PHYSICAL - CHEMICAL CHARACTERIZATION OF INDUSTRIAL WHEAT BRAN FROM LATVIA

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Abstract
Cereal and whole grain products are an important source of dietary fiber in the human diet. Since the milling process highly influences the proportions of the different cell types in the bran, it is expected that brans originating from different genetic/agricultural backgrounds and produced by different processes have different chemical composition. Wheat (*Triticum aestivum*) bran has not been studied in Latvia, therefore the aim of the present study was to analyze physical – chemical characteristics of wheat bran from Latvia's industrial mills. Four bran samples were collected from two industrial mills: Stock Company 'Dobeles dzirnavnieks' and SC 'Rigas dzirnavnieks'. All experiments were performed at the Food Technology of *Latvia University* of *Agriculture* in May 2011-February 2012. The particle size distribution of the bran samples was determined by sieving. The content of titratable acidity (TA) was detected by titration with 0.1 M NaOH till pH 8.5 was stable for 1 minute. Wheat bran colour was analysed by Hunter Lab colour measurement instrument using *ColorTec* colorimeter *PCM/PSM* in CIE L * a * b* system. Moisture content was analyzed using standard ICC 110/1 method by sample drying for 2 h at 150 °C. Results showed that there were significant differences between varieties ($p<0.05$) for titratable acidity and for particle size, but no significant differences ($p>0.05$) were found between the varieties in moisture, pH and colour. TA varied from 6.40±0.71 to 12.05±0.21°, moisture content- from 10.01±0.51% to 11.61±0.47%, pH–from 6.31±0.61 to 6.80±0.05, but colour of bran between the samples did not significantly differ.
Key words: wheat bran, particle size, colour, titratable acidity.

Introduction

Cereal and whole grain products are an important source of dietary fiber in the human diet. Wheat (*Triticum aestivum*) bran is the coarse outer layer of the wheat kernel that is separated from the cleaned and scoured kernel. It consists mainly of the large pieces of bran remaining after the flour has been extracted from the wheat.

Wheat bran is a composite material formed from different histological layers, and three different strips can be obtained from the soaked outer layers. The outer strip corresponds to outer pericarp (epidermis and hypodermis), the inner one corresponds to the aleurone layers, and the intermediate one remains a composite of several tissues (inner pericarp, testa, and nuclear tissue (Hemery et al., 2010).

Wheat grain is a complex structure composed of different tissues (Fig. 1) that have distinct functions and biochemical compositions. The starchy endosperm (80–85% of the grain) is mostly composed of starch and proteins, while most of the fiber, vitamins, minerals and antioxidants are concentrated in the outer layers (12–17% of the grain) and the wheat germ (3% of the grain) (Hemery et al., 2010). Wheat endosperm is surrounded by several adhesive outer layers (including pericarp, testa, and aleurone layer). After milling, a composite material that contains all these different layers is obtained and is commonly called bran. The current wheat grain milling process aims at recovering white flour (mostly composed of starchy endosperm), with bran and germ being discarded. Wheat bran is thus mostly used for animal feeding, even though – due to its high nutritional potential – it could be used to produce ingredients to increase the nutritional quality of human foods (Hemery et al., 2009).

Bran fractionation processes aim at recovering separately the different layers of the bran, to produce fractions rich in the different bran layers, such as pericarp-rich fractions (rich in fiber) or aleurone-rich fractions (rich in vitamins, minerals and antioxidant compounds). The existing bran dry fractionation processes take advantage of different properties such as particle size and density, in using sieving and air-classification of ground bran. However, these processes give insufficient results, due to the low differentiation in size and density of the particles generated from each bran tissue after grinding (Hemery et al., 2009).

Since the milling process highly influences the proportions of the different cell types in the bran, it is expected that brans originating from different genetic/agricultural backgrounds and produced by different processes have different chemical composition. The brans of different grains vary considerably in their chemical components including cell wall polysaccharides and bioactive compounds (Harris et al., 2005).

Wheat bran has not been studied in Latvia, therefore the aim of the present study was to analyze physical – chemical characteristics of wheat bran from Latvia's industrial mills.

Materials and Methods

Experiments were performed at the Faculty of Food Technology of Latvia University of Agriculture in May 2011-February 2012.

