A Study on Reformulation of Ginger-based Traditional Drink based on Consumer Acceptability and Flavor Preference

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Abstract
This research aimed to reformulate a Ginger-based Traditional Drink (GTD), traditionally consumed in Indonesia based on a consumer acceptance and flavor attribute preference. This study was conducted in Bogor, Indonesia. The research was divided into three steps, i.e. selection of GTD, optimization of the formula of selected GTD by Mixture Design in Design Expert 7.0 software, and final determination of physicochemical properties and acceptability of the optimized GTD. Fishbein and Wilcoxon’s tests were applied as a processor in analyzing the data obtained from questionnaires. The preference study showed that "bajigur" was the most favored GTD in which ginger pungency was found as the most important attribute. The usage of brown sugar, ginger, and coffee as ingredients significantly contributed to the preferences in product color, sweetness, and pungency but not in aroma. The reformulated GTD could be accepted by consumers from varied ethnicities (Batavians, Javanese, Sunatrans, Celebes, and Sundanese), although the majority was still from the Sundanese ethnic (67%). The optimized GTD formula was more preferred than the commercial "bajigur" with the hedonic scores of 3.44 and 1.25, respectively.

Keywords
Traditional Ginger-based Drink; Consumer Acceptance; Sensory; Reformulation; Flavor

Introduction
Ginger (Zingiber officinale Rosc) is a medicinal plant well-known in national, regional, and international market. Its ability to give a trigeminal impact “warm feeling” and the pleasant flavor characteristic are outstanding properties of ginger. Therefore, ginger is widely used as an ingredient in several recipes of Indonesian traditional drinks [1]. Ginger-based drinks have been known since long time ago in Indonesia and spread all over Indonesia with different names such as wedang jahe (ginger tea), bajigur, sekoteng, bandrek, serbat and bir pletok.

Indonesian ginger-based traditional drinks were previously reported to exert antioxidant effects [2]. However, study concerning their consumer preferences is rather scarce; thus, there is clearly a need to conduct a research focusing on identification of acceptability level of ginger-based traditional drinks by consumers. Since sensory attribute of a food is the main factor in determining its acceptability by consumers; hence, the acceptability of the ginger-based traditional drinks should be determined by using sensory test.

Preference and acceptability of food are influenced by intrinsic and extrinsic factors [3], which also affected ginger-based traditional drinks. The use of different ingredients in the drinks according to their origin and various processing parameters may alter their taste and aroma [4]. Moreover, demographic factors, such as social status, experience, knowledge, gender, age, and psychological state also influence sensory acceptability of the consumer [5].

Several researches on ginger-based traditional drinks have been made, which focus mostly on production technology and nutritional content [2], but studies pertaining their sensory acceptability seem to be still limited. Therefore, this research aimed to evaluate the sensory and flavor acceptability of available ginger-base traditional drinks by the consumer; while also observing the role and impact of certain ingredients frequently used in their production to the flavor attributes. Based on current reports, a modified formula of ginger-based traditional drinks will be developed. The available information will be further used as a basis to develop ginger-based traditional drinks according to consumer preference.

Materials and Methods

Materials
Main ingredients included ginger, coconut milk, palm sugar, while other materials used were coffee, salt, and pandanus leaves. These ingredients were purchased in Pasar...
Anyar Bogor, while ginger was obtained from BALITTRO (Indonesian Medicinal and Aromatic Crops Research Institute/Balai Penelitian Tanaman Obat dan Aromatik) Bogor. Different ginger-based traditional drinks, i.e. sekoteng, bandrek, wedang jahe, sarabba and birpletok, were used, whereas commercial bajigur purchased from street vendor in Bogor was regarded as a reference in consumer’s acceptability and preference. The experimental equipments included colorimeter (CR-310 Minolta Chromameter), pH meter (Hanna HI8014), Soxhlet extraction apparatus, distillation apparatus and glassware.

