Techno-economic analysis on cookies production made from Adlay (Coix lacryma-jobi) flour that supplemented with moringa (Moringa oleifera) leaves powder

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Abstract. The market demand of cookie products increases annually. In Indonesia, the growth average of cookies consumption per capita reaches of 33.34%. Exploration on alternative source used as raw material of cookies is an important issue as the major component of cookies production in Indonesia, wheat flour, is fulfilled by import. Adlay (Coix lacryma-jobi) flour is potential source that could be developed in cookies production due to its nutritional content. In this study, techno-economic analysis in establishment of mini plant to produce cookies made from Adlay flour that supplemented with Moringa (Moringa oleifera) leaves was carried out. From technological approach, the cookie products developed contents of water, ash, protein, fat and carbohydrate were 4.78, 8.24, 8.75, 51.73 respectively. From financial feasibility analysis, some feasibility criteria including net present value (NPV), benefit-cost ratio (B/C), internal rate of return (IRR), and payback period (PBP) indicated this mini plant was feasible with the values of 372,694,093 IDR, 1.17, 53%, and 28 months, respectively. This study revealed that the establishment of mini plant to produce cookies from Adlay flour that supplemented by Moringa leaves powder was techno-economically feasible.

1. Introduction
Cookie is a type of ready to eat of food product that can be consumed anytime. The market demand of cookies increases annually. Based on data from the Central Statistics Agency (BPS), it shows that the average growth of cookie consumers in Indonesia from 2011-2015 reach of 24.22%. Diversification of cookies product based on potential local commodity becomes important issue in context of product value addition. Segmentation, targeting, positioning, and differentiation of products are important to define in product development approach.

One of the strategies in dealing with business competition is differentiation. To get a competitive advantage, the cookie products developed should have strength point as a differentiating factor. The development of cookies based on hanjeli flour supplemented with moringa leaves could give high nutritional value of product. Business development requires careful design, not only in terms of products but also in terms of business feasibility analysis. Studies on technical and economic feasibility analysis have received relatively much attention from academics for analysis in various industrial fields including agro-based or agriculture-based industries [1].

According to Marizalni (2013) [2], cookies are small sweet pastries made of soft dough, high in fat, relatively crunchy and less dense when broken. Cookie products were chosen because the raw materials
used to make the product are easy to get and do not use special equipment, so there are no difficulties in the production process. Cookies can supply enough energy to carry out daily activities. The contribution of cookies to energy requirement for human consists of 0.8% protein, 1.1% fat and 5.4% carbohydrates (Directorate of Nutrition, Ministry of Health, 2009). The process of making cookies includes mixing, stirring, molding, and baking. Jayanti (2017) [3] reported the steps cookies making includes of mixing I, mixing II, forming dough, molding, and baking. The ingredients used in the manufacture of cookies are divided into binders and softening agents. Materials that function as binders are flour, milk, and egg white. Meanwhile, the ingredients that function as softener are sugar, fat, leavening agent (baking powder), and egg yolk. Wheat flour or another flour such as mocafl flour is also can be used. Nuraeni (2019) reported that the use of hanjeli flour can produce cookies with a protein content of 12.87% [4]. Hanjeli flour has the potential to be a food raw material because it contains 11.68 % protein and 55.756 mg Ca / 100g dry weight.

Hanjeli (Coix lachryma-jobi L.) is a cereal originating from East Asia and Malaya, but its distribution has spread to Southeast Asia. The distribution of jali plants in Indonesia is quite evenly distributed, starting from Sumatra, Java and Kalimantan. Ordinary jali is only processed into porridge or simply steamed, soup, sweet food, and drinks [5]. This is what makes jali increasingly forgotten by the community, even starting to become scarce in the market. The jali plant has the potential to become an alternative food in food diversification efforts because it has good nutritional content. In addition, the protein, fat and vitamin B1 content in jali is much higher than other cereal crops [6]. The need for other variations of food product innovation so that hanjeli is more developed.

