Influence of Amylose Content on Cooking Time and Textural Properties of White Salted Noodles

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Abstract White salted noodles were prepared from reconstituted flours of various amylose content to determine the effects of amylose content on noodle dough properties and texture of noodles cooked for optimum cooking time. With decrease of amylose content from 26.5 to 3.0%, optimum water absorption of noodle dough increased from 39 to 49% and cooking time of noodles decreased from 16 to 7 min. Hardness of cooked noodles prepared from reconstituted flour consistently decreased with increase in proportion of waxy starch. Noodles less than 12.4% amylose content exhibited higher springiness and cohesiveness than noodles greater than 17.1% amylose content. Cohesiveness and springiness of noodles prepared with partial waxy starches, of which amylose content ranged from 16.6 to 22.7%, were comparable to those of noodles prepared from <12.4% amylose content. Amylose content of starch was significantly correlated with hardness, springiness, and cohesiveness of cooked noodles prepared from reconstituted flours.

Keywords: wheat, white salted noodle, optimum cooking time, amylose content, texture

Introduction

Starch characteristics of wheat flour are believed to have as much influence as protein on the texture of white salted noodles. Protein content and quality are significantly related with textural properties of cooked noodles (1-4). High pasting viscosity, breakdown, and swelling power are desirable functional properties for the textural quality of white salted noodles (5-9). These starch characteristics are largely determined by amylose content of starch (10-12). Amylose content of wheat starch is controlled by granule bound starch synthase (GBSS). Common wheat contains all 3 GBSS genetic loci, Wx-A1, Wx-B1, and Wx-D1 (13,14). Wheat genotypes with a null allele in any of the wx-A1, wx-B1, and wx-D1 loci (single-null), or null alleles at 2 out of the 3 GBSS loci (double-null), are known as partial waxy and produce starch of reduced amylose content (14-16). Wheat flour of Wx-B1 null allele in GBSS is known to be suitable for production of white salted noodles of desirable textural properties (17). White salted noodles produced from double-null partial waxy wheat flours were softer, less adhesive, and more cohesive than noodles prepared from wheat flours of regular amylose content (18).

Cooking time of dry white salted noodles is often determined by squeezing samples of noodle strands during cooking and checking the disappearance of the white core. This method is, however, difficult to apply to fresh noodles, which do not show an evident white core, mainly due to their relatively high moisture content. Therefore, a fixed cooking time has often been used in the evaluation of eating quality of fresh white salted noodles. Optimum cooking time, as determined by sensory panel testing was positively correlated with amylograph onset temperature of cooked noodles and was largely influenced by amylose content rather than protein content (19). Park and Baik (19)
also proposed that in addition to a sensory test or the method of squeezing noodle strands and observing the disappearance of the white core during cooking, the optimum cooking time of noodles can be estimated objectively by monitoring the changes in amylograph onset temperature of noodles during cooking.

In this study, the effect of amyllose content on cooking time of white salted noodles was investigated in consideration of the avoidance of protein interference by using reconstituted flours with varying amyllose content. The effect of amyllose content on noodle making and textural properties of noodles cooked for optimum cooking time were also determined.

Materials and Methods

Materials  A soft wheat cultivar of wild type in granule bound starch synthase (GBSS), cv. Alpowa, and a hard wheat cultivar of \( Wx-B1 \) null in GBSS, wheat cv. IDO377S, were obtained from the USDA-ARS Western Wheat Quality Lab (Pullman, WA, USA). Two hard wheat genotypes of double null in GBSS, wheat cv. Ike (\( Wx-A1 \) and \( Wx-B1 \) double-null) and wheat line HWSW98017 (\( Wx-B1 \) and \( Wx-D1 \) double-null), and an advanced breeding line of waxy wheat, which carries null alleles at all 3 GBSS loci and which was derived from the Kanto107/BaiHuo/IDO377S, were provided by the Northwest Breeding Company (Pullman, WA, USA). Wheat grain was milled using a Bühler experimental mill, and flour of about 60% extraction was prepared by blending the millstreams.

Preparation of reconstituted flour  Wheat cvs. Alpowa, IDO377S, Ike, HWSW98017, and waxy wheat flours were used to prepare reconstituted flours. Wheat flour was fractionated into gluten, solubles, tailings starch and prime starch according to the method of Czuchajowska and Pomeranz (20), and the yield of each fraction was determined. Gluten, solubles and tailings starch were lyophilized, and prime starch was adjusted to the moisture content of prime starch (about 10%). Moisture and protein content of wheat flour were determined according to AACC Methods 44-15A and 46-30 (21). Amylose content of prime starches was determined according to the procedures of Williams et al. (22).

Gluten, tailings starch, and solubles isolated from Alpowa were used to prepare reconstituted flours. The proportion of each fraction for preparation of reconstituted flour was 0.5% for solubles, 16.0% for tailings starch, 8.6% for gluten, and 69.9% for prime starch, respectively. The reconstituted flours were prepared by blending solubles, tailings starch, and gluten of wheat cv. Alpowa with either the prime starch isolated from wheat cv. Alpowa, IDO377S, Ike, HWSW98017, or waxy wheat, or prime starch blends of waxy wheat and Alpowa. The blends of prime starch were prepared by mixing prime starches of wheat cv. Alpowa with 20-80% of prime starch of waxy wheat.

Preparation of white salted noodles  White salted noodles were prepared with optimum water absorption to achieve uniform, smooth, and non-sticky noodle dough. The optimum water absorption for making white salted noodles was determined through trial and error, based on how well the dough could be processed into noodles during sheeting and cutting as described by Oh et al. (23). Commercial noodle flour, which required 35% absorption to make uniform, smooth, and nonsticky dough, was used as a reference to be compared with other flours during the determination of optimum water absorption.

Flour (100 g, 14% m.b.) was mixed with NaCl solution, the concentration of which was adjusted to 2.0% with different water absorption of noodle dough in a pin mixer (National Mfg. Co., Lincoln, NE, USA) for 4 min. Dough was passed through the rolls of a noodle machine (Ohkake Noodle Machine Mfg. Co., Tokyo, Japan) at 8 rpm and a 3 mm gap; dough was folded and put through the sheeting rolls. The folding and sheeting were repeated 2 times for flours and 10 times for reconstituted flours. The dough sheet was rested for 1 h and then put through the sheeting rolls 3 times at progressively decreasing roll gaps of 2.40, 1.85, and 1.30 mm. Immediately after the last sheeting, thickness of the dough sheet was measured by a micrometer dial thickness gauge (Peacock Dial Thickness Gauge G, Ozaki Mfg. Co., Ozaki, Japan). The dough sheet was cut through no. 12 cutting rolls into strips of about 30 cm in length, with 0.3×0.2 cm cross section.

Determination of optimum cooking time  For the preparation of cooked noodles with different cooking times, raw noodles (20 g) were cooked for 2-18 min at 2 min intervals in 500 mL of boiling distilled water and then rinsed with cold water for 30 s. Uncooked noodles and noodles cooked for 2-18 min at 2 min intervals were lyophilized and ground in a Udy cyclone sample mill (Udy Co.) fitted with a perforated screen with 0.25-mm round openings. Pasting properties of the cooked, lyophilized, and ground noodles (7.0 g d.b.) were measured by micro visco-amylo-graph (Brabender \textregistered OHG, Duisburg, Germany). Ground noodles (7.0 g, d.b.) were suspended in 100 mL of distilled water and heated from 30 to 95°C at a rate of 7.5°C/min, then held at 95°C for 5 min, cooled to 50°C at a ratio of 5.0°C/min, and held at 50°C for 2 min under...