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Effect of replacing wheat with broken rice on nutrients metabolisability, egg production and quality in White Pekin ducks

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ABSTRACT

A study was conducted in the tropical coastal region of Odisha in 2019 to find out the effect of replacing wheat with broken rice (BR) on nutrients metabolisability, egg production and quality in White Pekin ducks. White Pekin ducks (45, 165 days) were divided into three groups with three replicates in each group and each replicate had five ducks. Three experimental diets without (BR-0) and with BR, replacing 50 (BR-50) and 100 (BR-100), per cent wheat were prepared. The above diets were offered randomly to the groups till 40 weeks followed by conduction of a metabolic trial. The dry matter intake (g/d) was similar among the groups. The metabolisability percentage of dry matter, organic matter, crude protein, ether extract and crude fibre in BR-0 and BR-50 were similar and higher than BR-100. There was no significant difference in N balance (g/d) among the groups. The total egg production, duck day egg production percentage and feed conversion ratio were similar among the groups. The external and internal egg quality parameters were similar among the groups as well. It was concluded that wheat can be replaced with broken rice at 50% level in the diets of White Pekin ducks during first phase of laying under intensive rearing system with increase in the metabolisability of the nutrients of the feed without affecting the performance.

Keywords: Ducks, Egg, Metabolisability, Nutrient, Rice, Wheat, White Pekin

In India, ducks represent only 3.98% of the total poultry population (841.405 Million), contributing only 1.15% of the total egg production (103.32 billion) of the country. Simultaneously, the duck population has increased more (42.36% vs 16.64%) than the fowls population. Further, the average annual egg production of desi duck from both backyard farming (110.97) and commercial farming (181.12) is higher than that of the backyard farming (108.99) and commercial farming (112.22) for desi fowls (Anonymous 2019). Besides, there are many advantages of duck rearing over chickens such as large sized eggs, early morning egg laying, hardiness to diseases, suitable to integrated farming, survivability in moist land, suitable for backyard farming, easily tamed, long production year, etc (Naik *et al.* 2022a, 2022b). White Pekin ducks can be reared in rural areas with supplementation of locally available cereal based feed mixture for both egg and meat production (Sahoo *et al.* 2014, Swain *et al.* 2018, Naik *et al.* 2020a, Naik *et al.* 2020b, Naik *et al.* 2021). However, as ducks are more susceptible to aflatoxicosis (Mishra *et al.* 2021), wheat based feed mixture is mostly preferred over maize based feed mixture, as maize is more prone to aflatoxin contamination than wheat. Additionally, as wheat cost is increasing extremely, duck farmers prefer to use locally available broken rice in place of wheat for feeding their birds. Therefore, a study was conducted to find out the effect of replacing wheat with broken rice on nutrients metabolisability, egg production and quality in White Pekin ducks.

MATERIALS AND METHODS

The study was conducted in the tropical coastal region of Odisha in 2019 to find out the effect of replacing wheat with broken rice (BR) on nutrients metabolisability, egg production and quality in White Pekin ducks. White Pekin female ducks (45) in first phase of laying (165 days) were divided into three groups. Each group had three replicates and each replicate had five ducks. Three experimental diets without (BR-0) and with BR, replacing 50 (BR-50) and 100 (BR-100), percent wheat were prepared (Table 1). The above diets were offered randomly to the above groups, as per the suggested practical levels of nutrient requirements for a period of 115 days till they attained 40 weeks (Singh and Panda 1996). During the experiment, the ducks were on deep litter system and the respective diets were fed *ad lib.* following standard management practices. At the end of the feeding trial, a metabolic trial of 4-d collection period was conducted on six birds from each group (two birds from each replicate) in individual cages. During the metabolic trial, a known quantity of feed was offered to each bird daily and the residues left were measured. The faeces voided over 24 h periods were collected

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Table 1. Ingredient compositions (kg/ 100 kg) of different diets