Another agricultural material that has the potential to be developed is moringa leaves. The results of the research by Fuglie (2001) [7] stated that moringa leaves contain various beneficial nutrients. The most superior content in this plant is protein, vitamin A (β-carotene), and high iron so it is good for consumption and can meet nutritional needs, especially in vulnerable groups [8]. Not only that, moringa leaves also contain various kinds of amino acids which are rarely found in vegetables [9].

Moringa leaves can be consumed by humans, but not many Indonesians consume them because the characteristics of moringa leaves have a distinctive odor and are not liked. According to Zakaria, et al. (2013), moringa leaves have not been widely processed as functional food. Therefore, there is a need for innovation in processing moringa leaves into a product that can be accepted by society. Thus, the nutritional content in moringa leaves can be utilized by the human body. The product diversification of cookies based on hanjeli flour and moringa leaves is expected to increase value addition of the product. To find out whether the prospect of the product is feasible to be developed, it is necessary to carry out a technical and economic analysis of the product development.

The definition of a feasibility study is a comprehensive assessment to assess the success of a project and avoid unprofitable investment. An illustration of how far the production plan and investment plan in a project will be illustrated if project evaluation and investment plans are carried out which of course can be justified. Financial factors consist of financial analysis of Internal Rate of Return (IRR), Net Present Value (NPV), payback period, and Benefit Cost Ratio (BCR) and non-financial aspects, namely technical aspects. While the technical analysis of production includes analysis of increasing production capacity, making factory layouts, determining the need for machines and equipment and determining the number of workers. Based on the above background, this study was conducted to analyze the business feasibility of hanjeli cookies supplemented with moringa leaves flour in terms of technical and financial aspects. For future work to do market testing, it is to obtain market feedback related products and to do improvements on the product or packaging in accordance with the expectations of consumers, so that the product will be easier accepted by the market.
2. Material and methods

2.1. Research Materials and Tools
The research was conducted at the Pilot Plant of Flour and Bakery Product of the Research Center for Appropriate Technology, LIPI, Subang. The materials used in this study including including hanjeli flour, moringa leaves powder, chicken eggs, refined sugar, margarine, baking powder, milk powder, salted butter, and salt were purchased commercially. Meanwhile, production equipment machines used include: scales, basins, mixers, mold trays, toaster ovens and other supporting equipment. These materials and equipment are needed for the production process experiment in order to obtain data and assumptions that will be used in calculating economic feasibility.

This research used a descriptive analysis method. The descriptive method is a method of examining the status of a group of people, objects, a set of conditions, a system of thought or a class of events in the present [10]. The research stage carried out was problem formulation, literature study, data collection, result analysis, conclusions and suggestions.

2.2. Type of data

2.2.1. Technical Aspects
The data obtained from the technical aspects are formulations and process flow diagram of product, number and specifications of machines, number of equipment and labors, product specification, operation time, and capacity of production.

2.2.2. Financial Aspects
Data obtained from the financial aspect consisted of variable costs, fixed costs, total costs, total investment cost, and interest.

2.3. Feasibility Analysis

2.3.1. Cost of Production (CP)
The method of determining the cost of production (CP) is using the full costing method as this method involves the calculation of all the production costs applicable both fixed and variable. The cost of production is calculated using a formula:

\[ Production\ Costs = \frac{Total\ Cost}{Total\ Product} \]

2.3.2. Break Event Point (BEP)
According to Soekarwati (2006) in Yunita (2017) [11], the break event point is an analysis to determine and find the number of goods or services that must be sold to consumers at a certain price to cover costs that arise and get a profit. The Break Event Point is calculated by formula:

\[ BEP\ production\ (kg) = \frac{Total\ cost\ (IDR)}{Selling\ price\ (IDR)} \]

