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Product development of black *Piper retrofractum* Vahl tea (black PrV tea)

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Abstract. Java long pepper or black PrV is one of the herbal plants that have active compounds and are beneficial for health. Almost all herbal medicine industries use black PrV only as supporting material, so it is necessary to develop new products with black PrV as the basic material. This study aims to determine the attributes of customer requirements and the dominant technical requirements in the production of black PrV tea using *Quality Function Deployment* (QFD) method. Then the experiment was carried out using the technical requirements with the highest weight as a factor. Experiments were carried out using Completely Randomized Design with two factors, namely type of supporting material and proportion of black PrV. The result showed that customers wanted black PrV tea that was not too peppery, natural taste, nice colour and flavour, and quick brewing time. The dominant technical requirements are the type of supporting material and proportion of black PrV. The best of supporting material is *secang* wood and the proportion of black PrV is 80%.

1. Introduction

Black *Piper retrofractum* Vahl (Black PrV) or Java long Pepper is a medicinal plant that widely grown in Madura island. Almost all parts of this plant have many benefits, such as roots, fruit, and leaves. The most widely used part of the plant in the herbal industry is fruit. Fruit used in dried fruit (simplicia) is often referred to *Retrofracti fructus* [9]. The active compounds contained in black PrV are piperine, resin, fixed oil and essential oils, piperidine, retrofractamide A, retrofractamide C, amino acids, monosaccharides, piperatine, β -sitosterol, alkaloids, methyl piperate, aldehydes, ketones, steroids, sesamin, and 3,4,5-trimethoxy-dihydrocinnamic acid, piperoctadecalidine, pipereicosalidine, N-isobuyleicosa-2, 4-dienamide, β -sitosterol β -D-glucopyranoside, 3-methyl-5-decanoylpyridine and 28-methylnonacos-27-en-1 oic acid [8, 10].

Some diseases that can be treated with black PrV are diarrhea, carminative, expectorant, oxytoxic, stimulant, bronchitis, cough, aphrodisiac, diuretic, antiseptic, gonorrhea, dysentery, rheumatism, mild irritation, ease of birth, mouthwash, and toothache [8, 10]. Because of the many active compounds and their benefits in overcoming several diseases, black PrV is widely used in the herbal industry, but until now its use is only as a supporting material. Therefore, it is necessary to develop new products that use black PrV as the basic material.

New product development can use the Quality Function Deployment (QFD) method. QFD is a method for developing higher quality products to meet customer needs through collecting and



analyzing the voice of customer [4]. QFD is a structured approach to define customer requirements and translate them into technical requirements to produce products to meet those requirements [3]. The customer requirements or ‘voice of customers’ is captured in a variety ways: focus group discussion, direct discussion or interviews, surveys, etc. This understanding of the customer requirements is then summarized in a product planning matrix called ‘House of Quality (HOQ)’. Some of benefit using QFD method are reduced time to market, reduction in design changes, reduced design and manufacturing costs, improved quality and increased customer satisfaction [13], therefore QFD can be a powerful tool for product development [11], including food product development. Nevertheless the disadvantage of using QFD for food product development can occurs because of the complexity of food products, the many interactions between the ingredients and the influence of production processes on the product’s functional properties [1].

This study aims to develop a new product called Black PrV tea using *Quality Function Deployment* (QFD) method. This study can determine the attributes of customer requirements and the dominant technical requirements in the production of black PrV tea. Then, the experiment was carried out using the technical requirements with the highest relative weight as factors.

2. Materials and Methods

2.1. Samples

There were two commercial products, which are *pokak* and instant ginger purchased from the local market. The products were used as benchmarks for sensory evaluation and competitive analysis. *Pokak* and instant ginger were herbal drinks originally from Indonesia which have peppery taste, similar with Black PrV. All samples were served in a 100 ml cup in warm conditions before measure their sensory properties in consumer survey and quantitative descriptive analysis. Product information has been intentionally blinded and labelled as samples A and B.

2.2. Collecting customer data

Focus group (10 panelist) were conducted to gather information from customers about type of tea. There were two alternatives of tea, black PrV tea in tea bag package (powder) and black PrV tea in aluminium foil package (liquid). The information about purchase and consumption of herbal drinks, especially herbal teas was also obtained through the focus group. This information was then used to design about customer requirements survey of black PrV tea. The customer survey was conducted in Bangkalan Regency for 100 customers of herbal drink. The survey focused on 2 customer age groups: 26-40 and 41-60 years old. The customers were randomly recruited at the universities campus and public places. They were asked to fill out questionnaires about customer needs and the level of importance of customer requirements from black PrV tea and do sensory evaluation (competitive analysis) by comparing black PrV tea with *pokak* and instant ginger by using 1-5 scale. Samples were served in the random order. Among the sample, water was served for mouth washing to reduce residual effects between samples.

