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FUNCTIONAL COOKIES WITH THE ADDITION OF BREWER'S BARLEY MALT AND REDUCED SUCROSE ADDITION

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Abstract: *The aim of this study was to investigate the effect of replacing part of wheat flour (20, 40 and 60 %) with special brewer's malted barley flour (Amber) and effect of reduced sucrose (66.6%, 33.3% and 0%) on cookies quality. Dimensional and textural properties, colour and sensory properties of cookies were evaluated. Analyses of total polyphenol content and antioxidant activity were also conducted.*

Based on the results of the research carried out it can be concluded that width and spread factor of cookies significantly decreased and thickness increased proportionally to the reduction of added sucrose. These changes were less pronounced in the samples with the addition of malted flour. Sucrose reduction significantly decreased snapping force and that decrease was even more evident for barley malt cookie samples. Brightness decreased proportionally with the addition of malted flour. Malt addition significantly increased total polyphenol content and antioxidant activity of cookies. According to sensory analyses, cookies with the addition of malted flour have a pleasant sweet and full flavour.

It can be concluded that special brewer's malted barley flour can be successfully used in the production of functional cookies with simultaneous reduction of sucrose addition.

Keywords: *functional cookies, malted barley flour, sucrose reduction*

INTRODUCTION

Cookies are type of the short dough biscuits and they are one of the most widely consumed cereal-based products in the world. They are often also called "sweet biscuits" or "tea biscuits". Typically, these products are produced with significant amounts of added sugar and fat using a low protein wheat flour (Manorah, R. S., 2015). The combined effect of high levels of sugar and fat results in reduced elasticity and extensibility of the dough, which causes the dough to break easily when the strain force is applied and this is where the term "short" comes from (Manley, D., 2001). Such dough properties are desirable in the manufacture of cookies to facilitate the formation of pieces of dough, as well as to ensure the slow spread of biscuits and to maintain proper shape during baking. In addition to contributing to the sensory properties of cookies, sugar and fat limit the formation of gluten in the dough by competing for available water (Manley, D., 2001; Gavrilović, M., 2003). In cookie recipes, sugar contributes to the spread and crispness while also providing colour and flavour (Pareyt, B., & Delcour, J. A., 2008). The increased spread rate of cookies with high levels of sucrose can be explained by progressive dissolution of sucrose which leads to an additional sucrose-water solvent phase resulting in a larger final diameter. Sucrose-water solvent phase plasticize gluten less than water alone, thus prevents gluten formation and induces cookie dough setting to take place at higher temperatures and at later stages of baking. In

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this way it is impossible for gluten proteins to form a continuous matrix that prevents the biscuits from spreading (Pareyt, B., Brijs, K., & Delcour, J. A., 2009).

Unlike bakery products, cookies are products that allows use of higher levels of wheat flour substitutes, because of their properties that do not require gluten development and high degree of extensibility and elasticity of dough (Jukić, M., Lukinac, J., Čuljak, J., Pavlović, M., Šubarić, D., & Koceva Komlenić, D., 2019). Barley flour is often used as a partial substitute of wheat flour in the production of cereal-based products due to high levels of β-glucans, lignans, phenolic compounds and many essential vitamins and minerals. Nevertheless, there is a small number of investigations about the use of malted barley flour in food production. Usually, malted barley is used in the production of different beverages, mostly in beer production. Malt is produced in a malting process which causes different changes in the composition of barley and involves an extended enzymatic degradation of barley endosperm. Starch is being hydrolysed to the fermentable carbohydrates (Gupta, M., Abu-Ghannam, N., & Gallaghar, E., 2010), mainly to maltose, dextrins, maltotriose, glucose (Balcerek, M., Pielech-Przybylska, K., Dziekońska-Kubczak, U., Patelski, P., & Strąk, E., 2016). Furthermore, typical colour and flavour are developed as a result of Maillard reactions and caramelization during kilning or roasting stage of malting process. Moreover, some products of Maillard reactions and phenolic compounds contained in barley malt exhibits an increased antioxidant activity (Carvalho, D. O., Gonçalves, L. M., & Guido, L. F., 2016; Gupta, M., Abu-Ghannam, N., & Gallaghar, E., 2010).

