Design formula and product of beverages made from Tamarillo fruit (*Solanum betaceum*) and Job’s tears (*Coix lacryma-jobi* L.) using Kano method

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Abstract. Tamarillo fruit and job’s tears contain polyphenol and phytosterol compounds known to encounter hyperlipidemia, so it is potentially used as ingredients to make a beverage product with health benefits. This study aims to obtain the consumer’s desired attribute and formulate the best sensory beverage products from the materials mentioned above. The research methods consist of a survey using Kano questionnaire, formulation, hedonic scale assessment, and economic production counting of the product. The results showed that six attributes could increase consumer satisfaction, including fruit-based drink, herbal-based drink, ready to drink product; has a predominantly fruity taste; low sugar content; and proven to have health benefits. All designed formula has hedonic assessment value as a mean from 4.21 to 5.02 (from 7 scale). Therefore, formula 4 was exhibited as the best product with lower cost compared to commercial products with highest tamarillo content.

1. Introduction

Coronary heart disease is a disease with a high risk of death in Indonesia, which is 26.4% higher than other diseases, even higher than cancer. Coronary heart disease can be caused by hyperlipidemia, which is a condition in which high levels of low-density lipoprotein (LDL) and triglycerides and low levels of high-density lipoprotein (HDL) in the blood [1]. The problems caused by this disease will continue if preventive actions are not taken. One of the preventive actions that can be taken is the consumption of healthy foods. Various functional beverages with antihyperlipidemic benefits have been widely studied, such as kombucha [2] and red yeast rice extract [3]. These beverages reported can reduce total and LDL levels as increase HDL in the blood.

Tamarillo (*Solanum betaceum*) contains polyphenols (flavonoid and anthocyanin) that can restore adipokine regulation in obese patients to reduce the production of triglycerides in adipose tissue. Tamarillo extract in doses of 200-300 mg/kg caused decreased blood LDL cholesterol levels in adult rats [4]. Job’s tears (*Coix lacryma-jobi* L.) are a white seed plant from tropical Asia that has round in shape with a dent on one side. These seeds are generally processed into various products such as porridge, soup, or ground into flour as raw material for cakes. Job’s tears are also processed into beverages such as yimishui (China), yulma cha (Korea), and zhu or dhu (Philippines) [5]. Phytosterols in job’s tears, predominantly β-sitosterol and stigmasterol, have been shown to reduce plasma cholesterol levels, inhibit cholesterol absorption in the intestine, and reduce liver cholesterol levels and bile acid synthesis in mice [6]. From those explanation, tamarillo and job’s tears can be used to develop a beverage product according to consumers’ characteristics. The Kano method shows consumer satisfaction with certain beverage products’ attributes so that the resulting product is under
consumer expectations and desires. The Kano model survey considers how the presence or absence of an attribute can affect consumer's satisfaction. The Kano model survey application is expected to guide to develop the attributes desired by consumers in beverage products and ignore the attributes that do not affect or reduce the level of consumer satisfaction [7].

The problems developed in this study include applying the Kano model in developing beverage product designs and finding ways to obtain beverage product formulas with desired sensory.

2. Methodology
2.1 Kano Survey
The Kano survey was carried out according to [8] with modifications. Before the Kano survey, a preliminary survey was conducted to select respondents appropriate to the Kano questionnaire criteria, particularly people with cholesterol disease or relatives who suffer from cholesterol disease. Subsequently, respondents who meet the criteria are given a Kano questionnaire in the form of paired-questions via Google form. Each question consists of two parts: the beverage product has an attribute (functional question), and the beverage product does not have an attribute (a dysfunctional question). Respondents are given five answer choices, namely (1) like; (2) hope; (3) neutral; (4) tolerant; (5) dislike. The answers to each functional and dysfunctional question were then converted into Kano categories based on the Kano classification table. Next, Kano’s category of each question attribute is determined using Blauth’s formula. The level of customer satisfaction is determined using the satisfaction index (SI) and dissatisfaction index (DI) equations as follows:

\[
SI = \frac{(A+O)}{(A+O+M+I)}
\]

\[
DI = -\frac{(O+M)}{(A+O+M+I)}
\]

where A is the attractive category, O is the one-dimensional category, M is the must-be category, and I is the indifferent category.

2.2 Formulation and organoleptic assessment of beverage
Sample preparation and formulation were carried out before the hedonic assessment. For obtaining job’s tears extract, a 300 g of dried job's tears were soaked overnight. Subsequently, it was drained first and then added with 3 L of water before boiled for one hour while stirring. The cooked job’s tears were filtered to obtain the extract. A 1 kg of fresh tamarillo fruit was peeled from its skin and added with 1 L of water on the other separated container. The mixture was mashed in a blender and filtered. Furthermore, both job’s tears and tamarillo extract were combined into several formulations.

