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Design of Soymilk Product Development from Grobogan Soybean Variety in Indonesia

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ABSTRACT

Soybean (*Glycine max* (L.) Merill) is protein which is cholesterol free. The objective of this study is to develop the downstream product of soybean as soymilk by attribute values. Factors of consumer needs in determining the priority level of the important attributes often have characteristics of uncertainty element and cannot be explicitly determined. The number of samples that used and representing the consumer needs is 100 respondents Special Region of Yogyakarta. This product development uses Value Engineering, while Fuzzy Logic methods uses at the information and determination stage. The results show soymilk powder attributes that are prioritized by consumers include colour, aroma, taste, price, packaging, nutrient content, and thickness. Based on the creativity stage, there are product concept with flavors original, ginger, chocolate, strawberry, and pandanus for soymilk powder development. The best concept is original flavor with the highest score of 4.68 with a performance value of 9,366.60.

Keywords: Grobogan soybean, product development, soymilk, value engineering

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INTRODUCTION

As a source of vegetable protein, soybean plays an important role to improve human nutrition (Sui et al., 2018). Soybean demand increase together with food industry development for consumer needs all over the world (Yao et al., 2020). Soybean based products such as tofu, tempeh, and soy sauce require large amounts of soybeans (Yasin et al., 2019). In 2014 and 2015, the average production of local soybean in Indonesia was 819,442 tons per year with the consumption of 2.2 million tons soybean per year (Ningrum et al., 2018). However, it still needs the soybean import by approximately 65% from the total consumption due to the availability of local soybean which only provides approximately 35% from the total consumption. Total national soybean demand tend to increase in average 3.30% annually together with the approximately 1-2% population growth (Zikri et al., 2020). It means that the growth of population will be followed by the enhancement of soybean demand. The soybean production tend to enhance started from 2016 to 2020 by 11.18% per year (Ningrum et al., 2018). The projection of soybean production in Indonesia during 2021 and 2022 are 502,934 and 425,246 tons, respectively (Zikri et al., 2020). As the downstream product of soybean, soymilk has been consumed widely in Asian countries, even accepted in Western countries due to its nutrients and health benefits (Li et al., 2021). Although soymilk has high-quality proteins (Chen et al., 2017) and many essential amino acids (Toro-Funes et al., 2014), the quality of soymilk is quite different than dairy milk. Nevertheless, it still contains essential fatty acids, and has no cholesterol, gluten and lactose that is very appropriate for lactose intolerance consumer because does not cause allergies (Toro-Funes et al., 2015). The other benefits of soymilk are anti-oxidation, prevention of anemia, osteoporosis and cancer because it contains lecithin, isoflavone, vitamin and other nutrients (da Silva Fernandes et al., 2017).

However, the unpleasant tastes of soymilk i.e., bitter, beany and rancid tastes are less preferred by some consumers (Ma et al., 2015). The unpleasant taste can be eliminated by appropriate processing technology and selection of superior soybean variety, such as Grobogan variety (Mustikawati et al., 2018). Grobogan variety was introduced in 2008 by purifying the population of local Malabar Grobogan (Ministry of Agriculture, 2008). Grobogan variety is a national superior soybean with a productivity of 3.4 tons/hectares and the average production yield reaches 2.77 tons/hectares (Mustikawati et al., 2018). Kuntyastuti and Lestari (2017) added that the productivity of that Grobogan variety could be enhanced from 1.65 t/ha to 1.84 t/ha by using 2.5 t manure/ha. The age of plants is approximately 76 days with the seed weight is approximately 18 g/100 seeds (Mustikawati et al., 2018). This weight is followed by Argomulyo and Anjasmoro which are 15.49 g/100 seeds and 14.65 g/100 seeds, respectively. Thus, the other variety with medium and small size level of soybean are 10-14 g/100 seeds and <10 g/100 seeds, respectively (Krisnawati & Adie, 2015). This gives an advantage for Grobogan variety compared to other common soybeans variety because it has a higher net weight than ordinary soybean seeds. This means that the size of Grobogan soybean variety seeds is larger than other ordinary soybeans seeds. The adaptability of soybean plant capable to grow by quite large in a number of different environmental conditions (Viana et al., 2013). In term of fisiological growth characteristic, Grobogan variety also has capability to adapt even under 50% and 70% of shading (Bestari et al., 2018). This makes it easier to grow soybean crops in the field, especially at the beginning of the rainy season with the limited facilities. Soymilk from local soybean variety, Grobogan, is the most potential downstream product by taste improvement. However, the liquid soymilk product only has approximately 24 hours of shelf life if it is not stored in the refrigerator. This could be a problem during distribution. People also tend to choose the simple product, long time storage and easily obtained. Therefore, product development of soybean focused on powder form and flavor improvement is conducted to gain the market.

