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Substitution of Soft White Wheat Bran for Hard Red Wheat Bran in Whole Wheat Instant Noodles

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Introduction

Whole grain foods are rich in dietary fiber and phytochemicals, and increasing the intake of dietary fiber and bioactive substance has been linked to numerous health benefits such as reduced glycemic index, lowered cholesterol levels and reduced risk of colon cancer (Onyeneho & Hettiarachchy, 1992 and Okarater & Liu, 2010). Asian noodles are one of the important parts of the Asian diet, making up to approximately 20-50% of total wheat flour consumption (Hou, 2010). Due to the potential health benefits of whole grain foods, whole-wheat noodle products are gaining more attention in Asia. For the last 6 years, Wheat Marketing Center (WMC) has conducted several whole-wheat noodle research projects and offered various whole-wheat noodle development workshops for Korean millers and noodle makers in cooperation with US Wheat Associates (USW). Our experience has shown that incorporating bran into refined flour can physically interfere with dough development, leading to discontinuation in the gluten matrix, therefore resulting in a negative impact on the sensory quality of the noodles. Finer bran particles of whole-wheat flour (WWF) are favorably associated with improved noodle texture (Niu et al., 2014). We also found that soft white wheat (SWH) bran particles are much finer than hard wheat bran particles under the same grinding conditions (Wang et al 2017; Liu et al 2016). In addition, due to lighter bran color, incorporating SWH bran to make a reconstituted WWF will result in more appealing noodle color.

The objectives of this study were to determine the effects of substituting SWH bran for hard red spring (HRS) wheat bran or hard red winter (HRW) wheat bran in WWF and to compare the quality of instant noodles made from blends of HRS or HRW refined flour and reconstituted WWF.

Material and Methods

Sample preparation

Samples of three wheat classes -- SWH (11% protein, 12% mb), HRS (14% protein, 12% mb) and HRW (12% protein, 12% mb) -- were sourced from Columbia Export Terminal and Federal Grain Inspection Service (Portland, OR). After cleaning, the wheat was tempered to 14.5% (SWH) and 16.5% (HRS and HRW) moisture, respectively, and milled on a Miag Multomat pilot-scale flour mill to obtain straight-grade flour (SGF). Bran, shorts, and red dog fractions were collected to prepare WWF. The bran and shorts were dusted to remove the bran-dusted flour and shorts-dusted flour. Then the bran and shorts were separately ground 5 times using a Perten 3100 laboratory mill. The 5^{th} grinding bran and shorts were combined with bran-dusted flour, shorts-dusted flour, red dog fractions, and SGF flour to obtain WWF.

Four different types of WWF were composited:

- Hard red spring whole wheat flour (HRS-WWF);
- Hard red winter whole wheat flour (HRW-WWF);
- Hard red spring SGF with soft white wheat bran substitution (HRS-SGF/SWH-bran);
- Hard red winter SGF with soft white wheat bran substitution (HRW-SGF/SWH-bran).

Flour and dough analysis

Moisture, falling number, protein, ash, wet gluten content and starch damage of the flour samples were determined according to AACCI Approved Methods 44-15.02, 44-15, 46-30.01, 08-10.01, 56-81.03 and 76-33.01, respectively. Solvent retention capacity was measured according to AACCI Approved Method 56-11.02. Flour particle size was determined by a Ro-Tap testing sieve shaker (WS Tyler Incorporated, USA). The mass median particle size of each WWF was determined by the method described by Penella et al (2008). Dough rheology was determined using a Farinograph according to AACCI Approved Method 54-21.02.

Noodle preparation

Korean instant noodles were prepared using the WMC standard protocol developed by the Korean flour millers and noodle makers.

Noodle quality analysis

Color: Color of ground noodles was measured using Minolta colorimeter. L*, a* and b* parameters were reported.

Sensory: Sensory test was conducted by professional noodle manufacturers from South Korea. Appearance, mouth feel, bite texture and texture stability (after 5 minutes of soaking in hot water) were reported.

Statistical analysis

All data were analyzed by analysis of variance using SPSS. Variables were considered significant with $P<0.05$ and differences were determined based on Tukey test.

