Effect of proving time on the quality of frozen pre-baked French style rolls elaborated with the addition of wholegrain flour and enzymes

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Abstract Proving is a step in the breadmaking process that can be crucial in determining the final characteristics of the product presented to the consumer. The objective of this work was to evaluate the effect of proving time on the quality of frozen pre-baked French style rolls elaborated with the addition of wholegrain flour and enzymes. With this objective, doughs from six different formulations were allowed to ferment to different stages of proving. The first stage corresponded to the stage where the dough presented the maximum point of volume development without losing its resistance to touch. The second stage was soon after the first one, being characterized by a loss of resistance to touch but without a marked loss of volume. The rolls were evaluated for their specific volume, crumb texture (firmness and springiness), oven spring, shape, cut opening and cut height. The results showed that the proving time influenced various characteristics of the pre-baked French bread. A longer proving time tended to result in greater specific volume of the rolls with greater crumb springiness, but with a less firm crumb and reduced cut opening and cut height. The oven spring and shape were not altered by the proving time. The increase in volume was the result of increases in the width and length of the rolls. This study showed that the proving time was one of the factors responsible for the collapse in the structure of the pre-baked rolls, and that an adequate formulation could overcome the loss in cut opening and cut height resulting from a longer proving time.

Keywords Proving · Pre-baked bread · French bread · Freezing · Wholegrain flour · Enzymes

Introduction

Bread and bakery products have a major role in human nutrition worldwide. Generally, wheat bread is considered an irreplaceable source of energy and nutrients for the human body. This is especially true for the products made from whole wheat flour or high-yield flour types (Demir and Elgün 2011). There is evidence of the relationship between the consumption of whole grain and prevention of illnesses such as cancer, cardiovascular disease, diabetes and obesity (Jensen et al. 2006; Slavin 2003). Despite the fact that whole cereals claims to promote good health, it is difficult to process these foods.

The French bread is the most consumed bread in Brazil (ABIP 2012), where a typical French bread has a brown and glossy crust 3–4 mm thick; a white soft and elastic crumb with a random cell crumb structure. It presents 50 g final weight with a cut opening width and a cut height on the surface and the following dimensions: 12.5 cm length and 5.5 cm diameter (Almeida and Chang 2012; Baardseth et al 2000; Carr and Tadini 2003).

Pre-baked bread is a growing sector of the market not just because it makes products available for finalization at the home, but because the products can be distributed for final baking at sales points. The intermediate products are frequently frozen for distribution (Wiggins 1999). Various problems concerning pre-baked rolls have been related to their freezing, such as reduction/contraction of the specific volume, collapse (shrinkage) of the structure, a loss of crumb color just under the crust to a color commonly known as snow-white, separation of the crumb from the crust and flaking of the crust. However Le Bail et al. (2005) showed that the conditions of the proving step influenced the quality of the rolls and that the relative humidity during proving was one of the key factors in the control of flaking. It was found that a relative humidity of 90–95 % during the proving was better than dry conditions (50–55 % relative humidity) in order to improve

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the crust of frozen, pre-baked and re-baked French rolls with regards to minimal flaking. However, there are divergences in the literature with respect to the proving time. According to Sluimer (2005) the proving time is usually the same as that used in the conventional process, but Ferreira et al. (1999) showed that this step should be shorter in the production of pre-baked French rolls.

The objective of the proving step is to continue the dough development that started during mixing, aiming to increase the specific volume of the dough due to the production of carbon dioxide by the yeasts, considering the gas retention properties of the wheat flour, such that the properties desired in the final product be obtained during baking. Under favorable conditions, the proving time should allow for the action of the yeasts and enzymes in the dough (Sluimer 2005). Proving is one of the critical phases in the production of French bread (Baardseth et al. 2000).

Proving of the dough should be optimized for the production of good quality baked products. An insufficient proving time results in products with a reduced volume and poor crumb structure, whereas excessive proving can produce sticky doughs with low viscosity, which are difficult to handle. Excessive proving times also represent unnecessary cost to the bakeries (Sinelli et al. 2008).

