea flour pancakes. There were significant differences in intensity of pea and buckwheat taste and aroma, colour and hardness ($p<0.05$), but there was no significant difference in structure ($p>0.05$). Sensory analysis showed that buckwheat flour incorporation into the pancake formulation caused decreasing of pea taste and aroma – predominance of pea taste and aroma was not acceptable according to the evaluation of sensory panelists. The amount of added buckwheat in pancake formula significantly ($p<0.05$) affected L*, a* and b* values as well as resulted softer structure on pancakes.

References

1. Amarakoon D., Thavarajah D., McPhee K., Thavarajah P. (2012) Iron-, zinc- and magnesium-rich field peas (*Pisum sativum* L.) with naturally low phytic acid: A potential food-based solution to global micronutrient. *Journal of Food Composition and Analysis*, Vol. 27, p. 8–13.
2. Arab E.A.A., Helmy I.M.F., Barch G.F. (2010) Nutritional evaluation of functional properties of chickpea (*Cicer arietinum* L.) flour and the improvement of spaghetti produced from its. *Journal of American Science*, Vol. 6(1), p. 1055–1072.
3. Bornet F.R., Billaux M.S., Messing B. (1997) Glycaemic index concept and metabolic diseases. *International Journal of Biology Macromolecules*, Vol. 21, p. 207-219.
4. Catassi C., Yachha S.K. (2009) The epidemiology of celiac disease. **In:** *The science of gluten-free foods and beverages*. E.K. Arendt, F. Dal Bello (eds). Minnesota, USA: Academic Press, p. 1–13.
5. Chillo S., Laverse J., Falcone P.M., Protopapa A., Del Nobile M.A. (2008) Influence of the addition of buckwheat flour and durum wheat bran on spaghetti quality. *Journal of Cereal Science*, Vol. 47, p. 144–152.

6. Choi S.M., Mine Y., Ma C.Y. (2006) Characterization of heat-induced aggregates of globulin from common buckwheat (*Fagopyrum esculentum Moench*). *Journal of Biological Macromolecules*, Vol 39, p. 201–209.
7. Choy A-L., Morrison P.D., Hughes J.G., Marriott Ph.J., Small D.M. (2013) Quality and antioxidant properties of instant noodles enhanced with common buckwheat flour. *Journal of Cereal Science*, Vol. 57, p. 281–287.
8. De la Hera E., Martinez M., Gómez M. (2013) Influence of flour particle size on quality of gluten-free rice bread. *LWT – Food Science and Technology*, Vol. 54, p. 199–206.
9. Gómez M., Oliete B., Rosell C.M., Pando V., Fernández E. (2008) Studies on cake quality made of wheat-chickpea flour blends. *LWT – Food Science and Technology*, Vol. 41, p. 1701–1709.
10. Hefnawy T.M.H., El-Shourbagy G.A., Ramadan M.F. (2012) Impact of adding chickpea (*Cicer arietinum* L.) flour to wheat flour on the rheological properties of toast bread. *International Food Research Journal*, Vol. 19(2), p. 521–525.
11. Ikeda K. (2002) Buckwheat: Composition, chemistry and processing. *Advances in Food and Nutrition Research*, Vol. 44, p. 395–434.
12. Ikeda K., Asami Y. (2000) Mechanical characteristics of buckwheat noodles. *Fagopyrum*, Vol. 17, p. 67–72.
13. Kaur M., Sandhu K.S., Singh N. (2007) Comparative study of the functional, thermal and pasting properties of flours from different field pea (*Pisum sativum* L.) and pigeon pea (*Cajanus cajan* L.). *Food Chemistry*, Vol. 104(3), p. 259–267.
14. Kohajdová Z., Karovičová J., Magala M. (2013) Rheological and qualitative characteristics of pea flour incorporated cracker biscuits. *Croatian Journal of Food Science and Technology*, Vol. 5(1), p. 11–17.
15. Lin L-Y., Liu H-M., Yu Y-W., Lin S-D., Mau J-L. (2009) Quality and antioxidant property of buckwheat enhanced wheat bread. *Food Chemistry*, Vol. 112, p. 987–991.
16. Mohammed I., Ahmed A.R., Senge B. (2012) Dough rheology and bread quality of wheat-chickpea flour blends. *Industrial Crops and Products*, Vol. 36, p. 196–202.
17. Piecyk M., Wołosiak R., Drużynska B., Worobiej E. (2012) Chemical composition and starch digestibility in flours from Polish processed legume seeds. *Food Chemistry*, Vol. 135, p. 1057–1064.
18. Prestamo G., Pedrazuela A., Penes E., Lasuncion M.A., Arroyo G. (2003) Role of buckwheat diet on rats as prebiotic and healthy food. *Nutrition Research*, Vol. 23, p. 803–814.
19. Sciarini S.L., Ribotta D.P., León E.A., Pérez T.G. (2008) Influence of gluten-free flours and their mixtures on batter properties and bread quality. *Food and Bioprocess Technology*. doi: 10.1007/s11947-008-0098-2
20. Simsek S., Tulbek M.C., Yao Y., Schatz B. (2009) Starch characteristics of dry peas (*Pisum sativum* L.) grown in the USA. *Food Chemistry*, Vol. 115, p. 832–838.
21. Sreerama Y.N., Sashikala V.B., Pratape V.M., Singh V. (2012) Nutrients and antinutrients in cowpea and horse gram flours in comparison to chickpea flour: Evaluation of their flour functionality. *Food Chemistry*, Vol. 131(2), p. 462–468.
22. Torbica A., Hadnadev M., Dapčević T. (2010) Rheological, textural and sensory properties of gluten-free bread formulations based on rice and buckwheat flour. *Food Hydrocolloids*, Vol. 24, p. 626–632.
23. Torbica A., Hadnadev M., Hadnadev T.D. (2012) Rice and buckwheat flour characterisation and its relation to cookie quality. *Food Research International*, Vol. 48, p. 277–283.
24. Wang N., Hatcher D.W., Warkentin T.D., Toews R. (2010) Effect of cultivar and environment on physicochemical and cooking characteristics of field pea (*Pisum sativum* L.). *Food Chemistry*, Vol. 118, p. 109–115.
21. Wang S., Sharp P., Copeland L. (2011) Structural and functional properties of starches from field peas. *Food Chemistry*, Vol. 126, p. 1546–1552.