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RESEARCH ARTICLE

Assessing the Influence of Butter-Substitution with Margarine in Sorbitol and Sucrose Cereal Bar Base: Taste, Texture, and Aroma Evaluation by Consumer Preference

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A B S T R A C T

Taste, texture, and aroma are fundamental sensory properties in influencing consumers' preferences for cereal bars. The majority of consumers ranked taste as the most important characteristic influencing their purchasing intent, followed by textural and aromatic features, which define the product quality and acceptability. Butter is a major component in cereal bars and plays an important role in its sensorial properties. However, butter is expensive and not vegan-friendly. Margarine is often used to substitute butter due to the cost and increasing trend of plant-based. This research aims to study the effects of butter substitution with margarine in sorbitol and sucrose cereal bar towards consumer preference on taste, texture, and aroma. There are four prototypes used in this experiment: (i) Formula 1, composed of butter and sucrose, (ii) Formula 2, composed of margarine and sucrose, (iii) Formula 3, composed of butter and sorbitol, and (iv) Formula 4, composed of margarine and sorbitol. The butter and margarine are on the same amount or ratio equivalent, whereas the sorbitol ratio is adjusted according to the sucrose-relative sweetness. All four prototypes were examined using triangle and nine-scale hedonic tests among 50 panelists. Statistical analysis was done using Mann-Whitney U test, with the results of this study showing that the substitution of butter with margarine in sucrose cereal bars was found to have a significant impact on various attributes, including firmness, chewiness, taste, and aroma. Furthermore, for the ranking test, the most preferred samples were butter-sorbitol and margarine-sucrose cereal bar bases, with a similar percentage of 38% of participants. Conversely, the least favorite sample was butter-sucrose, with 64% of the panelists choosing the samples. This indicates that different combination ingredients can provide high consumer product acceptance for a cereal bar and can be used to develop a butter-substitute cereal bar product desirable for the consumer market.

K E Y W O R D S

Butter-substitute, Cereal bar, Taste, Texture, Aroma

H I G H L I G H T S

- Taste, aroma, and texture are important attributes for consumer's liking of cereal bars.
- Butter is a major component in cereal bars, used to balance the taste, texture, and aroma.; however, butter is expensive and not vegan-friendly.
- Margarine is often known by consumers as a cheaper and non-dairy alternative to butter for use in cooking and food preparation.

- ❖ Polyols are often used to replace sucrose in baked goods.
- ❖ The use of sorbitol is related to the previous study that found sorbitol provided the highest acceptance rate among polyols and sugar itself.

INTRODUCTION

Cereal bar is a bar-shaped food, rich in simple and complex carbohydrates such as rice krispies, oats, nuts, seeds, and bonded together with sugar, butter, or any other binding agents (Aleksejeva, 2017). Due to their nutrient richness and functional benefits, cereal bars have been well-known as energy bars, *on-the-go* breakfast bars, and healthy snack alternatives (Sharma, 2014; Yadav & Bhatnagar, 2015). The rising demand and changing lifestyle from consumers towards food that is quick, convenient, tasty, and nutritious, have encouraged food industries to develop cereal bars that interest the target market. These food industries aim to address gaps in consumers' current preferences and needs in different varieties, functions, and uniqueness (Savoreat, 2022). Consumers demand more diversity and appealing taste, texture, and aroma, as well as the price value of the cereal bars (Aleksejeva, 2017). The formulations of cereal bars have been developed and improved for the benefit of both consumers and food industries. New product formulations or revitalization of known cereal bar formulations is important to optimize the cereal bar characteristics or properties in terms of shape, color, appearance, flavor, and texture (Dimic et al., 2013; Samakradhamrongthai et al., 2021). The physical properties and microstructure of baked goods are largely dependent on the ingredients (Pancharoen, 2019). Addition of new ingredients, replacement of existing ones, or changes in processing conditions, can result in either desirable or undesirable changes in sensorial attributes such as texture (Levine, 2018).

