Product development of sweet potato dry noodle using Quality Function Deployment (QFD)

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Abstract. The current consumption pattern of Indonesian consumers is increasingly diverse, creating a challenge for the industry to develop products. Quality Function Deployment (QFD) is a reliable tool to create a new product. One of the demanded products is dry noodle. However, the challenge is that the raw material, flours, is imported. Therefore, the alternative raw material is required to reduce wheat consumption. Sweet potatoes are local agricultural products which have the potential to be used as flour substitution to produce dry noodles. The purposes of this study were to determine consumer needs of dry noodles and to assess the organoleptic quality of sweet potato dry noodle. This study executed phase 1 and 2 of the QFD method. In the first phase, the QFD was used to determine consumer needs of dry noodles. There were 100 respondents involved by filling a questionnaire. The list of consumer needs were then used in the second phase to assess the potential of sweet potato dry noodles and compared it with two existing dried noodles products. Fifteen respondents performed a sensory test for the second phase. The results showed that there were 11 attributes of the dry noodles required by consumers. Sweet potato dry noodle was considered unable to satisfy the panellists. Besides, its quality should be improved by choosing high-quality raw materials and by adding wheat flour or dry gluten in the composition of sweet potato dry noodles. It is believed to affect the texture and elasticity of sweet potato dry noodles.

1. Introduction
The food consumption trend in Indonesian is increasing. The rise of middle-class economy challenge industries to develop products that suit consumer needs. The determining factors for the success of NPD (New Product Development) are the level of compatibility between new products and consumer needs. This can be found out with Quality Function Deployment (QFD) method.

The demand for noodles in Indonesia is high, which ranked second after China as the country with the most need for noodles, and the consumption is increasing [1, 2]. The growth of dry noodles consumption is an opportunity as well as a challenge for the industry because the raw material, flour, has to be imported. Therefore, raw materials alternative are needed to reduce flour consumption.

Sweet potatoes are a local agricultural product that has the potential to be used as an alternative flour. Sweet potato dried noodle is a new product idea whose acceptance level is unknown, so it needs to be tested for organoleptic by expert panellists. This study aims to determine the consumer's need for dry
noodle products and to determine the panellist's assessment of the organoleptic quality of sweet potato dry noodle products compared to wheat flour-based noodles.

2. Materials and Methods

2.1. Scope
The limitations of this study are (1) modified QFD food deployment is only up to phase II/III, which is a combination of part deployment and process planning. In this phase, it shows the product specifications what consumers want and in phase III shows a concrete process planning. (2) The discussion is completed on sensory attributes. (3) The sweet potato used as a composite material at the product development stage is white sweet potato. (4) This research produces product development concept of sweet potato dry noodles.

2.2. Population and sample determination
The sample was taken by using a purposive sampling technique. The Slovin formula determines the number of samples with a population of Malang City:

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    n = \frac{N}{1 + Ne^2}
\]

where \( n \) = sample size, \( N \) = population size, and \( e \) = allowance for inaccuracy due to tolerable sampling errors. These respondents filled out provided questionnaires in order to determine consumer needs for dry noodle products.

2.3. Sweet potato dry noodle making
The ingredients used are Besta (a local sweet potato fleshy white tuber variety), sodium bisulfite, hard flour type of flour with 20% protein content, salt, water, eggs, tapioca flour, and carboxy methyl cellulose. The tools needed in the manufacturing process are a mixer, an analytic scale, a dough thinner (seater), a noodle strand printer, a cabinet dryer, a gas stove, a steamer pan, a plastic basin, a paring knife, scissors, a sieve, moulds, tablespoons and a measuring cup.

The making of dried sweet potato noodles is based on the best treatment carried out by [4], namely dry sweet potato noodles with 0.3% sodium metabisulfite immersion (w/v) for 125 minutes and the addition of flour by 25%. Products were tested organoleptically by 15 expert panellists. Organoleptic analysis using the hedonic scale method includes 6 quality parameters, namely taste, colour, aroma, shape, texture and elasticity. The scale used is 1-5, which means 1 (strongly disliked), 2 (disliked), 3 (ordinary), 4 (liked) and 5 (strongly liked). Organoleptic assessment of dry noodles was carried out by cooking the noodles in advance.