Methods

Preference Analysis of Available Ginger-based Traditional Drinks (GTDs)

Questionnaire design and evaluation: Questionnaire was used as a survey instrument to determine which GTDs would be used in further experiment. The questionnaire included product description and general information of the respondent and contained 2 types of question, i.e. open and close questions. Thus, validity and reliability tests using 30 respondents were carried out to validate the questionnaire prior to use.

Location and respondent selection: The consumer's acceptability and preference test for ginger-based traditional drink (GTD) was conducted in Bogor, Indonesia. Respondents of this study were consumers in Bogor. They were selected using purposive sampling [6], while the eligible respondents for selecting GTD were untrained panelists who consumed GTD at least once in the last two months. Another criterion of the respondents was their ethnic, including Batavians, Javanese, Sumatrans, Borneo/Celebes, and Sundane.

Data collection: Data were collected by survey method [6] for 40 respondents. The type of data collected was primary data from the questionnaire using written interview.

Data analysis: The survey data for each GTD were analyzed to determine the most preferable product, indicated by the highest consumption frequency. The formula in the selected product was then chosen as a basis for the product reformulation.

Fishbein method was used to analyze data, which score of b and e, ranging from -2 to +2. These scores were then calculated according to the utilized attributes. The formula of Fishbein method can be expressed as:

\[ A_i = \sum_{j=1}^{n} b_i e_j \]

Where: \( A_i \) = the attitude toward various GTD product attributes

\( b_i \) = strength of belief about object

\( e_j \) = evaluative aspect of B about attribute i

\( n \) = the number of beliefs

GTD Formula optimization

The reformulated GTD was selected according to questionnaire evaluation in the first stage, focusing on the highest preference score (hedonic) in taste, aroma, and color.

Mixture Design (MD) in Design Expert (DX) 7.0 program was used to optimize formula. The input data required for DX 7.0 were test variables and level range of each variable. The results of preference test were used as response. This step was applied to find the optimum formula through multivariate equation. This multivariate equation was mapped in both contour plot (2-D) and surface plot (3-D).

Analysis of reformulated GTD

Physicochemical analysis: Physicochemical analysis included proximate tests (water, ash, crude fat and protein contents) [7], sugar content analysis by Luff Schoorl method [8], color measurement by Hunter method [9], and pH value.

Sensory evaluation by hedonic-test [10]: Hedonic test was carried out to evaluate sensory characteristics of product in several stages of research, i.e. product optimization, consumer acceptability and preference test. In product optimization, subjects were instructed to taste the samples and rank their aroma and test on the basis of line scale ranging from 0 (dislike extremely) to 8 (like extremely). The respondents were also asked to consume neutralizer prior to taste next sample.

In acceptability and preference test, subjects were instructed to taste samples and rate their aroma and test on the basis of a 5-hedonic scale from 1 = dislike very much to 5 = like very much. The samples (selected GTD and commercial bajigur) were served in a hot condition.

Consumer acceptability and preference test: In this experiment, acceptability and preference test was conducted using survey method [6] combined with sensory (hedonic) test as mentioned above. The collected data included primary data obtained from the questionnaire using a written interview and the result of sensory test.

In this stage, the validated questionnaire was used, with a slight modification in product terminology. The respondents were untrained panelists and consumed GTD at least once in the last two months. The data from acceptance and preference test were then statistically evaluated using Fishbein and Wilcoxon method in SPSS 13.0 software.

Results and Discussion

GTD Preference

Initial preference analysis of GTD was performed to determine a GTD candidate for reformulation. GTD demonstrating the highest score in each category was selected. The category was based on GTD consumption frequency in a week, the amount of GTD consumed in each serving, ethnic difference, and gender. The results showed that bajigur was selected as the most preferable GTD and therefore, its formula was optimized in further step. Based on the four selection categories, bajigur conformed to three selection categories, while sekoteng, birpletok, and sarabba only conformed to two and one selection category, respectively.

