Design formula and product prototype of beverage made from tamarillo (*Solanum betaceum*) fruit and sappan wood (*Caesalpinia sappan*) using Kano method

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Abstract. People's awareness of healthy foods and beverages has continued to increase. This phenomenon encouraged new product innovation of beverages with a health benefit. To be developed as a functional beverage, tamarillo fruit and sappan wood were well-known for their anti-hyperglycemic functionality. This study aimed to determine the design prototype of a beverage product from tamarillo fruit and sappan wood and determine the best formulation using the Kano method. The product design method was conducted using the Kano method, then the resulted data was used to formulate products. The results revealed four attributes categorized as one-dimensional, five attributes as attractive, one attribute as indifferent and one attribute as must-be. The optimum formula based on hedonic and product cost analysis was formula that consisted of 58.97% tamarillo extract, 9.83% sappan wood extract, 29.49% water, and a 1.7% stevia sweetener. The product prototype has several preferences criteria including ready to drink beverage, liquid-formed, bright-colored, using PET bottle as packaging, the inclusion of halal and nutrition fact label.

Keywords: Product design, tamarillo, sappan wood, beverage, Kano model.

1. Introduction
In recent years, there have been many changes and innovations in soft drink products due to the emergence of consumers' desire to benefit from the drinks they consume. One of the essential benefits that consumers expect is health benefits [1]. In this study, tamarillo fruit (*Solanum betaceum*) was used as a combination material for making functional drinks with secang wood (*Caesalpinia sappan*). Tamarillo fruit or tree tomato is a fruit that is small and has a reddish colour [2]. Tamarillo fruit has an exciting taste and different nutritional content, one of which is anthocyanins, which function as antioxidants [3]. Secang wood is a plant that is well known for its benefits, especially as traditional medicine. Secang wood is traditionally used to treat tuberculosis, diarrhea, dysentery, skin infections, and anemia [4]. Chemical studies of secang wood have shown the isolation of various structural types of phenolic compounds, including xanthones, coumarin, chalcones, flavones, homoisoflavonoids brazilin. Brazilin is the main compound that occurs naturally in secang wood. Brazilin has been reported to have various biological activities, including hypoglycemic [5] and antioxidants [6].

Research on secang wood and tamarillo as two different beverage ingredients that have the potential to be antidiabetic has been done quite a lot, but there has not been much further research on consumer interest as a product by mixing the two. In carrying out product development, it is necessary to have a picture from the consumer's point of view to see that consumer satisfaction and dissatisfaction with the
innovations made. The Kano model can help to find out consumer expectations of a product or service. With this model, the features that most stimulate consumers will be accepted, and then it will be made into a unique product that has the necessary features according to consumer satisfaction [7]. Through the Kano model, product formulations can be designed for superior attributes for consumers. The formula is made according to the Kano survey results, and then hedonic testing will be carried out. The best assessment in terms of organoleptic based on the best hedonic value will be used as the optimum formulation in determining the composition of the extract of tamarillo and secang wood extract.

2. Methodology

2.1 Kano Survey

Data collection was carried out, referring to the research of [8]. The Kano questionnaire was filled out online via Google form with the respondents' criteria, namely diabetics or having relatives or diabetes people. Questions compiled include the components of the ingredients used, the addition of sweeteners, shape, taste, colour, aroma, packaging, and labels. The questionnaire used has five levels of satisfaction scale. Questions made on the Kano questionnaire are made in pairs between functional questions and dysfunctional questions. Through questionnaire data, it will be known the level of customer satisfaction with the product's attributes. After the data is obtained from filling out the questionnaire, the answers to each functional and dysfunctional question will be combined and adjusted to the Kano evaluation table criteria. Next, Kano's category of each question attribute is determined using Blauth's formula. According to [9], 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

The beverage formulation was made after the Kano survey was carried out to obtain the desired attributes of consumers. For obtaining tamarillo extract, 4 kg of tamarillo fruit was sorted and washed, then cut to take the pulp. The water was added with water ratio: tamarillo pulp (1: 1), then blended until it became puree and strained to extract. Moreover, 50 grams of secang wood were weighed and boiled at 70° C for 20 minutes then filtered to extract. The ratio of secang wood: water was 1: 22 (b/v). Furthermore, both job’s tears and tamarillo extract were combined with the addition of water and sweetener to get four formulations.