2.4. Data analysis
A research instrument test was conducted using SPSS Statistic 17.0 to determine whether the questionnaire used can measure what is desired to measure (validity) and whether it is relatively consistent (reliability). House of Quality (HOQ) was carried out to determine consumer needs for dry noodle products, the first phase of QFD. Meanwhile, to assess the comparison of the satisfaction value of sweet potato noodle products compared to two existed products on the market, the second phase of QFD was executed, namely part deployment and process planning.
3. Results and Discussion

3.1 Overview of respondents
The respondents live in Malang City, and are women aged 16-25 years and work as students or college students with monthly income < IDR 750,000.00.

3.2 Research instrument test results
All indicators in the questionnaire have met the requirements r statistic> r table (α = 0.1; df = 98). Cronbach's alpha for all variables used in this study has good reliability because all of them are more than 0.6, showing that the instrument used was valid and reliable.

3.3 Phase 1 QFD data processing (house of quality)
There are 11 attributes of consumer needs which are called the voice of customers (VOC). VOC recapitulation is presented in Table 1. Of the 11 attributes, six attributes are sensory attributes (colour, texture, shape, elasticity, taste and aroma) and is shown in Figure 1. The analysis was carried out by looking for the relationship of "whats" attributes (VOC) and the "hows" attribute (product requirements). The determination of the relationship is done by calculating the results of the Pearson correlation using the SPSS between the scores of the first part of the questionnaire which is used to identify consumer needs and the second part of the questionnaire which measures the level of importance of the dry noodle product attributes. The terms of the "whats" and "hows" attribute value relationship according to [4], Pearson correlation with significance α <0.01 indicates a weak relationship with a score of 1, the 0.001 <α≤0.01 indicates a moderate relationship with a score of 3 and α <0.001 indicates a strong relationship with a score of 9.

Table 1. Voice of the customer of dry noodle.

| Statements                                | Score Average |
|-------------------------------------------|---------------|
| 1. The colour of dry noodle is appetizing | 3.20          |
| 2. The taste of dry noodle is delicious   | 3.50          |
| 3. Dry noodle has a specific flavour      | 3.43          |
| 4. Dry noodle has a soft texture         | 3.44          |
| 5. The shape of dry noodle is appealing  | 3.24          |
| 6. Dry noodle makes you full             | 3.30          |
| 7. Dry noodle is elastic                 | 3.77          |
| 8. Dry noodle can be served to taste     | 4.01*         |
| 9. Dry noodle has a long shelf life      | 3.81          |
| 10. Dry noodle has additional nutritional contents | 3.10** |
| 11. Dry noodle is suitable for anyone's consumption | 3.49 |

Note: * highest score; ** lowest score

The relationship between the attributes of good taste (whats) and colour (hows). This shows that for consumers, the need for good taste can be represented by colour sensory attributes. The same thing happened to the soft texture (whats) with the colour (hows) and the attractive noodle colour (whats) with the colour (hows).

Raw weight and normalized raw weight indicate the level of consumer needs (whats). As seen in Figure 1, the highest need value was chewy noodles with a raw weight score of 385 and a normalized raw weight of 18.7. The lowest score on the colour attribute with a score of 316 for the raw weight then 15.3 for the normalized raw weight on the colour of the noodles is appealing. The contribution value shows the level of contribution to the product requirement (hows) attribute.
### Sensory Attributes

| Sensory Attributes | Instrumental Testing |
|--------------------|----------------------|
| Taste | Texture | Flavour | Colour | Shape Consistency | Elasticity |
| Delicious Taste | .780 | .843 | .666 | o | .009 | .304 | .467 |
| Soft Texture | .105 | .561 | .344 | o | .009 | .287 | .659 |
| Specific Flavour | .540 | .032 | .019 | .269 | .412 | .740 |
| Appetizing Colour | .780 | .843 | .666 | o | .009 | .304 | .467 |
| Appealing shape | .460 | .098 | .581 | .012 | .233 | .413 |
| Elastic noodle | .061 | .204 | .573 | .540 | .418 | .779 |

| Raw Weight | Normalized Raw Weight |
|------------|------------------------|
| 356 | 17.2 |
| 343 | 16.6 |
| 343 | 16.6 |
| 316 | 15.3 |
| 323 | 15.6 |
| 385 | 18.7 |

| Contribution | 0 | 0 | 0 | 0 | 0 | 0 |
|--------------|---|---|---|---|---|---|
| Relative Contribution | 0 | 0 | 0 | 100 | 0 | 0 |

