Open Access Research Journal of
Science and Technology
Journals home page: https://oarjst.com/
ISSN: 2782-9960 (Online)

OARJ OPEN ACCESS RESEARCH JOURNALS

(RESEARCH ARTICLE)

Technical-technology aspect and financial analysis of sweet potato (*Ipomoea batatas* L) flour processing agroindustry in Lampung province

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Open Access Research Journal of Science and Technology, 2024, 11(01), 052–058

Publication history: Received on 15 March 2024; revised on 28 April 2024; accepted on 01 May 2024

Article DOI: https://doi.org/10.53022/oarjst.2024.11.1.0064

Abstract

Lampung Province is one of the Sumatra archipelago's fifth sweet potato-producing provinces. To provide added value and encourage the growth of agro-industry in Lampung Province, the development of sweet potato flour processing is needed. This study aims to determine the business feasibility of sweet potato flour in Lampung Province from raw materials, technical technology, and financial aspects. The research involved agencies and related institutions in Lampung Province and Lampung Tengah Regency. The research method used was a survey and interview method. The data obtained were analyzed in stages using the Exponential Comparison Method (ECM) and business feasibility analysis. The finding showed that the SP flour agro-industry is feasible to be established with a capacity of 4 tons of fresh SP as raw material in Way Pengubuan, Lampung Tengah District, Lampung Province. The project needs an initial investment capital of 3.36 billion and an annual operational capital of 14.44 billion. The project is projected to yield an NPV value of IDR. 1,320,768,285 over a 10-year business projection period, with an IRR of 21%, Net B/C of 1.11, and a PBP of 4 years and 17 days.

Keywords: Agroindustry; Sweet potato flour; Strategic location; Value-added; Development strategy

1. Introduction

The Province of Lampung is one of the fifth largest sweet potato-producing provinces in the Sumatra archipelago after West Sumatra, North Sumatra, Jambi, and Bengkulu. The production volume of sweet potatoes in the Lampung Province reaches 31,045 tons per year, and almost every district and city in the Lampung Province is a sweet potato producer [1]. As one of the agricultural products, sweet potato can be processed into various forms of food, one of which is sweet potato flour, which economically adds value to per capita society. If the fulfillment of flour is then partially replaced with sweet potato flour, it will reduce the amount of imported wheat as the main ingredient of flour production in Indonesia. Consequently, many competitive flour industries will compete to provide income for the state treasury.

Processing sweet potatoes into flour can facilitate storage, increase variety in utilization, and extend shelf life. Sweet potato flour can be processed into various foods, such as pastries, noodles, vermicelli, bread, and so on [2]. In flour form, sweet potato can be fortified with various desired nutrients. The process of making sweet potato flour can be relatively simple, easy, and inexpensive). Sweet potato flour has advantages or benefits due to its high bioactive compound and fiber compared to wheat flour. The presence of anthocyanin is exclusive to purple-fleshed sweet potato [3]. Yellow and orange-fleshed is a rich source of β-carotene (pro-vitamin A) [4]. These days, there is a high degree of development and widespread manufacture of gluten-free foods [5]. The advantages of purple sweet potato flour compared to wheat flour must be highlighted to enhance competitiveness. Besides its functional properties of anthocyanins, sweet potato has non-gluten content suitable for individuals with autism, gluten allergies, gluten intolerance (celiac disease), and lower glycemic index values. The gluten content in 'gluten-free' food products has been set at less than 20 mg/kg[5-6].

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As a substitute flour, sweet potato flour can be used in various proportions, for example, bread (20-30 percent), cakes and cakes (40-75 percent), cookies and biscuits (60-70 percent), and flakes (55 percent).[7-8]. Additionally, in sweet food products, substituting orange sweet potato flour can save on sugar usage. This represents a market potential for sweet potato flour as a substitute for food businesses and industries.

