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Evaluation of replacement of maize in the ration of Japanese quail with agro-industrial by product (broken rice)

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ABSTRACT

This study was done to assess the nutritional attributes of broken rice on feed intake, utilization of nutrients, performance, blood biochemical parameters and carcass traits in quails. Day-old commercial meat quails (Japanese quail) (n=300) were randomly distributed to five treatment groups. Basal maize-soya diet was fed to Control group, and for treatment groups, T_1, T_2, T_3, and T_4 5, 10, 15, and 20% maize was replaced with BR (w/w basis), respectively. The diets that were formulated were made to be iso-caloric and iso-nitrogenous. No significant difference in weekly FCR and PER was observed for the first five weeks. The blood biochemical parameters *viz*. plasma glucose, total protein, albumin, globulin, albumin-globulin ratio, cholesterol, triglycerides, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were similar in all the dietary treatments. Though, the cost per kg of feed was lower for treatment groups, the cost-benefit ratio was comparable for all five groups. It may be recommended that maize can be replaced up to 15 % level with broken rice in the ration of meat quails with no adverse effects on body weight, feed intake, Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER), utilization of nutrients, and blood biochemical parameters.

Keywords: Broken rice, Japanese quail, Maize

The relevance of protein sources in animal nutrition cannot be overemphasized. In this regard, the Japanese quail seems to be a preferable choice for enhancing animal protein base. *Coturnix coturnix* or common quail are reared for multiple reasons which includes eggs and meat. The meat from broiler quail bird is considered as a delicacy and is renowned for its high-quality protein with high biological value (Agina *et al.* 2017). In view of special attributes of quails such as its fast growth rate, early production, low initial investment, low space requirement and fast income returns, quail production is considered as a highly profitable enterprise (Silva *et al.* 2009).

Nutrition is of major importance in raising poultry, as feed accounts for more than 60% of the production cost of the poultry sector and maize has been found to have greater acceptability in poultry feed (Panda *et al.* 2010). However, maize production in our country is insufficient to meet the demand of the poultry sector. Moreover, humans also compete for maize as a food source. Abd El-Hack (2015) has stressed to use locally available feed ingredients to reduce the cost of poultry and quail production. Agro-industrial by-products like broken rice, due to their low cost and abundance, have the ability to serve as an alternative to maize, besides the close similarity in the protein and metabolizable energy (Sharma *et al.* 2016a, Sharma *et al.* 2016b, Sharma *et al.* 2017). There are reports on the utilization of broken rice in broiler diets with no detrimental effects on broiler health and performance (Cancherini *et al.* 2008, Ali *et al.* 2018). However, there are limited reports on the evaluation of broken rice in quail feeding (Sethi *et al.* 2006, Filgueira *et al.* 2014). Broken rice resembles polished grain in its chemical composition and can potentially replace maize fully or partially in the diets of quail bird (Filgueira *et al.* 2014). This study was conducted to analyze the effect of the replacement of maize with broken rice in the feed of quails.

MATERIALS AND METHODS

The present trial was carried out (4/IAEC-20/2021), using three hundred day-old chicks of commercial meat-type quails (Japanese quail). The feeding trial was undertaken for six weeks to evaluate the effects of the replacement of maize with broken rice on the performance

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of meat quails. Various parameters such as weekly feed intake, weekly body weight gain, protein efficiency ratio, feed conversion ratio, metabolisability of nutrients, carcass characteristics, blood biochemical parameters, intestinal micrometric parameters and the overall economics of quail feed with graded levels of broken rice were studied.

Experimental trial: The study was carried out in the poultry shed of the Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, R. S. Pura, Jammu during the months of December and January.

Experimental feed: All the feed ingredients used in the preparation of diet for the experimental birds were procured from local market. Maize was replaced by broken rice in the diets of treatment groups C, T_1, T_2, T_3, and T_4 at graded levels of 0, 5, 10, 15, and 20 %, respectively in both starter and finisher diets without any other adjustments. Isocaloric and isonitrogenous diets were formulated as per ICAR (2013).

Experimental design: The experimental design consisted of 300 birds divided into five treatment groups consisting of 60 birds each. Each treatment group was further subdivided into four replicates (15 birds in each replica).

Feeding and management: On the day of arrival, chicks were provided with electrolytes through drinking water. Starter feed in small amounts was scattered on the newspaper laid inside the limited brooding area to aid recognition and feed consumption by chicks, besides feed in known amounts was provided to chicks in feeders for up to a period of 21 days.

