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Product development of *Piper retrofractum Vahl* candy using value engineering

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ABSTRACT

Madura is the largest producer of Piper retrofractum Vahl in Indonesia. However, this commodity has not developed well, so it is necessary to develop Piper retrofractum Vahl candy products and conduct a feasibility study on establishing an agro-industrial factory in Madura. This research aims to develop Piper retrofractum Vahl candy product and feasibility study. The development of the Piper retrofractum Vahl candy product uses the Value Engineering method to produce the best alternative. The best product alternative will be an industrial feasibility analysis that includes analysis of Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PP), Benefit/Cost Ratio (B/C Ratio), and Break Even Point (BEP). The results of this study indicate that there are five attributes in the development of Piper retrofractum vahl candy, namely taste (5), shape (4.3), color (4.3), texture (3.6), and packaging shape (4.3). After conducting an analysis of alternative selection, the best alternative was selected, namely chocolate flavor with a performance value of 3.44, animal shape with a performance value of 5.62, red color with a performance value of 4.9, hard texture (hard candy) with a performance value of 8.04 and transparent packaging shape with a performance value of 8.34. The overall performance value of the best alternative design is 30.34. The results of the financial analysis of the Piper retrofractum Vahl candy product are said to be feasible because its value is above the standard. Thus, the project is economically feasible and can increase the sustainability of Madura local wisdom.

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INTRODUCTION

Madura Island is a very suitable place to cultivate Piper retrofractum Vahl. The leading producer of this commodity in Madura is in the easternmost Regency in Madura, namely Sumenep, which is spread across Bluto District. The quality of this commodity developed in Sumenep Regency is excellent. Piper retrofractum Vahl in Sumenep has a high piperine content, essential oils, and oleoresin (Aswar et al. 2022). Piper retrofractum Vahl contains around 4-6% piperine (Ulya et al. 2020a). The piperine contained in Piper retrofractum Vahl is around 2% (Widana 2021), and the essential oil content is around 1%. (Ulya et al. 2020a). The piperine substance in Piper retrofractum Vahl has benefits such as reducing fever and increasing body stamina. In addition, Piper retrofractum Vahl also contains high essential oils, which have benefits as antibacterials. (Widana 2021). Piper retrofractum Vahl is commonly used in mixtures of various types of traditional herbal medicine. (Rahman et al. 2023). The use of Piper retrofractum Vahl in traditional herbal medicine is done because of its effects, which can improve health and are not harmful to the body. (Mojiono and Ambarwati 2023).

Based on data from the East Java Central Statistics Agency in 2022, the production of Piper retrofractum vahl in Sumenep Regency reached 10,314.49 tons with a productivity of 4,762.85 kg/Ha. The output of Piper retrofractum Vahl has increased significantly from year to year. However, this commodity has not been balanced by the processing of Piper retrofractum Vahl on an industrial scale. Piper retrofractum vahl is only sold to collectors because the need for piper retrofractum vahl abroad is around 6 million tons. However, Indonesia can only meet one-third of the Piper retrofractum vahl export needs (Anisah and Hayati 2017). The export destinations for Piper retrofractum Vahl are India, Hong Kong, China, and Singapore (Suhardi and Subari 2020). Therefore, further processing of Piper retrofractum Vahl is needed to produce a product that will increase the added value. Further processing will increase the community's income and allow Piper retrofractum Vahl farmers to plant Piper retrofractum Vahl sustainably.

The potential content of compounds found in Piper retrofractum Vahl is widely extracted to be innovated into beverage and food products, including herbal candy. Candy is one of the snack products in demand by all groups, from children to adults. Candy is generally made from water, sucrose, glucose syrup, flavor, coloring, thickener, and acidifier (Amir et al. 2017). Herbal candy is an innovation made from herbal ingredients such as ginger, lime, kaempferia galanga, piper retrofractum vahl, mint leaves, etc. This herbal candy was developed by looking at the benefits needed by consumers (Daniela et al. 2024). One of the herbal candies is made from a combination of natural ingredients with Piper retrofractum vahl extract.

Many product development studies use the Value Engineering method, including in the development of herbal drink products (Ulya et al. 2020b), instant corn rice (Hidayat and Nasikin 2021), palm oil refinery (Waluyo 2018), crispy peperek products (Rosita et al. 2018), boran rice (Alfirmansyah et al. 2022), and the development of calcium (Sadikin et al. 2015). Meanwhile, the financial analysis method is used to determine the feasibility of the industry. Some studies that use financial analysis include research on the feasibility study of herbal tea (Nugroho et al. 2021), gluten-free brownies made of purple sweet potato (Mustafa and Elliyana 2020), coconut fiber (Yulia and Lisani 2023), salt industry (Efendy et al. 2023), soy milk extract (Cahyani and Novitasari 2021), potato chips machine (Prasnowo et al. 2019), and solar cells (Amir et al. 2022).