2.3.3. Net Present Value (NPV)
Nurmalina (2014) [12] stated that Net Present Value (NPV) is the difference between the total present value of benefits and the total present value of costs or the total present value of additional net benefits over the life of the business. The formula for calculating the Net Present Value is as follows:

\[ NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+i)^t} \]

Where:
- \( B_t \) = Gross social benefits in year \( t \)
- \( C_t \) = Gross social costs associated with the project in year \( t \)
- \( i \) = Interest rate in period
- \( t \) = Investment period (\( t=0,1,2,3,\ldots,n \))
2.3.4. **Internal Rate of Return (IRR)**

According to Giatman (2011) [13] the IRR method will look for the interest rate when the NPV is equal to zero. The calculation method for obtaining NPV equal to zero uses interpolation calculations. Information obtained is in the form of cash flow ability to return investment which is described in terms of time period%. An investment is said to be feasible if the IRR value is ≥ MARR. MARR (Minimum Attractive Rate of Return) is the value of obligations that must be fulfilled. IRR formula:

\[
IRR = i_1 + \frac{NPV_1}{NPV_1 - NPV_2} \times (i_1 - i_2)
\]

Where:
- \(i_1\) = Interest rates that results in a positive NPV
- \(i_2\) = Interest rate that results in a negative NPV
- \(NPV_1\) = NPV positive
- \(NPV_2\) = NPV negative

2.3.5. **Payback Period**

The period required to cover investment expenditures using cash flow is called the payback period. The formula for calculating the payback period:

\[
Payback\ period = \left(\frac{1}{\frac{I}{Ab}}\right) \times 1\ year
\]

Where:
- \(I\) = Investment value
- \(Ab\) = Net cash which has been discounted

2.3.6. **Benefit Cost Ratio (BCR)**

According to Khotimah (2014) [14] this ratio is obtained by dividing the present value of the flow of benefits (PV) with the present value of cost flows, which aims to determine the ratio between the amount of costs incurred in a business to the benefits it will get. The formula for calculating BCR is:

\[
Benefit\ Cost\ Ratio = \frac{\sum_{t=1}^{n} \frac{Bt-Ct}{(1+i)^t}}{\sum_{t=1}^{n} \frac{Ct}{(1+i)^t}}
\]

3. **Results and discussion**

3.1. **Technical Feasibility Analysis**

The technical aspect relates to production input and output. Input is the initial process or provision, while output is the result or final product. The parts analyzed in technical aspects were the production process, determining the amount of yield, specifications of equipment machines, production capacity, machines and equipment, production layout and determining the number of workers.

3.1.1. **Product Specifications**

Hanjeli cookies supplemented with moringa leaves powder were round in shape with a diameter of 4 cm, greenish in color, smell like cookies, have a savory taste of cookies and resemble the taste of green tea leaves. The product is packaged using aluminum foil and primary packaging in a box with each package containing 5 cookies with 60 gram net weight.

3.1.2. **Product Content**

Based on the table of nutritional content of the moringa hanjeli cookies, it is known that the product contains 8.75% protein and 26.9% fat has met with the SNI cookies requirements particularly for minimum of 5% protein and 9.5% fat.
### Table 1 nutritional content of the moringa hanjeli cookies

| Nutritional Analysis | Nutrient content |
|----------------------|------------------|
| Water (% dry weight) | 4,785            |
| Protein (% dry weight) | 8,751619       |
| Ash (%) | 8,245 |
| Fat (%) | 26,9 |
| Carbohydrate | 51,7375 |
| Total Energy | 482,38 |
| Calcium (Ca) | 3299,003 |
| Iron (Fe) | 2,9325 |
| Magnesium (Mg) | 62.79 |
| Zink (Zn) | 2,4925 |

### 3.1.3. Production process
The production process is the process of processing raw materials into a product through various production processes.

