Adlay (Coix lacryma-jobi), a potential source alternative to wheat flour: A financial feasibility analysis for small scale production

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Abstract. The consumption of wheat flour-based products such as noodles, biscuits, and cookies in Indonesia increases annually during the rising of costumer need for instant and ready to eat food products. On the other hand, the dependence on wheat import in Indonesia makes the searching of potential source alternative to wheat flour is important. Adlay (Coix lacryma-jobi), known as Hanjeli (in Sundanese), is underutilized cereal plant which easily found in Indonesia and has highly nutritional contents. This study was then conducted to evaluate financial feasibility of adlay flour production. From product analysis, several trials were carried out to produce adlay flour with nutritional compositions including moisture, ash, fat, protein, and carbohydrates were 13.61, 0.87, 1.41, 12.56, and 71.54 %, respectively. In financial feasibility analysis, the establishment of mini plant to produce adlay flour was feasible indicated by some feasibility criteria such as net present value (NPV), benefit-cost ratio (B/C), internal rate of return (IRR), and pay-back period (PBP) were 92.065 million IDR, 1.14, 48.89 %, and 24 months, respectively.

1. Introduction
The consumption of wheat flour-based products such as noodles, biscuits, and cookies in Indonesia increases annually during the rising costumer's need for instant and ready to eat food products. In Indonesia, the average flour consumption in 2014-2018 has increased with 19.92 per capita per year, wherein 2018, it reached 2638 per capita per year [1]. The dependence on wheat import in Indonesia makes searching for potential source alternatives to wheat flour becomes important issue. One of the potential cereals prospective to be developed as wheat flour alternative is Adlay (Coix lacryma-jobi).

Adlay (Coix lacryma-jobi), known as Hanjeli (in Sundanese), is an underutilized cereal plant that easily found in Indonesia and has highly nutritional contents. Syahputri and Wardani [2] reported that adlay has high protein (14%), fat (8%), vitamin B1, and calcium (54 mg/100 g) contents. Adlay plant in Indonesia is widely distributed from Sumatra, Java, and Kalimantan [3]. According to Sihombing [4], adlay is traditionally believed to treat ailments such as lung abscess, appendicitis, chronic inflammation, infections and urinary stones, swelling (edema), rheumatism, eczema, pneumonia, fever, cough shortness, and others.

Adlay seeds could be consumed as adlay rice or used as a mixture with paddy rice [5]. Adlay seeds are usually processed conventionally and mechanically into the rice. Adlay rice can be processed into adlay flour after it is first hydrated [6]. The utilization of adlay flour can support small, medium, and...
large food industries. However, the financial feasibility study on adlay flour production particularly for in small-medium enterprises (SME’s) is scarce. This study was then aim to evaluate the financial feasibility of adlay flour production in small scale production.

2. Material and methods

2.1. Materials
The Adlay (Coix lacryma-jobi) seeds were purchased from adlay farm in Sumedang, West Java. The samples were then pre-cleaning to separate off-grade seeds, dehulling to separated adlay husk and the bran layer from the kernel, and milling to make a flour. This flour was then subjected to proximate analysis to determine of water, fat, protein, ash, and carbohydrate contents of product. This step was carried out to evaluate the quality of flour product.

2.2. Characterization of Adlay Flour Quality
Characterization of Adlay flour was conducted in term of proximate analysis consisting of proximate (moisture, ash, protein, fat, and carbohydrate) and dietary fibre according the method previously reported [7].

2.3. Financial Feasibility Analysis of Adlay Flour Production
Some investment criteria namely break-even point (BEP), internal rate of return (IRR), net present value (NPV), and Benefit-cost Ratio (BCR).

2.3.1. Internal Rate of Return (IRR)
The internal rate of return represents a discount rate of the net present value (NPV) of all cash flows equal to zero in a discounted cash flow analysis. IRR calculation used the same formula as NPV does. This financial calculation is important to estimate the profitability of potential investments [8].

2.3.2. Net Present Value (NPV)
Net present value (NPV) is defined as the difference between the present value of cash inflows and the present value of cash outflows in a period of time. NPV is employed in investment planning and capital budgeting to analyze the profitability of a project. The cash flow of benefit calculation is Present Worth of Benefit (PWB), while the cash-out calculation is Present Worth of Cost (PWC), so NPV is the calculation of PWB minus PWC. Investment will be profitable if NPV is positive and calculated following the formula [9]:

\[
NPV = \sum_{t=1}^{n} \frac{R_t}{(1 + i)^t}
\]

Where:
\( R_t \) = Net cash inflow-outflows during a single period \( t \).
\( i \) = Discount rate or return that could be earned in alternative investments
\( t \) = Number of timer periods

