NOTE

Pentosans in Barley Varieties

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ABSTRACT

The pentosan content of 68 two-rowed and 50 six-rowed barley varieties was investigated. The varieties were grown at three different farms located in southern, central, and northern Finland. The pentosan content in the two-rowed varieties grown in southern Finland was between 6.7 and 9.8% of the dry matter, and in the six-rowed varieties between 7.3 and 10.6%. The corresponding values in the varieties grown in central Finland were 7.6–9.7% in the two-rowed varieties and 8.4–11.0% in the six-rowed ones. The pentosan content of the six-rowed varieties grown in northern Finland was 9.2–10.2%. The pentosan contents observed in the six-rowed varieties were significantly higher than in the two-rowed ones. The differences among the average pentosan contents of the varieties grown in the three locations were mainly the result of differences in varietal characteristics.

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Pentosans are polysaccharides composed of pentose sugar units. Nonstarchy polysaccharides (NSP), hemicellulose, and flour gums are the names that have been used to refer to them. Amado and Neukom (1984) reported that pentosans compose about 67% of the total NSP in wheat. Englyst et al (1983) reported that 75% of the total NSP in white breads is water-soluble, noncellulosic polysaccharides consisting of arabinose and xylose, the main pentose sugars in pentosans.

Pentosans can be found in many cereals, such as barley, wheat, oats, and rye, and in vegetables such as beans and cassava. The composition and properties of pentosans are very different in these materials. It has been shown that pentosans in the endosperm cell walls of barley kernels consist of chains of (1,4)-xylopyranose units (Briggs 1978). The hemicellulose fraction of barley husks is structurally similar, but it contains nonterminal arabinofuranose residues as well (Harris 1962).

The interest in pentosans is mainly concerned with their high water-adsorbing capacity, which often plays an important role in baking. Bushuk (1966) has shown that 23% of the water in a dough is bound to pentosans, thus giving the special properties to the dough and bread. Pentosans have an effect on bread volume, cell uniformity, crumb characteristics, and elasticity. According to Kim and D'Appolonia's studies (1977), pentosans also affect the rate of staling.

From a nutritional point of view, pentosans are considered a part of dietary fiber. It has been established that the dry matter of wheat contains 2.3–2.4% pentosans (Amado and Neukom 1984). Rye and barley are somewhat richer in pentosans (Englyst et al 1983).

The purpose of this study was to measure and compare the pentosan contents of some two- and six-rowed barley varieties grown in different parts of Finland.

MATERIALS AND METHODS

Barley Varieties

The samples analyzed consisted of 50 six-rowed and 68 two-rowed barley varieties. These varieties were grown at three different locations in Finland during 1983. The samples were supplied by Hankkija Plant Breeding Institute. Some varieties were grown at all three locations. The geographical coordinates of the locations are Anttila Experimental Farm 25.03°E and 60.42°N, Nikkilä Experimental Farm 24.23°E and 61.55°N, and Viskaali Trial Fields 25.98°E and 64.82°N.

Preparation of Barley Samples for the Recovery Studies

Barley with a pentosan content of 8.3% was used for the samples. Amounts of 94.6, 178.4, and 393.4 mg of xylose were added to 1 g of ground barley. After careful mixing, the pentosan contents of the test samples were determined with the method described in the next section. A recovery was obtained from the calculated and found amounts of pentosans.

Sample Pretreatment and Analytical Method

The kernels (about 100 g) were first milled in a Tecator Cyclotec 1093 sample mill using a 1-mm sieve. An aliquot of 100–250 mg of a thoroughly mixed flour was taken for the analysis. Pentosans were determined by Duffau's method (Cerning and Guilbot 1973), which is based on the hydrolysis of pentosans, the subsequent dehydration of pentoses into furfural, and the simultaneous distillation of furfural. The furfural content of the distillate is measured spectrophotometrically with aniline acetate. The pentosan content of barley varieties is expressed as a percentage of xylose based on the dry matter. The determinations were made in duplicate.

RESULTS AND DISCUSSION

The validity of the method for the determination of pentosans in barley was demonstrated with 10 independent analyses from the same barley sample. The results gave a value of 0.16 for standard deviation and 2.2% for coefficient of variation. The average recovery based on the analyses of barley samples with added xylose is 98.2%, the range being 95.5–100%. This is considered to be acceptable.

Table I summarizes the results obtained for the two- and six-rowed barley varieties and the average values for the varieties grown in the three locations. The values indicate that the pentosan content of the six-rowed varieties is, on average, significantly higher than in the two-rowed ones. This applies to the varieties grown in Anttila (Student's t value 6.35) and Nikkilä (t value 4.66).

The average pentosan contents of the two-rowed varieties grown in the two farms, Anttila and Nikkilä, also show a statistically significant difference (t value 4.42), as do the average contents of the six-rowed barley varieties grown in Anttila and Nikkilä. On the contrary, the average pentosan contents in the six-rowed varieties grown in Anttila and Viskaali or in Nikkilä and Viskaali show no statistical differences. We can conclude that the differences between the various locations are derived from the characteristics of the varieties rather than climatic conditions, latitude, or fertilization.