Fat is one of the key ingredients in baking products which provides desirable textural properties. Fat reacts with other ingredients to create and mold the texture, mouthfeel, and sensation of the product (Giese, 1996; Stauffer, 1998). It is crucial to understand the critical properties of fat within a baked good product so that the decisions regarding which type of fat should be used can be resolved. Two types of fat that have been widely used in baked goods products are butter and margarine. Butter is often used to balance the flavor, taste, and texture attributes of food (Rapp, 2007). Hence, due to the trend of plant-based food, animal-derived products such as butter are being switched to margarine, which is driven by both environmental and health reasons (Tso, 2021). In terms of health reasons, butter containing saturated fat can lead to cardiovascular diseases. On the contrary, margarine contains unsaturated fat and is made from vegetable oils, so it contains no cholesterol, as advised by health awareness consumers and health professionals (Jacqueline, 2013; Zeratsky, 2022). In terms of pricing and cost of food production, butter is highly priced for its rich flavor attributes (Krause, 2007). On the other hand, margarine is known by consumers as a cheaper alternative to butter for use in cooking and food preparation. The price, taste, spreadability, and convenience factors have made margarine a dietary staple in many countries around the world (Morris, 2003). Margarines are developed in a way that establishes desirable attributes such as the expected crispness, taste, form, etc. Furthermore, the interest in margarine is escalating due to the plant-based trend, where a wide-range use of margarine in plant-based food is being applied (BBM, 2020).

In terms of sensory attributes, the majority of consumers ranked taste as the most important characteristic influencing their purchase intent and acceptability of any product, which has the highest influence as far as market success of the product is concerned (Asefa, 2017; Bower, 2007). When food is consumed, its taste presents the consumer with important information about its quality and subsequent acceptability (Maina, 2018). The characteristic ranked as most desirable after taste is texture. Texture is one of the key attributes in food, which is used to define product quality and acceptability (Levine, 2018).

Texture is a very important quality attribute in most food products since it affects the sensory perception, acceptance, stability, and nutritional value of the food. Texture is a quality that can be felt by the hands, fingers, tongue, or the palate of the teeth. Texture does not involve the smell and taste sensations (Arifin, 2009). Texture is often considered neglected or termed the "forgotten attribute" in comparison to flavor (Guinard, 1996). Very few studies have been dedicated to investigating the textural characteristics of cereal snack bars (Kim, 2009). Another important factor that affects the consumer's liking for food products is aroma. Food aroma creates a crucial sensory signal and a critical component of flavor perception, thus shaping the way people experience taste and texture. Aroma serves as a signal to indicate whether a food is edible before the consumer even sees the food. The aroma of the food can stimulate salivation, enhance prospects of consumption, and increase appetite. These effects increase the chances of a food product's acceptability (Maina, 2018). Hence, the sensory cues based on food's aroma, taste, and texture are extremely critical before, during and after eating (Kostyra, 2016).

Previous studies have discussed about the health benefits between saturated and unsaturated fats of butter and margarine and nutritional evaluation of the cereal bars, where some of them citing the ingredients of cereal bars, such as the different grains and the functional benefits of each of them (Mamat, 2012; Sharma, 2014; Tso, 2021; Zeratsky, 2022). However, no studies have ever examined the substitution of butter with margarine in the application of cereal bars, and how the sensorial attributes are affected in terms of texture, taste, and aroma of the cereal bars. The closest related to our study is referring to the effect of fat types on the structural and textural properties of dough and semi-sweet biscuits (Mamat, 2012). As mentioned previously, fat is one of the key ingredients in baking products, which provides desirable textural, taste, and aromatic properties. Fat reacts with other ingredients to create and mold texture, mouthfeel, and sensation of the product (Giese, 1996; Stauffer 1998). Butter and margarine might have different impacts on the sensory properties, and these properties underlies preference and behavior of the consumers towards food products such as cereal bars. Therefore, the aim of this research is to study the effect of butter substitution with margarine in sorbitol and sucrose cereal bar towards consumer preference on taste, texture, and aroma. Four types of samples were examined: sucrose-butter, sucrose-margarine, sorbitol-butter, and sorbitol-margarine. A nine-point hedonic scale was carried out to describe the attributes and to evaluate the degree of acceptance for the texture, aroma, and taste. Furthermore, a triangle test was used to determine whether a sensory difference exists between two samples of cereal bars.

MATERIAL AND METHOD

The object of this experimental study was cereal bar (CB) base with four different formulas using the combinations of the following ingredients: sucrose-butter, sucrose-margarine, sorbitol-butter, and sorbitol-margarine. This study focuses on assessing respondents' perceptions of texture, taste, and aroma. During the sensory evaluation, there is no repetition in making the formulation, as the oven capacity is available for all the CB bases of each type to be baked at the same time. The preliminary sessions, however, were conducted prior to sensory evaluation to validate the procedure, ingredients, and replicability. Participants were recruited mostly from Institut Bio Scientia Internasional Indonesia and were chosen according to their willingness and availability. Figure 1 illustrates the experimental design of the study.

