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WHEAT BRAN STABILIZATION AND ITS EFFECT ON COOKIES QUALITY

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ABSTRACT

Wheat bran are widely used as a source of dietary fiber with enhanced health benefits. However, its hight application level in bakery products caused lower quality of these products (eg. reduced volume and increased hardness of product). Different mechanical, physical or chemical methods are used for modification of wheat bran physicochemical properties. Wheat bran obtained from two wheat variety was used to evaluate the effect of bran stabilization process on qualitative properties of baked goods. Stabilization was performed using hot air and microwave heating. Threated and unthreated wheat bran were blended with wheat flour at 5, 10 and 15% substitution level. Influence of bran addition on rheological properties was evaluated using Mixolab 2. Stabilized wheat bran increased water absorption up to 11.7% (hot air stabilization) and 11.9% (microwave stabilization), respectively. Hot air stabilization of wheat bran improved heat resistance of dough proteins during mixing and the stability of hot gel during heating. Stabilization process of wheat bran using both methods also increased the volume and spread ratio values of enriched cookies. Cookies incorporated with hot air treated bran were significantly softer than cookies contained raw bran. Sensory evaluation showed that addition of stabilized bran improved the shape and taste of cookies. Additionally, it was concluded that the most acceptable cookies were obtained at 5% addition level of bran stabilized using microwave heating.

Keywords: wheat bran; stabilization; dough rheology; cookie

INTRODUCTION

Wheat (*Triticum aestivum*) is a leading cereal crop which is mainly utilised for human consumption and livestock feed. A wheat kernel comprises three principal fractions – bran, germ and endosperm. The outer layers are all parts of the bran. The bran fraction is a by-product of milling and has food and nonfood applications **(Onipe et al., 2015)**. Bran can be processed from red or white, hard or soft, and durum wheat. Besides the obvious color difference, the bran from white wheat has a milder flavor than the bran from red wheat. The bran to be used in a specific application depends on the flavor, color, and appearance desired. The breakfast cereal industry uses both red and white wheat bran, but the bakery industry primarily uses red wheat bran. White bran has excellent potential for use in flour tortillas and pizza dough **(Lauková et al., 2016)**.

Wheat bran has a rich nutritional profile and shows beneficial physiological effects, making consumption of bran-rich food products more interesting from a health perspective than products based on refined flour. Because consumers become more aware of its benefits, wheat bran is increasingly added to mostly cereal-based food products (bread, cookies, breakfast cereals, pasta, snacks, cakes, and more) **(Hemdane et al., 2016)**.

In refined flours, the main components responsible for the water absorption are the gluten network proteins. Wheat bran particles can interfere with the gluten network, decrease dough resilience and impair the framework of gas cells and, thus, gas retention. These effects can lead to low bread specific volume and inferior baking quality **(Prückler et al., 2014)**. During the storage, rancidification can reduce the nutritional value of food, and cause some quality changes, involving flavor, texture, and appearance. Due to the possibility of rapid rancidity there is a necessity for stabilization **(Ertaş, 2016)**. Pretreating the bran before it is added back into the flour is a key to eliminating its adverse effects on the processing and quality of the flour system. Ultrafine milling, extrusion, heating, and biological methods are useful for bran pretreatment **(Zhang et al., 2018)**. Thermal steps like roasting, steaming, cooking under forced air or microwave radiation usually have little impact on the chemical composition, but some effects on the processing properties could be observed, like for example increased loaf volume of bread when containing autoclaved bran **(Prückler et al., 2014)**.

When heating in a forced air oven at 150 °C, the cellulose content decreases with the processing time in wheat. Thermal processing increased the soluble dietary fraction. In general, the changes in the dietary fiber composition during thermal processing may be partly attributed to the redistribution of the insoluble and soluble components of dietary fiber, and partly to the formation of resistant starch. An increased temperature breaks week bonds between polysaccharide chains and split glycosidic linkages in the polysaccharides. As consequence, the architecture of the fiber matrix may be modified, and insoluble fiber solubilized **(Căpriţă et al., 2012)**.

