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Economic and Technical Analysis of Utilization Pistia Stratiotes as Magelang Duck Alternative Feed: An Agribusiness Paradigm

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ABSTRACT

This study was conducted to determine the economic analysis, performance analysis and chemical quality of the meat of the utilization of pistia stratiotes (PS) in Magelang duck feed. Most duck feed is still very dependent on imports from other countries so there is a need to find alternative feedstuff that are not competing with humans. The experimental research was conducted at the Faculty of Animal Husbandry and Agriculture Undip using 4 treatments, namely T0 duck feed without the addition of PS in feed, T1 added 6% PS in feed, T2 added 12% PS in feed and T3 added 18% PS in duck feed. Parameters observed were final body weight, feed consumption, Feed Conversion Ratio (FCR), mortality, cholesterol, triglycerides, LDL, HDL, antioxidants, feed costs, income over feed costs, return on investment (ROI) and RC ratio. Feed consumption on T3 was the highest. Final body weight on T3 was not significantly different ($P > 0.05$) compared to T1 and T2 but higher than T0 ($P < 0.05$). The FCR between T3, T2 and T1 was not significantly different ($P > 0.05$), but was lower than T0, duck mortality in this study 0. Blood chemistry analysis (cholesterol, triglycerides, LDL, HDL) showed that T2 and T3 were significantly better than T0 and T1. The results of the economic analysis showed that ducks given PS at T2 and T3 had significant lower feed costs compared to T0 and T1, while ROI from T1, T2 and T3 were significantly higher than T0. The highest IOFC was achieved when duck were fed (T2), while the lowest IOFC was at T0. R/C ratio of T1, T2 and T3 was not significantly different, but higher when compared to T0. Based on the results of technical and economic analysis, the use of PS in 12% duck feed gave the best result of technical and economic performance

Keywords: Duck, Economic analysis, Feed, Pistia Stratiotes

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Introduction

Feed cost, revenue, income over feed cost (IOFC), return on investment (ROI) and revenue/cost ratio (R/C ratio) are some of the indicators of the poultry business. Of the components of production cost, feed cost is the highest component of the production cost. Up to present almost 70% cost component is feed cost (Santoso and Setiadi, 2016). Therefore increasing level of feed price would thereby lead to increase the production cost, conversely that lower feed price would decrease the feed cost and finally would decrease the production cost. The lower of production cost would increase the revenue, IOFC, ROI and R/C Ratio. In general poultry production will be sustainable when the high revenue, IOFC, ROI and R/C ratio are achieved.

Magelang duck is one of the local ducks that has the advantage of producing eggs and meat which are originated from Magelang, Central Java, Indonesia. The morphological

characteristics of Magelang ducks are specific and superior, which have a relatively large body size, relatively high egg production and varying feather color compared to other local ducks (Dewanti *et al.*, 2014). In general the feed of Magelang duck are composed of corn and soybean meal. These feedstuff are mainly imported from other countries, and therefore increased feed cost. Prices for feed ingredients have increased dramatically, prompting poultry nutritionists and feed manufacturers to seek low-cost alternative feed ingredients to reduce feed cost without compromising technical performance.

Pistia Stratiotes (PS) is one of the alternative feedstuff to reduce the utilization of corn and soybean meal, because of its high content of protein. PS is water plant which grow well in lake and rice field. In Indonesia, PS has not been commonly utilized as feedstuff. From the nutritional point of view, PS may be used as a feedstuff for poultry. Nisha and Gheetha (2017) showed that PS contain 15.96% crude protein,

5.10% crude fat, 11.08% crude fiber and 22.20% ash. PS also rich on antioxidant (Sinha *et al.*, 2005; Langeland *et al.*, 2008). Nisha and Gheetha (2017) used PS to replace fish meal and found that PS was able to improve growth, biochemical composition, hematology and digestive enzyme activity in *Labeo rohita* fish. In addition Mohapatra and Patra (2014) utilized PS as fish feed and found that PS as fish feed could reduce the feed cost.

It has been known that PS contain some functional properties including PUFA and antioxidant, hence feeding PS to Magelang duck may result in high nutritional and safe product and implicated in economic added value. Dwiloka *et al.* (2015) reported that giving of *Salvinia molesta* to duck feed was able to reduce cholesterol and LDL of meat and be able to increase HDL. It is known that the low cholesterol meat tend to increase the price of the product. The low cholesterol meat is usually consumed by diabetic, heart diseases patients etc. Hence, the increasing the quality of the duck meat by feeding PS as feed have economic advantage. The research purposes were to determine the economic analysis, performance analysis, and meat chemical quality analysis of utilization PS as Magelang duck feed.