Notes: Significance of $\alpha<0.01$ weak relationship, Significance of $0.001<\alpha\leq0.01$ medium relationship, Significance of $\alpha<0.001$ strong relationship

$\alpha$ Medium relationship (Score =3, total =3)

**Figure 1.** House of quality of dry noodle

Figure 1 shows that there is only one contribution value, namely the colour attribute with a score of 147.3 so that this attribute has a relative contribution value of 100 which indicates that the colour sensory attribute is an attribute that is very influential for consumers in choosing a product. In this study, consumers emphasize the colour-sensory attributes to answer the needs of both texture and taste. In food products, food colour creates a synergetic taste produced by the food consumed so that consumers will feel a better taste in these products [5]. According to [6], colour is an essential attribute for food products. In many cases, the colour change is accompanied by changes in texture, taste and flavour.

#### 3.4. Phase 2 QFD data processing

Voice of the engineer is obtained from the “hows” attribute on HOQ. There are 6 attributes of the voice of engineer which indicate the need of engineers to carry out product development. Importance score to engineer shows the importance level of the voice of engineer attribute. The list of the voice of engineers and their importance to engineer is presented in Table 2.

The Customer Satisfaction Performance (CSP) value is obtained from the third part of the questionnaire where in this section the respondents conduct an organoleptic test by comparing two products on the market, namely products A and B. In this section, an assessment of the physical properties of the product is carried out, namely taste, texture, elasticity, aroma, colour and shape. The same thing is also done with the product being developed, namely dried sweet potato noodles. The CSP values of the three products are presented in Table 2.

**Table 2.** Voice of the engineer, importance to engineer and customer satisfaction performance value.
Overall, dried sweet potato noodles had the lowest score of all the attributes tested. This shows that the dried sweet potato noodles have not been able to meet the needs of consumers for the six attributes. The low value shows the characteristics of the dry sweet potato noodles that are less favourable to the panellists. Comparison of the physical characteristics of dry sweet potato noodles and dry noodles A and B is presented in Table 3 and Figure 2. In addition, the low satisfaction score indicates that the quality of dried sweet potato noodles is less able to meet consumer needs. The quality of food products is influenced by several factors, one of which is composition. The composition of products A, B and sweet potato dried noodles is presented in Table 4.

**Table 3.** The comparison of product A, B and sweet potato dry noodle characteristics after cooking.

| No | Attributes   | Importance to Engineer | Product A | Product B | Sweet Potato Dry Noodle [3] |
|----|--------------|------------------------|-----------|-----------|----------------------------|
| 1  | Taste        | 4.36*                  | 3.48      | 3.49*     | 3.00**                     |
| 2  | Texture      | 3.79                   | 3.70*     | 3.59      | 3.53**                     |
| 3  | Elasticity   | 3.86                   | 3.60      | 3.62*     | 2.73**                     |
| 4  | Flavour      | 3.91                   | 3.14      | 3.24*     | 2.80**                     |
| 5  | Colour       | 3.55                   | 3.54      | 3.63*     | 3.33**                     |
| 6  | Shape        | 3.53**                 | 3.84*     | 3.73      | 3.53**                     |

Note: * highest score; ** lowest score

**Figure 2.** Dry noodle (A) product a; (B) product b; (C) sweet potato.

**Table 4.** Product A, B and sweet potato dry noodle ingredients
The low score of the dry sweet potato noodle texture attribute was due to the composition of the product. Sweet potato dry noodles compared to the other two products, do not use 100% flour. The amount of flour used is reduced to 25% and replaced with sweet potato flour. This greatly affects the texture of the resulting product because the texture of the noodles is affected by the gluten content in wheat flour. The sweet potato does not contain gluten because it comes from the non-cereal root class. Although the dried sweet potato noodles use egg as an additional composition, it is not enough to improve the texture quality of dry noodles. According to [7], eggs as texture formers produce a thin and strong layer on the surface of the noodles, besides that eggs, develop the dough.

The elasticity of the sweet potato dry noodle products was also less favourable when compared to the other two products. The elasticity of the noodle products is influenced by the gluten content contained in it [7]. The quality and quantity of flour determine gluten content. High-quality flour has a gluten content of 12% -14%. Flour with high gluten content causes high elasticity of the noodles and does not break easily.