Feed ingredient	BR-0	BR-50	BR-100
Wheat (kg)	55	27.5	0
Broken rice (kg)	0	27.5	55
Soybean (kg)	9	13	16
Fish meal (kg)	10	10	10
DORB (kg)	14	10	7
Oyster shell (kg)	10	10	10
DCP (kg)	2	2	2
Trace minerals (g)	300	300	300
DL-methionine (g)	200	200	200
Lysine (g)	100	100	100
Vit. AD_3B_3K (g)	25	25	25
Vit E & Se (g)	30	30	30
Vit B Complex (g)	25	25	25
Toxin binder (g)	150	150	150
Choline chloride (g)	150	150	150

quantitatively. On daily basis, aliquots of excreta were collected separately after mixing it well for dry matter and nitrogen estimations. For dry matter estimations, the faecal samples were dried in hot air oven at 70°C for 72 h. (Sahoo *et al.* 2014). For faecal nitrogen estimations, samples were preserved in 25% sulphuric acid in duplicate (Pathak and Kamra 1999). The samples of feeds, residues and faeces were analyzed for proximate principles following standard procedures (AOAC 1997). The metabolisability of the nutrients was calculated as the difference between nutrient intake and nutrient voided. The data on feed intake and egg production were recorded daily; while the live weights were recorded weekly. For external egg quality parameters, weight, length and width of the egg were recorded weekly and the egg shape index was calculated. For internal egg quality parameters, percent of albumen, yolk, shell, shell thickness; and length, width and height of albumen and yolk were recorded weekly; and albumen index, yolk index and Haugh unit were calculated. The external egg quality parameters were determined as per the formula of Shultz (1953); while the internal egg quality parameters were calculated as per the formula of Heiman and Carver (1936), Sharp and Powell (1930), Haugh (1937) and Funk (1948).

The experimental design used in this study was completely randomized design (CRD). The data were statistically analyzed (Snedecor and Cochran 1994) using one-way analysis of variance and the comparisons among means were made by Duncan's multiple range test (Duncan 1955) with significance level of P<0.05.

RESULTS AND DISCUSSION

The chemical compositions of the feeds are presented in Table 2. All the diets were iso-nitrogenous and iso-caloric. The dry matter intake of the ducks was similar among the groups (Table 3). The DM metabolisability (%) in group BR-0 and BR-50 were similar and higher (P<0.05) than BR-100. However, similar (72.99-75.38) and higher (76.17-78.87) DM metabolisability has also been reported by Sahoo *et al.* (2014) and Naik *et al.* (2021) in White Pekin ducks, respectively. Similarly, the OM metabolisability (%) in group BR-0 and BR-50 were similar and higher (P<0.05) than BR-100. The OM metabolisability observed in this experiment was lower than the findings (77.29-80.78) of the earlier workers (Sahoo *et al.* 2014, Naik *et al.* 2021) in White Pekin ducks. The metabolisability of CP in BR-50 group was higher (P<0.05) than BR-100 group, but similar to BR-0 group; however these values are close to the findings (67.26-70.73) of the earlier workers (Sahoo *et al.* 2014, Naik *et al.* 2021) in White Pekin ducks. The metabolisabilities of EE were similar in BR-0 group and BR-50 group and higher (P<0.05) than BR-100 group, which were similar to the findings (76.74-83.78) of the earlier workers (Mohanty *et al.* 2015, Naik *et al.* 2021). However, other workers (Sahoo *et al.* 2014, Joshi *et al.* 2015) observed lower EE metabolisability (50.66-

Table 2. Chemical compositions (on % DM basis) of different diets

Parameter	Wheat	Broken rice	BR-0	BR-50	BR-100
Dry matter and nutrient content (% DM)					
Dry matter	90.70	90.50	98.70	98.68	98.57
Organic matter	97.20	96.50	88.20	88.34	88.15
Crude protein	11.89	8.20	18.70	18.31	18.62
Ether extract	2.55	2.70	1.56	1.61	1.54
Crude fibre	2.20	2.40	6.87	6.13	6.26
NFE	80.56	83.20	61.07	62.29	61.73
Total ash	2.80	3.50	11.80	11.66	11.85
Calculated nutrient supply					
Energy (ME, kcal/kg)	3150	2800	2614	2620	2661
Lysine (%)	0.47	0.42	1.07	1.14	1.19
Methionine (%)	0.21	0.21	0.56	0.58	0.60
Ca (%)	0.18	0.11	4.93	4.91	4.89
Total P (%)	0.43	0.48	1.15	1.12	1.11

Table 3. Effect of feeding broken rice replacing wheat on dry matter intake, metabolisability of nutrients, nitrogen balances, feed conversion ratio and economics

