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Analysis of the Added Value of Hard Candy with Robusta Green Coffee Bean Powder Extract

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Abstract

Robusta green beans have a high chlorogenic acid content that is beneficial as an antioxidant, but their bitter and astringent taste limits consumer acceptance. This research aims to analyze the value added of the process of making hard candy based on robusta coffee green bean powder extract using the Hayami Method. The formulation for making hard candy is based on a modification of the research by Regia and Rini (2019), namely 80 g of robusta green bean powder extract, 640 g of sucrose, 160 g of glucose syrup, and 1000 g of water for 1.88 kg of hard candy. The process of making hard candy is carried out through the stages of mixing, heating, molding, and cooling. The innovation of processing into hard candy is expected to increase market acceptance while providing functional value to the product. Primary data was obtained through a laboratory-scale production process, covering raw material costs, other input contributions, labor, and output produced. Hayami's analysis was used to calculate the conversion factor, output value, added value, margin distribution, and profit margin. The Hayami value-added analysis of hard candy production with a heating temperature of 120°C and the addition of 10% robusta green bean powder extract resulted in a conversion factor of 0.87 with an added value of IDR 185,755/kg and an added value ratio of 28%. The net profit obtained reached IDR 172,457/kg or 25.97% of the product value, with the largest margin distribution in other input contributions (29.5%), followed by profit (68.26%) and direct labor income (2.72%).

Keywords: Added value; Hayami method; hard candy; green robusta beans; functional foods.

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1. Introduction

Coffee is one of Indonesia's leading agricultural commodities, playing a strategic role both economically and socially. Indonesia is known as one of the world's largest coffee producers after Brazil, Vietnam, and Colombia, contributing significantly to global coffee trade [1]. In addition to serving as a high-value export commodity, coffee is also an important part of Indonesian society, both as a refreshing beverage and as part of the daily consumption culture. The popularity of coffee has increased in line with changes in modern lifestyles, making coffee not just a beverage, but also a social identity and lifestyle [2].

Coffee is one of Indonesia's leading agricultural commodities, generally consumed as a refreshing and stimulating beverage [3]. This stimulating effect mainly comes from caffeine, a methylxanthine compound that stimulates the central nervous system. In addition to caffeine, coffee beans also contain other bioactive compounds, one of which is chlorogenic acid, a phenolic compound with various physiological benefits, such as reducing weight, cholesterol, and the risk of degenerative diseases such as diabetes mellitus and cardiovascular disease, as well as having potential as a colon cancer agent [4]. The mechanism of action of chlorogenic acid includes increasing fat metabolism in the liver and inhibiting fat absorption in the digestive tract [5]. The presence of compounds rich in benefits in coffee beans makes coffee beans potentially useful as a functional food ingredient.

Robusta (Coffea canephora) green coffee beans contain between 6.1 and 11.3% chlorogenic acid, which is higher than Arabica (Coffea arabica) coffee, which only contains around 4.1 to 7.9% chlorogenic acid [6]. However, the roasting process can significantly reduce the content of this compound. Therefore, the use of green coffee beans without roasting is recommended to maintain the bioactive activity of chlorogenic acid as an antioxidant and radical scavenger [7]. However, consumer preference for green coffee beans is still low due to their bitter and astringent taste. To increase consumer acceptance, product innovation through product diversification is needed. One potential alternative is the development of functional hard candies made from greenbean powder extract. The addition of sweeteners or other additives can help mask the unpleasant taste while maintaining its functional value.

Hard candy is an alternative in the development of functional food products, particularly through the use of chlorogenic acid from robusta green coffee beans. However, the use of chlorogenic acid in hard candy has not been developed, focusing on nutritional aspects and health benefits. The development of functional food products also needs to be accompanied by economic evaluation to determine the extent to which the processing provides added value to the raw materials used. One approach used to calculate this added value is the Hayami Method, which combines the value components of the production and distribution processes of the product.

The Hayami method is used to calculate added value by combining the added value from the processing and marketing processes [8]. This method involves various components such as conversion factors, labor coefficients, contributions from other inputs, as well as profits and margins. The Hayami method is based on a microeconomic approach to analyzing the added value of a product through the processing of raw materials into finished products. The Hayami method is very useful for assessing business efficiency, especially in small and medium-sized enterprises, as it can identify the contribution of each production component to the final value of the product. In addition, this method assists in business decision-making and industrial development policies based on local resources. In the context of developing hard candy with the addition of robusta green bean powder extract, the Hayami method can be used to evaluate whether this product innovation provides significant added value, both economically and in terms of high functional value. This study aims to calculate the added value analysis using the Hayami method for hard candy treated at a heating temperature of 120°C and the addition of 10% robusta mung bean powder extract.