Bran samples

Wheat bran samples were collected from industrial mills in Latvia:

1) Stock Company (SC) 'Dobeles dzirnavnieks'-large particle size wheat bran **(LSD);**
2) SC 'Dobeles dzirnavnieks'-small particle size wheat bran (**SSD);**
3) SC 'Rigas dzirnavnieks'-large particle size wheat bran (**LSR);**
4) SC 'Rigas dzirnavnieks'-small particle size wheat bran **(SSR).**

Bran analyses

Particle size

The particle size distribution of the bran samples was determined by sieving (sieve size ranging from 1.000 to 2.000 mm);

Microstructure of wheat bran samples

Microstructure of wheat bran samples was analysed under the triocular microscope Axioskop 40. Pictures were taken by digital compact camera Canon PowerShot A620 via 16×10 or 16×40 magnification of the microscope and processed with software Axiovision Le Rel 4.7. Wheat bran samples were placed on a glass slide.

Bran colour

Wheat bran colour was analysed by Hunter Lab colour measurement instrument. The colour of the brans was measured using a colorimeter *ColorTec PCM/PSM* in CIE L * a * b* system. A positive L*-value represents the lightness of colour, a positive a*-value designates redness, a negative a*-value represents greenness, a positive b*-value means yellowness, and a negative b*-value stands for blueness (Afaf Kamal-Eldin et al., 2009).

Moisture content of wheat bran

Moisture was analyzed by drying for 2 h at 150 °C (ICC Standard No, 110/1)

Titratable acidity

Titratable acidity was detected using Standard – 'Methoden für Getreide, Mehl und Brot' (Gottfried and Hans, 2000).

Ten grams of a sample were doused with 100 mL of water, slowly stirred, and then the mixed solution was transfused in a 150 mL beaker and pH was measured. Than the samples were titrated with 0.1 M NaOH till pH 8.5 was stable for 1 minute. Titratable acidity conformed with 0.1 M NaOH quantity.

pH value

Using JENWAY 3520 (Barloworld Scientific Ltd., ESSEX, UK) pH-meter, pH was measured. The pH electrode was dipped into a mixture of homogenized sample and distilled water (1:10) (AACC 02-52).

Statistical analysis

Data was processed by SPSS software version 17.0. Data was analysed using descriptive statistics and processed by one-way analysis of variance (Anova) where factor was bran and dependent parameters-performed analyses. Duncan's test was used for individual variety of characterization by a parameter. Statistical differences were considered significant at $p<0.05$. Microsoft office software version 2007 was used to determine significant differences between the samples.

Results and Discussion

Bran samples used in the experiments had considerably different particle sizes, which consequently may influence on physical–chemical properties such as colour, titratable acidity, and moisture. Therefore wheat bran samples were sieved (through the sieve) and the results exposed significant differences among the four studied bran samples regarding particle size and colour (Table 1). LSD particles were similar (1.6 – 1.8 mm), to those of SSR (1.6 – 1.8 mm) and LSR (1.6 – 2.0 mm), but compared with SSD (1.0 mm) data was different. Comparison in colour results (L*) was different, data varied from 50.12±1.70 (LSD) to 58.42±1.51 (LSR). The Δa* indicated that the LSD was redder as compared to SSD, and SSR was redder as compared to LSR. The SSD was greener as compared with other samples. The b* showed that the LSR was yellower than LSD, SSD and SSR.

Table 1

Relative particle size distribution and colour of different bran samples

Bran	LSD	SSD	SSR	LSR
Relative particle size distribution, mm	1.6 – 1.8□	1.0□	1.6 – 1.8□	1.6 – 2.0□
Colour (L*, a*, b* chromaticity measurements)				
L* (lightness)	50.12±1.70	57.57±3.25	53.25±2.71	58.42±1.51
a* (negative=green, positive=red)	2.87±0.64	2.12±0.45	3.28±0.99	2.96±0.45
b* (positive=yellow)	19.218±1.92	17.41±1.02	16.75±1.94	21.29±1.73

□ - significantly different ($p<0.05$)

