Feasibility Study of Cheddar Cheese Factory from Goat Milk in Indonesia

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Abstract. Cheddar cheese is the popular cheese that commonly used in Indonesia. Recently, cheddar cheese is fermentation product of cow milk. However, for some people especially with lactose intolerant, are not possible to consume cheddar cheese. One of the solution is to produce cheddar cheese from goat milk. It is well known that goat milk is more capable to digest in human body, since it has smaller protein size compared to cow milk. To support the development of cheese factory from goat milk, techno-economy study is needed. In this research, we did techno-economy feasibility study for cheddar cheese factory from goat milk. From our analysis, the Return on Investment (ROI) value is around 13.25%; the Pay out Time (POT) for 4.3 year and Break Even Point (BEP) around 22.53%. From techno-economy analysis results, it proving the feasibility for constructing cheddar cheese factory from goat milk.

Keywords: Cheddar cheese factory, Goat milk, Fermentation, Feasibility study, Techno-economy analysis

1 Introduction

Milk is the source of protein that contains high value of nutrition. Milk contains of water around 80-90%, fat around 2.5 -8.0%, lactose around 3.5-6.0%, albumin around 0,5-0,9% [1,2]. Fresh milk should be treated for the storage, since there is possibility for nutrition lost or contaminated by microorganism when its storage at room temperature [3]. Milk cow is highest feed stock for milk.

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However, goat milk can be the alternative. Goat milk contains 86.5% water, 3.9% protein, 4.3% fat, 5.8% lactose and 0.8% mineral [4]. Goat milk has more digestible proteins and higher mineral contents compared to cow milk which is healthier for human digestion [4-7].

Goat milk can be processed to valuable product such as cheese[4-8]. The increasing consumption rate in Indonesia resulting in growing for cheese industry in Indonesia. There are some cheese factories in Indonesia such as Baros, Indrakila, Yummy and Mazaraat, however the production from the local industry still could not fulfill the demand in Indonesia. In 2016, the import value of cheese reached around USD 36,000 which is higher than import value at 2018 (USD 33,000) [8]. One of solution to fulfill the demand for cheese in Indonesia is by establish new cheese factory from goat milk. To support the development of new cheese factory from goat milk in Indonesia, techno economy feasibility study is needed. In this study, we did feasibility study for cheddar cheese factory from goat milk with the capacity of 3000 ton per year.

2 Materials and Methods

The unit cost for the apparatus is based on the dimension of the apparatus. All of the apparatus has been well designed. The cost estimation for apparatus is based on the reference from Aries et.al[9]. The cost estimation is based on the capacity of factory which is 3000 ton/day and the present price is corrected by using correction factor which is chemical engineering plant index.

For the economic feasibility, we are following reference from Aries et.al and Timmerhaus et.al[9-10]. The feasibility of this process is measured from capital expenditures (CAPEX) and operational expenditures (OPEX). CAPEX consists of total direct cost (factory apparatus cost, instrumentation, etc) , total indirect cost (engineering, construction fee, etc) and working capital (product inventory, process inventory, etc). OPEX consist of manufacturing cost and general expenses. APEX and OPEX measurement is used for calculating important parameter for economic feasibility such as return on investment (ROI), payout time (POT) and break even point (BEP).

3 Result and Discussion

Figure 1 shows the production process for this factory that represent by block flow diagram. The factory production capacity of cheddar cheese is 3000 ton/year. After the milk arrived from the farmer, milk is storaged at silo with the silo temperature of 4 ^{o}C to maintain the quality of milk. The tank with agitator is used as pasteurizer. Pasteurizing is important for the cheese industry to kill the coliforms bactery that dangerous for human health. Pasteurizer operating temperature is 63 ^{o}C with the pasteuring time is 30 minutes. In Fermentor, fermentation is anaerob with the *Lactococcus Sp. Cremoris* for the fermentation bacteria. After fermentation, fermented milk is transferred to cheese vat apparatus. In cheese vat, rennet is added to agglomerate casein in the milk. Rennet is obtained from the stomach of cows and it rich in enzyme. In cheese vat, curd (soon will be cheese) and whey is formed. The total whey produced in this factory is 6662.409 ton/year. After from cheese vat, curd and whey is separated. Before cheese is formed at block former, salt is added at cheese. The roles of salt in cheese are for preservatives, taste and dietary natrium. The storage warehouse for the cheese is operated at temperature 4-8 ^{o}C and has the storage capacity for 12 months.