Meanwhile, low-quality flour with gluten content <12%. This type of flour tends to be used for cakes because of its brittle nature [8]. The low gluten content causes the noodles to break easily both when they are in the form of dough and after forming the noodle strands.

The low score of the flavour attribute of the dried sweet potato product was due to the smell of eggs produced. Dried sweet potato noodles use eggs in the noodle-making process, as well as product A. They smelled fishy. Unlike product B, which has the highest level of satisfaction, it does not add eggs to the noodle composition. According to [9], eggs cause a fishy aroma in boiled noodles.

The dried sweet potato noodles also have the lowest score on the colour attribute. In the research results, the dried sweet potato noodles tended to be dark in colour and after cooking. They were greyish yellow, while the colours A and B tended to be pale yellow. The dark colour is caused by the ash content in the flour used. According to [10], the ash content in flour can affect the colour. The higher the ash content, the darker the colour will be in the finished product. The white sweet potato flour used in this study had 3.53% ash content, higher than that of 1.04% in the experiment conducted by [11]. Also, the dried sweet potato noodle product does not use yellow synthetic dye (Tartrazine Cl 19140) in the noodle-making process. Dried sweet potato noodles use sodium metabisulphite mixed in soaking water for 125 minutes in the process of making sweet potato flour which functions to produce white sweet potato flour.

The dried sweet potato shape also had the lowest score. The most preferred is product A with an elongated straight shape, while the sweet potato dry noodle product also has a straight shape without waves like product B but the dried sweet potato noodles have short strands. This short strand is due to the low gluten content so that during the formation process, the noodles the strands break quickly. Noodles with long shapes without waves have been favoured by consumers these days. That is why there is an increase in demand for long straight noodles compared to the wavy (curly) noodles [12].

Table 5 shows that the goal used as a reference for improvement is the delicious taste, soft texture, non-fishy flavour, yellow noodle colour and elongated straight noodle shape. The overall goal value shows that it is necessary to improve all the attributes of sweet potato dry noodles. In this phase, a part deployment and process planning are obtained, which shows the technical response process with the essential score affecting the quality of the product produced (Figure 3). In this research, the most critical technical response is the quality of the raw materials followed by the composition of the raw materials.

| Product A | Product B | Sweet Potato Dry Noodle [3] |
|-----------|-----------|----------------------------|
| • Flour   | • Flour   | • White sweet potato powder, Flour and Tapioca |
| • Salt    | • Iodized salt | • Salt |
| • Acidity regulator (potash and natrium carbonate) | • Raising agent (potash and natrium carbonate) | • Carboxy Methyl Cellulose and ice water |
| • Egg     | • Sekuestran of natrium poliphosphate | • Egg |
| • Food colouring agent of tartrazine Cl 19140 | • Food colouring agent of tartrazine Cl 19140 | • Bleaching agent of sodium metabisulfite |

| Colour | Product A | Product B | Sweet Potato Dry Noodle |
|--------|-----------|-----------|------------------------|
| Ash    | 3.53%     | 1.04%     | 0.15%                  |
| Flour  | 0%        | 0%        | 12%                    |
| Salt   | 1.04%     | 1.04%     | 1.04%                  |
| Food   | 1.04%     | 1.04%     | 1.04%                  |
| Others | 1.04%     | 1.04%     | 1.04%                  |
Table 5. Goal and improvement ratio values.

| No | Attributes | Customer Satisfaction Performance Value | Goal | Improvement Ratio |
|----|------------|------------------------------------------|------|------------------|
|    |            | A    | B    | Sweet Potato Dry Noodle [3] |      |                  |
| 1  | Taste      | 3.48 | 3.49*| 3.00              | 3.49 | 1.163            |
| 2  | Texture    | 3.70*| 3.59  | 3.53              | 3.70 | 1.047**          |
| 3  | Elasticity | 3.60 | 3.62*| 2.73              | 3.62 | 1.324*           |
| 4  | Flavour    | 3.14 | 3.24*| 2.80              | 3.24 | 1.157            |
| 5  | Colour     | 3.54 | 3.63*| 3.33              | 3.63 | 1.089            |
| 6  | Shape      | 3.84*| 3.73  | 3.53              | 3.84 | 1.086            |

3.5. Recommendation for improvement

One way to meet consumer needs is to pay attention to the quality of raw materials and the composition of raw materials, such as by adding gluten content to the composition of dry sweet potato noodles which can be done by increasing the amount of flour or by using dry gluten. Dry gluten is the result of drying gluten [13]. Dry gluten maintains the physical functional properties of the product when it is added to the dough, which results in an increased dough volume and a chewier product texture [14]. The ratio between the flour and sweet potato flour used should be altered. Based on research by [15], the composition of the dry sweet potato noodles that was the chewiest was adding 70% flour and 20% corn flour. Only 10% of sweet potato flour is used. This composition produces the highest gluten content compared to noodles with other composite flour.