Based on the information above, establishing agro-industries based on sweet potatoes to produce sweet potato flour is expected to solve existing issues. Developing sweet potato flour processing is crucial to adding value and promoting agro-industries growth in Lampung Province. However, a feasible study on establishing sweet potato flour-based agro-industries has yet to be conducted in Lampung Province. Therefore, this research aims to evaluate the feasibility of the sweet potato flour agro-industry in Lampung Province based on raw material availability, technical technology, and financial feasibility.

2. Material and Method

The research used a survey and interview method. Primary and secondary data sources are documents, research findings, and information from the Central Bureau of Statistics and relevant agencies. In this research, the analysis begins with determining the strategic location of the industry and then continues with a feasibility analysis.

Strategic locations based on sweet potatoes are determined using the Exponential Comparison Method (ECM) referring to Marimin and Maghfiroh [9] by considering 15 criteria:

- Ease of licensing for industrial establishments;
- government support for industrial development,
- Land and building tax rates,
- Area conditions are conducive,
- Means of transportation,
- Availability of electricity,
- Supported by the community around the location of the establishment,
- The level of community adaptation to industry,
- Availability of telecommunications facilities,
- Availability of water facilities,
- Raw material potential,
- Labor availability,
- Availability of land for industry,
- Raw material supply,
- Market accessibility.

The weighting of the criteria and scores for each alternative are assessed by experts from the Lampung Province Industry Service, the Lampung Province Food Crops and Horticulture Service, the Lampung Province Bapenda, and the Lampung Province Food Security Service; apart from that, the assessment in filling out the questionnaire is carried out by academics from the university and practitioners operating in the flour industry in Lampung Province.

A feasibility analysis was based on technical, technological, and financial analyses. Financial analysis is conducted by determining the production capacity and selling price of sweet potato flour to calculate the NPV (Net Present Value), IRR (Internal Rate of Return), B/C Ratio (Benefit-Cost Ratio), and PBP (Payback Period) as measures of the feasibility of business activity. The financial projection for the feasibility study uses the Microsoft Excel program. The calculation is based on the economic lifespan of equipment and machinery, which ranges from 8 to 10 years.

3. Results and Discussion

3.1. Location Determination

Assessment data regarding location determination begins with selecting the areas with the most potential in Lampung Province. After getting the priority location for the assessment, data is collected using the exponential comparison method (ECM). The value resulting from data processing based on expert assessments at the provincial level from all relevant agencies was stated as ECM value and can be seen in Table 1.

Based on the district's ECM value, the district of Lampung Tengah is the main priority for developing the sweet potato flour agro-industry with a value of 78,340,619, followed by district Lampung Barat which has a value of 77,394,582. Even though the difference is not significant, Lampung Tengah is still considered to have more potential locations than Lampung Barat based on various criteria that respondents have assessed. Lampung Tengah Regency has accessible transportation facilities and a regional position close to other regions, so the distribution of raw materials will be more easily accessible. Another important consideration is the closeness to Bandar Lampung City, the capital of the Province of Lampung. Besides, the Regency of Lampung Tengah is supported by the availability of electricity, which is reflected by the fulfillment of the electricity needs of existing residents and companies. Apart from that, Lampung Tengah Regency has the highest score in licensing and government support for industrial activities. There are 111 large companies in the district of Lampung Tengah and 724 MSMEs registered under the supervision of the District Industry Service of Lampung Tengah.

After finding potential districts, the analysis continued to determine more specific areas at the sub-district level locations in Lampung Tengah Regency. The designated sub-district is Way Pengubuan Sub-District, Seputih Surabaya District, and Bandar Mataram District. The following table shows the results of analyzing the sub-district location determination assessment using the ECM method. The first potential location selected was Way Pengubuan District, with an ECM value of 177,274,827. Way Pengubuan sub-district is in the middle lane area; therefore, technically, we can cut the distribution route for raw materials. Quickly raw materials available make it very convenient for the manufacturing process.