Scientific hypothesis

Previous work focused to study the effect of wheat bran products has confirmed the negative influence of wheat bran on the quality parameters of bakery products. In this study, different stabilization methods were tested to remove the deterious effect of wheat bran on wheat dough and qualitative parameters of cookies.

MATERIAL AND METHODOLOGY

Wheat flour (moisture 11.36%, wet gluten 35.47%) and other ingredients (sugar, shortening, sodium bicarbonate, and sodium chloride) were purchased in local market. Wheat bran from wheat variety PS Bertold (BB) and PS 215 (WB) were observed from Research and Breeding Station, Vígľaš Pstruša, Slovakia and Research Institute of Plant Production Piešťany, Slovakia.

Wheat bran stabilization

Wheat bran from different wheat variety were stabilized using hot air and microwave heating acording to method described by **Ertaş (2016)**.

Hot air stabilization

Wheat bran was heated in hot air oven (Mora, Czech Republic) at 150 °C for 20 min and cooled for 30 min. Cooled bran was packed to polypropylene bags.

Microwave stabilization

Wheat bran was heated using microwave (Whirpool MWO602, USA) at 800 W for 2 min and cooled for 30 min. Cooled bran was packed to polypropylene bags.

Thermo-mechanical properties of dough

Effect of wheat bran addition (5, 10 and 15%) on thermo-mechanical properties of wheat dough was evaluated using Mixolab 2 (Chopin Villeneuve-la-Garenne, France) according to method described by **Lauková et al. (2018)**. The settings used in the test were 8 min at 30°C with a temperature increase of 4 °C.min^{-1} until the mixture reached 90 °C. There was a 7 min holding period at 90 °C, followed by a temperature decrease of 4 °C.min^{-1} until the mixture reached 55 °C, and then 6 min of holding at 55 °C. The mixing speed during the entire assay was 80 rpm. Determined parameters were: water absorption (WA), dough development time (DDT), stability (ST), initial maximum consistency (C1), protein weakening (C2), starch gelatinization (C3), stability of the starch gel formed (C4), starch retrogradation (C5).

Cookie preparation

The cookies were prepared using a recipe described by **Lauková et al. (2016)**, which included: 100 g wheat flour, 53 g sugar, 26.5 g shortening, 1.1 g sodium bicarbonate, 0.89 g sodium chloride and 12 cm^3 water. Prepared dough was rolled out (3 mm height) and cut into round shape (50 mm diameter). The cookies were baked for 8 – 9 min in hot air oven (Mora, Czech Republic) at 180 °C. After cooling, the cookies were packed in polyethylene bags. In the bran enriched cookies, the wheat flour was replaced by wheat bran at level 5, 10 and 15%.

Qualitative parameters of cookies

Qualitative parameters of cookies were evaluated 2 h after baking. The volume of cookies was measured by rapeseeds displacement method **(AACC Method 10-05.01)**. Volume index of cookies was measured using method acording to **Lauková et al. (2016)**. Baking loss (%) is determined according to dough weight before baking and product weight, which was detected one hour after baking according to **Minarovičová et al. (2018)**. Spread ratio was evaluated according to method described to **Kuchtová et al. (2016)** as the ratio of the diameter to the thickness of cookies. To determine the diameter, six cookies were placed edge to edge and the total diameter was measured. The cookies were rotated at 90 degree for duplicate reading. The average diameter was calculated. To determine the thickness, six cookies were placed on top of one another. The total thickness was measured. This process was repeated twice, and average thickness was calculated.

Texture analysis

Texture properties of baked cookies was determined using a texture analyser Ta.XT plus (Stable Micro Systems, GB) with 3-Point Bending Rig (HDP/3PB) according to modified method described by **Filipčev et al. (2012)**. A pre-test speed 1.0 mm.s^{-1}, test-speed 1.0 mm.s^{-1} and post-test speed 10 mm.s^{-1} were used. The gap distance was 20 mm. Texture determination was repeated 10 times.

Hardness and fracturability of cookies were recalculated using Exponent software (Stable Micro Systems, GB) version 6.1.4.0.

