Sensory profile analysis of steamed brownies using Quantitative Descriptive Analysis (QDA)

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Abstract. Brownies are popular cakes made of some basic ingredients such as chocolate, eggs, butter, sugar, flour, salt, and vanilla extract by either baking or steaming. This study aims to explore and evaluate the sensory properties of steamed brownies produced by small-medium enterprises in Surakarta. It used the quantitative descriptive analysis (QDA) method through trained panelists. Moreover, this analysis was carried out in several phases. They include the selection and training of panelists, conducting focus group discussion (FGD) and sensory profiling test. During the first stage, 15 panelists were selected, while at the FGD phase, 5 sensory attributes including color, aroma, taste, softness and moist, were confirmed for describing the sensory quality of brownies. Finally, the steamed brownies were dominated by the attributes of sweet, bitter, burnt chocolate, mocha, salty, margarine and milk powder.

Keywords: QDA, sensory profile, steamed brownies, panelist training

1. Introduction

Brownies were first introduced to America in 1897, and have become widespread and popular in most countries including Indonesia [1]. They are a type of solid chocolate cake made from wheat flour, eggs, fat, sugar, and cooking chocolate [2]. Based on cooking method, brownies are divided into two types, namely steamed and baked brownies [3]. In Indonesia, steamed brownies are preferred as the process of preparing them adds moisture to the dough, making them softer than their baked counterpart [4]. According to Putri et al., [5] steamed brownies are sweet with a strong chocolate aroma, have a dark brown color, a soft texture, and are solid in shape not fluffy.

Steamed brownies are mostly sold in the city of Surakarta (Indonesia), by a large food industry and small medium enterprises (SME). Despite this, the sensory profile of these brownies has never been evaluated. A preliminary survey conducted to investigate consumers at a SME in Surakarta revealed that the steamed brownies at the SME had a less dense texture and a higher sweetness than normal. At some point, these characteristics make the product less competitive in the market, therefore, its characteristics have to be improved. Furthermore, describing and evaluating the sensory profile of a product could be used to determine properties that need to be improved based on customers expectations.
Quantitative descriptive analysis (QDA) is a method that is used to determine a food product's specific sensory profile. Furthermore, the performance of QDA relies on the panelists' ability to evaluate the specific attributes of the product by quantitively measuring, describing, and analyzing them using the statistical tools [6]. Panelist selection, training, language development methods, scoring of samples, and processing of statistically obtained data are important stages in this method [7]. Research implementing QDA methods have been extensively done for many types of food products, such as muffins [8], sweet soy sauce [9], mayonnaise [10], local rice [11], instant noodles [12], rendang [13], burger [14], smoked fish [15], and green tea [16]. Therefore, understanding the sensory profile of steam brownies produced by SMEs in Surakarta would be beneficial to improving the quality of their products.

The statistical tools used to analyze data were ANOVA and Principal Component Analysis (PCA). ANOVA was used to assess sample attributes as well as the panelists' performance [17]. Meanwhile, the PCA was used to construct the correlation matrix meant for analyzing the relationship between main components and attributes given by the panelists [18]. Furthermore, the PCA result is also used for mapping the sensory characteristics of the product, as some similar studies have been done [14, 15]. This information is essential for the brownie producer to evaluate their product and compare it to that of competitors. Therefore, this study aims to investigate the sensory profile of steamed brownies produced by SME in Surakarta using quantitative descriptive analysis (QDA).