2. Materials and Methods

2.1. Research Objective Data types and sources

This study is both qualitative and quantitative. A quantitative approach was used to calculate in detail the financial aspects of the production process of hard candy made from robusta green coffee extract. The quantitative data collected included the quantity and price of raw materials, other input costs (such as energy, packaging, and additives), the number of workers employed, and the volume and value of output produced. This data is very important for measuring production efficiency and business feasibility based on value-added and profit indicators. A qualitative approach is used to describe the results of quantitative analysis in a narrative and contextual manner. Qualitative data consists of descriptions of the production process (mixing, cooking, molding, and cooling stages), the function of each ingredient in the formulation, and the implications of the added value generated for business sustainability. This descriptive approach allows the research results to go beyond mere numbers and provide a broader interpretation of the technical, economic, and social conditions of this product innovation [9].

2.2. Data Analysis Methods

Value added is analyzed using the Hayami method, which calculates value added per unit of raw material based on output, price, raw material comsuption, other inputs, and labor.

a) Calculating the conversion factor (output per unit of raw material)

The conversion factor shows the ratio between the amount of output produced and the total raw material inputs used. This value illustrates the technical efficiency of the production process. The higher the conversion factor, the better the utilization of raw materials in producing the final product.

b) Calculating the output value

The output value is obtained by multiplying the amount of output (kg) by the selling price per kilogram of product. This value reflects the gross income that may be obtained from the production of hard candy.

c) Calculating total variable costs (cost of raw materials and other inputs)

The output value is obtained by multiplying the amount of output (kg) by the selling price per kilogram of product. This value reflects the gross income that may be obtained from the production of hard candy.

d) Obtaining value added as the difference between output value and total variable costs.

Value added is calculated as the difference between the value of output and total variable costs. This calculation produces gross value added, which can then be reduced by labor compensation to obtain net value added.

Next, the ratio of value added to output value, labor compensation, the proportion of labor to value added, and profit margin are calculated.

3. Result and Discussion

3.1. Process of Making Hard Candy with Added Green Bean Powder Extract

The process of making hard candy begins with turning robusta green bean powder into robusta green bean powder extract, which is then added to the hard candy mixture. Making hard candy with robusta coffee powder extract involves several stages: mixing, heating, molding, and cooling. The process of making hard candy with a heating temperature of 120^{o}C and the addition of a concentration of 10% robusta green bean powder extract.

First, 640 g of sucrose is dissolved in water that has been boiled to a temperature of 100°C. After the sucrose is completely dissolved, heating is continued to a temperature of 110°C, then 160 grams of glucose syrup is added and reheated at 120^{o}C temperature for ± 10 minutes while stirring until the mixture is homogeneous. Next, add 80 g of robusta coffee powder extract obtained from the extraction of 1 kg of robusta green bean powder. The cooked mixture is then poured into molds and left to harden for ± 20 minutes. It is then removed from the molds for packaging.

3.2. Raw Materials for Making Hard Candy

The formulation of raw materials in the manufacture of hard candy generally consists of main components such as glucose syrup, water, and functional additives, in this case green robusta beans as a source of bioactive compounds. Glucose syrup is used in an amount of 160 g. Glucose syrup functions as a sucrose crystallization control, increases viscosity, and gives the candy product a smooth and transparent texture. Glucose syrup can also reduce the tendency for coarse sucrose crystals to form, thereby reducing the shelf life of the product through water activity control [10]. The use of glucose syrup in this formulation plays a role in maintaining the thermal stability and texture of the product during storage [11].

Sucrose is used in an amount of 640g. Sucrose functions not only as a sweetener but also as a basic structural component in candy through the mechanism of amorphous matrix formation when cooled from a hot state. This amorphous structure provides a dense, hard, and homogeneous texture that is characteristic of hard candy [12]. In addition, sucrose also contributes to organoleptic properties, especially sweetness, which can mask the bitter and astringent flavors of green coffee bioactive compounds. Water is used as the main solvent in the initial cooking stage, with the main function of dissolving sucrose and glucose syrup to obtain a homogeneous mixture.

Robusta green coffee beans are extracted into 1 kg of powder, which is then added to the hard candy mixture. Robusta green coffee is chosen because it has a relatively high chlorogenic acid content, ranging from 6-11.3%, compared to Arabica coffee, which only contains 4.1-7.9% [13]. The addition of green coffee bean extract to hard candy makes this product a functional food. Overall, the combination of sucrose, glucose syrup, water, and Robusta green coffee extract provides a balance between sensory, technical, and functional aspects. With this formulation, the resulting hard candy has a consumer-acceptable taste, smooth texture, good storage stability, and added health benefits through its bioactive compound content. The amount of raw materials used and the cost per production batch can be seen in Table 1.

