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SENSORY AND INSTRUMENTAL PROPERTIES OF NOVEL GLUTEN - FREE PRODUCTS
SENZORNE I INSTRUMENTALNE OSOBINE NOVIH BEZGLUTENSKIH PROIZVODA

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ABSTRACT

The purpose of this paper was to evaluate the quality of novel gluten-free cookies in terms of sensory, colour and textural properties. The light buckwheat flour was included in cookie formulations at three levels and compared to the control sample based on rice flour. Colour values of cookies were determined by a chromameter MINOLTA, CR-400. Textural properties, hardness and fracturability, were measured using a TA.XT Plus Texture Analyzer equipped with a 3-Point Bending Rig and a 30 kg load cell. Sensory properties were evaluated using a 5-point category scale. As regard the colour, buckwheat addition caused significant ($P < 0.05$) decrease of lightness, redness and yellowness. The addition of 20% buckwheat flour into the cookie formulation achieved the lowest differences in instrumental properties compared to the control sample and better sensory properties than other cookies with buckwheat.

Key words: *sensory properties, gluten-free, cookies, buckwheat, colour, texture.*

REZIME

Cilj ovog rada bio je da se oceni kvalitet novog bezglutenskog keksa u pogledu senzornih osobina, boje i teksture. Formulacija kontrolnog keksa izmenjena je supstitucijom pirinčanog brašna sa belim heljdinim brašnom u tri različite količine. Boja površine keksa određena je uz primenu hromametra MINOLTA, CR-400. Teksturna svojstva, čvrstoća i lomljivost, izmereni su na analizatoru teksture TA.XT Plus, uz upotrebu nastavka 3-Point Bending Rig i sa ćelijom opterećenja od 30 kg. Metodom bodovnog sistema ocenjene su senzorne osobine. Po pitanju boje, dodatak heljdinog brašna izazvao je značajno ($P < 0,05$) smanjenje svetiline, crvene i žute boje. Dodavanjem 20% heljdinog brašna u formulaciju keksa postižu se najmanje razlike u instrumentalnim osobinama u poređenju sa kontrolnim uzorkom i bolje senzorske osobine nego kod drugih formulacija.

Ključne reči: *senzorske osobine, bezglutenski, keks, heljda, boja, tekstura.*

INTRODUCTION

Gluten must be eliminated from the diet of people who suffer from celiac disease because even minor quantities of this protein causes inflammation of the small intestine and leads to the reduced absorption of several important nutrients (iron, folic acid, calcium, fat soluble vitamins) (*Gallagher et al., 2004*). Besides celiac disease patients, many other individuals cannot tolerate gluten protein because allergic reactions and they also need to avoid gluten containing food (*Mariotti et al., 2013*). On the other hand, absence of gluten in the flour brings major problems for bakers since it is the main structure forming protein responsible for the elastic characteristics of dough as well as for overall good appearance and crumb structure (*Gallagher et al. 2004*). Therefore, gluten-free products are generally market by reduced technological, nutritional and sensory quality.

In recent years there has been significantly more Research & Development on gluten-free formulations in order to improve the acceptability and shelf life of gluten-free products. Numerous researchers recommended usage of a range of gluten-free flours rather than just one flour type to achieve products with good sensory and textural properties. Furthermore, gluten-free formulations generally are not enriched/ fortified and because of that they may not contain the same levels of nutrients and fibres as their gluten-containing counterparts (*Sakač et al., 2011a*).

Due to the absence of gluten, rice is recommended as safe for people affected by celiac disease and it is commonly used to produce gluten-free products, alone or in combination with other no-gluten cereals and/or additives. The enrichment of gluten-free products with dietary fibres has been a topic of research for many studies (*Marco and Rosell, 2008*; *Gallagher et al., 2004; Gallagher et al., 2003; Torbica et al., 2010*). Among potential additives, buckwheat is one of the best plant sources of proteins, minerals, antioxidants and dietary fibres (*Sedej et al., 2011a; Sakač et al., 2011b; Šimurina et al., 2009)*. Moreover, *Marco and Rosell (2008), Sakač et al. (2011a) and Torbica et al. (2010)* showed that bland of buckwheat and rice have the potential to give gluten-free breads with good sensory attributes.

Bearing all this in mind, it is clear that production of good-quality gluten-free products with acceptable sensory and textural properties is a significant technological challenge. There are many studies about technological (*Schober et al., 2010; Crockett et al., 2011; Arendt et al., 2008)*, but just few studies about the sensory properties of gluten-free products. Consequently, the aim of present work was to examine sensory, colour and textural properties of gluten-free cookies containing rice and buckwheat flour in different ratios.

