JMBFS
Journal of Microbiology, Biotechnology and Food Sciences
International peer-reviewed scientific online journal
Published by Faculty of Biotechnology and Food Sciences

BREAD CRUMBS TEXTURE OF SPELT

Joanna Korczyk – Szabó, Magdaléna Lacko – Bartošová*

Address(es): Joanna Korczyk-Szabó,
Slovak University of Agriculture, Faculty of Agrobiology and Food Resources, Department of Sustainable Agriculture and Herbology, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic.

*Corresponding author: joanna.korczyk-szabo@uniag.sk

ARTICLE INFO

Received 21. 10. 2013
Revised 26. 11. 2013
Accepted 9. 1. 2014
Published 1. 2. 2014

Regular article

OPEN ACCESS

ABSTRACT

Texture analysis is an objective physical examination of baked products and gives direct information on the product quality, oppositely to dough rheology tests what inform on the baking suitability of the flour, as raw material. Evaluation of the mechanical properties of bread crumb is important not only for quality assurance in the bakeries, but also for assessing the effects of changes in dough ingredients and processing condition and also for describing the changes in bread crumb during storage. Crumb cellular structure is an important quality criterion used in commercial baking and research laboratories to judge bread quality alongside taste, crumb colour and crumb physical texture. In the framework of our research during the years 2010 – 2011 were analyzed selected indicators of bread crumb for texture quality of three *Triticum spelta* L. cultivars – Altgold, Rubiota and Ostro grown in an ecological system. The bread texture quality was evaluated on texture analyzer TA.XT Plus (Stable Micro Systems, Surrey, UK), following the AACC (74-09) standard and expressed as crumb firmness (N), stiffness ($N.mm^{-1}$) and relative elasticity (%). Our research proved that all selected indicators were significantly influenced by the year of growing and variety. The most soft bread was achieved in Rubiota, whereas bread crumb samples from Altgold and Ostro were the most firm and stiff. Correlation analysis showed strong negative correlation between relative elasticity and bread crumb firmness as well as bread stiffness (-0.65^{++}, -0.66^{++}). The spelt wheat bread crumb texture need further investigation as it can be a reliable quality parameter.

Keywords: spelt, crumb texture, bread, firmness, stiffness, relative elasticity

INTRODUCTION

Bread has existed as a 'processed' food for several thousands years and evolved into a wide variety of products, but many opportunities for developing new products, textures and eating characters remain. In part these opportunities arise because the cellular structure which characterises bread and other cerealbased foods yields products which may be eaten and enjoyed on their own or as key elements of multi-component foods. As with most foods, the textural characteristics of bread and other cereal products are most commonly described in terms of their sensory properties. Interest in bread texture arises because of its direct link with shelf life, eating qualities and flavour. Thus, an understanding of what contributes to bread texture has a direct impact on the sensory pleasures that we can derive from eating bread and other related bread products (**Cauvain, 2007**). Many instrumental methods are used to measure mechanical properties of baked goods that are, up to a certain extent, related to sensory characteristics (**Collar *et al.*, 2005**). Crumb hardness is often used as a measure of bread staling, which has been successfully determined using a texture analyser in a static compression mode (**Armero and Collar, 1998; Baik and Chinachoti, 2000**). Fresh and aged bread crumb mechanical properties are often connected to sensory perception of freshness and elasticity by consumers (**Bollaín *et al.*, 2005**). Traditional mimetic methods, such as texture profile analysis, firmness, stress relaxation, penetration and compression tests provide useful and well-recognised information about bread crumb mechanical properties (**Armero and Collar, 1998; Carson and Sun, 2001; Liu and Scanlon, 2003; Liu and Scanlon, 2004; Bollaín *et al.*, 2005; Collar *et al.*, 2005; Mandala *et al.*, 2007**). In general, though, the term texture usually refers to sensory perceptions associated with the mechanical properties of foods. **Bourne, (1982)** has indicated that, in the case of bread crumb evaluations, the term texture appears to be used exclusively to describe crumb uniformity and distribution of cell sizes. Therefore, to avoid conflict with the term texture, the term physical texture will be used to refer to the mechanical properties of bread, and visual texture to describe crumb cellular structure. Crumb cellular structure (or its grain) is an important quality criterion used in commercial baking and research laboratories to judge bread quality alongside taste, crumb colour and crumb physical texture (**Kamman, 1970; Pyler, 1988; Zayas, 1993**). Bread crumb visual texture accounts for approximately 20% of the weighting used in judging bread quality (**Pyler, 1988**). Regardless of the weight assigned to it, crumb grain is believed to have considerable importance in defining bread quality since the accuracy in scoring other quality attributes in bread depends on the underlying crumb grain characteristics (**Scanlon and Zghal, 2001**). The bread crumb has a reasonably complex rheological structure. Texture analysis is an objective physical examination of baked products and gives direct information on the product quality, oppositely to dough rheology tests what inform on the baking suitability of the flour, as raw material. The use of spelt in bread production is possible: bread with addition of spelt flour is characteristic by excellent taste and it stays longer fresh and soft. The objective of our study was to determine the texture of spelt wheat bread (crumb firmness, stiffness and relative elasticity) of three *Triticum spelta* varieties grown in ecological system.

