COMMUNICATION TO THE EDITOR

Zero Amylose Lines of Hull-less Barley

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In our research on the development of hull-less barley (HB), we select lines containing low and high β-glucan and low amylose (waxy) or high amylopectin starch for use in feeds, food, and industry. The amylose-to-amylopectin ratio in normal barley starch is ≈25:75, depending on the method of amylose determination. Several cultivars of HB have been registered in Canada, including three waxy cultivars, CDC Candle, Merlin, and HB803 (Bhatty 1995). Wide variations have been reported in the amylose content of waxy starch barley lines; Banks et al (1970) reported a range of 0.4–13% amylose in eight waxy barley lines, while Morrison et al (1984) reported a range of 2–8% in another eight lines of waxy barley. Several factors are responsible for such variation and are described by MacGregor and Fincher (1993). It is reported here that we have developed lines of waxy HB that are completely devoid of amylose by intercrossing two waxy types. We are not aware of published reports on regular waxy barley completely free of amylose, although Ishikawa et al (1995) reported zero amylose in sodium azide-treated mutants of barley. Amylose-free HB starch may have some unique food and industrial applications.

Two registered Canadian cultivars of HB, CDC Richard, and CDC Candle and two Crop Development Centre (CDC) breeding lines, SB94792 and SB94794 were used in this study. SB94792 and SB94794 are sister selections from the cross SB85750 × Arizona hull-less waxy (AHW) made at the CDC in 1990. SB85750 is a waxy hull-less breeding line developed at the CDC and AHW is a waxy hull-less breeding line developed at the University of Arizona. CDC Richard is a normal starch and CDC Candle and the two SB lines are waxy starch barley. All are 2-rowed hull-less and were from the 1995 crop grown at the Kernen Crop Research Farm, University of Saskatchewan, SK, Canada. The barley lines were ground in a Udy cyclone mill to pass a 0.5-mm screen.

Starch was isolated from the barley lines by a method described previously (Vasanthan and Bhatty 1995). The isolates contained 96–97% starch on air-dry basis. Starch content of the ground barley lines, isolated and defatted starches was determined by the method of Holm et al (1986) after boiling the starch samples with 80% ethanol for 30 min and centrifuging at 2,000 × *g* for 10 min. Portions of the starch samples were defatted in glass microfiber filter paper by refluxing for 6 hr with 200 mL of iso-propanol and water (3:1) and then air-dried. Amylose content of ground barley and starch samples was determined by the method of Chrastel (1987).

Viscoamylograph properties of isolated starch samples were determined using a Brabender viscoamylograph at a concentration of 8% starch containing 200 mg of mercuric acetate as α-amylase inhibitor.

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Syneresis of barley starch was determined on 8% starch slurry (pH 6.5) cooked in boiling water bath for 15 min. The starch paste was allowed to cool to room temperature. Water separation was determined by calculating percent water removed from the starch paste by centrifugation using the minisyringe method (Zheng and Sosulski, *unpublished data*). The starch paste was then stored at –18ºC for 18 hr and thawed at room temperature for 6 hr (1st freeze-thaw cycle). The freeze-thaw treatment was repeated two more times (three cycles). The starch paste was then stored at –18ºC for 11 days then thawed at room temperature for 6 hr (4th cycle). Percent syneresis was calculated by subtracting water separation determined from the fresh paste from that determined after four cycles of freeze-thaw treatments. For comparison, a commercial food-grade waxy corn starch (Staley Manufacturing Co, Decatur, IL) containing ≈1% amylose was included.

The amylose content of the barley lines and starches isolated from them is readily apparent from data given in Table I. No amylose was detected in ground barley or in starches isolated from lines SB94792 and SB94794. In CDC Richard, used as a control, and in CDC Candle, amylose content was highest in the defatted starch. Similarly, it was higher in the isolated starch than in the ground barley lines, clearly showing interference of nonstarch components and of starch lipid in iodine binding capacity of amylose. Starch granule size is another interfering factor in iodine binding; small granules give lower iodine values than large granules, indicating less amylose in the small granules (MacGregor and Fincher 1993).

TABLE I
Amylose Content (%) of Barleys and Isolated Starches[a]

Product	SB94792	SB94794	CDC Candle	CDC Richard
Ground barley	0	0	3.9	24.6
Starch	0	0	4.3	26.8
Defatted starch	0	0	6.2	30.1

[a] Data are means of duplicate determinations.

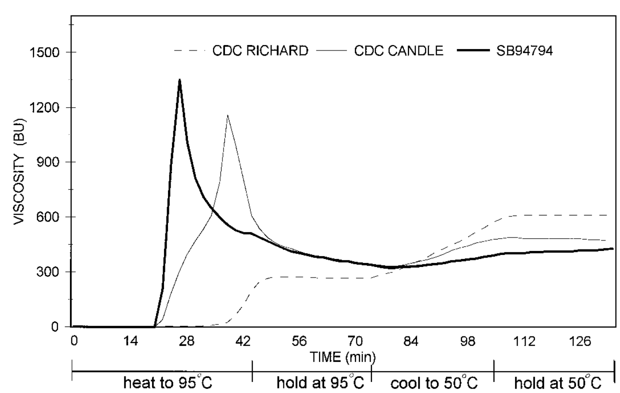

Fig. 1. Pasting properties of CDC Richard (normal), CDC Candle, and SB94794 (waxy) starches.

TABLE II
Syneresis (Freeze-Thaw Stability) of Corn and Barley Starches[a]

	Water Separation (%)		
Starch Sample	**Fresh Paste**	**Freeze-Thaw Cycles (4)**	**Syneresis (%)**
Waxy corn	3.9	53.9	50.0
Barleys			
SB94794	3.9	7.9	4.0
CDC Candle	3.7	25.1	21.4
CDC Richard	4.3	62.5	58.2

[a] Data are means of quadruplicate determinations.

Figure 1 shows the amylograph properties of CDC Richard, CDC Candle, and SB94794 starches. The pasting properties of CDC Richard and of CDC Candle are typical of normal and waxy starches, respectively. However, there were differences in the pasting properties of the CDC Candle and SB94794 starches. The swelling of SB94794 starch was higher (1,350 BU) and its set-back viscosity on cooling to 50ºC was lower (390 BU) than that of CDC Candle starch (swelling 1,160 BU; viscosity at 50ºC, 480 BU). Lower amylograph set-back viscosity of starch paste suggested high freeze-thaw and textural stability. This was confirmed by freeze-thaw data given in Table II. The zero amylose starch from line SB94794 had only 4% syneresis compared to 21.4% for CDC Candle starch containing 4–6% amylose (Table I). The lower syneresis is indicative of higher stability and water binding capacity. A higher freeze-thaw stability is an important property of starches used in frozen foods. Chemically modified (cross-linked and substituted) waxy corn starches having high shear, textural, and freeze-thaw stabilities are presently used in frozen foods. The modified SB94794 barley starch may show comparable functionality to modified waxy corn starch. The functional properties of native and chemically modified zero amylose HB starch needs further investigation.

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