Formulation of CB bases

The CB bases were prepared using a combination of puffed cereals, fat (either butter or margarine), sweeteners, and binding agents. The main ingredient, puffed cereal, was a blend of rice flour, corn CGV,

wheat flour, salt, and other components. Two types of fats were utilized and compared: Butter (Pure New Zealand Butter Anchor) and margarine (Master Gioia Margarine). The sweeteners used were sucrose and sorbitol, with the amount of sorbitol being adjusted to match the relative sweetness of sucrose. This causes the total weight of the formula between sucrose and sorbitol to differ, hence the difference in ingredients percentage. Xanthan gum, presented at a concentration of 1%, was employed as the binding agent. Xanthan gum (1%) required proper hydration prior to usage. Detailed breakdown of the formulation of the cereal bar base samples is shown in Table 1. There are four prototypes used in this experiment: (i) formula 1, utilizing butter and sucrose, (ii) formula 2, employing margarine and sucrose, (iii) formula 3, combining butter and sorbitol, (iv) formula 4, using margarine and sorbitol.

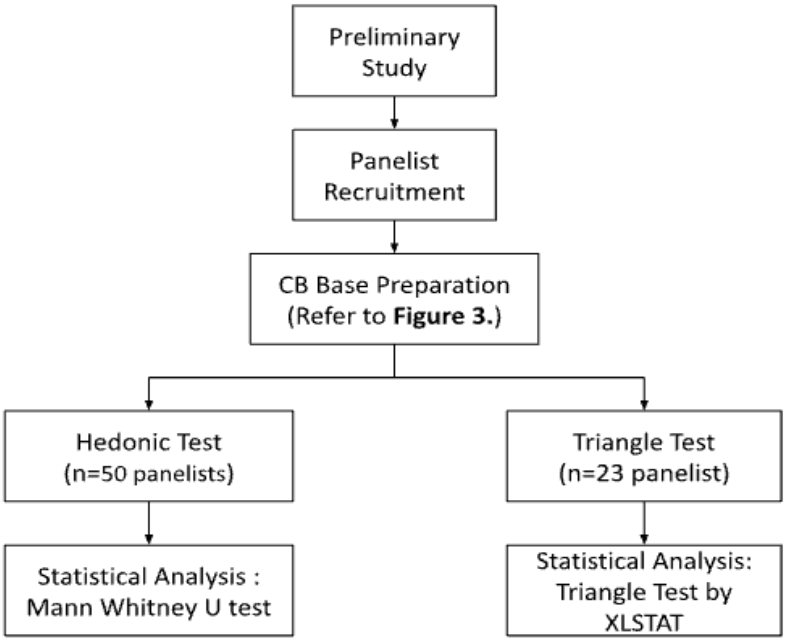

Figure 1. Experimental design.

Table 1. Formulation of CB bases.

Formula / Ingredients	F1*	F2	F3*	F4
Puffed Cereals	52.24%	52.24%	47.51%	47.51%
Butter	10.45 %	-	9.50 %	-
Margarine	-	10.45%	-	9.50 %
Sucrose	14.92%	14.92%	-	-
Sorbitol	-	-	22.63%	22.63%
Xanthan Gum (1%)	22.39 %	22.39%	20.36%	20.36%
% per total gram	67 gr	67 gr	73.67 gr	73.67 gr

*Note: *control groups. F1: Butter-Sucrose, F2: Margarine-Sucrose, F3: Butter-Sorbitol, F4: Margarine-Sorbitol.

Cereal bar preparation

The cereal bars were developed in the pilot plant laboratory of Institut Bio Scientia Internasional Indonesia, Jakarta, Indonesia. Materials and supplies were procured from local markets in North Jakarta or online stores. The process of preparing the cereal bar base involved hydrating xanthan gum first, as illustrated in Figure 2.

