

# Economic Perspective in the Production of Preserved Soybean (Tauco) with Various Raw Material Quantities

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**Abstract :** The aim of this study was to evaluate the production of Indonesian preserved soybean (tauco) from engineering and economic perspectives. To ensure the feasibility study for the possibility profit in this production, various raw material quantities were tested in the evaluation process. In short of the process, we evaluated the production of tauco using dual fermentation processes. The first fermentation was used for the yeast process, whereas the second was for the brine fermentation to give a distinctive flavor and aroma to tauco product. Several economic evaluation parameters were analyzed to inform the potentiality of the tauco production, including gross profit margin, break even point, net present value, and so on. The engineering analysis showed that production of tauco can be done in the variation of initial soybean from 20 to 100 kg. This inform that present tauco production can be produced in the home industry and micro-scale production. To get excellent profit, economic analysis showed the minimum soybean must be more than 60 kg. We believe that this study will be important in introducing one of the Indonesian local wisdom foods for strengtning economy.

## 1. Introduction

Tauco is one of the Indonesian traditional foods from Cianjur, in West Java [1]. Tauco serves as a flavoring agent because of its distinctive aroma and flavor. Tauco is a durable food product because its salt content is quite high [2].

To produce tauco, two steps of fermentation processes can be used by employing *Aspergillus oryzae* and *Rhizopus oligosporus* [1]. The steps are yeast fermentation and brine fermentation. [3] During these fermentations, components inside the tauco-forming feedstock change due to the existence of enzymatic process produced by microorganism. Both types of fermentations are connected each other. Thus, the product of the yeast fermentation influences the condition and the final product of the brine fermentation [4]. Fermentation was used to adjusted the concentration of carbohydrates, amino acids, citric acid, and so on [5].

Although the production of tauco has been well-documented, report on the economic evaluation of tauco is not existence. Thus, the purpose of this study was to evaluate the production of Indonesian preserved soybean (tauco) from engineering perspective supported with several economic evaluation parameters, such as gross margin (GPM), internal return rate (IRR), payback period (PBP), cumulative net value (CNPV), breakeven point (BEP), and profitability index (PI) Sales to investment. To ensure



the evaluation, the product quantity was varied, in which this can be used for optimizing the process to be profitable. The results showed that variation of production capacity has a direct impact to the profitability of the tauco production project. Indeed, this study will give information for further development, especially relating to the introduction of Indonesian local wisdom food for strengthening local economy. The economic evaluation is varying depends on capital and operational cost, and electricity cost [6]

