B-5144
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RESEARCH ARTICLE Indian Journal of Animal Research

Effect of Replacing Fish Meal by Soybean Meal on the Performance, Nutrient Utilization and Egg Quality of Khaki Campbell Ducks in Late Laying Phase

B.K. Swain[1], P.K. Naik[1], S.K. Sahoo[1], S.K. Mishra[1], D. Kumar[1], C.K. Beura[1]

10.18805/IJAR.B-5144

ABSTRACT

Background: Feed quality in terms of protein source plays an important role in achieving targeted production. The quality of fish meal available in market is of highly variable in nature. Hence, an attempt was made to see the response of laying ducks to diets where fish was replaced by soybean meal with supplementation of critical aminoacids *i.e.* lysine and methionine over and above the normal requirement.

Methods: A 16 week biological trial consisting of 72 Khaki Campbell laying ducks (83 weeks) subjected to three treatments (T_1-Control diet with fish meal, T_2- fish meal totally replaced by soybean meal, T_3-T_2 + Supplementation of Lysine and Methionine distributed equally to 9 replications of 8 laying ducks each was conducted following completely randomised design to see the effect of treatments on the performance, nutrient digestibility/retention and egg quality in Khaki Campbell laying ducks. Standard analytical and statistical procedures were followed for proper interpretation of the data.

Result: The egg production (nos and dozen) and DDEP percent were significantly (P<0.05) higher and FCR was significantly (P<0.05) better for ducks reared on T_1 compared to other groups. The dry matter, organic matter and crude fibre digestibility was significantly (P<0.05) higher for ducks fed fish meal. However, the EE digestibility was significantly (P<0.05) higher for T_3 group. The egg quality parameters were significantly higher for T_3 group. It is concluded that the performance of Khaki Campbell laying ducks fed diet without fish meal was deteriorated but the egg quality was improved.

Key words: Egg production, Egg quality, Fish meal, Khaki Campbell ducks, Soybean meal.

INTRODUCTION

India ranks second in world duck population, with a total duck population of around 33.5 millions according to the 20th livestock census of India, 2019 (BAHS,2019 and Naik *et al*., 2022). Duck egg and meat are relished by people next to chicken and has higher market value. Fish meal is cherished by farmers and Nutritionists in developing countries because it is composed of higher content of digestible crude protein, essential amino acids, fats, vitamins and minerals (Blair, 2008 and Chadd, 2008). The nutritive value of fish meal is comparable to soybean meal in many aspects, but its protein quality and effectiveness of some unknown growth factors vary extensively (Swain and Chakurkar, 2011). Earlier studies revealed that protein from fish meal can be completely replaced by soybean meal protein with supplementation of 0.10% methionine in broiler ration economically (Aziz *et al*., 2001). Fish meal can be replaced by soybean meal as a main protein source along with supplementation of synthetic amino acids in the diet for ducklings and broilers (Yuan, 1989 and Okan and Ogun, 1988). Fish meal is an exceptional protein source for poultry feeding as it has ample quantity of all essential amino acids particularly lysine and methionine required by poultry (Scott *et al*., 1982). It is a excellent source of mysterious factors (Bondi, 1987). However, inadequate accessibility in recent years, want for consistency and elevated market price compared to vegetable protein sources has restricted its inclusion in broiler diets (Blair, 2008 and Chadd, 2008). Soybean meal has high protein and essential amino acid contents to meet the nutrient requirement of poultry (Yasothai, 2016). Therefore, the present study was conducted to evaluate the effect of replacing fish meal by soybean meal along with supplementation of additional lysine and methionine in the diet on the performance, nutrient utilization and egg quality of Khaki Campbell laying ducks in late laying phase.

[1]ICAR-Directorate of Poultry Research Regional Station, Bhubaneswar-751 003, Odisha, India.

Corresponding Author: B.K. Swain, ICAR-Directorate of Poultry Research Regional Station, Bhubaneswar-751 003, Odisha, India. Email: nbkswain@gmail.com

How to cite this article: Swain, B.K., Naik, P.K., Sahoo, S.K., Mishra, S.K., Kumar, D. and Beura, C.K. (2023). Effect of Replacing Fish Meal by Soybean Meal on the Performance, Nutrient Utilization and Egg Quality of Khaki Campbell Ducks in Late Laying Phase. Indian Journal of Animal Research. DOI: 10.18805/IJAR.B-5144.

