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Economic feasibility of chlorella and dried artemia-based artificial feed for ornamental koi fish (*Cyprinus carpio Haematopterus*) larviculture: case in Indonesia

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Introduction

Indonesia was one of the top 10 world exporting countries for ornamental fish with revenue of US$21.54 million in 2014 [1]. Koi carp (*Cyprinus carpio haematopterus*) is one of main ornamental fish cultivated in Indonesia. In 2011, the production reached about 450 million of fish or 30% of total ornamental fish production. According to Sharif C. Sutardjo, demand of koi fish would continue to increase and Indonesia should improve the production of koi fish in terms of quality and quantity [2]. One of the ways to increase the production of koi carp is to improve the productivity of koi carp larvae. At larval stage, live feed (*e.g.* Chlorella and Artemia) became one of the most important parts because of its several specific nutrients that very important for larval growth [3]. However, large-scale production of live feed was limited due to impractical technology for farmer and high investment cost to build its rearing system. Therefore, live feed-based artificial feed for koi carp larvae is needed. Based on previous research, artificial feed based Chlorella and Artemia has better performance for koi carp larvae compared to commercial feed with survival rate of 72.11% and 70.22%, respectively (Suantika et al., unpubl. data). In order to meet industry sector, feed must be carried out its economic feasibility. Therefore, research on the economic feasibility of artificial feed based on Chlorella and Artemia for koi ornamental fish larvae was done.

Materials and methods

Collecting Data
Artificial feed tested as a product was feed contained of 10% Chlorella, 5% Artemia, and 85% other raw materials which had the best performance from previous research (Suantika et al., unpubl. data). Required data were the price of all investments and operations cost for feed production through internet, market survey and previous research, including commercial feed control at the price of US$4.10/kg.

Economic Feasibility Analysis
Economic feasibility was calculated based on the following assumptions: (1) The term industry used is small-scale industry with production of 2000 kg/day [4]; (2) forecasting production period for 10 years; and (3) price conversion referred to January 2, 2017 with US$1 = Rp13,503 and no inflation after 10 years. The economic feasibility analysis was included calculation of investment cost, operational cost, raw material cost and cost of goods sold. The calculation was used for the analysis of Pay Back Period (PBP), Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit/Cost (B/C) Ratio analysis [5].

Results and discussion

The economic feasibility is the important aspect to determine whether the business theoretically is feasible to be commercialized or not, in this case, artificial feed for koi carp. Artificial feed consisted of Chlorella and Artemia as live feed components and other raw materials that was summarized in Table 1 below.

Table 1. Calculation of feed components cost per month

Raw Material	% in feed	Price per kg ($)	Total price/kg of feed ($)	For 2000 kg of feed ($)	Monthly cost ($)
Chlorella	10	0.60	0.06	120.00	3,600.00
Artemia	5	22.45	1.12	2,245.00	67,350.00
Others	85	N/A	0.41	820.00	24,600.00
				Total	**95,550.00**

Investment cost included land and building, several production equipment, and non-production facilities.

Production equipment included generator set, silo, bed dryer, hammer mill, disk mill, sieving machine, steam boiler, mixer machine, micropelletizer, cooler machine, sealer, trolley, wagon, tools kit, water pump, display rack, scales, shovel, tanks, and small truck. Non-production facilities included office facilities, electricity and household equipment. Depreciation was calculated based on its economic life. Table 2 showed estimation cost of investment cost and depreciation.

Table 2. Estimation of investment cost and depreciation cost for 10 years

Investment cost	Total Cost (USD$)	Depreciation per month ($)
Land and building	44,435.29	370.29
Production equipment	19,697.30	322.41
Non-production equipment	5,270.98	150.97
Total	**69,403.57**	**843.67**

Operational cost included packaging, labor, administration cost. Packaging cost consisted of labelled-aluminium package. Labor cost consisted of production and non-production employees. Administration cost consisted of electricity, phone and internet cost, fuel, promotion and sales, entertainment, cleaner, and license. Table 3 below summarized total of operational cost.

Table 3. Estimation cost of operational cost

Component	Monthly cost ($)
Packaging cost	7,200.00
Production employees	5,250.64
Non production employees	2,700.00
Administration cost	1,283.56
Total	**16,434.20**

Based on three tables above, now we calculated cost of goods sold (COGS) that consisted of total of feed component cost, depreciation of investment cost, and operational cost. Also, maintenance cost was included in COGS, detailed calculation in Table 4.

Table 4. Cost of goods sold of feed and sale price

Component	Total ($)
Total of feed component cost	95,550.00
Depreciation	843.67
Operational cost	16,434.20
Maintenance cost	250.00
COGS for (2000x30 kg of feed produced)	**113,077.87**
COGS for one kg of feed	**1.86**
Sale price (150% of COGS)	**2.70**

Based on the table, sale price of one kg of feed was 2.70 compared to control feed that price is US$4.10/kg, price was much smaller by margin of US$1.4, this is because of considering supply chain before reach consumer. There was no supply chain data for control feed through several intermediate suppliers. Based on the sale price, 10-year sales target was sat starting from 60% from year 1 with an annual increase of 20%, and in 10th year, sales target reached 240%. Initial investment cost used (t = 0) was total investment cost (Table 2) plus initial working capital for 4 months. The addition was intended when the project has not profited yet, there was continue to produce. The working capital was COGS multiplied by 4 months, so the value was US$447,177.26. Therefore, the initial investment cost was US$516,580.83. The following table shows Cash Flow Balanced and Present Value, with a 10% of discount rate.

Table 5. Cash flow balance and Present Value during 10 years

Year	Sale Target (%)	Cash Flow Balance	Present Value
0	0	(516,580.83)	(516,580.83)
1	60	(249,317.35)	(226,652.14)
2	80	(88,876.02)	(73,451.25)
3	100	109,381.32	82,179.80
4	120	345,454.65	235,950.17
5	140	619,343.99	384,563.89
6	160	924,137.24	521,651.38
7	180	1,273,658.58	653,588.24
8	200	1,660,995.92	774,866.85
9	220	2,086,149.26	884,730.93
10	240	2,549,118.59	982,795.57
	NPV		**3,703,642.62**
	IRR		**28.59%**
	PBP		**3.08 year**
	B/C ratio		**2.61**

Based on table above, the value of NPV is positive, it means that the project is economically feasible, the value of IRR is greater than discount rate (28,59% compared to 10%, respectively). B/C ratio has a value higher than 1 [5].

Conclusion

It can be concluded that artificial feed production is economically feasible to be implemented at small scale industry.

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