Table 1: Raw Materials in a production

No.	Raw Material	Quantity Used	Unit Price (Rp)	Cost (Rp)
1.	Glucose Syrup (L)	0.16	26,000	4,160
2.	Sucrose (kg)	0.64	15,000	9,600
3.	Water (gallon)	1	5,000	5,000
4.	Coffee beans (kg)	1	60,000	60,000
	Total			78,760

3.3. Other Input Contribution Costs

Other input costs are all costs incurred in the production process other than the cost of primary raw materials, which directly or indirectly support the formation of the final product. These costs fall into the category of intermediate costs and include auxiliary materials, packaging costs, energy (electricity or fuel), equipment depreciation, and direct labor costs involved in the production process. According to [8], the magnitude of other input contributions greatly affects producers' profit margins because in many cases of small and medium-sized agro-industries, secondary input costs are actually higher than the costs of primary raw materials. Therefore, careful analysis of these components is important for assessing business efficiency and industrial sustainability.

The cost of other input contributions in the hard candy production process in a single production run can be seen in Table 3. The ingredients in the input contribution are 10 liters of ethanol. Ethanol functions as a solvent in the extraction process of bioactive compounds (chlorogenic acid) from green beans [12]. Dissolution using ethanol allows for the acquisition of bioactive components with high purity without leaving harmful residues in the final product, in accordance with food safety regulations [14]. Furthermore, 1 unit of packaging is used at a price of Rp. 11,000, which plays an important role in maintaining product quality, preventing contamination, and extending shelf life. In addition, packaging also serves as a marketing tool because the design and information on the packaging influence consumers' perceptions of product value. Innovations in packaging systems, especially for functional food products, not only extend shelf life but also increase market appeal.

Operating costs include the use of 1 kWh of electricity at a price of 2,380, which is used to extract green bean powder from robusta green beans. The total recorded cost of auxiliary materials and operations is Rp 400,653. Equipment depreciation costs consist of equipment used during the production of hard candy. Equipment depreciation calculates the decrease in the economic value of production equipment due to use and time. Other input costs contribute significantly to the total cost structure. This is in line with the findings of other agro-industry studies that emphasize that efficient management of secondary inputs (such as energy, packaging, and auxiliary materials) is key to improving the profitability of small and medium-sized enterprises [15]. Thus, optimization strategies for other input costs, such as choosing more economical solvents, using efficient packaging that still meets food safety standards, and utilizing renewable energy, are important steps in improving product competitiveness.

Table 2: Total Cost of Other Input Contributions

Description	Quantity (Unit)	Price (Rp)	Amount (Rp)
Ethanol	10 L	35,000	350,000
Packaging	1	11,000	11,000
Electricity Cost	kWh	1	2,380
Gas Cylinders	1	20,000	20,000
Equipment Depreciation			17,273
Total			400,653

3.4. Hayami Method Calculation Analysis

Value-added analysis was performed on the best products. The value-added calculation results show the amount of value added per kilogram of raw material, the value-added ratio (%), profit (Rp/kg), and profit margin (%). The production of hard candy for a single production process is 1.65 kg. The product requires a total of 1.88 kg of raw materials, consisting of 640 g of sucrose, 160 g of glucose syrup, 1000 g of water, and 80 g of green bean powder extract, resulting in a conversion factor of 0.87. This conversion factor indicates that not all raw materials used will be converted into the final product, as some are lost during the cooking, evaporation, or absorption processes in the container. The conversion factor is an indicator of technical efficiency in the production process, where the higher the value, the more optimal the utilization of raw materials [8]. The production of hard candy generates an added value of Rp185,755 per kilogram. This figure is derived from the difference between the product’s market value and the combined costs of raw materials and additional inputs. The calculated value represents the gross added value, as deductions for labor wages involved in the production process have not yet been made. Within the framework of agroindustry, gross added value illustrates the potential profit margin that can be further distributed across production factors such as labor and capital [16]. A detailed breakdown of the value-added analysis for hard candy is presented in Table 3

