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Short Communication

EFFECT OF FREEZING DURATION AND DOUGH IMPROVER ON THE SENSORY PROPERTIES OF PARTIALLY PROOFED AND FRESHLY BAKED CROISSANTS

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ABSTRACT

Objective: This study aimed to evaluate how freezing duration affects the sensory properties of partially proofed croissants with 2% dough improver and to determine the maximum freezing period that maintains acceptable quality.

Methods: Croissants were partially proofed for 1.5–3 h, depending on intended storage, frozen at −23°C for up to 15 days, then defrosted at room temperature and baked at 165°C for 18 min. A trained panel of six assessed appearance, color, texture, aroma, and taste using a 5-point hedonic scale. All analyses were performed in triplicate, with significant differences determined by one-way analysis of variance ($p<0.05$).

Results: Croissants retained good sensory quality for up to 10 days of freezing, with no significant changes in appearance, color, texture, aroma, or taste. Beyond 10 days, slight declines were observed in dough rise, crust appearance and color, internal texture, and overall sensory scores, indicating that prolonged freezing adversely affects product quality.

Conclusion: Partially proofed croissants with dough improver can be frozen for up to 10 days without significant loss of sensory quality, while longer storage may reduce appearance, texture, and overall acceptability.

Keywords: Croissants; Sensory; Freezing, Proofing, Baking.

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Freezing is a widely used preservation method in the bakery industry, especially for products requiring time-consuming preparation steps, such as croissants. Partially proofed frozen dough offers practical advantages by allowing final baking on demand, reducing preparation time and waste. However, freezing may negatively affect dough structure and the final sensory quality of the product [1, 2]. The use of dough improvers can help maintain product performance during freezing and baking [3]. Studies have shown that freezing rate and terminal freezing temperature significantly influence frozen croissant dough quality, affecting volume, firmness, and yeast viability. Proper control of these factors is essential to preserve dough integrity during storage [4]. Similarly, research on delayed baking technologies has demonstrated that dough improvers can improve croissant structure and volume, even after freezing and storage, thus enhancing final product quality [5].

This study aimed to evaluate the effect of freezing duration on the sensory properties of fresh, partially proofed croissants made with 2% dough improver, to determine the maximum recommended storage period without compromising product quality. The findings of this study provide valuable insights for bakery production and supply chain management by identifying the optimal freezing duration to preserve the sensory quality of partially proofed croissants.

The main ingredients of croissants: Flour, milk, salt, sugar, butter, and yeast were used in this study. In addition, a dough improver, containing sourdough (wheat) and microbial cultures (wheat), was used at a 2% level. The dough improver was supplied by the company "*Minordija*" (Kaunas, Lithuania). The dough improver exhibited the following sensory properties: beige color, characteristic smell and taste of the used ingredients, and a homogeneous consistency. Store unopened packages in dry and well-ventilated places at a maximum temperature of 25°C. The dough was partially proofed for 1.5–3.0 h before freezing; proofing duration varied depending on the length of frozen storage. The dough was partially proofed for 1.5–3.0 h before freezing; proofing duration varied depending on the length of frozen storage. Freshly baked (non-frozen) croissants were proofed for 1 h 30 min, while croissants frozen for 5, 10, and 15 days were proofed for approximately 2 h, 2 h 30 min, and 3 h, respectively. Freezing was conducted at a constant temperature of −23°C for up to 15 days. Sensory evaluation was performed after different freezing durations, with croissants defrosted at room temperature before baking. Baking was carried out in a standard oven at 165°C for 18 min. The sensory profile was evaluated by a trained panel of six expert assessors in accordance with ISO 13299:2016. Panel selection and training were conducted following the ISO 8586:2012 guidelines. The evaluation was performed under controlled conditions, in line with ISO 6658:2017.

Assessment criteria included appearance, color, texture, aroma, and taste, rated on a 5-point hedonic scale ranging from 1 (disliked

