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Filgueira, TMB; Freitas, ER; Quevedo Filho, IB; Fernandes, DR; Watanabe, PH; de Oliveira, AN
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Corn Replacement by Broken Rice in Meat-Type Quail Diets

■Author(s)

Filgueira TMB[I]
Freitas ER[II]
Quevedo Filho IB[I]
Fernandes DR[I]
Watanabe PH[II]
Oliveira AN de[I]

[I] Universidade Federal de Santa Maria, Student of the Programa de Pós-Graduação em Zootecnia, Av. Mister Hull, 2977, bloco 810, Campus do Pici, CEP: 60.356-001, Fortaleza, Ceará, Brasil.
[II] Universidade Federal de Santa Maria, Programa de Pós-Graduação em Zootecnia, Av. Mister Hull, 2977, bloco 808, Campus do Pici, CEP: 60.356-001, Fortaleza, Ceará, Brasil.

■Mail Address

Corresponding author e-mail address
Universidade Federal do Ceará – UFC
Av. Mister Hull, 2977 – Campus do Pici
60021-970 – Fortaleza – CE
E-mail: ednardo@ufc.br

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ABSTRACT

An experiment was conducted to evaluate the effects of broken rice inclusion as substitute for corn in the diet on the performance, carcass yield, and economic viability of meat-type quails between 7 and 49 days of age. A number of 288 quails was distributed according to a completely randomized design into six treatments with six replicates of eight birds each. Treatments consisted of increasing levels of broken rice (0, 20, 40, 60, 80 and 100%) in replacement of corn. Increasing levels of corn substitution by broken rice in the diet of 7- to 49-day-old meat-type quails did not affect feed intake, weight gain or feed conversion ratio (p>0.05). Relative to carcass traits, the inclusion of broken rice in the diets did not influence (p>0.05) dressing percentage or breast, leg (thigh+drumstick), liver, and gizzard yields. Moreover, feed cost per kilogram of live weight gain, cost index, and economic efficiency index were not influenced by the replacement of corn by broken rice in the diets. The performance, carcass traits and economic viability of broilers fed the different levels of broken rice inclusion were not different from the control group (p>0.05). These results indicate the economic viability of total replacement of corn by broken rice in the feeding of meat-type quails.

INTRODUCTION

Quail production is considered a profitable activity and an alternative to traditional broiler production due to their fast growth rate, early production and sexual maturity, low initial investment, and fast financial returns (Santos *et al.,* 2006; Silva *et al.,* 2009). Although egg production is still more important than meat production in quails, meat-type quails could be an alternative to the poultry industry due to the high growth rate and reduced feed intake of birds (Oliveira *et al.,* 2002).

Similarly to broiler production, feed accounts for about 70% of production costs of meat-type quails, highlighting the importance of evaluating feedstuffs specifically for these birds. Corn is the main cereal grain used in poultry feeds, and production and logistic costs have increased corn price, especially during off-season periods (Moura *et al.,* 2010). Therefore, agro-industrial by-products such as broken rice, consisting of broken grains resulting from the process of sieving after rice hulls are removed, may be an alternative to corn due to their low cost and high availability, in addition of presenting similar protein and metabolizable energy contents (Daghir, 2008).

The inclusion of broken rice in broiler diets has been evaluated and no effects on feed intake, weight gain and feed conversion of birds were observed (Cancherini *et al.*, 2008). Similarly, working with Japanese quails, Sethi *et al.* (2006) asserted growth performance is not affected by the replacing 50% of dietary corn by broken rice. However, gizzard and carcass pigmentation linearly decreased with increasing levels of broken rice in broiler diets due to the lower content of carotenoids of this feedstuff (Brum Júnior *et al.,* 2007).

In literature, there are reports of broken rice inclusion in Japanese quail layer diets (Swain *et al.,* 2006; Oliveira *et al.,* 2007), but little information has found on the evaluation of this feedstuff for meat-type quails. Therefore, this study aimed at evaluating the effects of the inclusion of broken rice as a substitute for corn in meat-type quail diets on performance, carcass yield, and economic viability.

MATERIAL AND METHODS

Initially, a number of 400 one-day meat-type quail chicks (*Coturnix coturnix coturnix*) was housed in pens (6 x 8 m) with concrete floor covered with wood-shavings litter. Brooding circles, heating, feed and water were provided to birds during the first week. At seven days of age, 288 quails with an average initial weight of 35 ±2.40 g were selected based on body weight uniformity and distributed according to a completely randomized design with 6 treatments of 6 replicates with 8 birds per experimental unit.