Figure 2 shows the proposed factory layout for cheddar cheese factory with the scale of 1:1000. The factory layout should fulfilled the aspects of safety, operation and economics. The safety aspect in here is the location of process that not very close with office and also the availabilty of hydrant, fire station, and safety officer that has qualified for firefighter. The operation in here is the factory layout should support for the process itself from the location of control room and the acces for storage/warehouse loading and unloading. The economy aspect in here is how to optimized the usage area of factory so the production process is well performed.

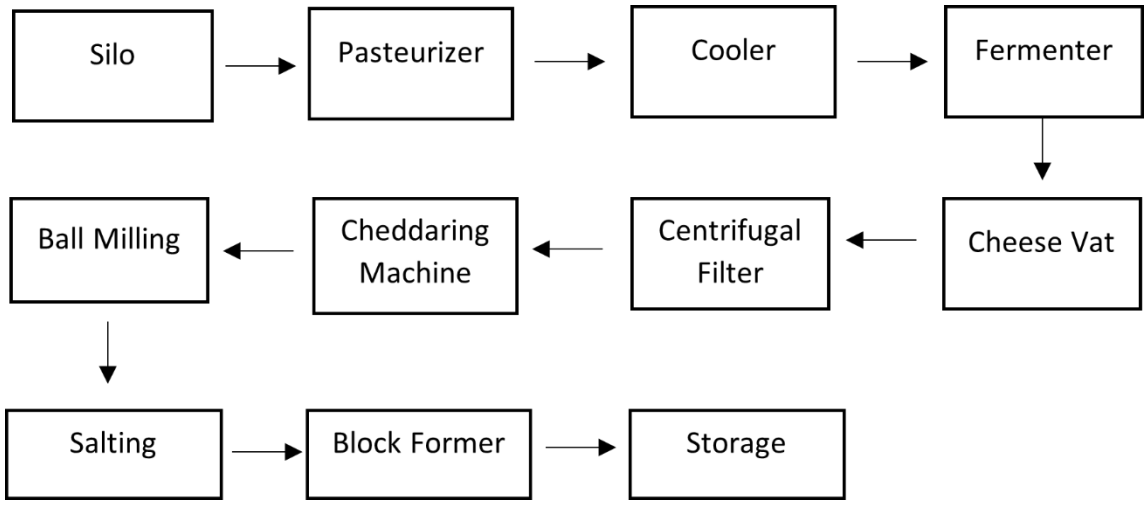

Fig. 1 Block flow diagram of cheddar cheese factory

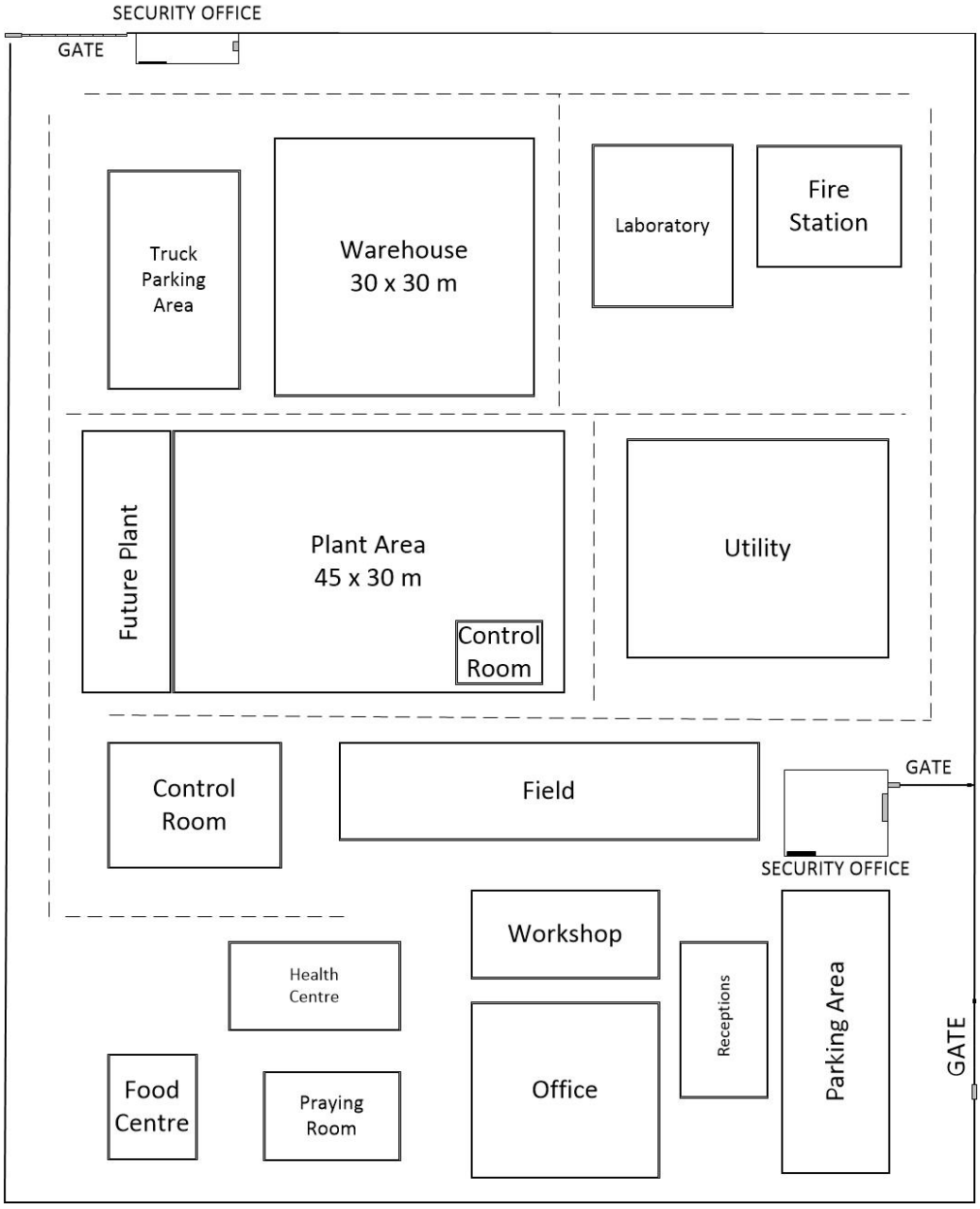

Fig. 2 Factory layout with scale 1:1000

Table 1 shows capital expenditures (CAPEX) of cheese factory. Total CAPEX of this factory is Rp 280,760,345,822. Table 2 shows manufacturing cost for this factory and Table 3 shows general expenses of this factory. Operational expenditures (OPEX) is the total value of manufacturing cost and general expense. OPEX value for ths factory is Rp 280,502,769,212.