Results and discussion

Flour and dough quality parameters

Table 1 shows flour analysis data of four different flour blends: HRS-SGF/HRS-WWF (67/33), HRW-SGF/HRW-WWF (67/33), HRS-SGF/HRS-WWF with SWH bran (67/33), and HRS-SGF/HRW-WWF with SWH bran (67/33). As the amount of HRS straight-grade flour in each blend is fixed (67%), therefore the samples will be simply referred to as HRS-WWF, HRW-WWF, HRS-WWF with SWH bran, and HRW-WWF with SWH bran from this point forward. Flour protein of the four different blends ranged from 12.3% to 13.3%. Ash content of HRS-WWF and HRW-WWF were significantly higher than HRS-WWF with SWH bran and HRW-WWF with SWH bran even though their blends were all made at the same ratio ($p<0.01$). Falling number indicated that the wheat was sound, and that there was no sign of sprouting. Starch damage of HRS-WWF and HRS-WWF with SWH bran was higher than HRW-WWF and HRW-WWF with SWH bran ($p<0.05$) because HRS wheat had harder kernels than HRW.

Median particle size of the blends ranged from 96 to 98 microns. There was no significant difference in median particle size between flour blends made with HRS, HRW or SWH bran although particle size distribution could be different.

As expected, HRS-WWF with SWH bran and HRW-WWF with SWH bran were brighter than HRS-WWF and HRW-WWF. This was due to the lighter colored seed coating on the SWH compared to darker and redder colored seed coating on HRS and HRW. HRS-WWF with SWH bran and HRW-WWF with SWH bran were also significantly less red (smaller a* value) than the two other samples.

Table 2 shows the SRC absorption values and Farinograph dough mixing properties of the four flour blends. SRC water absorption was not significantly different among the flour blends ($p>0.05$). Both SRC sucrose and sodium carbonate absorption fell into two general groupings; blends with HRS (HRS-WWF and HRS-WWF with SWH bran) were more similar and higher than blends with HRW (HRW-WWF and HRW-WWF with SWH bran). Lactic acid SRC however, significantly increased with the substitution of SWH bran. This showed that substituting SWH bran for HRS or HRW bran contributed to increased lactic acid absorption, indicating that SWH bran had less interference with gluten polymer formation than hard wheat bran, which could be positive to improved dough structure and cooked noodle firmness.

Farinograph water absorption decreased significantly as hard wheat bran was replaced by SWH bran ($p<0.05$), probably because the damaged starch level was lower in SWH bran fraction's softer kernels. Farinograph peak time also decreased when SWH bran was used, especially in the case of HRW-WWF with SWH bran. Farinograph peak time dropped from 16.9 min in HRW-WWF to 7.6 min in HRW-WWF with SWH bran. This suggested that the smaller particle size of

SWH bran greatly reduced the time required for dough hydration and development, i.e., shorter mix time in noodle processing. Stability was not different in the groups where SWH bran was present or absent, thus, SWH bran did not have detrimental effects on dough stability.

Instant Fried Noodle Quality

Figure 1 shows the appearance of the instant noodle cakes. As expected from flour color data in Table 1, noodle cakes made with SWH bran were brighter and whiter than noodle cakes made with HRS or HRW bran. Table 3 shows the sensory evaluation results of the instant noodles. Sensory analysis was performed by a team of 4 professional noodle makers and flour specialists from South Korea. Noodles made with SWH bran scored higher in appearance, mouthfeel, bite texture, texture stability and overall scores compared to noodles made with HRS or HRW bran. Within the whole-wheat flour blends with SWH bran substitution, the sample HRS-WWF with SWH bran had the highest scores across all parameters.

