Available online at www.sciencedirect.com
ScienceDirect
LWT - Food Science and Technology 41 (2008) 2085–2091
LWT
www.elsevier.com/locate/lwt

Variations in water absorption capacity and baking performance of barley varieties with different polysaccharide content and composition

A.K. Holtekjølen [a,b,*], H.H.R. Olsen [a], E.M. Færgestad [a], A.K. Uhlen [c], S.H. Knutsen [a]

[a] *MATFORSK AS – Norwegian Food Research Institute, Osloveien 1, N-1430 Ås, Norway*
[b] *Department of Chemistry, Biotechnology and Food Science, Norwegian University of Life Sciences, P.O. Box 5003, N-1432, Norway*
[c] *Department of Plant and Environmental Sciences, Norwegian University of Life Sciences, P.O. Box 5003, N-1432, Norway*

Received 30 May 2007; received in revised form 17 December 2007; accepted 18 December 2007

Abstract

In the present study, water absorption capacity (WAC) and the resulting baking performance of different barley–wheat flour blends were investigated by baking breads containing 40% barley flour. The different barley varieties varied in polysaccharide contents and composition. Knowledge about variations in WAC and its possible effects on the baking performance were gained by choosing a constant water addition. These variations were related to differences in chemical content and composition. Large variations in WAC were observed for the different barley–wheat mixtures. These variations further resulted in variations in weight, volume and form ratio of the breads. Thus, large individual differences in baking performance were observed and these differences related to differences in polysaccharide content and composition of the different barley flours. Total β-glucan content was the most important parameter for the baking performance and hence, the bread quality due to its significant contribution to the WAC.

Keywords: Barley; Bread; β-Glucan; Multivariate statistics; Non-starch polysaccharides

1. Introduction

With an increasing focus on dietary fibre and their health benefits, barley, with its high contents of these constituents, has gained increased attention over the last decade. The intake of fibre is generally too low in populations of industrialized countries, and consequently new products, with an increased level of fibre, are continuously being developed and promoted. Incorporation of barley in breads would increase their fibre content and contribute to the overall goal of an increased dietary fibre intake.

It is well known from the literature that arabinoxylan (AX), in addition to starch and protein, contributes to the baking performance in wheat. It is not only the type or fraction of AX (soluble or insoluble) or the amount (Shogren, Hashimoto, & Pomeranz, 1987), but also the size (molecular weight) (Biliaderis, Izydorczyk, & Rattan, 1995) that will influence the results. Also in rye, AX has been proven important to the final product quality (Autio et al., 1996). In general, the effects of other non-starch polysaccharides (NSP) such as β-glucans are less known and usually only reported as an added ingredient. In the late 1980s and early 1990s, there were some investigations of different uses of barley in breads, and different barley varieties were reported to affect bread differently (Marklinder, Johansson, Haglund, NagelHeld, & Seibel, 1996). However, investigations dealing with baking performance of barley regarding effects of its chemical parameters have been scarce. Newman et al. (Newman, McGuire, & Newman, 1990) compared different

* Corresponding author. MATFORSK AS – Norwegian Food Research Institute, Osloveien 1, N-1430 Ås, Norway. Tel.: +47 64 97 01 00; fax: +47 64 97 03 33.
E-mail address: ann.katrin.holtekjolen@matforsk.no (A.K. Holtekjølen).

0023-6438/$34.00
doi:10.1016/j.lwt.2007.12.010

baking characteristics of different barley varieties, but in relation to muffins and not bread. Instead, the literature usually focuses on effects of isolated fractions added as ingredients (Cavallero, Empilli, Brighenti, & Stanca, 2002; Chaudhary & Weber, 1990; Inagaki & Seib, 1992; Izydorczyk, Hussain, & MacGregor, 2001; Knuckles, Hudson, Chiu, & Sayre, 1997; Newman, Ore, Abbott, & Newman, 1998) or effects of different starch types compared to standard wheat loaf quality (Gill, Vasanthan, Ooraikul, & Rossnagel, 2002b; Izydorczyk et al., 2001; Trogh et al., 2005). Others have focused on the proportion of barley flour that can be blended with wheat to achieve acceptable breads (Basman & Koksel, 2001; Dhingra & Jood, 2002; Dhingra & Jood, 2004; Ereifej, Al-Mahasneh, & Rababah, 2006; Prentice, Burger, & Dappolonia, 1979; Swanson & Penfield, 1988). To our knowledge, there have been few, if any studies with focus on natural variations in the chemical compositions of polysaccharides in the barley flour itself and how these affect technological parameters and bread quality. Usually, the industry does not distinguish between different barley varieties. The barley varieties are therefore mixed into one blend as different barley flours are presumed as more or less equal with minor variation.