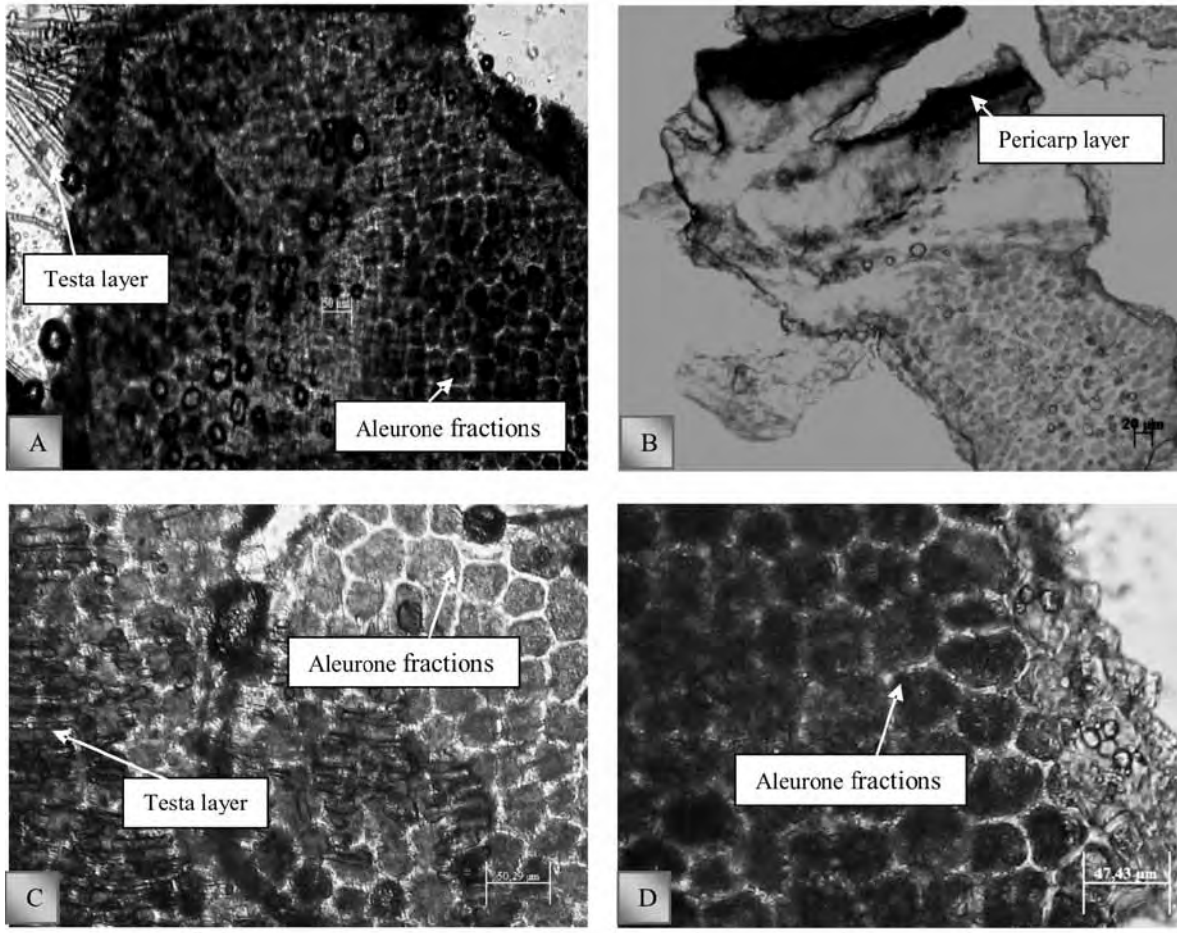

Figure 1. Microstructure of wheat bran samples: A-LSD, B-SSD, C-LSR, D-SSR.

There was a large variation in the starch content of wheat bran, indicating differences both in grain type, and varietal heterogeneity as well as differences in processing. As it is known, wheat bran with a larger particle size is rich in different bran layers, such as pericarp-rich fractions or aleurone-rich fractions. Accordingly to other scientific works it is possible to make a conclusion that wheat bran with a large particle size contains less starchy endosperm, more grain outer layer, as a result date wheat bran is darker and redder in colour. The pictures of wheat bran samples from microscopy showed that wheat samples LSD and LSR contain more grain outer layers (aleurone fractions, pericarp and testa) and less starchy endosperm (Figure 1).