Submitted: 10-05-2023 **Accepted:** 30-09-2023 **Online:** 10-10-2023

MATERIALS AND METHODS

The experiment was carried out at ICAR-Directorate of Poultry Research Regional Station, Bhubaneswar during

April to July 2022. A control diet with fish meal and two experimental diets (Table 1) were formulated by replacing fish meal with soybean meal and supplementation of additional lysine and methionine *i.e*. T_1 (Fish meal 7%), T_2 (Fish meal-0%) and T_3 (Fish meal 0% + Lysine + Methionine). All the diets were made isonitrogenous and isocaloric. Seventy two Khaki Campbell laying ducks (83 weeks) were divided into three groups (each group had three replicates with 8 laying ducks per replicate) and were randomly fed above three diets for an experimental period of 16 weeks. All the birds were reared on deep litter system following standard management practices. The weekly feed intake, daily egg production and weekly egg weight were recorded and FCR was calculated as amount of feed consumed in kg to produce one dozen egg. The external egg quality parameters *i.e*. egg weight, length, width and shape index as per formula of Shultz (1953) were recorded. The internal egg quality parameters *i.e*. height of the albumen and yolk, length and width of the albumen and yolk were recorded and albumen index, yolk index and haugh unit were calculated as per the formula of Heiman and Carver (1936), Sharp and Powell (1930) and Haugh (1937), respectively. The feed cost to produce dozen egg was calculated. The proximate composition of fish meal, soybean meal and standard layer diet was analyzed (AOAC, 2005, Table 2). At the end of the biological trial, a metabolic trial was conducted with 4 days collection period by keeping the laying ducks in individual metabolic cages. A known quantity of feed was offered daily and excreta voided over 24 hr period was collected quantitatively. The aliquots of excreta were collected daily after mixing it well for dry matter and nitrogen estimation. For dry matter estimation the excreta samples were kept in hot air oven at 70°C for 72 hr (Sahoo *et al*., 2014). For faecal nitrogen estimation samples were preserved in 25% sulphuric acid in duplicate (Pathak and Kamra, 1999). The samples of feeds, residues and faeces were analyzed for proximate composition (AOAC, 2005). The metabolizability of the nutrients was calculated as the difference between nutrient intake and nutrient voided.

The data on various parameters were analysed (Snedecor and Cochran, 1989). The significant differences between the means were tested by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The egg production, duck day egg production percent, egg weight and feed intake were significantly ($P<0.05$) higher in ducks fed diet with inclusion of fish meal (Table 3). The feed conversion ratio and cost of feed/dozen egg were significantly ($P<0.05$) better in laying ducks fed fish meal diet. Similar to present findings, Mundhem and Opstvedt (1981) observed that inclusion of fish meal in the diet of layers significantly increased the egg production with improvement in the efficiency of feed utilisation compared to soybean meal. In an earlier study, significantly higher ($P<0.05$) egg production and better feed conversion ratio were reported in laying hens fed 3% fish meal compared to control group fed only soybean meal (Rowghani *et al*., 2007).

Table 1: Composition of experimental diets.

Ingredients	T_1 (Control diet with fish meal)	T_2 (Without fish meal)	T_3 (Without FM and supplementation of lysine and meth.)
Wheat	60	60	60
Soybean meal	16	24.5	24.5
Fish meal	07	-	-
DORB	07	03	03
Shell Grit	08	10	10
DCP	01	1.5	1.5
Calcite	01	01	01
Trace Min. Mix.	100 g	100 g	100 g
Lysine	Nil	Nil	250 g
DL-Meth.	Nil	Nil	240 g
AB2D3K	15 g	15 g	15 g
B-Complex	15 g	15 g	15 g
Toxin binder	100 g	100 g	100 g
Choline chloride	100 g	100 g	100 g
VitE Se	15 g	15 g	15 g
Chemical composition (%, Calculated)			
CP, analysed	18.28	18.04	18.04
ME (Kcal/Kg)	2670	2650	2650
Lysine	0.75	0.75	1.12
Methionine	0.30	0.30	0.45
Ca	4.0	4.0	4.0
AvailP	0.5	0.5	0.5