![Flowchart of making cookies hanjeli kelor](image)

**Picture 1.** Flowchart of making cookies hanjeli kelor

The explanation of each stage includes:

1. **Weighing of production materials**
   Weighing ingredients aimed to obtain the amount of material that must be used based on the formulation used. The weighing process is carried out using digital scales.
2. Mixing gradually
   The first ingredients to be mixed were margarine and refined sugar, then chicken eggs, and the last is mixing hanjeli dry ingredients, milk powder, baking powder, cornstarch, and salt.

3. Molding Dough
   The molding dough is the process of forming the dough into the desired shape. The shape of the dough that is molded is a circle with a diameter of 4cm.

4. Baking
   The baking process is the process for ripening the dough using a temperature of 150°C for 10 minutes. The next baking stage is the second roasting to ripen the bottom of the cookies.

5. Tempering
   The tempering process is a process of reducing the temperature by storing it at room temperature.

6. Packaging
   The packaging process aims to facilitate product storage so that the product is durable and makes it easier to market and distribute the product.

3.1.4. Production Equipment Machineries

| No. | Machine Details                      | Number of units |
|-----|--------------------------------------|-----------------|
| 1   | Dough mixer with a capacity of 10 kg | 1               |
| 2   | Toaster oven                         | 3               |
| 3   | Hand sealer                          | 1               |
| 4   | Baking dish                          | 12              |
| 5   | Digital scales                       | 1               |
| 6   | Stainless table                      | 2               |
| 7   | Raw material rack                    | 2               |
| 8   | Supporting equipment                 | 1               |
| 9   | 12 kg gas cylinder                   | 2               |

The equipment used in the manufacture of cookies are a scale for weighing the ingredients, a mixer that mixes the ingredients to produce dough, the printer functions to print the dough according to the shape of the mold, the oven serves to ripen the product or dough, and the sealer machine functions to package the product. Supporting tools used are containers to accommodate ingredients, spoons and trays.

3.1.5. Number of employees

The analysis number of employees was carried out by calculating the amount of production completion time and the effective time of completion of production. Production completion time data obtained from production trials with the largest percentage yield. The highest percentage of output yield, with a production capacity of 15 kg, was 77.93 percent with a processing time of 450 minutes. With this data, it can be calculated the total need for employees or labor. Assuming the effective working time is 5 hours / day, then
The total number of employees required to make cookies per day is 2 employees. 1 additional person as a manager who is in charge of managing all the running of the business. The total number of industrial employees is 3 employees. Salary or labor costs are calculated based on hours worked per day.

3.1.6. Production Layout
Industrial layout is the arrangement of factory facilities and infrastructure to support the production process and to achieve an effective production process. The effectiveness of the production process is influenced by the layout of the production which can effectively streamline the working distance. In business design, the production layout is designed based on production trials, adjustments to equipment and space requirements. Total production space requirements:

Table 3 Total Production Space Needs Cookies Hanjeli Kelor Size (m) Total area (m²)

| Room Name                        | Total | Size (m) | Total area (m²) |
|----------------------------------|-------|----------|-----------------|
| Production room                  | 1     | 5.5 X 8.6| 47.3            |
| Product storage space            | 1     | 3 X 3    | 9               |
| Raw material room                | 1     | 2 X 3    | 6               |
| Utility room                     | 1     | 2 X 2    | 4               |
| Restroom                         | 1     | 1 X 2    | 2               |
| Prayer room                      | 1     | 1 X 3    | 3               |
| Manager's room                   | 1     | 1 X 3    | 3               |
| Administration and marketing room| 1     | 2 X 2    | 4               |
| Parking lot                      | 1     | 5.5 X 1.5| 8.25           |
| **Total area**                   |       |          | **117.05**      |

3.2. Financial Feasibility Analysis
Financial analysis was carried out to determine the feasibility of a business. The components to be analyzed are investment in machine tools, analysis of production costs, analysis of investment criteria such as Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR), and payback period. The value of the investment criteria is arranged in the form of cash flow.

