

## Effects of Micronutrient Fortification, Baking Temperature, and Baking Time on Sensory Acceptance of Butter Cookies

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### ABSTRACT

This research aims to evaluate the effect of multiple-micronutrient fortification, baking temperature, and baking time on the sensory acceptance of butter cookies. Unfortified and fortified cookies with 3.2% (w/w) multiple-micronutrient mix were baked with different treatments: 170°C for 15 minutes and 190°C for 9 minutes. Untrained adult female panelists (n=50) did a sensory test using a 9-point hedonic scale. Interaction between treatments significantly affected texture and aroma ( $p < 0.05$ ). Cookies fortified with micronutrients baked at 190°C had a lower mean hedonic score for texture ( $5.90 \pm 1.91$ ) and aroma ( $6.54 \pm 1.61$ ) among other treatments ( $p < 0.05$ ). These findings indicate that micronutrient fortification and baking profile affect the aroma and texture acceptance of butter cookies.

**Keywords:** baking treatments, butter cookies, fortified cookies, micronutrient premix, sensory acceptance

### INTRODUCTION

Single and multiple-micronutrient fortification on baked products, such as biscuits or cookies, has successfully improved the nutritional status of toddlers and pregnant women in Indonesia (Dewi & Mahmudiono 2021). Nevertheless, several micronutrients are sensitive to heat. Hence, applying the appropriate baking temperature and duration is critical to minimize micronutrient loss caused by heat exposure. The complex interactions between ingredients, baking temperature, and baking time can influence the sensory quality of the cookies. During the baking process, the moisture content evaporates and affects the texture of the cookies. In addition, the Maillard reactions occur due to the interaction between reducing sugar and amino acids during heating; this process may change other sensorial properties, such as color (Budžaki *et al.* 2014). This research aims to evaluate the effect of multiple-micronutrient fortification, baking temperature, and baking time on the sensory acceptance of butter cookies.

### METHODS

The experiment was conducted at the pilot plant of i3L in March–June 2022. A 2 x 2 factorial

design was used to evaluate the interaction between variables (Table 1).

### Sensory evaluation

Fifty 18–40-year-old untrained females evaluated the samples using a 9-point hedonic scale (1=extremely dislike; 9=extremely like) on ten sensory attributes (color, aroma, taste, sweetness, sourness, texture, mouthfeel, aftertaste, overall appearance, and overall liking). The panelists were provided with two cookies in blind order. This study passed the ethical review from the Research Ethics Commission of Unika Atma Jaya, with COA number 0004P/III/PPPE. PM.10.05/05/2022.

### Data analysis

The IBM SPSS Statistics 29.0.1.0 statistical software was utilized to analyze the data. A two-way ANOVA with a confidence level of 95% was used to test the significant interaction effect between treatments, and the test was continued with Tukey's HSD post-hoc test to evaluate the single main effect between group pairs.

### RESULTS AND DISCUSSION

A statistically significant interaction between multiple-micronutrient mix and baking temperature and time was found in texture and

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(Received 09-06-2023; Revised 13-07-2023; Accepted 26-07-2023; Published 30-12-2023)

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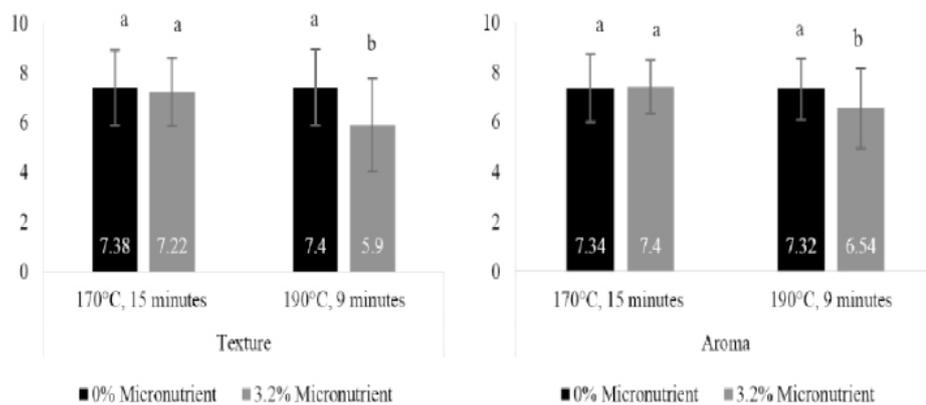
Table 1. Experimental design for butter cookies produced with different multiple-micronutrient concentrations and baking temperatures and time

2x2 Factorial design	Baking temperature and time	
	170°C 15 minutes	190°C 9 minutes
Multiple-micronutrient mix concentration	0% (w/w) $A_1B_1$	0% (w/w) $A_1B_2$
	3.2% (w/w) $A_2B_1$	3.2% (w/w) $A_2B_2$

aroma attributes ( $p < 0.05$ ), but not in color, taste, sweetness, sourness, mouthfeel, aftertaste, overall appearance, and overall liking ( $p > 0.05$ ). Figure 1 shows that Tukey’s post-hoc test revealed that the mean hedonic scores for texture ( $5.90 \pm 1.91$ ) and aroma ( $6.54 \pm 1.61$ ) attributes in cookies fortified with 3.2% micronutrient mix baked at 190 °C for 9 minutes was the lowest among the other treatments ( $p < 0.05$ ).

The lower score for texture of the fortified cookies baked at 190 °C for 9 minutes might be due to the influence of the multiple-micronutrient mix on the moisture content during the baking process. According to S Abd El-Baset and Almoselhy (2023), higher and longer baking temperatures and time resulted in lower moisture content and higher hardness value of biscuits. Nevertheless, higher or lower hardness values did not assure a better texture hedonic score

since the panelists rated the acceptance score for texture based on their preference. In addition, the mineral content in the multiple-micronutrient mix might also influence the moisture content. The properties of water that can bind minerals in foods (e.g., salts) might affect evaporation during the baking process and eventually affect the final moisture content, as the bound water can only exert the characteristics of free water after the cells collapse through the heating process (Khan *et al.* 2017). A higher heating temperature can also induce the reaction between amino acids and reducing sugar to produce Maillard reaction products. However, inorganic compounds in foods, such as minerals from the micronutrients mix, might promote or inhibit the production of aromatic-related compounds and explain the lower mean hedonic score for aroma (Lund & Ray 2017).



Data with the same superscript letter are not significantly different ( $p > 0.05$ ) from Tukey’s HSD test

Figure 1. Interactions between multiple-micronutrient concentrations, baking temperatures, and baking time on the mean hedonic score for texture (left) and aroma (right)

## CONCLUSION

Multiple-micronutrient fortification and baking temperature and time influence the sensory acceptance of butter cookies. Cookies baked at 190°C for 9 minutes had lower acceptance scores for aroma and texture. Sensory acceptance of the samples were also affected by the multiple micronutrient mix.

## ACKNOWLEDGEMENT

This research has received funding from the Indonesia International Institute for Life Sciences (i3L) under the Internal Research Grant scheme year 2021/2022 (grant agreement No 002/SK/WRII-IBSII/I/2022). We would also like to acknowledge PT. Global Vita Nutritech for providing the micronutrient mix.

## DECLARATION OF CONFLICT OF INTERESTS

The authors have no conflict of interest to disclose during the experiment and the preparation of the manuscript.

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