Dietary concerns due to high sucrose intake are associated with diabetes, obesity and dental disease (Pareyt, B., Brijs, K., & Delcour, J. A., 2009). Therefore, taking into account the fact that the malted barley flour contains its own sugars, the aim of this study was to investigate physical and sensory properties of cookies with the addition of brewer's malted barley flour as a partial substitute for wheat flour and sucrose.

EXPOSITION

Material and methods

Commercial all-purpose plain white flour (Belje d.d. Beli Manastir, Croatia) and non-diastatic (not enzymatically active) brewer's barley malt "Amber" (Slavonija Slad d.o.o., Nova Gradiška, Croatia) were used in this research. Malted barley grains were grinded in IKA MF 10 Mill (Werke GmbH and Co. KG, Germany). Other ingredients for cookie production were shortening (Zvijezda d.d., Zagreb, Croatia), dextrose, sucrose, sodium chloride (NaCl) and sodium bicarbonate ($NaHCO_3$) from a local market.

Cookies were produced according to the AACC Method 10-50.05 by replacing part of wheat flour (20, 40 and 60 %) with the special brewer's malted barley flour (Amber) and with reduced sucrose addition (66.6%, 33.3% and 0%). Control sample without addition of malted flour and with 100 % sucrose (according to standard method) was also produced (AACC Approved Methods 2010). Cookies were prepared in triplicate batches. The exact recipe is given in Table 1. Dimensional properties (width, height and spread factor) of cookie samples was also determined according to the AACC Method 10-50.05. Baked cookie samples are presented in Figure 1.

The textural properties of cookies were evaluated using a TA.XT2i Texture Analyzer (Stable Microsystems Ltd., Surrey, UK) with Texture Expert™ software 24 hours after baking. Three cookie samples from each batch were subjected to the three-point bend/break test and snapping force (N) was recorded. The distance between the two bottom supports was adjusted to 30 mm and the procedure was performed with the 92 mm knife blade at a test speed of 1 mm s^{-1} until the cracking point was achieved.

Colour was estimated with the use of chromameter Konica Minolta CR-400 and expressed as CIE$L^*a^*b^*$ coordinates. L^* is the luminance or lightness component, which ranges from black (L=0) to white (L=100), and parameters a* (from green to red) and b* (from blue to yellow) are the two chromatic components, which range from –128 to 127 (León, K., Mery, D., Pedreschi, F., & León, J., 2006).

Total phenolic content (TPC) was determined using the Folin–Ciocalteu reagent and the results were expressed in mg equivalent of gallic acid (GAE) per g dry weight. Antioxidant activity was determined using the DPPH radical-scavenging ability method.