Recently, consumers have realized that in order to obtain good value for the money spent. They want to have equal value between money that they spent and the quality of the product that is bought. Producers should market the products that provide good value for consumers and companies. The profits depend on the ability of producers to make high quality products with low cost. Value Engineering is an appropriate method to develop this soybean downstream product. This method is used to get the functionally balanced product concept including minimum costs, maximum performance, and maintaining the expected quality (Heralova, 2016). Fuzzy Logic method is integrated in Value Engineering to maximize the performance of product development method because at the stage of determining the priority ranking of the score ratio of attributes, each attribute has fuzziness characteristics that cannot be expressly categorized with a value of 1 (if the weight exceeds the attribute being compared) and a value of 0 (if less than compared) (Sarkar et al., 2020). Integration of Fuzzy Logic method on Value Engineering in this study is used to organize the fuzzy membership function from the scores that are compared to the ranking determination of priorities used in product design and development. Therefore, fuzziness characteristics in the comparison of the attribute score priority are still considered according to the value of the membership function owned by each of the priority attributes.

MATERIALS AND METHODS

Soymilk Powder Ingredients

The main raw material is local soybeans by Grobogan variety, which was purchased from traditional market in Grobogan District, Central Java, Indonesia. Refined sugar was used for sweeteners. Pandanus, ginger, chocolate, and strawberry flavoring agents which were added for 1.5% respectively was purchased from Bratachem, Yogyakarta.

Soymilk Powder Production

The soybean was soaked in the fresh water for overnight at the room temperature. The soaked soybean which separated from the liquid was prepared to be produced into soymilk. Soymilk was produced by "Maspion" Soya-Bean Milk Maker. This soybean was placed in that machine chamber together with mineral water by soybean and mineral water ratio approximately 200g : 1,5L. After that, the machine was turned on for heating at boiling temperature. When the boiling temperature achieved, the mixer was turned on automatically for 5 minutes. The soymilk processing is complete; thus, it was filtered manually by filter cloth. Furthermore, this liquid form was heated by open pan with gas stove and stirred until the liquid changed into powder form. This product does not use any gum or other hydrocoloid to produce powder particulate. The soybean milk can produce powder without any gum or hydrocoloid to produce the body to the powder. However, this method is especially addressed for smal enterprises, so they can produce the soybean powder without addition of cost of production due to buying gum or hydrocoloid as a filler. Proximate analysis and sensory evaluation were conducted by this powder products at Quality Analysis and Standardization Laboratory, Department of Agroindustrial Technology, Universitas Gadjah Mada. The protein, fat, water, ash, and crude fiber contents were determined for all products except product from market which only takes the number of protein and fat contents from its nutrition label. Factors observed on the powder include consumer preferences, quality attributes assessed by consumer preferences, product performance (the value of overall product's appearance), cost production, and value which explains the comparison between performance and cost production. The evaluation of consumer preferences was conducted by questionnaire method to gain the primary data from respondent directly. The result of questionnaire was determined by Likert scale modified by fuzzy logic. Quality attributes assessed by consumer preferences was conducted by determining the priority level of quality attribute development. This determination was gained from the average result of the rank towards quality attribute by respondents from the previous questionnaire combined using fuzzy logic calculations and affirmation (defuzzification) by the centroid method. Product performance (the value of overall product's appearance) was calculated by multiplying the number of respondent assessments towards quality attributes of each concept with the attribute scores. Cost production was calculated by the expense of each raw material and processing cost for a single unit product. The value of the product was calculated by the ratio between performance of each product concept and its cost production.

Data Collection

Data was collected by field observation, questionnaire, sensory evaluation, and literatures observation. Field observations were conducted by two ways including interview and discussion and direct observation. The interview and discussion were carried out by question and answer directly to the producer of soymilk powder from local soybean variety, Grobogan, to obtain in-depth information about various matters related to the product. Direct observation was done towards the object, namely the production of soymilk powder by roasting method. The roasting method is the method that was explained previously by heating the liquid form on the open pan with gas stove together by stirring until the liquid is changed into powder form. Questionnaire was conducted by giving a list of questions to the respondent to answer. Questionnaire was consisted by 3 steps i.e., preliminary questionnaire, consumer needs questionnaire, and sensory evaluation questionnaire. The first step was done by 30 respondents to assess the priority level for soymilk quality attribute development. The second step was conducted by 100 respondents to gain the quality attributes that were desired by the consumer from the first questionnaire result. The last step of the questionnaire was carried by sensory evaluation to determine the level of performance of the product development design based on the quality attributes of the developed product. This questionnaire used 30 respondents to evaluate the products. The provision of total respondent is appropriate with Wang et al., (2019) who used 10 respondents as trained panelist from School of Life Science in Shanxi University for sensory evaluation of sour porridges product. Furthermore, each answer to the question was determined by a Likert scale modified with fuzzy logic started from 1=very dislike; 2=dislike; 3=like; 4=very like. The respondents of this questionnaire are consumers who know and/or have ever consumed the soymilk. Sensory evaluation was conducted by trained panelists. Literature observation was done by collecting data from scientific books and articles or other sources obtained from ongoing research.

Validity and Reliability Tests

Data from the questionnaire were evaluated for validity and reliability. Validity was measured by SPSS. Validity coefficients that are more than 0.3 are satisfy and give good contribution to the efficiency of a research object. Reliability was measured by Alpha Cronbach method using SPSS. More than 0.50 of Alpha Cronbach value indicates that the variable is reliable. The evaluation is reliable if the alpha coefficient value exceeds the critical value. The criteria for decision making are that if the r results are positive and more than the value of the table, the item will be reliable and vice versa.

