LWT - Food Science and Technology 63 (2015) 590–598

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Aroma of wheat porridge and bread-crumb is influenced by the wheat variety

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ARTICLE INFO

Article history:
Received 19 July 2014
Received in revised form
24 December 2014
Accepted 13 March 2015
Available online 31 March 2015

Keywords:
Sensory evaluations
Wheat varieties
Wheat porridge
Whole-meal bread
Low-extraction bread

ABSTRACT

Sensory evaluations were conducted on wheat-flour porridge and baked-bread samples, made from wheat varieties with known odour and flavour variations. The purpose was to determine if these odour and flavour variations were expressed in baked-bread. In all, 24 wheat varieties were used for porridge evaluation, from these eight were selected for bread evaluation. Porridge and bread results were compared. Variations were found in both evaluations. Five odour- and nine flavour descriptors were found to be common to both wheat porridge and bread. The results for two descriptors: “cocoa” and “oat porridge” were correlated between the wheat porridge and bread samples. Analysis of whole-meal and low-extraction samples revealed that the descriptors “malt”, “oat-porridge”, “øllebrød”, “cocoa” and “grain” mostly characterized wheat bran, while descriptors for “maize”, “bean-shoots”, “chamomile”, “umami”, and “fresh grass” mostly characterized wheat endosperm. Low-extraction bread made from four different varieties also differentiated for five odour- and six flavour descriptors. These results indicate that variations in wheat flavour and odour directly affect bread flavour and odour even in low-extraction bread. This knowledge is important to the baking industry and to plant breeders as wheat aroma could possibly become a future quality parameter in breeding.

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1. Introduction

Modern plant breeding methods, which became understood in the early 20th century, placed emphasis on improving yield capacity, however baking quality has also been regarded as an important parameter (Belderok, Mesdag, & Donner, 2000). Bread volume and texture are the two main baking quality parameters. These are important for consumer acceptance however bread aroma is increasingly receiving attention from consumers and producers. Therefore efforts to increase knowledge on wheat aroma variation could be of interest to the baking industry. Plant breeders may also find this knowledge useful in wheat breeding. The odours and flavours which are produced in bread result from complex interactions between several factors. These include the amount and type of ingredients used, yeast activity in the dough during fermentation, fermentation temperatures and times (Birch, Petersen, Arneborg, & Hansen, 2013; Birch, Petersen, & Hansen, 2012; Frasse, Lambert, Richard-Molard, & Chiron, 1993) and the bread baking process (Folkes & Gramshaw, 1977; Schieberle & Grosch, 1985, 1987, 1991). Sensory studies of bread crumb aroma have focussed on the impact of bread freshness contra staling (Heenan, Dufour, Hamid, Harvey, & Delahunty, 2009); (Jensen, Oestdal, Skibsted, Larsen, & Thybo, 2011; Jensen, Østdal, & Thybo, 2010) and consumer perception (Heenan, Dufour, Hamid, Harvey, & Delahunty, 2008; Hersleth, Berggren, Westad, & Martens, 2005).The contribution that wheat flour makes to bread flavour has not been so well described, although Czerny and Schieberle (2002) noted that components found in wheat flour are likely contributors to overall bread flavour. Chang and Chambers (1992) found odour and flavour differences between bread made from hard red winter wheat and hard white winter wheat. Løje, Møller, Laustsen, and Hansen (2003), made a sensory evaluation of cooked grains of cultivars of spelt, einkorn and emmer wheat and they could distinguish between the wheat species. Starr, Bredie, and Hansen (2013) found that a sensory panel could distinguish between different wheat varieties which were prepared as cooked grains, by sensory analysis. Differences in flavour between whole-meal flour and low-extraction flour may also impact on bread flavour. Heiniö, Liukkonen, Katina, Myllymäki, and Poutanen (2003) conducted a sensory evaluation of bread made from different

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http://dx.doi.org/10.1016/j.lwt.2015.03.048
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milling fractions of rye, and they reported that bread made from the inner endosperm fraction of rye kernels had the mildest descriptors whereas bread made from the outer bran fraction contained the most intense flavours and aftertaste. Furthermore the same descriptors which were differentiated in the rye-flour fractions were also found to be differentiated in bread which was made from these samples. Wheat flour is the basic ingredient in bread, therefore variations in the odour and flavour of different varieties, species and landraces of wheat should be discerned in the odour and flavour of bread crumb. The aim of this paper is to investigate if it is possible to distinguish whole-meal bread made from different wheat varieties by sensory analyses. The wheat varieties used for the bread making will be selected based on sensory testing of whole-meal porridge made from 24 varieties, species and landraces as it is easier to make a porridge compared to bread. Additionally, it will also be tested if it is possible to distinguish bread made from low-extraction flour from different wheat varieties by sensory analyses.

2. Materials and methods

2.1. Wheat samples

Based on the results of sensory testing of cooked wheat grain (Starr et al., 2013) twenty four wheat samples were selected for the sensory test of whole-meal porridge and they were: spelt wheat (Oberkulmer Rotkorn), Emmer, Einkorn and Kamut (Aurion milling and baking company, Denmark); Solstice (Ian Foot, – Limagrain UK Ltd); Dragon (Per Kølster, Fuglebjerggård, Denmark); Complet (Saarzucht Firlbeck GmbH & Co., Germany); Extra Squarehead, Goldblume, Halland, Kolben, Purple Justin, Konini and Øland Wheat (Per Grupe, Mørdrupgård A/S, Denmark). Kossack, Kuban, Magnifik and Stava (Tina Henriksson, SW Seeds, Sweden); Kraka (Erik Tybirk, Nordic Seeds, Denmark); Ure (Peer Hummeluhr and descendants, Denmark); Heroldo, Hereward, Tuareg and Vinjett (Lars B. Eriksen, Sejet Plant Breeding, Denmark).