Treatments consisted on increasing levels of corn replacement (0, 20, 40, 60, 80 and 100%) by broken rice in the diets. The experimental diets (Table 1) were formulated according to the nutritional recommendations of the NRC (1994) for growing quails. Feedstuffs were analyzed for dry matter and crude protein contents (AOAC, 2005) and their nutritional composition were adjusted based on the values proposed by Rostagno *et al.* (2011).

During the entire experimental period, temperature and relative humidity data were daily recorded at 8:00 am and 4:00 pm. At the beginning of the experimental period, birds were housed in galvanized wire cages (24 cm x 50 cm x 25 cm) equipped with trough feeders and nipple drinkers. On day 10, chicks were vaccinated against Newcastle disease. Birds received feed and water *ad libitum* during the entire experimental period. On days 1, 21 and 49, feeds, feed residues and birds were weighed per replicate in order to calculate weight gain (g/bird), feed intake (g/bird), and feed conversion ratio (g/g).

At 49 days of age, after six hours of feed fasting, all birds were weighed. One male and one female per replicate were selected according to replicate body weight to determine body composition. The selected quails were sacrificed, and then plucked and eviscerated. Sacrifice was performed in accordance with institutional guidelines on animal use, and every effort was made to minimize pain and discomfort to the quails. Carcasses without head, neck and feet were weighed to determine dressing percentage relative to live weight. Then, the whole breast and legs (thigh+drumstick) were cut up. The gizzard and the liver were separated and weighed to calculate their yield. Breast, leg, liver, and gizzard yields were calculated as ratio between the measured weight and hot carcass weight.

Table 1 – Composition of experimental diets fed to quails from 7 to 49 days of age.

Ingredients	Level of corn replacement by broken rice (%)					
	0	20	40	60	80	100
Corn	52.10	41.69	31.27	20.85	10.44	0
Broken rice	0	10.34	20.68	31.02	41.26	51.70
Soybean meal	42.99	42.96	42.93	42.90	42.86	42.84
Soybean oil	1.91	2.02	2.14	2.25	2.37	2.49
Limestone	1.20	1.18	1.16	1.14	1.13	1.11
Monodicalcium phosphate	0.94	0.95	0.97	0.99	1	1.02
Sodium chloride	0.44	0.44	0.43	0.43	0.43	0.43
DL-Methionine	0.02	0.02	0.02	0.02	0.02	0.01
Vitamin and mineral supplement[1]	0.40	0.40	0.40	0.40	0.40	0.40
Total	100	100	100	100	100	100
Cost/kg of diet (US$)	1.77	1.77	1.77	1.75	1.75	1.73
Calculated nutritional composition						
Metabolizable energy (kcal/kg)	2.900	2.900	2.900	2.899	2.899	2.899
Crude protein (%)	23.80	23.80	23.80	23.80	23.80	23.80
Crude fiber (%)	3.45	3.32	3.20	3.07	2.95	2.82
Calcium (%)	0.80	0.80	0.80	0.80	0.80	0.80
Available phosphorus (%)	0.30	0.30	0.30	0.30	0.30	0.30
Total lysine (%)	1.32	1.32	1.32	1.33	1.33	1.33
Total Methionine + Cystine (%)	0.87	0.87	0.88	0.88	0.88	0.87
Total methionine (%)	0.50	0.51	0.51	0.51	0.52	0.51
Total threonine (%)	0.93	0.93	0.92	0.92	0.91	0.91
Total tryptophan (%)	0.30	0.31	0.31	0.31	0.32	0.32

[1] Composition per kg of product: folic acid – 138 mg; calcium pantothenate – 2,750 mg; antioxidant - 500 mg; biotin - 13.80 mg; cobalt - 25 mg; copper – 2,500 mg; choline – 111,450 mg; iron – 6,250 mg; iodine - 260 mg; manganese – 13,000 mg; methionine – 300 g; niacin – 6,875 mg; pyridoxine - 550 mg; colistin – 1,750 mg; riboflavin – 1,375 mg; selenium - 45 mg; thiamine - 550 mg; vit. A – 2,150,000 IU; vit. B12 – 2,750 mg; vit. D3 – 555,000 IU; vit. E – 2,750 IU; vit. K - 400 mg; zinc – 11,100 mg; silicate – 20,000 mg.