Nutrient utilization and retention: A metabolism trial was conducted in the 5th week of the experimental period for four consecutive days with three days as adaptation period. During the trial, 2 birds from each replicate were caged in metabolic cages with provisions for quantitative collection of the droppings. The droppings were collected at an interval of 24 hr from the birds in metabolic cages from the polythene sheets used to line the removable trays fitted under the cages. The excreta voided by the birds was weighed, only after the removal of the extraneous materials, feed particles, and feathers. Proximate analysis was done as per (AOAC, 2012) and the apparent digestibility of various nutrients of experimental diets was determined.

Blood collection: At the end of the feeding trial (day 42), blood was collected from wing vein in eight birds per treatment group (two birds per replicate) for profiling the blood biochemistry.

Carcass characteristics: At the end of six weeks, 2 birds per replicate *i.e.* a total of eight birds from each treatment group, were selected randomly. The birds were then weighed, followed by slaughtering them for evaluation of carcass characteristics of all treatment groups.

Feed cost economics: The relative feed economics of raising meat quails to 6 weeks of age on different dietary treatments by replacing graded levels of maize with broken rice was calculated. The cost of production based per bird was calculated and the comparative economics was based on the actual input cost, live weight, livability, and the prevailing market price of quails.

Statistical analysis: Statistical analysis (one-way analysis of variance) of data from different parameters was done using a completely randomized design (CRD). Method of analysis was as per Snedecor and Cochran (2004). Significantly different means were evaluated using Duncan's multiple range test (DMRT), as per Duncan (1955). $P<0.05$ was considered as the level of significance.

RESULTS AND DISCUSSION

Chemical composition of feed ingredients: The values of different constituents *viz*. maize, soybean meal (SBM), meat cum bone meal (MBM), and broken rice (BR) were found to be within the range of available literature (Table 1). The nutrient composition and ingredient composition data of different experimental diets employed in the quails' starter (0-3 weeks) and finisher phase (3-6 weeks) has been presented in table 2 and 3, respectively. Basal maize-soya diet was fed to Control group, and for treatment groups, T_1, T_2, T_3, and T_4 5, 10, 15, and 20% maize was replaced with BR (w/w basis), respectively. The diets that were formulated were made to be iso-caloric and iso-nitrogenous.

The proximate composition of broken rice in terms of CP, EE, CF, TA, and NFE was determined on a DM basis, and was more or less compatible to the earlier reports of Ani *et al.* (2013); Channa *et al.* (2013). Higher protein and fiber levels in broken rice might be due to an admixture of rice polish or the samples of rice analyzed might be of high protein variety. The chemical composition of grains may vary because of different reasons such as different agro-climatic conditions, soil conditions, maturity stage, strain, variety, fertilizers, and irrigation (Bhong *et al.* (2020); Datt *et al.* 2017).

Feed intake: The FCR values of the treatment groups did not differ significantly for the first five weeks (Table 4). However, during the sixth week, FCR improved for T_0 but was similar to T_1, T_2 and T_3. T_4 differed significantly ($P<0.05$) from T_0, T_1, and T_2. The FCR of T_3 treatment group

Table 1. Proximate composition of feed ingredients (on DMB)

Ingredient	CP	EE	CF	TA	NFE	Ca	P
Maize	9.24±0.35	4.13±0.13	2.15±0.24	1.52±0.07	82.84±4.57	0.28±0.002	0.30±0.02
MBM	47.54±0.53	7.62±1.27	9.03±1.04	21.31±0.97	14.21±0.83	10.48±1.08	5.19±0.47
SBM	47.82±1.77	5.26±0.29	7.23±1.33	8.21±1.35	31.37±1.54	0.43±0.04	0.97±0.05
Broken rice	7.99±0.27	2.07±0.11	1.76±0.27	1.43±0.18	86.75±2.91	0.18±0.01	0.20±0.01

Table 2. Ingredient and chemical composition (%) of quail starter ration (on DMB)