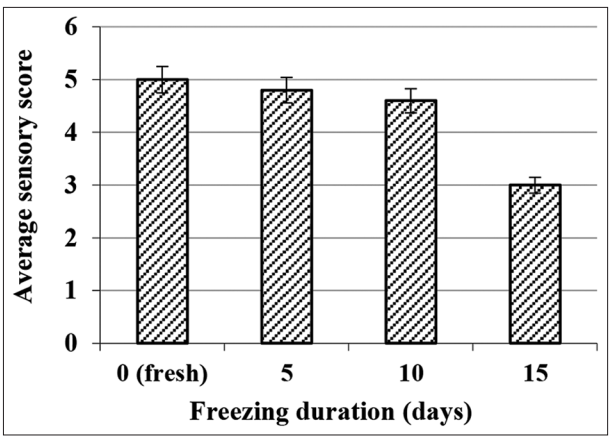

Fig. 1: Effect of freezing duration on the average sensory score of samples

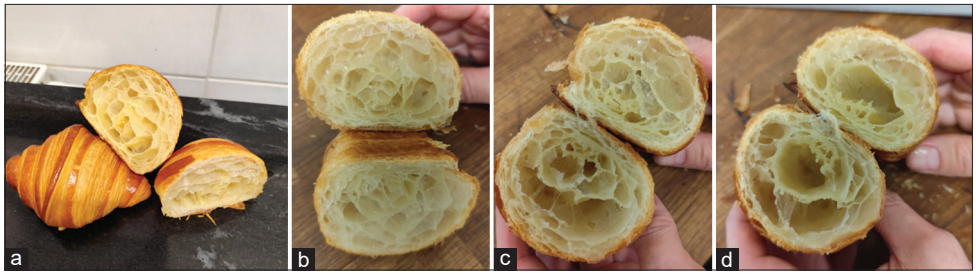

Fig. 2: Internal structure of freshly baked (a) and frozen croissants after 5 (b), 10 (c), and 15 (c) days of storage

very much) to 5 (liked very much). Sensory analyses were carried out in triplicate, and the results are expressed as mean ± standard deviation.

Significant differences among means were determined by one-way analysis of variance, using the statistical package Statgraphics Plus 5.1. Fisher's Least Significant Difference (LSD) was used to determine significant difference among the treatments at $p<0.05$.

Sensory evaluation of freshly baked (non-frozen) croissants and partially proofed samples stored at −23°C for varying durations revealed significant changes in sensory attributes depending on the length of frozen storage. Sensory evaluation of croissants after various freezing periods is shown in (Figs. 1 and 2).

The fresh-baked croissants exhibited a golden-brown color, an evenly browned crust, a crisp exterior, and a soft, layered crumb structure. Their aroma was pleasant and characteristic of freshly baked products, with a buttery note, while the flavor was mildly sweet and free from off-flavors.

Croissants frozen for up to 5 days and thawed before baking at 165°C for 18 min retained their excellent sensory properties. Their appearance, color, texture, aroma, and taste remained comparable to those of freshly baked croissants, with most attributes rated between 4 and 5 on a 5-point scale. The only noticeable difference was a longer proofing time - approximately 30 min more (about 2 h total) - which is related to reduce yeast activity.

After 10 days of freezing, the croissants were thawed, proofed for about 2 h and 30 min, and baked under the same conditions at 165°C for 18 min. It was observed that the sensory properties began to deteriorate: While the aroma remained unchanged, air pockets formed inside, and the dough started to stick to the teeth during eating. These are the first signs of the negative effects of freezing on the croissants' structure and texture.

However, a noticeable decline in quality was observed after freezing for more than 15 days and baking at 165°C for 18 min. Croissants frozen beyond this period exhibited poor rising, unattractive appearance, and significantly lower scores in texture, aroma, and taste. This study corresponds with the findings of previous research, which demonstrated that freezing affects the rheological and thermal properties of dough, leading to changes in texture and overall quality [6,7]. However, the use of 2% dough improver positively influenced the preservation of croissants' quality during freezing and baking. The improver helped maintain dough structure and elasticity, which are critical for proper rising and layering of croissants [8,9]. These findings align with previous studies demonstrating that dough improvers can mitigate the negative effects of freezing on bakery products [7,9]. The results suggest that partially proofed croissants made with 2% dough improver can be stored frozen at −18°C for up to 10 days without significant loss of sensory quality. Longer freezing periods significantly deteriorate product quality, which may negatively affect consumer acceptance and marketability [3,6].

The findings of this study are also valuable from a practical perspective. They provide useful guidelines for frozen bakery producers who supply cafés, hotels, and small bakeries with partially proofed products. Defining a 10-day quality threshold helps optimize storage planning, reduce food waste, and improve product consistency at the point of sale. Furthermore, the use of dough improvers presents a simple and cost-effective strategy for maintaining product quality without resorting to more complex processing or additives. This can support the wider adoption of frozen dough technologies in small-scale or decentralized bakery operations, where freshly baked quality is expected but daily dough preparation may be impractical [10-12].

Based on the experimental results, the following conclusions can be drawn: Croissants frozen for up to 10 days retained excellent sensory qualities after proper thawing, proofing, and baking. Freezing for longer than 10 days caused significant quality deterioration, including poor rising and changes in texture. Proper proofing and baking after freezing are essential to maintain croissant quality. Therefore, it is recommended to limit freezing time to 10 days to preserve product quality and ensure efficient production and supply.

AUTHOR CONTRIBUTIONS

Conceptualization: Eglė Purvaneckaitė and Evaldas Juška, Methodology: Evaldas Juška, Data collection: Vaida Makaravičienė, Analysis: Vaida Makaravičienė, Writing – original draft: Vaida Makaravičienė, Writing – review and editing: Eglė Purvaneckaitė, Supervision: Eglė Purvaneckaitė

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CONFLICTS OF INTEREST

There are no conflicts of interest to declare.

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