The economic evaluation of the inclusion of broken rice in diets considered the cost of the diet (in US dollars) per kilogram of live weight gain, according to the equation proposed by Bellaver *et al.* (1985): Yi = (Qi × Pi) / Gi, where Yi = cost of feed per kilogram of weight gain in the ith treatment; Qi = amount of feed intake in the ith treatment, Pi = price per kilogram the feed used in the ith treatment, and Gi = weight gain of the ith treatment. The economic efficiency index (EEI) and the cost index (CI) were then calculated according to Fialho *et al.* (1992) as EEI = (LCei / CTei) and CI = 100 × (CTei / LCei) × 100, where LCei = the lower cost of feed per kilogram of gain observed between treatments and CTei = the cost of treatment considered. Feed cost (in US dollar) was determined considering diet compositions and the prices of feedstuffs obtained in January 2012 in the city of Fortaleza, state of Ceará, Brazil.

Data were statistically analyzed using the GLM procedure of SAS software program (Statistical Analysis System, 8.1). Data were submitted to analysis of variance according to a complete randomized design, and the degrees of freedom relative to broken rice inclusion level, except for the control diet (zero level of inclusion), were deployed in a polynomial curve to establish the best description of data analysis and, when possible, to determine the best level of the broken rice inclusion. The test of Dunnett at 5% of probability level was used to compare the results obtained at each level of broken rice with those obtained with the control diet.

RESULTS AND DISCUSSION

Average minimum and maximum temperatures and average relative humidity recorded inside the barn during the experiment were 26.22±1.53 °C, 30.61±2.16 °C, and 78%, respectively, which were higher than the range of thermal comfort for quails.

The increasing levels of corn substitution by broken rice in the diets did not affect feed intake, weight gain or feed conversion ratio (p>0.05) of meat-type quail between 7 and 49 days of age (Table 2).

Although feedstuffs that stimulate relatively high glucose and insulin postprandial responses, such as broken rice, may increase feed intake and weight gain (Vicente *et al.,* 2008), higher feed intake by animals fed diets containing increasing levels of this feedstuff was not observed in the present study.

As weight gain of birds is a result of dietary nutrient ingestion and absorption, the result obtained for this variable directly reflects the effects on feed intake obtained. Consequently, due to lack of significant differences in feed intake and weight gain among treatments, feed conversion ratio also was not influenced by increasing dietary levels of broken rice.

When evaluating the replacement of corn by broken rice in broiler diets at the levels of 0%, 20% and 40%, Brum Júnior *et al.* (2007) did not find any significant effects (p>0.05) on feed intake, weight gain, or feed conversion ratio. Cancherini *et al.* (2008) also did not observe any influence of 22.5% dietary inclusion of broken rice on broiler performance. In Japanese quail layers, Swain *et al.* (2006) concluded that broken rice could substitute corn only at 5% inclusion level. However, for growing phase quails, Sethi *et al.* (2006) concluded that broken rice could replace up to 50% of dietary corn without affecting quail growth performance.

Nanto *et al.* (2012) obtained higher final weight in broilers when corn was totally replaced by dehulled paddy rice in the diets. Similarly, Gonzalez-Alvarado *et al.* (2007) obtained better performance in broilers fed a diet containing dehulled paddy rice as main energy source compared with those fed with corn, and attributed this effect to the higher starch and lower fiber contents of rice. Tester *et al.* (2006) stated that the best performance of birds fed diets containing dehulled rice can be explained by its smaller particle size and lower amylose and non-starch polysaccharide contents of this feedstuff.

Table 2 – Performance of meat-type quails fed diets containing broken rice in replacement of corn (n=288).

Level of corn replacement by broken rice (%)	Evaluated Parameters		
	Feed intake (g/bird) (g/bird)	Weight gain (g/bird)	Feed conversion ratio (g/g)
0	976.58	229.81	4.25
20	1046.28	232.48	4.50
40	1072.31	237.18	4.53
60	1048.85	238.92	4.40
80	993.73	234.27	4.26
100	1086.20	234.52	4.63
Effect – ANOVA[1]	0.12	0.90	0.27
Regression Analysis (p value)			
Linear	0.16	0.48	0.31
Quadratic	0.46	0.35	0.90
CV[2] (%)	6.89	5.76	6.86

[1]ANOVA = Analysis of variance; [2]CV = Coefficient of variation.

The evaluation of carcass traits (Table 3) showed that the replacement of corn by broken rice in the diets did not affect dressing percentage, breast, leg, liver, or gizzard yields of meat-type quails. According to Freitas *et al.* (2006), when dietary nutritional levels are properly evaluated, it is unlikely that carcass yield is influenced by the inclusion of alternative feedstuffs in experimental diets in which most of the nutritional parameters are similarly in feed formulation. On the other hand, if the metabolizable energy content of a feedstuff, and particularly net energy, are underestimated or overestimated, its inclusion in the diet may change energy:protein ratio, consequently changing carcass and cuts composition.