There are few studies on the influence of the proving step on pre-baked rolls. Thus, the objective of this work was to evaluate the effect of proving time on frozen pre-baked French style rolls elaborated with the addition of wholegrain flour and enzymes, and determine the changes that this parameter can cause to the quality characteristics of the rolls.

Material and methods

Material A mixture of 60 % whole wheat flour (Anaconda, São Paulo, Brazil) with 40 % type 1 wheat flour (Anaconda, São Paulo, Brazil) was used. The mixture presented 7.77 ± 0.29 % moisture, 12.31 ± 0.16 % protein ($N \times 5.7$), 1.39 ± 0.05 % lipids and 1.15 ± 0.05 % ash contents. The water absorption capacity, stability, mixing tolerance index, maximum resistance (135 min) and extensibility (135 min) were 65 %, 5 min, 60 FU, 500 BU and 127 mm, respectively, and the Falling Number was 378 ± 6 s. The other ingredients and additives used were ascorbic acid (DSM, São Paulo, Brazil), azodicarbonamide (Granotec, Curitiba, Brazil), Fleischmann instant baker's lean dough yeast (AB Brasil, Pederneiras, Brazil), vital gluten (Roquette Frères, Lestrem, France), Panodan® 20 tartaric acid ester diacetylated with mono and diglycerides (Danisco, Cotia, Brazil), Grindamyl™ A 500 fungal alpha-amylase (Danisco, Cotia, Brazil), Grindamyl® Powerbake 4100 glucolipase (Danisco,

Cotia, Brazil) and Grindamyl™ Sure Bake 900 hexose oxidase (Danisco, Cotia, Brazil). The hemicellulase used was a mixture of 70 % Grindamyl™ Powerbake 7500 inhibition-free bacterial hemicellulase (Danisco, Cotia, Brazil) and 30 % Grindamyl™ H 460 fungal hemicellulase (Danisco, Cotia, Brazil).

Roll formulation Six formulations of pre-baked French rolls were used in this study, containing different concentrations of the enzymes glucolipase, hemicellulase and hexose oxidase. The base formulation used in this research was the following: whole wheat flour (60 %), refined wheat flour (40 %), water (62 %), instant baker's yeast (0.8 %), salt (2 %), vital gluten (1 %), tartaric acid ester diacetylated with mono and diglycerides (0.5 %), ascorbic acid (0.017 %), azodicarbonamide (0.0045 %), and 5000 SKB fungal α -amylase (0.02 %). In addition to the basic formulation, formulation F1 contained glucolipase (0.0120 %), hemicellulase (0.0091 %) and hexose oxidase (0.0030 %); formulation F2 contained glucolipase (0.0120 %), hemicellulase (0.0359 %) and hexose oxidase (0.0030 %); formulation F3 contained glucolipase (0.0030 %), hemicellulase (0.0091 %) and hexose oxidase (0.0120 %); formulation F4 contained glucolipase (0.0120 %), hemicellulase (0.0091 %) and hexose oxidase (0.0120 %); formulation F5 contained hemicellulase (0.0225 %), hexose oxidase (0.0075 %) and without the addition of glucolipase; formulation F6 contained glucolipase (0.0075 %), hexose oxidase (0.0075 %) and without the addition of hemicellulase.