Moisture tempering is a long-established practice performed by millers to improve the milling process. This pre-treatment, also called 'conditioning', consists of two steps: damping followed by a resting period. It is often regarded by millers as inducing 'bran toughening', which results during milling in better separation from the endosperm, with the recovery of the bran in coarser pieces and with fewer bran specks in the flour. Indeed, the rheological properties vary greatly according to the moisture content of the outer layers (Khan and Shewry, 2009).

Analysing data of bran moisture (Figure 2.) it's possible to conclude that the highest moisture content was in 'Rigas dzirnavnieks' wheat bran with large particle size (11.61±0.47%), but the lowest in SC 'Rigas dzirnavnieks' wheat bran with small particle size (10.01±0.51%). One-way Anova showed there were no significant differences between the four bran samples ($p>0.05$). Moisture content varied from 10.01±0.51% to 11.61±0.47%.

According to the information from fourth edition of 'Wheat chemistry and technology' (Khan and Shewry, 2009), the moisture content increases in outer layers. This increase in bran probably results from a plasticizing effect of water, which reflects a phase transition within the cell walls and more particularly within the most hydrophobic regions, which are rich in cutin (Evers and Reed, 1988).

The highest pH value was found in SC 'Rigas dzirnavnieks' wheat bran with large particle size, the lowest in -SC 'Dobeles dzirnavnieks' wheat bran with large particle size. This partially confirms the findings in the literature that the large pieces of bran increase

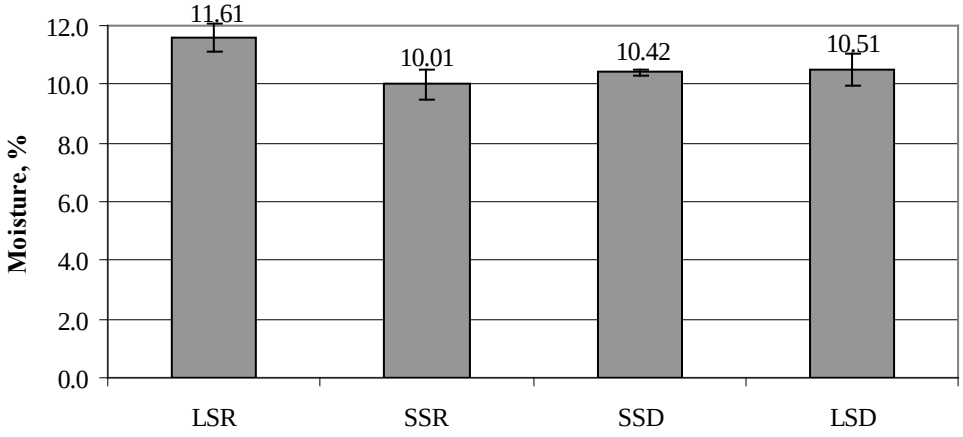

Figure 2. Moisture of wheat bran samples.

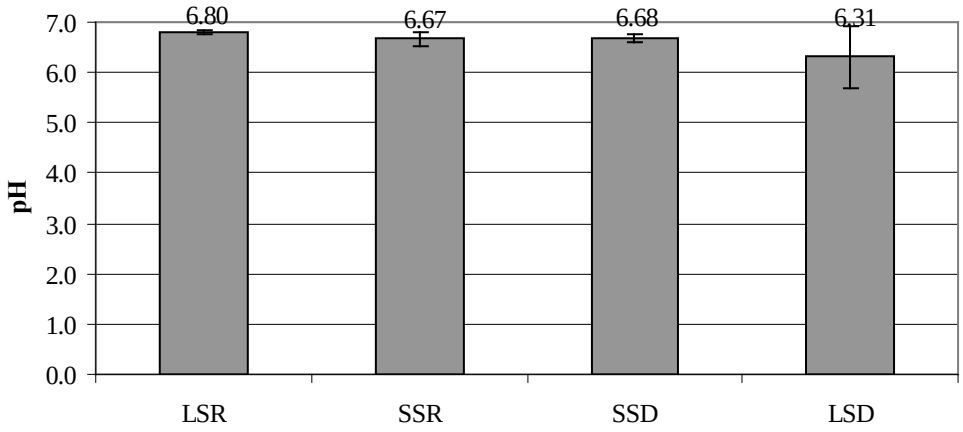

Figure 3. Comparison of pH value in wheat bran samples.

the pH value because of the high content of pericarp-or aleurone -rich fractions. One-way Anova showed no significant differences between the four bran samples ($p>0.05$). The pH value ranged from 6.31±0.61 to 6.80±0.05. Our results (Figure 3.) agree with the conclusions made by researchers in other countries that the pH value in wheat bran is approximately pH 6.90 (Nermin and Şenol, 2006).