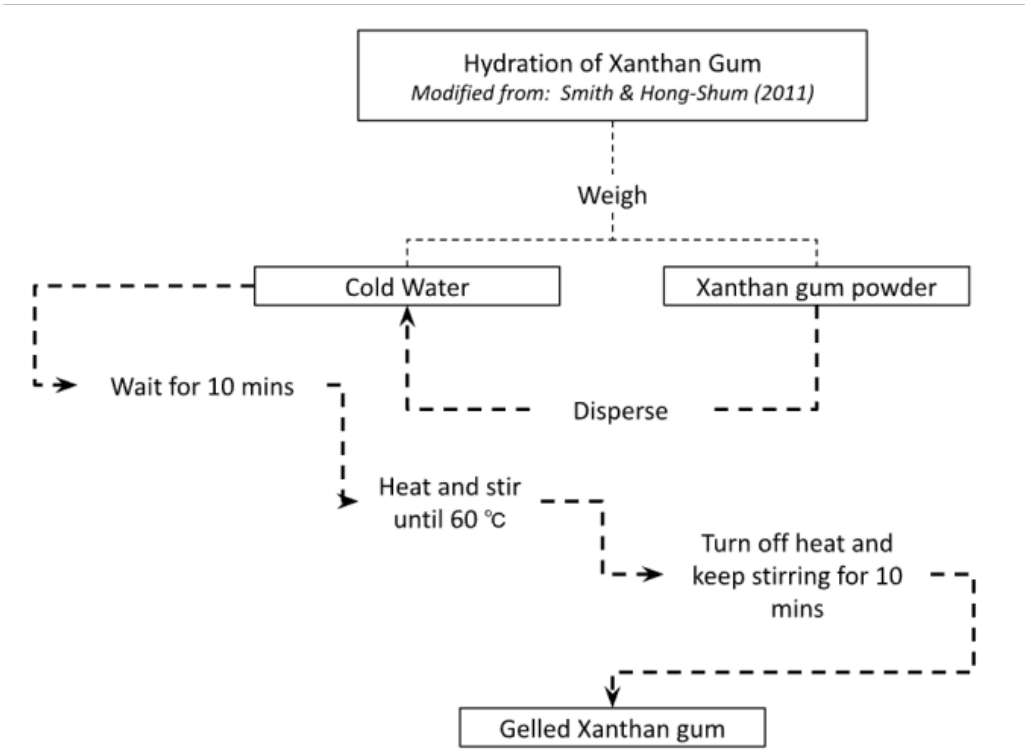

Figure 2. Hydration of xanthan gum.

The hydrated xanthan gum (1%) was then incorporated into the entire process as a gel form, as shown in Figure 3. The dimensions of the cereal bar base were 3 cm x 3 cm x 1.5 cm, deliberately made bite-sized to prevent sensory fatigue during the sensory evaluation. It is recommended to coat the baking pan with butter or margarine based on the desired formulation and to avoid using baking paper. Additionally, freezing and demolding steps were introduced due to the unavailability of heat-resistant molds.

Sensory evaluation

The panelists for the sensory evaluations consisted of students, lecturers, and staff members from Indonesia Institute for Life Sciences in Jakarta, Indonesia. The inclusion criteria for the panelists were based on their availability, willingness to participate, and the absence of health conditions that could potentially affect their evaluations. Two types of sensory tests were conducted: a nine-point hedonic test and a triangle test. All of the tests were done in a single take from each participant to gather their spontaneous reactions.

The purpose of the nine-point hedonic test was to evaluate the panelists' preferences for the CB base samples. It is simple, rapid, and easy to understand from the panelists' point of view. A total of 50 panelists were involved in this test, evaluating the taste, aroma, firmness, and chewiness of each sample on