Determination of Priority for Quality Attribute Development

The priority order for quality attributes development was determined by the average rating of quality attributes by respondents in the first stage questionnaire. The priority development is the quality attribute which has the lowest average value. The calculations were also combined by fuzzy logic calculations, which begin using the fuzzy set formation stage (determining the degree of membership for each attribute) and the affirmation stage (defuzzification) using the centroid method.

Determination of Characteristics for Consumer Needs

Quality attributes that have been known and have been determined for priority order in the previous stage were used to identify consumer needs through the second questionnaire. Product specifications obtained from that questionnaire will be used as a basis for developing the product concepts.

Function Analysis System Technique

This analysis begins with brainstorming to determine product concepts that will be developed based on the results of identifying product quality attributes and consumer needs. Furthermore, Function Analysis System Technique (FAST) method was conducted to identify product functions. The FAST was arranged according to function hierarchy which high-level functions are placed on the left and low-level functions are on the right.

Creativity and the Best Product Determination

The creativity stage can be carried out by determining product development specifications by making alternatives of product concept based on the observation and FAST stages that has been conducted on the assessment of consumer needs. Product determination as the last step was divided into five parts i.e., sensory evaluation, performance value, cost of production, product concept value, and the best product concept determination. Sensory evaluation was conducted on various characteristics and concepts of soymilk powder that will be developed. Performance values can be obtained by multiplying the total of respondents' ratings towards quality attributes of each concept with the score of their attributes. At the zero-one calculation stage, the comparison of attributes is done by Fuzzy Logic integration method. This is because the zero-one method in value engineering uses crisp limits (1 and 0) regardless of the value of its membership function. Fuzzy logic serves to fix the exact boundaries of the zero-one method into constraints in fuzzy sets having different membership values. Grouping several values into fuzzy sets with different membership values can solve the discrepancies in the crisp approach of the zero-one method. In addition, 0 and 1 seem unfair because in fact each attribute has a different value or degree. Therefore, the zero one method was integrated with fuzzy logic to find the degree of membership from each attribute. Cost of production was calculated for each of product concept based on the raw material because the other things are assumed to be similar. The value of a product was obtained by comparing the performance of each product concept with the cost of production. The best product concept is the concept that the highest value based on the questionnaire.

RESULTS AND DISCUSSION

Information Stage

The identity stage of product quality attribute was conducted by brainstorming with researchers who firstly produce soymilk by local soybean from Grobogan. This step was also conducted by interview with consumers to give information about the desired soymilk quality attributes. The results obtain nine important quality attributes namely colour, aroma, taste, price, nutritional content, packaging, viscosity, raw materials, and shelf life. Identification of quality attributes of soymilk powder was done by distributing preliminary questionnaires to 30 respondents aged 20-40 years. Respondents were chosen from who consume soymilk both regularly and non-routinely. They assess the level of importance and give priority order for the development of soymilk quality attributes.

Table 1
Validity and reliability test results of product quality attribute

Quality Attribute	Validity		Reliability	
	Correlation Coefficient	Note	Alpha Coefficient	Note
Colour	0.496	Valid	0.802	Reliable
Aroma	0.698	Valid	0.778	Reliable
Taste	0.410	Valid	0.742	Reliable
Price	0.374	Valid	0.754	Reliable
Nutrition content	0.645	Valid	0.795	Reliable
Packaging	0.433	Valid	0.739	Reliable
Thickness	0.552	Valid	0.706	Reliable
Raw material	0.271	Not Valid	-	-
Shelf life	0.279	Not Valid	-	-

Validity and reliability tests are conducted on the identification results of product quality attributes. The data used are ordinal scale data. Instruments that were used in validity measurement of questionnaire are the results of correlation between the statement score and the overall score of the respondents' statements towards the information in questionnaire. The validity test results in Table 1 show that all correlation coefficients are positive. Nevertheless, there are two quality attributes that have values below 0.364, namely raw materials and shelf life. Based on the table for Spearman's Rank Correlation by total of sample 30 and significance level 5%, it achieves the value of r table by the α value (0,025) 0.364. Table 1 shows that the r count value is higher than r table value. Thus, it can be stated that the 7 attributes for colour, aroma, taste, price, nutrition content, packaging, and thickness are valid, while 2 attributes for raw material and shelf life are invalid. They can be invalid for data regarding raw material and shelf-life attributes. It can be caused by the differences of consumers interpretations to assess the type of raw materials and their own desire perceptions about the shelf life of the products. These invalid items do not need to be included in the next questionnaire. After validity test, it continues by reliability test to find out the consistency of the measurement of an instrument. The reliability test method is Alpha Cronbach by 95% confidence level or a 5% significance level. The items which is evaluated by reliability test are only items that have been valid. Kim et al. (2020) also used Alpha Cronbach to evaluate the quality of nursing doctoral education by validity and reliability tests.