The result of total preference percentage (by ignoring the ethnic differentiation) also supported bajigur as the selected GTD to be optimized further. In term of number of respondents, the best preference was attributed to bajigur with 12 respondents (30%), sekoteng and bandrek with each 8 respondents (20%), wedang jahe and sarabba with each 5 respondents (12.5%) and birpletok with 2 respondents (5%).

Fishbein \( (e) \) evaluation score test was also performed in this preference step, enabling to guide better formula optimization. Evaluation score data \( (e) \) of the selected GTD (bajigur) could be seen in Table 1. Two types of product attributes included internal (aroma, umami, sweet, ginger pungency, and color) and external (easy-to-get, served hot). Based on evaluation score data \( (e) \), all attribute scores were positive which indicated that the attributes were considered important for bajigur. Among them, the pungency of ginger with 1.17 \( e \) score was considered as the most important attribute by consumer.

<table>
<thead>
<tr>
<th>No.</th>
<th>Bajigur Attributes</th>
<th>Average evaluation score ((e))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aroma</td>
<td>0.92</td>
</tr>
<tr>
<td>2</td>
<td>Umami taste</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>Sweetness</td>
<td>0.67</td>
</tr>
<tr>
<td>4</td>
<td>Pungency (ginger)</td>
<td>1.17</td>
</tr>
<tr>
<td>5</td>
<td>Color</td>
<td>0.83</td>
</tr>
<tr>
<td>6</td>
<td>Easy-to-get</td>
<td>0.58</td>
</tr>
<tr>
<td>7</td>
<td>Served hot</td>
<td>1.08</td>
</tr>
</tbody>
</table>

Table 1: Evaluation score (e) towards every bajigur’s attributes in ginger-base traditional drink (GTD) preference analysis
Therefore, it is regarded as the main target in optimization. Moreover, based on Table 1, it could be concluded that “served hot” as external attribute should be considered as important criterion for bajigur.

Umami seems to be the least important by consumer for choosing bajigur. Hence, it might be concluded that umami was not very important for the consumer. Therefore, in the next step of this study (consumer acceptability), umami was not included in the test. Another reason for eliminating umami in the following test was to avoid bias since untrained panelists could not distinguish between umami and salty taste.

**GTD Formula Optimization**

GTD formula optimization was performed by mixture design approach using Design Expert 7.0 (DX7) program. Ingredients of GTD, including palm sugar, ginger and coffee, were included as test variables with each ingredient in its own range. Test variables were inserted with certain total amount, while the rest was a total from fixed variables (coconut milk, salt and pandanus leaf). Fixed variables were components whose composition was not changed in the formula.

In addition to optimize pungency flavor; the optimization aimed to produce optimum responses in color, sweetness and aroma. Therefore, palm sugar and coffee are also included as test variables.

Trial design using two repeated measurements without grouping consisted of 10 formulas, while the responses included average preference score of four attributes (response variable), i.e. color, aroma, pungency (ginger) and sweetness. The results of the experiment are presented in Table 2.

As a result, DX7 offered the polynomial model with the best order for each response variable. Table 3 showed summary for attribute regarding order and model. With “prob>F” lower than 0.05 exhibited significant effect on the response [11]. The model with significant difference could be used as prediction model in optimization step. Based on analysis of variance (ANOVA), the resulted model for color, pungency and sweetness responses could be statistically acceptable as prediction model. Model for aroma response was not utilized further due to the negligible effect of palm sugar, ginger, and coffee on aroma.

The optimization stage also aimed not only to minimize efforts or operational cost, but also to maximize desirability [11], ranging from 0 to 1 (least to most desirable, respectively). Desirability at value of approximately 1 indicates greater probability for obtaining desirable response value [12].

Based on the trial design and evaluation data (color, sweetness and pungency score) of 10 GTD formulas, DX7 displayed suggested optimum formulas, in which the best one (formula A) was achieved at desirability of 0.668. Formula A consisted of 80% coconut milk, 11.88% palm sugar, 5% ginger, 1.12% coffee, 1.5% salt and 0.5% pandanus leaves.