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TABLE I
Pentosan Contents (%) of Two- and Six-Rowed Barley Varieties Grown at Three Sites

Varieties	Anttila (%)				Nikkilä (%)		Viskaali (%)	
Two-Rowed	Aladin	6.9	Jo 1220	8.6	Atem	8.2	...	...
	Apex	6.7	Jo 1369	8.6	Europa	8.1	...	...
	Cerise	8.4	Karat	7.6	Gunhild	8.1	...	...
	Cytris	8.0	Karri	7.0	Hjan Aapo	9.2	...	...
	Diabas	7.0	Koral	7.6	Ida	8.6	...	...
	Flare	8.0	Koru	9.8	Ideal	8.4	...	...
	Gimpel	8.9	Kustaa	8.3	Ingrid	8.3	...	...
	Grit	7.9	Kym	7.5	Kustaa	7.6	...	...
	Havila	8.6	Maris Mink	8.2	MG 4074.5	9.5	...	...
	Hja 62403	6.9	Opal	8.4	MG 7168	9.0	...	...
	Hja 62418	8.0	Patty	7.6	M 1162	9.5	...	...
	Hja 62434	7.7	RPB 412.78	8.0	RPB 1036.78	8.4	...	...
	Hja 62485	8.4	RPB 459.78	7.3	RPB 7506.20-1	8.4	...	...
	Hja 62599	8.2	RPB 822.77	7.8	Semu 1271	8.6	...	...
	Hja 62721	7.7	RPB 9002.77	7.4	Semu 2269	8.4	...	...
	Hja 62845	8.5	Roland	7.1	Semu 2280	8.8	...	...
	Hja 77059	8.5	Safir	7.2	Semu 0242	8.7	...	...
	Hja 78036	8.0	Spartan	6.7	Semu 1166	9.7	...	...
	Hja 78175	9.0	Svå 72112	8.9	Stange	9.6	...	...
	Hjan Aapo	7.9	Tasman	7.0	Tron	9.1	...	...
	Hjan Aapo	8.9	Trumpf	7.5	...	...	...	...
	Ida[a]	8.0	WW 6731	8.3	...	...	...	...
	Ida[a]	8.8	Yriba	8.1	...	...	...	...
	Ingrid	8.2	Zephyr	7.4	...	...	...	...
n		48			20		...	
Range		6.7–9.8			7.6–9.7		...	
Mean[b]		7.9 b			8.7 a		...	
SD		0.7			0.6		...	
Six-Rowed	Agneta	7.6	Hjan Pokko	9.6	Agneta	8.8	Agneta	9.2
	Arra	9.5	Hjan Potra	9.9	Arra	10.1	Arra	9.5
	Hja 63909	9.4	Jo 1328	8.1	Hja-673	10.2	Hja-673	9.7
	Hja 63912	8.3	Jo 1360	10.3	Hjan Pokko	10.0	Hjan Eero	10.2
	Hja 70185	8.9	Jo 1374	8.2	Kalle	9.1	Hjan Pokko	9.5
	Hja 71384	7.3	Kajsa	8.8	Lise	11.0	Ibon 258	9.6
	Hja 77061	8.1	Kalle	7.9	Pomo	9.8	Manker	10.0
	Hja 77082	9.2	Kilta	9.1	Sch. 1638.73	10.8	Pomo	9.8
	Hja 78003	9.7	Otra	10.6	Tunga	10.8	...	...
	Hja 78012	9.7	Paavo	8.4	Vena	8.4	...	...
	Hja 78042	8.2	Pirkka	9.8	Yrjar	9.9	...	...
	Hja 78104	8.3	Pomo[a]	9.4	...	...	...	...
	Hja 79671	9.0	Pomo[a]	8.9	...	...	...	...
	Hja 79678	9.6	SVJ 7229	9.0	...	...	...	...
	Hja-673	10.4	Silja	9.8	...	...	...	...
	Hjan Eero	9.0	...		...	...	...	...
n		31			11		8	
Range		7.3–10.6			8.4–11.00		9.2–10.2	
Mean[b]		9.0 a			9.9 c		9.7 ac	
SD		0.8			0.8		0.3	

[a]Varieties Pomo and Ida are cultivated in two different test fields of Anttila site.
[b]Significant differences at the 5% level are indicated by different letters.

CONCLUSION

The average pentosan content is significantly higher in the six-rowed barley varieties than in the two-rowed ones. The observed differences in the pentosan contents can mainly be explained by the genetic composition of the varieties studied.

LITERATURE CITED

AMADO, R., and NEUKOM, H. 1984. Minor constituents of wheat flour: The pentosans. Page 241 in: New Approaches to Research on Cereal Carbohydrates. R. D. Hill and L. Munck, eds. Elsevier Science Publishers B. V.: Amsterdam.

BRIGGS, D. E. 1978. Page 98 in: Barley. Chapman & Hall: London.

BUSHUK, W. 1966. Distribution of water in dough and bread. Bakers Dig. 40(5):38.

CERNING, J., and GUILBOT, A. 1973. A specific method for the determination of pentosans in cereals and cereal products. Cereal Chem. 50:176.

ENGLYST, H. N., ANDERSON, V., and CUMMINGS, J. H. 1983. Starch and non-starch polysaccharides in some cereal foods. J. Sci. Food Agric. 34:1434.

HARRIS, G. 1962. The structural chemistry of barley and malt. Page 475 in: Barley and Malt, Biology, Biochemistry, Technology. A. H. Cook, ed. Academic Press: London.

KIM, S. K., and D'APPOLONIA, B. L. 1977. Bread staling studies. III. Effect of pentosans on dough, bread, and bread staling rate. Cereal Chem. 54:225.

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