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Changes in the physical and the sensorial properties of wheat bread caused by interruption and slowing of the fermentation of yeast-based leaven

Renata Różyło [a,*], Dariusz Dziki [b], Janusz Laskowski [a]

[a] Department of Equipment Operation and Maintenance in the Food Industry, University of Life Sciences, Doświadczalna 44, 20-280 Lublin, Poland
[b] Department of Thermal Technology, University of Life Sciences, Doświadczalna 44, 20-280 Lublin, Poland

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ABSTRACT

Here we propose an original study on the effect of an interruption and slowing of the fermentation of yeast-based leaven on the physical properties of bread.

Bread loaves were made using the straight-dough method, the two-phase method and a method incorporating the interruption and slowing of the fermentation of yeast-based leaven. During the process of making dough, modifications of the method were made by both changing the yield of the leaven (180 and 210%) and the duration of the fermentation of the leaven (from 1 to 3 h). The fermentation of leaven was conducted at the optimum temperature of 28 °C and at a lowered temperature of 10 °C (fermentation slowing).

It was noted in the study that the simultaneous shortening of the duration of fermentation of leaven to 2 h and its slowing under conditions of lowered temperature to 10 °C produces satisfactory baking results with a shortening of the process on the day of baking. In addition, the bread produced has comparable loaf features and better crumb quality compared to bread produced with the standard two-phase method. The proposed method does not need the application of dough improvers and can be used in the production of organic bread.

1. Introduction

The physical properties of bread are important indicators of its quality which is frequently affected as a result of changes in process parameters, and also depends on the methods of bread production.

The basic methods used in the production of wheat bread are the straight-dough and two-phase methods. The straight-dough methods are short, consisting of a one-time mixing of the dough, its fermentation in bulk, division into dough pieces, proofing and baking. These methods are often modified through the application of an intensive mixing of the dough or through the use of improvers accelerating dough fermentation. Typical two-phase methods consist of the preparation of leaven, its fermentation, and then the formation of dough. There are several kinds of two-phase method, examples of which include the firm yeast-based leaven (sponge dough) method (Kariluoto et al., 2004), the liquid yeast-based leaven (poolish dough) method (Boulet, 1996), or the method involving the use of prefermented yeast dough (Mrvčić et al., 2009) or lactic acid bacteria sourdough (Arendt et al., 2007; Minervini et al., 2011). Sometimes chemically leavened systems are used (Bellido et al., 2009; Patel et al., 2012).

Studies conducted so far have shown that, compared to the straight-dough method, bread produced with the two-phase method is characterized by better sensory values (Gänzle et al., 2008) and better quality parameters (Kilborn et al., 1981; Różyło, 2013). Moreover, bread made with the two-phase method is characterized by greater volume, the crumbs have larger pores and significantly lower hardness (Różyło and Laskowski, 2009), and additionally such bread is characterized by a greater homogeneity of crumb texture (Różyło, 2013) and higher nutritive value (Arendt et al., 2007). The production of bread with this method, however, is more time and labor consuming. The traditional two-phase method consists of prior preparation of yeast-based leaven, its fermentation

Abbreviations: C, bread prepared by the straight-dough method; LD, bread made through two-phase method from yeast-based leaven with 180% yield; IS-LD, bread made through two-phase method from yeast-based leaven with 180% yield with the use of the interruption and slowing of leaven fermentation; IS-WLD, bread made through two-phase method from yeast-based leaven with 210% yield with the use of the interruption and slowing of leaven fermentation; WLD, bread made through two-phase method from yeast-based leaven with 210% yield.

* Corresponding author. Tel.: +48 (82) 461 00 61.
E-mail address: renata.rozylo@up.lublin.pl (R. Różyło).

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for 3–5 h at a temperature of 25–30 °C. After the fermentation of leaven, dough is prepared, fermented and proofed. A possible method to reduce the time requirements in the two-phase method of wheat bread production might be the interruption and slowing of the fermentation of yeast - based leaven. However, results published so far relate only to methods in which the fermentation of final dough pieces is delayed and blocked under freeze-storage conditions (Boettger and Schmid, 1981; Le Bail et al., 2010; Selomulyo and Zhou, 2007) or under refrigeration (Boettger and Schmid, 1981), while there are no reports concerning the interruption and slowing of the fermentation of yeast-based leaven. The application of low temperatures permits production to be delayed till the next day, during which the whole process of bread production is shortened. The application of the method proposed here permits the elimination of the shift system in bakery production.

In view of the above, the objective of the study was to determine changes in the physical properties of wheat bread produced with the two-phase method incorporating the proposed new application of an interruption and slowing of fermentation of yeast-based leaven. The goal of the paper was to optimize the process and to find a method, through a series of comparisons of standard and modified methods, which provides the best economic and quality traits.

2. Materials and methods

2.1. Materials

The white bread wheat flour used in this study had 11.0 g/100 g protein content (ISO, 20483:2006), 26 g/100 g wet gluten content (ISO 21415-1:2006), 0.76 g/100 g ash content (ISO 2171:2007), 220 s falling number (ISO 3093:2009) and 56% water capacity up to 500 jB (ISO 5530-1:1997) was used in this study. Commercially produced wheat bread flour was used. The dried instant yeast (Instaferm) was sourced from Lallemand Iberia, SA. Salt and sugar were purchased from the local market.