Materials and Methods

The research was conducted at the Poultry Production Laboratory, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang. Feed analysis ingredients was conducted in Nutrition and feed Laboratory (Table 1).

The material used in the study was 100 heads of 2 weeks male Magelang ducks, with body weight of 218.76 ± 0.54 gr, the cage used in this study was a flock. The equipment used in the form of a ration place, 20 pieces drinking

containers, a digital weighing capacity of 5 kg with a precision level of 0.1 g to weigh feed and duck, the cage spray, *hygrometer* and thermometer.

The experimental design used was Completely Randomized Design (RAL) with 4 treatments and 5 replicates. Each unit of experiment consisted of 5 ducks. The treatments applied were: T0: basal diets do not contain PS, T1: diets containing 6% PS, T2: diets containing 12% PS, T3: diets containing 18% PS. PS was harvested then was sundried for 3 days and was grinded into a powder form (dry). The feed contained fat, fiber, methionine, lysine, calcium, and phosphor. Fiber was the most prominent content.

The study was carried out for 6 weeks, in the first 2 weeks the duck was placed on the main *flock* before being divided into the experimental plot. Feeding was given in the morning and afternoon while drinking was given *ad libitum*.

Feed consumption is carried out every day by weighing the feed given and the rest of the feed the day before. Weight measurement is carried out every week to determine the duck body weight. Feed costs during treatment using PS were calculated at the end of trial.

Feed consumption

Feed consumption was measured by weighing the given ration with the rest of the ration every day in grams during treatment. The difference in giving with the rest of the feed is consumption per day.

$$\text{Feed consumption/day} = \frac{\text{Total feed consumed}}{\text{period length}}$$

Body weight gain

Data on body weight gain during the study were obtained from weighing the head per week in grams/head; data collected during the seven

Table 1. The composition of the feed

Feed materials	T0	T1	T2	T3
		---%---		
Corn	55.00	52.80	51.10	51.10
PS	0.00	6.00	12.00	18.00
Soybean meal	17.80	15.50	14.20	13.00
Vegetable oil	1.30	1.00	1.00	1.00
Bran	15.00	14.70	13.00	9.30
Fish flour	6.50	6.50	6.50	6.50
CaCO ₃	1.10	1.00	0.50	0.20
Premix	1.10	1.00	0.60	0.30
Methionine	1.10	0.60	0.40	0.30
Lysine	1.10	0.90	0.70	0.30
Total	100.0	100.0	100.0	100.0
Nutrient content				
Met. Energy (kcal kg ⁻¹)	2936.82	2908.70	2905.21	2903.51
Crude fat (%)	6.11	5.68	5.46	5.11
Crude fiber (%)	7.21	7.80	8.04	7.71
Methionine (%)	1.35	0.99	0.89	0.89
Lysine (%)	1.62	1.69	1.77	1.66
Ca (%)	1.66	1.82	1.60	1.56
P (%)	0.53	0.54	0.54	0.51
Price (IDR kg ⁻¹)	6,842	6,219	5,821	5,387

* Proximate analysis were conducted in Faculty of Animal Science and Agriculture Diponegoro University.

** Feed Ingredients Composition Table, Amrullah (2004).

weeks of maintenance were then calculated using the formula:

$$\text{Body weight gain} = \text{Final body weight} - \text{Initial body weight}$$

Feed conversion ratio (FCR)

Feed conversion ratio (FCR) is calculated based on the comparison between the rations consumed and the body weight gain produced with the same time and body weight units. The ration conversion value is good when the quotient is obtained by a small number.

$$\text{FCR} = \frac{\text{Total feed consumed}}{\text{Body weight gain}}$$

Economic analysis

Feed cost, revenue, income over feed cost (IOFC), Return on Investment (ROI) and Revenue/Cost Ratio (R/C ratio) were done to determine the economical perspective.

Income Over Feed Cost (IOFC) tells how much income we stand to gain from making a feeding change. Or in other word, IOFC is the net income after paying feed costs and is expressed in IDR/head.

$$\text{IOFC} = (\text{BB} \times \text{duck price/kglive}) - (\Sigma \times \text{feed intake of feed cost/kg})$$

Return on Investment (ROI) tries to directly measure the amount of return on a particular investment, relative to the investment's cost. To calculate ROI, the benefit (or return) of an investment is divided by the cost of the investment.