3.2.1. Investment Capital Machine Tools
The amount of investment required for machine equipment depends on the production capacity to be achieved. The investment capital for machinery and equipment for the production of 15 kg of raw material / day are presented in table 4.
### Table 4 Investments in Cookies Production Equipment Machines with a capacity of 15 kg

| No. | Machine Details                      | Total (unit) | Total price (IDR) |
|-----|--------------------------------------|--------------|-------------------|
| 1   | Dough mixer with a capacity of 10 kg | 1            | 7.000.000         |
| 2   | Toaster oven                         | 3            | 30.000.000        |
| 3   | Hand sealer                          | 1            | 4.600.000         |
| 4   | Digital scales                       | 1            | 600.000           |
| 5   | Baking dish                          | 12           | 468.000           |
| 6   | Stainless table                      | 2            | 3.000.000         |
| 7   | Raw material rack                    | 2            | 2.400.000         |
| 8   | Supporting equipment                 | 1            | 5.000.000         |
| 9   | 12 kg gas cylinder                   | 2            | 1.200.000         |
|     | **TOTAL**                            |              | **45.268.000**    |

The calculation of the financial aspect uses a number of assumptions that refer to the economic growth and inflation rate in Indonesia. The following is a table of assumptions:

### Table 5 Financial Calculation Assumptions

| Assumptions set                                      |  |
|------------------------------------------------------|---|
| Product capacity / day                               | 15 kg of raw material |
| Number of working days / month                       | 24 days |
| Total manpower                                       | 3 people |
| percentage of total product sales                    | 85% |
| the percentage increase in product sales each year   | 2.5% |
| the percentage increase in production costs each year| 5%  |
| product price / packaging 100 gr                     | Rp 19,500 |
| the percentage increase in product prices each year  | 2.50% |

#### 3.2.2. Calculation of Production Operational Costs

Production operational costs consist of fixed costs and variable costs which can be seen in table 6.

### Table 6 Fixed Costs of Cookies Production

| Description               | unit cost | FC/ month |
|---------------------------|-----------|-----------|
| a. FC Cash                |           |           |
| Staff salary, person / month | 1,800.000 | 5,400.000 |
| Rent building / month     | 1,500.000 | 1,500.000 |
| Total FC cash             |           | 6,900.000 |
| b. FC non cash            |           |           |
| Depreciation of tools     | 591,111   |           |
| Maintenance cost          | 113,170   |           |
| Total FC non cash         | 704,281   |           |
| Total                     | 7,604,281 |           |

Fixed costs are costs that are fixed and do not depend on the amount of production. Fixed costs consist of depreciation and maintenance costs for machines, salaries for labor and building rent. In 1 month consists of 24 working days with a total workforce of 3 people. The total fixed cost per month of IDR 7,604,281 can be seen in Table 6.
Table 7 Variable Costs of Cookies Production

| Description                               | VC/ month |
|-------------------------------------------|-----------|
| 1. Raw material                           | 36,511,740|
| 2. Supporting materials                   | 2,805,840 |
| 3. Utility costs                          | 573,644   |
| 4. Administration and communication       | 500,000   |
| 5. Marketing transportation               | 500,000   |
| 6. Cleanliness and safety fees            | 60,000    |
| TOTAL                                     | 40,951,224|

Variable costs are costs whose amounts change with the total production capacity. Variable costs consist of the cost of raw materials, supporting materials, fuel, packaging materials, transportation and marketing costs and communication administration costs. Utility costs consist of utility costs for fuel, gas, electricity and water. Total variable cost per month is IDR 40,951,224.00.

Table 8 Total Cookies Production Costs

| Description                               | VC/ month |
|-------------------------------------------|-----------|
| Total fixed costs                         | 7,604,281 |
| Total variable costs                      | 40,951,224|
| Total cost                                | 48,555,505|

The total operational cost is the total cost required for production, which is IDR 48,555,505 / month. The calculation of the total production cost is needed to determine the cost of goods manufactured and the selling price which can be seen in Table 9.