2.2. Baking methods

The different breads were prepared and baked according to both the standard method (Jakubczyk and Haber, 1983) and our own modification in a laboratory oven with a fermentation cabinet (Sadkiewicz Instruments, PL) and using different methods: (1) the straight-dough method; (2) the two-phase method with modification of the yield and duration of the fermentation of yeast-based leaven; and (3) the two-phase method with an interruption and slowing of leaven fermentation.

The bread making methods are shown in Table 1. In the straight-dough baking method (C), all ingredients were mixed together and left for fermentation, proofing and baking. The basic dough formula consisted of flour (100%), water (up to 350 BU consistency), salt (2% flour basis), and dried instant yeast (equivalent to 3% compressed yeast). All ingredients were mixed in a slow-speed mixer (type GM-2, Sadkiewicz Instruments, PL) and fermented at 30 °C and 75% RH for 60 min (with 1 min transfixion after 30 min). Pieces of dough (300 g) were molded by hand, panned, and proofed at 30 °C and 75% RH over the period required for optimal dough development. The loaves were baked at 230 °C for 25 min in an oven (live steam was injected immediately after the loaves were placed in the oven).

In the two-phase bread making method (2) (LD and WLD), the yeast-based leaven was prepared and fermented, and then the dough was prepared, fermented, proofed and baked. The yeast - based leaven formula consisted of flour (50%), water (to obtain 180% (LD) and 210% (WLD) yield), and dried instant yeast (equivalent to1% compressed yeast). The ingredients were mixed and fermented at 28 °C and 75% RH for 1, 2 and 3 h. Subsequently, the yeast-based leaven was mixed with flour (50%), water (up to 350 BU consistency), sugar (1%) and salt (2%) and fermented for 20 min at 30 °C. Pieces of dough (300 g) were molded by hand, panned, and proofed at 30 °C and 75% RH over the period required for optimal dough development. The loaves were baked at 230 °C for 25 min in an oven (live steam was injected immediately after the loaves were placed in the oven).

In the interrupted and slowed two-phase bread making method (3) (IS-LD and IS-WLD) the yeast-based leaven was prepared, fermented at 28 °C (75% RH) for 1, 2 and 3 h, after fermentation the temperature was reduced to 10 °C. The fermentation slowing temperature was determined (10 °C) on the basis of preliminary studies performed in the range from 4 to 10 °C (only cooling temperatures were taken into consideration to avoid adverse microbiological changes). In these studies, no significant differences were observed in the properties of bread. Moreover, the temperature of 10 °C was assumed based on the economic aspects. The yeast-based leaven was stored for 18 h (in the preliminary tests no significant differences were noted between 12, 18 and 24 h of storage of the leaven). Thereafter, the dough was prepared, fermented, proofed and baked as above.

After baking, the different types of bread were sealed in hermetic plastic bags and stored at a temperature of 20 °C. The bread was made in nine replicates.

Table 1
Bread making methods.

Bread-making conditions	Straight-dough method	Two-phase method (yeast-based leaven – dough method)	Two-phase method (interrupted and slowed yeast-based leaven -dough method)
Number of phases	1 (dough)	2 (yeast-based leaven, dough)	2 (yeast-based leaven, dough)
Recipe for yeast-based leaven	–	Flour (50%) Yeast (1%) Water, 2 variants (LD and WLD) (Yield 180% – LD) (Yield 210% – WLD)	Flour (50%) Yeast (1%) Water, 2 variants (IS-LD and IS-WLD) (Yield 180% - IS-LD) (Yield 210% - IS-WLD)
Leaven conditions	–	28 °C, 75 RH 1, 2, 3 h	28 °C, 75 RH 1, 2, 3 h
Slow down of leaven conditions	–	–	10 °C, 75% RH 18 h
Recipe for dough	Flour (100%) Water (up to 350 BU consistency) Yeast (3%) Salt (2%)	Yeast-based leaven Flour (50%) Water (up to 350 BU consistency) Salt (2%) Sugar (1%)	Yeast-based leaven Flour (50%) Water (up to 350 BU consistency) Salt (2%) Sugar (1%)
Dough fermentation conditions	30 °C, 75% RH 1 h (transfixion after 0.5 h)	30 °C, 75% RH 20 min	30 °C, 75% RH 20 min
Dough proofing conditions	30 °C, 75% RH time until optimal growth	32 °C, 75% RH time until optimal growth	32 °C, 75% RH time until optimal growth
Baking conditions	230 °C, 30 min	230 °C, 30 min	230 °C, 30 min

C – Bread prepared by the straight-dough method, LD – Bread made through two-phase method from yeast-based leaven with 180% yield, IS-LD – Bread made through two-phase method from yeast-based leaven with 180% yield with the use of the interruption and slowing of leaven fermentation, IS-WLD – Bread made through two-phase method from yeast-based leaven with 210% yield with the use of the interruption and slowing of leaven fermentation, WLD - Bread made through two-phase method from yeast-based leaven with 210% yield.