We undertook a study to investigate the role of polysaccharide composition in barley on water absorption and thereby baking performance of hearth breads baked with 40% barley flour of 10 different well-characterized barley varieties. The relationship between water absorption, baking performance and different chemical components were investigated using multivariate statistics.

2. Materials and methods

2.1. Barley samples

Ten barley samples were chosen from a larger set of varieties grown in field trials conducted by Graminor AS (Bjørke Research farm, Ilseng, Norway) during 2002 to include different genotypes (Table 1) with varying polysaccharide contents. Complete data including polysaccharide composition for the large set of varieties are reported elsewhere (Holtekjølen, Uhlen, & Knutsen, 2008). The selected key chemical variables for the barley subset used in this baking experiment are given in Table 1. The wheat flour used for baking was a commercial Norwegian baking flour (Norgesmøllene AS, Norway) containing 12% protein.

2.2. General methods

The whole barley grains were ground on a Retsch centrifugal mill (Model ZM1; Retsch GmbH, Haan, Germany) with a 0.5-mm sieve without dehulling to study possible effects of the hull. This differs from the industrial process, where such varieties most often are subjected to an additional dehulling by pearling. However, the dehulling process itself may contribute to uncontrollable variability between the samples as well as mask possible differences induced by the different raw materials.

Table 1
The grain qualities of the different barley varieties represented by mainly polysaccharide content and composition presented as g/100 g dry weight

Varieties	Genotype	Starch	T-β-Glucan	I-β-Glucan	S-β-Glucan	Protein	T-NSP	I-NSP	S-NSP	T-AX	I-AX	S-AX	A/X(T-AX)	A/X(I-AX)	Cellulose	α-Amylase activity
1. Olsok	6rd, H N	55.8	4.1	0.1	3.9	12.6	17.9	14.1	3.8	8.6	8.2	0.4	0.46	0.39	4.3	0.04
2. Justina	2rd, H N	62.8	3.5	0.8	2.6	9.4	16.9	12.9	4.0	7.7	7.3	0.4	0.41	0.39	4.7	0.02
3. Olve	2rd, H N	54.9	4.7	0.1	4.5	11.5	20.6	14.6	6.0	9.5	8.5	1.0	0.47	0.41	5.4	0.03
4. CDC Dolly	2rd, H N	61.6	4.6	0.9	3.7	10.2	17.1	12.2	4.9	7.3	7.1	0.2	0.46	0.42	4.3	0.02
5. NK95003	2rd, H-L N	64.5	4.2	0.4	3.9	12.5	15.3	7.5	7.8	5.5	5.0	0.5	0.67	0.68	4.6	0.03
6. CDC Dawn	2rd, H-L N	65.7	3.7	1.0	2.7	11.2	11.9	8.4	3.5	5.4	5.2	0.2	0.65	0.63	1.9	0.08
7. CDC McGwire	2rd, H-L N	64.4	4.7	1.4	3.4	11.5	12.4	7.3	5.1	5.0	4.7	0.3	0.7	0.69	1.7	0.04
8. CDC Candle	2rd, H-L W	60.8	6.1	1.2	4.9	12.8	14.7	7.7	7.0	5.4	4.6	0.8	0.71	0.7	2.0	0.04
9. CDC Alamo	2rd, H-L W	58.0	6.4	2.3	4.2	13.6	17.5	8.3	9.2	5.6	5.0	0.6	0.71	0.68	4.4	0.05
10. SB94897	2rd, H-L H	57.5	6.8	2.5	4.3	14.7	17.2	8.2	9.0	6.4	5.0	1.4	0.66	0.62	2.9	0.06

6rd: 6 rowed, 2rd: 2 rowed, H: Hulled, H-L: Hull-less, N: normal starch, W: Waxy starch, H: high amylose starch, T: total, I: insoluble, S: soluble, NSP: non-starch polysaccharides, AX: arabinoxylans, A/X: degree of branching in arabinoxylans.