Potential of bran from various wheat variety for cookies production

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Abstract: The effect of replacing wheat flour with different kinds of wheat bran and spelt bran at level 5, 10 and 15 % on dough rheology, qualitative parameters of cookies as well as on sensory properties was studied. Addition of bran increased water absorption and mixing tolerance index, prolonged dough development time and decreased dough stability. It was also observed that incorporation of wheat bran modified qualitative parameters of cookies (volume, specific volume, spread ratio and porosity decreased). From the sensory evaluation resulted that higher amounts of wheat bran negatively affected taste, hardness and overall acceptability of cookies. Addition of bran up to 5 % resulted in cookies with high overall acceptability.

Keywords: cookie, dough, farinograph, spelt bran, wheat bran

Introduction

Wheat (*Triticum aestivum* L.) is an important raw material in many countries. The grain is composed of a nutritious inner part, the starchy endosperm, and surrounded by multiple histological layers that are typically separated as one from the endosperm through roller milling, yielding millers bran (Hemdane et al., 2016a). Bran fraction constitutes approximately 11 % of total milling by-products and only 10 % of bran is used as fiber supplement in breakfast cereals and bakeries while the remaining 90 % is sold as animal feed at an extremely low price (Hossain et al., 2013). Recently the use of wheat bran (WB) and other cereal bran has gained great importance in the formulation of various types of food products (Kamal 2015). Fortification of cereal-based products with WB is basically performed in 2 ways. Flour is either supplemented with bran or bran is mixed together with its germ and flour complements in their naturally occurring proportions in the kernel, resulting in "whole-grain" flour (Hemdane et al., 2016b).

However, it has also been known that WB is not a standardized product with a defined quality and chemical composition (Ellouze-Ghorbel et al., 2010). Bran composition depends on many different factors, including the species and variety of grain, kernel size, shape, maturity, germ size, thickness of the outmost layer, grain storage duration and conditions, system of grain conditioning before milling, the milling system itself and, above all, the type of flour produced (Pavlovich-Abril et al., 2015).

Bran can be processed from red or white, hard or soft, and durum wheat. Besides the obvious colour difference the bran from white wheat has a milder flavour than the bran from red wheat. The bran to be used in a specific application depends on the flavour, colour, and appearance desired. The breakfast cereal industry uses both red and white WB, but the bakery industry primarily uses red WB. White bran has excellent potential for use in flour tortillas and pizza dough (Dreher, 1999).

WB is subdivided into three distinct layers, viz testa, aleurone and pericarp. WB is composed of about 53 % dietary fibre (xylans, lignin, cellulose, galactan, and fructans). Other components include vitamins and minerals and bioactive compounds such as alkylresorcinols, ferulic acid, flavonoids, carotenoids, lignans and sterols (Onipe et al., 2015).

In the last decades, several studies have shown potential in incorporation of WB in cereal based products such as bread (Nandeesh et al., 2011; Boita et al., 2016; Le Bleis et al., 2015), biscuits, cookies (Silky et al., 2014; Kamal 2015; Ellouze-Ghorbel et al., 2010) and cakes (Lebesi and Tzia, 2011).

The aim of this study was to investigate the effect of different kinds of WB on the rheological properties of dough and physical parameters of cookies with addition of WB. Sensory evaluation of products was also performed.

Material and methods

Materials

Fine wheat flour, commercial wheat bran WB1 (PRO-BIO, s.r.o., Staré mesto, Czech Republic), commercial spelt bran SB (PRO-BIO, s.r.o., Staré mesto, Czech Republic) and other ingredients (shortening, sugar, salt and baking powder) were purchased from local market. Other samples of wheat bran WB2 (wheat Lubica – crossbreed *Triticum aestivum* × *Triticum spelta*), WB3, WB4 (from variety with purple colour of grain) were obtained from Research and Breeding Station, Vígľaš Pstruša, Slovakia and Research Institute of Plant Production Piešťany, Slovakia.