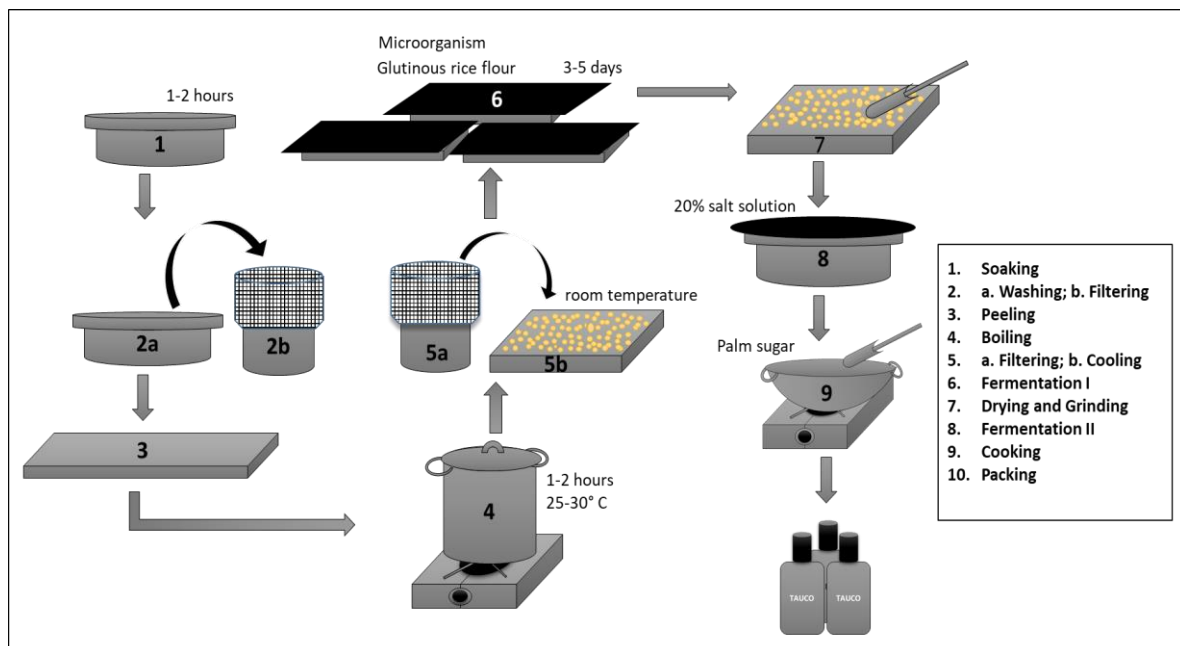
## 2. Methods

This method used some data (i.e. optimum condition, price, cost, and specification) based on sources derived from textbooks, research papers, and commercially available online shopping web. To solve the evaluation, several assumptions were made, in which detailed assumptions are described in the results and discussion section. All data are calculated using a simple mathematical analysis, especially for calculating energy and mass balance as well as economic parameters (i.e. GPM, IRR, PBP, CNPV, BEP, and PI sales to investment). This method uses an approach and assumption: one USD is equivalent to 10,000 IDR and all the data were then evaluated economically using Lang factor from reference [7].

## 3. Results and discussion

Figure 1 illustrates the processing steps in the tauco production. Based on the figure, there are 10 processing steps performed. Raw materials used for producing tauco include yellow soybean, yeast, glutinous rice flour, salt, and brown sugar. In this study, soybean with various amounts of 20, 40, 60, 80 and 100 kg per processing cycle was tested.

Step (1) is the process for soaking soybean in water. This step is used for softening soybean and making peeling soybean's skin easier. The soaking process is done for 1-2 hours. The soybean are then washed with clean water (step (2)) and peeled (step (3)) manually. Skin removal is intended to facilitate growth of microorganism (i.e. *Rhizopus sp.* and *Aspergillus sp.*) since these microorganisms can not grow well on medium containing cellulose components. Immersion is intended to activate enzymes in seeds and sustain microorganisms that can live only in low oxygen environments [4].



**Figure 1.** Diagram process of tauco from soybean

The next step (step (4)) is the process for boiling soybean. This step is conducted in about 1-2 hours with an initial temperature of 25-30°C. The soybean is tested to ensure that the successful softening process. The soft soybeans are then filtered and cooled (step (5)) to room temperature. The cooled soybean is put into the first fermentation process (step (6)) [8]. In addition to soybean, yeast and glutinous rice flour is added. The addition of rice flour is used as a medium for mold growth. The microorganism produces enzymes that are required for yeast fermentation process. The types of enzymes produced by both molds are hydrolytic enzymes, such as amylase enzymes, lipases, and proteases [9].

During the fermentation process, the solubility of components of soybean such as proteins degraded into peptides, peptone, and amino acids. Fat is degraded to free fatty acids, whereas carbohydrates degraded to organic acid [10]. At the time of fermentation, the container is a closed system. Indeed, no direct contact with air and oxygen cannot disturb the fermentation process. To achieve the optimum results, fermentation is done for 3-5 days. Chemical component changes, in which this is due to the role of yeast fermentation and enzymatic reaction [9].

Soybeans that have passed through the first fermentation process are dried and mashed (step (7)). The mashed soybean is then put into the second fermentation process in the 20% of salt solution, known as brine fermentation (step (8)) [4]. In this process, the purpose of addition of salt is to preserve the durability of the product against organism decomposer, enhance taste of the product, select the growing microorganism activity, and develop aroma and flavor by yeast and lactic acid bacteria [9,11].

