Indian Journal of Animal Sciences **95** (7): 666–670, July 2025/Article
https://doi.org/10.56093/ijans.v95i7.161421

Effect of varying levels of fish meal replacing soybean meal on the performance, nutrient metabolizability and egg quality in Khaki Campbell laying Ducks

B K SWAIN[1]✉, P K NAIK[1], S K SAHOO[1], S KMISHRA[1], D KUMAR[1], C K BEURA[1] and S K BHANJA[1]

ICAR-Directorate of Poultry Research Regional Station, Bhubaneswar-751 003

Received: 28 November 2024; Accepted: 17 October 2025

ABSTRACT

The current investigation was carried out to study the effect of replacing soybean meal with fish meal on the performance, nutrient metabolizability and egg quality of Khaki Campbell laying ducks. Three groups of Khaki Campbell laying ducks (72, 55 weeks) were randomly fed three isonitrogenous and isocaloric experimental diets (T_1-Control diet without fish meal, T_2- fish meal (4%), T_3- fish meal (8%) for 153 days. Ducks given 4 % fish meal exhibited significant (P<0.05) improvements in egg production, duck day egg production percent and FCR. Feed intake and cost per dozen egg were decreased (P<0.05) in ducks provided 4 % fish meal with significantly improved (P<0.05) metabolizability of nutrients. Ducks given 4 % fish meal had significantly (P<0.05) higher egg quality attributes, i.e. haugh unit score, yolk index, albumin % and shape index. It may be concluded that substituting soybean meal with 4 % fish meal in Khaki Campbell laying duck diets improved egg production, FCR, egg quality, nutrient metabolizability and reduced egg production cost.

Key words: Duck, Egg, Fish meal, Khaki Campbell, Metabolizability

According to 20th livestock census of India, country has about 33.51 million ducks overall, placing it as second-largest duck population in world (Anonymous 2019). Duck meat and egg are favoured by people after chicken; therefore, market demand has been increaseing over previous years. Fish meal contains essential amino acids, fats, vitamins, digestible crude protein and minerals. Consequently, farmers and nutritionists value it in underdeveloped nations (Blair 2008, Chadd 2008). The nutritive value of fish meal is similar to soybean meal in various aspects, but its protein quality and effectiveness of some unidentified growth factors vary widely (Swain and Chakurkar, 2011). The fish meal contains highly digestible protein, EPA & DHA, vitamins, as well as minerals (IFOMA 2001). Higher egg production, enhanced disease resistance, increased fertility, and greater egg nutritional value due to EPA and DHA deposition, are all advantages of feeding fish meal to layers at optimal levels (Thongwittaya 2007).

Fish meal includes all essential amino acids, including methionine and lysine, resulting in an ideal chicken diet (Scott *et al*. 1982). It provides outstanding unidentified factors (Bondi 1987). According to Thongwittaya and Tasaki (1992b) Khaki Campbell and Thai Native ducks cross that were fed 6.5 % fish meal performed better in terms of feed conversion ratio, egg weight(g), along with egg production percentage. Its applications in broiler diets are restricted by its recent limited availability, uneven quality and higher cost in comparison with plant protein sources (Blair 2008, Chadd 2008). Soybean meal provides protein as well as critical amino acids for poultry (Yasothai 2016). Given these facts, the current investigation examined the effect of varying amount of fish meal substituting soybean meal on Khaki Campbell laying ducks performance, nutrient metabolizability and egg quality.

Present address:[1]ICAR-Directorate of Poultry Research Regional Station, Bhubaneswar, Odisha, India. ✉Corresponding Author email: nbkswain@gmail.com

MATERIALS AND METHODS

The experiment was performed at ICAR-DPR Regional Station, Bhubaneswar, Odisha. Three experimental diets (Table 1) were formulated by replacing soybean meal of the control diet with fish meal i.e. T1 (Fish meal 0%), T2 (Fish meal 4%) and T3 (Fish meal 8 %).