METHODS

The Value Engineering method developed this Piper retrofractum vahl candy product. Because the value engineering method is excellent for product development and emphasizes cost efficiency (Jagannathan 1995, Miles 2015, Tao and Yu 2017, Hasibuan et al. 2018). The stages in product development are the information, creativity, and analysis stages.

The production process of piper retrofractum vahl candy begins with grinding dried piper retrofractum vahl using a grinder and extracting it. The extraction results are then evaporated using a rotary evaporator. Glucose, sucrose, flavors, and water are heated until thick, then Piper retrofractum vahl extract is added, and heated until boiling. The resulting dough is poured into a mold and left to harden. The candy is then packaged using a standing pouch.

The information stage is the initial stage that will focus on collecting information from experts who have been selected according to the topic taken. The most important product attributes are identifying threats and opportunities for consumer preferences in consuming piper retrofractum vahl candy products, the production process for making piper retrofractum vahl candy, and the priority level of its importance. The information stage is carried out by distributing questionnaires and interviews with three experts: a candy business owner, the research and development team of the industry, and researchers (Giacalone et al. 2013). The creative stage is to identify the attribute factors of the Piper retrofractum vahl candy product and conduct a more detailed analysis to find out the factors that can influence the attributes. The purpose of the creative stage is to eliminate and combine the lowest value of each component or function of the product.

The Analysis Stage is to analyze the functions needed, which will later obtain the lowest cost, find out the main functions and supporting functions, and identify costs that can be reduced or even eliminated without compromising product quality. This development stage performs activities by comparing the conclusions of previously established studies. This stage is helpful for preparing alternative ideas that are selected for further development, controlling risks and costs, accordingly, analyzing cost benefits, and developing a plan by following up and identifying implementation steps, schedules, and responsibilities for each selected alternative.

From the Value Engineering method, the best product alternative will be obtained. The best product alternative will undergo an industrial feasibility analysis, which includes analysis of *Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PP), Benefit/Cost Ratio (B/C Ratio), Break Even Point (BEP)* (Brown 2016). The formula presented in Equation (1) to (6).

$$BEP\ unit = \frac{F}{P - V} \quad (1)$$

$$BEP\ price = \frac{Total\ fixed\ costs}{Total\ production} \quad (2)$$

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} \quad (3)$$

$$IRR = 1 + \frac{NPV_1}{NPV_1 - NPV_2} \times (i_2 - i_1) \quad (4)$$

$$PP = \frac{total\ investment}{Net\ cash} \times 1 years \quad (5)$$

$$B/C ratio = \frac{Present\ value\ of\ net\ cash\ flow}{Investment\ value} \quad (6)$$

Remarks,
BEP = Break event point
NPV = Net present value
IRR = Internal rate of return
PP = Payback Period
B/C = Benefit/Cost Ratio
F = Fixed cost
P = Price unit
V = Variable unit
Bt = Benefit
Ct = Cost-t
I = interest rate
n = n period
t = years-t

RESULTS AND DISCUSSION

Information Stage

The initial stage of the Value Engineering method is the information stage, which is the stage to determine several factors that developed in the herbal candy product Piper retrofractum Vahl. Based on interviews with three experts: a candy business owner, the research and development team of industry, and researchers, several important attributes were obtained to be developed, including herbal candy with an attractive shape, sweet taste, striking color, good texture for consumers and of course practical packaging without neglecting and reducing the consistency of product quality. Piper retrofractum Vahl candy is made from natural ingredients, especially medicinal plants or herbs, and has specific health benefits.

Piper retrofractum Vahl candy is one of the herbal candies with high efficacy, one of which is that it can be helpful as an appetite enhancer. In general, piper retrofractum vahl candy consists of piper retrofractum vahl extract, sucrose, glucose, water, and complementary ingredients, namely coloring and flavoring. Piper retrofractum Vahl candy is usually round, hard, and soft, with the primary packaging used being closed plastic (Hidayat et al. 2024).

Based on the results of interviews with three expert respondents, it was found that five important attributes will be developed in the Piper retrofractum vahl candy product, namely in terms of taste, packaging, color, texture, and packaging shape. The average results of each factor are taste (5), shape (4.3), color (4.3), texture (3.6), and packaging shape (4.3). Because the average results of the factors are above 3, these factors are considered important. (Miles 2015).

Creative Stage

The creative stage is conducted using an interview method with three expert respondents to develop alternatives and criteria. In the creative stage, several alternative designs prioritize aspects of the product's quality, safety, and beauty. The results of interviews with three expert respondents produced several alternative flavors, shapes, colors, textures, and packaging shapes. The flavor factor has four alternatives: chocolate, strawberry, orange, and melon. The shape factor has three alternatives: fruit shape, animal shape, and object shape. The third factor is color; there are three alternatives: red, yellow, and green. The fourth factor is texture, which has two alternatives: soft and hard candy. The last factor is the packaging shape, which has two alternatives: transparent and closed packaging. Based on these data, the number of designs obtained is $4 \times 3 \times 3 \times 2 \times 2 = 144$ designs of Piper retrofractum vahl candy products.