In the brine fermentation, three stages of fermentation occur: fermentation refinement, lactic acid fermentation (by lactic acid bacteria), and alcohol fermentation (by yeast). These three stages of fermentations are conducted simultaneously. The fermentation refinement used  $\alpha$ -amylase enzyme (produced from the first fermentation) for converting carbohydrates into simple saccharides such as glucose and maltose. These compounds is fermented by yeast (to form alcohol) and lactic acid bacteria (to form lactic acid). The protease enzymes produced by bacteria break the protein into polypeptides, peptides, and then split into simple amino acids. One of the main amino acids that plays an important role in the formation of flavors is glutamic acid. The lipase enzyme breaks down fat into free fatty acids and glycerol. Furthermore, these free fatty acids may react with alcohols, organic acids, and acetic acids to form esters serving as a scent agent in tauco. Brine fermentation is done for 15-30 days. Fermented soybeans are then cooked by adding palm sugar and water until tauco crackle. Tauco ready packed into bottles [9].

To calculate the mass balance in Figure 1, several assumptions were taken:

1. Based on reference [12], for 1 kg of soybean, the process uses 0.5 kg glutinous rice flour, 1.5 g of yeast, 400 g of salt, and 250 g of palm sugar.
2. The concentration of salt solution in the second fermentation is 17-20% [4].
3. Nutrient content of raw soybeans consists of protein (40.40%); fat (16.7%); carbohydrates (24.9%); water (12.7%). After soybeans are boiled, the contents are protein (20.2%); fat (8.2%); carbohydrate (12.7%), and water (56.8%). These values were adopted from reference [10].
4. Nutrient content of tauco consist of protein (33.19%); fat (18.37%); carbohydrate (0.09%); and water (36.7%), in reference [13].
5. Skin content of raw soybean is 8% [14].
6. Conversion factor of water content before and after addition of glutinous rice flour which is 60% to 45%, in reference [8].

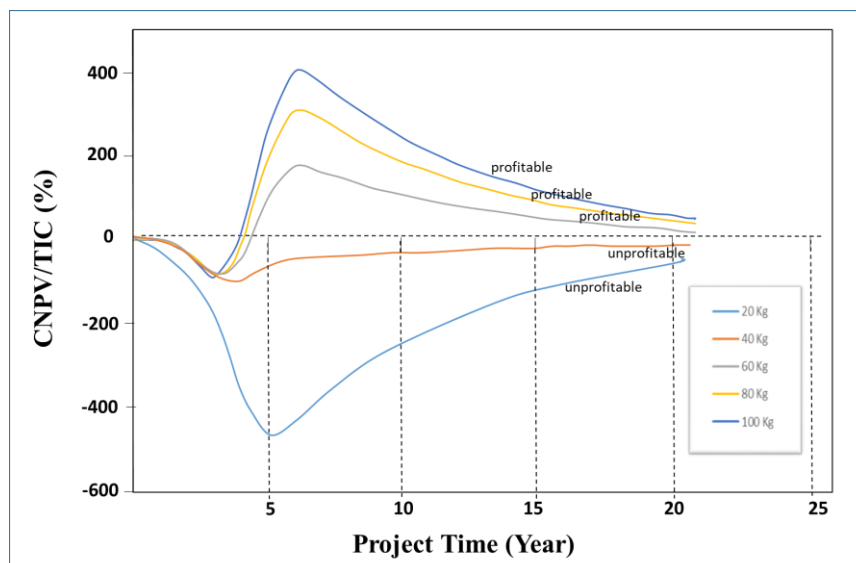
Based on the above assumptions, Table 1 shows effect of initial quantities of soybean on the quantities of product and GPM. The highest ratio of GPM indicated by soybeans with quantity 100 kg and the lowest GPM indicated by soybean with amount of 20 kg. An increase in the number of soybeans was followed by an increase in GPM. Thus, to gain greater benefits of eating tauco production should be more and more. To achieve profit, another parameter is used to calculate the further economic evaluation of this tauco production.