A hedonic scale assessment was carried out according to [10]. The sample was arranged sequentially from left to right, starting from the lowest concentration. The number of samples given to the panelists using shot glasses poured in the same volume. Each sample with a different concentration will be given a three-digit random number code. The sample will first be assessed based on color attributes, then followed by the aroma, taste, and overall according to the 7-point hedonic scale principle, where 1-immensely dislikes, 2-dislikes, 3-slightly dislikes, 4-neutral, 5-few likes, 6-likes, and 7-likes very much. The results were statistically analyzed using the One-Way ANOVA with a significance level of 5% and Post-hoc test (Duncan). A product production analysis was applied to complete the hedonic assessment to justify the best product.

3. Result and Discussion

3.1 Kano Survey

In this survey, the respondents involved were people with or had relatives who had diabetes or non-sufferers in the age range of 15 to over 50 years. The number of respondents in filling out this survey was 66 people with 40 people with diabetes or having relatives who have diabetes. Respondents with
diabetes or have relatives with diabetes and who do not have diabetes disease were given the same four questions and two different questions precisely for diabetes people. The following Table 1 shows the tabulated answers to the initial survey questions.

**Table 1. Results of Kano’s preliminary survey**

| No | Questions                                                                 | Answer                        | Frequency |
|----|---------------------------------------------------------------------------|-------------------------------|-----------|
| 1  | Actions were taken to prevent or treat disease (especially for sufferers) (more than one answer is allowed) | Go to a doctor                 | 33        |
|    |                                                                           | Take personal medication       | 12        |
|    |                                                                           | Maintain diet and lifestyle    | 14        |
| 2  | Foods and beverages were taken to treat disease (especially for sufferers) (more than one answer option is allowed) | Fruit juice                   | 9         |
|    |                                                                           | Herbs beverages                | 10        |
|    |                                                                           | Low-sugar foods and beverages  | 30        |
| 3  | Knowing a functional drink                                               | Yes                           | 49        |
|    |                                                                           | No                            | 17        |
| 4  | Knowing that tamarillo fruit has the potential to reduce diabetes risk    | Yes                           | 15        |
|    |                                                                           | No                            | 51        |
| 5  | Knowing that sappan wood has the potential to reduce diabetes risk        | Yes                           | 11        |
|    |                                                                           | No                            | 55        |
| 6  | Form of the beverages that respondents wants                             | Ready to drink                | 38        |
|    |                                                                           | Powder drinks/sachet          | 27        |

Based on Table 1, it can be seen that the preference for consumption of fruit juices and herbal drinks is lower than those with low sugar content. It shows that respondents still have a lack understanding of fruit juices and herbal drinks. Tamarillo fruit and sappan wood ingredients are combined into a functional beverage formulation that can be consumed as an alternative low-sugar drink. Moreover, respondents also did not fully understand that tamarillo and secang wood has a potency to reduce diabetes risk. Research conducted by [11] shows that tamarillo can reduce glucose levels in obese rats, whereas [12] reported that secang wood extract can reduce blood sugar levels in alloxan-induced mice. Regarding the product's form, the respondents prefer ready to drink, where drinks in this form can be consumed directly without requiring any other process. In buying a product, practicality is a matter of consideration [13].

**Table 2. Kano’s questionnaire attributes**

| No | Attributes using in the Kano’s questionnaire                        |
|----|---------------------------------------------------------------------|
| 1  | Contains completely natural ingredients                              |
| 2  | Tamarillo extract is used as ingredient                              |
| 3  | Stevia is used as sweetener                                          |
| 4  | Sappan wood extract is used as ingredient                            |
| 5  | Liquid form, juice                                                  |
| 6  | Bright colour drinks                                                |
| 7  | The dominant aroma of tamarillo extract                              |
| 8  | The dominant taste of tamarillo extract                              |
| 9  | PET bottle as packaging                                             |
| 10 | Has a Halal label on the packaging                                   |
| 11 | Have a nutrition fact inclusion                                      |

Based on Table 2, there are 11 attributes used in the study. The attributes in points 2, 3, 4, 7, and 8 are tamarillo as main ingredients, stevia as natural sweeteners, secang wood as extract as additional ingredients, and the dominant aroma and taste of tamarillo extract came from the development and analysis of initial survey.