MATERIAL AND METHOD

Materials

The rice flour was mixed with varying inclusions of 10, 20 and 30% of the white buckwheat flour and three different gluten-free formulations were made according to *Torbica et al., (2012)*. The control cookie formulation contained rice flour only. Cookies were made in the pilot plant of the Institute of Food Technology, Novi Sad.

Colour determination

Surface colour of cookie samples was determined by a Minolta Chromameter (Model CR-400, Minolta Co., Osaka, Japan). Colour values of top and bottom surfaces, at five measured

points (centre and corners of cookies), were recorded for ten randomly chosen cookies per batch. The results were expressed as L^* (lightness), a^* (+ a^* = redness, -a^* = greenness), and b^* (+b^* = yellowness, -b^* = blueness), according to CIE $L^*a^*b^*$ system.

Textural Properties

Textural properties of the gluten-free cookies, hardness and fracturability, were measured by a TA.XT Plus Texture Analyzer (Exponent Stable Micro System, UK) equipped with a 3-Point Bending Rig (HDP/3PB) and a 30 kg load cell in compression mode. Each cookie was precisely centred on the base and rounded-edge blade, positioned just above it, was slowly lowered to break the cookie at a travel distance of 5 mm. The cookies were analysed at a test speed of 0.5 mm/s, with trigger force of 5 g. Textural properties were determined on eight cookies per batch.

Sensory analysis

Prior to sensory analysis, sensory profile of gluten-free cookies was established by a multidimensional approach *(Jambrec et al., 2012)*. The established sensory profile included one descriptor of whole product (colour), two for odour (odour and off-odour), five for texture (fatness, hardness, fracturability, adhesiveness and particle size or shape), two for appearance/texture of cross-section (crumbliness and sharpness), and two for taste (taste and off-taste). In order to evaluate differences between cookies, six trained panellists were evaluated cookies 24 h after baking, using 5-point category scale. The panellists were selected from previously trained academic staff of the Institute for Food Technology, Novi Sad, according to ISO 8586-2 (1994).To provide the necessary concentration for individual panellist, the work of panellists was performed in the boots and the prescribed environmental conditions according to ISO8589 (2007). Tap water and slices of apple were used to clean the mouth between samples.

Statistical analysis

Results were expressed as mean ± standard deviation. The obtained data were statistically analyzed by a one-way analysis of variance (ANOVA) and Fisher LSD test was used to establish the significance of differences among samples at $P < 0.05$.

RESULTS AND DISCUSSION

The brownish colour of the cookies' surface was generated in the baking process possibly due to non-enzymatic browning (Maillard reactions) between reducing sugars and amino acids, but also possibly to sugar caramelization *(Zucco et al., 2011)*. Differences in colour characteristics of gluten-free cookies are presented in Fig. 1. Decrease in the colour values with regard to formulation was noticed. Namely, cookie samples with added buckwheat flour were significantly darker, less yellow and less red than the control sample. ANOVA showed that the addition of buckwheat significantly decreased the quantitative component of lightness. Moreover, the variations observed in the colour coordinates values (a^*, b^*) were significant ($P < 0.05$). According to *Fujita et al. (2004)* there is significant positive correlation between antioxidant activity and b^* parameter. Additionally, many studies confirmed high antioxidant potential of buckwheat *(Sakač et al., 2011; Sedej et al., 2011b)* which may be one reason that caused such colour changes.

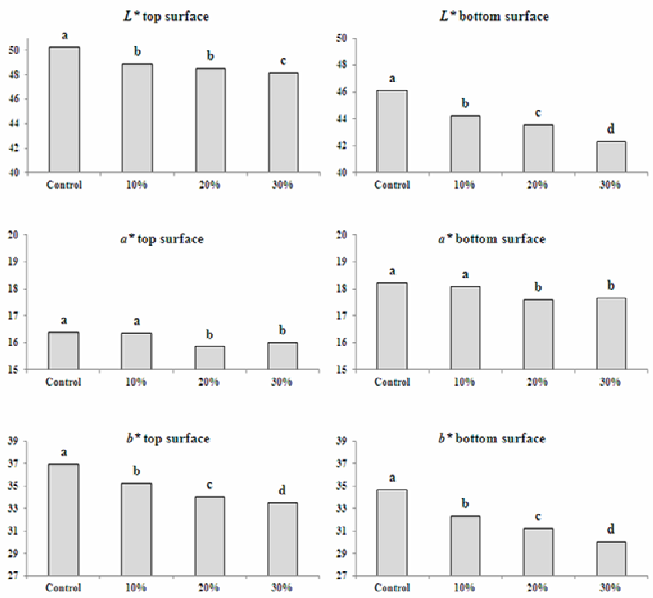

Fig. 1. Gluten-free cookies' top and bottom surfaces colour characteristics (L^* (lightness), a^* (+ a^* = redness, -a^* = greenness), and b^* (+b^* = yellowness, -b^* = blueness). Bars are means of 10 x 5 replications. Bars signed with a different letter (a, b, c, d) are significantly different ($P < 0.05$)