Rheological properties of dough

Dough mixing properties were analysed using Farinograph Brabender (Duisburg, Germany) according to method ISO 5530-1:2013. The measured farinographic parameters were: water absorption (WA), dough development time (DDT), dough stability (DS) and mixing tolerance index (MTI).

Cookies preparation

Cookies were prepared using a recipe according to Kohajdová et al. (2011). Wheat flour was replaced by WB at level 5, 10 and 15 %. The cookies were round in shape with thickness of 2 mm and diameter of 50 mm and were baked in an electric oven (Mora, Slovakia) at 180 °C for 8–10 min. Cooled cookies were packed in polyethylene bags.

Qualitative properties of cookies

Volume of cookies was determined using rapeseed displacement method (AACCI Method 10-05.01). Specific volume was calculated by dividing the values of volume by weight (Shittu et al., 2007). Diameter (D) and thickness (T) were measured with a calliper at three different places in each cookie. Spread ratio of cookies was calculated from the formula: spread ratio = D/T (Nandeesh et al., 2010). Porosity of cookies was measured according to method described by Shittu et al. (2007).

Sensory evaluation of cookies

Sensory analysis of cookies was carried out by a panel of trained judges using 9-point hedonic scale, where 9 and 1 represent extremely like and extremely dislike values; respectively. The attributes evaluated were visual appearance, odour, taste and firmness. Overall acceptability was evaluated using 100 mm non-structured abscissae with description of extreme points (minimal or maximal intensity, from 0 to 100 %) (Kohajdová et al., 2011).

Statistical analysis

All analyses were carried out in triplicate and average values were calculated. The results were expressed as mean ± standard deviation. Significant differences between mean values were

Tab. 1. Effect of WB on farinograph parameters of wheat dough.

		WA (%)	DDT (min)	DS (min)	MTI (BU)
control		56.43 ± 0.34	3.03 ± 0.06	15.97 ± 0.25	25.00 ± 1.00
WB1	**5 %**	58.63 ± 0.48	4.63 ± 0.15*	8.33 ± 0.12*	30.00 ± 1.00
	10 %	62.45 ± 0.38*	5.20 ± 0.20*	7.10 ± 0.19*	40.00 ± 2.00
	15 %	64.38 ± 0.29*	5.53 ± 0.06*	6.53 ± 0.16*	49.67 ± 0.58*
WB2	**5 %**	59.16 ± 0.38	3.97 ± 0.15*	9.07 ± 0.14*	48.67 ± 1.15*
	10 %	60.98 ± 0.33*	4.50 ± 0.20*	8.52 ± 0.12*	51.67 ± 1.53*
	15 %	62.64 ± 0.76*	5.40 ± 0.17*	7.50 ± 0.16*	59.00 ± 1.00*
WB3	**5 %**	59.60 ± 0.29*	4.15 ± 0.18*	7.66 ± 0.15*	38.00 ± 1.00*
	10 %	60.63 ± 0.19*	4.32 ± 0.23*	6.70 ± 0.19*	42.00 ± 1.00*
	15 %	62.17 ± 0.24*	4.46 ± 0.19*	6.35 ± 0.13*	45.67 ± 0.58*
WB4	**5 %**	57.71 ± 0.57	4.09 ± 0.16*	8.01 ± 0.11*	41.33 ± 1.53*
	10 %	58.94 ± 0.38	4.31 ± 0.10*	6.53 ± 0.15*	47.00 ± 1.00*
	15 %	59.63 ± 0.62*	5.21 ± 0.20*	5.65 ± 0.14*	51.67 ± 1.53*
SB	**5 %**	59.23 ± 0.33	4.05 ± 0.18*	10.52 ± 0.14*	29.33 ± 1.15
	10 %	60.65 ± 0.48*	5.03 ± 0.16*	7.51 ± 0.13*	42.33 ± 2.08*
	15 %	62.76 ± 0.57*	5.50 ± 0.17*	6.52 ± 0.16*	51.67 ± 1.53*

WB – wheat bran, SB – spelt bran, WA – water absorption, DDT – dough development time, DS – dough stability, MTI – mixing tolerance index, BU – Brabender units.