Sensory evaluation

The sensory evaluation of baked cookies was performed according to **Kohajdová et al. (2011)** by panel of 11 judges (staff and students of the Faculty of Chemical and Food Technology, Slovak University of Technology, Slovakia) using five-point hedonic scale (5 – most liked, 1 – most disliked). Descriptors determined were: shape, colour, taste, flavour, hardness. The overall acceptance of cookies was determined using 100 mm graphical non-structured abscissas with the description of extreme points (0% – minimal intensity, 100% – maximal intensity).

Statisic analysis

All determinations were carried out in triplicate except texture analysis and the average values were calculated. Student`s test at p <0.05 was used to establish the significant differences between mean values. As the statistical analysis software was used Microsoft Excel version 2010.

RESULTS AND DISCUSSION

Thermo-mechanical properties of dough

Knowledge of the influence of fibers on rheological properties is essential for the development of good quality products. The most serious technological drawbacks related to the rheological properties of dough include problems with adhesion to work surfaces and changes in shape, color, density and texture of the baked product. These modifications prove inconvenient in the production process and in sensory aspects of the product, both visual and flavor **(Blanco Canalis et al., 2017)**. One of the latest instruments used to determine the rheological quality of dough is Mixolab. Mixolab allows the characterization of the physicochemical behavior of dough when submitted to dual mixing and temperature constraints. Therefore, it is possible to record the mechanical changes due to mixing and heating simulate the mechanical work as well as the heat conditions that might be expected during the baking process **(Xhabiri et al., 2016)**. Effect of wheat bran addition on thermo-mechanical properties of wheat dough is sumarised in the Table 1.

Water absorption (WA) represents the amount of water that flour can absorb to obtain a pre-set dough consistency to produce a torque (peak C1) of 1.1 Nm ±0.05 at 30 °C **(Blandino et al., 2015)**. It was noticed, that WA significantly increased with addition of raw wheat bran from 55.83% (wheat flour) to 60.25% (15% BB) and 57.75% (15% WB), respectively. The higher WA of wheat bran is explained by the greater number of hydroxyl groups in the fiber structure, which allows more water interaction through hydrogen bonding. These effects can be also related to the presence of arabinoxylans, which tightly bind water in the dough system thereby reducing the availability of water for developing the gluten network **(Prückler et al., 2014)**. Stabilization of wheat bran using different methods significantly increased the WA. The highest values (62.40 and 62.50%) were obtained after addition of 15% WB stabilized by hot air and microwave heating.

Dough stability (DS) is indicator for the kneading properties of doughs and thus for the flour strength, whereas stronger doughs have higher values. The addition of wheat bran in general causes shorter DS values, a fact which is due to the interruption of the gluten network **(Prückler et al., 2014)**. From the results, it was noted that DS significantly decreased with increasing addition level of raw wheat bran. Incorporation of wheat bran stabilized using microwave caused shorter DS compared to addition of raw bran.

The C2 indicates a dough consistency loss during exposure to physical-mechanical and thermal stress **(Wang et al., 2017)**. Higher the C2 torque, lower is the protein weakening (Moza and Gujral, 2018). Control C2 value for wheat flour sample was 0.58 Nm. Generally, addition of wheat bran caused decreasing of C2 values to 0.50 Nm (15% BB) and 0.41 Nm (15% WB). The stabilization of wheat bran using a hot air resulted in a lesser weakening of the protein structure compared to raw bran and stabilization using a microwave.

The torque at C3 indicates the starch gelatinization behavior and viscosity of the dough upon heating and it strongly depends upon type and quality of starch **(Moza and Gujral, 2018)**. Wheat flour contributed to a better starch performance of the samples (higher starch gelatinization, C3) than composite flour with bran. This could be ascribed to the competence for water established between the starch and the bran **(Lauková et al., 2018)**. From the results concluded, that C3 values with addition of raw wheat bran ranged from 1.94 Nm (5% WB) to 1.80 Nm (15% WB) which was significantly lower than C3 value for wheat flour (2.11 Nm). Addition of wheat bran using microwave resulted in lower gelatinization of starch (1.92 – 1.65 Nm) compared to adition of raw bran. On the other hand, with the incorporation of hot air heated bran, C3 values were significantly higher (2.01 – 1.84 Nm).

