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Relationship of various flour properties with noodle making characteristics among durum wheat varieties

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ABSTRACT

The grain, flour, dough and noodle making properties of Indian durum wheat varieties were evaluated. Varieties having higher grain weight had lower hardness and higher yellow pigment content. Gluten performance index showed positive correlation with α-helix and negative with intermolecular + antiparallel-β-sheets in gluten. The proportion of extracted polymeric proteins was related to dough strength. Elastic (G') and loss (G'') modulus of dough were positively correlated to intermolecular + antiparallel-β-sheets and negatively with β-turn+ β-sheets proportion of dough and gluten. PDW291 with exceptionally higher G' and G'' and best noodle making properties showed the presence 90 kDa and 88 kDa polypeptides corresponding to 14 + 15 and type 2 banding pattern.

1. Introduction

India is a major durum wheat producing country in the world with an annual production of around 2.5 million tons that has the potential to export to the world market since it is not used in chapatti, biscuits and cake making. These products consume the major portion of wheat produce in India. Durum wheat *(Triticum durum)* is gaining popularity among Indian farmers, mainly due to its higher yield potential and higher degree of resistance to rusts and Karnal bunt as compared to common wheat. Moreover, it possesses a harder kernel, having considerably higher yellow pigment and grain protein content as compared to common wheat. It is mainly employed in the production of many food items, pasta being the most popular, due to its unique color, flavor and cooking quality (Feillet & Dexter, 1998). There is growing interest in utilizing durum wheat in bakery and Asian noodles products because of its higher lutein products (Fu, Assefaw, Sarkar, & Carson, 2006; Hatcher, Edwards, & Dexter, 2008; Liu, Shepherd, & Rathjen, 1996). Noodles are widely popular staple food in many parts of Asian countries due to the easy preparation, desirable sensory attributes, long shelf life, low price and easy cooking methods (Park & Baik, 2002; Yadav, Yadav, Kumari, & Khatkar, 2014). Yellow pigment concentration (YPC) is a desirable end-use quality trait in durum wheat both visually and nutritionally, and an elevated pigment concentration has been the target of durum breeding programs worldwide (Reimer et al., 2008). The amount of this pigment varies between cultivars and fluctuates yearly depending on environmental conditions during kernel development. The attractive bright yellow color of durum is accompanied due to the higher accumulation of xanthophylls and carotenoids. Among these xanthophylls and carotenoids, the β-carotene is important for pasta quality and nutrition that acts as a preservative and precursor of vitamin-A biosynthesis in human and animal diets with

Abbreviations: HI, hardness index; TGW, thousand grain weight; YPC, yellow pigment content; Ex-PP, extractable polymeric protein; Ex-MP, extractable monomeric protein; UnEx-PP, unextractable polymeric protein; UnEx-MP, unextractable monomeric protein; SRC, solvent retention capacity; SodSRC, sodium carbonate SRC; SuSRC, sucrose SRC; LASRC, lactic acid SRC; WSRC, water SRC; GPI, gluten performance index; MPT, mixograph peak time; MPH, mixograph peak height; MPW, mixograph peak width; WS, weakening slope; Intermolecular+ antiparallel-β-sheets, IM+ AP-β-sheets; G', elastic modulus; G'', viscous modulus; WG, wet gluten; DG, dry gluten; GI, gluten Index; HMW-GS, high molecular weight-glutenin subunits; LMW-GS, low molecular weight-glutenin sub units; WA, water absorption; Coh, cohesiveness; Gum, gumminess; PCA, principal component analysis.

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potential anticancer activity (Krinsky, 1987; Lambert, Koch, & Kornhauser, 1990). Many researchers have established that content and composition of proteins, especially the gluten strength, are important attributes for the cooking quality of pasta and noodles made from durum (Novaro, D'Egidio, Mariani, & Nardi, 1993; Walsh & Gilles, 1971). Earlier 25 durum wheat cultivars were evaluated to develop a relationship among sedimentation value and HMW-GS combination and demonstrate that as compared to HMW-GS subunit 20, the sedimentation value have positive correlation with of subunit 13 + 16 and 7 + 8, for Glu-A1 and Glu-B1 alleles, respectively). Interestingly, the frequency of null allele (Glu-A1c) of Glu-A1 was highest among 25 Indian durum cultivars Ram (2003). Studies carried out by Ram (2003) and Liu and Rathjen (1996) have shown that sedimentation value have a positive or negative correlation with HMW-GS allelic combinations that ultimately influence the dough making properties of durum wheat. However, the physico-chemical properties of durum flours and relationships with gliadins and glutenins and evaluation of secondary and tertiary structure of storage proteins with respect to cooking and textural attributes of noodles was not evaluated for recently developed durum wheat varieties except yield, disease resistance, tolerance towards biotic and abiotic stresses. The objective of the present study was to investigate the interrelationship between grain, flour, dough, gluten and noodle making properties of durum wheat varieties.