The desirability values were largely influenced by component complexity, range of the components, and desired targets. The range of treatment values was relatively not large, while the desired goal was expected to reach approximately 8. Consequently, the desirability value obtained in this study only reached 66.8% (0.668).

**Physico-chemical analysis**

The largest chemical composition in a drink is water. According to Woodroof [13], water composition in a drink was more than 85%. As presented in Table 6, water was the most dominant component (63.05% wb) in optimum formula of GTD, although it was much lower than 85%. This may be due to the fat content and other hygroscopic components present in GTD. Harjadi [14] stated that if the water retention in the sample was high due to any absorption or chemical reaction in the sample, then water loss became low and more difficult in evaporation. This could be caused by the presence of sucrose, glucose, maltose, lactose, and hydrates from ions and polymers which enabled to generate water binding activities [15]. Water and fat content in bajigur mostly come from coconut milk. Hagemair [16] stated that fat content in coconut milk could reach 38%. As exhibited in Table 5, we can state that the drink appears to have normal properties with high fat content and bright yellowish brown in color.

<table>
<thead>
<tr>
<th>No.</th>
<th>Test variable</th>
<th>Response Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>% palm sugar</td>
<td>% Ginger</td>
<td>% Coffee</td>
</tr>
<tr>
<td>1</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>12.5</td>
<td>3.5</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>14</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2: Trial design and average score of ginger-base traditional drink (GTD) sensory attributes

<table>
<thead>
<tr>
<th>No.</th>
<th>Response variable</th>
<th>Model Order</th>
<th>Polynomial model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Color</td>
<td>Quadratic</td>
<td>Y=(-4.69)X_1+75.37X_2-185.73X_3-67.82X_4+314.07X_5-91.15X_6</td>
</tr>
<tr>
<td>2</td>
<td>Aroma</td>
<td>Linear</td>
<td>Y = 3.84X_1 + 7.41X_2 + 2.36X_3</td>
</tr>
<tr>
<td>3</td>
<td>Pungency</td>
<td>Special cubic</td>
<td>Y=60.53X_1+549.65X_2+1246.86X_3+956.88X_4+1896.43X_5+5983.52X_6+096.76X_7+096.76X_8</td>
</tr>
<tr>
<td>4</td>
<td>Sweetness</td>
<td>Quadratic</td>
<td>Y=(-5.73)X_1+52.39X_2-188.85X_3-30.8X_4+225.59X_5-148.72X_6</td>
</tr>
</tbody>
</table>

Table 3: The chosen order model and its response variable
Table 4: Analysis of variance (ANOVA) of model for each response variable

<table>
<thead>
<tr>
<th>Response variable</th>
<th>Model order</th>
<th>Sum of squares</th>
<th>db</th>
<th>Mean square</th>
<th>F test</th>
<th>Prob&gt;F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Quadratic</td>
<td>10.56</td>
<td>5</td>
<td>2.11</td>
<td>8.49</td>
<td>0.0297</td>
<td>Significant</td>
</tr>
<tr>
<td>Aroma</td>
<td>Linier</td>
<td>0.65</td>
<td>2</td>
<td>0.33</td>
<td>1.74</td>
<td>0.2436</td>
<td>Not significant</td>
</tr>
<tr>
<td>Pungency</td>
<td>Special cubic</td>
<td>4.13</td>
<td>6</td>
<td>0.69</td>
<td>8.96</td>
<td>0.0499</td>
<td>Significant</td>
</tr>
<tr>
<td>Sweetness</td>
<td>Quadratic</td>
<td>8.22</td>
<td>5</td>
<td>1.64</td>
<td>22.60</td>
<td>0.0049</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Table 5: Physicochemical analysis result of ginger-base traditional drink (GTD) optimum formula