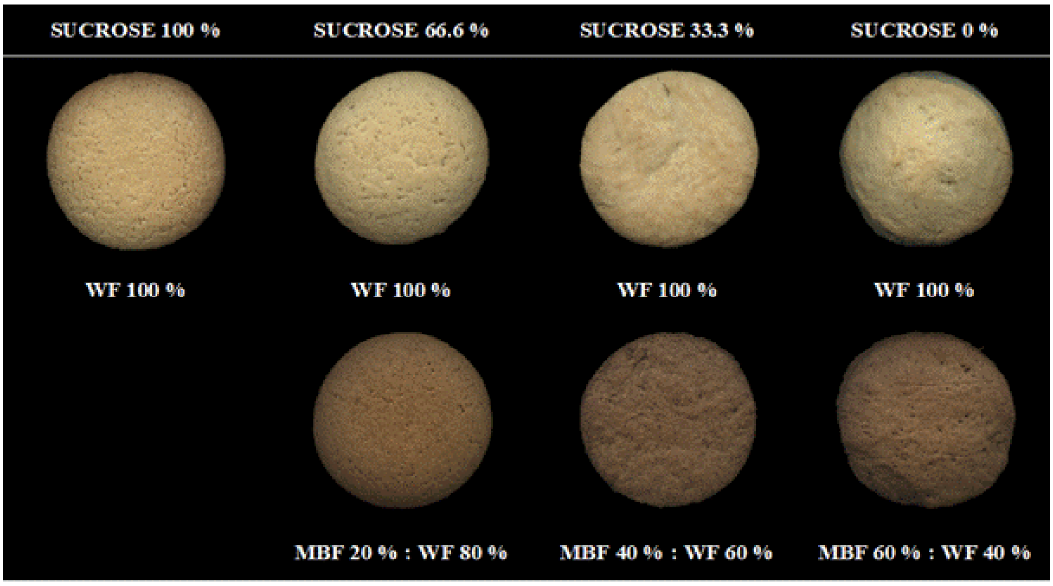
The sensory evaluation was conducted according to the method of Yamsaengsung, R., Berghofer, E., & Schoenlechner, R., (2012) by a panel of nine trained examiners for colour, shape, structure, odour, texture, taste and overall acceptance. Panellists rated each sensory attribute by marking on the 10 cm line (from 0 cm – dislikes extremely to 10 cm – likes extremely).

Obtained experimental data was analysed by an analysis of variance (ANOVA) and Fisher's least significant difference (LSD), with significance defined at $p<0.05$. A statistical analysis was carried out with Statistica ver. 12.0 software (Stat Soft Inc. Tulsa, OK, USA).

Table 1. Cookies recipe formulation

Sample	MBF*	WF**	Sucrose***	Shortening	NaCl	$NaHCO_3$	H_2O
WF Cookies	-	100	58 (100 %)	28	0.8	1	7
	-	100	38 (66.6 %)	28	0.8	1	7
	-	100	19 (33.3 %)	28	0.8	1	7
	-	100	- (0 %)	28	0.8	1	7
MBF-WF Cookies	20	80	38 (66.6 %)	28	0.8	1	7
	40	60	19 (33.3 %)	28	0.8	1	7
	60	40	- (0 %)	28	0.8	1	7

* MBF – Malted barley flour (Amber); ** WF – Wheat flour; *** Values in parentheses are percentages of sucrose of the standard recipe.



WF-Wheat flour; MBF-Malted barley flour

Fig. 1. Baked cookie samples

RESULTS AND DISCUSSION

The dimensional properties of cookie sample are presented in Figure 2. The most significant dimensional changes were in cookie width (diameter). Cookie width was proportionally decreased with the decreased sucrose addition, from 7.1 cm for the control sample to 5.4 for the wheat flour sample without sucrose addition. These results are in agreement with those obtained in the study conducted by Pareyt, B., Talhaoui, F., Kerckhofs, G., Brijs, K., Goesaert, H., Wevers, M., & Delcour, J. A., 2009. Compared to the wheat flour samples with a reduced sucrose addition,