Therefore, the use of average chemical composition values of the main energy feedstuffs and of metabolizable energy value of broken rice for broilers in the present work could modulate feed net energy content, with consequent changes in protein and lipid deposition. Accordingly, the actual metabolizable energy and digestible amino acid content of broken rice needs to be considered in order to prevent excessive fat accumulation and not to affect performance when included as the main energy source in quail diets (Rama Rao *et al.,* 2000).

The carcass yield results of quails are consistent with those reported for broilers (Brum Júnior *et al.,* 2007), where no influence of corn substitution by broken rice at levels of 0, 20, or 40% in the diet on broiler carcass or cuts yields was observed. Cancherini *et al.* (2008) also did not find any significant effects of dietary broken rice inclusion on broiler carcass yield. According to Nanto *et al.* (2012), high soybean oil inclusion levels in diets where dehulled paddy rice completely replaced corn had negative effect on carcass traits due to the accumulation of abdominal fat. However, in the present study, increasing soybean oil inclusion levels as broken rice inclusion increased did not have the same effect.

Although no effect on gizzard yield was observed, Brum Júnior *et al.* (2007) and Nanto *et al.* (2012) found reduced gizzard weight as the substitution of corn by broken rice and dehulled paddy rice increased. The authors associated this result to the reduced stimulation of this organ as a consequence of the higher starch and lower non-starch polysaccharide levels of broken rice (Choct, 2002). Similar adaptive changes in the structure and function of the gut associated with low-fiber ingredients were reported by Dibner *et al.* (1996). Therefore, reductions in crude fiber levels as broken rice inclusion in the present study were not sufficient to reduce gizzard weight.

The economic viability evaluation (Table 4) showed that feed cost per kilogram of live weight gain, cost index, and economic efficiency index were not influenced by broken rice inclusion in replacement of corn in the diets. It was also observed that the economic viability was not different between broken rice inclusion levels and the control group for. These results indicate the economic viability of the inclusion of up to 100% broken rice in the diet of meat-type quails, when the price of broken rice was approximately 10% lower than corn.

Evaluating increasing levels of corn substitution by broken rice up to 40% for growing chickens, Swain *et al.* (2005) concluded that feed cost was reduced when 30% of corn was replaced. However, the results found in the present study are consistent with obtained by Rama Rao *et al.* (2000), who suggested that broken rice could completely replace corn in broiler breeder diets in order to reduce production costs at prices prevailing in that situation. Due to the costs of the main energy sources, the price of broken rice was 91.43%

Table 3 – Carcass yield, relative to live weight, and breast, legs, liver, and gizzard yields, relative to carcass weight, of meat-type quails fed diets containing broken rice in replacement of corn (n=72).

Level of corn replacement by broken rice (%)	Carcass (%)	Breast (%)	Leg (%)	Liver (%)	Gizzard (%)
0	78.93	34.37	20.14	2.01	0.45
20	79.65	34.92	19.61	1.89	0.40
40	78.83	35.92	19.82	1.99	0.42
60	77.79	33.64	20.05	2.12	0.44
80	77.32	32.47	20.07	2.16	0.40
100	78.48	33.98	19.37	2.08	0.38
Effect - ANOVA[1]	0.45	0.10	0.84	0.25	0.09
Regression Analysis (p value)					
Linear	0.16	0.06	0.85	0.06	0.08
Quadratic	0.16	0.51	0.14	0.18	0.60
CV[2](%)	3.49	7.81	7.67	13.37	15.10

[1]ANOVA = Analysis of variance; [2]CV = Coefficient of variation.

Table 4 – Economic viability evaluation of the replacement of corn by broken rice in diets for meat-type quails (n=288).

Level of corn replacement by broken rice (%)	Feed cost (US$/kg of weight)	Economic efficiency index (%)	Cost index (%)
0	7.44	99	101
20	7.84	94	106
40	7.86	94	107
60	7.60	98	103
80	7.33	100	100
100	7.92	94	107
Effect - ANOVA[1]	0.36	0.35	0.36
Regression Analysis (p value)			
Linear	0.65	0.58	0.66
Quadratic	0.25	0.20	0.26
CV[2] (%)	6.88	7.11	6.97

[1]ANOVA = Analysis of variance; [2]CV = Coefficient of variation.

of corn price. This difference allowed increasing the proportion of oil in the feed to maintain the same level of nutrients and energy.

Based on the present findings, broken rice can be considered a potential substitute of corn in meat-type quail diets. Since it is a byproduct of rice processing which composition may vary, studies for determination of metabolizable energy and digestible amino acid contents may allow maximizing its inclusion in quail diets.

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