Every diet had been designed as isocaloric and isonitrogenous. Over a 153 day investigation, 72, 55-week-old Khaki Campbell laying ducks were divided into 3 groups of 3 replicates each with 8 laying ducks per replicate. Each group had been subsequently randomly fed all three diets. Every bird was reared utilizing deep litter system with standard management practices. FCR, or the amount of feed consumed in kg for producing a dozen eggs has been determined by recording the weekly feed intake and daily egg output. Subsequently weekly egg weights were recorded. The Shultz (1953) formula was used to measure egg length, width and shape index. Recorded egg quality criteria included albumin, yolk height, length, along with width. The formulas developed by Sharp & Powell (1930), Heiman & Carver (1936), as well as Haugh (1937),

Table 1. Composition of Experimental Diets

Ingredients	T_1(Control diet without Fish meal)	T_2 (4 % Fish meal)	T_3 (8 % Fish meal)
Wheat	60	60	60
Soybean meal	22	18	14
Fish meal	-	04	08
DORB	7.0	7.5	08
Shell Grit	09	08	08
DCP	1.0	1.5	01
Trace Min. Mix.	100g	100g	100g
DL-Meth.	140g	130g	120g
AB2D3K	20g	20g	20g
B-Complex	20g	20g	20g
Toxin Binder	100g	100g	100g
Choline Chloride	100g	100g	100g
VitE Se	20g	20g	20g

have been employed for determining yolk index, albumin index, along with haugh unit, correspondingly. Cost of feed for a dozen eggs was also determined. The proximate composition of fish meal, soybean meal and experimental diets was also analysed (AOAC 2005, Table 2). Six laying ducks from each treatment were kept in separate metabolic cages after biological trial completion; then metabolic experiment was performed using four-day collecting period. Excreta had been quantitatively collected over a span of 24 hours, and an identified quantity of feed had been supplied each day. Each day, after thoroughly mixing the excreta, aliquots have been collected for the assessment of dry matter & nitrogen. Dry matter was estimated by keeping the excreta samples in hot air oven at 70 ^{0}C for 72 hr (Sahoo *et al*. 2014). Faecal nitrogen was determined by preserving the samples in 25 % sulphuric acid in triplicate (Pathak and Kamra 1999). The proximate composition of feeds, residues and faeces were determined through accepted methods (AOAC 2005). Difference between nutrient intake and voided were utilised for assessing metabolizability.

Data associated with various parameters was examined via one-way analysis of variance, as reported by Snedecor & Cochran (1994). For validating substantial differences at P<0.05, Duncan's Multiple Range Test (Duncan 1955) has been employed.

RESULTS AND DISCUSSION

Table 2. displayed chemical composition of experimental diets, fish meal and soybean meal. Ducks fed diet containing 4% fish meal exhibited "significant (P<0.05) increase in egg production as well as duck day egg production percent, along with an improvement in FCR (Table 3).

Ducks fed 4% fish meal had significantly (P<0.05) lower feed intake as well as costs per dozen eggs. Similar findings were reported by earlier research workers where egg production increased with improvement in the efficiency of feed utilisation in laying hens fed fish meal compared to soybean meal (Mundhem and Opstvedt 1981). Compared to the soybean meal group, laying hens fed 3%

Table 2. Chemical Composition of Fish meal, Soybean meal and experimental diets

Analysed, %	T_1 (Control diet without Fish meal)	T_2 (4 % Fish meal)	T_3 (8 % Fish meal)	Fish Meal	Soybean Meal
Crude Protein	18.12	18.34	18.76	52.40	46.45
Ether Extract	3.13	3.17	3.14	4.78	1.65
Crude Fibre	5.45	5.36	5.32	3.52	6.88
Total Ash	9.10	9.72	10.47	20.45	9.39
NFE	64.20	63.41	62.31	18.85	35.63
Calculated, %					
ME(,Kcal/kg)	2641	2639	2640		
Lysine	0.65	0.65	0.65		
DL-Meth.	0.30	0.30	0.30		

Table 3. Effect of varying level of fish meal replacing soybean meal on the performance of Khaki Campbell laying ducks

Treatments/Attributes	T_1	T_2	T_3	SEM	P Value
Egg Production (nos)	78.71^a	88.44^b	78.81^a	1.546	0.001
Egg production(dozen)	6.56^a	7.43^b	6.57^a	0.132	<0.001
DDEP %	46.55^b	58.13^a	48.85^b	1.61	<0.001
Feed intake (kg)*	18.13^a	17.90^b	18.00^b	0.034	0.004
FCR	2.764^a	2.410^b	2.743^a	0.052	<0.001
Cost of Feed/Dozen egg (Rs)	99.04^a	85.85^b	95.75^a	9.461	<0.001