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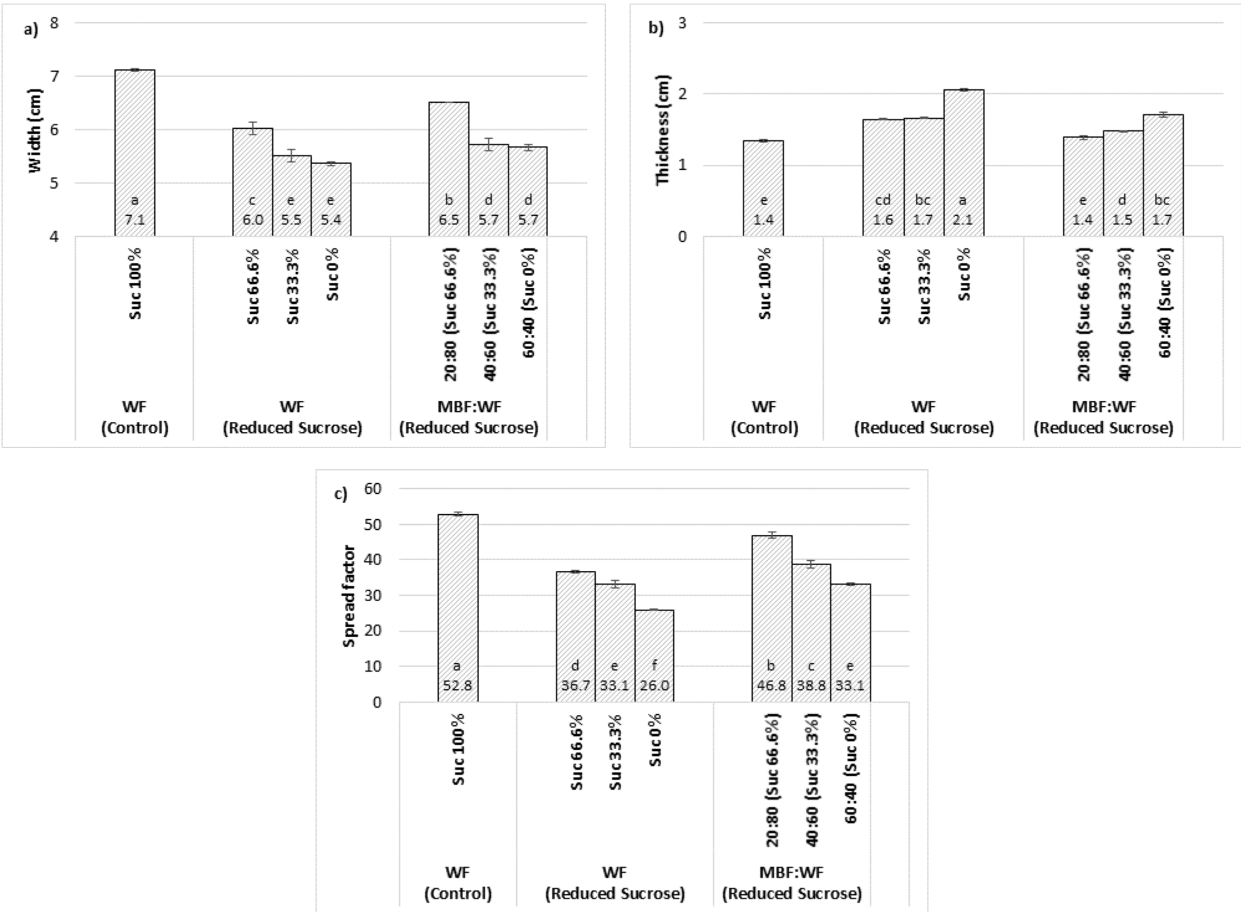
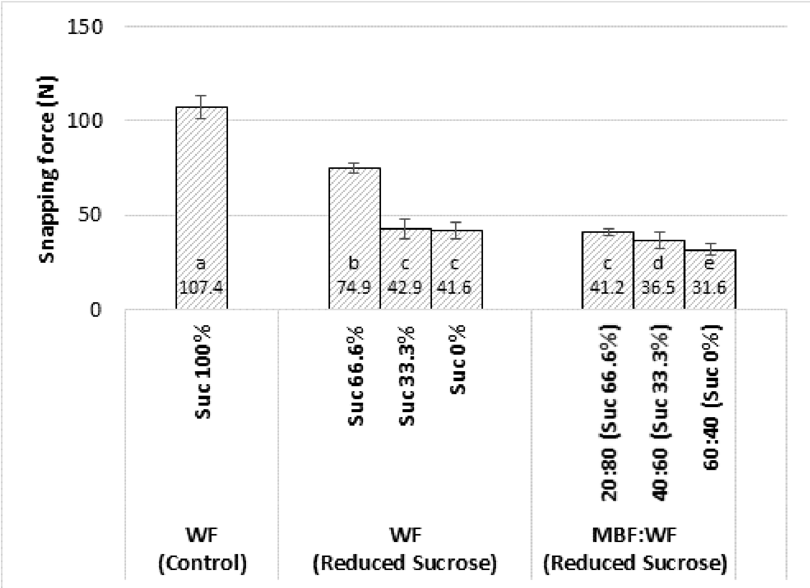
samples with malted barley flour had significantly (p>0.05) higher diameters, from 6.0 cm for the sample with 20 % malted barley flour and 66.6 % sucrose to 5.7 cm for the sample with 60 % malted barley flour and without sucrose addition. Opposite effect was noticed for cookie thickness: reduced sucrose addition resulted in higher thickness of cookies. This was less expressed when malted flour was used. Consequently, spread factor (W/Tx10) was also decreased with a reduced sucrose addition, which was less pronounced when malted barley flour was used. These results can be explained by a larger formation of gluten in the samples with less sucrose, which prevents the cookie spreading.