The two parameters used to estimate the texture characteristics of cookies were hardness and fracturability. These textural parameters can be recognized as desirable sensory property but only until they become extreme. Hardness (peak force) represents maximum resistance of each cookie against the rounded-edge blade and occurs when the sample is starting to break. It means that cookies with higher peak force are harder which is undesirable for cookie product *(Agyare et al., 2005)*. Fracturability is distance to peak force, and cookies with greater distance values are more compressible and less fracturable. Changes caused by the addition of buckwheat flour in our experiment are presented in Figure 2.

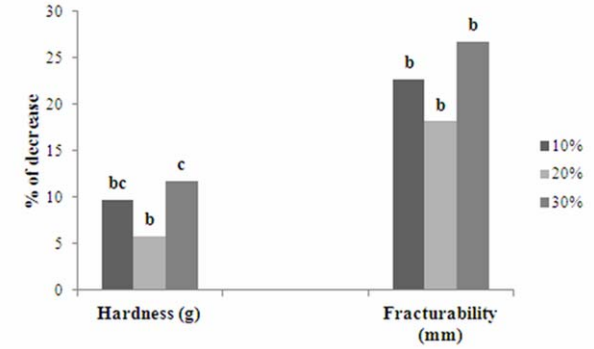

Fig. 2 Textural properties of gluten-free cookies
Bars signed with a different letter (b, c) are significantly different percentage of decrease of observed textural parameters in comparison to the control sample (a) ($P < 0.05$)

In general, buckwheat flour addition in cookie formulation was followed by significant ($P < 0.05$) decrease in hardness (from 5.84 to 11.78 %) and fracturability (from 18.16 to 26.68 %). Furthermore, it should be noted that among the cookies with buckwheat flour, the addition of 20% buckwheat flour resulted in the lowest percentage decrease of hardness and fracturability values in comparison to the control sample which was evaluated the best scores by trained panel (Fig. 3). In term of fracturability values there was no statistically difference between all enriched cookies. However it should be noted that the enriched cookie with 20% buckwheat flour showed the lowest percentage de-

crease in related to the control sample. It means that the addition of 20% buckwheat flour is more suitable in holding the proper shape of cookie and in showing the crumbliness.

The sensory quality of the produced gluten-free cookies was defined based on the established profile showed in Figure 3. Data analysis of the sensory evaluation revealed that almost all observed sensory properties of cookies enriched with buckwheat flour rated higher scores than the control sample. The obtained results pointed that among the buckwheat cookies the sample enriched with added 20% of buckwheat flour rated significantly ($P < 0.05$) better in terms of colour, odour and taste. It was in accordance to Bilgiçli (2009) who also revealed that the addition of 20% buckwheat flour shown acceptable sensory properties compared the different percentage of buckwheat substitution.

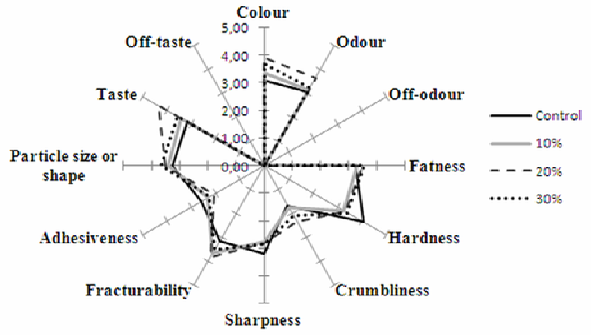

Fig. 3. Spider diagram of the sensory property scores of gluten-free cookies

CONCLUSION

The results of this study indicated that buckwheat flour addition into the rice flour cookie formulation did not lead to a negative impact on the sensory quality of the evaluated samples. Sensory evaluation showed that almost all observed sensory properties of cookies enriched with buckwheat flour rated higher scores than the control sample. The addition of 20% buckwheat flour into the cookie formulation achieved the lowest differences in instrumental properties compared to the control sample and better sensory properties than other cookies with buckwheat. The results of this paper could be used for the introduction of novel rice-buckwheat gluten-free cookies in the market which would increase assortment of functional foods appropriate for celiac disease patients. There is a need to create models that can integrate studies of the effects of buckwheat characteristics and processing on the cookies sensory qualities, with studies of consumer preferences and their attitudes towards this product.