Particulars	Starter (0-21 days)				
	C	T_1	T_2	T_3	T_4
Ingredient composition					
Maize	52.80	50.16	47.52	44.88	42.24
Meat bone meal	5.00	5.00	5.00	5.00	5.00
Soybean meal	39.80	39.80	39.80	39.80	39.80
Broken rice	0.00	2.64	5.28	7.92	10.56
Salt	0.25	0.25	0.25	0.25	0.25
Sodium bicarbonate	0.01	0.01	0.01	0.01	0.01
SBO	1.45	1.45	1.45	1.45	1.45
Methionine	0.15	0.15	0.15	0.15	0.15
Lysine	0.16	0.16	0.16	0.16	0.16
Dicalcium phosphate	0.05	0.05	0.05	0.05	0.05
Limestone powder	0.18	0.18	0.18	0.18	0.18
Vitamin supplement	0.05	0.05	0.05	0.05	0.05
Trace minerals	0.10	0.10	0.10	0.10	0.10
Chemical composition					
Organic matter	94.47	94.58	94.64	94.71	94.89
Crude protein	25.06	25.03	24.92	24.87	24.81
Ether extract	5.76	5.61	5.48	5.46	5.37
Crude fibre	4.86	4.79	4.73	4.69	4.52
Total ash	5.53	5.42	5.36	5.29	5.11
Nitrogen free extract	58.79	59.15	59.51	59.69	60.19
Calcium	1.12	1.11	1.08	1.06	1.03
Phosphorus	0.84	0.79	0.81	0.77	0.72
ME (kcal/ kg calculated value)	2900	2900	2900	2900	2900

Table 3. Ingredient and chemical composition (%) of finisher ration (on DMB)

Particulars	Finisher (21-42 days)				
	C	T_1	T_2	T_3	T_4
Ingredient composition					
Maize	64.08	60.88	57.67	54.47	51.26
Meat bone meal	4.90	4.90	4.90	4.90	4.90
Soybean meal	29.76	29.76	29.76	29.76	29.76
Broken rice	0.00	3.20	6.41	9.61	12.82
Salt	0.25	0.25	0.25	0.25	0.25
Sodium bicarbonate	0.01	0.01	0.01	0.01	0.01
SBO	0.28	0.28	0.28	0.28	0.28
Methionine	0.16	0.16	0.16	0.16	0.16
Lysine	0.15	0.15	0.15	0.15	0.15
Dicalcium phosphate	0.00	0.00	0.00	0.00	0.00
Limestone powder	0.26	0.26	0.26	0.26	0.26
Vitamin supplement	0.05	0.05	0.05	0.05	0.05
Trace minerals	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00
Chemical composition					
Organic matter	95.01	95.19	95.23	95.41	95.55
Crude protein	21.51	21.47	21.44	21.40	21.37
Ether extract	5.86	5.70	5.61	5.37	5.32
Crude fibre	4.64	4.52	4.49	4.27	4.13
Total ash	4.99	4.81	4.77	4.59	4.45
Nitrogen free extract	63	63.5	63.69	64.37	64.73
Calcium	1.1	1.02	0.98	0.96	0.94
Phosphorus	0.81	0.73	0.71	0.76	0.74
ME (Kcal/ Kgcalculated value)	2950	2950	2950	2950	2950

Table 4. Effect of broken rice supplementation on FCR of quails

Week	FCR					SEM	P value
	T_0	T_1	T_2	T_3	T_4		
1	1.58±0.03	1.50±0.07	1.48±0.11	1.53±0.09	1.57±0.05	0.03	0.851
2	2.14±0.04	2.24±0.07	2.23±0.08	2.24±0.07	2.42±0.09	0.03	0.159
3	2.45±0.12	2.47±0.06	2.50±0.09	2.49±0.09	2.51±0.03	0.03	0.983
4	3.22±0.06	3.25±0.06	3.31±0.06	3.36±0.02	3.53±0.17	0.04	0.182
5	5.46±0.21	5.59±0.27	5.61±0.26	5.82±0.23	6.05±0.48	0.13	0.680
6	9.99^{a}±0.40	10.15^{a}±0.27	10.25^{a}±0.60	10.89^{ab}±0.43	11.94^{b}±0.40	0.24	0.036

^{ab}Mean with different superscripts within a row differ significantly ($P<0.05$)

Table 5. Effect of supplementation of broken rice on body weight (g) and nutrient intake (g/day) of quail during metabolism trial