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 2, 4, and 7. In this study, tamarillo was used as raw material and sappan wood as additional material. Tamarillo has a distinctive aroma with a deep reddish-purple color and rich in fiber, resulting in a fruit extract with medium consistency [14]. With the right level of maturity, this fruit gives an attractive appearance in terms of sensory appearance [15]. While secang wood water extract has long been used as an ingredient in herbal drinks in Thailand, Indonesia, and India [16]. Therefore, these attributes attract respondents if they are to be used in the development of functional drink.

The one-dimensional category is in attribute 1, 3, 5, 6, 9 and 10. Natural ingredients contain antioxidants, anti-inflammatory, anti-cancer, and anti-obesity [17]. These things generally give the public the perception that food or drinks derived from natural ingredients are healthier than those using artificial additives. Stevia sweetener can be an option from consumers for those who want low-calorie beverage products [18]. Characteristics of beverages with liquid forms require less oral processing than semi-solids and solids, so they are easier to consume. Research shows that thick drinks produce a more prolonged feeling of fullness than those thinner [19]. Whereas, color is the first sensory character received by consumers before buying a food product to significantly influence consumer decisions [16]. By using the PET bottle, practicality consumers can easily see the contents of the product. The trend of beverage products [18]. Characteristics of beverages with liquid forms require less oral processing than semi-solids and solids, so they are easier to consume. Research shows that thick drinks produce a more prolonged feeling of fullness than those thinner [19]. Whereas, color is the first sensory character received by consumers before buying a food product to significantly influence consumer decisions [16], it can be seen that the respective satisfaction and dissatisfaction indexes of the 15 attributes that compose the tamarillo extract and secang wood extract drinks. The satisfaction index ranges from 0 to 1 and 0 to -1. On the satisfaction index, the closer it is to 1, the attribute will be more influencing customer satisfaction, but if it gets closer to 0, it has little effect on satisfaction [9]. On the dissatisfaction index, the closer the value is to -1, the higher the effect on consumer dissatisfaction [22].

### Table 3. Data tabulation of Kano questionnaire’s results

| No | Product components | Type of attributes | Category | Total |
|----|---------------------|-------------------|----------|-------|
| 1  | Contains completely natural ingredients | A R O M Q I | O | 40 |
| 2  | Tamarillo extract is used as ingredient | 8 0 24 0 0 8 | O | 40 |
| 3  | Stevia is used as sweetener | 21 1 8 3 0 7 | A | 40 |
| 4  | Sappan wood extract is used as ingredient | 23 0 3 2 0 12 | A | 40 |
| 5  | Liquid form, juice | 12 1 13 6 0 8 | O | 40 |
| 6  | Bright colour drinks | 0 0 23 0 0 17 | O | 40 |
| 7  | The dominant aroma of tamarillo extract | 20 1 8 0 0 11 | A | 40 |
| 8  | The dominant taste of tamarillo extract | 10 4 5 3 5 13 | I | 40 |
| 9  | PET bottle as packaging | 7 1 15 6 0 11 | O | 40 |
| 10 | Has a Halal label on the packaging | 9 1 13 6 0 11 | O | 40 |
| 11 | Have a nutrition fact inclusion | 11 0 5 18 0 6 | M | 40 |

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

In Table 4, it can be seen that the respective satisfaction and dissatisfaction indexes of the 15 attributes that compose the tamarillo extract and secang wood extract drinks. The satisfaction index ranges from 0 to 1 and 0 to -1. On the satisfaction index, the closer it is to 1, the attribute will be more influencing customer satisfaction, but if it gets closer to 0, it has little effect on satisfaction [9]. On the dissatisfaction index, the closer the value is to -1, the higher the effect on consumer dissatisfaction [22].

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

| No | Attributes          | SI    | DI    | Category |
|----|---------------------|-------|-------|----------|
| 1  | Contains completely natural ingredients | 0,8000 | -0,6000 | O        |
| 2  | Tamarillo extract is used as ingredient | 0,7436 | -0,2821 | A        |
| 3  | Stevia is used as sweetener | 0,6250 | -0,5750 | O        |
| 4  | Sappan wood extract is used as ingredient | 0,6500 | -0,1250 | A        |
3.2 Formulation and organoleptic assessment of beverage

The formulation was designed based on the existing criteria in the Kano survey. The one-dimensional (O) and attractive (A) categories were considered in the formulation design. The formula was combined from several variables, such as the percentage composition of tamarillo extract, secang wood extract, water, and stevia, in a volume of 300 ml each formula. This combination can be seen in Table 5.