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REFERENCES

Agyare, K. K., Addo, K., Xiong, Y. L., Akoh, C. C. (2005). Effect of structured lipid on alveograph characteristics, baking and textural qualities of soft wheat flour. Journal of Cereal Science, 42, 309–316.

Arendt, E. K., Morrissey, A., Moore, M. M., Dal Bello, F. (2008). Gluten-free breads. In E. K. Arendt, & F. Dal Bello (Eds.), Gluten-free cereal products and beverages (289–319). London: Academic Press.

Bilgiçli, N. (2009). Effect of buckwheat flour on chemical and functional properties of tarhana. LWT - Food Science and Technology, 42, 514–518.

Crockett, R., Ie, P., Vodovotz, Y. (2011). How do xanthan and hydroxypropyl methylcellulose individually affect the physicochemical properties in a model gluten-free dough? Journal of Food Science, 76, 274–282.

Fujita, K., Inouei, N., Hagiwara, S., Yang, Z., Katoi, M., Hagiwara, M. (2004). Relationship between antioxidant activity and flour and hull color in tartary buckwheat. Fagopyrum, 21, 51–57.

Gallagher, E., Gormley, T. R., Arendt, E. K. (2004). Recent advantages in the formulation of gluten-free cereal-based products. Trends in Food Science and Technology, 15, 143-152.

Gallagher, E., Kunkel, A., Gormley, R. T., Arendt, K. (2003). The effect of dairy and rice powder addition on loaf and crumb characteristics, and on shelf life (intermediate and long-term) of gluten-free breads stored in a modified atmosphere. European Food Research & Technology, 218, 44-48.

ISO 8586-2. (1994). Sensory analysis: General guidance for the selection, training and monitoring of assessors. Part 2: Experts. Geneva, Switzerland: International Organization for Standardization.

ISO 8589. (2007). Sensory analysis: General guidance for the design of test rooms. Geneva, Switzerland: International Organization for Standardization.

Jambrec, D., Pestorić, M., Žigon, U. (2012). Development and application of descriptors for establishing sensory profile of gluten-free cookies by a multidimensional approach. Food and Feed Research, 39, 41-50.

Marco, C., Rosell, C. M. (2008). Functional and rheological properties of protein enriched gluten-free composite flours. Journal of Food Engineering, 88, 94-103.

Mariotti, M., Ambrogina Pagani, M., Lucisano, M. (2013). The role of buckwheat and HPMC on the bread making properties of some commercial gluten-free bread mixtures. Food Hydrocolloids, 30, 393-400.

Sakač, M., Torbica, A., Sedej, I., Hadnađev, M. (2011). Influence of breadmaking on antioxidant capacity of gluten free breads based on rice and buckwheat flour. Food Research International, 44, 2806-2813.

Sakač, M., Sedej, Ivana, Mandić, A., Mišan, A. (2011b). Wheat and buckwheat milling fractions – insight in their fuctional characteristics. PTEP – Journal on Processing and Energy in Agriculture, 15 (3), 173-178.

Schober, T. J., Moreau, R. A., Bean, S. R., Boyle, D. L. (2010). Removal of surface lipids improves the functionality of commercial zein in viscoelastic zein-starch dough for gluten-free breadmaking. Journal of Cereal Science, 52, 417–425.

Sedej, I., Sakač, M., Mandić, A., Mišan, A., Pestorić, M., Šimurina, O., Čanadanović-Brunet, J. (2011a). Quality assessment of gluten-free crackers based on buckwheat flour. LWT - Food Science and Technology 44, 694-699.

Sedej, I., Sakač, M., Mandić, A., Mišan, A., Tumbas, V., Hadnađev, M. (2011b). Assessment of antioxidant activity and rheological properties of wheat and buckwheat milling fractions. Journal of Cereal Science, 54, 347–353.

Šimurina, O., Sedej, I., Sakač, M., Hadnađev, M., Filipčev, B., Pestorić, M., Pribiš, V. (2009). Buckwheat in the wholegrain cracker production. PTEP – Journal on Processing and Energy in Agriculture, 13, 153-156.

Torbica, A., Hadnađev, M., Dapčević Hadnađev, T. (2012). Rice and buckwheat flour characterization and its relation to cookie quality. Food Research International, 48, 277–283.

Torbica, A., Hadnađev, M., Dapčević, T. (2010). Rheological, textural and sensory properties of gluten-free bread formulations based on rice and buckwheat flour, Food Hydrocolloids 24, 626-632.

Zucco, F., Borsuk, Y., Arntfield, S. D. (2011). Physical and nutritional evaluation of wheat cookies supplemented with pulse flours of different particle sizes. LWT - Food Science and Technology, 44, 2070-2076.

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