WF-Wheat flour; MBF-Malted barley flour; Suc-Sucrose

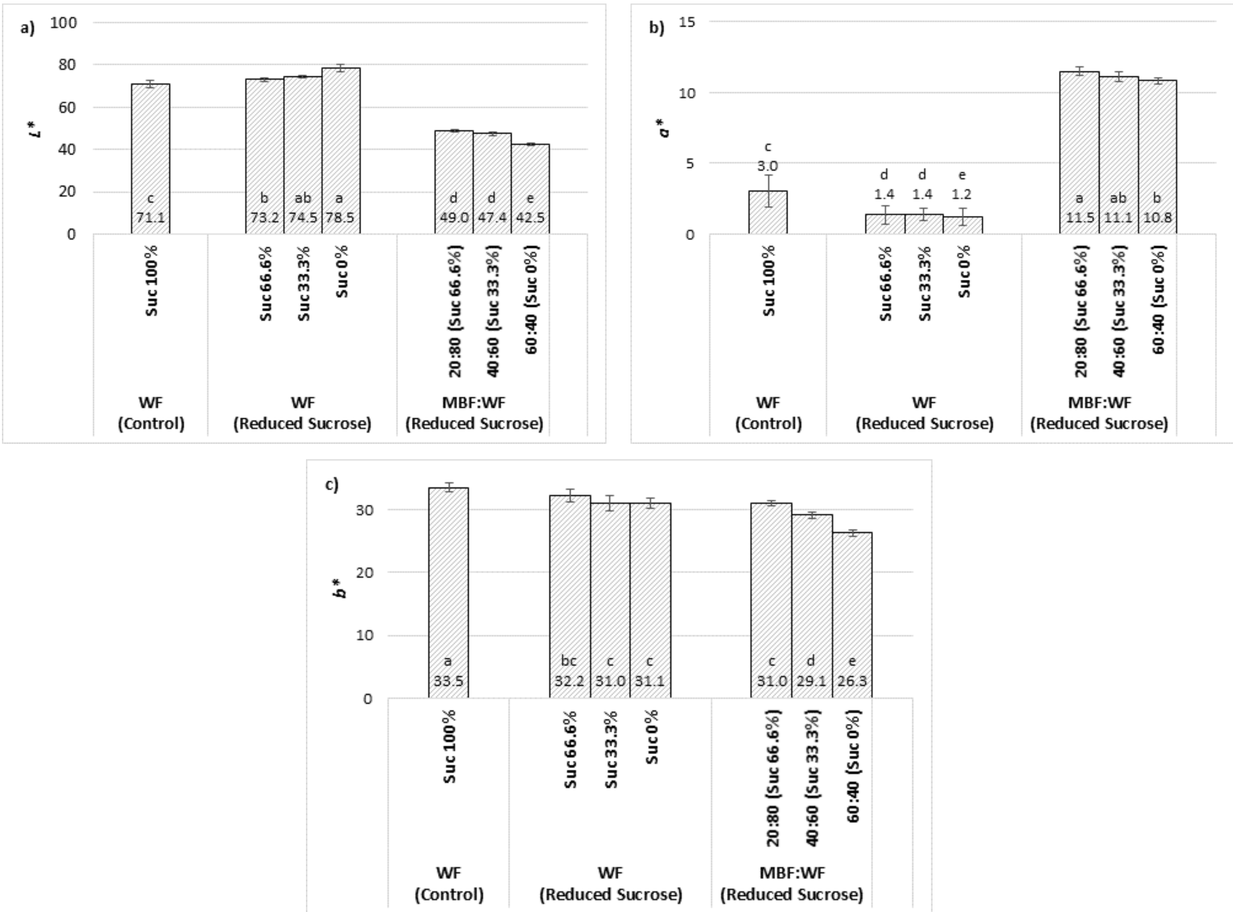
Fig. 2. Dimensional properties of cookies