The reliability test results in Table 1 show that all quality attributes have values above 0.7. It means that all quality attributes are included in the high reliability classification because the reliability coefficient approaches 1.00. Reliable items are considered consistent. It reflects that the measurement results obtained are correct measurement and reliable. From the alpha coefficient values obtained indicate that the attributes have a high level of confidence. The colour value has the highest coefficient value because this item is the most understood and trusted by the respondent. Quality attributes that have been evaluated by validity and reliability tests can be used for the next stage.

Furthermore, the respondents determine the order of priority for quality attributes development in the follow-up questionnaire. After validity evaluation, two attributes are invalid, so seven attributes will be developed. Questionnaires are distributed to 100 respondents. The result of development priority ranking of each quality attributes is used as reference in the development of soymilk powder. The results of priority ranking for development of quality attributes of soymilk powder based on defuzzification process can be seen in Table 2.

Based on the results in Table 2, the priority order of attributes based on score calculation is taste, nutrient content, price, aroma, packaging, colour, and thickness. Whereas based on fuzzy calculations using centroid method, the order of development is taste, nutrient content, packaging, price, aroma, viscosity, and colour. Centroid method determines the center of area of membership function (Rouhparvar & Panahi, 2015). Calculations using the attribute score directly divide the total rating score with the number of respondents. In this calculation, there are several things that need to be improved regarding the selection of information from consumers when filling out the questionnaire. At the initial questionnaire, consumers have been restricted to use explicit Likert values, 1-4. Initial input from the fixed

Table 2
The result of priority development for soymilk powder quality attributes using Attribute Score and Fuzzy Calculations

Quality Attribute	Attribute Score		Fuzzy	
	Attribute Score	Development Priority	Result of *Fuzzy*	Development Priority
Colour	2.66	6	6.14	7
Aroma	3.81	4	6.98	5
Taste	5.66	1	8.09	1
Price	3.98	3	7.2	4
Nutrition content	5.51	2	7.88	2
Packaging	3.74	5	7.33	3
Thickness	2.64	7	6.51	6

value questionnaire which is calculated by attribute score calculation obtains a fractional value resulting fewer representative data. Fuzzy calculations try to bridge the desires of consumers by providing flexibility to fill scores by fraction values obtaining fractional value computation by fuzzy calculation. Furthermore, defuzzification is conducted to produce crisp value which is more representative for the desires of consumers. When questionnaires distribution, there is scale modification of 1-8 and respondents can fill by fractional numbers. The higher the results exceeding scale 8 shows that the attribute is important to be prioritized because the degree of attribute membership is 1.

Quality attributes that have been determined in priority order in the previous stage are used to identify the consumer needs by distributing the second stage questionnaire. The respondents who are chosen should ever consume soymilk either men or women aged 20-40 years. In this study, the degree of deviation (d) 10% are used with a 95% confidence level (significance level of 5%) and a proportion value (p) 0.5. Based on the calculation, seventy-nine peoples should be used as respondents and 100 respondents will be used in real to get more easily calculation in future. The proportion of respondents in each region can be seen in Table 3. Interview and questionnaires are used for sampling. The quality attributes in question are quality attributes that have previously been declared valid and reliable namely colour, aroma, taste, price, nutrient content, packaging, and viscosity. The output from this stage is evaluation to design the needs of consumers which will be transformed in the product manufacture. The identity and profile of respondents in each regency/district can be seen in Table 4.

Table 3

Total proportion of samples in each regency

Regency	∑ Population Aged 20-40 Years	Proportion (X)	∑ Theoretical Sample	∑ Actual Sample
Yogyakarta	142464	0.173	17.3	18
Bantul	291391	0.3539	35.39	35
Sleman	389550	0.4731	47.31	47
Total	823405	1.00	100	100

Table 4

Identity and profile of respondents

Profile		Assessment Result (%)
Gender	Male	44
	Female	56
Occupation	Student	75
	Civil Servant	5
	Private Employee	15
	Housewife	2
	Others	3

This second stage questionnaire was conducted randomly towards 100 respondents. The result from this step, 96% of respondents ever consume soymilk and 4% is never. Based on the questionnaire data, the relation of total respondent in percent and their frequency of soymilk consumption follow; 48% consume soymilk <7 times per week; 20% consume soymilk more than twice per week; 16% consume soymilk once per week; 3% consume soymilk every day; 2% consume soymilk >5 times per week; and 11% consume soymilk in uncertain frequency. Based on the exposure of soymilk powder product in market by respondent, 67% of respondents know soymilk powder in market, but 33% do not know because they never find and buy soymilk powder product in the market. In other hand, from the consumer's like and dislike towards soymilk powder product from market, 61% of respondents do not like soymilk powder currently on the market because of unpleasant taste especially beany flavour. Total 39% of respondents like the soymilk powder in the market because of simple, lightweight, easy to carry, and easy to brew. Total 95% of respondents state that the nutrient in soymilk is important for the human body. The results of consumer needs identification can be seen in Table 5.