The organoleptic test using a hedonic scale assessment was carried out according to [9] with modifications. The test was carried out in a sensory laboratory with standard lighting and room temperature. Each untrained-panelist was placed in a separate booth and given four shot glasses containing samples. Each shot glass was marked with a different three-digit numeric code. Then, the panelists assessed the taste, aroma, color, and overall of each formula according to the 7-point hedonic scale principle, where 1- very dislikes, 2- dislikes, 3- slightly dislikes, 4- neutral, 5- few likes, 6- likes, and 7- likes very much. Mineral water is provided for the panelists to neutralize the sense of taste so that the accumulation of flavors can be avoided. The sensory test results were statistically analyzed using the One-Way ANOVA with a significance level of 5% and Post-hoc test (Duncan). Moreover, the product production analysis was applied to complete the justification of best product.

3. Result and Discussion
3.1 Kano Survey
Table 1 show the 85 respondents which followed the preliminary survey dominated by age >40 years, and the occupation was dominated as an employee. A total of 24 respondents had cholesterol disease, and 30 respondents had relatives with cholesterol disease so that 54 panelists could participate in the
advanced questions (Table 2) and the Kano model survey. Hyperlipidemia is one of the inherited metabolic disorders caused by mutations of four genes, including the LDL receptor, apolipoprotein B, subtilin convertase proprotein, and LDL receptor adapter protein [10]. Therefore, respondents who have relatives with cholesterol disease were included as respondents because they potentially suffer from cholesterol.

### Table 1. Demographic of respondent on preliminary survey

| Respondent information | Frequency (n=85) |
|------------------------|-----------------|
| Gender                 |                 |
| Male                   | 36              |
| Female                 | 49              |
| Ages (year)            |                 |
| <30                    | 25              |
| 30-40                  | 8               |
| >40                    | 52              |
| Occupation             |                 |
| Employment (private and government sectors) | 46 |
| Unemployment           | 17              |
| Student                | 22              |
| Cholesterol disease status |             |
| Suffered               | 24              |
| Unsuffered             | 31              |
| Have relatives who suffered | 30 |

### Table 2. Response for advanced questions on preliminary survey

| Respondent response | Frequency |
|---------------------|-----------|
| Actions were taken to treat cholesterol disease (can choose more than one option) |          |
| Routine consultation with a doctor | 20 |
| Maintain a diet without treatment | 38 |
| Maintain a diet, with drug treatment | 3 |
| Follow certain therapies | 1 |
| Medicine consumption | 7 |
| Take no action | 1 |
| Consuming other foods/drinks besides drugs to reduce cholesterol |          |
| Yes | 27 |
| No | 27 |
| Types of food/drink to reduce cholesterol |          |
| Fruit-based milk beverages | 3 |
| Vitamin | 2 |
| Herbs beverages | 14 |
| Vegetables and fruits | 5 |
| Meat and fish oils | 1 |

The ten attributes used in the Kano questionnaire were obtained from the preliminary survey (Table 3). The Kano category of each attribute was determined using Blauth's formula, by comparing the number of O + A + M and I + R + Q categories. If O + A + M number was greater than I + R + Q, then the Kano category will be O, A, or M. On the contrary, if the number of O + A + M categories is smaller than the number of I + R + Q, the Kano category used were I, R, and Q.

Attractive categories in this study are found in attributes 1, 3, 4, 9, and 10. The fresh and distinctive taste of the fruit is the main attraction of beverage products with fruit as basic ingredients [11]. In a study conducted by [12], consumers’ attraction to buy fruit-based beverage products is the practicality and price of the product. In research conducted by [13], consumers generally pay attention to the specifications of health claims in a food product to address certain health problems, such as heart disease and obesity. Therefore, respondents in this study were interested in the attributes of beverage products that have been scientifically proven to have the property of lowering blood cholesterol.

The one-dimensional category is in attribute 8. The level of public awareness of healthy behavior is increasing. Beverage products with high sugar content are generally synonymous with unhealthy
drinks because they can affect blood sugar and cause diabetes as well as obesity [14]. Therefore, respondents will feel satisfied if beverage products contain low sugar and vice versa, they will feel disappointed if beverage produced high sugar.