The further reduction in viscosity (C4 value) is the result of the physical breakdown of the granules due to the mechanical shear stress and the temperature constraint **(Dapčević Hadnađev et al., 2011)**. As can be seen from the Table 1, C4 value (hot gel stability) for wheat flour was 2.11 Nm. Increasing addition level of bran caused significant decreasing of hot gel stability. Xhabiri et al. (2016) reported that wheat bran mostly represents the cover of the grain which contains a high amount of α-amylase, which is the cause of decrease of C4 values. From the results concluded, that adition of bran stabilized by hot air increased the stability of hot gel (2.01 – 1.84 Nm) compared to raw bran (1.94 – 1.80 Nm). Incorporation of bran stabilized by microwave resulted in lower stability of hot gel. The C5 values were related to starch gelatinization, pasting, and retrogradation properties **(Koksel et al., 2009)**. From the results concluded that incorporation of wheat bran to wheat dough significantly decreased the C5 values (wheat flour 2.92 Nm). Moreover, addition of stabilized wheat bran using hot air heating caused higher C5 values compared to raw wheat bran. A higher C5 values means more starch retrogradation, thus the decreased value of C5 portrays longer shelf stability and better texture of the end products **(Ding et al., 2018)**.

Cookies quality and texture

Effects of wheat bran addition on qualitative properties of cookies are sumarised in Table 2.

Generally, addition of raw wheat bran resulted in reduced volume from 8.90 cm3 (control sample) up to 7.14 cm3 (15% WB). Reduced volume may also be caused by gluten dilution and physicochemical reactions among fibre components, water and gluten **(Kurek et al., 2016)**. This effect is in agreement with previous study after incorporation of wheat bran from different wheat variety in cookies **(Lauková et al., 2016)**. Compared to cookies contained raw bran, stabilization of wheat bran led to increase the volume about 10% (hot air treatment) and 15% (microwave treatement).

Dough making and handling, cookie baking and quality of the final product are thus largely influenced by cookie dough components. Cookie spread, i.e. the extent to which the dough piece spreads during baking represents one of the major quality parameter **(Dapčević Hadnađev et al., 2011)**. Cookies with higher spread ratios are considered the most desirable **(Ostermann-Porcel et al., 2017)**. Spread ratio for control sample was 9.68. With increasing adition level of raw bran the spread ratio significantly decreased up to 5.69. Stabilization of wheat bran using both methods improved this parameter of enriched cookies. This is in agreement with results observed by **Nandeesh et al. (2011)** after incorporation of roasted, steamed and microwave treated bran.

Table 1 Thermo-mechanical properties of wheat dough with addition of different treated wheat bran.

