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Performance of Quail (*Coturnix Japonica*) Fed Diets with Fish Meal Substituted by Catfish Offal Flour *(Pangaius hypopthalmus)*

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ABSTRACT

Catfish offal flour (COF; *Pangaius hypopthalmus*) has the potential to replace fish meal (FM) due to its high crude protein content. The present study aimed to investigate the effects of substituting FM with COF in basal diets on food intake (FI), body weight gain (BWG), and feed conversion ratio (FCR) in quails. A total of 100 male quails were randomly assigned to five treatment groups, each with four replicates. The treatment groups were fed with basal diet + 0% COF and 100% FM (T0), basal diet + 25% COF and 75% FM (T1), basal diet + 50% COF and 50% FM (T2), basal diet + 75% COF and 25% FM (T3), and basal diet + 100% COF and 0% FM (T4). Feed intake, BWG, and FCR were measured from 0 to 35 days of age. The findings indicated that substituting FM with COF up to 100% did not significantly affect FI, BWG, and FCR. It can be concluded that COF has the potential to replace FM in basal diets while maintaining performance in quails.

Keywords: Catfish offal flour, Body weight gain, Feed intake, Feed conversion ratio, Quail

INTRODUCTION

Quail farming is a popular practice in many communities and has long been a significant source of animal protein in Indonesia, particularly through the production of its meat and eggs. The population of quails in Indonesia increased from 13,932,649 to 14,819,755 in 2020 (Directorate General of Livestock and Animal Health, 2020). The management of quail maintenance is similar to that of other poultry, encompassing both breeding and feeding strategies. Among these practices, feed management is a crucial aspect of the maintenance of quails. Each developmental stage in quails requires feed with a specific protein content. During the starter period, the feed should contain a maximum of 24% crude protein (CP) and 2,800 Kcal/kg of metabolizable energy (ME). In the grower period, the feed should contain up to 20% of CP and 2,600 Kcal/kg of ME. Finally, for the layer period, the feed should contain a maximum of 22% CP and 2,700 Kcal/kg of ME (SNI 01-3907, 2006). Catfish offal is a protein source derived from fishery waste that can be utilized as animal feed. In 2018, the production of catfish in Riau, Indonesia was 36,554.82 tons (Directorate General of Livestock and Animal Health, 2020). Moreover, fish offal constitutes 10-15% (depending on the species) of the fish biomass (Bhaskar and Mahendrakar, 2008). Utilizable catfish offal includes intestines, swim bladders, liver, and gonads, which account for approximately 7.5% of the whole fish weight (Prabosasongko, 2003). According to Prabosasongko (2003), catfish offal silage contains 54.17% protein, 21.79% fat, 4.29% ash, 1.81% crude fiber, and 17.95% nitrogen-free extract. Previous studies have reported that catfish offal meal contains 53.38% CP, 18% crude fat, and 2.04% crude fiber, making it a potential substitute for fish meal in animal feed. Based on the aforementioned considerations, this study aimed to investigate the effects of utilizing catfish (*Pangasius*) offal waste as a substitute for fish meal in fulfilling protein requirements in livestock feed. In particular, the objective of this study was to examine the effects of substituting fish

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meals with catfish offal meals on the performance of quails (*Coturnix japonica*).

MATERIALS AND METHODS

Ethical approval

This investigation was performed under strict regulations by the recommendations in the Guide for the Care and Use of Animals, at the Faculty of Agriculture and Animal Science, State Islamic University of Sultan Syarif Kasim Riau, Pekanbaru, Indonesia.

Formulation of feed

The feed used in this study was custom-formulated, with its nutritional content tailored to meet the requirements of quails during the starter and growth phases, as specified by the NRC (1994). The nutritional composition of the feed ingredients and the formulation of the experimental diets are presented in Table 1.

Table 1. Composition and feed content of starter-phase of dietary with catfish offal flour in quail.

Treatment (%) / Feed Ingredients	T0	T1	T2	T3	T4
Yellow corn	26	26	26	26	27
Rine bran	49	49	49	49	48
Soybean Meal	13	13	13	13	13
Fish meal	10	7.5	5	2.5	0
COF	0	2.5	5	7.5	10
Top Mix	2	2	2	2	2
Total	100	100	100	100	100
Chemical analysis					
EM (Kcal/kg)	2892.47	2893.72	2894.97	2896.22	2899.5
CP (%)	19.94	19.95	19.97	19.99	19.97
CFr(%)	5.8	5.71	5.63	5.55	5.40
CF(%)	2.46	2.70	2.93	3.16	3.43
Calsium (%)	5.41	4.13	2.86	1.58	0.31
Phosphor (%)	0.62	0.55	0.48	0.41	0.35

COF: Catfish offal flour; CP: Crude Protein; CFr: Crude Fiber; CF: Crude Fat; Top Mix compound minerals and vitamins. Crude Fat; Top Mix compound minerals and vitamins. T0: Basal diet consisted of 100% FM + 0% COF, T1: Basal diet + 75% FM+25% COF, T2: Basal diet + 50% FM + 50% OF, T3: Basal diet + 25% FM + 75% COF, T4: Basal diet + 0% FM + 100% COF.