2.3. Creating House of Quality (HOQ)

HOQ reflection a powerful tool for the product development, however when applied to food products, its general structure has to be adapted [2]. One of the commonly used HOQ models is the Four-Phase Model of HOQ [4], which can be seen on Figure 1. This research was only created the first HOQ for generic black PrV tea. The process of creating HOQ consists of 6 stages:

1. Identify customer requirements through focus groups (10 panelists) and rate the importance of customer requirements
2. Identify technical requirements through filling out questionnaires by 3 experts of herbal drink, especially herbal tea. The experts were 2 lecturers of Agroindustrial Technology Study Program and 1 owner of herbal tea industry.

3. Link customer requirements with technical requirements (relationship matrix) with 3 rating scales 1 (weak), 3 (medium) and 9 (strong) through filling out questionnaires by 3 experts of herbal drink, especially herbal tea (point 2)
4. Conduct competitive analysis based on the attributes found in customer requirements. At this stage the customer was asked to rate 1-5 (weak-best) scale at 3 samples (black PrV tea, *pokak* and instant ginger)
5. Link between technical requirements by giving rating : strong positive (++), positive (+), strong negative (--) or negative (-). This rating made by 3 experts.
6. Determine the dominant technical requirements or have a high value of relative weight.

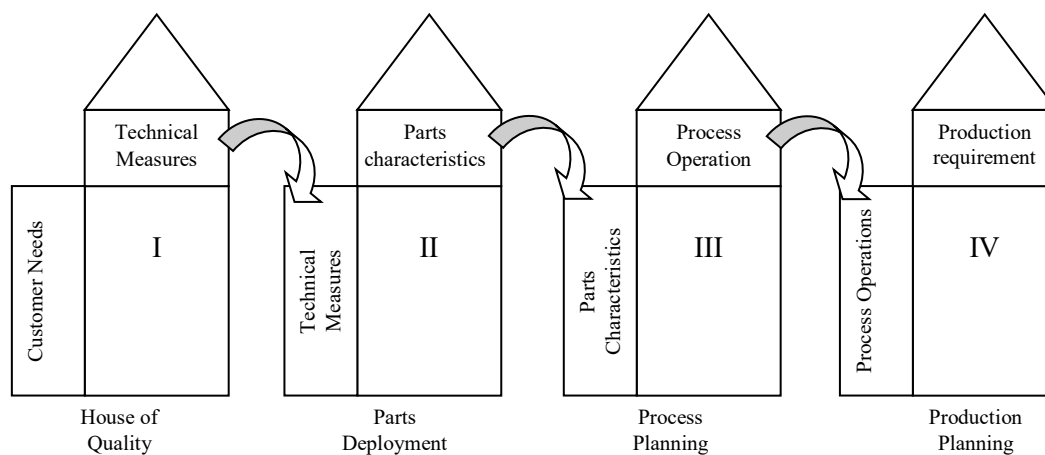


Figure 1. The four-phase model of quality function deployment [4].

2.4. Conducting experiment based on dominant technical requirements

This experiment was carried out to determine the best formulation based on sensory analysis in the production of black PrV tea. The experiment was carried out using a completely randomized design with 2 factors and 3 replications. 2 The factors used are dominant technical requirements from HOQ of Black PrV tea. The best formulation was chosen based on the highest value of preference for color, taste, flavor and overall preference.

3. Results and Discussion

3.1. Focus group discussion

The focus group discussion was conducted involving 10-trained panelists who were accustomed to consuming herbal drinks, especially *pokak* and instant ginger. The panelists were given 2 alternative new products to be developed by the researcher, namely black PrV tea (powder) packed in a tea bag and black PrV tea liquid in a sachet package. In this focus group discussion, researchers provide black PrV tea (powder) and liquid products and serve them in 200 ml cups. Black PrV tea in dye bag packaging is the chosen product, due to its familiarity, practicality and durability.