Sample		Water absorption (%)	Stability (min)	C2 (Nm)	C3 (Nm)	C4 (Nm)	C5 (Nm)
WF		55.83 ±0.11	10.61 ±0.09	0.58 ±0.01	2.11 ±0.01	1.85 ±0.01	2.92 ±0.02
Raw bran							
BB	**5%**	59.10 ±0.08*	9.72 ±0.01*	0.51 ±0.01*	1.92 ±0.01*	1.83 ±0.02	3.00 ±0.02
	10%	60.10 ±0.06*	9.78 ±0.02*	0.53 ±0.01*	1.92 ±0.01*	1.78 ±0.02*	2.76 ±0.01*
	15%	60.95 ±0.12*	9.53 ±0.01*	0.50 ±0.00*	1.88 ±0.01*	1.71 ±0.01*	2.71 ±0.01*
WB	**5%**	56.20 ±0.09	10.53 ±0.02*	0.45 ±0.00*	1.94 ±0.01*	1.70 ±0.02*	2.93 ±0.02
	10%	57.52 ±0.11*	8.55 ±0.01*	0.44 ±0.01*	1.93 ±0.01*	1.59 ±0.02*	2.82 ±0.01*
	15%	57.75 ±0.06*	8.15 ±0.03*	0.41 ±0.00*	1.80 ±0.01*	1.51 ±0.01*	2.66 ±0.00*
Hot air stabilization							
BB	**5%**	60.40 ±0.10*	9.82 ±0.04*	0.53 ±0.01*	1.94 ±0.01*	1.83 ±0.01	3.03 ±0.02
	10%	61.30 ±0.05*	10.38 ±0.01*	0.54 ±0.01*	1.94 ±0.01*	1.80 ±0.01*	2.83 ±0.01*
	15%	62.00 ±0.02*	10.45 ±0.05*	0.52 ±0.00*	1.93 ±0.01*	1.79 ±0.01*	2.82 ±0.01*
WB	**5%**	60.75 ±0.06*	8.16 ±0.01*	0.56 ±0.01*	2.01 ±0.01*	1.48 ±0.01*	2.96 ±0.02
	10%	61.45 ±0.06*	8.37 ±0.01*	0.49 ±0.00*	1.97 ±0.01*	1.46 ±0.01*	2.95 ±0.02
	15%	62.40 ±0.23*	9.55 ±0.02*	0.48 ±0.00*	1.84 ±0.01*	1.43 ±0.00*	2.94 ±0.01
Microwave stabilization							
BB	**5%**	59.75 ±0.19*	9.56 ±0.08*	0.53 ±0.01*	1.92 ±0.02*	1.77 ±0.02*	2.89 ±0.02*
	10%	60.30 ±0.06*	9.63 ±0.06*	0.50 ±0.00*	1.90 ±0.01*	1.70 ±0.01*	2.78 ±0.02*
	15%	60.90 ±0.14*	9.46 ±0.03*	0.49 ±0.00*	1.90 ±0.01*	1.68 ±0.01*	2.66 ±0.01*
WB	**5%**	60.80 ±0.09*	8.98 ±0.09*	0.45 ±0.00*	1.66 ±0.01*	1.36 ±0.02*	2.92 ±0.02
	10%	61.60 ±0.23*	8.87 ±0.06*	0.44 ±0.00*	1.65 ±0.01*	1.31 ±0.02*	2.82 ±0.02*
	15%	62.50 ±0.17*	8.45 ±0.02*	0.44 ±0.00*	1.65 ±0.01*	1.32 ±0.02*	2.64 ±0.01*

Note: WF – wheat flour, * denotes statistically significant difference at p <0.05 level.

Table 2 Qualitative properties of cookies enriched with stabilised and unstabilized wheat bran.