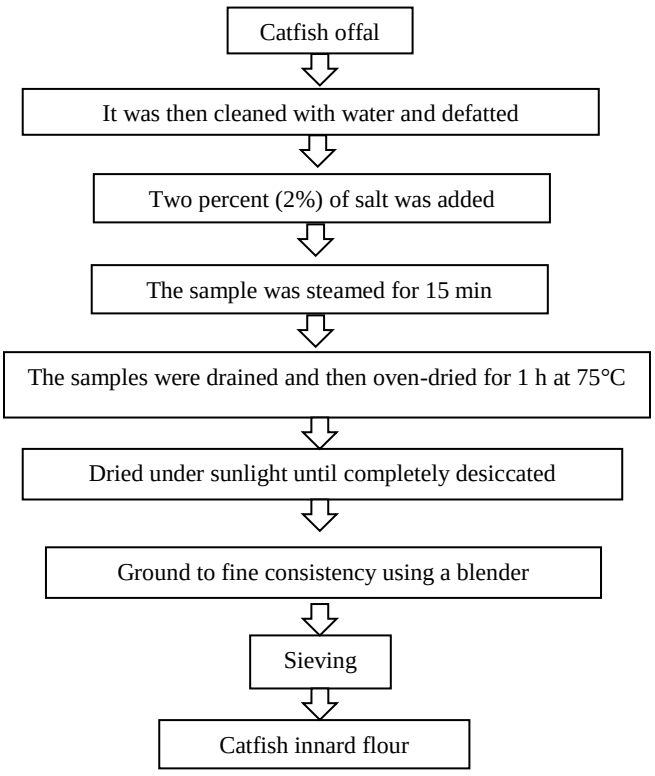

Figure 1. The production processing of Catfish innard flour

Research procedure

This study was conducted from July to August 2021 at the Livestock Production Technology Laboratory, Faculty of Agriculture and Animal Science, State Islamic University of Sultan Syarif Kasim Riau, and the Garuda Sakti Quail Farm, Jalan Sepakat, Gang Keluarga, Pekanbaru, Indonesia. The experiment involved 100 male Japanese quails, divided into five treatment groups with four replications each.

The quails were housed in cages maintained at a constant temperature of 30 ± 1^0C and provided with continuous lighting throughout the experiment. Treatments were administered from day-old quails (DOQ) until they reached 63 days of age. The treatments tested the use of catfish offal flour (COF) as a substitute for fish meal (FM) in the basal diet in quails (Figure 1). The treatment groups were as follows included T0 (basal diet with 100% FM + 0% COF; control), T1 (basal diet with 75% FM + 25% COF), T2 (basal diet with 50% FM + 50% COF), T3 (basal diet with 25% FM + 75% COF), and T4 (basal diet with 0% FM + 100% COF).

Measured parameters

Feed intake

Feed intake (FI) was determined as the amount of feed consumed by the quails, calculated by subtracting the amount of leftover feed from the total feed provided

(Maknun et al., 2015). The feed intake over the period from 0 to 35 days was determined by measuring the reduction in the amount of feed consumed from a pre-weighed feeder.

Body weight gain

The body weight gain (BWG) of the quails was calculated as the difference between their initial body weight and their final body weight during each weighing period.

Feed conversion ratio

The feed conversion ratio (FCR) was determined by dividing the total feed intake (FI) by BWG during each period, following the methods of Wen et al. (2018).

Data analysis

This study was designed as a completely randomized design (CRD). Data were analyzed using the StatView software package (Version 5, SAS Institute, Cary, USA, 1998). Analysis of variance (ANOVA) was performed, and the Tukey test was done as a post hoc test. Prior to the analysis, raw data were examined using Thompson's method at a significance level of $p < 0.05$ to identify outliers. Once the data were confirmed to meet the assumptions of ANOVA, statistical comparisons were conducted.

RESULTS AND DISCUSSION

Feed intake

The average feed intake (g/quail) of quails fed a ration containing COF as a replacement for fish meal in the basal diet over a 35-day experimental period was presented in Table 2. The results showed that substituting fish meal with COF at levels ranging from 25% to 100% did not have a significant effect ($p > 0.05$) on feed intake in treatments. The average feed intake across treatments ranged from 238.75 to 283.60 grams.

The non-significant effect of substituting commercial fish meal with COF was likely due to the relatively similar nutritional content, including crude protein, crude fiber, and metabolizable energy across all treatments, resulting in comparable feed intake levels among quails. Some factors may influence feed use including appetite, intestinal digestion, and energy metabolism (So et al., 2007; Byrne et al., 2015).

The non-significant difference in feed intake observed in this study was likely because the substitution of commercial fish meal with COF at levels from 25% to 100% in the diet met the nutritional requirements, particularly for protein. This finding was supported by Dauhi et al. (2021), who reported that substituting commercial fish meal with fish offal meal up to 12% in the diet resulted in no significant difference in feed intake due to the low protein content in Japanese quails.