Table 1 Results of District Location Determination Values with ECM

Priority	Alternative Districts	ECM Value
Potential Location 1	Lampung Tengah	78,340,619
Potential Location 2	Lampung Barat	77,394,582
Potential Location 3	Tanggamus	57,538,729
Potential Location 4	Lampung Utara	43,053,408

Table 2 Results of Sub-district Location Determination Values with ECM

Priority	Alternative Sub-Districts	ECM Value
Potential Location 1	Way Pengubuan	177,274,827
Potential Location 2	Bandar Mataram	82,180,888
Potential Location 3	Seputih Surabaya	49,554,784

3.2. Technical and Technological Aspects

Technically, several things must be considered when processing sweet potatoes into flour. Sweet potato flour processing involves technology, such as tools and machines, which help simplify the sweet potato processing process and reduce business operational costs. Production capacity to produce sweet potato flour is designed based on the maximum capacity of the primary equipment drying machine installed as a rotary dryer. The maximum capacity for non-heat-resistant food (indirect) is at ±200 kg/hour. Therefore, the production determination is adjusted to the number of working hours per day, and the total daily production obtained is at 4,000 kg/day of sweet potatoes or the equivalent of 4 tons of fresh sweet potatoes.

The raw materials used are purple, yellow, and white sweet potatoes with capacities of around 40%, 20%, and 40% of the total raw materials. Purple sweet potato flour is planned to be more significant because the market price is higher than yellow sweet potato flour. Consumer interest in these two flours is not only because of their color but also because of the health benefits of purple and yellow sweet potatoes. Orange-fleshed sweet potato varieties are superior sources of β-carotene (pro-vitamin A), while Purple-fleshed sweet potato varieties have excellent levels of anthocyanins. These compounds are reported to have good antioxidant capacity[4].

The selected sweet potato flour processing technology refers to a non-fermentation process to minimize operational costs. The primary process consists of sorting and washing, peeling, slicing, drying, milling, and sieving, as well as packaging (Figure 1).