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameters</th>
<th>Average value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Moisture content (% wet basis)</td>
<td>63.05</td>
</tr>
<tr>
<td>2</td>
<td>Ash content (% wet basis)</td>
<td>0.41</td>
</tr>
<tr>
<td>3</td>
<td>Protein (%)</td>
<td>1.47</td>
</tr>
<tr>
<td>4</td>
<td>Total crude fat (%)</td>
<td>28.32</td>
</tr>
<tr>
<td>5</td>
<td>Sugar content (%)</td>
<td>5.81</td>
</tr>
<tr>
<td>6</td>
<td>pH</td>
<td>5.96</td>
</tr>
</tbody>
</table>

* average value of three repeated measurements

Table 6: Attribute score (A) of respondents to ginger-base traditional drink (GTD) optimum formula

<table>
<thead>
<tr>
<th>Attributes</th>
<th>A (GTD optimum formula)</th>
<th>B (Commercial Bajigur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aroma</td>
<td>0.99</td>
<td>0.58</td>
</tr>
<tr>
<td>Sweetness</td>
<td>0.81</td>
<td>0.34</td>
</tr>
<tr>
<td>Pungency</td>
<td>0.57</td>
<td>0.09</td>
</tr>
<tr>
<td>Color</td>
<td>1.07</td>
<td>0.24</td>
</tr>
<tr>
<td>Total</td>
<td>3.44</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Consumer acceptability and preference test

Profile of respondents: The respondent was randomly selected, although the preferable subjects are from those who experienced consuming bajigur previously. This condition is needed because the GTD formula produced from the modification of bajigur formula.

According to Shepherd and Spark [3], gender is one of the factors influencing one’s preference to certain food product. Based on gender, the respondents consisted of 60 female (60%) and 40 male (40%).

Furthermore, respondent’s age was not decided, considering that bajigur is consumed by wide range of ages (except for infant). In fact, the age of respondents was >15 years old since they are regarded capable of filling out the questionnaire and considered to be able to give comments without external interference. Most respondents consuming bajigur were 36-50 years old (37%), which was slightly higher than other age groups of 20-35 years old (29%), <20 years (26%) and >50 (8%). This results suggested that bajigur consumers were from wide range of age.

Regarding acceptability and preference of bajigur, the result indicated that most respondents consuming bajigur were dominantly from unwork group such as students and housewife (56%), followed by civil servant (16%), employee (14%), entrepreneur (12%), and retired man (2%). Based on monthly expenditure (rupiah per month), the bajigur consumers were classified as follows: <500,000 (29%), 1,000,001-1,500,000 (23%), 500,001-1,000,000 (20%), 1,500,001-2,000,000 (19%) and 2,000,000 (9%). Furthermore, most respondents consumed the drink less than once a week. The result showed that the bajigur consumption frequency at less than once a week was voted by 64% respondents, followed by less than 3 times a week (32%) and 3 times a week (4%). This may be linked with the unified location of the bajigur street vendors because they often moved to other places; therefore, consumers only purchased bajigur when they could find the vendor. This was also supported by the result of survey, demonstrating that 94% of respondents purchased bajigur in street vendors, while others purchased it in supermarket (4%) and small shop or warung (2%).

In case of amount, most respondents (69%) consumed bajigur at less than 250 ml, followed by 250-300 ml (29%) and 301-350 ml (2%).

Based on consumer’s acceptability to reformulated GTD, we noticed that 96% of respondents could accept the modified formula of GTD, while only 4% of respondents did not accept the product. Through direct interview, we found that their unacceptability was due to the changes in taste which are not familiar with their expectation.

The consumer’s acceptability and preference test in Bogor demonstrated that the optimum GTD formula could be accepted by consumers from various ethnics including Batavians, Javanese, Sumatrans, Borneo/Celebes and Sundanese. However, Sundanese seemed to be the biggest consumers (67%). In summary, the consumers of bajigur were female (60%) and their age was 36-50 years old (37%). Furthermore, they were also from non-working consumers (56%) and people with expenditure of <Rp. 500,000 per month (29%). Additionally, 71% of non-working consumers was female.