Table 1. Capital expenditures (CAPEX) of factory

No	Components	Price (Rp)
1	Factory apparatus prices	18,658,226,675
2	Apparatus installation	10,262,024,671
3	Instrumentation	9,329,113,337
4	Piping	2,985,316,268
5	Electrical system	5,597,468,002
6	Building	12,687,594,139
7	Area development	3,731,645,335
8	Facility	14,926,581,340
9	Land price	4,536,000,000
.	TOTAL DIRECT COST	82,713,969,769
1	Engineering	5,597,468,003
2	Construction fee	13,184,521,577
3	Legal fee	3,955,356,473
4	Contractor fee	6,6177,117,582
5	Contingency	19,776,782,365
	TOTAL INDIRECT COST	49,131,245,999
	FIXED CAPITAL COST	131,845,215,768
1	Raw materials inventory	13,527,303,235
2	Process inventory	64,567,093,842
3	Product inventory	21,522,364,614
4	Extended credit	27,776,003,750
5	Cash money availability	21,522,364,614
	WORKING CAPITAL	148,915,130,054
	CAPITAL EXPENDITURES COST	280,760,345,822

From the production capacity of this factory, we can arrange Table 4 for the total sales of the products. The total annual sales (Sa) is Rp 333,312,045,000. From Table 3, we calculated profit before tax.

Profit before tax = Total sales − OPEX
=Rp 333,312,045,000 − Rp 280,502,769,212
= Rp 52,809,275,789

According to Indonesia goverment regulation (UU nomor 36 pasal 17 ayat 1(b), 2018), the industrial tax is 28%. Then the profit after tax is

Profit after tax = Profit before tax – (tax*profit before tax)
Profit after tax = Rp 38,022,678,568

Table 2. Manufacturing cost of factory

	Components	Price (Rp)
1	Raw materials	162,327,638,820
2	Employee salary	17,328,000,000
	Components	Price (Rp)
3	Supervision	2,599,200,000
4	Factory utility	4,009,392,328
5	Maintenance	7,910,712,946
6	Inventory supply	1,186,606,942
7	Laboratory cost	519,840,000
8	Royalty and patent	16,830,166,153
	DIRECT PRODUCTION COST	212,711,557,188
1	Depreciation	924,922,808
2	Local tax	1,318,425,158
3	Insurance	1,318,425,158
4	Loan interest	28,076,034,582
	FIXED CHARGES	31,637,861,706
	FACTORY OVERHEAD COST	13,918,956,473
	MANUFACTURING COST	258,268,375,367

Table 3. General expenses of factory

	Components	Prices (Rp)
1	Administration	2,599,200,000
2	Distribution and marketing	5,610,055,384

3	Research and development	14,025,138,461
	GENERAL EXPENSES	22,234,393,845

Table 4. Total sales of product

	Components	Total production (ton/year)	Prices (Rp/ton)	Prices (Rp)
1	Cheddar cheese	3000	100,000,000	300,000,000,000
2	Whey	6662.409	5,000,000	33,312,045,000
	TOTAL SALES			333.312.045.000

By using the data from Table 1 until Table 4, we calculated the discounted value (i) to prove the benefit for establishing this factory. We caluclated discounted value by using equations below [10]:

$$WC + SV + \left(C\ x\ \frac{(1+i)^N - 1}{i}\right) = (FC + WC) + (1+i)^N \quad (1)$$

Notes:

WC : working capital = Rp 148,915,130,054

SV : salvage value which consists of building and land price = Rp 17,223,594,139

C : cash flow which consists of profit after tax, depreciation and loan interest = Rp 67,023,635,958

FC : fixed capital cost = Rp 131,845,215,768

i : discounted value

N : operational life of factory = 20 year

By using *trial and error method*, we got discounted cash (i) = 23.50%. The value of discounted cash (i) is bigger than average saving deposito interest rate in Indonesia (3%). The higher discounted cash value prove that inverstation for cheddar cheese factory in Indonesia is profitable.