2. Methods
This study was carried out through the consecutive steps of panelist selection and training, focus group discussion (FGD), qualitative and quantitative analysis. Panelist selection was carried out to choose individuals that would participate in the QDA. The steps involved in panelist selection are filling out the prescreening questionnaire, acuity test, and personal interview [19]. Focus Group Discussion (FGD) was conducted to determine the sensory attributes of the original steamed brownie product, introduce and determine the reference for the QDA, and evaluate the intensity of the reference. Furthermore, participants involved in the FGD were those selected in previous stages such as the employees of brownie SMEs in Surakarta and students from the Dept. of Food Science and Technology, Universitas Sebelas Maret. The FGD is led by a panel leader or moderator which acted as the principal investigator of this research. The panelist training was conducted to improve their ability to consistently evaluate the sensory characteristics of the brownies. Furthermore, the training was carried out using a line scale at the attributes of color, aroma, taste, softness and mildness. Qualitative analysis aimed to obtain a description of the sensory attributes of the brownies and it involved all of the trained panelists and a moderator. Consequently, the analysis was also done to determine the intensity of the sensory attributes of all samples using an unstructured 15 cm line scale where the far left and right indicated “extremely weak” and “extremely strong” respectively. Within the line, an indicator was provided as reference. The data was presented in the form of a table and diagram. Subsequently, it was statistically analyzed using ANOVA with SPSS 26 to obtain any significant difference (α=0.05) and Principal Component Analysis with XL STAT software.

3. Result and Discussion
3.1 Panelist selection, FGD and panelist training
Panelist selection was conducted in 3 weeks. The first step was the pre-screening using a questionnaire with Google form. Forty two out of 58 participants were selected based on the following parameters: (1) Available to do training and analysis within the scheduled timeframe; (2) did not have diabetes, hypoglycemia, allergy, mouth and tooth problems and respiratory disorder; (3) possess sufficient knowledge on brownies; and (4) could correctly answer 50% of the given questions. The 42 panelists then performed an acuity test to identify basic taste and aroma, a triangle test, an Ishihara test, and
texture analysis using the rating test method. Based on the results of this selection step, 38 panelists were able to identify 100% of tested taste and 50% of tested aroma. The triangle test was conducted 12 times with a solution containing a mixture of monosodium glutamate and slat, and 25 panelists were able to correctly answer 50% of the questions. In the Ishihara test, 25 panelists were selected based on their ability to correctly pass at least 13 out of 24 plates of color evaluation. In the texture evaluation, 20 panelists were able to properly answer more than 50% of the questions. Finally, a deep personal interview was conducted for each panelist to evaluate their commitment and ability to perform sensory analysis, and thus 15 panelists were chosen.

The FGD was conducted three times. The first was carried out to determine the sensory attributes of steamed brownies and 22 were identified. The second FGD was done to introduce a standard solution possessing the aforementioned attributes which was then used by the panelist as the reference. The last FGD was conducted to determine the intensity of the reference (data is not shown and will be available by request). Panelist training was then carried out for about 2 weeks using a rating method and a 15 cm unstructured line scale containing the attributes of taste, aroma, color, softness and mildness. Materials used in this training as the standard included mocha and dark chocolate paste, cocoa powder, chocolate sweetened condensed milk, tiramisu, vanilla, caramel, and mocha flavor, coffee powder, wheat flour, egg, margarine, sugar, salt, margarine, milk powder, cream cheese, cheese, sausage, cheese and vanilla cake, and mandarin bread (data about the concentration and intensity used during training is not shown and will be available by request). Panelists were trained until they are consistently able to give scores according to the standard.

3.2 Sensory profile of Steamed Brownie

3.2.1. Taste

Table 1 shows that taste attributes that were dominantly identified in all samples were sweet, sweet and bitter chocolate. Sweet attributes predominantly came from sugar and the chocolate taste came from the chocolate as the two important ingredients of brownies [20]. Figure 1 shows the correlation among taste attributes. Sweet and bitter chocolate attributes were identified to have a correlation level of -0.186, meaning that the higher the sweet intensity, the lower the bitter chocolate. Furthermore, the sweet and sweet chocolate attributes had a positive correlation at a level of 0.575. In Figure 1, it was shown that the data variance was about 65.70% with F1 was at level of 42.5%, while F2 was at level of 23.2%. The brownies samples of 3 and 9 were in the Quadrant 1 with milk powder, mocha, margarine, and salt taste. Meanwhile, those of 10, 1, and 4 were in the Quadrant 3 with sweet and sweet chocolate taste. The brownie samples of 2, 5, and 8 were in the Quadrant 4 with bitter chocolate, burnt chocolate and milk powder.

