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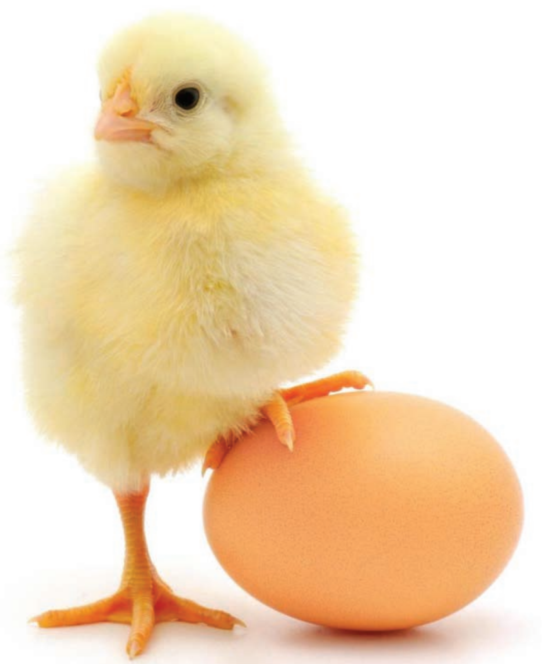

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Research Article
The Use of Sapu-Sapu Fish (*Hypostomus plecostomus*) as Substitute of Commercial Feed to Improve Production Performance of Mojosari Ducks

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Abstract
Objective: This study was conducted to evaluate the effect of sapu - sapu fish (*Hypostomus plecostomus*) as substitute of commercial feed on the production performance and eggs quality of Mojosari ducks. **Materials and Methods:** A total of 100 Mojosari laying ducks were distributed randomly into four dietary treatments with five replicates of five ducks. The treatments were P0 (mixture of 80% rice bran and 20% commercial feed), P1 (mixture of 90% rice bran and 10% sapu-sapu fish), P2 (mixture of 80% rice bran and 20% sapu-sapu fish), P3 (mixture of 70% rice bran and 30% sapu-sapu fish). **Results:** The results showed that the average weight gain during three month feeding trial for P2 and P3 were 136.6±41.78 g and 101.7±92.78 g which were significantly ($p<0.05$) higher than P0 and P1 which were 72.6±20.58 g and 46.9±33.07 g. Egg production of ducks fed on P0, P2 and P3 diets were 47.2±7.33%, 45±9.0% and 41±5.2% respectively, which was significantly ($p<0.05$) higher than those given P1 diet. The feed conversion ratio, egg weight and egg index were not affected by dietary treatments. While yolk color of ducks fed on P0 was 10.56±0.932 which was significantly higher than those fed on P1, P2 and P3. The egg and meat cholesterol of the ducks fed diet containing sapu-sapu fish was lower than those offered commercial feed ($p<0.05$). **Conclusion:** It was concluded that sapu-sapu fish can substitute up to 20% of commercial feed.

Key words: Egg production, egg quality, Mojosari duck, sapu-sapu fish, poultry feed

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Sapu-sapu fish (*Hypostomus plecostomus*) is a fresh water fish species that can live in polluted waters. It is one close relative of cat fish (*Siluriformes*) family. All of its body is covered by hard scales, except on the stomach. Perhaps, that is why it does not used for human consumption. Sapu-sapu fish population is quite high. Asnawi *et al.*[1] stated that the daily collection by duck farmers is about 272 kg, equivalent to 99.28 t year^{-1}.

Sapu-sapu fish (SSF) is a potential source of dietary protein and energy for ducks. Asnawi *et al.*[1] reported that SSF contains crude protein (37.07$\pm$3.5%), crude fat (16.85$\pm$4.35%) and gross energy (4559.1$\pm$244.37 kcal) and total of essential and non-essential amino acids (24 027$\pm$1.796%) . As a source of mineral, this fish contain calcium (0.4984$\pm$0.0001%) and phosphorus (0.1762$\pm$0.004%). Our previous study[2] showed that the apparent metabolizable energy value of this fish is 2890.52 kcal g^{-1} and protein digestibility value measured with Mojosari ducks is 64.80%. In addition, Mozzoni *et al.*[3] reported that SSF eat detritus, cut-plant and chlorophyceae and contain fiber digesting enzymes. German[4] found 14 different kinds of fiber-digesting enzyme on digestive tract of the fish *(Hypostomus* sp.) such as: amilolytic, laminarinase, cellulase, xylanase, mannase, chitinase, trypsin, lipase, maltase, β-glucosidase, β-xylosidase, β-mannosidase, N-acetyl-β-d-glucosaminidase and aminopeptidase[5,6]. The availability of fiber digesting enzymes in SSF is very beneficial for duck farmers in Lombok Island who use rice bran as a primary feed ingredient. It is expected that the enzymes could improve the digestibility of rice bran leading to better egg production. A study was conducted to evaluate the effect of incorporating sapu-sapu fish (*Hypostomus plecostomus*) as a substitute of commercial feed on production performance and eggs quality of Mojosari duck.