Data on the textural properties of biscuits is presented in Figure 3. Snapping force represents the force required to break the biscuit at certain distance and could be used to describe cookie flexibility and fracturability, as well as cookie hardness. Snapping force decreased with lower levels of added sucrose. Similar results was obtained in research of the role of sugar and fat in sugar-snap cookies (Pareyt, B., Talhaoui, F., Kerckhofs, G., Brijs, K., Goesaert, H., Wevers, M., & Delcour, J. A., 2009). The smallest snapping force was observed in samples with malted flour. A decreased snapping force of these samples points to a lower gluten content of composite flour, resulting in a reduced hardness and cohesiveness of cookies.



WF-Wheat flour; MBF-Malted barley flour; Suc-Sucrose

Fig. 3. Textural properties of cookies



WF-Wheat flour; MBF-Malted barley flour; Suc-Sucrose

Fig. 4. Results of colour determination

Sucrose is very important ingredient for colour formation of cookie throughout the caramelization and dextrinization processes taking place during baking. The results of the colour determination are depicted in the Figure 4. The lightness (L^*) of the wheat flour cookies produced with different levels of sucrose showed a significant ($p<0.05$) increasing trend along with the increased reduction of sucrose addition. The increasing values of L^* indicates the lighter colour of

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samples with decreased levels of sucrose and the lightest sample (L*=78.5) was cookie without sucrose. Malted barley flour significantly decreased L* values due to an initially darker colour of malted flour, as well as due to an increase reducing sugar content that participate in Maillard reactions in which more intense colour develops. Samples with malted flour also showed higher a* values (more intensive red component) than corresponding wheat flour cookie samples. The wheat flour cookies had higher b* values (more yellow colour component).