The indifferent categories in this study are found in attributes 2, 5, 6, and 7. In this study, tamarillo was used as raw material. Tamarillo has a distinctive aroma with a deep reddish-purple color and rich in fiber, resulting in a fruit extract with medium consistency[15]. However, the respondents’ perception of the color, aroma, and consistency of tamarillo extract will not affect the beverage products' satisfaction. The herbal ingredients used in this study were job’s tears extract, which did not have a distinctive taste or aroma [16]. Similar to tamarillo, the addition of job’s tears will not affect the respondent’s satisfaction.

### Table 3. Kano's categories for ten attributes

| No. | Attributes                  | Category | A | M | R | O | I | Q | Total |
|-----|-----------------------------|----------|---|---|---|---|---|---|-------|
| 1   | Fruit-based drink           | A        | 28| 3 | 1 | 9 | 9 | 4 | 54    |
| 2   | Herbs-based drink           | I        | 18| 2 | 6 | 6 | 21| 1  | 54    |
| 3   | Ready to drink              | A        | 23| 1 | 1 | 17| 10| 2  | 54    |
| 4   | Predominantly fruit taste   | A        | 26| 3 | 0 | 6 | 17| 2  | 54    |
| 5   | Have a deep color           | I        | 8 | 1 | 8 | 1 | 31| 5  | 54    |
| 6   | Have a distinctive aroma    | I        | 8 | 0 | 10| 3 | 29| 4  | 54    |
| 7   | Moderate level of consistency| I       | 13| 1 | 1 | 2 | 32| 5  | 54    |
| 8   | Low sugar content           | O        | 15| 3 | 2 | 19| 11| 4  | 54    |
| 9   | Proven to have a healthy benefit | A    | 25| 5 | 1 | 18| 4 | 1  | 54    |
| 10  | Affordable price            | A        | 12| 11| 1 | 8 | 21| 1  | 54    |

Notes: A=Attractive, M=Must-be, R=Reverse, O=One dimensional, I=Indifferent, Q=Questionable

### Table 4. Coefficient satisfaction of consumers (CSC)

| No. | Attributes                  | SI   | DI   | Category |
|-----|-----------------------------|------|------|----------|
| 1   | Fruit-based drink           | 0.755| -0.245| A        |
| 2   | Herbs-based drink           | 0.511| -0.17 | A        |
| 3   | Ready to drink              | 0.784| -0.353| A        |
| 4   | Predominantly fruit taste   | 0.615| -0.173| A        |
| 5   | Have a deep color           | 0.219| -0.049| I        |
| 6   | Have a distinctive aroma    | 0.275| -0.075| I        |
| 7   | Moderate level of consistency| 0.313| -0.063| I        |
| 8   | Low sugar content           | 0.708| -0.458| A        |
| 9   | Proven to have a healthy benefit | 0.827| -0.442| A        |
| 10  | Affordable price            | 0.385| -0.365| I        |

The consumer satisfaction coefficient (CSC) in Table 4 can be obtained from the SI and DI calculations for each attribute. There are 6 attributes with high SI values and DI values in the attractive category, including attributes 1, 2, 3, 4, 8, and 9. These attributes can increase customer satisfaction if found in a product, but does not cause disappointment if these attributes are not present in a product [17]. These attributes will be used in developing beverage products because these attributes can increase customer satisfaction. There are 4 attributes with low SI values and low DI values in the indifferent category, including attributes 5, 6, 7, and 10. The low SI and DI values indicate that these attributes do not affect the level of satisfaction or consumer disappointment [18] so that it will not be used to develop beverage products.
3.2 Formulation and organoleptic assessment of beverage

The formulation was made based on the Kano method's attractive category attributes, including attributes 1, 2, 4, and 8, so that four samples were produced (Table 5).

The hedonic scale for each attribute has a mean of 4.21 to 5.02 (Table 6). However, the four formulas' mean hedonic scale did not differ significantly for each attribute (p> 0.05). The insignificant color difference was caused by the four formulas, which were faded red to slightly dark, and the insignificant difference in taste was caused by the accumulation of tannins on the tongue so that it did not make a difference to the panelist's preferences. This phenomenon is referred to as the carry-over effect (COE), sensory refraction caused by sensory sensations leftover from previously sampled samples [19]. The insignificant difference in the aroma was because the four formulas had a dominant of tamarillo aroma. This dominant aroma causes the panelist to experience fatigue in the sense of smell (olfactory fatigue), which is a condition in which the receptors in the sense of smell have adapted to an aroma to not cause new olfactory sensations for the receptors [20]. The insignificant overall hedonic value can be influenced by the halo effect, which affects the attributes given the first assessment can affect the assessment of the next attribute.