Parameter	BR-0	BR-50	BR-100	P value
Dry matter intake				
DM Intake (g/d)	153.48±2.54	157.57±3.97	151.17±4.37	0.483
Metabolisability (%) of nutrients				
Dry matter*	73.97^{b}±0.64	74.81^{b}±1.24	68.98^{a}±1.53	0.007
Organic matter*	74.35^{b}±0.90	75.75^{b}±1.13	70.19^{a}±0.70	0.002
Crude protein*	70.73^{b}±0.79	72.18^{b}±1.39	66.41^{a}±1.86	0.030
Ether extract*	78.49^{b}±0.94	82.30^{b}±1.86	73.31^{a}±1.46	0.002
Crude fibre*	55.98^{b}±1.08	51.72^{b}±2.22	45.02^{a}±2.89	0.010
Nitrogen (N) balance				
N intake (g/d)	3.80^{a}±0.10	4.38^{b}±0.12	4.36^{b}±0.13	0.003
N out go (g/d)	1.11^{a}±0.02	1.21^{a}±0.04	1.46^{b}±0.05	0.000
N balance (g/d)	2.69±0.09	3.17±0.14	2.91±0.16	0.070
N balance as % of N intake	70.73^{ab}±0.79	72.18^{b}±1.39	66.41^{a}±1.86	0.030
Feed conversion ratio (FCR)				
Total feed intake (kg)	17.80±0.45	18.28±0.25	17.54±0.45	0.456
Total egg production (dozen)	6.59±0.46	7.02±0.39	6.29±0.18	0.413
DDEP%	68.22±4.71	72.63±4.03	65.11±1.85	0.415
Feed conversion ratio (feed consumed in kg per dozen egg produced)	2.74±0.28	2.62±0.13	2.79±0.09	0.797
Economics				
Cost of feed (₹/kg)	32.50±0.00	31.95±0.00	31.56±0.00	
Cost (₹)/ egg	7.42±0.75	6.97±0.34	7.33±0.22	0.798

* Means bearing different superscripts in a row differ significantly (P<0.05).

61.18) than the present study. The CF metabolisability in BR-100 group was lower (P<0.05) than BR-0 group and BR-50 group, which were similar. However, the range of the CF metabolisability (45.02-55.98%) observed in this experiment was higher than the findings (41.57-51.23) of the earlier workers (Sahoo *et al.* 2014, Joshi *et al.* 2015) and lower than the findings (59.57-62.05) of Naik *et al.* (2021). Increase in metabolisability of DM, EE, NFE and nitrogen retention; and decrease in metabolisability of CF; with decrease in egg production in laying hens fed broken rice based diets (50%) have been reported by the earlier workers (Jadhao *et al.* 2000). In contrast, in this study, there is decrease in metabolisability of DM, OM, CP, EE and CF; without affecting the egg production performance in laying ducks fed broken rice based diets (55%), which need further research. The higher nutrients metabolisability in BR-50 group may be attributed to the synergetic effect of mixture of nutrients from two different sources of cereals (wheat and broken rice).

The nitrogen intake (g/d) in BR-50 group and BR-100 group was similar and higher (P<0.05) than BR-0 group; but, the nitrogen outgo (g/d) only in BR-100 group was higher than BR-0 group and BR-50 group, which were similar. The nitrogen balance (2.69-3.17, g/d) was similar among the groups; but, when the nitrogen balance was expressed as percentage of nitrogen intake, it was higher (P<0.05) in BR-50 group than BR-100 group, which were similar to BR-0 group. Similar nitrogen balance (3.76-3.90, g/d) and nitrogen balance as percentage of nitrogen intake (67.40-70.09) have also been reported by Naik *et al.* (2021) in White Pekin ducks.

The total feed intake and egg production was similar among the groups (Table 3). There was no significant difference in the percentage of duck day egg production (DDEP) among BR-0 group (68.22%), BR-50 group (72.63%) and BR-100 group (65.11%). The feed conversion ratio (feed consumed in kg per dozen egg production) was similar among the groups and ranged from 2.62 to 2.79. The cost (₹) of per kg feed in BR-0, BR-50 and BR-100 was 32.50, 31.95 and 31.56, respectively. The cost (₹) per egg in BR-50 was lower than BR-100 and BR-0. The higher nutrients metabolisability in BR-50 group might have the reason for the better performance of the ducks of the BR-50 group.