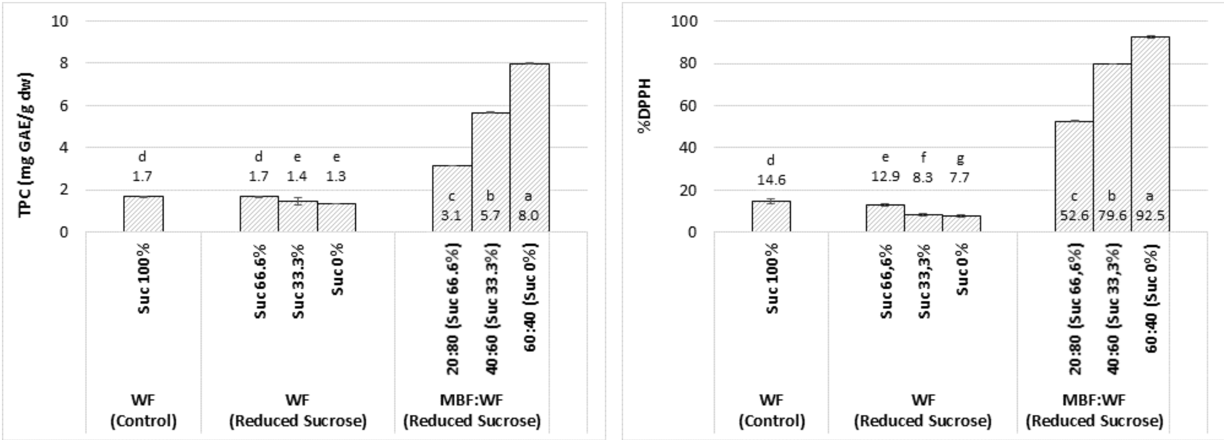
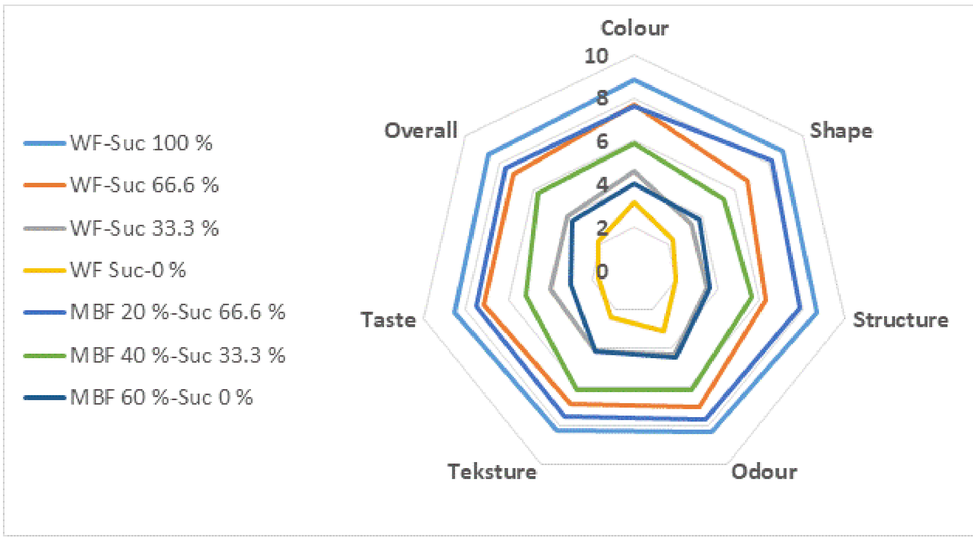


Fig. 5. Total phenolic content and antioxidant activity of cookie samples



WF-Wheat flour; MBF-Malted barley flour; Suc-Sucrose

Fig. 6. Results of sensory evaluation

Some products of Maillard reactions and phenolic compounds contained in barley malt exhibits an increased antioxidant activity (Carvalho, D. O., Gonçalves, L. M., & Guido, L. F., 2016; Gupta, M., Abu-Ghannam, N., & Gallaghar, E., 2010). Results of the Total phenolic content (TPC) and Antioxidant activity (AOC) determination are presented in Figure 5. Malted barley flour significantly increased TPC and AOC of cookie samples. The highest values were determined in the sample with 60 % of malted flour, 8.0 mg GAE/g and 92.5 %DPPH for total phenolic content and antioxidant activity, respectively.

The results of sensory evaluation are shown in Figure 6. Sensory scores were highest for control sample. Very high scores was also obtained for cookies with 20 % malted barley flour and 66.6 % sucrose. Panellists has emphasized that this sample have a pleasant caramel-sweet and full flavour. Furthermore, unpleasant bitter taste was too prominent in samples with highest amount of malted barley flour. Similar findings were obtained in the research by Sharma,S., & Chopra R., 2015 in which they added coconut powder in the recipe in order to mask the off-flavour of the malted barley flour when used in quantities higher than 40 %.

CONCLUSION

The present research has demonstrated that malted barley flour can be successfully used as a functional and nutritionally valuable substitute for wheat flour and sucrose, in quantities up to 20 %, without significant deterioration of the technological quality of cookies. Results showed that malted barley flour addition modifies dimensional and textural properties of cookies, influences colour, gives specific flavour to cookies and increases total phenolic content and antioxidant activity.

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