Fishbein multi-attribute analysis: Table 6 showed the results of Fishbein multi-attribute score (A). The total number of attribute score of each attribute would be a total attribute score. According to [17], the higher total attribute score of a product increased the consumer preference.

Based on Table 6, total attribute score of reformulated GTD (3.44) was higher than commercial bajigur (1.25). It means that respondent preferred the reformulated GTD than the commercial bajigur. The result of this total Fishbein attribute was in accordance with attribute score prediction [response] in formulation optimization step by using DX7. Using DX7, the optimized GTD formula was predicted to produce optimum score in respondent evaluation towards each attribute/response which is suitable with the respondent's desire.

Wilcoxon test: Table 7 showed that Batavians and Borneo/Celebes stated that no difference in preference between the two types of bajigur, reformulated and commercial, either in their aroma, sweetness, pungency (of ginger), color or overall attribute. In the other hand, the Javanese indicated that there was significant difference in their preference to aroma, pungency, color and overall attribute of the two GTDs. Only the sweetness attribute was found to have no difference in preference to both types of GTD.

Similar result was observed in Sundanese group. They seemed to be more familiar with bajigur, since this traditional beverage originated from West Java (Sunda area). The result of Wilcoxon test in Table 7 showed that the preference of all attributes was significantly different, except for aroma.

Regarding to Sumatrans, there was a difference in preference to pungency and overall attributes to both types of GTD, while there was no difference in aroma, sweetness, and color attributes.

These different preferences by ethnic groups strongly indicated the correlation between ethnical culture (or eating habit) and product’s preferences. This was in line with the statement of Cardello [18], finding that sensory properties in food will be processed in the brain, which is influenced by the cultural factor.
Hue of 48.52. GTD optimum formula

Sweetness

Pungency (of ginger)

Color

Overall

Batavians

-

-

-

-

-

-

Javanese

+

-

+

+

-

+

Borneo/Celebes

-

-

-

-

-

-

Sumatrans

-

-

+

-

-

+

+ = Significantly different, - = not significantly different

Table 7: The result of Wilcoxon test for ginger-base traditional drink optimum formula and attributes

Furthermore, most ethnics, except for Javanese, expressed that there was no difference in preference to aroma. This was in accordance with ANOVA prediction in formulation optimization using DX7 program, indicating that changes in components (palm sugar, ginger, and coffee) unaltered the preference of aroma.

The evaluation in ginger pungency attribute showed a reversed result compared to aroma attribute. The pungency preference by most ethnics to both GTD samples was recorded as significant difference. This was supported by the result of Fishbein test (Table 6). The result showed that consumer preference score to pungency of reformulated GTD was much higher (0.57) in comparison with that of commercial bajigur (0.09). This finding also indicated that the optimization was carried out according to respondent preferences.

Conclusion

In this present work, bajigur was found to be the most desirable ginger-based traditional drink by consumers compared to bandrek, sekoteng, bir pletok, wedang jahe, and sarabba. The ginger pungency in bajigur appeared as the most important attribute according to consumer evaluation.

The optimization of GTD formula based on aroma, sweetness, pungency and color produced a reformulated GTD with desirability value of 0.668. It was made of 80% coconut milk, 11.88% palm sugar, 5% ginger, 1.12% coffee, 1.5% salt, and 0.5% pandanus leaves, while its chemical composition was 63.05% moisture, 0.41% ash, 1.47% protein, 28.32% fat, and 5.81% sugar. Physically, the reformulated drink had a pH level of 5.96 and appeared in a range of red color with lightness value of 46.90 and Hue of 48.52. GTD optimum formula could be accepted by consumers from various ethnics (Batavians, Javanese, Borneo/Celebes, Sumatrans and Sundanese). We also found that the greatest percentage of bajigur consumer was Sundanese (67%), while difference in ethnics also influenced preference to each bajigur attributes. The reformulated GTD was more preferred (3.44) by the consumers compared to commercial bajigur (1.25). The reformulation of GTD according to respondent's preference was achieved.

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