Table 5
Results of consumer needs identification

No	Question	Answer	Percentage (%)
1	Do you like the soymilk from market?	Yes	31
		No	69
2	Soymilk taste variation	Original	40
		Pandanus	5
		Strawberry	4
		Ginger	6
		Chocolate	41
		Coffee	2
		Vanilla	1
		Honey	1
3	Sugar addition	Yes	61
		No	39
4	Degree of sweetness of soymilk	Very sweet	1
		Sweet	13
		Moderate Sweet	71
5	Soymilk aroma	Pandanus	36
		Vanilla	33
		Chocolate	7
6	Soymilk thickness	Viscous	20
		Moderate Thickness	76
		Aqueous	3
7	Soymilk colour	Original colour	78
		Natural colourant addition	11
8	Soymilk packaging	Alumunium foil	43
		Plastic	33
		Pouch by zipper lock	23
9	Packaging size	Sachet	60
		100 g	22
		200 g	14
10	Price for once drink	IDR 1000-1500	10
		IDR 2000-3000	49
		>IDR 3000	41

Based on the results of the second stage questionnaires distribution, it can be concluded that the soymilk powder desired by consumers has the following specifications (this specifications are then used as a basis for product concept development that will be applied): variation of flavors with original flavors, chocolate, ginger, pandanus, and strawberries; need to add sweeteners (sugar); moderate sweetness level of taste; medium level of thickness; colour like the original colour of soy (brown cream); forms of soymilk powder in sachet packaging using aluminum foil; soybean powder need to be smoother (not much pulp/ sediment); the price of soymilk sachets is around IDR 2000-3000.

Analysis Stage

The characteristic development of soymilk powder products based on questionnaires I and II was conducted by identification of product functions. Identification of product functions and their interrelationships was conducted by a function diagram called Function Analysis System Technique (FAST). This diagram represent a function showing the inter-relationship of function to each other in a how and why logic (El-Nashar & Elyamany, 2018). Identification of product functions begins by observation of soymilk powder on the market and direct observation of soymilk powder production (prototype) from Faculty of Agricultural Technology, Universitas Gadjah Mada. This product was developed because of consumer dissatisfaction towards soymilk taste. The comparison product is local soymilk from supermarket which has equal quality to the developed product. Furthermore, it can be identified the functions of soymilk powder products and then these functions can be mapped and can be known for their association by FAST diagram in Figure 1.

From the FAST diagram, it can be identified that soymilk has two primary functions i.e., function of quality and price. The primary function of product quality is followed by secondary functions of colour, aroma, taste, nutrient content, packaging, and thickness. In other hand, price has a secondary function which is cost of production. The secondary function of colour is influenced by the raw material and colouring agent addition in soymilk. The secondary function of aroma is influenced by raw material and kinds of soybean. The secondary function of taste is influenced by the degree of sweetness and addition of other ingredients. The secondary function of nutrient content is determined by the quality of raw materials and raw materials composition. The secondary function of packaging is determined by the kinds of packaging material and information on the packaging. The secondary function of thickness is influenced by kinds and combination of raw materials. The secondary function of production cost is affected by how soymilk products are produced in accordance with the secondary functions of quality i.e., colour, aroma, taste, nutrient content, packaging, and thickness. Attributes that will be developed to determine the design alternative of soymilk product development include:

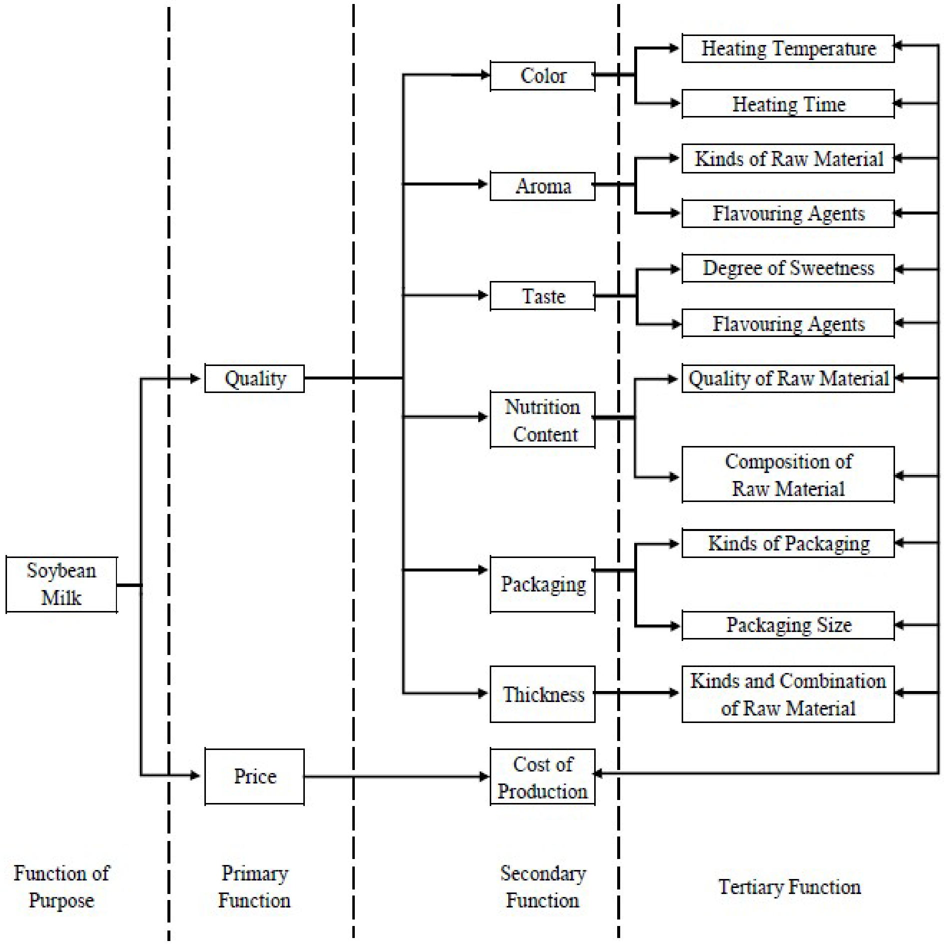

Figure 1. FAST diagram *of soymilk product development*

a. Taste: the most priority quality attribute to be developed according to respondents. From the results of the second questionnaire distribution, it is found that 40% of respondents want the original taste, 41% chocolate, 6% ginger, 5% pandanus, and 4% strawberry. Total 61% of respondents want a sugar addition into soymilk powder with a moderate level of sweetness.

b. Colour: 78% of respondents want a soymilk powder with a creamy brown colour. Soybeans generally have a creamy brown colour. It makes no additional colourant agent.

c. Aroma: 36% of respondents want a soymilk with soy aroma combined with pandanus aroma. Grobogan soybean has a strong soybean aroma. It is also in accordance with the desired aroma by respondents.

d. Packaging: 60% of respondents want soymilk that is packaged in sachets form. It will make that product ready to be brewed and consumed by adding hot water. Product development will be carried out by production the soymilk products in aluminum foil sachets packaging.

e. Thickness: 76% of respondents want the soymilk with medium thickness.

Creativity Stage

Based on consumer need identification by questionnaire, it will be developed for concept alternatives of soymilk powder products. The alternative product concepts can be seen in Table 6. The alternative products are supported by flavor enhancement ingredients including chocolate, pandanus, strawberry, and ginger.

Table 6

Alternative concepts of soymilk powder products

Product Concept	Ingredient and Proportion
A	Soymilk Liquid : Sugar = 1000 mL : 100 g
B	Soymilk Liquid : Sugar : Ginger = 1000 mL : 100 g : 10 g
C	Soymilk Liquid : Sugar : Chocolate = 1000 mL : 100 g : 2 mL
D	Soymilk Liquid : Sugar : Strawberry = 1000 mL : 100 g : 2 mL
E	Soymilk Liquid : Sugar : Pandanus = 1000 mL : 100 g : 2 mL

Determination Stage

This stage is consisted of sensory evaluation, determination of product performance value, determination of production costs and product concept value, and determination of the best product concept. Comparison between developed products and products from market is conducted to determine the acceptable of developed products to the public. As the beginning of determination stage, sensory evaluation, the soymilk products are tested to 30 trained panelists. They are requested to rate the product quality attributes by Likert scale which 4 is “very good”; 3 is “good”; 2 is “bad”; and 1 is “very bad”. This Likert scale is widely used for sensory evaluation including the microgreens from commercial and local farms in Tuscaloosa, Alabama (Tan et al., 2020). Sugared soymilk instant from market is also included in this sensory evaluation as a comparison product, at the same time. The sensory evaluation result can be seen in Table 7.

Table 7
Sensory evaluation results

Attributes	Product	Attribute Score (Value)				Total Score	Average Score
		1	2	3	4		
Taste	A	2	5	14	9	90	3.00
	B	3	9	10	8	83	2.77
	C	4	13	8	5	74	2.47
	D	4	9	4	13	86	2.87
	E	2	5	11	12	93	3.10
	Market	17	11	1	1	46	1.53
Colour	A	0	1	20	9	98	3.27
	B	0	3	21	6	93	3.10
	C	2	6	21	1	81	2.70
	D	2	0	23	5	91	3.03
	E	0	5	16	9	94	3.13
	Market	4	15	9	2	69	2.30
Aroma	A	1	3	15	11	96	3.20
	B	3	5	14	8	87	2.90
	C	3	9	12	6	81	2.70
	D	2	8	13	7	85	2.83
	E	0	5	12	13	98	3.27
	Market	9	15	4	2	59	1.97
Thickness	A	0	2	23	5	93	3.10
	B	1	1	26	2	89	2.97
	C	0	5	22	3	88	2.93
	D	2	6	15	7	87	2.90
	E	1	0	21	8	96	3.20
	Market	10	9	8	3	64	2.13