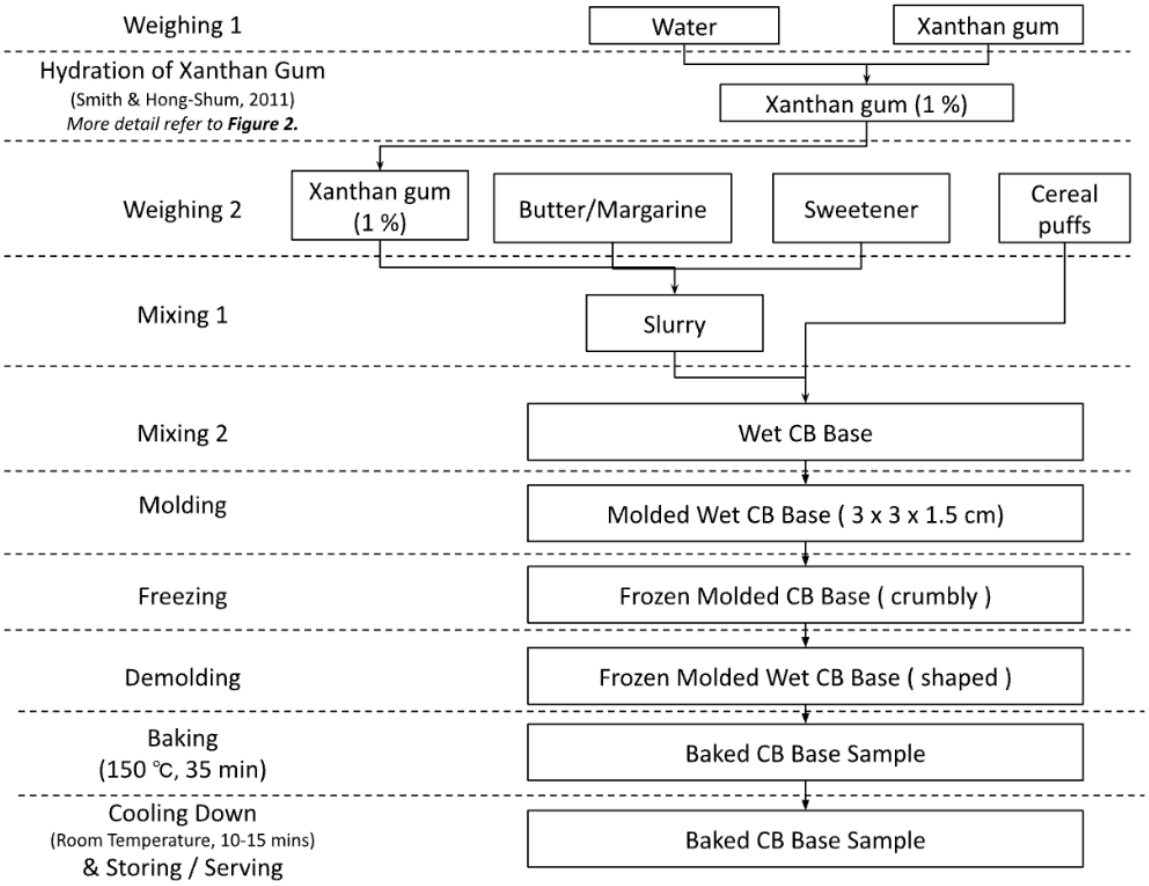

Figure 3. CB base sample preparation.

a nine-point scale. At the conclusion of the test, the panelists were asked to choose their “most favorite” and “least favorite” samples among the four samples provided. Additionally, the panelists were also requested to provide a reason for their choices.

The triangle test, on the other hand, was designed to detect any noticeable differences resulting from the substitution of butter with margarine. In this test, 23 panelists participated. The panelists were tasked with identifying the one different sample between the three provided samples. There were two sets of triangle tests: One to differentiate between sorbitol-margarine and sorbitol-butter CB base, and the other to determine the difference between sucrose-margarine and sucrose-butter CB bases.

Statistical analysis

The sensorial preference analysis was performed using IBM SPSS Statistics 26 version. Mann Whitney U test was utilized to find significant difference in each attribute preference of samples upon fat substitution (firmness, chewiness, aroma, and taste): (i) butter-sorbitol CB base and margarine-sorbitol CB base; and (ii) butter-sucrose CB base and margarine-sucrose CB base. The test was chosen as an option in the case of a non-parametric data set. The triangle test results were processed using XLSTAT 2023 for each set: (i) margarine-sucrose and butter-sucrose CB base; and (ii) butter-sorbitol and margarine-sorbitol CB base.

RESULTS

Preference of CB sensorial attributes

The effect of fat substitution towards preference of sucrose and sorbitol CB base sensory attributes using Mann Whitney U test is presented in Table 2. The results show that the fat substitution from butter to margarine in the sucrose CB base sample had a significant difference ($p<0.05$) in the liking rate of the firmness, chewiness, aroma, and taste of CB samples. While for the sorbitol CB base sample, the only attribute that had a significant difference ($p<0.05$) was the panelists' preference on the chewiness.

Table 2. Effect of fat substitution in sucrose CB base and sorbitol CB base using Mann-Whitney U.

	Fat Substitution	
	Sucrose	**Sorbitol**
Attributes	**p-value**	**p-value**
Firmness	<0.001*	0.118
Chewiness	<0.001*	0.005*
Aroma	<0.001*	0.761
Taste	0.001*	0.163

*Note: *significant difference (p-value < α; α= 0.05).

According to the additional ranking questions (proportion detail refer on Figure 4), the "most favorite" samples were butter-sorbitol and margarine-sucrose CB base with similar proportions, which was 38% of the participants (n=50). On the other hand, the "least favorite" sample was butter-sucrose, with 64% of the panelists (n=50) choosing the samples. Based on the comment or reasonings section, 95% of panelists that chose butter-sorbitol CB as the best sample complimented that the sample had the most appropriate firmness and chewiness among all the other samples provided. Moreover, the sample had the best aroma and taste was also included in several comments. On the other hand, panelists that chose margarine-sucrose as their favorite sample, pointed out especially on its favorable crunchiness attribute as well as best taste and aroma. The least favorite sample was butter-sucrose, as it was considered to have an unpleasant texture such as "too hard" or "too firm" or "needed much effort to bite through." There were also a few comments in terms of taste and aroma that mentioned the sample (butter-sucrose) lacking sweetness and not smelling as good as the other three samples.