Revenue per Cost Ratio (R/C ratio) compares the expenses generated by sales activity to the revenue (Rawat *et al.*, 2018; Reyes *et al.*, 2018; Pagua *et al.*, 2014).

Analytical determination

Cholesterol content was measured by a modified saponification process. Approximately 2 g of each sample were saponified with 4 mL

50% potassium hydroxide and 6 mL 95% ethanol, absolute, heated to complete solubilization at 40°C, and then heated for 10 min at 60°C. Next, 5 mL of water was added and the samples were cooled. The non-saponifiable fraction was extracted three times using 10 mL hexane. Aliquots of hexane extracts (3 mL) were dried under a nitrogen flow. After saponification, samples were analyzed by enzymatic methods. The extract was diluted in 0.2 mL isopropyl alcohol and analyzed with an enzymatic kit (Merck® Diagnostica, Darmstadt, Germany) (Dwiloka *et al.*, 2015).

Results and Discussion

Technical performance analysis

As shown in Table 2. The performance of duck fed PS on their feed. The feed intake was significantly difference among treatments (P<0.05). weight of birds feed T1-T3 was significantly difference from birds fed T0. FCR was not difference among the treatments but ducks fed T1-T3 better FCR than ducks fed T0. No mortality was found during the study.

The consumption of duck feed is calculated based on feeding minus the remainder per head per day. Based on the results of the study, it shows that the average consumption of ducks between controls with the treatment using PS was significantly different (P<0.05). Feed consumption tends to be increased as the level of PS increased. The palatability of diet would influence the feed consumption. This finding is in line with Santoso *et al.* (2017) who stated aquatic plant has a good palatability, so it would increase the feed consumption. The highest feed intake was in the feed treatment using 18% PS during day 37-43. Male Magelang duck consumed more feed contain high fiber than control, Male Magelang duck could effectively convert the high fiber to be the weight, so there was a positive correlation

Table 2. Performance of duck fed PS on their feed

Day	Treatment group				P-value
	T0	T1	T2	T3	
Feed consumption (g bird-1)					
2-8	2,428.4±2.08 ^a	2,418.2±0.75 ^a	2,530.8±1.52 ^{ab}	2,725.4±0.97 ^b	< 0.01
9-15	2,611.6±3.35 ^a	2,721.0±3.39 ^a	2,958.0±3.08 ^a	3,434.8±1.46 ^b	< 0.01
16-22	3,186.8 ±2.33 ^a	3,149.0±3.02 ^a	3,180.8±2.71 ^a	3,634.2±1.39 ^b	< 0.01
23-29	3,134.0±4.20 ^a	3,302.4±1.52 ^a	3,389.4±1.79 ^a	3,411.2±1.10 ^a	< 0.05
30-36	3,888.4±2.86 ^a	4,085.2±0.97 ^a	4,228.0±3.03 ^{ab}	4,519.6±2.38 ^b	< 0.05
37-43	4,680.2±1.35 ^a	4,732.6±1.56 ^a	4,593.4±1.65 ^a	4,937.2±1.12 ^b	< 0.01
Weight (g bird-1)					
2-8	470.28±0.20 ^a	483.72±0.12 ^a	498.40±0.15 ^a	543.16±0.30 ^b	< 0.05
9-15	582.16±0.34 ^a	629.48±0.06 ^{ab}	657.68±0.38 ^b	716.56±0.53 ^c	< 0.05
16-22	718.60±0.51 ^a	786.83±0.36 ^b	802.76±0.41 ^b	886.8±0.51 ^c	< 0.05
23-29	831.12±0.49	864.56±0.40	919.21±0.31	926.28±0.67	0.31
30-36	960.36±0.60 ^a	1,019.17±0.81 ^{ab}	1,078.86±0.24 ^{ab}	1,075.38±1.08 ^b	< 0.05
37-43	1,054.24±0.76 ^a	1,178.89±0.93 ^b	1,231.39±0.36 ^b	1,210.03±0.73 ^b	< 0.05
FCR					
2-8	5.16±0.35	4.99±0.04	5.07±0.23	5.01±0.19	0.71
9-15	4.48±0.32	4.32±0.57	4.49±0.27	4.79±0.18	0.25
16-22	4.43±0.20	4.00±0.43	3.96±0.28	4.09±0.11	0.07
23-29	3.77±0.34	3.81±0.23	3.68±0.24	3.68±0.34	0.88
30-36	4.04±0.22	4.00±0.34	3.91±0.27	4.20±0.56	0.59
37-43	4.43±0.22 ^a	4.01±0.39 ^a	3.73±0.20 ^c	4.08±0.28 ^b	< 0.05
Mortality					
	0	0	0	0	

a,b,c superscripts means with different letters in a same column differ significantly (P<0.05).

between feed intake and weight. The increasing intake of the birds fed T2 and T3 resulted the best weight of day 37-43.

