Economic analysis of using duckweed as feed supplement in the commercial rations of native chickens

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Abstract. Native chickens is considered to be a very important species of poultry in determining the profitability of keeping native chickens in Indonesia in agribusiness. The main objective of this study was to study the economic analysis of using duckweed as a feed supplement in the rations of native chickens. 100 native chickens used in this study and they were kept in a litter system confinement lined with rice chaff using wire mesh as their walls. The study was used a randomized complete block design with five treatments and four replicates. The following treatments were used: T\textsubscript{0} as control = commercial feed without duckweed; T\textsubscript{1} = T\textsubscript{0} + 10\% duckweed; T\textsubscript{2} = T\textsubscript{0} + 20\% duckweed; T\textsubscript{3} = T\textsubscript{0} + 30\% duckweed; and T\textsubscript{4} = T\textsubscript{0} + 40\% duckweed. The benefit-cost (B/C) ratio of native chickens recorded for T\textsubscript{0}, T\textsubscript{1}, T\textsubscript{2}, T\textsubscript{3}, and T\textsubscript{4} were 0.91, 1.02, 1.24, 1.47, and 1.46, respectively. The higher B/C ratio in case of native chickens in our study indicated that native chickens rearing was much more profitable when using duckweed as the feed supplement in their rations between 10 – 40\%.

1. Introduction

It is well-recognized that in the total production cost required for raising poultry there is 60 – 70\% involvement of cost of poultry feed in Indonesia which is also connected with the high cost of sources of imported sources of proteins like soybean meal. Therefore, demand for an alternative source of protein required for poultry feeding which is also found in the local areas has been increased in Indonesia. Using local protein sources which have a same level of quality as compared to the meal of soybean which can be replaced by imported sources can be the solution to reduce production costs of poultry production in Indonesia [1]. It is expected that other protein sources which are cheap and easily affordable should be explored. In this regard, a protenaceous aquatic resource such as algae and duckweed has great potential to address the feed shortage problem by reducing the competition between the animals and human beings [2]. Duckweed particularly which is also called water lentil is one of the four plants species that is from the botanical family named as Lemnaceae. It is also classified as higher plant species or it can also be called as macrophytes and mistaken for algae. They are also the simplest and smallest plants of the world and distributed worldwide in ponds, ditches lakes, and canals forming green mats [3]. Duckweed is a promising feedstock for production of biofuels, due to their characteristics that include rapid growth and high biomass production potential, high starch accumulation capability, low lignin content and ease of harvesting and processing. Duckweed has also been widely used in
environmental biotechnology, such as wastewater treatment and phytoremediation. This aquatic monocot has also been considered as a valuable plant expression platform for the production of recombinant proteins including antigens, monoclonal antibodies and exogenous enzymes. Additionally, duckweed can be used as a dietary supplement for humans and animals because of its high nutritional value. Based on the above advantages, duckweed has even been recommended as an alternative crop for the future [4].

Numerous studies have demonstrated the value of duckweed as a feed for poultry, fish and other animals [5]. Duckweed closely resembles to the animal protein and has a better array of essential amino acids than the vegetable protein [3]. The amino acid profile of duckweed and soybean is very similar [6] and also has a rich concentration of beta carotene and xanthophyll [7]. Dried duckweed contains crude protein up to 40% and can be compared with soybean meal as a source of plant protein [8]. Duckweed was used as feed for poultry because of its high nutritional value. Duckweed when dehydrated has been used to replace alfalfa (Lacene) meal as a protein source in conventional poultry diets as it has high protein content 20-40%, low fiber content, high mineral content, non-toxicity and few known pest. The protein content of duckweed responds quickly to the availability of nutrients in the water [3]. Duckweed has been known for a long period of time as a potential source of food for humans and animals and as a source of natural products it is the only source of supplementary protein for fish, chickens, ducks and pigs [9]. Village pigs, horses or ruminants could be fed on freshly harvested duckweed. For most applications with poultry, dried duckweed would be preferable as it could be expected that duckweed would provide an ideal wet supplement to any high energy diet [10]. Fresh duckweed can be used to replace the soyabean meal for fattening ducks fed broken rice as the energy source [11], to replace fish meal in broiler chickens [12] and to replace soyabean meal in laying hens fed [13]. Native chickens are commonly raised in many areas of Indonesia and play a major role in food production, often providing the main source of dietary protein in the diet of people. They are often called “non-breed chickens”— (or “ayam kampung” or “ayam buras”) to differentiate local chickens from commercialized chicken breeds such as widely known strains of Cobb, Hubbard, Hybro, Isa, Hyline and Hisex. They are historically the result of years of domestication of four wild chicken species: Red Junglefowl (Gallus gallus); Grey Junglefowl (Gallus soneratti); Green Junglefowl (Gallus varius); and Ceylon Junglefowl (Gallus lavayetti). The Red Junglefowl, which is believed to be the progenitor of the domesticated chicken, has its widest distribution in east Asia, from Pakistan through China, Eastern India, Burma, most of Indo-China, and on the islands of Sumatra, Java and Bali [14]. The aim of the present study was to analyse the economic advantages of using duckweed as feed supplement in the commercial rations of native chickens.