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

Table 4. Effect of varying level of fish meal replacing soybean meal on metabolizability of various nutrients and nitrogen balance in Khaki Campbell laying ducks

Parameters	Dietary Groups			SEM	P Value
	T_1	T_2	T_3		
Metabolizability (%) of Nutrients					
Dry matter	79.84[b]	80.83[a]	80.07[b]	0.12	<0.001
Organic matter	81.70[b]	82.92[a]	81.84[b]	0.14	<0.001
Crude protein	74.99[b]	76.79[a]	74.68[b]	0.24	<0.001
Ether extract	79.32[b]	80.79[a]	79.72[b]	0.18	<0.001
Crude fibre	62.10[c]	63.82[a]	62.72[b]	0.19	<0.001
Nitrogen Balance					
N intake (g/d)	4.09[a]	4.22[a]	3.92[b]	0.04	0.003
Nitrogen outgo (g/d) *	1.02	0.98	0.98	0.01	0.148
N Balance (g/d)	3.06[b]	3.24[a]	2.93[b]	0.04	<0.001
N balance as % of N intake	74.99[b]	76.79[a]	74.68[b]	0.24	<0.001

fish meal had considerably higher (P<0.05) egg production and FCR (Rowghani *et al.* 2007). Inclusion of 6.5 % fish meal in crossbred ducks (Khaki Campbell X Native Thai ducks) improved egg production %, egg weight and feed conversion ratio during 18-36 weeks of age (Thongwittaya and Tasaki 1992 b). Results of current research contradicted Yuan (1989) who observed that ducklings could receive their nutrition from synthetic amino acids containing soybean meal instead of fish meal. In a similar study, Thongwittaya and Tasaki (1992a) had concluded that laying ducks fed soybean meal (21%) diet on basis of without fish meal had normal egg production. However, the egg production improved further with supplementation of methionine and lysine. The cost per kg of feed for T_1, T_2 and T_3 were Rs 35.83, Rs 35.62 and Rs 35.62, respectively. Significantly (P<0.05) lower feed cost per dozen egg was recorded in T_2 which might be due to the better FCR in this group. A study concluded that substituting fish meals with varied vegetable proteins or synthetic amino acids increased production efficacy while decreasing production costs (RamaRao *et al.* 1998).

Ducks fed 4% fish meal have significantly (P<0.05) higher DM digestibility (80.83) (Table 4).

DM metabolizability was lower in White Pekin ducks (76.17-78.87) (Naik *et al*. 2021) and Khaki Campbell laying ducks (75.46-79.38 and 74.91-75.78) (Joshi *et al*. 2015, Sahoo et al. 2014). In T2 group, OM digestibility considerably higher (P<0.05), although Sahoo et al. (2014) and Joshi et al. (2015) reported lower (77.29-80.78) and higher (80.67-83.79) values, correspondingly. Ducks fed 4% fish meal have considerably higher CP metabolizability (76.79) (P<0.05) as compared to Naik *et al.* (2021) (67.40-70.09) & Sahoo *et al.* (2014) (67.26-70.73). Investigation concluded that ducks fed 4% fish meal have a substantially higher (P<0.05) EE metabolizability (76.79) than prior research (Joshi *et al.* 2015). They also have considerably

higher (P<0.05) CF metabolizability (63.82) than prior studies (41.57-51.23 and 59.57-62.05) (Sahoo *et al.* 2014, Naik *et al.* 2021). T2 group has higher nitrogen balance than others. N-balance as a percentage of N intake follows a similar pattern in present research. Higher crude protein metabolizability & N-balance could be due to better amino

Table 5. Effect of varying level of fish meal replacing soybean meal on the egg quality characteristics

Treatments/Attributes	T_1	T_2	T_3	SEM	P value
Egg Weight (g)*	61.95	62.12	61.98	0.225	0.956
Shape Index	67.12[a]	69.20[b]	67.55[a]	0.299	0.004
Albumen index*	0.154	0.151	0.152	0.001	0.562
Yolk index	0.517[a]	0.532[b]	0.541[b]	0.003	0.004
Haugh Unit	93.83[a]	94.65[b]	94.11[ab]	0.131	0.025
Shell thickness with membrane	0.556[ab]	0.536[b]	0.561[a]	0.005	0.032
Shell thickness without membrane	0.472[ab]	0.458[b]	0.482[a]	0.004	0.001
Albumen,%	53.13[b]	55.93[a]	55.57[a]	0.450	0.001
Yolk, %*	30.84	31.70	31.00	0.461	0.228
Shell,%*	9.54	9.41	9.38	0.076	0.671

[a,b] Means with different superscripts in a row differ significantly (P<0.05) * Non-Significant

acid availability in fish meal diet as it is an excellent protein source with better amino acid balance for feeding poultry (Scot *et al*. 1982).