Statistically, the final weight of the duck between the control and the treatments were significantly different ($P \leq 0.05$). The highest body weight was found in duck fed T2, while the lowest duck weight was in the control feed. The weight of duck fed PS at 23-29 day not statistically different ($P > 0.05$). The final weight (37-43 day) of duck was highest in T2, while the lowest final weight at T0. FCR were not statistically different among treatments ($P > 0.05$) during 2-36, but at 37-43 day the FCR was statistically different, and T2 was the lowest number. No mortality was found during the study, indicated there were no negative effect of utilization PS in Magelang duck feed.

Economic performance analysis

Feed price of T0 was IDR 6,842, T1 was IDR 6,219, T2 was IDR 5,821 and T3 was IDR 5,387 (Table 3). Based on Table 3, feed price of T3 was the lowest, Increasing level of PS on the diet would decrease the feed price. Utilization of PS in the diet could reduce the percentage of other feedstuff therefore could reduce the feed cost. Duck fed T2 (12%) gave the best economic performance. IOFC, R/C ratio and ROI of duck fed T2 (12%) gave the highest value compared with T0, T1, and T3.

Feed is the highest component of production cost (60-70%), feed consumption influenced to the feed cost which is paid, increasing feed consumption would increase the feed cost. Utilization of PS in the Magelang duck diet could increase the feed consumption, increasing level of PS in the diet could increase the feed consumption but the feed cost would decrease because the increasing level of PS in the diet cheaper the diet. T2 gave the lowest feed cost compared with T0, T1, and T3 because T2 also had the lowest FCR which means it was the most efficient in the amount of feed. Nguyen *et al.* (2012) stated that utilization of duckweed as feedstuff could reduce the feed cost. This result in agreement with Nguyen *et al.* (2012) which reported utilization of by-product would decrease the feed cost. The result also in agreement with Santoso and Setiadi (2016), increasing level of water plant such as *Salvinia molesta* in the duck feed reduced the feed cost. Based on the economic analysis, duck fed T2 gave the best economic performance compared with bird fed T0, T1, and T3. Thus economically, utilization of PS at 12% level in the feed gave the best value in term

of feed cost, IOFC, revenue, ROI and R/C ratio. Revenue was influenced by weight, weight of duck fed T2 was the highest compared with duck feed T0, T1, and T3. The increasing of weight would increased the revenue was achieved. The highest IOFC was achieved when duck were fed (T2), while the lowest IOFC was at T0. IOFC is influenced by selling prices. Ducks weighing 1,200 grams have a selling price of IDR 40,000/head while ducks weighing less than 1,200 grams have a selling price of IDR 38,000/head. The results in agreement with Mohapatra and Patra (2014) which stated that increasing level of PS in the feed could reduce the feed cost and finally could increase the revenue and IOFC. Utilization of PS 12% (T2) in the Magelang duck diet resulted higher ROI and R/C ratio compared with T1, T3 and T0. ROI was the reflection of ability business to compared between income and investment. Investment needed for 1000 ducks was IDR 75 million which includes the cost of making a cage and procurement of equipment. ROI of duck fed T2 was 86.70%. So every IDR 100 for the investment could produce IDR 86.70 income. R/C ratio utilization of PS in the diet could resulted high value. The best R/C ratio was achieved in duck fed T2 (12% PS). T2 gave better economic performance than T3 because they generated the same amount of revenue while T2 was lower in cost.

Meat chemical analysis

The quality of duck meat fed PS in the diet can be seen in Table 4. Cholesterol of duck meat fed T3 was the lowest compared with T0, T1 and T2. Triglyceride of bird fed T2 was the lowest compared with duck meat fed T0, T1 and T3. LDL of bird fed T2 was the lowest compared with duck meat fed T0, T1 and T3, but HDL and antioxidant activity of duck meat fed T3 were the highest compared with duck meat fed T0, T1, and T2.