There were significant differences ($p<0.05$) in titratable acids amount among the four studied samples (Figure 4.). Titratable acidity (12.05°±0.21) was higher in SC 'Dobeles dzirnavnieks' wheat bran with small particle size compared to SC 'Rigas dzirnavnieks' small particle size (6.40°±0.71), SC 'Dobeles dzirnavnieks' wheat bran with large particle size (10.40°±0.28), and SC 'Rigas dzirnavnieks' wheat bran with small particle size (9.35±0.49). According with information from other scientific sources (Afaf Kamal-Eldin et al., 2009) SC 'Dobeles dzirnavnieks' wheat bran with small particle size (12.05°±0.21) titratable acidity is not correct, there is a great difference between the samples, TA is more than a standard.

In comparison to the pH and TA values presented in the literature, in our research titratable acidity in bran increased because of the high protein content. Hydrolytic processes increase pH value and titratable acidity in wheat bran (Конева and Могучева, 2011). Since titratable acidity of wheat bran from the different stock companies significantly differed between the samples, less from the bran size, it indicates the influence of the milling process.

Conclusions

1. Results in this study showed, that there are significant differences in the titratable acids and particle sizes, but did not significant differences ($p>0.05$) between samples for colour, moisture and pH between four wheat bran samples from Latvia industrial mills.
2. SC 'Dobeles dzirnavnieks' wheat bran with large particle size particles were generally larger in size 1.6 – 1.8 mm and darker in colour L* 50.12±1.70 as compared with SC 'Dobeles dzirnavnieks' wheat bran with small particle size 1.0 mm, L* 57.57± 3.25. SC 'Rigas dzirnavnieks' wheat bran

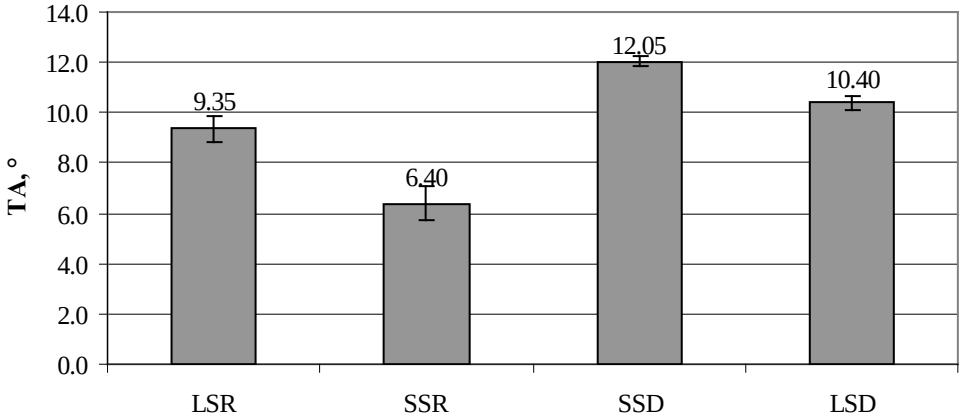

Figure 4. Titratable acidity of wheat bran samples.

particles were similar (1.6. – 2.0 mm), but colour L* 53.25±2.71 (SSR), L* 58.42±1.51 (LSR) was different.

3. Titratable acidity of wheat bran is significantly influenced by technological process of milling, since the milling process highly influences the proportions of the different cell types in the 'bran', therefore SC 'Dobeles dzirnavnieks' samples contained the highest titratable acidity 10.40±0.28 – 12.05±0.21, whereas SC 'Rigas dzirnavnieks' sample had 6.40±0.71 to 9.35±0.49.

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