In contrast, Yuan (1989) reported that fish meal can be replaced by soybean meal supplemented with synthetic amino acids for ducklings. There was significant decrease in egg production (Nos), duck day egg production % and poor FCR and cost of egg production per dozen eggs (Table 1) due to replacement of fish meal by soybean meal along with additional lysine and methionine. This may be due to the high quality protein in fish meal compared to plant protein source like soybean meal (Fanatico *et al* (2018); highly available form of calcium and phosphorous in fish meal (Mile and Jacob, 2011); fish meal is an excellent source of all essential amino acids particularly lysine and methionine (Scott *et al*., 1982); it is also a good source of unidentified factors (Bondi, 1987). Earlier researchers also observed that the egg production, fertility and hatchability have improved due to inclusion of fish meal in the diet of laying hens (Almayehu *et al*., 2015). The above extraordinary nutritional qualities in fish meal might have increased the egg production significantly with a great margin in ducks fed fish meal compared to those fed soybean meal with or without additional lysine and methionine. In contrast, Thongwittaya and Tasaki (1996) observed normal egg production in laying ducks fed on a diet based on soybean meal (21%) with no fish meal, however, supplementation with methionine and lysine increased the egg production. Results of an earlier study demonstrated that replacement of fish meal with either different vegetable proteins or synthetic amino acids gave better results in efficiency of production and cost of production (Rama Rao *et al*., 1998). The digestibility/ retention of dry matter (DM), organic matter (OM), crude protein (CP) and crude fibre (CF) were higher in ducks fed diet with fish meal compared to those fed diet without fish meal and with amino acid supplementation (Table 4). Higher DM metabolizability was reported in white pekin ducks (Naik *et al*., 2021) and in Khaki Campbell ducks (Joshi *et al*., 2015). However, lower DM digestibility was reported in White Pekin and Khaki Campbell ducks, respectively (Sahoo *et al*., 2014). The OM digestibility was higher than the values reported by Sahoo *et al*. (2014) and similar to Joshi *et al*. (2015). The metabolizability of CP values were higher than the values reported by Naik *et al*. (2021) and Sahoo *et al*. (2014). The metabolizability of EE in present study was significantly higher in T_2 group (without fish meal) and higher than the values reported by earlier workers (Joshi *et al*., 2015). The CF metabolizability values were higher than the values (41.57 to 51.23 and 59.57 to 62.05) reported by earlier workers (Sahoo *et al*., 2014 and Naik *et al*., 2021). The nitrogen balance (2.69 to 2.98) and nitrogen balance as % of N intake (75.93 to 78.75) were higher in groups fed fish meal compared to other treatment groups. Similar values of nitrogen balance (2.35 to 4.22) and lower nitrogen balance as % of N intake (67.40 to 70.09) were reported by earlier researchers (Naik *et al*., 2021). The difference in the values of nutrient metabolizability among the findings of various studies might be due to the difference in the feeding regimes. The egg weight was similar for all the treatment groups. However, higher ($P<0.05$) egg weight was reported in laying hens fed 3% fish meal compared to those fed only soybean

Table 2: Chemical composition of fish meal, soybean meal and experimental diets.

Analysed, %	T_1 (Control diet with fish meal)	T_2 (Without fish meal)	T_3 (Without FM and supplementation of lysine and meth.)	Fish meal	Soybean meal
Crude protein	18.28	18.04	18.04	49.40	46.45
Ether extract	3.13	3.17	3.14	4.78	1.65
Crude fibre	4.45	4.36	4.32	3.52	6.88
Total ash	10.47	9.22	9.10	20.45	9.39
NFE	63.19	65.18	65.32	21.85	35.63
Calculated, %					
ME (Kcal/kg)	2670	2650	2650		
Lysine	0.75	0.75	1.12		
DL-meth	0.30	0.30	0.45		

Table 3: Effect of replacing fish meal by soybean meal on the performance of Khaki campbell ducks in late laying phase.

Treatments/Attributes	T_1	T_2	T_3	SEM
Egg production (nos)	74.80^a	57.23^b	49.60^c	3.741
Duck day egg production (DDEP), %	61.81^a	47.28^b	40.98^c	3.093
Egg production (dozen)	6.23^a	4.77^b	4.14^c	0.311
Feed intake (kg)*	17.52	17.53	17.46	0.022
FCR	2.815^c	3.647^b	4.159^a	0.205
Cost of feed/dozen egg (Rs)	95.75^c	132.40^b	158.62^a	9.461

Means bearing different superscripts within a row differ significantly ($P<0.05$).