Attributes	Groups					SEM	P value
	T_0	T_1	T_2	T_3	T_4		
IBW	142.18±4.33	140.19±4.39	141.16±4.78	139.09±4.80	133.51±4.22	1.96	0.689
FBW	168.11±5.72	168.45±5.18	169.36±5.32	167.00±5.57	161.35±5.37	2.32	0.845
ABW	155.15±12.96	154.32±14.13	155.26±14.10	153.04±13.95	147.43±13.92	1.49	0.454
Nutrient intake (g/day/bird)							
FI	19.53±0.72	18.33±0.88	18.06±1.06	17.95±1.04	17.49±0.77	0.39	0.599
DMI	18.16±0.67	17.04±0.82	16.80±0.99	16.70±0.97	16.27±0.72	0.37	0.599
OMI	17.25±0.63	16.22±0.78	16.00±0.94	15.93±0.92	15.54±0.69	0.35	0.642
CPI	3.91±0.14	3.66±0.18	3.60±0.21	3.57±0.21	3.48±0.15	0.08	0.547
EEI	1.01^{b}±0.04	0.97^{b}±0.05	0.94^{b}±0.06	0.90^{b}±0.05	0.72^{a}±0.03	0.03	0.004
CFI	0.84^{b}±0.03	0.77^{ab}±0.04	0.75^{ab}±0.04	0.71^{a}±0.04	0.67^{a}±0.03	0.02	0.054
TAI	0.91±0.03	0.82±0.04	0.80±0.05	0.77±0.04	0.72±0.03	0.02	0.056
NFEI	11.44±0.42	10.82±0.52	10.70±063	10.75±0.62	10.53±0.47	0.23	0.794

^{a,b}Values with different superscripts differs in a row significantly (P<0.05),

IBW- initial body weight, FBW- final body weight, ABW-average body weight, FI-feed intake, DMI-dry matter intake, OMI-organic matter intake, CPI-crude protein intake, EEI-ether extract intake, CFI-crude fibre intake, TAI-total ash intake, NFEI-nitrogen free extract intake.

was non-significantly lower than T_4. Filgueira *et al.* (2014) found no effect on the feed intake of meat-type quails from 7-49 days upon increasing the levels of maize substitution by broken rice in their diet. Brum-junior *et al.* (2007) also evaluated the replacement of maize with broken rice at 0, 20, and 40% levels in broiler diets and found no significant effects (P>0.05) on the feed intake of quail birds. Similar conclusions were also drawn by Sharma *et al.* 2012 and 2013.

On contrary, Ashour *et al*. (2015) found that feed intake in meat-type quails was significantly (P<0.05 or P<0.01) affected by replacing yellow corn with broken rice up to 50% during the experimental period of one to five weeks in growing Japanese quail-fed broken rice and reported highest LBW and BWG values at 20 % and 30% replacement levels during the starter phase, finisher phase, and the entire experimental period (5 weeks).

Nutrient utilization and retention: The influence on nutrient intake of various nutrients upon the dietary inclusion of BR in the diet of meat-type quail birds is depicted in table 5. No significant variation was observed in the values of initial and final BW (g) of different groups despite the differences in dietary treatments. Similarly, no significant difference was observed in the values of average BW of the entire metabolism trial among the different treatment groups.

The influence of the dietary inclusion of BR in the diet of meat type quail birds, at graded levels on the intake of various nutrient and apparent nutrient metabolisability is presented in table 5. An increasing trend was observed in the DM metabolizability with an increase in replacement percentage of dietary treatments but the differences were non-significant. CP metabolisability values were highest for T_3 followed by T_4 and the lowest values were obtained for T_0. However, the differences were non significant. A variable trend with non-significant differences was observed

Table 6. Effect of broken rice supplementation on haemato-biochemical profile of Japanese quail

Parameters	Groups					SEM	P Value
	T_0	T_1	T_2	T_3	T_4		
Glucose (mg/dl)	179.12±8.08	181.25±9.07	184.45±9.42	189.79±9.55	188.12±11.10	4.01	0.918
Cholesterol (mg/dl)	184.25±14.93	180.02±12.84	170.34±11.36	166.41±12.13	160.42±10.14	5.39	0.650
Triglycerides (mg/dl)	62.73±4.67	62.69±4.39	61.66±3.83	61.60±3.63	60.83±4.78	1.78	0.997
Total Protein (g/dl)	3.91±0.26	3.77±0.27	3.68±0.25	3.94±0.55	3.72±0.25	0.13	0.964
Albumin (g/dl)	2.45±0.20	2.43±0.28	2.29±0.22	2.48±0.32	2.31±0.11	0.10	0.972
Globulin (g/dl)	1.47±0.08	1.34±0.06	1.39±0.04	1.46±0.19	1.42±0.45	0.05	0.952
A:G	1.67±0.10	1.84±0.25	1.64±0.13	1.77±0.23	1.72±0.16	0.08	0.942
SGOT(IU/L)	62.42±5.71	58.07±7.04	61.60±8.06	59.39±6.26	58.23±4.66	2.70	0.983
SGPT(IU/L)	21.11±2.68	22.34±3.09	23.94±3.36	20.90±4.37	22.60±4.40	1.53	0.976