Roll production The rolls were produced in batches containing 1.8 kg wheat flour using the modified straight dough process. The ingredients were mixed in a HAE 10 dough mixer (Hypo, Ferraz de Vasconcelos, Brazil) until complete gluten development. The water was added cool or partly in the form of ice, such that the final dough temperature was 29 ± 2 °C. The dough was mixed at slow speed for 5 min and high speed for 5.40 ± 0.41 min. Immediately after mixing, each dough batch was divided into 90 ± 1 g portions. The doughs were divided into slightly heavier balls than used for conventional French bread (90 g instead of 65 g) to avoid the low specific volume. Despite the elevated amounts of enzymes added, the doughs elaborated with whole wheat flour were less tolerant to proving, making it impossible for them to attain good performance with respect to specific volume in the pre-tests. The portions were rolled into balls, left to rest for 20 min and molded in a HM2 Hp 0.5 molder (Hypo, Ferraz de Vasconcelos, Brazil) and left to ferment in a CCKU 586820-1 proofing chamber (Super Freezer, Poços de Caldas, Brazil) at 30 ± 3 °C and 80 ± 5 % RH, until two different stages of proving were reached: stage 1 = the stage at which maximum volume was reached without losing its resistance to touch and stage 2 = the stage soon after stage 1, being characterized by a loss of resistance to touch but without a marked loss of volume. The evaluations of resistance to touch were carried out subjectively. Tables 1, 2, 3, and 4 show the

times required for the different dough samples to reach stages 1 and 2, described as t_1 and t_2 , respectively. Since each formulation contained different amounts of the enzymes, providing differentiated tolerance to the dough, the times t_1 and t_2 varied according to the formulation. The fermented doughs were pre-baked in an Ipanema IP 4/80 hearth oven (Haas, Curitiba, Brazil) with steam injection during the first 3 s of baking, with a top temperature of 190 ± 5 °C and hearth temperature of 210 ± 5 °C. When the center of the roll reached 93 °C, the oven door was opened and pre-baking continued until the center of the roll reached 96 °C. The total pre-baking time was 11 ± 1 min. The temperature was monitored using “T” type thermocouples with a Data Logger 177-T4 data acquisition system (Testo, Lenzkirch, Germany). The pre-baked rolls, cooled until the center was 35 °C, were frozen in a UK 05 mechanical static freezing chamber (Klimaquip, Pouso Alegre, Brazil), using forced air convection at low temperature (−40 °C). The freezing process was stopped when the center of the roll reached −18 °C and the freezing time was 50 ± 3 min. After remaining frozen for 7 days at −18 °C in a FFE24 vertical freezer (Eletrolux, Curitiba, Brazil), the rolls were re-baked in an electronic EC3 Gourmet combined oven (Prática Technicook, Pouso Alegre, Brazil) at 180 °C for the first 4 min with steam injection, followed by 8 min without steam.

Product evaluation

The pre-baked (not frozen) and re-baked (pre-baked, frozen, stored frozen for 7 days and re-baked) rolls were evaluated using the following evaluations.

Specific volume

The apparent roll volume was determined by the millet displacement method, and the mass determined using a semi-analytical balance. The specific volumes of the pre-baked and re-baked rolls were determined from the volume/mass ratio and expressed in mL/g. The specific volume was determined as soon as the temperature at the center of the roll reached 32 °C.

Texture: firmness and springiness

Crumb firmness was determined using AACC method n° 74–09.01 (2010), and springiness by an adaptation of this method according to Sangnark and Noomhorm (2004). The analyses were carried out using a TA-XT2 texturometer with a 25 kg load (Stable Micro Systems, Surrey, England) and the P/25 cylindrical aluminum probe. The parameters established were: test option and mode = measurement of the compression force, and hold until the stipulated time; pre-test speed = 1.0 mm/s; test speed = 1.7 mm/s; post-test speed = 10.0 mm/s; distance =

40 %; time = 60 s and auto trigger = 10 g. Fourteen replicates were carried out for each formulation.

Oven spring

This was evaluated according to Shittu et al. (2008), determined from the difference in height of the dough at the end of the proving period and the height of the pre-baked bread. A pachymeter was used to obtain these measurements.

Shape

The shape of the rolls was determined according to Bodroza-Solarov et al. (2008). The height and width of the central slice of the roll were measured using a pachymeter and the shape determined from the height/width ratio. A ratio of 0.5 indicates a regular roll shape, a ratio above 0.5 indicates a spherical shape, whilst a ratio below 0.5 indicates a flat shape.