*Non-significant.

Table 4: Effect of replacement of fish meal by soybean meal on metabolizability of various nutrients and nitrogen balance in khaki campbell laying ducks.

Parameters	Dietary groups			SEM
	T_1	T_2	T_3	
Metabolizability (%) of nutrients				
Dry matter	79.37[a]	78.61[b]	78.02[b]	0.18
Organic matter	82.03[a]	81.28[b]	80.91[b]	0.16
Crude protein	78.75[a]	76.79[b]	75.93[b]	0.34
Ether extract	73.27[b]	73.96[a]	72.64[b]	0.18
Crude fibre	68.47[a]	67.05[b]	66.57[c]	0.21
Nitrogen balance				
N intake (g/d)	3.79[a]	3.79[a]	3.67[b]	0.02
Nitrogen outgo (g/d)	0.81[a]	0.80[a]	0.77[b]	0.01
N Balance (g/d)	2.98[a]	2.88[b]	2.69[c]	0.03
N balance as % of N intake	78.75[a]	76.79[b]	75.93[b]	0.34

[a,b] Means with different superscripts in a row differ significantly (P<0.05).

Table 5: Effect of replacement of fish meal by soybean meal on the egg quality characteristics.

Treatments/attributes	T_1	T_2	T_3	SEM
Egg weight (g)*	75.92	75.98	74.97	0.732
Shape index	65.77[b]	65.76[b]	69.05[a]	0.514
Albumen index	0.136[b]	0.159[a]	0.155[a]	0.003
Yolk index	0.506[b]	0.512[ab]	0.518[a]	0.002
Haugh unit	92.51[b]	97.43[a]	97.24[a]	0.585
Shell thickness with membrane	0.556[ab]	0.536[b]	0.561[a]	0.005
Shell thickness without membrane	0.472[ab]	0.458[b]	0.482[a]	0.004
Albumen,%	53.13[b]	55.93[a]	55.57[a]	0.450
Yolk, %*	30.84	31.70	31.00	0.461
Shell,%*	9.54	9.41	9.38	0.076

[a,b] Means with different superscripts in a row differ significantly (P<0.05).

*Non-significant.

meal as a protein source (Rowghani *et al*., 2007). On the other hand, significant (P<0.05) increase in egg weight was reported in egg laying ducks and Hy-Line laying hens as dietary lysine level was increased (Fouad *et al*., 2018 and Proschaska *et al*., 1996). The egg quality parameters *i.e*. shape index, albumen index, yolk index, haugh units, shell thickness with and without membranes and albumen % were significantly (P<0.05) better in laying ducks fed diets with SBM (without fish meal diet) and diet 3 with addition of lysine and methionine (Table 5). Earlier researchers reported that albumen quality increased with increased dietary lysine concentration (Balnave *et al*., 2000). Since, better albumen quality implies better albumen height which is a indication of better albumen index and haugh unit .This may be the reason of better egg quality *i.e*. albumen index and haugh unit in ducks fed diet with soybean meal replacing fish meal with or without additional lysine and methionine.

However, earlier workers reported that dietary supplementation of lysine had no effects on egg shape index and haugh unit (Fouad *et al*., 2018). In contrast, no improvement in haugh unit in Hy-Line Brown laying hens and Hy-Line W-36 laying hens was reported due to dietary supplementation of lysine (da Rocha *et al*., 2009 and Souza *et al*., 2014). The value of haugh unit ranged from 92.51-97.24 in present study. In contrast, lower value (87.80 -90.45) was reported in Khaki Campbell laying ducks in earlier study (Swain *et al*., 2020).

CONCLUSION

It may be concluded that replacement of fish meal by soybean meal reduced the performance of Khaki Campbell laying ducks in the late phase of laying in terms of lower egg production and egg weight and poor FCR. However, the egg quality was improved due to replacement of fish meal by soybean meal and with additional lysine and methionine.

ACKNOWLEDGEMENT

The authors are thankful to Indian Council of Agricultural Research (ICAR), New Delhi, for providing financial support to conduct this study.

Conflict of interest: None.

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