Furthermore, the panelists discussed the customer requirements of black PrV tea in a dye bag. Customer requirement is a description, in the customer's own words, of the benefit to be fulfilled by the product or service [7]. Black PrV tea has a peppery or spicy taste, similar to *pokak* and instant ginger, so these panelists are considered to understand the customer requirements of black PrV tea. Focus group discussion produces 14 customer requirements, including: natural taste, less peppery, nice color, nice flavor, quick brewing time, healthy and nutritious, good packaging design, available expiration date, good instructions, ingredient list and nutrition, inexpensive, simple and convenient product, safe, and long shelf life.

3.2. House of quality (HOQ) of black PrV tea

3.2.1. Rate the importance of customer requirements

This stage was carried out by distributing questionnaires to 100 respondents who had consumed *pokak* or instant ginger. Respondents were asked to rate the importance of 14 customer requirements black PrV tea as shown in Figure 2. There are 8 attributes that have values of 6 (important) to 7 (very important), starting from the most important is less peppery, nice flavor, natural taste, quick brewing time, nice color, good instructions, healthy and nutritious and safe respectively. Rate the importance of customer requirements was very important because can influence customer purchasing behaviour and achieve customer satisfaction [5]

Max Relationship value in	Relative weight	Weight/Importance	Technical Requirements Customer Requirements	Black PrV proportion and other materials	Type of other materials	Materials amount in tea bag	Particle size	The bag material	The bag shape	The bag size	Time to make	Total Plate Count	Type of packaging	Packaging design	Information in Packaging	Moisture Content	Competitive Analysis		
																	Black PrV	<i>Pokak</i>	Instant ginger
9	7.6	6.4	Natural taste	9	9	9											5	5	5
9	8.1	6.8	Less peppery	9	9	9											2	4	5
9	7.5	6.3	Nice color	9	9	3	1				1						3	4	5
9	7.9	6.6	Nice flavour	9	3	3					1						3	5	5
9	7.5	6.3	Quick brewing time	9	9	9	9	9									3	5	5
9	7.3	6.1	Healthy and nutritious	9	9	9											5	5	5
9	5.8	4.9	Good packaging design										9	9	3		5	5	4
9	6.9	5.8	Expired date available												9		5	4	5
9	7.4	6.2	Good instructions												9		5	5	5
9	7.0	5.9	Ingredient list and Nutrition												9		5	4	4
9	6.2	5.2	Inexpensive	9	3	3		3	3	3	9		1				4	5	5
9	6.9	5.8	Simple and convenient product								9						5	4	4
9	7.3	6.1	Safe					9				9	9			9	5	5	5
9	6.6	5.5	Long shelf life									9				9	5	4	4
			Max relationship value in column	9	9	9	9	9	3	3	9	9	9	9	9	9			
			Weight/importance	469	384.5	339.4	75.2	151.8	18.6	18.6	133.5	124.9	124	52.3	209	124.9			
			Relative weight	21.1	17.3	15.2	3.4	6.8	0.8	0.8	6.0	5.6	5.6	2.3	9.4	5.6			

Figure 2. HOQ of black PrV tea

The two highest attributes of Black PrV tea are less peppery and nice flavor. This is in accordance with research from Willis et al. [15] that consumers do not prefer spicy herbal drinks. Consumers also do not want Black PrV tea with a too strong flavor, because the flavor of black PrV is indeed very strong and not favored by consumers [12]. Based on these results, Black PrV tea is expected to be developed in accordance with the customer requirements, not too peppery and nice flavor.

3.2.2. *Technical requirements*

The Quality Function Deployment (QFD) method translated customer requirements into technical requirements [1]. Three (3) experts were asked to identify technical requirements related to 14 customer requirements of focus group results. The identification results showed that there were 13 technical requirements (Figure 2) needed in developing black PrV tea products. Those include: black PrV proportion and other materials, types of other materials, materials amount in tea bag, particle size, the bag material, the bag shape, the bag size, time to make, total plate count, packaging design (shape and color), information in packaging, and moisture content.

Black PrV tea that consumers want was one that has natural taste, less peppery and nice color and flavor, therefore we need to add other materials besides black PrV. Because if pure black PrV produces too peppery drinks, the color was not good and the flavor was too strong so that consumers did not like it.

3.2.3. *Relationship between customer requirements and technical requirements*

The relationship between customer requirements and technical requirements as seen in Figure 2, was assessed by 3 experts based on 3 value: 9 (strong relationship), 3 (moderate relationship) and 1 (weak relationship). There were 5 technical requirements that have relationships with 4 or more customer requirements at once, namely black PRV proportion and other materials, type of other materials, materials amount in tea bag, time to make and information in packaging.