Cut opening and cut height after pre-baking

The cut opening and cut height of the pre-baked rolls were measured using a pachymeter. The cut opening of the pre-baked rolls was defined as the linear distance between the two sides of the cut at the center of the loaf. The cut height was defined as the linear height of unsticked side of the roll in relation to the surface at the center of the volume at an angle of approximately 45°.

Statistical analysis In order to compare the difference in the characteristics of the rolls due to differences in the proving time and in the enzymes utilization, the data obtained were submitted to an Analysis of Variance (ANOVA) and to Tukey’s test ($p < 0.05$), using the Statistica 5.0 program (StatSoft Inc., Tulsa, USA). The assays were carried out in duplicate. All analyzes were carried out in four replicates, except the texture analysis which was carried out in eight replicates.

Results and discussion

Specific volume Table 1 shows the data obtained for volume, weight and specific volume of the pre-baked and re-baked rolls whose doughs were submitted to different proving times. It can be seen that the proving point of the dough, characterized in this study by the proving time, influenced the volume and specific volume of the pre-baked and re-baked rolls. For the pre-baked rolls, independent of the formulation, the increase in time to reach proving stage 2 (t_2) caused a significant increase in the volume and specific volume ($p < 0.05$). For the re-baked rolls, the volume and

Table 1 Volume, weight and specific volume of the pre-baked and re-baked rolls

Formulations	Proving time (h)		Pre-baked bread			Re-baked bread		
			Volume (mL)	Weight (g)	Specific Volume (mL/g)	Volume (mL)	Weight (g)	Specific Volume (mL/g)
F1	t1	1.33	263±6 b	81.2±0.89 a	3.2±0.10 b	250±7 b	80.5±0.37 a	3.1±0.09 b
	t2	1.42	306±6 a	80.0±0.36 a	3.8±0.09 a	281±5 a	79.5±0.34 b	3.5±0.06 a
F2	t1	1.17	280±4 b	80.9±0.22 a	3.5±0.05 b	263±5 b	80.5±0.54 a	3.3±0.04 b
	t2	1.67	365±5 a	79.8±0.03 b	4.6±0.06 a	353±9 a	78.2±0.21 b	4.5±0.12 a
F3	t1	1.00	278±9 b	80.2±0.45 a	3.5±0.10 b	270±14 a	79.9±0.57 a	3.4±0.20 a
	t2	1.50	305±7 a	80.0±0.59 a	3.8±0.10 a	275±4 a	80.4±0.62 a	3.4±0.07 a
F4	t1	1.58	283±5 b	81.4±0.40 a	3.5±0.07 b	268±10 b	81.1±0.76 a	3.3±0.15 b
	t2	1.83	298±5 a	80.2±0.59 b	3.7±0.08 a	305±9 a	79.8±0.56 b	3.8±0.13 a
F5	t1	1.42	268±5 b	81.3±0.44 a	3.3±0.05 b	241±6 b	81.1±0.71 a	3.0±0.10 b
	t2	1.67	295±7 a	81.1±1.01 a	3.6±0.09 a	275±10 a	81.4±0.15 a	3.4±0.13 a
F6	t1	1.50	258±5 b	79.2±0.18 b	3.3±0.06 b	249±3 b	78.9±0.50 a	3.2±0.05 b
	t2	1.67	310±4 a	80.3±0.51 a	3.9±0.07 a	294±5 a	79.0±0.46 a	3.7±0.06 a

* mean ± standard deviation, $n=4$. Formulations F1–F6: refer to text. t1 = proving time to reach stage 1 and t2 = proving time to reach stage 2. Means followed by the same letter in the same column for the same formulation do not differ according to Tukey's test ($p<0.05$)

specific volume were also higher for the rolls with longer proving time, with the exception of the F3 rolls, for which there was no significant difference ($p<0.05$). As expected, up to a certain point, the longer the proving time, the more time the yeast had to produce carbon dioxide and hence produce a roll with a greater specific volume. However, the increase in volume only occurred up to a certain point after which the yeast has no more substrate to produce gas and also the dough has no further strength to maintain the structure. Thus, if the rolls had been examined with a proving time greater than stage 2, a decrease in specific volume would have been detected. If the specific volume versus proving time are plotted, a hyperbolic curve will

probably be obtained with the maximum point for specific volume at optimum proving time.