MATERIAL AND METHODS

A field stationary experiments were carried out at the Research Experimental Station of the Slovak University of Agriculture in Dolná Malanta near Nitra. Three varieties of *Triticum spelta* were: Altgold (Swiss variety, originated from parental varieties Oberkulmer /Sedmeier), Ostro (originated from parental varieties Oberkulmer Rotkorn / Steiners Roter Tiroler) and Rubiota (registered in Czech Republic, originated from individual selection of Fuggers Babenhauser Zuchtw.). In the framework of our research during the years 2010 – 2011 was analyzed selected indicators for bread texture quality on texture analyzer TA.XT Plus (Stable Micro Systems, Surrey, UK), following the AACC (74-09) standard method and expressed as crumb firmness (N) – the maximum force needed to compress the bread crumb sample, stiffness ($N.mm^{-1}$) – the linear part of the slope of the force/deformation curve and relative elasticity (%) – ratio between the remaining force measured 20 seconds after the maximum force was reached and the maximum force. Firmness is defined in this method as the force (Newtons) required to compress the product by a pre-set distance (i.e. force taken at 25% compression of 25 mm). It´s conducting a „measure of force in compression" test with an AACC 36 mm cylinder probe with radius (P/36R). The analyser was set at a 'return to start' cycle, a pre-test speed of 1 mm.s^{-1}, a test speed of 1.7 mm.s^{-1}, a post-test speed 10.0 mm.s^{-1} and a distance of 6.25 mm. Relative elasticity was performed by two sequential compression events (compression depth 15%, probe speed 10 mm.s^{-1}, trigger force 0.05N) using a compression plate SMS P/100, 5-kg load cell and a 20-s gap between penetration band the force deformation curve was recorded. Crumb samples (40mm x 40mm x 30mm thick) were cut from the centre of each slice using a circular cutter and then placed between the parallel plates 24 hours after baking. They were evaluated in six replicates and the results presented are means of the six realized measurements. All data were statistically analysed by analysis of variance (ANOVA) and Fischer test. The least significant difference at the 5% probability level (P value<0.05) was calculated for each parameter.

RESULTS AND DISCUSSION

Crumb texture is an important quality indicator, as consumers prefer different bread taste. Texture analysis is primarily concerned with the evaluation of mechanical characteristics where a material is subjected to a controlled force from which a deformation curve of its response is generated. These mechanical characteristics in food can be further sub-divided into primary and secondary sensory characteristics which have proven to be correlated to sensory perception. It is a common agreement that good quality bread should have a high porosity and fine, regular gas cell structure in the crumb (**Liu and Scanlon, 2003; Lassoued *et al*., 2008**). Good crumb quality is dependent on several rheological and physical properties achieved by both small and large deformation measurements (**Angioloni and Collar, 2009**). Mostly breads with softer texture are required, it means that low maximum forces by compression of the crumb sample is in demand (**Sipos *et al*., 2008**). The bread texture quality was evaluated and expressed as crumb firmness, stiffness and relative elasticity.