Table 2. Average feed intake (g/quail) of quail from 0 to 35 days of age fed by substitution of fish meal with Catfish offal flour in basal diets

Treatment	Feed intake (g/quail/35 days)
T0	257.05 ± 54.76
T1	238.75 ± 77.46
T2	269.80 ± 22.48
T3	283.60 ± 11.98
P-value	0.79

T0: Basal diet consisted of 100% FM + 0% COF, T1: Basal diet + 75% FM+25% COF, T2: Basal diet + 50% FM + 50% OF, T3: Basal diet + 25% FM + 75% COF, T4: Basal diet + 0% FM + 100% COF.

Body weight gain

The average body weight gain (g/quail) of quails-fed diets containing COF as a substitute for fish meal in the basal diet over a 35-day study period was shown in Table 3. The results indicated that substituting fish meal with COF at levels ranging from 25% to 100% in quails aged from 0-35 days did not significantly affect ($p > 0.05$) body weight gain in treatments. Moreover, the results demonstrated that the body weight gain of quails was not affected by the substitution of commercial fish meal with COF in their diet. The average weight gain in this study ranged from 80.79 to 84.14 grams.

The lack of significant differences in body weight gain can be linked to feed intake, which remained unaffected by the substitution of commercial fish meal with COF. According to Richards and Proszkowiec-Weglarz (2007), increases in body weight in commercial chickens were often accompanied by unintended increases in feed intake. Hence feed intake is very important for increasing body weight gain and better feed efficiency (Wen, et al., 2018; Yan, et al., 2019). They also stated that body weight gain was primarily a result of metabolic accumulation, which was supported by the quantity of feed consumed by livestock and the optimization of feed utilization.

Table 3. Average Body weight gain (g/quail) of 35-day-old quails fed by substitution of fish meal with Catfish offal flour in basal diets

Treatment	Weight gain (g/quail/35 days)
T0	80.79 ± 2.14
T1	82.81 ± 1.80
T2	83.68 ± 0.93
T3	82.20 ± 1.75
T4	84.14 ± 2.87
P-value	0.32

T0: Basal diet consisted of 100% FM + 0% COF, T1: Basal diet + 75% FM+25% COF, T2: Basal diet + 50% FM + 50% OF, T3: Basal diet + 25% FM + 75% COF, T4: Basal diet + 0% FM + 100% COF.

Feed conversion ratio

The average feed conversion ratio (g/quail) of quails fed a diet containing COF as a substitute for fish meal in the basal diet over a 35-day study period was presented in Table 4. The results demonstrated that substituting fish meal with COF at levels ranging from 25% to 100% did not significantly affect ($p > 0.05$) the feed conversion ratio among treatments. The mean FCR ranged from 2.90 to 3.30.

Table 4. Average feed conversion ratio of 35-day-old quails fed by substitution of fish meal with Catfish offal flour in basal diets

Treatment	Feed Conversion ratio
T0	3.19 ± 0.72
T1	2.90 ± 0.97
T2	3.23 ± 0.28
T3	3.45 ± 0.11
T4	3.30 ± 0.54
P-value	0.85

T0: Basal diet consisted of 100% FM + 0% COF, T1: Basal diet + 75% FM+25% COF, T2: Basal diet + 50% FM + 50% OF, T3: Basal diet + 25% FM + 75% COF, T4: Basal diet + 0% FM + 100% COF.

The results of this study were lower than those reported by Dauhi et al. (2021), who observed no significant differences in FCR when adding up to 12% catfish offal meal to quail diets ($p > 0.05$). It was hypothesized that the non-significant difference in feed conversion ratio observed in this study may be attributed to the lack of significant effects on both feed intake and body weight gain, which also showed no significant differences.

This finding was consistent with that of Richards and Proszkowiec-Weglarz (2007) who reported that the higher BWG of broiler chickens was accompanied by improved feed utilization efficiency. Increased body size in broiler chickens has been accompanied by unintended increases in FI. Therefore, high FI was crucial for higher BWG and better FCR (Wen et al., 2018; Yan, et al., 2019). Mahmudah et al. (2015) emphasized this important point that the quality of the diet can change by the balance of dietary protein in quails.

CONCLUSION

Based on the findings of this study, it was concluded that substituting fish meal with COF up to 100% in the basal diet can effectively support the performance of Japanese quails. It was suggested that further research be conducted to explore the use of COF in diets for other poultry species.

DECLARATIONS

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Authors' contributions

Edi Erwan, Rendi Pratama, and Irdha Mirdhayati conducted the experiments, prepared and analyzed the data, and drafted the manuscript. Jordi Aditiya Prameswara, Mozhdeh Emadi, and Ilyas Husti reviewed and edited the manuscript. All authors have checked and approved the final version of the manuscript.

Competing interests

The authors declare no conflicts of interest.

Availability of data and materials

All the data and materials are available on request from the corresponding author.

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Ethical consideration

The authors affirm that all ethical issues have been addressed, including plagiarism, consent to publish, misconduct, double publication and/or submission, and redundancy.

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