It can be seen that the formulation influenced the magnitude of specific volume increase with an increase in proving time. Of all the formulations, the dough formulation F4 showed the longest proving time to reach stage 1 and hence to reach stage 2. However the F4 rolls were not those presenting the greatest specific volume. The doughs formulations F2, F5 and F6 showed the same proving times to reach stage 2 (1.67 h) but presented different values for specific volume.

Texture: firmness and springiness Table 2 shows the values obtained for the firmness and springiness of the pre-baked

Table 2 Firmness and springiness of the pre-baked and re-baked rolls

Formulations	Proving time (h)		Firmness pre-baked (gf)	Firmness re-baked (gf)	Springiness pre-baked	Springiness re-baked
F1	t1	1.33	143.9±9.09 a	133.6±6.70 a	49.7±1.17 b	51.5±1.16 a
	t2	1.42	86.5±4.66 b	82.2±4.73 b	51.0±0.88 a	51.8±1.20 a
F2	t1	1.17	128.4±8.96 a	132.8±7.14 a	50.4±0.77 b	52.7±1.05 a
	t2	1.67	66.0±3.47 b	77.1±3.35 b	53.2±1.11 a	53.6±1.47 a
F3	t1	1.00	139.6±11.09 a	120.8±5.66 a	50.8±0.56 a	53.3±0.70 a
	t2	1.50	86.7±4.06 b	89.7±7.73 b	50.4±0.95 a	53.2±1.24 a
F4	t1	1.58	113.6±7.03 a	108.7±5.00 a	50.3±1.18 a	52.3±1.18 a
	t2	1.83	92.6±4.12 b	85.1±5.28 b	50.6±0.95 a	51.2±1.53 a
F5	t1	1.42	132.7±9.87 a	123.4±6.81 a	51.8±0.65 a	54.4±0.96 a
	t2	1.67	92.6±4.86 b	91.1±5.15 b	51.7±1.08 a	55.0±0.87 a
F6	t1	1.50	158.8±15.30 a	133.3±5.97 a	52.1±0.87 a	52.7±1.10 b
	t2	1.67	87.8±4.09 b	101.7±6.19 b	51.3±1.33 a	54.3±0.90 a

* mean ± standard deviation, $n=14$. Formulations F1–F6: refer to text. t1 = proving time to reach stage 1 and t2 = proving time to reach stage 2. Means followed by the same letter in the same column for the same formulation do not differ according to Tukey's test ($p<0.05$)

Table 3 Height of the dough before baking, height of the roll soon after pre-baking, oven spring, width, length and shape of the pre-baked rolls