MATERIALS AND METHODS

Experimental site: This study was performed in local farm in Mataram city of Lombok Island, Indonesia. Egg quality was evaluated in Animal Production Laboratory, Animal Husbandry Faculty, Mataram University. Cholesterol evaluation was performed in Hepatika Laboratory, Mataram, Indonesia.

Materials and research tools: One hundred 4-5 months old Mojosari laying ducks were obtained from local farmers in the Lombok Island. Twenty cages were made by bamboo partition. Each unit has a 1.5 m length and 1m width. Feeding and drinking apparatus were provided in each unit. Duck feed used in this study consisted of rice bran and sapu-sapu fish.

Sapu-sapu fish (SSF) was collected from rivers around Town of Mataram. Fresh fish was crushed using an 8 HP diesel engine prior to feeding.

Research procedure: The duck was weight using Ohause scale, to get uniform body weight and then distributed into 20 cages, 5 ducks for each cage. SSF was minced and mixed as treatment designed in Table 1.

Feed was given twice a day, in the morning and in the evening. The duck was adapted to treatment for one month period, before data collection. Eggs collection was performed in the morning, followed by feeding according to treatments. Evaluation of outer and inner part of egg quality and cholesterol content was performed after adaptation time of one month.

Data collection: Feed consumption is amount of feed consumed every day. Feed consumption was measured by amount of feed given to the duck minus feed left in the feed container every day. Daily eggs production was calculated by the number of eggs every day, divided by number of ducks

Table1: Structure and composition of feed materials

	Treatments			
Feed materials	P0	P1	P2	P3
Rice bran	80	90	80	70
Sapu-sapu fish	-	10	20	30
Commercial feed	20	-	-	-
Amount	100	100	100	100
Nutrients composition				
Metabolizable energy (kcal kg^{-1})	2080.00	2268.60	2637.20	3005.80
Crude protein (%)	15.60	13.65	16.31	18.96
Crude fiber (%)	4.80	6.30	7.60	8.89
Extract ether (%)	11.20	11.01	10.01	9.02
Ca (%)	2.25	0.45	0.83	1.22
P (%)	1.40	1.41	1.33	1.24

from each treatment. Weight gain was determined by taking duck weight at the end, minus at the beginning of study (g), beside the individual duck was weight every two weeks. Feed conversion ratio is an indicator of an efficient feed consumption. It was calculated as taking the amount of feed consumed and divided it by weight gain and eggs weight.

Eggs weight (g) was performed by using Ohaus scales. Eggs length (mm) was measured from the blunt part to the sharp part of egg, by using caliper scale. The distance of both sides of eggs was found to measure eggs width (mm) by using caliper. Eggs index was calculated by dividing the eggs width (mm) by eggs length (mm) and multiplied by 100. Eggs shell weight was found by breaking the eggs and let them dry, then weight it using "Ohaus" scale. Eggs shell thickness was measured by caliper.

Height of albumin was measured by putting it on a flat glass using depth micrometer. Albumin weight was measured using "Ohaus" scale by separating it from yolk using egg separator. Weight of egg yolk was measured using "Ohaus" scale after separated it from albumin. Color of eggs yolk was observed by breaking an egg, then separated it from albumin using separator and the yellow color was compared using Roche yolk color fan.

Haught Unit (HU) was calculated using the following equation as described by of Romanoff and Romanoff[7]:

$$HU=100\log\left\{H-\left[\sqrt{G}\,(30W^{0.37}-100)/100\right]+1.9\right\}$$

Where

H : Height of albumin (mm)
W : Eggs weight (g)
G : Constants of gravitation (32.2)

At the end of the study, one egg was taken as a sample from each replication and send to Hepatika Laboratory, Mataram, Indonesia for the analysis of egg yolk cholesterol level using the method of AOAC 994.10:2012[8].