Sample		Volume (cm^3)	Spread ratio	Volume index (cm)	Baking loss (%)	Hardness (g)	Fracturability (mm)
Control		8.90 ±0.02	9.68 ±0.22	1.73 ±0.00	15.09 ±0.12	1157.58 ±21.36	19.35 ±0.78
Raw bran							
BB	**5%**	8.43 ±0.04*	7.01 ±0.03*	1.87 ±0.00*	15.64 ±0.40*	1268.95 ±26.14	18.88 ±0.48*
	10%	7.90 ±0.02*	6.59 ±0.02*	2.14 ±0.01*	15.57 ±0.02*	1360.32 ±35.69*	18.69 ±0.75*
	15%	7.22 ±0.03*	5.69 ±0.01*	2.39 ±0.01*	15.27 ±0.16*	1648.77 ±14.82*	18.49 ±0.36*
WB	**5%**	8.20 ±0.03*	8.44 ±0.04*	1.77 ±0.00	15.98 ±0.15*	1213.42 ±36.52	18.80 ±0.64*
	10%	7.64 ±0.03*	7.90 ±0.03*	1.87 ±0.00*	15.35 ±0.23*	1488.20 ±55.26*	18.53 ±0.54*
	15%	7.14 ±0.03*	6.92 ±0.02*	2.24 ±0.01*	15.12 ±0.75*	1753.50 ±25.22*	18.50 ±0.54*
Hot air stabilization							
BB	**5%**	8.98 ±0.02	7.24 ±0.04*	2.04 ±0.01*	14.80 ±0.16*	1137.69 ±19.22	18.59 ±0.69
	10%	8.20 ±0.03*	6.84 ±0.03	1.99 ±0.00*	14.75 ±0.44*	1291.44 ±25.63*	18.65 ±0.41*
	15%	8.00 ±0.04*	7.07 ±0.02	2.13 ±0.01*	14.20 ±0.31*	1381.30 ±26.22*	19.20 ±0.25*
WB	**5%**	8.88 ±0.03	6.72 ±0.02	2.02 ±0.01*	13.92 ±0.28*	1093.60 ±22.54	18.67 ±0.15*
	10%	8.08 ±0.02*	7.97 ±0.03*	1.93 ±0.00*	13.70 ±0.14*	1268.15 ±26.15*	18.81 ±0.22*
	15%	7.82 ±0.02*	7.71 ±0.04*	2.08 ±0.01*	12.57 ±0.64*	1484.36 ±33.22*	19.18 ±0.51
Microwave stabilization							
BB	**5%**	8.72 ±0.03*	7.80 ±0.02*	1.76 ±0.00	15.86 ±0.06	1181.40 ±18.91	18.73 ±0.51*
	10%	8.60 ±0.03*	6.88 ±0.03	2.12 ±0.01*	15.03 ±0.21	1227.82 ±11.34	19.08 ±0.56
	15%	8.14 ±0.02*	7.04 ±0.02	2.14 ±0.01*	13.85 ±0.15*	1484.36 ±24.28*	19.11 ±0.44
WB	**5%**	8.92 ±0.03	6.94 ±0.2	2.11 ±0.01*	15.61 ±0.25	1180.30 ±22.33	18.40 ±0.16*
	10%	8.56 ±0.03*	7.64 ±0.04*	2.06 ±0.01*	15.22 ±0.45	1394.67 ±15.96*	18.73 ±0.20*
	15%	8.22 ±0.03*	7.14 ±0.03*	2.19 ±0.01*	14.03 ±0.26*	1586.26 ±31.85*	19.10 ±0.33

Note: * denotes statistically significant difference at p <0.05 level.