As shown in Table 3 cholesterol content between the control (T0) and the treatments (T1, T2, and T3) had a significant difference ($P \leq 0.05$). The highest cholesterol content was found in the control (T0) while the lowest cholesterol was found in T3, which had the highest level of fiber. Increasing level of fiber in the diet could suppressed the cholesterol, the result of the study in agreement with Kalinowski *et al.* (2007) and Lemahieu *et al.* (2013), which reported utilization of high fiber could suppressed the duck meat cholesterol. Santoso *et al.* (2016) reported utilization of high fiber seaweed glacialaria could reduce the meat cholesterol.

Table 3. Economic analysis of duck fed PS in their diet

Items economic parameter	Treatment			
	T0	T1	T2	T3
Feed price	6,842	6,219	5,821	5,387
Feed cost (IDR)	27,271	25,384	24,309	24,416
Revenue (IDR/bird)	38,000	38,000	40,000	40,000
Income over feed cost (IDR/bird)	10,729	12,616	15,691	15,584
ROI (%)	68.18	84.33	86.70	85.36
R/C	1.05	1.15	1.20	1.18

Table 4. The meat quality of duck meat fed PS in the diet

Parameter	Treatment				p-Value
	T0	T1	T2	T3	
Cholesterol (mg/100g)	2.78±0.15 ^a	2.22±0.06 ^b	2.56±0.12 ^c	1.04±0.04 ^d	<0.001
Triglyceride (mg/100g)	3.76±0.18 ^a	3.51±0.18 ^a	3.14±0.10 ^b	3.73±0.26 ^a	<0.001
LDL (mg/100g)	1.57±0.12 ^a	1.96±0.17 ^b	0.63±0.04 ^c	1.76±0.10 ^d	<0.001
HDL (mg/100g)	0.57±0.05 ^a	1.23±0.05 ^b	1.04±0.04 ^c	1.96±0.09 ^d	<0.001
Antioxidant	2.49±0.26 ^a	2.60±0.19 ^a	2.46±0.12 ^a	5.19±0.32 ^b	<0.001

^{a,b,c,d} means with different letters in a same column differ significantly ($P < 0.05$)

Triglyceride content in duck meat has a significant difference ($P \leq 0.05$) between T0, T1, and T3 with T2. The lowest triglyceride was found in birds fed 12% PS in diet. The high fiber content of PS may suppress the meat triglyceride content. Meat Triglyceride was influenced by fat level in the diet. Utilization of PS could reduce fat level in the diet, therefore the fat level in the blood is high because of high feed consumption would be desposited to the muscle. The result in agreement with Brand *et al.* (2003) study, increasing level of protein and rich fiber could reduce the triglyceride content of meat.

The LDL and HDL content in Magelang duck meat had a significant difference between treatment and control ($P \leq 0.05$), the highest LDL content in the duck fed T1 and the lowest at duck meat fed T2. While the highest HDL was in T3 and the lowest was in the use of T0, this result in agreement with Dwiloka *et al.* (2015), increasing level of water plant in the diet could increased the HDL level. HDL had a positive correlation to LDL which influenced by cholesterol level in the blood. The low HDL because of high antioxidant of PS. The result in agreement with Tugiyanti *et al.* (2016) which found utilization of high fiber soursop leaf meal could decreased the LDL level.

Antioxidant content in Magelang duck meat has a significant difference ($P \leq 0.05$) between T3 and T0, T1 and T2. The highest antioxidant content was found in duck feed T3. Jha *et al.* (2012) reported PS contain high antioxidant, increasing level of PS in the feed would increase the antioxidant in duck meat. The high antioxidant in the PS would be desposited to the muscle. The increasing level of PS in the feed could suppressed the cholesterol, triglyceride, and LDL, but could increased the HDL and antioxidant content. The increasing level of PS in the feed lead to increase the antioxidant activity and HDL level but make lower the cholesterol content, thus PS is very potential to produce high nutritional and safety product which has very valuable economic value added.

Conclusions

The use of PS in feed could improve economic performance (feed cost, revenue, IOFC, ROI and R/C ratio) and technical performance (feed consumption, weight, and FCR) and meat quality of Magelang duck. The utilization of PS could also improve the chemical quality of duck meat were seen by lowering cholesterol and triglycerides and increasing HDL and antioxidant content in duck meat. The utilization of PS 12% in

the feed gave the best economic performance, technical performances, and meat quality.

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