| Table 5. Formulation of beverage made from tamarillo and job’s tears |
|---------------------------------------------------------------|
| **Formula** | **Composition** |
|               | **Job’s tears extract (%)** | **Tamarillo extract (%)** | **Mineral water (%)** | **Stevia sweetener (%)** |
| 1             | 39.32                       | 39.32                       | 19.66                     | 1.70                     |
| 2             | 34.40                       | 49.15                       | 14.74                     | 1.70                     |
| 3             | 29.49                       | 58.98                       | 9.83                      | 1.70                     |
| 4             | 24.57                       | 68.81                       | 4.91                      | 1.70                     |

| Table 6. Results of sensory analysis |
|---------------------------------------|
| **Attributes** | **Formula** |
|                | 1          | 2          | 3          | 4          |
| Color         | 4.64 ± 1.265 \(^a\) | 4.71 ± 1.215 \(^a\) | 5.02 ± 1.199 \(^a\) | 4.62 ± 1.577 \(^a\) |
| Aroma         | 4.57 ± 1.451 \(^a\) | 4.43 ± 1.151 \(^a\) | 4.69 ± 1.093 \(^a\) | 4.55 ± 1.152 \(^a\) |
| Taste         | 4.36 ± 1.543 \(^a\) | 4.6 ± 1.415 \(^a\)   | 4.45 ± 1.383 \(^a\)   | 4.21 ± 1.335 \(^a\)   |
| Overall       | 4.5 ± 1.153 \(^a\)    | 4.52 ± 1.153 \(^a\)   | 4.69 ± 1.179 \(^a\)   | 4.33 ± 1.243 \(^a\)   |

Values in mean ± SD. The same row values with the same superscript were not significantly different (p> 0.05).

One-way ANOVA test results from the sensory test with p value> 0.05 (Table 6). These results indicate no significant difference between the fourth formula for each sensory attribute, so that additional analysis is needed to obtain the formula that came by the respondent. In the Kano survey, the "affordable price" attribute falls into an attractive category so that these attributes can attract consumers' attention. Therefore, the calculation of capital per package is carried out to obtain the beverage product formula.

Price is an aspect that can influence consumer purchasing decisions for a product. A price penetration strategy can help a product to compete with similar products. When a product is launched, the price of a product should be lower than existing commercial products so that it can attract consumers' attention to buy and try the new product [21]. The beverage products developed in this study are beverage products with the potential to lower blood cholesterol. Nutritive Benecol® is an existing commercial beverage product in Indonesia with the claim “lowering cholesterol level”. It has a price range of around Rp. 20,000 for 300 ml.

The price calculation (Table 7) of the four formulas show that all formulas have a price below Rp. 20,000, so the prices for the four formulas are still lower than the mentioned product. Formula 4 was chosen as the best beverage product formula because it has a dominant tamarillo content.
4. Conclusion

Based on the study, six attributes can increase consumer satisfaction in designing beverage products, including fruit-based; herbal-based; practical and ready to drink; has a predominantly fruity taste; low in sugar; and proven to have health benefits. Each attribute’s sensory test results do not show a significant difference with the hedonic scale, for each attribute has a mean of 4.21 to 5.02 (neutral-slightly like). Formula 4 exhibited as the best beverage product formula because it has highest tamarillo content with lower price compared to the existing commercial product.

Acknowledgment

This work was supported by Research and Technology Transfer Office, Bina Nusantara University, as a part of Penelitian Terapan Binus entitled “Production of anti-hyperglycemic functional beverages and anti-cholesterol made from tamarillo, sappan wood, red yeast rice, and job’s tears” with contract number: No.025/VR.RTT/IV/2020 and contract date: 6 April 2020

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| Raw materials       | Formula (per 300 ml) |
|---------------------|----------------------|
|                     | 1        | 2        | 3        | 4        |
| Tamarillo           | Rp 1,936 | Rp 2,420 | Rp 2,904 | Rp 3,388 |
| Job's tears         | Rp 1,880 | Rp 1,645 | Rp 1,410 | Rp 1,175 |
| Water               | Rp 340   | Rp 255   | Rp 170   | Rp 85    |
| Stevia sweetener    | Rp 2,000 | Rp 2,000 | Rp 2,000 | Rp 2,000 |
| Packaging           | Rp 5,000 | Rp 5,000 | Rp 5,000 | Rp 5,000 |
| Total               | Rp 11,156| Rp 11,320| Rp 11,484| Rp 11,648|