Analysis Stage

The analysis stage is carried out by analyzing each alternative design of the Piper retrofractum vahl candy product. An important alternative obtained in the previous stage is the creative stage, which is analyzed based on the assessment of expert respondents. This analysis stage aims to obtain an alternative design with the best value. The selected alternative has the highest performance value of the 144 selected alternatives. The alternative score value is obtained from interviews and questionnaires with three experts. The performance value for the first selected alternative, namely with the code A1B2C1D1E1, gets a value of 30.34, the second selected alternative with the code A1B2C2D1E1 gets a value of 30.22, the third alternative with the code A1B1C3D1E1 gets a value of 30.22, the fourth alternative with the code A1B2C3D1E1 gets a value of 30.22, and the last selected alternative with the code A1B1C1D1E1 gets a value of 30.18.

Table 1 is the best alternative with code A1B2C1D1E1 is chocolate flavor with a performance value of 3.44, animal shape with a performance value of 5.62, red color with a performance value of 4.9, hard candy with a performance value of 8.04, and transparent packaging shape with a performance value of 8.34. The overall performance value of the best alternative design is 30.34.

Table 1 Alternative design plan

Attribute	Alternative	Performance
Flavor	Chocolate	3,44
Shape	Animal	5,62
Color	Red	4,9
Texture	Hard Candy	8,04
Packaging	Transparent	8,34
Total		30,34

Financial Analysis

After getting the best alternative, the next step is to conduct a financial analysis to determine whether it is feasible to establish a Piper retrofractum vahl candy industry (Park and Sharp 2021). Piper retrofractum Vahl requires several machines to support the manufacturing process of making herbal candy. The machines and equipment used include grinders, mixers, sealers, pans, molds, gas stoves, filter cloths, wooden spoons, scales, and measuring cups. The total cost of the machines required is IDR.11,330,000. The raw materials include Piper retrofractum vahl, sucrose, glucose, water, coloring, and flavorings.

Table 2 Casflow

Years	Net Cashflow	Cumulative
1	IDR 9,551,874	IDR 9,551,874
2	IDR 12,009,669	IDR 21,561,543
3	IDR 12,009,669	IDR 33,571,212
4	IDR 12,009,669	IDR 45,580,882
5	IDR 12,009,669	IDR 57,590,551
PP		2.8

The result of the Internal Rate of Return (IRR) of the Piper retrofractum vahl candy that will be built is 25.14%. The criteria that indicate a business is feasible or can be run are that the IRR is greater than the interest rate applicable in that year. The interest rate is 12%, so the business is feasible (Kusmayadi et al. 2017).

Table 3 Net present value (NPV)

Years	Net Cashflow	df 12.00%	Present Value
1	IDR 9,551,874	0.8929	IDR 8,528,868
2	IDR 12,009,669	0.7972	IDR 9,574,108
3	IDR 12,009,669	0.7118	IDR 8,548,483
4	IDR 12,009,669	0.6355	IDR 7,632,145
5	IDR 12,009,669	0.5674	IDR 6,814,286
Total PV net cashflow			IDR 4,097,890
Total Investment			IDR 32,361,961
NPV			IDR 8,735,929

Table 2 is the result of the Payback Period of the Piper retrofractum vahl candy product of 2.8 can be interpreted as 2 years and 9 months. Based on the feasibility criteria, Piper retrofractum vahl candy is feasible because the payback period value is smaller than the economic life of the business, which is five years. Net present value (NPV) calculations are in table 3.

The results of the financial analysis of the best alternative piper retrofractum vahl candy product are Payback Period of 2.8 (2 years, 9 months) < 5 years, Net Present Value (NPV) value > zero which is IDR 8,735,929, Internal Rate of Return (IRR) value of 25.14% > 12%, Net B/C of 1.73 is declared feasible because > 1, and BEP price of IDR 7,761/unit.

CONCLUSION

The results of this study indicate that there are five attributes in the development of herbal Piper retrofractum vahl candy: taste (5), shape (4.3), color (4.3), texture (3.6), and packaging shape (4.3). After analyzing the alternative selection, the best alternative was selected; chocolate flavor with a performance value of 3.44, animal shape of 5.62, red color of 4.9, hard candy of 8.04, and transparent packaging shape of 8.34. The overall performance value of the best alternative design is 30.34. The results of the financial analysis of the Piper retrofractum vahl candy product are said to be feasible because its value is above the standard.

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