The egg weight was similar (P<0.05) in all the groups (Table 5).

According to Rowghani *et al.* (2007), laying hens fed 3% fish meal instead of just soybean meal had higher (P<0.05) egg weights. Research indicates that higher dietary lysine levels substantially improve (P<0.05) egg weight in Hy-Line laying hens & ducks (Fouad *et al.* 2018, Proschaska *et al.* 1996). Feeding laying ducks 4% fish meal significantly improved (P<0.05) egg quality metrics, including shape index, yolk index, haugh unit, & albumen percentage compared to diets without fish meal. The value of haugh unit ranged from 93.83-94.65 in the present study. In contrast, lower values, i.e. 85.43 to 86.98 and 87.80 to 90.45, have earlier been reported in White Pekin (Naik et al.2022) & Khaki Campbell (Swain *et al*. 2020) laying ducks, respectively.

This might be due to better amino acid availability in 4% fish meal diet. In contrast, dietary lysine supplementation did not enhance haugh unit in Hy-Line Brown & W-36 laying hens (da Rocha *et al*. 2009, Souza *et al*. 2014). Further, Fouad *et al.* (2018) reported no effect of lysine supplementation on egg shape index or haugh unit.

It can be concluded that inclusion of 4% fish meal by replacing soybean is beneficial for improved egg production, FCR, egg quality with increased metabolizability of nutrients and decreased cost of egg production in Khaki Campbell laying ducks.

ACKNOWLEDGEMENT

The Indian Council of Agricultural Research (ICAR), New Delhi, is acknowledged by the authors for its financial assistance in performing this investigation.

REFERENCES

Anonymous.2019. *BasicAnimal Husbandry Statistics*. Ministry of Fisheries, Animal Husbandry and Dairying, Department of Animal Husbandry and Dairying, Krishi Bhawan, New Delhi.

AOAC. 2005. *Official Methods of Analysis*. 18th edn. Association of Official Analytical Chemists, Washington, DC, USA.

Blair R. 2008. *Nutrition and feeding of organic poultry*. 2nd edn. Cabi Series, CABI, Wellingford, UK.

Bondi A A. 1987. *Animal Nutrition*. John Wiley & Sons, New York.

Chadd S. 2008. Future trends and developments in poultry nutrition in: FAO.Poultry in the 21st Century:avian influenza and beyond. Proceedings of International Poultry Conference held on 5-7 November 2007, Bangkok,Thailand, *FAO Animal and Health Proceeding* No.9.Rome.

da Rocha T C, Gomes P C, Donzele J L, de Toledo Barreto S L, de Carvalho Mello H H and Brumano G. 2009. Digestible lysine levels in feed for 24-40 week old laying hens. *Revista Bras Zootecnica* **38**: 1726–31.

Duncan D B.1955. Multiple range and multiple F test. *Biometrics* **11**: 1–42.

Fouad A M, Chen W, Ruan D, Wang S, Xia W and Zheng C. 2018. Effects of dietary lysine supplementation on performance, egg quality, and development of reproductive system in egg laying ducks. *Journal of Applied Animal Research* **46**: 386–91.

Haugh R R. 1937. The Haugh unit for measuring egg quality. *U.S. Egg and Poultry Magazine* **43**: 552–55.

Heiman V and Carver J S. 1936. The albumen index as a physical measurement of observed egg quality. *Poultry Science* **15**: 141–48.

IFOMA 2001. Advantages of using fishmeal in animal feeds. *Sociedad nacional de pesqueria* (*National Fisheries Society*) (SNP) *Web http://fis.com/snp/.*

Joshi S K, Sahoo, S K, Babu, L K, Giri S C and Mondal D. 2015. Effect of feeding different levels of proteins on the performance in Khaki Campbell during starter stage. *Indian Journal of Animal Research* **49**: 70–76.