**Table 1.** Gross profit margin for various quantities of soybean

<i>Quantities of Soybean</i>	<i>Quantities of Product (300 ml/ bottle)</i>	<i>GPM (USD)</i>
<b>20 kg</b>	97	5,239
<b>40 kg</b>	193	10,464
<b>60 kg</b>	290	15,690
<b>80 kg</b>	387	20,916
<b>100 kg</b>	484	26,142

To evaluate the economic evaluation, we used the following assumptions:

1. The labor wages is 5,160 USD annually, and the tauco production plant employs 5 labors.
2. The length of operation of this project is 20 years with the total TIC of 2,039.23 USD; 2,969.93 USD; 3,900.62 USD; 4,831.32 USD; 5,762.02 USD for converting 480 kg; 960 kg; 1,440 kg; 1,920 kg; 2,400 kg of preserved soybean per year.
3. The discounted rate in this project is 15% annually.
4. The income tax is 10%.
5. This project does not progress with loan from bank.
6. The sales of tauco is 22.5 USD per 300 ml/bottle.



**Figure 2.** CNPV/TIC curve in accordance to project time with various raw soybean to production of tauco

Figure 2 shows the relationship between CNPV/TIC over project time of the tauco production assumed for 20 years. With a tauco product price of 22.5 USD (300 ml per bottle), the production will be profitable when the main raw material used is 60 kg. To reach the repayment period, the production must be conducted at least 3 years. However, the graph shows that from the 6th year of the production, the profits begin to decrease. Thus, to increase the profit, additional innovation for the product is required.

To get profit, the BEP required 8.62 (8-9 times) production. This result concluded that if the production is run with the quantity of the main raw material of below 65 kg and less than 9 processing cycle, the project will be lost. This is because income generated is not proportional for covering other the expenses.

To confirm the profitability analysis of the project, other economic analyses were also done (See Table 2). This table shows in detail PI sales to investment, IRR, BEP, and last CNPV on the project.

In the case of BEP, the 20 and 40 kg is unprofitable. The BEP analysis for 20 and 40 kg needed 1-2 times of the production cycles, whereas that for 100 kg is only once production cycle. Then, these profitability analyses were supported by PI sales to investment, in which the 60, 80, and 100 kg were 1.70; 3.00; and 3.87, respectively. The latest CNPV for both projects were also magnificent with percentage values of 23.49; 41.28; and 53.32, respectively. Based on these analyses, 100 kg of initial raw material is more profitable than the other.

Other analysis such as IRR showed that the percentage of IRR for the production of 60 kg is 110 %. This value is attractive compared to local bank interest rate. This IRR replies that investing 100 USD can create additional fund of 110 USD.

The production performed on this observation adopted the semi-modern method. However, based on literature, tauco production achieves excellent profit if the production is made by the conventional method, especially home industry. The modern production can be profitable if the product can be adsorbed by consumers, while the consumers are limited. Otherwise, the project will get loss since the sales proceeds can not cover the value of expenditure, especially on tools or machinery. In addition, the production using the conventional method also gives between taste of tauco. The more production capacity tends to decrease the taste of tauco itself.

**Table 2.** Analysis of IRR, BEP, and last CNPV on the project

Type of project	PI to investment	IRR	BEP	Last CNPV/TIC
<b>20 Kg</b>	-4.43	120 %	1.59	-60.78 %
<b>40 Kg</b>	-0.41	90 %	1.16	-5.43 %
<b>60 Kg</b>	1.70	110 %	1.01	23.49 %
<b>80 Kg</b>	3.00	120 %	0.94	41.28 %
<b>100 Kg</b>	3.87	130 %	0.90	53.32 %

#### 4. Conclusion

Production of tauco has been evaluated from engineering perspective and economic feasibility study. The engineering perspective shows that tauco production is potentially made using current technologies. However, the economic evaluation shows the difference in yields from the quantity of raw materials used. Tauco production with soybean quantity of 20 and 40 kg is not suitable for practical use as the evaluation suggests unprofitable. To increase the profitability of the production of tauco, enlargement of the quantity of raw materials is suggested. Indeed, this increases the yield of production and sales. Production of tauco began to be profitable when using raw materials of more than 60 kg. However, further increases in the production capacity must be considered. The greater the raw material used will be followed by increasing cover the expenses used for one-time production.

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