Experimental design: The ducks were randomly assigned to four dietary treatments according to a completely randomized design (CRD). Each treatment consisted of five replicates with five ducks each. The dietary treatments were P0 consisted of 80% rice bran and 20% concentrate, P1 with 90% rice bran and 10% SSF, P2 with 80% rice bran and 20% SSF and P3 with 70% rice bran and 30% SSF.

Parameters measured: Feed intake and egg production were noted daily, while body weight was measured at the beginning and at the end of the observation period. The quality of the eggs was expressed in terms of egg weight (g), egg length (mm), egg depth (mm), egg shell weight (g) and thickness (mm), Haught Unit (HU), yolk color and meat cholesterol level was also measured.

Statistical analysis: Data were tabulated and analyzed using SPSS-17 software.

RESULTS AND DISCUSSION

Feed consumption: Production performances of Mojosari ducks fed on different levels of SSF is presented at Table 2. Feed consumption of the ducks fed diet containing SSF was not significantly (p>0.05) different from those given commercial feed. The feed consumption of ducks fed diet containing 20% commercial concentrate and those fed diet containing 10, 20 and 30% SSF were 171±7.26, 163±10.64, 171±10.3 and 163±16.0 g head^{-1} day^{-1} respectively.

Feed consumption noted in this study was slightly higher than those reported by Agustina *et al.*[9] who found that the feed consumption of the ducks given probiotics was 144.92±2.12 g head^{-1} day^{-1} and study by Wardoyo[10] who found that feed consumption of Khaki Campbell laying ducks at the age of 7 months given fermented rice bran was 133.40 -152.22 g head^{-1} but in accordance with those reported by Sarengat[11] who found that the feed consumption

Table 2: Production performances of Mojosari ducks given feed containing sapu-sapu fish

	Treatments			
Variables	P0	P1	P2	P3
Initial body weight (g duck^{-1})	1246.000±19	1314.000±43	1283.00±83	1268.000±46
Feed consumption (g day^{-1})	171.000±7.26	163.000±10 .4	171.00±10.3	163.000±16.3
Final body weight (g duck^{-1})	1297.600±48.18	1326.300±53.83	1419.60±74.85	1333.700±80.62
Average daily gain (g duck^{-1})	72.600±20.58^a	46.900±33.07^a	136.60±41.78^b	101.700±92.78^b
Egg production (%)	47.200±7.33^b	37.400±5.24^a	45.00±9.0^b	41.000±5.2^b
Feed conversion ratio	6.768±0.94	7.985±1.94	6.76±0.87	6.727±2.08

Means in a row followed by different subscripts differ significantly (p<0.05)

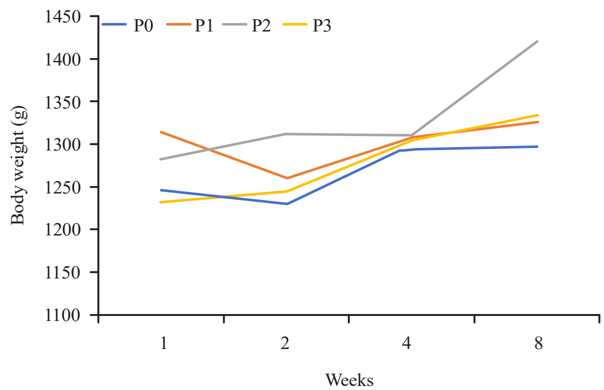


Fig. 1: Weekly body weight changes

P0: Mixture of 20% commercial feed and 80% rice bran, P1: Mixture of 10% sapu-sapu fish and 90% rice bran, P2: Mixture of 20% sapu-sapu fish and 80% rice bran, P3: Mixture of 30% sapu-sapu fish and 70% rice bran