3.2.4. *Competitive analysis*

This study used 3 samples for sensory testing (Competitive analysis) by 100 respondents, namely Black PrV tea, *pokak* and instant ginger. All samples are presented in their original packaging and served in a 100 ml cup. The results of competitive analysis can be seen in Figure 2.

Based on Figure 2, it can be seen that Black PrV tea was worse than its competitors on 5 attributes: less peppery, nice color, nice flavor, quick brewing time and inexpensive. Therefore, several experiments were needed to obtain the best formulation in the production of black PrV tea suitable with customer requirements. The 5 customer requirements were strongly related to 3 technical requirements, including namely black PRV proportion and other materials, type of other materials, and materials amount in tea bag.

3.2.5. *Relationship between technical requirements*

Each technical requirement may be related to other technical requirements. This relationship was indicated by 4 values, namely strong positive, positive, strong negative and negative. Relationship between technical requirements can be seen in Table 1.

Table 1 showed that Black PrV proportion and other materials are strongly related to the type of materials and materials amount in tea bag. Whereas the materials amount in tea bag related to strong positive with the bag size and is positively related to time to make. Relationship between technical requirements must be considered so that all technical requirements can produce products suitable with customer requirements.

3.2.6. *Determine the dominant technical requirements*

In the QFD method, each of the technical requirements was calculated for absolute and relative weight by considering importance, the value of the relationship matrix and the value of competitive analysis. Figure 2 showed the calculation of absolute weight and relative weights from technical requirements.

The two technical requirements with highest value of relative size weight include: the proportion of black PrV proportion and other materials, and type other materials. Furthermore, these two technical requirements are used as factors in the experiment to determine the best formulation.

3.3. Conducting the experiment

End Product characteristics showing higher technical importance rating above are selected for further deployment by conducting experiment [6]. The experiment was carried out using a completely randomized design with 2 factors. The first factor is black PrV proportion with 3 levels, namely 90%, 80% and 70% and the second factor is type of other materials with 2 levels, namely *secang* wood and tin leaf tea. The experimental results were shown in Table 2.

Table 1. Relationship between technical requirements

Technical Requirements	Black PrV proportion and other materials	Type of other materials	Materials amount in tea bag	Particle size	The bag material	The bag shape	The bag size	Time to make	Total Plate Count	Type of packaging	Packaging design	Information in Packaging	Moisture Content
Black PrV proportion and other materials		++	++										
Type of other materials													
Materials amount in tea bag							++	+					
Particle size								++					
The bag material													
The bag shape													
The bag size													
Time to make													
Total Plate Count													
Type of packaging													
Packaging design													
Information in Packaging													
Moisture Content													

Table 2. Experimental results.

Treatment	Average value of customers preference			
	Color	Flavor	Peppery taste	Overall preference
90% PrV : 10% <i>secang</i> wood	3.56	3.16	2.24	3.54
90% PrV : 10% tin leaf tea	3.21	2.54	2.10	3.25
80% PrV : 20% <i>secang</i> wood	4.65	3.85	3.26	3.88
80% PrV : 20% tin leaf tea	3.92	3.24	3.18	3.45
70% PrV : 30% <i>secang</i> wood	4.36	3.65	3.32	3.72
70% PrV : 30% tin leaf tea	4.25	3.30	3.20	3.68

The best formulation based on experimental results (Table 2) was 80% Black PrV and 10 % *secang* wood because giving red color [14] that preferred by consumers, but peppery taste was not good.

Secang wood Based on the experimental results, there was needed another study about type of other materials and Black PrV proportion.

4. Conclusion

There are 14 customer requirements of Black PrV tea include: natural taste, less peppery, nice color, nice flavor, quick brewing time, healthy and nutritious, good packaging design, available expiration date, good instructions, ingredient list and nutrition, inexpensive, simple and convenient product, safe, and long shelf life. Thirteen technical requirements are required to develop black PrV tea, include: black PrV proportion and other materials, types of other materials, materials amount in tea bag, particle size, the bag material, the bag shape, the bag size, time to make, total plate count, packaging design (shape and color), information in packaging, and moisture content. The findings confirmed that the best formulation to produce black PrV tea was 80% black PrV and 10 % *secang* wood.

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