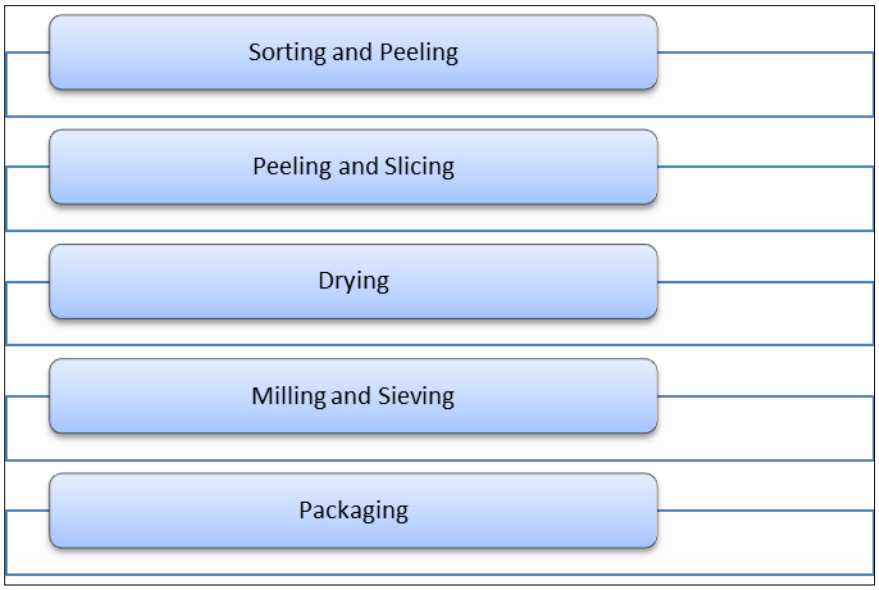

Figure 1 The main processing flow diagram of SP flour

The selection of machinery and tools is determined based on the processing stages and the machinery and tools' required capacity. Before the sweet potatoes are washed, they are sorted to separate the good from the damaged ones due to transportation, field management, and post-harvest pest and disease attacks. The sorting activity is estimated to take 1 hour per 720 kg of sweet potatoes. With the assistance of 4 people for sorting, a total of 5,760 kg of sweet potatoes can be sorted in 2 hours. The sorting activity is assisted by washing personnel so that the work can be completed for up to 4,200 kg per day within 8 hours. Sweat potatoes are washed mechanically using a sweet potato washing machine with a maximum power of 4.1 kW and a capacity of 700 kg per hour. Washing will be done by two sorting personnel, one washing machine operator, and one assistant for washing sweet potatoes. The calculation for completion is 4,200 kg /700 kg per hour, resulting in 6 hours of work to complete the washing of sweet potatoes.

The peeling of sweet potatoes will be done mechanically using an automatic electric peeling device capable of peeling 250 – 300 kg of sweet potatoes per hour, with a power consumption of 370 watts. The slicing of sweet potatoes aims to accelerate the drying process to achieve a moisture content of 10–12%. Slicing will use an automatic slicer that produces 1-5mm thick slices. The machine is made of stainless-steel material to ensure the cleanliness of the sliced sweet potatoes. The machine operates with an electric power of 750 watts, 220 V, with a production capacity ranging from 100 to 300 kg per hour.

Drying is a crucial process that requires careful consideration in sweet potato flour processing to determine production capacity. Masud et al. [10] have identified food security and economic sustainability as significant obstacles due to the high energy requirements of drying. Technically, sweet potato drying can use sunlight, ovens, rotary dryers [11], and even advanced drying techniques, such as fit thin-layer models [12]. In this project, the drying process will use a rotary dryer widely used in sweet potato flour production companies. This dryer is affordable and offers quick drying times. The heat energy used by the machine comes from a burner. A burner is recommended for heat-sensitive foods like sweet potatoes. Uncontrolled heat can damage the carotenoids and anthocyanins contained in sweet potato chips. The rotary dryer can dry food items like chips using a "continued thermal air space system" or continuous hot air space system. With these considerations, a rotary dryer with an approximately 200 kg/hour production capacity of heat-sensitive material (indirect) will be used.

The purpose of drying sweet potatoes is to reduce the moisture content to 10–12%, even less than 10%. Less free water reduces microbial growth and biochemical reactions at this level, consequently increasing food shelf life [13]. Drying is a critical process among all processing stages as it determines the product quality and production costs. The company's operational system will employ a 2-shift system in one day, totaling ten working hours. During the 10-hour operation

of the rotary dryer, 2-4 tons of sweet potatoes can be dried in one day or 20 working hours. Using a 2-shift system in one working day aims to achieve the maximum capacity value of the installed rotary dryer equipment.

The milling process will utilize an automatic Disc mill with a motor power of 7,500 watts, capable of producing flour at 300 kg per hour in one operation. One daily worker assists in the milling process, and the milled product will then go to the sieving section. The size of the sweet potato flour resulting from the sieving process is 80 – 100 mesh. The sieving of sweet potato flour will use an automatic sifter machine. The machine operates with an electric power of 1800 watts, 220 V, with a capacity of 100 kg per hour, producing 900 kg of flour within 9 hours. Flour that does not pass through the sieve will be re-milled again. Consistent fineness will affect sweet potato flour's quality and selling price.

Flour is a hygroscopic substance that requires effective packaging materials to maintain its desirable quality and shelf stability over extended periods of storage. Polypropylene bags are packaging commonly used for the transportation, distribution, and storage of food wheat flour produced worldwide in large quantities [14]. Therefore, the packaging of sweet potato flour in this project will use polypropylene plastic. Labels are applied to the packaging using screen printing techniques to ensure that the brand on the packaging does not quickly deteriorate. The weighing scale is digital with a maximum load capacity of 30 kg. After weighing, the plastic is sealed using a continuous sealer with a maximum load capacity of 5 kg per package.