*Denotes a statistically significant difference at p = 0.05 level.

compared using Student's test at significance level p = 0.05 using Microsoft Excel version 2010.

Results and discussion

Rheological measurements of dough are used to define its physical properties. Rheology is a valuable tool that gives a quantitative measure for the amount of stress in the dough, which is closely related to the quality of the molecular gluten network (Amjid et al., 2013). The determination of rheological properties of wheat flour dough is essential for the successful manufacturing of various bakery products because they determine the behaviour of dough during mechanical handling, thereby affecting the quality of the finished products (Koksel et al., 2009). The farinograph parameters for wheat dough with additions of different kind of wheat bran are shown in Tab. 1.

WA (amount of water required by a given weight of flour to yield a dough of a given consistency) (Shenoy and Prakash, 2002) of dough with different kinds of bran were ranged from 57.71 % to 64.38 %. Generally, it can be noticed that the addition of WB resulted in higher WA. Incorporation of WB1, SB and WB2 significantly increased this value at addition level 10 and 15 % compared to control (56.43 %). Moreover, addition of WB3 increased WA at all addition levels. The effects of the WB are related to the strong tendency of bran to absorb water that might result in the competition for water between bran and the other key flour components (proteins and starch), and to the negative physical and mechanical effects of fiber on the formation of the gluten network (Messia et al., 2016). Similar observations were made by Boita et al. (2016) and Shenoy and Prakash (2002) after incorporation of WB to the wheat dough.

DS is defined as the time difference between the point where the top of the curve first intercepts the 500 FU line and the point where the top of the curve leaves the 500 FU line. This value, in general, gives some indication of the tolerance of the flour to mixing (Lei et al., 2008). As can be seen from the Tab. 1, addition of WB significantly reduced DS compared to control (15.97 min). The low stability time during the dough mixing period is indicative of a weak gluten network structure of the dough (Rodriguez-Sandoval et al., 2012).

DDT is the time from the water addition to the flour until the dough reaches the point of the greatest torque. During the mixing phase, water hydrates flour components and the dough is developed (Lei et al., 2008). It was observed that the addition of WB significantly prolonged DDT at all addition levels. DDT increased from 3.03 min for control to 5.53 min, 5.50 min, 5.40 min, 4.46 min and 5.21 min for WB1, SB, WB2, WB3 and WB4 respectively at 15 % addition level. The addition of WB in general causes higher development time values and shorter DS values, a fact which is due to the interruption of the gluten network (Prückler et al., 2014). Besides this fact, some additional negative effects seem to play a role. Bran might impede proper gluten development by physically preventing proper contact between flour particles. This hypothesis, together with the relatively slow water uptake of bran, can explain the fact that higher dough development times are reported in Farinograph analyses when flour is replaced by higher levels of bran (Hemdane et al., 2016). The same effect on DDT and DS was reported by Boita et al. (2016) and Sudha et al. (2007) in the dough to which WB was added.

MTI is the consistency difference between the height at the maximum and the value after 5 min (Hromádková et al., 2007). Generally, MTI value increased with the addition of WB at all addition levels. Furthermore, higher MTI values were observed in dough with incorporation of WB2. Increased MTI values indicate a reduced resistance of the dough to mechanical working (Pavlovich-Abril, 2015). Recently, Boita et al. (2016), Sudha et al. (2007) and Zhang et al. (1997) also described an increase in MTI in dough incorporated with WB.