Based on the sensory evaluation results, Concept E (pandanus flavor) has the highest score of taste attribute. Major respondents in second questionnaire desire the taste and aroma of pandanus as an alternative to the development of flavor in soymilk powder. The second ranking is Concept A (original) followed by Concept D (strawberry flavor), Concept B (ginger flavor), Concept C (chocolate), and product from market. Product from market has the lowest score in all the evaluated attributes including taste, colour, aroma, and thickness. This confirms that soymilk products from the market have preferred by the public, especially in terms of bitter, beany and rancid tastes (Ma et al., 2015). Based on the results of colour attribute, Concept A (original) has the highest score of colour attribute. Second questionnaire result shows that more respondents prefer the original colour of soy (brown cream) as an alternative to the development of colour attribute in soymilk powder. The lower score of colour attribute is followed by Concept E, Concept B, Concept D, Concept C, and product from market. Aroma attribute score from Table 7 shows that Concept E (pandanus flavor) has the highest score followed by Concept A (original), Concept B, Concept D, Concept C, and product from market. It has similar reason with the previous result which explain that more respondents from second questionnaire want the pandanus aroma to be an alternative towards the development of aroma in soymilk. For the thickness attribute, Concept E (pandanus flavor) has the highest score followed by Concept A (original), Concept B, Concept C, Concept D, and product from market. The respondents from second questionnaire desire the moderate thickness in soymilk.

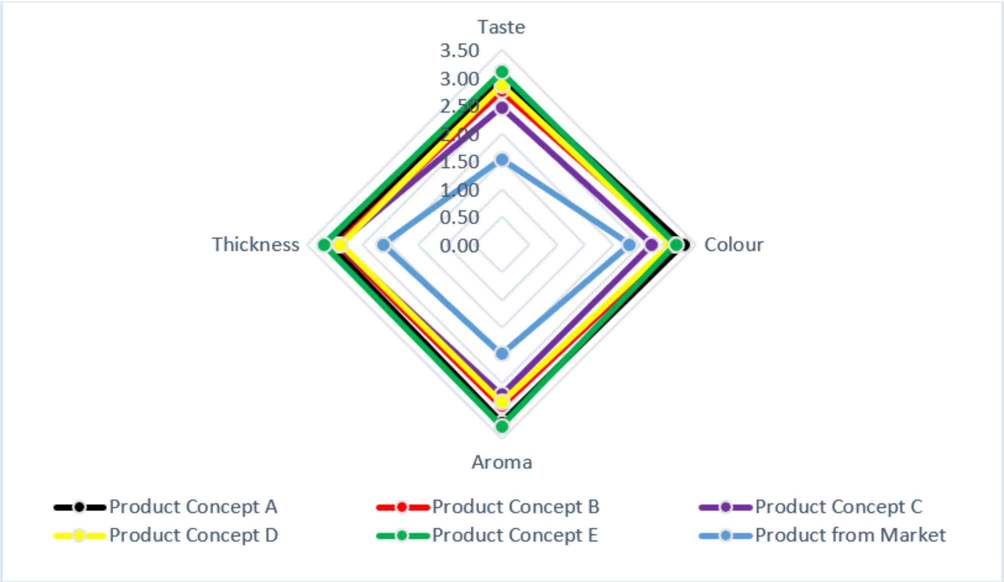

Figure 2. Attribute Value Comparison of Sensory Evaluation Result

Figure 2 informs that Concept E has the highest performance value followed by Concept A, Concept B, Concept D, Concept C, and product from market. It indicates that panelists would rather accept the developed product concepts than product from market. However, product from market tends to have unpleasant taste and odor with high precipitate. Regarding value engineering, sensory evaluation could be used to determine the level of performance of the product development design based on the quality attributes of the product being developed.

In this step, the determination of product performance value is conducted. From the calculation of the attribute score in Table 8, comparison among quality attribute could be made by the zero-one method. The comparative analysis of factor attributes determining product design and development uses zero-one method. This method defines a crisp limit of 1 if the score exceeds the compared attribute and 0 if less than the compared attribute without considering its value of membership function for any score (Sarkar et al., 2020). This condition has an inappropriate impact because each compared score has unconsidered membership value. Fuzzy Logic method could improve the definite limits on zero-one method in Value Engineering into limits in fuzzy sets that have different membership values. Grouping several values into fuzzy sets with different membership values could resolve the discrepancies on the crisp approach in zero-one method in Value Engineering. The comparison results of quality attributes by fuzzy logic can be seen in Table 9.

Based on Table 9, comparison among quality attributes could be made by zero-one method. The higher attribute score will get 1 and the lower one is 0. The similar attribute comparison will be given (-). However, 0 and 1 are considered unfair because each attribute has different value or degree. Therefore, the zero-one method will be integrated by fuzzy logic method which will begin by finding the degree of membership of each attribute. From the comparison results of quality attributes by fuzzy logic, taste has the highest value to be developed, then followed by aroma, colour, and thickness. Comparison on each compared

Table 8
Calculation of attribute score

Attribute	Importance Level				Total	Total Score	Attribute Score (%)	Ranking
	1	2	3	4				
Taste	0	3	9	18	30	105	35	1
Colour	12	12	3	3	30	57	19	3
Aroma	1	5	16	8	30	91	30.33	2
Thickness	17	10	2	1	30	47	15.67	4
Total	30	30	30	30	120	300	100	-