3.2.2. Aroma

Beside taste, aroma is an important attribute which determines the quality and consumer acceptance of food [21-24]. Table 1 shows that taste attributes that were dominantly identified in the all samples possessed the typical aroma of chocolate paste, and margarine. The chocolate paste, and margarine aroma expectedly came from sugar, chocolate and margarine as the important ingredients of brownies [25].

Figure 1 shows the correlation among aroma attributes. Taste, flavor, and aroma are parameters that were possibly analyzed by PCA because at least two of these attributes were perceived by panelists. However, only two attributes such as the parameters color and texture were perceived, therefore PCA analysis was not possible.
Table 1. Description of sensory attributes based on the result of the qualitative analysis

| Sample Code | Taste and flavor Descriptor | Aroma Descriptor | Color Descriptor | Mildness Descriptor | Softness Descriptor |
|-------------|----------------------------|-----------------|-----------------|--------------------|-------------------|
| 1           | Sweet, Sweet and Bitter Chocolate | Chocolate Pasta, Sweet, Chocolate Sweetened Condensed Milk, Fishy Egg, Margarine | Brown | Mild | Soft |
| 2           | Sweet and Bitter Chocolate, Sweet, and Mocha | Cocoa Powder, Chocolate Pasta, Sweet, Mocha, Coffee, Margarine | Dark Brown | Mild | Soft |
| 3           | Sweet, Burnt Chocolate, Mocha, Salty, Milk Powder, Margarine | Chocolate Pasta, Sweet, Mocha, Vanilla, Margarine | Black | Mild | Slightly dry |
| 4           | Sweet, Sweet and Bitter Chocolate | Cocoa Powder, Sweet, Chocolate Sweetened Condensed Milk, Wheat Flour, Fishy Egg | Dark Brown | Slightly hard | Slightly dry |
| 5           | Sweet, Sweet and Bitter Chocolate, Burnt Chocolate, Milk Powder | Cocoa Powder, Sweet, Wheat Flour, Fishy Egg, Margarine | Dark Brown | Mild | Slightly dry |
| 6           | Sweet, Mocha, Salty, Margarine | Chocolate Pasta, Sweet, Vanilla, Mocha, Wheat Flour, Fishy Egg | Brown | Slightly hard | Slightly dry |
| 7           | Sweet, Salty, Margarine | Chocolate Pasta, Sweet, Wheat Flour, Fishy Egg, Margarine | Dark Brown | Hard | Dry |
| 8           | Sweet, Sweet and Burnt Chocolate, Milk Powder | Cocoa Powder, Chocolate Pasta, Sweet, Chocolate Sweetened Condensed Milk, Fishy Egg | Dark Brown | Mild | Soft |
| 9           | Sweet, Mocha, Milk Powder, Margarine | Chocolate Pasta, Sweet, Caramel, Mocha, Fishy Egg, Margarine | Brown | Slightly hard | Slightly dry |
| 10          | Sweet, Sweet Chocolate, Milk Powder, Margarine | Chocolate Pasta, Sweet, Vanilla, Mocha, Fishy Egg | Dark Brown | Mild | Soft |

Figure 1. Biplot attributes the taste and flavor (A) and aroma (B) of steamed brownie. Active variables are sensory parameters that were observed. Active observations are the brownie samples.

The typical aroma of cocoa powder and chocolate paste had a negative correlation, meaning that an increase in the aroma of cocoa powder intensity leads a decrease in chocolate paste intensity. Meanwhile, typical aroma of sweet and chocolate paste aroma had a positive correlation. In Figure 1, it was shown that the data variance was about 61.86% with F1 at the level of 42.52% and F2 at 19.34%. Quadrant 1 contained the brownie samples of 1 and 2 which had the typical aroma of sweet and condensed milk. The brownie samples of 6, 3, and 10 were also in Quadrant 1. These samples however, possessed the typical aroma of mocha, vanillin and chocolate paste, with the typical aroma of sweet and...
condensed milk. Quadrant 3 which contained the brownie samples of 7 and 9 had the typical aroma of margarine, egg, flour and caramel. Meanwhile the brownie samples of 4, 5 and 8 were in the Quadrant 4 with the typical aroma of cocoa powder.