Mundheim H and Opstvedt J. 1981. The value of herring type fish meal and soybean meal as protein supplements to poultry diets based on different types of cereals 1. Comparison of fish meal and soybean meal in maize based and barley wheat based layer diets. *Acta Agriculturae Scandinavica* **31**: 287–98.

Naik P K, Swain, B K, Sahoo, S K, Kumar D and Mishra S K. 2021. Effect of feeding graded levels of broken rice on nutrient metabolizability in White Pekin ducks during second year of laying. *Animal Nutrition and Feed Technology* **21**: 199–203.

Naik P K, Swain, B K, Sahoo, S K, Kumar D and Mishra S K. And Beura CK. 2022. Effect of replacing wheat with broken rice on nutrient digestibility, egg production and quality in White Pekin ducks. *Indian Journal of Animal Sciences* **92**: 1343–47.

Pathak N N and Kamra D N. 1999. Method of conducting digestion/metabolic trial on experimental animals. In: *Laboratory Manual of Animal Nutrition* (Eds.V.R.B.Sastry, D.N.Kamra and N.N.Pathak). Indian Veterinary Research Institute, Izatnagar, India, pp 131–36.

Proschaska J F, Carey, J B and Shafer D J. 1996. The effect of L-lysine intake on egg component yield and composition in laying hens. *Poultry Science* **75**: 1268–77.

Rama Rao S V, Praharaj N K, Mohapatra S C, Raju M V L N, Chawak M M and Mishra S K. 1998. Substitution of fish meal with different plant protein supplements and synthetic amino acids in layer diet. *Indian Journal of Poultry Science* **33**: 26–30.

Rowghani E, Boostani A D, Mahmoodian Fard H R and Frouzani R. 2007. Effect of dietary fish meal on production performance and cholesterol content of laying hens. *Pakistan Journal of Biological Sciences* **10**: 1747–50.

Sahoo S K, Naskar S K, Giri S C, Padhi M K and Panda S K. 2014. Performance of White Pekin ducks on replacement of maize with cassava tuber meals. *Animal Nutrition and Feed Technology* **14**: 291–300.

Scott M L, Nesheim M C and Young R J. 1982. *Nutrition of the chicken*. M.L. Scott and Associates, Ithaca, NY.

Sharp P F and Powell C K.1930. Decrease in internal quality of hens egg during storage as indicated by the yolk. *Indian Journal of Chemistry* **22**: 909–10.

Shultz P T.1953. Analysis of egg shape in chickens. *Biometrics* **9**: 336.

Snedecor G W and Cochran W G.1994. *Statistical Methods*, 8th ed. Oxford and IBH Publishing Co. Calcutta, India.

Souza H R B, Fari D E, Caetani V C, Santos A L, Araujo R B and Sakamoto M L. 2014. Digestible lysine levels for brown layers. *Acta Scientiarum Animal Science* **36**: 369–72.

Swain B K and Chakurkar E B. 2011. Replacement of Soybean meal by Fish meal in growing Vanaraja Chickens. *Indian Veterinary Journal* **88**: 44–45.

Swain B K, Naik P K, Sahoo S K, Mishra S K and Kumar D. 2020.Effect of feeding Azolla pinnata on the performance of Khaki Campbell layers. *Indian Journal of Poultry Science* **55:** 221–24.

Thongwittaya N and Tasaki I. 1992a. Energy and protein requirement of Khaki Campbell X Thai native laying ducks. *Asian-Australasian Journal of Animal Sciences* **5**: 365–68.

Thongwittaya N. and Tasaki I. 1992b. Dietary fish meal requirement of Khaki Campbell X Thai Native ducks. *Journal of the National Research Council of Thailand* **24:** 19–30.

Thongwittaya N.2007. Substitution of plant protein for fish meal in the diet of laying ducks. *Animal Science Journal* **78**: 351-55.

Yasothai R. 2016. Antinutritional factors in soybean meal and its deactivation. *International Journal of Science and Environmental Technology* **5**: 3793–97.

Yuan G D. 1989. Performance of table ducklings fed with diets on plant-protein alone. *Chinese Journal of Animal Science* **25**: 3–5.