Table 9

Comparison results of quality attributes by zero-one and fuzzy logic

Method	Attribute	Taste	Colour	Aroma	Thickness	Total	Ranking
Zero-One	Taste	-	1	1	1	3	1
	Colour	0	-	0	1	1	3
	Aroma	0	1	-	1	2	2
	Thickness	0	0	0	-	0	4
Fuzzy Logic	Taste	-	1.88	1.15	2.23	5.26	1
	Colour	0.53	-	0.62	1.19	2.34	3
	Aroma	0.87	1.63	-	1.94	4.43	2
	Thickness	0.45	0.84	0.52	-	1.80	4

attribute is stated in fuzzy membership function leading to still have a value according to its membership function limit. This is more appropriate to represent the comparison criteria. The next step is calculation of performance value for each product concept. This value could help to optimize a product concept by maximizing the functional performance of each product concept (Heralova, 2016). The results of performance value calculation for each product concept can be seen in Table 10.

Table 10

The result of performance value calculation for each product concept

Quality Attribute	Taste	Colour	Aroma	Thickness	Performance Value
Attribute Score	38.03	16.92	32.03	13.02	
Product Concept A	90	98	96	93	9366.60
Product Concept B	83	93	87	89	8675.44
Product Concept C	74	81	81	88	7924.93
Product Concept D	86	91	85	87	8665.59
Product Concept E	93	94	98	96	9516.13
Product from Market	46	69	59	64	5639.91

Product performance is stated as good if the value exceeds the comparative product performance value (product from market). Based on Table 10, product E (pandanus) has the highest performance value followed by product A, product B, product D, product C, and product from market.

However, a higher product performance value does not necessarily indicate that the product has a better value. The value of a product is also influenced by the production costs. In this case, value is a comparison between performance and production costs. It should be considered because products with high performance will get low values if it has high production costs.

In this step, the determination of production costs and product concept value is conducted. The calculation of production costs in this study is limited only to the cost of raw materials because the product development focuses on flavor diversification and the other things are done with the similar process. From the calculation, Product A has the lowest cost of IDR 2,000 followed by product from market IDR 2,072.5, product E IDR 2,244, product B IDR 2,300, and product C and D having similar result IDR 2,303. Furthermore, the value of each product concept could be determined by performance comparison of each product concept with its production cost. The results of value calculation for each product concept can be seen in Table 11.

Table 11
Value of each product concept

Product	Performance	Production Cost (IDR)	Value	Ranking
Product Concept A	9366.6	2000	4.68	1
Product Concept B	8675.44	2300	3.77	3
Product Concept C	7924.93	2303	3.44	5
Product Concept D	8665.59	2303	3.76	4
Product Concept E	9516.13	2244	4.24	2
Product from Market	5639.91	2072.5	2.72	-

Table 12
Proximate analysis profiles of some soymilk powder products

Proximate Analysis	Soymilk Powder Product		
	Developed Product	Commercial Product	
	Product Concept A	Prototype Product	Product from Market
Protein (%)	10.31	6.11	11
Fat (%)	3.76	3.38	2
Water (%)	5.31	1.31	-
Ash (%)	1.07	0.93	-
Crude Fiber (%)	1.12	0.12	-

As the last step, the determination of the best product concept is conducted here. Based on Table 11, product concept A (original flavor) has the highest value due to its lowest production cost. It could be stated that the best concept of this product development is concept A (original flavor) because it has the highest value with a high performance and low cost of production. This product also indicates the preference of the consumer. Proximate analysis profiles of product concept A and other commercial products can be seen in Table 12. Based on Table 12, product concept A has 5.31% of water content, 1.07% of ash content, and 1.12% of crude fiber. This results are closer to study that was conducted by Mazumder & Hongsprabhas (2016). They stated that water content, ash, and crude fiber of spray dried soymilk powder are 1.93%, 3.05%, and 3.59% respectively. In other hand, protein and fat contents are different i.e. 57.26% and 27.6%, respectively (Mazumder & Hongsprabhas, 2016). That contents are higher than the protein and fat contents in this study, 10.31% and 3.76%, respectively. Since the process of soymilk production conducting the soaking method towards the soybean for overnight, it is predicted that a lot of protein dissolve into the liquid soaking medium. This has been confirmed by Martinson et al. (2012) who stated that the soaking of soybean could decrease the protein content. Nilufer-Erdil et al., (2012) also explained that soymilk powder needs to have no less than 38% of soy protein and 13% of soy fat. Product from market only show the number of protein and fat contents which take from its nutrition label, as described in the method part above.

CONCLUSION

The priority of attributes development for soymilk powder are taste, nutrient content perception from respondents, packaging, price, aroma, thickness, and colour. Meanwhile, the consumer needs include variations in taste, sugar addition (medium sweetness), medium thickness, aluminum foil packaging in sachet sizes, and prices ranging from IDR 2000-3000. Five concepts of soymilk powder product development obtained from the creativity stage include product concept A (original), product concept B (ginger), product concept C (chocolate flavor), product concept D (strawberry flavor), and product concept E (pandanus flavor). The best concept is product concept A (original) that has the highest value (4.68), high performance (9,366.60) and low production cost (IDR 2000).

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