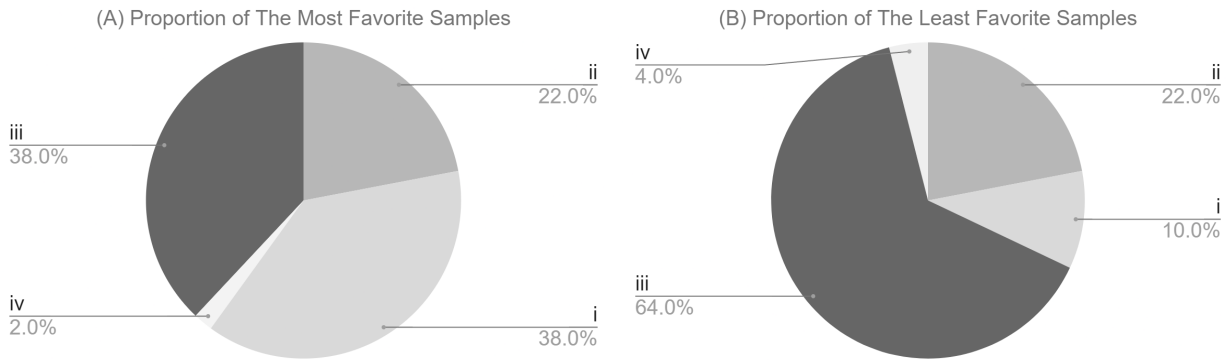

Figure 4. Answer proportion of 9-point hedonic additional questions (ranking questions: "Most Favorite" and "Least Favorite" samples). (A) Proportion of the most favorite samples; (B) Proportion of the least favorite samples. i: Butter-sucrose; ii: Margarine-sucrose; iii: Butter-sorbitol; iv: Margarine-sorbitol.

Table 3. Preference value of CB base sensorial attributes (firmness, chewiness, aroma, and taste) according to the nine-point hedonic test.

Formulations	Sensorial Attributes Preferences Value (Hedonic)			
	Firmness	**Chewiness**	**Aroma**	**Taste**
F1	3.60 ± 2.18	3.22 ± 1.95	5.8 ± 1.54	5.66 ± 1.81
F2	5.54 ± 1.86	5.54 ± 1.93	6.98 ± 1.36	6.8 ± 1.44
F3	6.30 ± 1.83	6.66 ± 1.56	6.42 ± 1.42	6.44 ± 1.5
F4	5.70 ± 2.04	5.52 ± 2.01	6.3 ± 1.43	6.00 ± 1.54

F1: Butter-Sucrose, F2: Margarine-Sucrose, F3: Butter-Sorbitol, F4: Margarine-Sorbitol.

In the study, Table 3 presented the mean score of liking rate per sensorial attributes based on a nine-point hedonic scale. The highest liking for firmness and chewiness was observed in the butter-sorbitol samples. These samples received positive evaluations for their desirable textural characteristics, displaying an appropriate level of firmness and chewiness. On the other hand, the highest liking for aroma and taste was found in the margarine-sucrose samples. Participants favored the distinct aroma and taste profile associated with the use of margarine in the sucrose CB. Conversely, the butter-sucrose samples received the lowest preference ratings across all four sensory attributes. This indicated that participants were less satisfied with the texture, aroma, and taste of these samples compared to the other variations.

Detection of fat substitution in CB

The p-values for both sets of triangles indicated a statistically significant difference ($p<0.05$). To be specific, the difference between sorbitol CB with margarine and sorbitol CB with butter was both significant and detectable. This observation holds true for the comparison between sucrose CB with margarine and sucrose CB with butter as well.

Table 4. Discrimination test (triangle test) statistical analysis result.

	Margarine and Butter	
Triangle Test	**Set A: Sorbitol**	**Set B: Sucrose**
p-value*	0.001*	0.012*

Note : *significantly different (p-value < α; α= 0.05).