Bread crumb firmness is expressed as the maximum force needed to compress the bread crumb sample. The low maximum force indicates soft bread crumb texture. The average bread crumb firmness of three *Triticum spelta* varieties was 19.81 N. Statistical analysis confirmed significant differences among evaluated breads prepared from three spelt varieties. Rubiota bread had the softest crumb (Tab 1). Contrary, the most firm bread crumb (more than 25 N) was found in Altgold. Weather conditions during vegetative period significantly affected crumb firmness which was better in 2010 (17.16 N) as compared with 2011 (22.48 N), when 31.00% higher firmness was achieved.

Table 1 Texture analysis of spelt wheat bread, average values for 2010-2011 (ANOVA, LSD test, α=0.05)

VARIETY	Crumb firmness (N)	Crumb stiffness (N.mm^{-1})	Relative elasticity (%)
Altgold	25.29 c	1.60 c	94.23 a
Rubiota	15.76 a	0.99 a	96.72 c
Ostro	18.41 b	1 17 b	96.19 b
YEAR			
2010	17.16 a	1.09 a	95.67 a
2011	22.48 b	1.42 b	95.76 a
AVERAGE	**19.81**	**1.25**	**95.72**
standard error	±5.32	±0.33	±1.42

Stiffness is described as the resistance to deformation. Crumb stiffness is an important property of bread because of its close human precipitation of freshness. The higher is the resistance, the harder is the bread crumb. The average bread crumb stiffness was 1.25 N.mm^{-1} and ranged between 0.99 – 1.60 N.mm^{-1}. The lowest crumb stiffness (less than 1.0 N.mm^{-1}) was observed in Rubiota. Crumb stiffness was significantly higher in 2011 (1.42 N.mm^{-1}) than in 2010 (1.09 N.mm^{-1}).

The softer bread crumb with higher elasticity generally better satisfies consumer´s requirements. In this case there is a large deformation under the compression force. Furthermore, the elastic deformation within the whole deformation is also large when the loading is stopped. The lowest relative elasticity was found in Altgold (Tab 1). However, the plastic deformation in the bread crumb is relatively small. The ratio of elastic deformation to the maximal deformation is the creep-recovery coefficient, namely the elasticity (**Nagy *et al*., 2007**). The highest relative elasticity was found in Rubiota (96.72%). In overall evaluation of bread crumb we could suppose that spelt bread crumb was resist to the compression.

Table 2 Correlation analysis of spelt wheat bread crumb texture

	Bread firmness (N)	Bread stiffness (N.mm^{-1})	Relative elasticity (%)
Bread firmness	1.00	1.00^{++}	-0.65^{++}
Bread stiffness		1.00	-0.66^{++}
Relative elasticity			1.00

High correlation coefficient (1.00^{++}) confirmed the dependence among bread crumb firmness and stiffness (Tab 2).The higher was the firmness, the higher was also the resistance to deformation. Correlation analysis showed strong negative correlation between relative elasticity and bread crumb firmness as well as bread stiffness (-0.65^{++}, -0.66^{++}). Texture analysis is an objective physical examination of baked products and gives direct information on the product quality, oppositely to dough rheology tests what inform on the baking suitability of the flour, as raw material (**Carson and Sun, 2001**). This is why the texture analysis is one of the most helpful analytical methods of the product development, as it is suitable to quantify the effects of flour blends and additives on physical properties of crust and crumb of the breads.

CONCLUSION

The spelt wheat bread crumb texture needs further investigation as it can be a reliable quality parameter. The bread quality is considerably dependent on the texture characteristic of bread crumb. Evaluation of the mechanical properties of bread crumb is important not only for quality assurance in the bakeries, but also for assessing the effects of changes in dough ingredients and processing condition and also for describing the changes in bread crumb during storage.

Our research proved that all selected indicators were significantly influenced by the year of growing and variety. The used firmness test method was found to be suitable for the evaluation of the bakery products texture. The most soft bread was measured in Rubiota, whereas bread crumb samples from Altgold was the most firm and stiff. The highest firmness and stiffness of Altgold is probably due to more compact crumb structure than in other varieties. Relative elasticity confirmed that the lowest firmness and stiffness was found in Rubiota bread. The spelt grain can be a good source for making bread flour, but it is closely related to the choice of spelt variety.