| Formula | Tamarillo extract | Sappan wood extract | Water | Stevia sweetener |
|---------|------------------|---------------------|-------|------------------|
| X1      | 39.32%           | 19.66%              | 39.32%| 1.7%             |
| X2      | 49.15%           | 14.74%              | 34.40%| 1.7%             |
| X3      | 58.97%           | 9.83%               | 29.49%| 1.7%             |
| X4      | 68.81%           | 4.91%               | 24.57%| 1.7%             |

Table 5. Formulation of beverage made from tamarillo and sappan wood extract

| Formula | Color | Aroma | Taste | Overall |
|---------|-------|-------|-------|---------|
| X1      | 4.36 ± 1.21<sup>a</sup> | 4.33 ± 1.18<sup>a</sup> | 3.76 ± 1.32<sup>a</sup> | 3.88 ± 1.13<sup>a</sup> |
| X2      | 4.48 ± 1.11<sup>ab</sup> | 4.19 ± 0.99<sup>a</sup> | 3.88 ± 1.33<sup>a</sup> | 4.02 ± 1.14<sup>ab</sup> |
| X3      | 4.95 ± 1.10<sup>bc</sup> | 4.33 ± 1.41<sup>a</sup> | 4.36 ± 1.46<sup>ab</sup> | 4.48 ± 1.25<sup>bc</sup> |
| X4      | 5.12 ± 1.21<sup>c</sup> | 4.62 ± 1.23<sup>a</sup> | 4.88 ± 1.40<sup>b</sup> | 4.88 ± 1.11<sup>c</sup> |

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

The hedonic scale for each attribute has a mean of 3.88 to 5.12 (Table 6). The formula with the highest value of sensory attributes was X4. However, the formula X3 and X4 did not differ significantly for each attribute (p > 0.05). The insignificant color difference was caused by the opaque color of beverages, which is dominantly red to slightly dark for all formula. The tamarillo extract's percentage of each formula was slightly different, resulting in an insignificant difference in taste. This is because of the carry-over effect (COE), sensory refraction caused by sensory sensations leftover from previously sampled samples [23]. Moreover, the aroma's insignificant difference was that the four formulas were slightly different in tamarillo extract percentages. It caused fatigue in the sense of smell (olfactory fatigue), a condition in which the receptors in the sense of smell have adapted to an aroma not to cause new olfactory sensations [24]. The nominal overall hedonic value can be influenced by attributes given that the first assessment can affect the next attribute's assessment or halo effect. The price analysis was conducted to determine the best formulation between formula X3 and X4 (Table 7). Based on the price analysis, it can be seen that the price estimation in formula X3 is lower than formula X4. Therefore, formula X3 was chosen as the final formula in product development.

Table 6. Results of sensory analysis

| Product components | Dimension | Price (IDR) | Formula X3 (IDR) | Formula X4 (IDR) |
|--------------------|-----------|-------------|------------------|------------------|
| PET packaging      | 300 ml    | 1.500       | 1.500,00         | 1.500,00         |
| Mineral water      | 600 ml    | 3.400       | 501,33           | 417,69           |
| Sappan wood        | 50 g      | 13.000      | 507,92           | 253,61           |
| Tamarillo fruit    | 500 g     | 13.300      | 2.904,00         | 3.323,50         |
| Stevia sweetener   | 50 sachet | 50.500      | 2.020,00         | 2.020,00         |
| Packaging label    | 10 cm x 4 cm | 750 | 750,00 | 750,00 |
| Price estimation   |           | 8.118,00    | 8.264,00         | 8.264,00         |
Based on the initial survey and the Kano survey, the product prototype was designed. Product was designed based on the description from the survey including ready to drink product, liquid form such as juice, bright color, use PET bottles, have a halal label and nutrition fact as can be seen in Figure 1.

![Product Prototype](image)

**Figure 1.** Design product prototype of beverages

### 4. Conclusion

Based on all the stages of the research that has been carried out, it can be concluded that the formula made from the Kano method includes: natural components in the product, the use of stevia natural sweeteners, and bright drink colors, using tamarillo as the primary materials, using secang wood as additional material, in the form of liquid drinks such as juice, the dominant aroma of tamarillo extract. Formula X3 was exhibited as the best formula with 58.07% composition of tamarillo extract, 9.83% of secang wood extract, 29.49% of water, and 1.7% of stevia sweetener. The product prototype has several characteristics, including ready-to-drink, have liquid forms such as juices, brightly colored drinks, PET packaging bottles, and packaging with a halal label and nutrition fact.

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