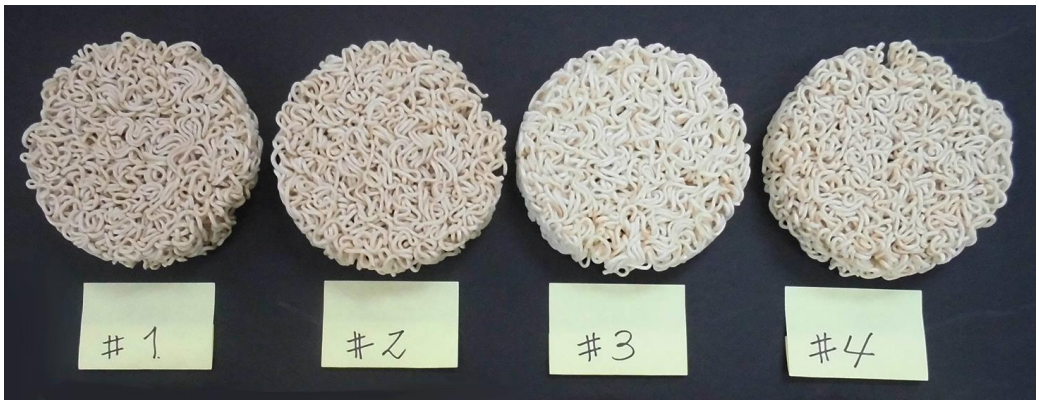

Figure 1: Appearance of instant noodle cakes (1: HRS-WWF, 2: HRW-WWF, 3: HRS-WWF with SWH bran, 4: HRW-WWF with SWH bran)

Conclusions

Substituting hard wheat bran with SWH bran significantly increased lactic acid SRC value and shortened dough development time (Table 2). Median particle size of flour blends made up of hard wheat bran or SWH bran were very similar, however, reconstituted WWF made with SWH bran substitution was significantly brighter ($p<0.05$) (Table 1). In addition, instant noodles made with SWH bran substitution were also brighter than those made with hard wheat bran (Fig. 1). Sensory analyses concluded that instant noodles made with SWH bran substitution received higher scores than hard wheat bran (Table 3).

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Table 1. Flour quality analysis of reconstituted whole-wheat flour and refined flour blends

Sample	Blend (%)	Moisture (%)	Protein (%, 14% mb)	Ash (%, 14% mb)	FN (%, 14% mb)	Starch Damage (%, 14% mb)	Median Particle size (microns)	Color		
								L*	a*	b*
HRS-SGF/HRS-WWF	67/33	13.4 b	13.3 c	0.716 b	409 a	8.10 ab	96	87.3 a	-0.42 d	9.3 d
HRS-SGF/HRW-WWF	67/33	13.6 c	12.4 a	0.680 b	388 ab	7.82 a	98	89.5 b	-0.75 c	8.5 a
HRS-SGF/HRS-WWF with SWH bran	67/33	13.4 ab	12.8 b	0.593 a	427 b	8.65 b	97	90.4 d	-1.31 a	8.7 b
HRS-SGF/HRW-WWF with SWH bran	67/33	13.3 a	12.3 a	0.604 a	419 ab	7.73 a	98	90.2 c	-1.03 b	9.0 c

* Means in the same column followed by different letters are significantly different from each other $p<0.05$.

Table 2. SRC and Farinograph data of flour blends

		SRC				Farinograph			
Sample	Blend (%)	Water (%, 14% mb)	Sucrose (%, 14% mb)	Lactic Acid (%, 14% mb)	Sodium Carbonate (%, 14% mb)	Absorption (%, 14% mb)	Peak time (min)	Stability (min)	MTI (BU)
HRS-SGF/HRS-WWF	67/33	84.9 a	112.1 b	122.3 ab	110.3 ab	69.2 d	9.3 a	15.4 a	4
HRS-SGF/HRW-WWF	67/33	81.4 a	105.2 a	120.4 a	105.3 a	67.0 b	16.9 b	18.2 b	24
HRS-SGF/HRS-WWF with SWH bran	67/33	85.6 a	113.3 b	150.9 c	112.1 b	67.8 c	9.0 a	16.3 a	5
HRS-SGF/HRW-WWF with SWH bran	67/33	81.7 a	107.4 a	128.4 b	107.2 ab	66.2 a	7.6 a	16.4 ab	7

*Means in the same column followed by different letters are significantly different from each other ($p<0.05$).

Table 3. Sensory evaluation data of instant noodles

		Sensory Evaluation Results				
Sample	Blend (%)	Appearance (max 10)	Mouthfeel (max 30)	Bite texture (max 30)	Texture stability (max 30)	Overall score (max 30)
HRS-SGF/HRS-WWF	67/33	6.8	25.0	25.0	24.5	81.3
HRS-SGF/HRW-WWF	67/33	7.8	25.5	26.0	26.0	85.3
HRS-SGF/HRS-WWF with SWH bran	**67/33**	**8.3**	**27.3**	**27.5**	**27.0**	**90.0**
HRS-SGF/HRW-WWF with SWH bran	67/33	7.5	26.0	26.5	26.3	86.3

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