Table 7. Effect of broken rice supplementation on cost economics of Japanese quail

Attributes	Groups				
	T_0	T_1	T_2	T_3	T_4
No of quail chicks	60	60	60	60	60
Cost of quail chick @ Rs.18/chick	1080	1080	1080	1080	1080
Cost of litter (Rs.)	150	150	150	150	150
Cost of starter feed (Rs.)	575	575	577	571	565
Cost of finisher feed (Rs.)	1268	1238	1278	1233	1232
Total cost of feed (Rs.)	1843	1813	1855	1804	1797
Mortality (in no.)	3	1	1	2	3
Mortality (%)	5	1.67	1.67	3.33	5
Total live quail birds (in no.)	57	59	59	58	57
Total input coat (in Rs.)	3073	3043	3085	3034	3027
Final body weight of treatment groups (kgs)	10.48	10.69	10.85	10.32	9.73
Income from quail birds @ Rs.60 per 100g of live weight	6285.96	6414.13	6511.83	6191.27	5837.26
Total difference over control (Rs.)	0	128	226	-95	-449
Difference over control/bird (Rs.)	-	2	4	-2	-8
Cost benefit ratio	1.05	1.11	1.11	1.04	0.93

in the OM, CF, NFE and EE metabolizability indicating that the dietary inclusion of BR has no significant effect on the activity of the digestive enzymes and intestinal integrity and can be used as a maize substitute. The observations are in accordance to the conclusions of Kumar *et al.* (2007), however the findings of the present study are contrary to Gonzalez-Alvarado *et al.* (2007) who attributed better digestive and absorptive capacity of broken rice-based diets to the lower levels of NSPs, besides superiority in the amylopectin content and suitable size of the starch granules of BR (3 to 8 µm), when compared with maize (3 to 23 µm).

Blood biochemical parameters: No adverse effect of maize replacement by BR inclusion at graded levels was observed on the biochemical parameters (Table 6). Variable levels of plasma glucose were observed in the different treatment groups. These values were in accordance with the results of Naik *et al.* (2020) who reported non-significant differences in the blood glucose levels of white perkin ducks upon replacement of maize by graded levels of BR. Cholesterol and triglyceride levels (mg/dl) of serum were also found to be within the normal suggested range of quail birds. The findings were in agreement in broilers and cockerels on the blood and meat cholesterol levels upon graded replacement of maize by paddy and Naik *et al.* (2020) who found similar effects in white Perkin ducks. Moreover, A:G ratio also, did not show any significant difference irrespective of the differences in the levels of dietary inclusion rates of BR and they were within the range suggested by Agina *et al.* (2017). Non-uniform variation which was within the normal physiological range was observed in the activity levels of enzymes SGOT (ALT) and SGPT (AST) (IU/L) respectively, among the different dietary groups suggesting no harmful effect of supplementation of broken rice at graded levels on functions of vital organs like liver in quail birds. The findings are in concordance with the observations of Bala *et al.* (2017) who concluded that the activity of serum enzymes (ALT and AST) remains unaffected in broiler chicken, if maize was substituted by varying levels of pearl millet and broken rice mixture. No unfavourable effect of BR inclusion at graded levels while replacing maize was observed and all analyzed blood biochemical parameters were found to be within the suggested normal physiological ranges of Kour *et al*. 2022, Prusty *et al*. 2019.

Cost economics: The cost-benefit ratio and the overall economics of the experimental trial is presented in supplementary table 7. The cost-benefit ratio was highest for T_1 (1.11), and T_2 (1.11) followed by T_0 (1.05), T_3 (1.04) and least in T_4 (0.93).

It is recommended that maize can be economically replaced with broken rice up to 15 % level in the quail ration with no adverse effects on body weight (g), feed intake (g), and utilization of nutrients, PER, FCR and biochemical parameters of blood

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