DISCUSSION

Preference in sensorial properties of CB

Previous studies have highlighted the significant impact of ingredients such as butter and margarine on the sensory characteristics of baked goods, particularly in terms of texture and other sensorial attributes. Nafisah (2022) noted that the use of butter and margarine in baking greatly influences the aroma, taste, and texture of the final product. Margarine, developed as an alternative for butter, aims to mimic the taste and functionality of real butter (Mecmesin, 2023). However, due to differences in ingredients and manufacturing processes, creating an identical substitute product becomes challenging for margarine processors (Mecmesin, 2023).

Texture is a crucial aspect in baked goods, often used as a key parameter for comparison. Thus, achieving similar textural properties along with consistent flavor and color between butter and margarine is important (Mecmesin, 2023). A sensory study conducted by Bower & Whitten (2007) emphasized that taste is the primary consideration for the purchasability of a product, followed by texture. Taste has an interlocking relation with aroma, hence the assessment of both perceptions is related to each other (Kakutani et al., 2017).

In the context of cereal bars (CB), firmness and chewiness are considered representative attributes of texture, since they significantly impact the snacking experience and satisfaction of consumers (Tramujas et al., 2021). Firmness refers to the hardness or resistance to pressure exhibited by a food product. Chewiness, on the other hand, describes the effort required for mastication or breaking down of the food until swallowing. Both firmness and chewiness contribute to the sensory experience and directly influence taste perception and customer satisfaction (Cecchi et al., 2019). Hence, these attributes play a vital role in defining the texture quality of food items and significantly impact consumer preference.

In summary, taste, aroma, and texture, particularly firmness and chewiness, are important attributes considered by consumers that contribute to their acceptance and preference towards food products. These four sensorial attributes are influenced by the ingredients, such as fat components (e.g. margarine and butter).

Butter-sucrose CB base

Based on the result, butter-sucrose CB samples had the least preference value of firmness and chewiness. According to Tramujas et al. (2021), a desirable cereal bar exhibits a firm texture without requiring excessive effort to chew. The butter-based sucrose CB, however, exhibited an overly firm texture, which resulted in it being the least favorite sample among the participants. Moreover, the samples also had the lowest liking rates in terms of taste and aroma. It is possible that the liking rate of taste and aroma of the butter-sucrose sample was affected by the unpleasant texture, which was considered extremely firm and too hard to bite. Overwhelming unpreferable texture attributes may lower the rates of the rest of attributes. According to previous studies, food texture acts as the main driver of food rejection, acceptability, and purchasability (Chen & Rosenthal, 2015; Lu & Cen, 2013).

Butter-sorbitol CB base

Preference in terms of firmness and chewiness were the dominant reasons for the butter-sorbitol CB samples to become the “most favorite” sample along with margarine-sucrose. Several panelists added comments regarding the samples having the best aroma and taste as well. However, as the segmentation of liking in butter-sorbitol and margarine-sucrose as “most favorite” samples were based on texture, this finding could potentially indicate the presence of different preference groups in terms of CB texture.

Margarine-sucrose CB base

According to the results, the substitution of butter with margarine in sucrose CB has been shown to significantly ($p<0.05$) affect preference of various attributes, including firmness, chewiness, taste, and aroma. In this study, the sucrose CB made with margarine received higher liking rates in terms of firmness, chewiness, taste, and aroma compared to the samples made with butter. The substitution of butter with margarine proved to be beneficial in improving the liking rate of the sucrose CB on the four sensorial attributes, especially firmness and chewiness. Margarine, which typically contains more unsaturated fat compared to butter, contributed to the desired firmness of the food product, as it can maintain a semisolid consistency at room and refrigeration temperatures (Li et al., 2022). By adjusting the firmness of sucrose CB to a more appropriate level, margarine may enhance the liking rate among consumers.

In addition, most of the panelists complimented the margarine-sucrose CB base samples specifically for its crunchiness. Crunchiness itself can be defined as a series of fracturing sensation followed by low-pitched sound from the fractures (Tunick et al., 2013). Several studies have pointed out this attribute as desirable for CB (Bower & Whitten, 2007; Yadav & Bhatnagar, 2015; Samakradhamrongthai et al., 2021; Ishak et al., 2022). However, its specific assessment poses several challenges during the implementation (Chauvin et al., 2008; Tunick et al., 2013). In this study, the panelists' reasoning for choosing the "most favorite" sample allowed for the consideration of this complex attribute. Consistent with previous studies, crunchiness was found to be a desirable attribute of cereal bars, and the margarine-sucrose CB base samples demonstrated favorable crunchiness.