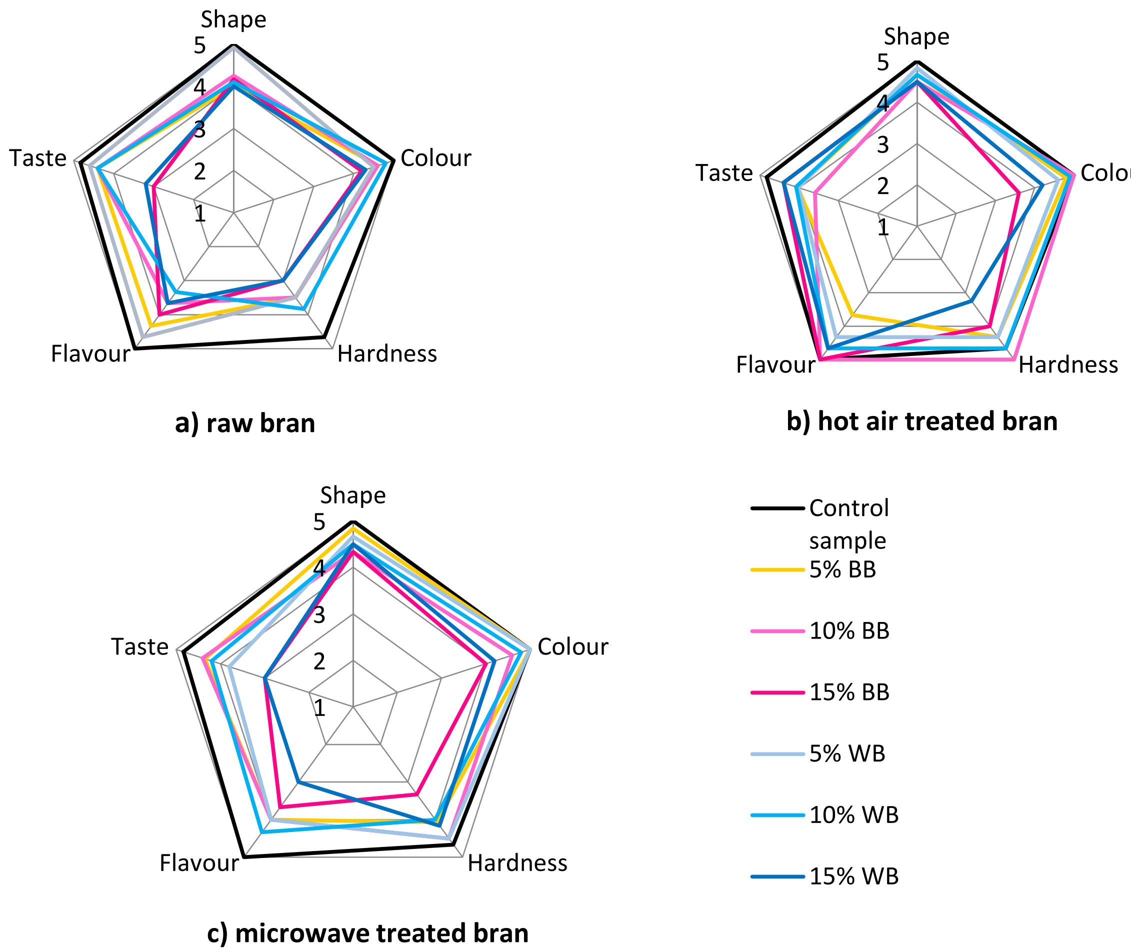

Figure 1 Sensory evaluation of cookies with addition raw wheat bran (a), hot air threated bran (b) and microwave treated bran.

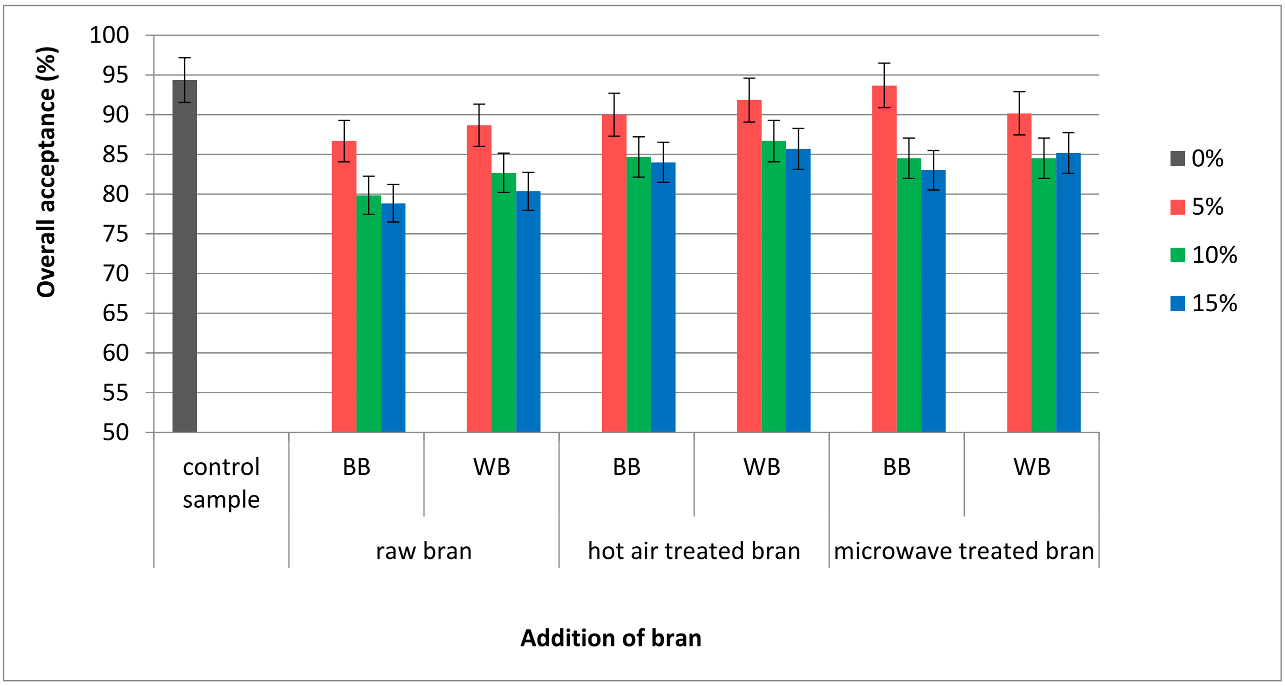

Figure 2 Overal acceptability of wheat bran incorporated cookies. Note: WB – wheat bran from wheat variety PS 215, BB – wheat bran from wheat variety PS Bertold.