The samples were from the same batch that was used for sensory testing of cooked grain. Based on the results from the sensory evaluation of porridge eight varieties were selected for evaluation as whole-meal bread: Dragon Goldblume, Heroldo Konini, Kraka, Magnifik, Oberkulmer Rotkorn and Øland Wheat. Four of these varieties were selected for sensory evaluation of low-extraction bread: Goldblume, Konini, Magnifik and Oberkulmer Rotkorn. All grain samples were cleaned by visual assessment against a white paper background and removal of impurities. The pure grain samples were subsequently milled as whole-meal on a Quadrumat Junior Mill (Brabender OHG, Duisberg, Germany). The wheat samples which were prepared as low-extraction samples were refined through a 250 μm particle size mesh on a JEL 2000 test sieve (J.Engelsmann AG, Ludwigshafen am Rhein, Germany).

2.2. Porridge sample preparation

480 ml ordinary tap water was then added to 120 g of whole-meal or low-extraction samples in a 600 ml glass beaker and stirred until a homogeneous consistency was achieved throughout the sample. A Conmatic line Combi-steamer (Hounö A/S, Randers, Denmark), was set to full steam in order to mitigate crust formation on the top of the porridge sample. The temperature was selected to 135 °C. At this temperature, the samples, which were briefly re-stirred and then covered with aluminium foil, were placed in the oven for 23 min. After cooking the porridge samples were re-stirred to ensure a homogeneous consistency. Then the porridge was portioned out into approximately 35 g samples in FIX PACK, clear, round, 110 ml plastic beakers with lids made from a plastic material which was approved for foodstuffs. The plastic beakers were labelled with a three digit code. The sample beakers were tempered in a cooled incubator cabinet series KB8000, (Termaks A/S, Bergen, Norway) at 40 °C for 1 ½ hours before serving.

2.3. Bread sample preparation

The moisture content of the milled wheat samples was measured on the day of baking on a HOH-express He 90 moisture meter (Pfeuffer GmbH, Kitzingen, Germany). The amount of flour used for bread making was adjusted according to the water content so all the milled samples had 14 g/100 g moisture content. Bread dough was prepared thus: For whole-meal bread 300 g freshly milled whole-meal from the wheat variety being tested and 100 g commercial wheat flour “Bagerens Hvedemel” (Magdeburger Mühlenwerke GmbH, Magdeburg, Germany) were mixed. For low-extraction bread: 400 g freshly milled and sifted low-extraction flour from the variety being tested was used without adulteration. To all doughs were added: 272 ml tap water (30 °C) with the required adjustments for each sample to ensure 14 g/100 g moisture content moisture content of flour, 4 g “Malteserkors” yeast (De Danske Gærfabrikker A/S, Grenå, Denmark), 5.6.g salt, 5.6 g sugar were added. The ingredients were mixed in XBM 5 bread-mixing machines (Fovea A/S, Randers, Denmark) and the program was set to knead for 19 min. Kneading was staggered by a 2 min interval between samples to ensure that there was uniformity of sample treatment during dough kneading and placement of dough for fermentation. The kneaded doughs were transferred to baking trays, one per dough, and these were fermented at 10 °C for 18 h in a Termaks series 6000 cooling incubator (Termaks A/S, Bergen, Norway). Dough samples were then baked in a Conmatic line Combi-steamer (Hounö A/S, Randers, Denmark) for 40 min at 200 °C with full steam setting in order to minimise browning of the crust. The bread samples for sensory analysis were sliced on a Universal Metal Type 372 electric-slicer (Krups GmbH, Offenbach am Main, Germany) into one cm thick slices (Fig. 1). The crust was removed to a depth of 1 cm and discarded. The slices were cut into samples approximately 2 cm in width and portioned out into 30 g samples in 200 ml square plastic salad boxes with lids. The plastic material was approved for foodstuffs. Item number: 5181 and 5185. The plastic boxes were labelled with a three digit code. The bread samples were tempered in an incubator cabinet series KB8000, (Termaks A/S, Bergen, Norway) at 21 °C for 1 ½ hours before serving.

2.4. Sensory evaluation method

Both sensory evaluations were conducted within a two month interval, first the porridge evaluation then the bread evaluation. Evaluations took place in a sensory evaluation laboratory, which was equipped after guidelines laid down in ISO 85589:2007. One box was assigned to each assessor. The panels for this study were recruited from the external sensory panel at the University. This panel is selected based on olfaction and taste tests, their interest and motivation as well as ability to describe sensory impressions verbally (ISO 3972:1991). The external panel has experience in descriptive analysis of a range of food products.

The panellists evaluated the intensity experienced for each sensory descriptor on a continuous unstructured 15.0 cm scale line which was verbally anchored at each end with indentations. The left side of the scale corresponded to the lowest intensity of the descriptor and the right side corresponded to the highest intensity. Evaluations were registered electronically the data was collected in FIZZ Network Acquisition (Version 2.4 OE). The evaluation method used in both evaluations followed the same procedure and was

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