2. Materials and methods

2.1. Materials

Durum wheat varieties viz. HI-8663, HD-4725, HI-8498, PDW-314, NIDW-295, HD-4713 and PDW-291 were procured from Indian Agriculture Research Institute, New Delhi.

2.2. Grain characteristics

L^*-, a^*- and b^*-values of grains were determined using Hunter colorimeter Model D 25 optical sensor (Hunter Associates, USA). Thousand grain weight (TGW), diameter and hardness index (HI), were analyzed using AACC method 55-31 (2000). The moisture content of grains ranged from 10% to 11%.

2.3. Flour milling

The grains were conditioned for 48 h at 14% moisture and milled in the Quadrumat Senior mill (Barbender, Germany).

2.4. Flour characteristics

Color of the flour was determined as described earlier (Kaur et al., 2013). Moisture, ash, fat and protein contents were determined by employing standard methods of analysis (AOAC, 1990).

2.5. Yellow pigment content

Yellow pigment content (YPC) was determined according to AACC method (2000). 8 g of sample were weighed in a stoppered conical flask and a 40 ml of *n*-butanol were added. The content was shaken for 1 min and kept undisturbed for 30 min. The content was sheken again and filtered through a Whattman No. 1 filter paper. The absorbance was measured at 436 nm on spectrophotometer.

2.6. Protein characterization

SDS-extractable and un-extractable polymeric proteins (Ex-PP and UnEx-PP, respectively) were obtained by using method Gupta, Khan, and Macritchie (1993). SDS-extractable and un-extractable polymeric proteins (Ex-PP and UnEx-PP, respectively) were obtained by using method (Gupta et al., 1993). Two replicates of each flour sample were used for the investigation of size distribution. Flour (10 mg) was suspended in 1 mL of 1% SDS and 0.1 M sodium phosphate buffer (pH 6.9) and stirred for 5 min using a pulsing vortex mixer. The mixture was centrifuged for 20 min at 12,000×*g*. The extractable protein was dissolved in supernatant and filtered through a 0.2 μm membrane filter. The un-extractable protein was obtained from the residue. The residues were sonicated for 60 s with 1 mL of extraction buffer. Then the mixture was centrifuged for 20 min at 12,000×*g* and the supernatant was filtered and injected on SE-HPLC for analysis. SDS-extractable and un-extractable protein fractions were separated by a narrow bore column PROSEC 300S (300 × 7.5 mm). Injection volume was 20 μL. Eluting solution was 50% acetonitrile in water with 0.1% trifluroacetic acid at a flow rate of 0.5 mL/min. Solutes were detected at 214 nm using a photodiode array detector.

2.7. Mixographic characteristics

Dough mixing properties were analyzed by AACC method (2000) using mixograph (Kaur, Singh, Kaur, Ahlawat, & Singh, 2014). Mixographs were recorded electronically using a 10 g bowl (National Mfg. Co. Lincoln, NE, USA) with the spring fixed at 10th position in the scale. For construction of mixograms, moisture content and protein content of the samples were determined according to AACC method (2000). Various parameters evaluated were mixograph peak time (MPT), mixograph peak height (MPH), mixograph peak width (MPW) and weakening slope (WS).

2.8. Rheological characteristics

Dynamic rheometry of dough was performed as described earlier in Kaur et al. (2013).

2.9. Gluten characteristics

WG, DG and GI was analyzed using Glutomatic 2200 (Perten Instruments) according to AACC method (2000). Dynamic rheometry of gluten as mentioned above.

2.10. Secondary structure of dough and gluten

Secondary structure of the dough and gluten was determined using FTIR (Vertex 70, Bruker, Germany). Dough was prepared as described earlier by Kaur et al. (2014). Spectra of an empty cell were taken as background. Measurements were performed over wavenumbers ranging from 800 to 2000 cm^{-1} (fingerprint region) with 4 cm^{-1} resolution. Wavenumber 1612–1632 cm^{-1}, 1650–1660 cm^{-1}, 1665–1670 cm^{-1} were assigned to IM+ AP-β-sheets, α-helix and β-turn+ β-sheets, respectively by Wang et al. (2014).

2.11. SDS–PAGE

Gliadins and glutenins were extracted from different Indian durum wheat varieties according to the method of Singh, Shepherd, and Cornis (1991). Numbering of gliadins and glutenins were done according to Oak, Tamhankar, Rao, and Bhosale (2004).