Physical parameters of WB containing cookies are presented in Table 2. Baked cookie volume is an important indicator of ingredient performance and subsequent acceptance by consumers (Onvulata, 2008). It was observed that cookies volume decreased with increasing concentration of wheat bran. This effect is due to the dilution of gluten, and also could result from the interaction between gluten and fibre material (Kohajdová et al., 2011). Cookies volume ranged from 8.84 cm^3 for control to 7.64 cm^3 for WB1 at addition level 15 %. Maximum cookie volume was achieved with addition 5 % of WB3 (9.20 cm^3). These results are in accordance with findings of Silky et al. (2014) and Onvulata (2008) who reported that the volume of WB incorporated cookies decreased with the increasing level of WB.

Generally, WB supplementation of flour resulted in significantly decreasing of spread ratio at level 10 and 15 % for WB1, SB and WB2 and at all levels for WB3 and WB4. Moreover, the highest spread ratio was observed for cookies with WB2 addition. Sudha et al. (2007) made similar observations at incorporation cereal bran to biscuits at level 10–40 %. Porosity values ranged from 0.37 for WB1 at level 5 % to 0.16 for 15 %. It could be also concluded from results that the incorporation of WB significantly decreased porosity of cookies at levels 10 and 15 %

Tab. 2. Effect of wheat bran addition on physical parameters of cookies.

		Volume (cm³)	Specific volume (cm³·100 g⁻¹)	Spread ratio	Porosity (cm³)
control		8.84 ± 0.26	239.91 ± 10.12	12.97 ± 0.21	0.35 ± 0.01
WB1	**5 %**	8.50 ± 0.23	236.11 ± 11.33	13.28 ± 0.41	0.37 ± 0.01
	10 %	7.96 ± 0.33*	235.80 ± 9.87	13.08 ± 0.45*	0.29 ± 0.01*
	15 %	7.64 ± 0.26*	230.72 ± 3.06*	11.95 ± 0.11*	0.25 ± 0.01*
WB2	**5 %**	7.96 ± 0.38*	223.60 ± 10.78	13.54 ± 0.25	0.28 ± 0.01*
	10 %	7.88 ± 0.35*	220.73 ± 10.88*	13.48 ± 0.32*	0.25 ± 0.01*
	15 %	7.76 ± 0.30*	219.20 ± 10.04*	13.46 ± 0.38*	0.24 ± 0.01*
WB3	**5 %**	9.20 ± 0.32*	255.89 ± 9.72*	11.92 ± 0.17*	0.35 ± 0.01
	10 %	9.12 ± 0.41*	249.86 ± 10.54*	11.66 ± 0.20*	0.33 ± 0.01*
	15 %	8.80 ± 0.32	241.09 ± 11.23*	11.49 ± 0.15*	0.26 ± 0.01*
WB4	**5 %**	8.48 ± 0.41	232.33 ± 11.34	12.89 ± 0.32*	0.26 ± 0.01*
	10 %	8.28 ± 0.36*	220.54 ± 8.19*	12.80 ± 0.22*	0.24 ± 0.01*
	15 %	8.16 ± 0.36*	217.32 ± 10.76*	12.68 ± 0.32*	0.21 ± 0.01*
SB	**5 %**	8.72 ± 0.39*	256.28 ± 10.39	13.80 ± 0.23	0.30 ± 0.01
	10 %	8.56 ± 0.26*	224.74 ± 7.39*	12.16 ± 0.26*	0.27 ± 0.01*
	15 %	7.76 ± 0.33*	211.44 ± 11.65*	11.91 ± 0.18*	0.16 ± 0.01*

WB — wheat bran, SB — spelt bran.

*Denotes a statistically significant difference at p = 0.05 level.

Tab. 3. Sensory parameters of cookies incorporated by wheat bran.