Determining the actual baking losses is very important as the finished product after baking must have a defined weight. The loss by baking is influenced mainly by the weight of the product, by shape and moisture content **(Minarovičová et al., 2018)**. Evaluation of baking loss showed that addition of raw wheat bran increased this parameter from 15.09% (control sample) up to 15.98% (5% WB). Higher water evaporation may be due to initially higher water content in the bran-containing biscuit dough as compared to the control because addition of bran to biscuit formulation increases the level of water required **(Filipčev et al., 2017)**. The results also showed that stabilization of bran caused significantly lower values of baking loss (12.57 – 14.80% and 13.85 – 15.86% for cookies enriched with hot air and microwave treated wheat bran, respectively) compared to control sample.

This study shoved that volume index values of cookies enriched with wheat bran were higher compared to control sample of cookies. The highest volume index (2.39 cm) was observed after 15% incorporation of BB.

Texture evaluation of cookies with addition of wheat bran is summarized in Table 2. Maximum peak force recorded from force/distance curve (the maximum force required to break a cookie or maximum resistance of cookie when break) has been reported as hardness **(Dapčević Hadnađev et al., 2013)**. The results showed that supplementation of wheat flour with wheat bran resulted in hight hardness of cookies. This fact is in agreement with study of cookies enriched with roasted, steamed and microwave treated bran by **Nandeesh et al. (2011).** On the other side, cookies incorporated with 15% of bran stabilized using hot air was about 16% softer compared to cookies with addition of raw bran. Stabilization of bran using microwave concluded in about 11.5% decrease of cookies hardness.

Sensory evaluation

Sensory evaluation of cookies incorporated with treated and raw wheat bran is showed in Figure 1 a-c. The surface color of a baked product is, together with texture and taste, a very important element for the initial acceptability of baked goods by consumers **(Ostermann-Porcel et al., 2017)**. From the results concluded that sensorial scores for cookies shape and colour decreased with increasing level of raw wheat bran. Stabilization of wheat bran improved the sensory score of cookies shape. It was also noticed that taste score decreased with increasing addition level of bran. Moreover, the evaluation of taste showed that addition of wheat bran increased the bitter taste of cookies, which is due to content of tannins and phenolic acids **(Heiniö et al., 2016)**. The assessors also describe that incorporation of bran led to dryer cookies. The drying effect of wheat bran might be explained by its water-absorptive properties. Both wheat bran and flour absorb water, but during baking wheat bran may lose water more readily than flour. Biscuits containing wheat bran had less flour; consequently, less water may have remained after baking and the resultant biscuits therefore were perceived as dry by panelists (**Khalil et al., 2015**). Incorporation of wheat bran in cookies caused lower sensory score of cookies hardness. From the results concluded that stabilization of bran using different methods led to higher hardness acceptance of cookies.

The overall acceptability of cookies with addition of raw and stabilized wheat bran is shown in Figure 2. In general, higher addition levels of bran (10 and 15%) significantly decreased the overall acceptability of cookies. It was noticed that stabilization of bran improved the acceptability of enriched cookies.

CONCLUSION

This study was focused on influence of wheat bran stabilization on qualitative parameters of enriched cookies. Incorporation of wheat bran significantly modified the thermo-mechanical properties of wheat dough. Stabilized bran caused higher protein resistance and stability of hot gel in dough during heating. This study also shoved that pretreatment of wheat bran (using hot air and microwave heating) may improve the qualitative properties of cookies such as volume and hardness. Moreover, the cookies enriched with stabilized bran were more acceptable for assessors.

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