2.3.3. Benefit-Cost Ratio (BCR)
Benefit-cost ratio (BCR) is a method that used ratio of cost and benefit to summarize the overall relationship between the relative costs and benefits of a proposed project. If the value of BCR is greater than 1.0, the project is expected to deliver a positive net present value and firm feasibility to be conducted [10].
2.3.4. Payback Period (PBP)
Payback period refers to the amount of time that takes to recover the cost of an investment. It is one of the simplest investment appraisal techniques and can be calculated following the formula [11]:

\[ PBP = t + \frac{CCF_t}{CCF_{t-1}} \]  \hspace{1cm} (2)

where:
- \( t \) = the last period number with a negative cumulative cash flow.
- \( CCF_t \) = the absolute value (i.e. value without negative sign) of cumulative net cash flow at the end of the period \( t \).
- \( CCF_{t-1} \) = the total cash inflow during the period following period \( t \).

3. Results and Discussion

3.1. Adlay Flour Specification
The characteristics of Adlay flour in comparison with Indonesian national standard of wheat flour (SNI-3751:2009) are presented in Table 1. The selected quality parameters for example moisture and protein met with national quality standard, while for ash Adlay flour didn’t meet. In this study the content of calcium, carbohydrate, and dietary fibre were measured, while, in the case of national quality standard they were not be required. In the context of protein content Adlay flour was suitable with Indonesian standard quality for wheat flour. This study was in agreement with Ottoboni et al [12], that reported protein content of Adlay reached of 20%.

| Selected parameters | Adlay flour | Wheat flour standard* |
|---------------------|------------|-----------------------|
| Particle size (passed 90 mesh sieve) (%) | Not measured | Min 95 |
| Moisture (%)        | 13.61      | Max 14.5              |
| Ash (%)             | 0.87       | Max 0.7               |
| Protein             | 12.56      | Min 7.0               |
| Dietary fibre (%)   | 7.43       | Not used              |
| Carbohydrate (%)    | 71.54      | Not used              |
| Calcium (mg/100 g dry weight) | 111.79    |                       |

*Indonesian National Standard (SNI) 3751:2009

3.2. Financial Feasibility Analysis

3.2.1. Investment, Fixed and Variable Costs
Investment cost in this study consisted of machineries (disc mill and dryer) with total amount of 17.00 million IDR. While for fixed cost including labours, maintenance, depreciation, and building rent costs reaches 50.26 million IDR/year. For variable cost that consisted of material, utility, administration, and communication costs were 92.62 million IDR/year. Total of investment, fixed, and variables cost, cost of goods manufactured, and selling price are presented in Table 2. Variable cost showed the highest component of production cost. This result was in line with Belloti et al. [13] that reported variable cost is the major component of production cost.
Table 2. Investment, fixed, and variable costs in Adlay flour production

| Description                        | Unit                   | Total       |
|------------------------------------|------------------------|-------------|
| Production capacity                | Pack @ 1 kg flour/ month | 255         |
| Fixed costs                        | IDR/year               | 50,266,700  |
| Variable cost                      | IDR/year               | 92,622,449  |
| Cost of goods manufactured         | IDR/pack               | 46,479      |
| Selling price                      | IDR/pack               | 50,000      |

IDR= Indonesian Rupiah.

3.2.2. Feasibility Analysis
The financial feasibility criteria in Adlay flour production including net present value (NPV), internal rate of return (IRR), Benefit-Cost ratio (B/C), and payback period (PBP) are illustrated in Table 3. The data showed that all of investment criteria were feasible.

Table 3. Investment criteria in Adlay flour production

| Feasibility Criteria       | Values               | Feasible or not                      |
|----------------------------|----------------------|--------------------------------------|
| Benefit-cost ratio         | 1.14                 | ≥ 1, feasible                        |
| Internal rate of return    | 48.89%               | ≥ MARR (18%), feasible               |
| Net present value          | 92,065,278 IDR       | ≥ 0, feasible                        |
| Payback period             | 24 month             | ≤ project period (5 years), feasible |

MARR= minimum attractive rate of return. IDR= Indonesian Rupiah.

4. Conclusion
In this study, financial feasibility analysis in producing of Adlay flour for small scale production was evaluated. In product specification analysis, we found that two quality parameters of Adlay, moisture and protein contents, were suitable with Indonesian national standard quality of wheat flour (SNI-3751: 2009). In financial feasibility analysis, with production capacity 255 kg/month and selling price per pack was 50,000 IDR, all investment criteria including benefit-cost ratio (BCR), internal rate of return (IRR), net present value (NPV), and payback period showed that production of Adlay flour was feasible with the values of 1.14, 48.89%, 92,064 million IDR, and 24 months, respectively. However, further analysis in product specification were required to more clearly understand about physicochemical properties of Adlay flour in comparison with wheat flour.

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