Another key value to calculate the feasibility of factory are return on investment (ROI) and pay out time (POT). We calculated the value of ROI and POT after tax below, based on equation from reference :

$$\textit{Return on Investment}\ (\text{ROI}) \text{ after tax } = \frac{profit\ after\ tax}{total\ capital\ investment}\ x\ 100\% \quad (2)$$

$$= \frac{\text{Rp } 38{,}022{,}678{,}568}{Rp\ 280{,}760{,}345{,}822}\ x\ 100\%$$

$$= 13.41\%$$

Pay Out Time (POT) after tax $$= \frac{total\ capital\ investment}{profit\ after\ tax + (0.1\ x\ total\ capital\ investment)} \quad (3)$$

$$= \frac{Rp\ 280{,}760{,}345{,}822}{\text{Rp } 38{,}022{,}678{,}568 + (0{,}1\ x\ Rp\ 280{,}760{,}345{,}822)}$$

$$= 4.27 \text{ year}$$

The value for ROI is higher than highest inflation rate in Indonesia at 2022 which is 6.95 % [11]. proving the investment for cheddar cheese factory is acceptable. Based on reference, low risk investment that has low risk of failure should be less than 5 year [10]. The POT for cheddar cheese factory is lower than 5 year, proving the feasibility of this factory. There are few studies related with the ROI or POT value for cheese plant. Other study mentioned that pay out time (POT) for gouda cheese plant from cow milk was 5 year and its comparable with our research [12].

Break even point (BEP) and shut down point (SDP) are another parameters for proving the feasibility of investment. Below are the calculation for BEP and SDP, based on equation from reference.

Fixed expenses at maximum production (Fa) = depreciation + local task + insurance (4)

= Rp 924,922,808 + Rp 1,318,425,158 + Rp 1,318,425,158

= Rp 3,561,827,124

Regulated cost at maximum production (Ra) = employee salary + factory overhead + general expenses + maintainance + inventory supply + laboratory cost + supervision (5)

= Rp 17,328,000,000 + Rp 13,918,956,473 + Rp 22,234,393,845 + Rp 7,910,712,946 + Rp 1,186,606,942 + Rp 519,840,000 + Rp 2,599,200,000

= Rp 65,697,710,206

Variable cost at maximum production (Va) = raw materials + factory utility + royalty and patent (6)

= Rp 162,327,638,820 + Rp 4,009,392,328 + Rp 16,830,166,153

= Rp 183,167,197,300

Break Even Point (BEP) $= \frac{Fa + (0.3\ x\ Ra)}{Sa - Va - (0{,}7x\ Ra)}\ x\ 100\%$

$$= \frac{Rp\ 3{,}561{,}827{,}124+(0.3\ x\ Rp\ 65{,}697{,}710{,}206)}{Rp\ 333{,}312{,}045{,}000-Rp\ 183{,}167{,}197{,}300\ -(0{,}7\ x\ Rp\ 65{,}697{,}710{,}206)}\ x\ 100\%$$

$$= 22.34\%$$

Shut Down Point (SDP) $= \frac{(0.3\ x\ Ra)}{Sa-Va-(0{,}7x\ Ra)}\ x\ 100\%$

$$= \frac{(0.3\ x\ Rp\ 65{,}697{,}710{,}206)}{Rp\ 333{,}312{,}045{,}000-Rp\ 183{,}167{,}197{,}300\ -(0{,}7\ x\ Rp\ 65{,}697{,}710{,}206)}\ x\ 100\%$$

$$= 18.92\%$$

The BEP value of 22.34 % related with the production capacity in the factory that the operational cost is similar with the profit. The SDP value of 18.92% related with the limit for the factory to shutdown the operation. If the capacity production of factory less than 18.92% then the production should be stopped, since the operational cost is higher than the profit.

4 Conclusion

From our study, the cheddar cheese factory from the goat milk is feasible to be established in Indonesia. The discounted cash value (23.50%) is higher than saving deposito interest in Indonesia (3%), proving the investment for cheddar cheese factory is promising. Furthermore, the value for return on investment (ROI) is higher (13.41%) than highest inflation rate in Indonesia at 2022 (6.95%)%), proving the investment for cheddar cheese factory is promising.

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