4. Conclusions

The QFD results showed that there are 11 attributes of consumers’ needs for dry noodle products, namely pleasing colour, tasty dry noodles, distinctive aroma of noodles, soft texture noodles, attractive shape of noodles, large portion serving of dry noodles, chewy dry noodles, customizable dry noodles taste, have
a long shelf life, have high nutritional content and suitable for anyone consumption. The results of the development of dried sweet potato noodles cannot satisfy the panellists compared to wheat flour-based noodles existed on the market. Further research on sweet potato noodle recipes is required.

References
[1] World Instant Noodles Association 2014 Global demand for instant noodles. World Instant Noodles Association (WINA)
[2] Badan Pusat Statistik 2012 Statistik konsumsi pangan 2012 (Food consumption statistics 2012) (Jakarta: Badan Pusat Statistik-Statistics Indonesia) [In Indonesian]
[3] Mahmud K 2015 Karakteristik organoleptik mi kering ubi jalar putih (kajian lama perendaman natrium bisulfit dan konsentrasi penambahan tepung terigu) (Organoleptic characteristics of white sweet potato dried noodles (Study of soaking time for sodium bisulfite and addition of wheat flour concentration)). Undergraduate Thesis, Universitas Brawijaya Malang [In Indonesian]
[4] Ratnaningsih S, Jangchud A, Jangchud K, Therdthai N, Wilkinson B H P 2010 Gold kiwifruit leather product development using quality function deployment approach Food Quality and Preference 21 1 339–345
[5] Nikolinakos D, Georgiadou A, A Protopapas, Tzavaras A, Potagas C 2013 A case of colour-taste synesthesia Neurocase. 19 3 282-294
[6] Field R W, Bekassy-Molnar E, Lipnizki F, Vatai G 2017 Engineering aspect of membrane separation and application in food processing (Boca Raton: CRC Press)
[7] Koswara S 2009 Teknologi pengolahan mie (Noodle processing technology) (Semarang: eBookPangan Universitas Muhammadiyah Semarang) [In Indonesian]
[8] Offia-Olua B 2014 Chemical, functional and pasting properties of wheat (Triticum spp)-walnut (Juglans regia) flour Food and Nutrition Sciences. 51 1591-1604
[9] Abidin Z A, Devi C, Adeline 2013 Development of wet noodle based on casava flour J. Eng. Technol. Science. 45 1 97-111
[10] Keran H, Salkic M, Odobasic A, Jasic M, Ahmetovic N, Sestan I 2009 The importance of determination of some physical – chemical properties of wheat and flour Agriculturae Conspectus Scientificus, 74 3 197-200
[11] Liur I J, Musfiroh A F, Mailoa M, Bremeer R, Bintoro V P, Kusrahayu 2013 Potensi penerapan tepung ubi jalar dalam pembuatan bakso sapi (Potential application of sweet potato flour in beef meatballs making) J. Aplikasi Teknologi Pangan 2 1 40-42 [In Indonesian]
[12] Research and Markets. 2013. Research report: the 2011-2016 outlook for dry shaped pasta in india (US: Research and Market Report Publishing)
[13] Kumar N, Khatkar B S, Kausik R 2013 Effect of reducing agents on wheat gluten and quality characteristics of flour and cookies Food Technology. 37 2 68-81
[14] Day L, Augustin M A, Batey I L, Wrigley C W 2006 Wheat-gluten uses and industry needs Trends in Food Science & Technology. 17 2006 82–90
[15] Ratnaningsih, Permana A W, Richana N 2010 Pembuatan tepung komposit dari jagung, ubikayu, ubijalar dan terigu (lokal dan impor) untuk produk mi (Composite flour making from corn, cassava, sweet potato and wheat (local and imported) for noodle products). Prosiding Pekan Serealia Nasional 2010 [In Indonesian]