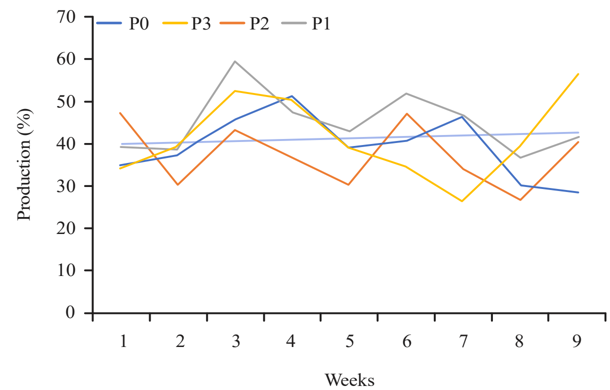


Fig. 2: Weekly egg production

of Tegal ducks fed diet with a protein content (15.95%) and metabolizable energy (2800 kcal kg^{-1}) were 151.44 g $head^{-1}$ day^{-1}. Many factors govern the amount of feed consumed by poultry. The most prominent factors are the metabolizable energy and protein contents.

Body weight gain: Average body weight gain of Mojosari layer ducks fed diet containing different amount of SSF, for three months (observation period) was significantly different ($p<0.05$). Average body weight gain of ducks received diet supplemented with 20 and 30% SSF was significantly higher ($p<0.05$) than those given commercial feed and those given diet supplemented with 10% SSF. Although their feed consumption was not significantly different, higher dietary protein content in both diets (Table 1) have permitted higher protein deposition as indicated by higher body weight gain (Fig. 1).

Egg production: There was no significant difference in egg production of the ducks fed diet supplemented with 20 or 30% SSF or those fed on control diet but those fed diet supplemented with 10% SSF was significantly lower than other dietary treatment. This discrepancy might be due to the protein content of the diets. Table 1 shows that protein content of diet supplemented with 20 and 30% SSF was slightly higher than control while diet containing 10% SSF was much lower than other diets. This indicate that the addition of 20% SSF in the diet of Mojosari laying ducks is sufficient to replace a commercial feed. Dietary protein is the most important factor that govern egg production. Shen[12] stated that the increase in dietary protein level from 15-17.5% can increase the egg production of duck. A previous study found that a group of ducks that consumed feed with high protein content (17.5 and 20%) gave significantly better egg production than the group that consumed feed with protein levels of 15 and 12.5%[13], Fig. 2 shows the weekly egg production.

Feed conversion ratios (FCR): Feed conversion ratios of all ducks received diet supplemented with SSF were not significantly ($p>0.05$) different from those given commercial feed. The FCR of the ducks fed diet containing 20% commercial feed, 10, 20 and 30% SSF were 6.768±0.94, 7.985±1.94, 6.760±0.87 and 6.727±2.08 respectively. Similar FCR was reported by Iskandar *et al.*[14] who fed the ducks with a diet containing 20% Rucah fish.

Exterior egg quality: Exterior egg quality parameters were determined by the amount of egg weight, egg shape index, shell thickness and egg shell weight. The results of exterior egg quality are presented in Table 3.

The diet containing SSF was significantly heavier than the weight of the egg produced by the ducks fed on commercial feed. Table 3 indicates that the higher the levels of SSF in the diet the heavier the egg is produced. Heavier egg weight in this study was caused by higher protein intake. Wahju[15] suggested that protein in the feed is the main factor that affecting egg weight. Each treatment has different protein content, where the higher content of SSF resulted in higher protein content of the diet (Table 1). The egg weight noted in this study was higher than egg weight reported by Rasetyo and Usanti[16] who found that the egg weight of Mojosari duck at first laying was 53.69 g. In another study Juliambarwati *et al.*[17] reported that the egg weight of Mojosari ducks fed shrimp waste was between 55.89-58.36 g.

Table 3: Exterior egg characteristic of Mojosari ducks

	Treatments			
Variables	P0	P1	P2	P3
Egg weight (g)	61.64±2.381[a]	64.20±5.069[ab]	65.60±3.647[ab]	70.80±6.98[c]
Egg high (mm)	5574.40±98.88	5729.00±100.08	6010.00±891.9	5801.00±269.2
Egg wide (mm)	4463.40±72.28[a]	4435.00±107.35[a]	4523.00±74.13[ab]	4675.00±196.98[c]
Shape index	80.15±0.731	77.45±3.013	76.32±8.99	80.66±3.55
Eggshell weight (g)	13.36±1.417	11.40±2.073	9.60±7.701	14.20±1.48
Percentage	21.62±1.825	17.72±2.64	14.19±11.39	20.21±2.75
Eggshell thickness (m)	0.48±0.019	0.47±0.044	0.46±0.022	0.49±0.02