The egg weight was similar among the groups (Table 4). Earlier workers (Rath *et al.* 2016, Naik *et al.* 2020a) have also reported similar egg weight (71.33-73.33 g) in White Pekin ducks. However, higher (72.79-74.79 g) and lower (59.03 g) egg weights in White Pekin ducks have also been reported by Swain *et al.* (2018) and Kavitha *et al.*

Table 4. Effect of feeding broken rice replacing wheat on egg production and egg quality

Parameter	BR-0	BR-50	BR-100	P value
External egg quality				
Egg weight (g)	71.27±0.94	72.16±0.81	71.93±1.09	0.792
Egg shape index	69.19±0.79	69.06±0.47	67.11±0.41	0.343
Internal egg quality				
Albumen index	0.12±0.00	0.13±0.00	0.13±0.00	0.485
Yolk index	0.43±0.00	0.44±0.01	0.42±0.01	0.222
Haugh unit	85.65±0.63	86.98±1.70	85.43±1.03	0.625
% Albumen weight	55.62±0.41	55.09±0.39	55.71±0.33	0.478
% Yolk weight	31.75±0.09	32.38±0.46	31.84±0.33	0.365
% Shell weight	12.63±0.40	12.60±0.36	12.45±0.23	0.924
Shell thickness with membrane (mm)*	0.51^{a}±0.006	0.53^{ab}±0.006	0.53^{b}±0.003	0.035
Shell thickness without membrane (mm)	0.44±0.003	0.45±0.009	0.45±0.003	0.422

* Means bearing different superscripts in a row differ significantly (P<0.05).

(2017), respectively than the present study. In general, egg weight in ducks is heavier than the chickens; and further, egg weight in White Pekin is higher than the other breeds of ducks, might be due to their heavier body weight. The egg shape index was similar among the groups, which were very close to the findings (68.97-73.44) of other workers (Swain *et al.* 2018, Naik *et al.* 2020a). However, higher egg shape index values (74.36-77.63) have also been reported by the earlier workers (Rath *et al.* 2016, Kavitha *et al.* 2017) in White Pekin ducks.

There was no difference (P>0.05) in albumen index and yolk index among the groups; and the values corroborate well with those of the earlier workers in Whit Pekin ducks (Rath *et al.* 2016, Kavitha *et al.* 2017, Swain *et al.* 2018, Naik *et al.* 2020a). The Haugh unit was similar among the groups, but were lower (P<0.05) than the findings of other workers (Swain *et al.* 2018, Naik *et al.* 2020a). The egg contents, viz. percentage of albumen and yolk were similar among the groups, which corroborated well with the findings (50.32-55.10% and 33.52-36.87%) of the earlier workers (Rath *et al.* 2016, Swain *et al.* 2018, Naik *et al.* 2020a). The percentage of shell weights was similar among the groups, which was lower than the findings of other workers (Swain *et al.* 2018, Naik *et al.* 2020a), but higher than the observations (9.07-9.10 %) of Rath *et al.* (2016). The shell thickness (mm) with membrane was higher (P>0.05) in BR-100 group than BR-0 group (0.51); however, both were similar to BR-50 group. Similar (0.50-0.53 mm), lower (0.35-0.47 mm) and higher (0.55-0.56 mm) egg shell thickness have also been recorded in White Pekin ducks (Palanivel and Harikrishnan 2011, Rath *et al.* 2016, Kavitha *et al.* 2017, Swain *et al.* 2018, Naik *et al.* 2020a). The shell thickness without membrane were similar (P>0.05) among the groups, which were very close to the findings (0.43-0.48 mm) of the earlier workers (Swain *et al.* 2018, Naik *et al.* 2020a). Similarly, shell thickness without membrane was not affected by substitution of wheat with BR, even though wheat contains higher Ca than BR; as the contribution of the cereals to total Ca supply was very low (Singh and Panda 1996). Thus, the reduction in absolute Ca supply due to substitution of wheat was rather meagre to cause any adverse impact on shell formation. The CP content of wheat was higher than the BR and the comparative amino acid profile of the two cereals revealed that wheat contained higher amount of lysine than BR (Singh and Panda 1996, Panda 2013). In spite of these, no adverse impact on egg quality parameters was observed, when wheat was replaced completely with BR. It could be explained on the basis that the absolute contribution of cereal grains to the CP, lysine and methione supply is rather low. Moreover, the rations were balanced to be iso-nitrogenous by adjusting the amount of soybean meal in the ration. Earlier, it was reported that the complete replacement of wheat by broken rice in the diets of white Pekin ducks during second year of egg production had no affect on the egg quality and blood biochemical parameters (Naik *et al.* 2020a, 2020b).

It can be concluded that wheat can be replaced with broken rice at 50% level in the diets of White Pekin ducks during first phase of laying under intensive rearing system with increase in the metabolisability of the nutrients of the feed without affecting the performance.

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