		Appearance	Odour	Hardness	Taste	Overall acceptability (%)
control		7.67 ± 0.30	7.42 ± 0.32	7.83 ± 0.29	7.75 ± 0.31	80.67 ± 3.81
WB1	**5 %**	7.25 ± 0.26	5.92 ± 0.21*	7.67 ± 0.33	7.25 ± 0.35	76.62 ± 3.54
	10 %	7.25 ± 0.36*	5.75 ± 0.20*	7.33 ± 0.31	6.67 ± 0.28*	71.50 ± 3.01*
	15 %	6.83 ± 0.29*	5.75 ± 0.24*	7.17 ± 0.35	5.75 ± 0.20*	67.91 ± 2.98*
WB2	**5 %**	6.92 ± 0.34*	6.18 ± 0.29*	7.92 ± 0.31	6.75 ± 0.21*	72.92 ± 3.56*
	10 %	7.08 ± 0.35*	6.07 ± 0.24*	7.67 ± 0.31	7.00 ± 0.29*	69.58 ± 3.21*
	15 %	6.75 ± 0.32*	5.97 ± 0.24*	7.25 ± 0.35	6.32 ± 0.21*	68.67 ± 2.68*
WB3	**5 %**	6.17 ± 0.30*	6.08 ± 0.25*	7.33 ± 0.36	7.50 ± 0.29	73.08 ± 3.59*
	10 %	6.50 ± 0.29*	6.17 ± 0.23*	7.33 ± 0.33	6.92 ± 0.24*	72.50 ± 3.24*
	15 %	6.50 ± 0.23*	6.11 ± 0.27*	7.67 ± 0.34	6.33 ± 0.35*	70.00 ± 2.97*
WB4	**5 %**	7.08 ± 0.33*	6.83 ± 0.26*	8.00 ± 0.37	7.50 ± 0.31	76.67 ± 3.17
	10 %	7.00 ± 0.31*	6.08 ± 0.29*	7.67 ± 0.37	7.50 ± 0.35	76.42 ± 3.73
	15 %	6.75 ± 0.26*	5.42 ± 0.24*	7.33 ± 0.36	7.33 ± 0.31*	74.42 ± 3.61*
SB	**5 %**	7.43 ± 0.30	6.33 ± 0.27*	7.58 ± 0.33	7.08 ± 0.24*	70.17 ± 2.81*
	10 %	7.32 ± 0.34*	6.17 ± 0.28*	7.75 ± 0.36	7.02 ± 0.24*	71.08 ± 2.67*
	15 %	7.25 ± 0.31*	5.83 ± 0.23*	7.75 ± 0.34	6.92 ± 0.28*	69.33 ± 3.19*

WB — wheat bran, SB — spelt bran.

*Denotes a statistically significant difference at p = 0.05 level.

for WB1, SB and WB3 and at all levels for WB2 and WB4.

Cookies incorporated with different kinds of wheat bran were evaluated for sensory attributes (appearance, odour, hardness and taste) and overall acceptability. Sensory evaluation of cookies with 5, 10 and 15 % flour replacement with WB is presented in Table 3. It was recorded that the addition of higher amounts of WB decreases scores of appearance, odour and taste. Panellists also indicated bitter

aftertaste as WB levels increased (10 and 15 %). Furthermore, as the content of WB increased, the overall acceptability of cookies decreased.
The most acceptable cookie was prepared with 5 % WB4 (76.67 %). Similar decrease of overall acceptability was recorded by Gujral et al. (2003) and Silky et al. (2014) for cookies incorporated with WB.

Conclusion

The incorporation of different kinds of bran modified the rheological parameters of wheat dough. The addition of WB in general causes higher water absorption and mixing tolerance index, longer development time values and shorter dough stability values. It was also observed that addition of higher levels (10, 15 %) of bran negatively influenced qualitative parameters of cookies (volume, specific volume, spread ratio and porosity). Sensory evaluation revealed that increasing levels of different WB reduce the overall acceptability. In general, it can be concluded from the results that cookies with acceptable qualitative and sensory properties can be developed by WB supplementation of flour at the level of 5 %. Moreover, it was observed that cookies incorporated with WB4 at the level of 5 % were the most acceptable from assessors. In conclusion, this study demonstrated the potential of WB as a cheap and readily available source of dietary fibre for cookies production.

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