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Baked product texture: Correlations between instrumental and sensory characterization using Flash Profile

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Abstract

Fifteen wheat doughs with various compositions have been selected and baked in order to obtain products with densities in the range of commercial bread values (0.25–0.35 g/cm^3). A quick sensory profiling technique (Flash Profile), based on the combination of free choice profiling and a comparative evaluation of the whole product set was used. The sensory jury had to focus on the sensory perception of crumb texture (tactile and visual). The treatment of collected data by Generalized Procustes Analysis shows that products were perceived differently by the panel. The main differences concern the uniformity and the size of gas cells but also mechanical properties of corresponding crumb for which attributes like hardness, springiness and crumbliness were used. Instrumental characterization was performed using uniaxial compression (Young's modulus) and image analysis based on texture granulometry (fineness and homogeneity of cell distribution). A Multiple Factor Analysis allowed assessing the correlations between the sensory attributes and the instrumental measurements. Density and Young's modulus are positively correlated with the sensory elasticity. The instrumental and sensory measurements of the size and of the homogeneity of the cells distribution are correlated.

Keywords: Bread; Crumb texture; Sensory analysis; Image analysis; Young's modulus; Density; Sensory–instrumental correlation

1. Introduction

The visio-tactile perception of bread texture seems to be a decisive criterion of consumers' acceptability. For example, Pyler (1988) found using a consumer acceptance test that bread crumb structure accounts for approximately 20% of the judgement of bread quality. The author pointed out that how the crumb feels by touch or in the mouth is greatly influenced by the size or the structure of the crumb cells: finer, thin-walled, uniformly sized cells yield a softer and more elastic texture than do coarse, open and thick-walled cell structures. Besides, bread mechanical properties are often connected to the perceived elasticity and freshness of the crumb and also largely influence consumers' purchase (Scanlon and Zghal, 2001).

These evidences would suggest that it is of prime importance for baking companies to take into account consumers' sensory perception of bread texture. However, sensory evaluation is seldom used in the baking industry mostly because of the cost and the time necessary to train and to manage a sensory panel. Another possibility is the use of instrumental methods to evaluate bread texture. Instrumental measurements are usually cheaper and easier to achieve and thus represent an interesting alternative to the sensory measurement of texture, providing that instrumental data can be related to the sensory description. Then these instrumental measurements could be used to monitor bread quality during processing and storage.

Bashford and Hartung (1976) reported first a good correlation between sensory evaluations of bread freshness and Instron measurements of mechanical deformation during compression. Today, the evaluation of the mechanical properties of bread crumb by compression test is used for routine quality control in the baking industry. It is also

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used for example, to assess the effects of changes in various dough ingredients and processing conditions, and also to assess the staling during shelf life and its effect on consumers' purchase (Baruch and Atkins, 1989). Recently, some studies attempted to correlate instrumental measurements of bread texture with the sensory data obtained from conventional sensory profiling. The ISO now provides a descriptive vocabulary (ISO, 1994) which is widely used in most of these studies. It should be noted that these studies essentially focus on the mechanical aspects of bread texture (Brady and Mayer, 1985; Gambaro et al., 2002). Sensory parameters like hardness, cohesiveness and elasticity are generally evaluated and good correlations are usually found with instrumental parameters determined by the Texture Profile Analysis (AACC Method 74-09, 1996; Bourne, 1978). The visual aspects of texture have been studied by few authors. Sensory parameters like crumb color (Kihlberg et al., 2004) or visual dryness (Gambaro et al., 2002) have been evaluated. Baardseth et al. (2000) consider the global aeration of baked products through the porosity parameter evaluated according to the Dallmann's pore table (Dallmann, 1958) and related it to the instrumental porosity calculated by image analysis (IA) by counting the number of "black" pixels (corresponding to the cells) covering the bread sample. However, these studies did not give any information on the crumb texture perception.

To date no study focused on the sensory characterization of crumb structure, in spite of its potential impact on consumers' purchase behavior. Overall, the relatively small number of systematic sensory studies of bread texture can be partly explained by experimental limitations. Actually, for material and time constraints, it is difficult to run a sensory evaluation of breads made at lab scale. Conventional sensory profiling techniques indeed require that samples of experimental breads are made at a precise time before the sensory sessions. Such samples need to be provided for both training and evaluation sessions and in sufficient quantity. This supposes material and logistical conditions that are rarely granted. When it comes to manufacturing an important number of samples simultaneously (e.g. when the study is conducted according to a factorial design), the task becomes hardly feasible in a reasonable period of time.

These difficulties can be partly overcome by using a fast descriptive technique such as the Flash Profile. This technique indeed requires only one session, providing that the participants (subjects) are experienced in sensory description (Sieffermann, 2002). The Flash Profile is derived from the Free Choice Profiling method (Williams and Langron, 1984) in which the subjects are not imposed the use of a common vocabulary. Two methodological changes make the Flash Profile faster and more flexible: first, the whole product set is presented simultaneously, which allows a direct comparative evaluation; second, the subjects are not specifically trained for the evaluation of the product set under consideration, which might decrease somehow the robustness of the results but greatly reduces the duration of the study. This method thus gives a quick access to the relative sensory positioning of a set of products. It has been successfully applied to the characterization of common products such as jams (Dairou and Sieffermann, 2002) and to the evaluation of the flavor of fruit dairy products (Delarue and Sieffermann, 2004). In these studies, the sensory maps obtained by the Flash Profile were similar to those obtained by conventional profiling.

In the present work, we aimed at characterizing both visual and tactile aspects of bread texture on the basis of a set of 15 breads of various compositions. This was achieved using the Flash Profile. In order to find instrumental alternatives to the sensory evaluation of key characteristics of bread texture, series of instrumental measurements were also performed. Mechanical properties were evaluated by a compression test and bread crumb structure was characterized by using an image analysis (IA) method based on texture granulometry (Lassoued et al., 2007; Rouillé et al., 2005). Finally, relationships between sensory and instrumental data are sought using multidimensional data analysis methods.

2. Materials and methods

2.1. Samples

Fifteen doughs with various amounts (all indicated proportions are based on flour weight (as is), Table 1) of water (50–65%), sucrose (0–15%) and rapeseed oil (0–20%) were selected and baked in order to obtain breads with different textures. Compositions were chosen in order to vary fat, water and sugar one by one. As an example, recipes H, A, L, D, O and E contained about 55 wt% of

Table 1
Composition of the 15 studied doughs

	wt% flour basis		
	Water	Sugar	Oil
B	50.0	2.0	10.0
H	54.7	0.0	9.7
F	54.7	2.0	2.0
A	54.9	2.0	9.7
G	55.0	2.0	19.5
L	55.3	5.0	10.0
D	55.0	7.0	10.0
O	55.3	10.0	10.0
M	55.0	14.8	2.0
E	54.9	15.0	10.0
C	59.9	2.0	10.2
I	60.4	2.0	2.0
K	63.0	0.0	0.0
J	64.8	2.0	2.0
N	65.0	10.0	10.0

Three percent of compressed yeasts and 2% salt (moist flour weight basis) were systematically added.