Means in a row followed by different subscripts differ significantly ($p<0.05$)

Egg shell weights of Mojosari ducks in the present study were 9.6 g (14.19%) to 14.2 g (20.1%) and did not affected by the inclusion levels of dietary SSF. These results are higher than those reported by Juliambarwati *et al.*[17] who found that the egg shell weight of the ducks given shrimp waste varied from 5.82 g (10.12%) to 6.17 g (10.58%). Stadelman[18] stated that the egg shell weight was 9 to 12% of the total egg weight. It is caused by a content of protein; energy, Ca and P were almost the same. According to Clunies *et al.*[19], the higher dietary Ca can increase shell thickness. Similar trend was also observed in egg shell thickness. These might be due to almost similar amount of Ca and P in the diets.

Sarwono[20] reported that the birds fed with high calcium content usually produce a thick egg shell, while the eggshell thickness will affect the eggshell weight. In this study, eggshell weight and shell thickness did not significantly ($p>0.05$) affected by feeding SSF. Wahju[15] reported that eggshell quality is determined by the thickness and structure of the eggshell. The content of Ca and P in the feed contributes to the quality of the eggshell because the eggshell formation is necessary for the carbonate ions and Ca ions sufficient to form $CaCO_3$ of eggshell. Clunies *et al.*[19] observed that higher calcium intake increase the quality of the eggshell. The average of eggshell thickness in this study was 0.46-0.49 mm. This result is higher than those reported by Juliambarwati *et al.*[17] who found that eggshell thickness of ducks fed shrimp waste ranged from 0.35-0.36 mm.

Egg shape index is the ratio of the width to the length of the egg. Romanoff and Romanoff[7] found that the ideal egg shape index is 73.68%. Results of the present study showed that egg shape index of ducks fed diet containing 20% commercial concentrate, diet supplemented with 10%, 20% and 30% SSF, were 80.15±0.731%, 77.45±3.013%, 76.32±8.99% and 80.66±3.55% respectively.

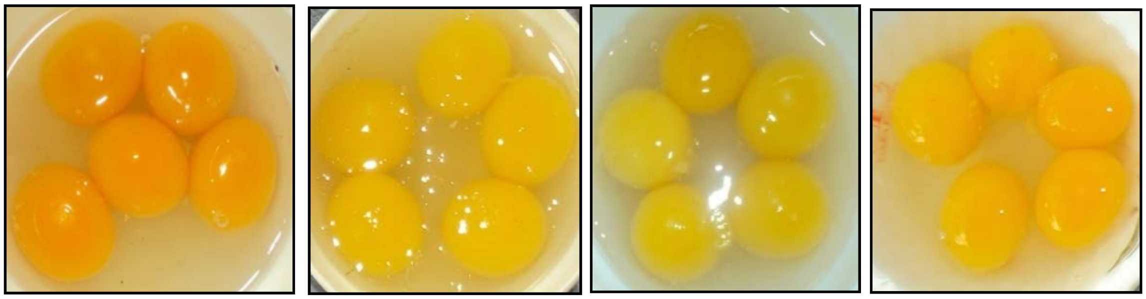
The inner quality of eggs: Inner egg quality is determined by the albumin height, albumin weight, yolk weight and yolk color index. Inner egg quality in this study is presented in Table 4.

Egg albumen levels are indicated by the level of viscosity. The higher albumen indicates that the eggs are more viscous. The results showed that the ducks fed diet containing 30% SSF resulted in higher viscosity than those of the ducks fed diet containing 20% commercial feed, 10 and 20% SSF. Wahju[15] noted that the higher egg albumin is an indicator for viscosity, which is influenced by feeding regimes and storage time.

Haugh Unit (HU) is an indicator to assess the freshness of eggs, which is influenced by storage time of the eggs. The results showed that HU values were not significantly affected ($p>0.05$) by dietary treatments. It may also be due to the egg retrieval time and uniform measurement in the morning shortly after the eggs came from ovipositor. North and Bell[21] stated that the value of HU depends upon egg storage time and age of hens. HU value is not influenced by the composition of the feed if the protein and metabolizable energy of feed is well balanced.