3.3. Financial Analysis

This financial analysis schematic is based on the models where the working capital is from bank loans, with an assumed interest rate of 11% for corporate loans. If the business activity's profit percentage exceeds the cost of capital return plus the loan interest percentage charged by the bank, the business can be deemed feasible.

The investment model consists of direct and indirect investments. The total direct and indirect investment capital amounts to 3,359,654,631 IDR. A summary of investment capital can be seen in Table 3. The components of direct investment capital consist of land costs, building and facility costs, installed equipment prices, instrumentation and control tools, piping costs, electrical installation costs, insulation costs, office inventory costs, and transportation facilities. Indirect investment capital components consist of licensing costs, engineering and supervision costs, contractor costs, unforeseen costs, and construction costs. Direct and indirect investment capital is summarized in Table 3 as expenditure on land and buildings, expenditure on equipment and machinery, and expenditure on supporting tools and facilities.

The working capital or operational cost is prepared for the factory to operate for 10 years. The components of this working capital include raw material costs, marketing and administrative costs, employee salaries, and taxes. The total annual working capital for operations amounts to 14,437,968,183 IDR (Table 4).

Table 3 Investment Capital

Items	Amount (IDR)
Expenditure on Land and Buildings	2,581,100,000
Expenditure on Equipment and Machinery	465,653,000
Expenditure on Supporting Tools and Facilities	286,241,500
Total Investment	3,359,654,631

Table 4 Operational Cost/Year

Items	Amount (IDR)
Expenditure on Purple Sweet Potato Raw Materials	2,661,120,000
Expenditure on Yellow Sweet Potato Raw Materials	1,088,640,000
Expenditure on White Sweet Potato Raw Materials	1,693,440,000
Marketing and Administrative Costs	7,678,117,683

Labor Costs	1,262,400,000
Land and Building Tax	5,162,200
Income Tax (PPh)	42,508,800
Vehicle Tax	6,579,500
Total Operational Cost/Year	14,437,968,183

The feasibility criteria of the business are evaluated based on the values of NPV, IRR, PBP, and Net B/C (Table 5). The calculation results show NPV of IDR 1,320,768,285; IRR of 21%; PBP of 4.05 years; and Net B/C of 1.11. The project is deemed feasible to be executed because of the positive NPV value, IRR greater than the discount rate, and Net B/C greater than 1. The positive NPV value indicates that the project is profitable. IRR greater than the discount rate indicates that investing in this project is more profitable than depositing money in a bank. A Net B/C of 1.11 means that for every investment of 1 IDR, a benefit of 1.11 IDR will be obtained. All investments will be recovered within 4 years and 17 days of the project's lifespan.

Table 5 Table Result Financial Feasibility Analysis

Criteria	**Value**	**Statement**
NPV (IDR)	1,320,768,285	The project is feasible to run
IRR (%)	21	
Net B/C ratio	1.11	
PBP (year)	4.05	

4. Conclusion

Based on the Exponential Comparison Method, the strategic location identified is in the Lampung Tengah Regency, particularly in the Way Pengubuan District, with an ECM value of 177,274,827, making it the chosen strategic location for establishing a sweet potato flour agro-industry in Lampung Province. Furthermore, the financial analysis results based on the feasibility scenario calculations indicated that the sweet potato flour agro-industry with a capacity of 4 tons of raw material is feasible to operate. With an initial investment capital of 3.4 billion and annual operational capital of 14.44 billion, the project is projected to yield an NPV value of 1,320,768,285 IDR over a 10-year business projection period, with an IRR of 21%, Net B/C of 1.11, and a PBP of 4.05 years, equivalent to 4 years and 17 days.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

All authors declare and confirm that the version of the submitted manuscript have been read and approved.

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