Formulations	Proving time (h)		Height before baking (cm)	Height after baking (cm)	Oven Spring (cm)	Width (cm)	Length (cm)	Shape
F1	t1	1.33	5.0±0.08 b	5.9±0.08 b	0.93±0.113 a	7.5±0.16 b	10.4±0.13 b	0.78±0.006 a
	t2	1.42	5.2±0.13 a	6.4±0.22 a	1.18±0.256 a	8.0±0.21 a	11.7±0.20 a	0.80±0.035 a
F2	t1	1.17	4.8±0.09 b	6.2±0.24 a	1.38±0.256 a	7.8±0.02 b	10.1±0.35 b	0.80±0.029 a
	t2	1.67	5.3±0.21 a	6.1±0.27 a	0.80±0.342 a	8.7±0.22 a	12.1±0.44 a	0.70±0.042 a
F3	t1	1.00	5.0±0.11 a	6.3±0.31 a	1.28±0.329 a	7.7±0.17 a	10.5±0.15 b	0.82±0.056 a
	t2	1.50	5.1±0.13 a	6.1±0.06 a	1.05±0.143 a	7.8±0.26 a	12.1±0.45 a	0.79±0.022 a
F4	t1	1.58	5.0±0.11 a	6.2±0.10 a	1.16±0.149 a	7.9±0.25 a	10.7±0.20 b	0.79±0.031 a
	t2	1.83	5.1±0.06 a	6.2±0.08 a	1.05±0.078 a	8.3±0.15 a	11.3±0.13 a	0.75±0.012 a
F5	t1	1.42	4.7±0.13 a	6.1±0.13 b	1.48±0.184 a	7.6±0.10 b	10.5±0.21 b	0.81±0.023 a
	t2	1.67	5.0±0.25 a	6.5±0.15 a	1.47±0.292 a	8.1±0.23 a	11.4±0.15 a	0.79±0.034 a
F6	t1	1.50	5.0±0.18 a	5.7±0.21 b	0.69±0.277 a	7.6±0.01 b	10.2±0.16 b	0.76±0.011 a
	t2	1.67	5.1±0.12 a	6.0±0.06 a	0.91±0.134 a	7.8±0.06 a	11.7±0.19 a	0.77±0.006 a

* mean ± standard deviation, $n=4$. Formulations F1–F6: refer to text. t1 = proving time to reach stage 1 and t2 = proving time to reach stage 2. Means followed by the same letter in the same column for the same formulation do not differ according to Tukey's test ($p<0.05$)

and re-baked rolls with different proving times. It can be seen that for all variants, the rolls fermented to stage 1 (t1) were statistically firmer than those with a longer proving time ($p<0.05$). This was due to the fact that the rolls with a longer proving time had a larger volume and a crumb with more open alveoli. For volumes of equivalent mass, differences in volume generally imply differences in cell wall thickness, and air cells size and number.

With respect to springiness, the crumbs of the rolls fermented to stage 1 (t1) were less or equally springy to the crumbs of rolls fermented to stage 2 (t2), for both the pre-baked and re-baked rolls. In the present study, the more open alveoli probably tended to provide greater springiness to the crumb.

Oven spring Table 3 shows the values obtained for the height of the dough before baking, height measured immediately after pre-baking and oven spring. It can be seen that although the dough of some of the rolls passed the point of losing the resistance to touch (stage 2–t2), the dough height of some formulations before baking was not significantly different ($p<0.05$) from those that retained their resistance to touch (stage 1–t1). The other dimensions (width and/or length) of these doughs expanded more than height. This shows a structure that was inadequate to retain the gas produced and rise vertically. The same occurred with the height of the rolls after pre-baking, with the rolls presenting no statistical difference in oven spring, independently of proving time ($p<0.05$).

Shape Table 3 shows the values obtained for the height, width, length and shape of the pre-baked rolls. It can be seen that although the rolls of some formulations

with different proving times presented no significant differences with respect to height, they presented increases in the width and/or length ($p<0.05$), reflecting an increase in roll volume, as shown above (Table 2).

There was a tendency for the rolls with increased dimensions to collapse; consequently some rolls presented a fold at their lower side. Rolls with longer proving did not have enough strength to hold up after pre-baking. In porous foods like bread, this phenomenon may occur especially in rolls with a thin crust. The gas nuclei present in the proofed dough expand as the

Table 4 Cut opening and cut height of the pre-baked rolls

Formulations	Proving time (h)		Cut opening (cm)	Cut height (cm)
F1	t1	1.33	3.0±0.26 a	1.3±0.10 a
	t2	1.42	2.8±0.26 a	1.1±0.10 b
F2	t1	1.17	2.7±0.24 a	0.8±0.06 a
	t2	1.67	2.0±0.07 b	0.5±0.16 b
F3	t1	1.00	2.8±0.39 a	1.1±0.05 a
	t2	1.50	2.4±0.20 a	0.8±0.22 b
F4	t1	1.58	3.8±0.31 a	1.4±0.11 a
	t2	1.83	2.2±0.07 b	0.8±0.14 b
F5	t1	1.42	2.9±0.24 a	1.2±0.15 a
	t2	1.67	3.0±0.12 a	1.2±0.07 a
F6	t1	1.50	3.8±0.35 a	1.5±0.10 a
	t2	1.67	2.1±0.15 b	0.5±0.13 b