Table 3: Analysis of the Added Value of Hard Candy

Variabel		Description	Value
I.	Output, Input, and Price		
1.	Output (kg)	(1)	1.65
2.	Raw Material Input (kg)	(2)	1.88
3.	Labor input (HOK)	(3)	3
4.	Conversion factor	(4) = (1)/(2)	0.877
5.	Labor Coefficient (HOK/kg)	(5) = (3)/(2)	0.532
6.	Output Price (Rp/kg)	(6)	756,619
7.	Average wage rate (Rp/HOK)	(7)	25,000
I.	Revenue and Profit		
8.	Raw material input price (Rp/kg)	(8)	78,760
9.	Contribution of other inputs (Rp/kg)	(9)	399,539
10.	Output value (Rp/kg)	(10) = (4) x (6)	664,054
11.	a. Value Added (Rp/kg)	(11a) = (10)-(8)-(9)(11b) =	185,755
	b. Value Added ratio (%)	(11a)/(10)x 100%	28
12.	a. Employee compensation (Rp/kg)	(12a) = (5) x(7)	13,298
	b. Labor Department (%)	(12b)=(12a)/(11a)x 100%	7.2
13.	a. Profit	(13a) = (11a)-(12a)	172,457
	b. Profit Rate (%)	(13b)= (12a)/(10) x 100%	25.97
II.	Remuneration for Production Factors		
14.	Margin (Rp/kg)	(14) = (10) – (8)	585,294
Labor Income (%)		(14a)= (12a)/(14) x 100%	2.72
Contribution of other inputs (%)		(14b) = (9)/(14) x 100%	29.5
Profit (%)		(14c) = (13a)/(14) x 100%	68.26

Based on Table 3, the labor coefficient value obtained is 1.064 HOK/kg. The value of the labor coefficient is derived from the ratio between labor input per production batch and the raw material utilized. The wage rate applied is IDR 25,000/kg, whereas the cost of raw materials reaches IDR 78,760/kg. Other input contributions for hard candy production amount to Rp. 400,653/kg, which is obtained from equipment depreciation costs, electricity costs, packaging costs, and auxiliary materials used per production run. The electricity cost used during one production run is calculated at Rp. 2,380. This is calculated from 1.7 kWh of electricity used multiplied by Rp. 1,400 per kWh. The value-added ratio is the ratio of value added to product value. The value-added ratio obtained was 28%. This ratio represents the comparison between added value and product value. A ratio above 20% indicates that processing contributes significantly to increasing the economic value of a commodity [15]. These results show that diversifying Robusta green coffee products into hard candy is an economically viable strategy because it increases the selling value of the product compared to simply selling green coffee as a raw material.Labor compensation is obtained from the estimated labor coefficient with an average labor wage of Rp. 13,298/kg. Labor income is obtained from labor compensation divided by the profit margin of 7.2%. Wages on capital and profits are obtained from the reduction in added value by labor wages. The profit is Rp. 172,457 or a profit margin of 25,97% of the product value. This profit is the total profit obtained from each production of hard candy. This profit percentage is relatively high when compared to the average profit margin of small-scale food industries, which usually ranges from 10–15% [17]. This indicates that the innovation of processing green coffee into hard candy can be a promising business opportunity, especially for small and medium enterprises (SMEs) in the functional food sector. Analysis of value added reveals that the margin derived from raw material conversion into hard candy is shared across labor remuneration, input expenses, and business profit. The margin represents the gap between the product's value and the raw material cost per kilogram. Processing 1 kg of raw material results in a margin of IDR 585,294, of which 2,72% is allocated to workers as direct earnings. Other input contributions are 29.5% and include a profit of 68.26%. The margin for other input contributions is the largest part when compared to direct labor income and production profits. The dominance of other inputs shows that production cost efficiency, especially in terms of additives, energy, and packaging, greatly determines the amount of profit obtained by producers. In the coffee-based agroindustry, secondary input costs such as energy and packaging are often dominant factors affecting profitability [13]. Therefore, efficiency strategies, such as the use of renewable energy or environmentally friendly packaging at competitive prices, can significantly increase profit margins.

4. Conclusion

The conversion of Robusta green coffee beans into hard candy by heating at 120ºC with the addition of 10% concentration of robusta green bean powder extract yields significant economic benefits, generating added value of IDR 185,755 per kilogram with a ratio of 28%, reflecting effective process efficiency. The net profit of IDR 172,457/kg, equivalent to 25.97% of the product value, demonstrates its potential feasibility for small and medium-scale industries. Margin analysis shows that the largest portion is absorbed by other inputs (29.5%), with smaller portions allocated to profit (68.26%) and direct labor (2.72%). Furthermore, this production method maintains chlorogenic acid content, thus offering functional benefits to consumers. Thus, this innovation can be positioned as a competitive functional candy product while increasing the economic value of coffee commodities upstream.

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