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Original Paper

COMPARASION OF LUPIN MEAL BASED DIETS COST EFFICIENCY FOR JUVENILE *Penaeus monodon* TESTED UNDER POND CONDITIONS

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ABSTRACT

A comparison of the cost efficiency of the formulated diets for juvenile Penaeus monodon in which fish meal or fish meal and soybean meal mixture were substituted with lupin (Lupinus angustifolius) meal at different levels has been conducted and is described in this study. The method used in the study was to estimate the relative economic performance for each dietary treatment using cost efficiency analysis equations. All diets containing different levels of lupin meal (0–30% and 0–48%) were compared in terms of total feed cost to determine the most cost-effective lupin meal based diet for juvenile Penaeus monodon reared in pens under pond conditions. The results show that inclusion of lupin meal at a level of 30% that substitute 75% of fish meal protein in D4 formulation saved 18% in price in Australia and 11% in price in Indonesia when compared with D1 with no lupin meal. Diet D9 including 48% of lupin meal to substitute 75% of a mixture of fish meal and soybean meal saved 21% in price in Australia and 14% in price in Indonesia when compared with D6 with no lupin meal. it is concluded that diets D4 and D9 containing 30% and 48% dehulled lupin (L. angustifolius) meal as a replacement of 75% protein of fish meal and the mixture of fish meal and soybean meal, respectively can be considered as the most economical and profitable diets with an acceptable level of production for semi-intensive pond culture of P. monodon stocked at a level of 10 animals/m^2.

Key words : *Lupinus angustifolius*, *Penaeus monodon*, lupin meal, feed cost efficiency

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INTRODUCTION

Economically productive aquaculture systems depend upon an adequate supply of low-cost feeds with high nutritional quality. In semi-intensive or intensive shrimp culture, feed is considered to be the highest single cost factor, constituting up to 60% of the total production costs (Akiyama *et al.*, 1992; Sarac *et al.*, 1993). Formulated feeds in countries such as Indonesia are expensive as most of the ingredients are imported and prices are variable. Since protein is the most critical ingredient in aquaculture diets from the standpoint of cost (Akiyama and Dominy,

1991; Twibell and Brown, 1998), it is necessary to seek cost-effective replacements for expensive protein ingredients by supplying dietary protein from less expensive materials.

The study described by Sudaryono (1998; 2003) showed that lupin meal could replace up to 75% of the protein in diets formulated either from fish meal alone or from a mixture of fish meal and soybean meal, with no significant difference in growth, survival and FCR of pond rearing juvenile *Penaeus monodon*. Thus, a total inclusion level of up to 30% (diets containing only fish meal) to 48% (diets containing a mixture of fish meal and soybean meal) of lupin meal could be incorporated into the diets tested under pond conditions without any loss of dietary performance. This study aimed to compare the cost efficiency of the formulated diets for juvenile *P. monodon* in which fish meal or fish meal and soybean meal mixture were substituted with lupin (*Lupinus angustifolius*) meal at different levels.

MATERIALS AND METHODS

Formulation and shrimp production data collected in the previous studies (Sudaryono, 1998; 2003) were used in this study to determine cost-effective diets. The method used in this study was to estimate the relative economic performance for each dietary treatment using cost efficiency analysis equations described by Maguire *et al.* (1988), Allan and Maguire (1992), Trino *et al.* (1992), Trino and Sarroza (1995), and Millamena and Trino (1997). Variable operating cost calculated in this study included feed only, while other variable operating costs such as fry, agricultural lime, fertiliser, net installation, gasoline and oil for water pumps, and labour were not taken into account. They were considered to be equal in all treatments.

All diets containing different levels of lupin (*L. angustifolius*) meal (0–30% and 0–48%, pond Experiments 1 and 2, respectively, as described by Sudaryono were compared in terms of total feed cost to determine the most cost-effective lupin meal based diet for juvenile *P. monodon* reared in pens under pond conditions.

The following formulae were used in calculations for cost efficiency analysis after Maguire *et al.* (1988), Allan and Maguire (1992), Trino *et al.* (1992), Trino and Sarroza (1995) and Millamena and Trino (1997):

Total feed cost (Rp/m^2) = total weight of feed used (kg/m^2) x feed price (Rp/kg).

Feed cost per kg of shrimp produced (Rp/kg) = total feed cost (Rp/m^2)/shrimp production (kg/m^2), where shrimp production equals mean final weight of shrimp multiplied by number of shrimp per m^2 at the end of the experiments.