### 3.2.3. Color

Table 1 demonstrates that color attributes that were dominantly identified in the samples were blackish brown (the brownie samples of 2, 4, 5, 8 and 10) and brown (the brownie samples of 1, 6 and 9). The rests had a dark grayish brown and a brownish black color. Chocolate as the most important ingredient in the brownie plays a significant role in its characteristics [26]. The difference in the brownies color will be determined by the quality of raw materials or the processing method. It has been widely known that the characteristics of the final product are highly affected by the initial quality of raw materials [26, 27, 28]. Table 2 shows that the samples have a significant difference in the parameter of color (p value < 0.05). Therefore, the brownie sample of 5 was significantly different from others. Similar results were found in the samples of 5, 8 and 9. Furthermore, 3 and 7 had the highest color intensity indicating that the color of these brownies tended to be blackish.

### Table 2. The intensity of color, mildness and softness of brownies

| Sample Code | Color     | Mildness   | Softness   |
|-------------|-----------|------------|------------|
| 1           | 4.54 ± 1.22a | 4.16 ± 1.36ab | 3.65 ± 1.00b |
| 2           | 8.99 ± 4.54d | 3.22 ± 1.17c  | 2.73 ± 1.18c  |
| 3           | 11.24 ± 1.03f | 5.18 ± 1.61bc | 9.21 ± 1.28c  |
| 4           | 9.22 ± 1.18f | 9.35 ± 1.54d  | 8.92 ± 0.76e  |
| 5           | 6.44 ± 1.03d | 5.23 ± 0.65bc | 7.64 ± 1.19d  |
| 6           | 3.72 ± 1.27b | 9.63 ± 1.39d  | 8.38 ± 1.14de |
| 7           | 10.98 ± 1.15f | 10.15 ± 1.32d | 10.12 ± 1.12f |
| 8           | 7.74 ± 1.33d  | 5.39 ± 1.41c  | 5.85 ± 1.11c  |
| 9           | 2.40 ± 1.08a  | 9.10 ± 1.32d  | 7.94 ± 1.29d  |
| 10          | 9.66 ± 1.43c  | 5.17 ± 1.08bc | 4.38 ± 1.67b  |

Note: Values followed by different letters show significantly different (p < 0.05) at the same column as tested using the DMRT method.

### 3.2.4. Hardness and smoothness

Table 1 and 2 show that the samples of 1, 2, 3, 5, 8 and 10 were considered soft (low level of hardness), while the those of 4, 6, and 9 were perceived as quite hard (medium level of hardness). Sample 7 was the hardest among all the brownies. The results show that all the brownies have a significant difference in the parameter of softness (p value < 0,05). The difference in the textural properties might be due to the margarine proportion in the brownie’s recipe. This is because margarin has a softening function in brownies [29]. Samples 1, 2, 8, and 10 were considered smooth as indicated by the absence of any particles, lumps and bumps in the product, while 3, 4, 5, 6 and 9 were perceived as slight, coarse and dry (not smooth). In agreement with the result obtained from the softness analysis, the sample of 7 was the most coarse and dry among the samples. Furthermore, the samples had a significant difference in the parameter of smoothness (p value < 0,05). According to Astawan [30], egg and milk powder play a significant role in textural properties of brownies.

### 4. Conclusion

From the qualitative descriptive sensory test, steamed brownie samples in Surakarta have attributes of sweet, sweet, bitter, and burnt chocolate, mocha, salty, margarine and milk powder. The aroma attributes include cocoa powder, chocolate pasta, sweet, vanilla, caramel, mocha, coffee, chocolate sweetened condensed milk, wheat flour, fishy egg, and margarine. The taste attributes that were identified dominantly were sweet, sweet and bitter chocolate while the aroma attributes that were identified were chocolate paste, sweet, and margarine aroma. The 10 samples in this study had significant differences
in the attributes of color, hardness, and softness. Furthermore, chocolate pasta aroma has a positive correlation with sweet aroma.

Acknowledgements

This research was financially supported by Hibah Riset Grup (HRG) PNBP UNS 2020.

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