* mean ± standard deviation, $n=4$. Formulations F1–F6: refer to text. t1 = proving time to reach stage 1 and t2 = proving time to reach stage 2. Means followed by the same letter in the same column for the same formulation do not differ according to Tukey's test ($p<0.05$)

baking temperature increases. The evaporation of volatile solubles from dough such as carbon dioxide and ethanol takes place as well as the thermal expansion of gases and, particularly, the increase of vapor pressure at higher temperatures (Sluimer 2005). The internal pressure within the gas nuclei decreases as a function of the temperature decrease during cooling. Thus, a partial vacuum over the product can be formed, causing a collapse. The product undergoes shrinkage and becomes more dense and tough (Mizrahi 2012).

These events indicate that it is important that the pre-baked roll presents a structure to support the gas retraction during cooling. Since this type of bread has a thin crust after pre-baking, suitable dough strength at the end of the proving process is fundamental. Loss of dough strength is coupled with an excessive volume increase and it can be adjusted through the proving time. The performance of the pre-baked rolls (absence of defects) depends on the formulation, but mainly on the proving time.

With respect to shape, the rolls with different proving times did not present statistical differences ($p < 0.05$). On average, the rolls presented values between 0.75 and 0.82, indicating a shape between a regular shape and a spherical one. In other words, the rolls did not present a shape tending to flatness (value for shape < 0.5).

Cut opening and cut height after pre-baking Table 4 shows the values obtained for cut opening and cut height of the pre-baked rolls with different proving times. In general it can be seen that when the dough passed stage 1 and reached stage 2 in which it started to lose resistance to touch (stage 2–t2), the roll developed more volume but in consequence exhibited reduced cut opening and cut height. Since higher volume was developed during proving and the roll structure was already stressed to retain the extra gas produced, it appears that, on baking, the rolls lacked sufficient strength to open the cut opening and cut height, despite presenting the same rise in the oven (oven spring). The surface cut made in the dough after the final proving is a part of the processing of French bread, leading to a characteristic of the product. The cut frees the stress in the dough during baking, that is, it increases the dough expansion area, giving an attractive appearance to the baked product (Baardseth et al. 2000).

The intensity of the increase in volume during proving and the consequent loss of the cut height in the oven appear to depend on the formulation. The rolls from formulation F5, despite the fact that the dough lost its resistance to touch (stage 2–t2), still managed to maintain the same cut opening and cut height as those made from dough that still exhibited resistance to touch (stage 1–t1). For all other formulations, the rolls showed lower cut height by reaching the proving stage 2 (t2). Probably the adequate and proportional doses of the enzymes hemicellulase and hexose oxidase

in the wheat flour mixture used allowed the rolls made from the formulation F5 to present this characteristic.

Conclusions

The results of this study allow for the conclusion that the proving point of a dough influences various characteristics of the final product. Depending on the bread formulation used, a proving time slightly longer than that in which the dough still retains its resistance to touch can allow the roll to attain a greater specific volume and reduce crumb firmness, but on the other hand reduces cut opening and cut height, quality attributes considered essential for French bread. In addition the rolls show a collapse of the structure. The pre-baked and re-baked rolls were influenced in the same way with respect to specific volume, crumb firmness and springiness with variation in proving time. Pre-baked rolls with different proving times showed no differences in oven spring or shape, but showed differences with respect to collapse. Thus insertion of the dough into the oven at the stage when the dough still retains its resistance to touch is a crucial factor in obtaining good quality pre-baked French style rolls, that is, without defects.

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