2. Materials and Methods
The study was conducted for 12 weeks in Village of Telaga Jernih, Sub-district of Secanggang, Langkat District, North Sumatera, Indonesia. 100 native chickens used in this study and they were kept in a litter system confinement lined with rice chaff using wire mesh as their walls. The study was used a randomized complete block design with five treatments and four replicates. The following treatments were used: T_0 as control = commercial feed without duckweed; T_1 = T_0 + 10% duckweed; T_2 = T_0 + 20% duckweed; T_3 = T_0 + 30% duckweed; and T_4 = T_0 + 40% duckweed. The commercial diets for the birds supplied by Charoen Pokphand Jaya Farm Co. The feed and water were offered ad libitum. The native birds were sold to directly to the consumer after 12 weeks at the prevailing market rates of Rp.45,000/kg. Items of cost included fixed cost e.g. cages, equipment and variable costs e.g. cost of day-old chick (DOC), feed cost, medicine cost, vitamins cost, miscellaneous cost and depreciation cost. The net returns were calculated by deducting the returns from birds from net cost of production in Indonesian Rupiah [IDR]. B/C ratio: The ratio of total value of benefits to the total value of the costs in Indonesian Rupiah [IDR] is the b/c ratio. A B/C ratio greater than or equal to one is the reliable measurement to accept the business [15].
3. Results and Discussion

Economic performance in productivity of native chickens in terms of several important parameters is presented in Table 1. Data on Table 1 showed that the lowest total production costs of Rp. 31,017/bird obtained for T₄. This is due to the addition of 40% duckweed as the feed supplement to their diets which make the price of feed is getting cheaper. Birds fed on T₄ also showed an analysis of profit and loss of Rp.14,255/bird with B/C ratio of 1.46. They fed T₃ showed the total production cost of Rp.32861/bird, and produced the highest income and loss analysis of Rp.15,300/bird with B/C ratio of 1.47. They fed T₂ showed total production cost of Rp.33,731/bird with an analysis of profit and loss of Rp.8,250/bird with B/C ratio of 1.24. They fed T₁ showed total production cost of Rp.35,022/bird with an analysis of profit and loss of Rp.613/bird, and B/C ratio of 1.02. While, they fed T₀ the costs of Rp.3,194/bird without duckweed as the feed supplement to their diets, and B/C ratio of 0.91.

Table 1. Production performance of the native chickens during 12 weeks of study.

| Treatments | Production Costs (IDR/bird) | Cost of income and loss analysis (IDR/bird) | B/C Ratio | Total Production Costs (IDR/bird) |
|------------|-----------------------------|---------------------------------------------|-----------|----------------------------------|
| T₀         | 34,007                      | -3,194                                      | 0.91      | 37,201                           |
| T₁         | 35,636                      | 613                                         | 1.02      | 35,022                           |
| T₂         | 41,981                      | 8,250                                       | 1.24      | 33,731                           |
| T₃         | 48,161                      | 15,300                                      | 1.47      | 32,861                           |
| T₄         | 45,272                      | 14,255                                      | 1.46      | 31,017                           |

The benefit-cost (B/C) ratio of native chickens were recorded for T₀, T₁, T₂, T₃, and T₄ were 0.91, 1.02, 1.24, 1.47, and 1.46, respectively in the present study. The higher benefit cost ratio native chickens was due to high level of using duckweed as the feed supplement in the rations of native chickens. The B/C ratio was higher than one for T₁ – T₄ compared to the control (T₀). This result indicated that the three treatments were viable. The B/C ratio values for these treatments compared to the control in our study were economically accepted [15]. In Bangladesh, for example, the average cost benefit ratios of broiler native chickens was 1.10 under intensive system of management [16]. The higher B/C ratio in case of native chickens in our study indicated that native chickens rearing was much more profitable when using duckweed as the feed supplement in their rations between 10 – 40%.

Table 2. The cost of production performance of the native chickens during 12 weeks of study.

| Treatments | Cage equipment costs (IDR) | Medication & vitamins costs (IDR) | Electricity costs (IDR) | DOC costs (IDR) | Feed costs (IDR) | Total costs (IDR) |
|------------|-----------------------------|-----------------------------------|-------------------------|-----------------|------------------|------------------|
| T₀         | 3,575                       | 145                               | 450                     | 6,500           | 26,531           | 37,201           |
| T₁         | 3,575                       | 145                               | 450                     | 6,500           | 24,352           | 35,022           |
| T₂         | 3,575                       | 145                               | 450                     | 6,500           | 23,061           | 33,731           |
| T₃         | 3,575                       | 145                               | 450                     | 6,500           | 22,191           | 32,861           |
| T₄         | 3,575                       | 145                               | 450                     | 6,500           | 20,347           | 31,017           |

The results of the analysis during 12 weeks of the study for all treatments showed the cost of the cages, medication and vitamins, electricity, DOC for T₀, T₁, T₂, T₃, and T₄ were fixed at Rp. 3,575, Rp. 145, Rp. 450 and Rp. 6,500, respectively. In the present study, the total cost of production up to 12 weeks of age was found to be higher in the control (T₀) compared to the other three counterparts (T₁ – T₂) were Rp. 37,201 vs. Rp. 35,022, Rp. 33,731, Rp. 32,861, and Rp. 31,017, respectively. The higher total production cost in native chickens might be due to higher commercial feed fed to native chickens. This is in accordance with [17], who also reported that feed cost alone contributed 90.95% of the total cost of production followed by chick cost, medicine cost and vaccine cost in backyard poultry farming in...
India. In Indonesia, for example, total cost of feed were 73% followed DOC costs (16%), brooding costs (2%), medication costs (3%), cage costs (3%), and labour cost (3%) for commercial broiler farms (Figure 1) [1].

![Figure 1. Total production costs of integrated broiler farms in Indonesia [1].](image-url)

4. Conclusions
The conclusion of this study was the business of native chickens that use duckweed as feed supplement in their rations were economically accepted. The B/C ratio values for these treatments compared to the control was much more profitable when using duckweed as the feed supplement in their rations between 10 – 40%. The higher total production cost in native chickens might be due to higher commercial feed fed to native chickens. The feed cost of native chickens alone contributed higher cost of the total cost of production followed by chick cost, medicine cost and vaccine cost in backyard poultry farming.

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