The CB taste and aroma were very important in determining the liking rates. Aroma and taste are mutually dependent on one another and affect each other's experiences, thus, their preference is commonly related to each other (Kakutani et al., 2017). When compared to the other three samples, the margarine-sucrose CB base got the highest score in terms of taste and aroma. Sucrose undergo maillard reaction and caramelization during the heat exposure (Kocadağlı & Gökmen, 2019), contributing to the hints of desirable taste and aroma of the food product. Polyols, such as sorbitol, do not participate in such reactions (Petković, 2019). Hence, taste and aroma preference using polyols scored slightly lower than sucrose CB.

Margarine-sorbitol CB base

The substitution of butter with margarine in sorbitol CB base has been found to lead to a significant difference ($p<0.05$) in the preference for the chewiness attribute. The use of margarines in sorbitol CB lowers the preference for the evaluated sensory attributes. Similar to Martinez-Cervera (2014), the use of sorbitol in baked goods produces a less firm texture compared to using sucrose. This is due to sorbitol's ability to retain more moisture, effectively maintaining a proper balance and preventing the baked goods from drying out (Ghosh & Sudha, 2012).

Fat substitution detection

The triangle test conducted in the study aimed to determine the detectability status of butter substitution within the CB. The results of the study indicated that the substitution was indeed detectable ($p<0.05$). The detectability of the substitution between margarine and butter in a food product can be attributed to several factors. These factors include differences in flavor, texture, and aroma profiles between margarine and butter.

Margarine is typically made from vegetable oils, often including additives to mimic the taste and texture of butter (Mecmesin, 2023). However, the distinct characteristics of butter, such as its specific fatty acid composition and unique flavor compounds, present challenges to fully replicate (Krause et al., 2007). The ratio of fat and emulsifier in margarine has been observed to influence taste and aroma outcomes, with higher-fat margarine exhibiting better perception of buttery aroma and taste, while margarine with lower fat content is associated with improved creaminess perception (Dadali & Elmaci, 2019). Furthermore, the natural characteristics of butter have yet to be completely captured in margarine. Lactones, compounds responsible for giving butter its fruity, creamy, and buttery flavors, is one such example (Demirkol et al., 2016). Yoshinaga et al. (2019) found that upon heating, butter showed an increased lactone content, whereas margarine did not exhibit the same reaction.

A study by Nafisah (2022) also demonstrated the use of butter and margarine leading to different end sensory characteristics in a food product. The study stated that cake, cookies, and pastry made with butter provided distinct flavor, texture, and aroma compared to those baked with margarine; products

made with butter have a milky scent, tastier, or crumblier, and products made of margarine are more stable and firmer.

Implications and limitation

The research on butter and margarine substitution in cereal bars (CB) provides valuable insights into the effects of these substitutions. According to the hedonic result, it is possible that the combination of sorbitol with butter or sucrose with margarine is popular because the resulting texture balances out the characteristics of the fat, resulting in the most favorable and appropriate sensorial characteristics. While conducting the study, it is important to consider certain factors that may contribute to variations in results and outcomes.

The research utilized a specific brand of butter and margarine, offering a focused analysis of their impact. Further investigations can explore different margarine brands, providing opportunities to uncover additional nuances and variations in sensory attributes. By exploring a wider range of products, a more comprehensive understanding of the potential benefits of margarine substitution can be achieved.

It is worth noting that sensory acceptability and purchasability can vary among individuals due to their unique preferences and sensitivities. The study's focus on specific attributes allows for an in-depth analysis of the effects of butter and margarine substitution, providing valuable insights into their sensory impact. Furthermore, during the replication of the CB base, it is essential to consider various factors that can influence slight variations in the final product. These factors include resource availability, raw ingredient variations, equipment performance, and storage conditions.

CONCLUSION

There are significant differences ($p<0.05$) that were observed in the sucrose CB preferences for firmness, chewiness, taste, and aroma when the fat content was substituted from butter to margarine. However, the only significant difference in preference was found in the chewiness attribute with the sorbitol CB base. Among the samples tested, both margarine-sucrose and butter-sorbitol CB were the “most favorite” samples mainly due to its crunchy characteristics and appropriate firm-chewy texture. The study also found that the substitution of butter with margarine was still detectable ($p<0.05$), suggesting that adjustments should be made when using margarine as a substitute in existing marketed products. However, it is worth noting that depending on the choice of sweetener used, the substitution could potentially lead to an improvement in the overall liking rate. For future research, it is recommended to explore further different characteristics and profile of the butter replacer in terms of production method, raw ingredients, total fat content, and multiple different levels of margarine and butter in order to cover a wider range of data.

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