Egg yolk color scores of the ducks fed diet containing SSF and commercial feed was significantly different ($p<0.05$). The average yolk color score of the duck fed commercial diet was 10.56±0.932, higher than the yolk color score of the duck fed diet containing 10% (3.4±1.140), 20% (5.8±0.447) and 30% (6.8±0.45) SSF. This might be due to commercial feed which contained corn and other ingredients that contains xanthophylls which provide more yellow yolk color. Yolk color difference in each treatment is presented in Fig. 3.

Egg and meat cholesterol: The cholesterol content in eggs and meat of ducks fed diet containing SSF are presented in Table 5. The results of the present study showed that the yolk cholesterol levels of the eggs produced by ducks fed diet containing 10, 20 and 30% SSF were lower than those of the ducks fed diet containing 20% commercial feed and significantly different ($p<0.05$). Similarly, cholesterol levels in meat tends to decrease significantly ($p<0.05$). Low yolk cholesterol levels of the egg laid by ducks fed diet containing SSF was due to the presence of omega-3 fatty acid. Griffin[22]



P0 P1 P2 P3

Fig. 3: Differences in yolk color in each treatment

Table 4: Inner eggs quality of Mojosari laying duck

	Treatments			
Variables	P0	P1	P2	P3
Albumin height (mm)	878.88±113.5^{a}	867.400±165.55^{a}	835.80±159.1^{a}	1102.00±153.78^{b}
Albumin weight (g)	26.96±1.24^{a}	30.800±2.28^{b}	32.80±3.033^{b}	31.60±2.88^{b}
Percentage	43.81±2.40^{a}	48.019±2.05^{ab}	50.26±6.84^{ab}	44.74±2.78^{bc}
Yolk weight (g)	21.32±1.101	22.000±20	23.20±2.168	25.00±4.85
Percentage	34.57±0.758	34.250±1.136	35.55±4.967	35.05±3.77
HU	97.17±0,61	96.850±0,66	96.03±0,66	98.10±0,48
Yolk color	10.56±0.93^{c}	3.400±1.14^{a}	5.80±0.45^{b}	6.80±0.45^{b}

Means in a row followed by different subscripts differ significantly ($p<0.05$)

Table 5: Egg and meat cholesterol contains of Mojosari laying ducks are feeding sapu-sapu fish (mg/100 mL)

	Treatments			
Variables	P0	P1	P2	P3
Yolk cholesterol	23.600±2.275^{b}	12.60±1.140^{a}	13.00±3.082^{a}	15.200±4.15^{a}
Meat cholesterol	3.225±1.554^{b}	1.55±1.173^{a}	3.43±2.142^{b}	1.525±1.21^{a}

Means in a row followed by different subscripts differ significantly ($p<0.05$)

found that one of the functions of omega-3 is to inhibit the biosynthesis of cholesterol. Piliang and Al Haj[23] found that omega-3 fatty acids play a role in the regulation of cholesterol metabolism which includes transport and excretion of cholesterol. Patrick and Schaible[24] stated that saturated fatty acids are very rapidly absorbed by the digestive system, whereas omega-3 fatty acids (unsaturated) in fish oil will inhibit the biosynthesis of cholesterol and lowering triglycerides and VLDL cholesterol in blood plasma. According to Keshavaz[25] the fatty acids in egg yolk is influenced by the composition of fatty acids in the diet. If the diet contain high levels of unsaturated fatty acid such as omega-3 fatty acids, then those fatty acids are found in the eggs too.

Previous study[26] showed that Lemuru fish contains lots of omega-3 fatty acids that can lower cholesterol levels in egg yolk of quail. Suripta and Astuti[26] reported that the use of Lemuru fish oil in feed significantly lowered the cholesterol content (from 120.32-54.82 mg/100 g) in the quail eggs. Saerang[27] stated that the use of Lemuru fish oil in quail feed can lower cholesterol levels of the egg from 147.63-145.68 mg. Fish oils are rich in omega-3 fatty acids, if that oils are used in the feed of laying hens, It can decrease the cholesterol content of eggs and blood serum[28].

CONCLUSION

The diet of Mojosari ducks layer can be formulated using 20% sapu-sapu fish and 80% rice bran to replace similar amount of comercial feed. Inclusion of sapu-sapu fish in the diet resulted in better eggs quality compared to commercial feed. However, the egg yolk color was lighter. Yolk and meat cholesterol contents of the ducks fed diet containing sapu-sapu fish was found lower than those duck fed comercial feed.

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