All data were statistically analysed using one way analysis of variance (ANOVA) and Duncan's multiple range test (SPSS Release 6.1 for Windows) to determine significant differences among treatment means at the 95% level of significance (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Tables 1 and **2** show the composition and cost calculations based on Australian feed price and Indonesian feed price, respectively of the pond diets containing lupin meal and diets with no lupin meal which were treated as controls. Both control diets (D1 and D6) had the similar price of Rp 6,267 – Rp 6,287/kg (Australian price basis) or of Rp 5,545 – Rp 5,551/kg (Indonesian price basis) and the price for diet 9 (D9) was the lowest (Rp 4,953/kg in Australia or Rp 4,752/kg in Indonesia). The second cheapest diet was diet D4 (Rp 5,207/kg based on Australia

price and Rp 4,856/kg based on Indonesian price). The results show that inclusion of lupin meal at a level of 30% that substitute 75% of fish meal protein in D4 formulation saved 18% in price in Australia and 11% in price in Indonesia when compared to D1 with no lupin meal. Diet D9 including 48% of lupin meal to substitute 75% of a mixture of fish meal and soybean meal saved 21% in price in Australia and 14% in price in Indonesia when compared to D6 with no lupin meal.

Comparative feed cost analysis of lupin meal based diets and control diets in both Australian and Indonesian prices is summarised in **Table 3**. Average total shrimp production and feed used per m^2/pen were not significantly (P>0.05) different among diets tested ranging from 0.125 to 0.143 kg and 0.176 to 0.195 kg, respectively. Based on prices in Australia, diets D4 and D9 had significantly (P<0.05) lower total feed costs than diets D2, D3, D7 and both control diets (D1 and D6). Costs of diets D3, D4, D8, and D9 per kg of shrimp production were similar and significantly (P<0.05) lower than D2 and both control diets (D1 and D6). Although there was no significant difference in terms of total feed cost and feed cost per kg of shrimp produced among D4, D8 and D9, the use of D4 tended to be the most cost effective. Similar results were obtained following calculations based on Indonesian prices (**Table 3**).

This study evaluates the cost efficiency of artificial diets based on the inclusion of lupin meal as an alternative protein source to either fish meal alone or a mixture of fish meal and soybean meal for the production of juvenile *P. monodon* reared in pens under pond conditions for 60 days. According to ABARE (2003) lupin meal is cheaper (cost per tonne = Rp 1,950,000) than imported fish meal (68% protein) (cost per tonne = Rp 7,800,000) and imported soybean meal (44% protein) (cost per tonne = Rp 3,640,000) in Australia. Even in Indonesia, lupin seed imported from Australia (cost per tonne = Rp 2,021,500) is also cheaper than imported fish meal (68% protein) (cost per tonne = 6,500,000) and imported soybean meal (44% protein) (cost per tonne = Rp 3,250,000) (PT. Comfeed Indonesia, personal communication, 2003). In the present study, diet D4 (75% replacement of fish meal) was found to be the most cost-effective (feed cost per kg of shrimp produced = Rp 7,085/kg compared to Rp 8,613/kg and Rp 9,029/kg for control diets D1 and D6 on Australian feed price basis respectively, see **Table 3**). A similar result was found for diet D4 based on Indonesian feed price basis **(Table 3**). Although diets D4, D8 and D9 were similar in terms of total feed cost and feed cost per kg of shrimp produced, overall economical performance of the diet D4 was slightly better than that of D8 and D9.

Overall performance showed that the low-cost feed made mostly from lupin meal as an alternative major protein source for imported fish meal and soybean meal can support production of *P. monodon* stocked at 10 animals/m^2 in pens under brackishwater pond conditions for a period of 60 days. From an economic standpoint, diets with the inclusion of lupin meal at level of either 30% (to replace partially 75% of protein of fish meal) or 48% (to replace 75% of the mixture of fish meal and soybean meal) would be the most profitable. Although no cost-benefit analysis estimating the value of shrimp production in this study was conducted, it may be assumed that shrimp harvested from all dietary treatments have similar values. Therefore, an increase in profit would be achieved by using diets D4 or D9.

The level of feed cost calculations per kg of shrimp produced from the results with diets D4, D8 and D9 in the present study (both Australian and Indonesian feed price basis) is comparable or better than production costs reported by other authors for *P. monodon* stocked at 5 to 10

animals/m^2 and reared under semi-intensive conditions in fertilised brackishwater ponds. Trino *et al.* (1992) noted a production cost of approximately Rp 34,840/kg (growth rate = 162 mg/day; feed conversion ratio (FCR) = 2.90; survival = 64%) for the cost-effective diet (34% protein) with no vitamin supplement; and Trino and Sarroza (1995) reported a production cost of approximately Rp 12,545/kg (growth rate = 168 mg/day; FCR = 1.79; survival = 92%). A production cost of approximately Rp 14,755/kg (growth rate = 144 mg/day; FCR = 2.60; survival = 67%) was reported by Millamena and Trino (1997). These studies were conducted for 120–135 days. The higher production costs in these studies compared with those of the present study reflect differences in growth rate (144–168 mg/day vs. 223 mg/day), FCR (1.79–2.90 vs. 1.45) and survival rate (64–92% vs. 93%) of shrimp.

CONCLUSION

It can be concluded that diets D4 and D9 containing 30% and 48% dehulled lupin (*L. angustifolius*) meal as a replacement of 75% protein of fish meal and the mixture of fish meal and soybean meal, respectively can be considered as the most economical and profitable diets with an acceptable level of production for semi-intensive pond culture of *P. monodon* stocked at a level of 10 animals/m^2.

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