3.2.3. Cost of Production (CP) and Break Event Point (BEP)

Table 9 Details of Cookies Production Costs, Cost of Production and BEP

| Description                               | Unit             | Total  |
|-------------------------------------------|------------------|--------|
| Production                                | packs / month    | 2,806  |
| Total fixed cost                          | Rp / month       | 7,604,281|
| Total variable cost                       | Rp / month       | 40,951,224|
| Total cost                                | Rp / month       | 48,555,505|
| Cost of Production (CP)                   | Rp / pack 100 gr | 17,305 |
| Selling price                             | Rp / pack        | 19,500 |
| BEP (unit) per month                      | packaging / month| 390    |

The determination of the cost of goods manufactured is by dividing the total cost of production or the total cost by the number of cookies products per month. Total production 2,806 packs per month with working days is 24 working days in one month. The calculation of the Cost of Production (CP) is as follows:

\[
CP = \frac{Total \ cost}{jumlah \ produk} \\
= Rp. 17,305,00
\]
The cost of producing cookies with a weight of 100 grams per package is Rp. 10,709.00. The selling price set is Rp. 19,500, - so that the company gets a profit or profit of 12.68%. Based on the calculation, the BEP obtained is 390 packages / month, which means that the business is at the break-even point if 390 packages are sold / month.

\[
\text{BEP production} = \frac{\text{Total biaya (Rp)}}{\text{Harga Jual (Rp)}} = 390 \text{ packs}
\]

3.2.4. Financial Feasibility Investment Criteria

| Table 10 | Investment Criteria for Cookies Production Business |
|----------|---------------------------------------------------|
| Investment Criteria     |                                                 |
| NPV       | Rp 372,694,093                                    |
| IRR       | 53 %                                              |
| Net B/C   | 1.17                                              |
| Payback Period | 28 months                                        |

- **Net Present Value (NPV)**
  The investment eligibility criteria based on the NPV value is if the NPV value is more than zero then the business design is declared feasible, whereas if the NPV value is less than zero then the business design is declared not feasible. The calculation results showed that the NPV value was IDR 372,694,093, so the hanjeli flour-supplemented cookies business plan was declared feasible to run.

- **Internal Rate of Return (IRR)**
  Financial analysis can be declared feasible if the IRR value is more than the MARR (Minimum Attractive Rate of Return) value. The MARR value set is 12.5% in accordance with the determined interest rate. Based on the IRR calculation, the IRR value is 53%, thus the business design can be declared feasible.

- **Benefit Cost Ratio (BCR)**
  A business design is declared feasible if the BCR value is more than one, while the business design is deemed inadequate if the BCR value is less than one. Based on the calculation of the BCR value, the BCR value was 1.17 so that the hanjeli flour-supplemented cookies business design was declared feasible.

- **Payback Period**
  The calculation result shows that the payback period is reached at 28 months. If the length of the payback period is less than the age of the factory, the business is declared feasible, whereas if the length of the payback period is greater than the age of the factory, the business is not feasible. Based on the results, the payback period is shorter than the planned investment life, which is 5 years, so it can be stated that the hanjeli flour-supplemented cookies business is feasible to run.

4. Conclusion

Analysis of technical aspects of cookies based on hanjeli flour supplemented with Moringa leaves powder has been fulfilled and can be realized. The output yield of the 15 kg production capacity is 12 kg or 78% with a processing time of 450 minutes per day.

The business design of cookies based on hanjeli flour supplemented with Moringa leaves powder is feasible in terms of financial aspect analysis, based on the calculation of investment criteria with a
discount factor of 12.5% resulting in an NPV value of IDR 372,694,093 with an IRR value of 53%, Net B / C value of 1, 17, and a payback period of 28 months.

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