The test method developed provides a reliable evaluation procedure of bread crumb texture quality for research purposes and the bakeries, as well. Texture analysis is suitable analytical method for evaluation of bakery products and, after several references data, may be suitable to determine the type of unknown samples. On the one hand the opportunities for developing new bread texture appear limitless, but on the other they appear limited by our (still) imperfect knowledge of how to make bread textures. Given the long tradition of breadmaking this may seem surprising. This is not the case to those involved in the study of cereal-based foods. The processes which go to make-up the baking remain a mixture of part science, part technology, part craft and part 'art'.

Acknowledgments: The research presented in this paper was supported by the project of VEGA no. 1/0513/12 "Research of agroecosystems to reduce climate change, ecological food production and improve nutrition and health parameters of human" and ITEBIO "Support and innovations of a special and organic products technologies for human healthy nutrition" ITMS: 26 220 220 115, implemented under Operational Programme Research and Development.

REFERENCES

ANGIOLONI, A., COLLAR, C. 2009. Bread crumb quality assessment: a plural physical approach. *European Food Research and Technology*, 229(1), 21–30.

ARMERO, E., COLLAR, C. 1998. Crumb firming kinetics of wheat breads with anti-staling additives. *Journal of Cereal Science*, 28(2), 165–174.

BAIK, M.Y., CHINACHOTI, P. 2000. Moisture redistribution and phase transitions during bread staling. *Cereal Chemistry*, 77(4), 484–488.

BOLLAÍN, C., ANGIOLONI, A., COLLAR, C. 2005. Bread staling assessment of enzymes supplemented pan breads by dynamic and static deformation measurement. *European Food Research and Technology*, 220(1), 83–89.

BOURNE, M.C. 1982. Food texture and viscosity: concept and measurement. New York: Academic Press, 1–23.

CARSON, L., SUN, X.S. 2001. Creep/recovery of bread and correlation to sensory measurements of textural attributes. *Cereal Chemistry*, 78(1), 101–104.

COLLAR, C., BOLLAÍN, C., ANGIOLONI, A. 2005. Significance of microbial transglutaminase on the sensory, mechanical and crumb grain pattern of enzyme supplemented fresh pan breads. *Journal of Food Engineeiring*, 70(4), 479–488.

CAUVAIN, S.P. 2007. Bread – the Product. *Technology of Breadmaking,* 1-19. ISBN 978-0-387-38563-1.

KAMMAN, P.W. 1970. Factors affecting the grain and texture of white bread. *Bakers Digest*, 44(2), 34–38.
LASSOUED, N., DELARUE, J., LAUNAY, B., MICHON, C. 2008. Baked product texture: correlations between instrumental and sensory characterization using Flash Profile. *Journal of Cereal Science*, 48(1), 133–143.
LIU, Z., SCANLON, M.G. 2003. Predicting mechanical properties of bread crumb. *Trans Inst Chem Eng C*, 81(3), 224–238.
LIU, Z., SCANLON, M.G. 2004. Revisiting crumb texture evaluation methods: tension, compression, and indentation. *Cereal Foods World*, 49(2), 76–82.
MANDALA, I., KARABELA, D., KOSTAROPOULOS, A. 2007. Physical properties of breads containing hydrocolloids stored at low temperature. I. Effect of chilling. *Food Hydrocolloids*, 21(8), 1397–1406.
NAGY, M., MERETEI, A., FEKETE, A. 2007. Bread type characterization by rheological and mechanical properties. Annual International Meeting. Minneapolis: ASABE. Technical Papers, 11.
PYLER, E.J. 1988. Baking science and technology : volume 2. Sosland: Merriam.
SCANLON, M.G., ZGHAL, M.C. 2001. Bread properties and crumb structure. *Food Research International*, 34(10), 841–864.
SIPOS, P., ELEK, A., GYORI, Z. 2008. Application of texture analyzer in the quality analysis of bakery products. *Journal of Food Physics*, 229–234.
ZAYAS, I.Y. 1993. Digital image texture analysis for bread crumb grain evaluation. *Cereal Foods World*, 38(10), 760–766.