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# Effect of Graded Replacement of Corn by Broken Rice in Growing Japanese Quail Diets on Growth Performance, Carcass Traits and Economics

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## ABSTRACT

This study evaluated the effect of replacing maize with broken rice (0, 10, 20, 30, 40 and 50 %) on growth performance, feed utilization and carcass traits of growing Japanese quails (1-5 weeks of age). A total of 324 quails (1 week old) were used in a complete randomized design experiment with six treatment groups. Each group was subdivided into three replicates with 18 birds per replicate. Live Body Weight (LBW) and Body Weight Gain (BWG) were significantly ($p<0.05$) affected by treatments throughout the experiment. The highest values of LBW (189.53g) and BWG (5.70 g) achieved by birds fed broken rice at 20% level during all the experimental periods compared to the other groups. Feed Intake (FI) was significantly ($p<0.05$ or 0.01) affected by broken rice replacement during all the experimental periods. Feed Conversion Ratio (FCR) was statistically ($p<0.05$) influenced by broken rice levels through 1-5 weeks of age only. Replacement of corn by broken rice in the diets did not affect ($p>0.05$) dressing, carcass, giblets, heart, liver and gizzard percentages of meat-type quails as compared to corn-soya diet. Economical efficiency did not affect with the different levels of broken rice throughout the experiment. Based on the present findings, broken rice can be considered a potential substitute of corn up to 50% in meat-type quail diets. Since, it is a by-product of rice processing its composition may vary, studies for determination of metabolizable energy and digestible amino acid contents may allow maximizing its inclusion in quail diets.

**Key words:** Broken rice, growth performance, carcass traits, quails

## INTRODUCTION

The increase in the world population has led to the need to intensify livestock production but this is constrained by high cost of production especially in Egypt. Due to economic situation of the nation, protein intake of most Egyptians is inadequate and often lacks protein of high biological value derived from animal products. Recently, there is a tremendous decrease in poultry production as a result of high cost of protein and energy feedstuffs. Cereal grains especially maize which forms the bulk of energy in poultry feeds are in short supply as a result of industrial and human requirements. Rising cost of poultry feeds have continued to be a major problem in developing countries as feed cost is about 65-70% (Nworgu *et al*., 1999) and 70-75% (Opara, 1999) of the total cost of production compared to about 50-60% in developed countries (Tackie and Flenscher, 1995). Similarly, there has been a steady increase in the cost of conventional feed ingredients such as maize, groundnut cake, soybean meal and fish meal in the past years and this has led to increase in the prices of animal protein sources (Adejinmi *et al.,* 2007). Many researchers have emphasized the need for utilizing alternative feed ingredients removed from human and industrial uses (Fanimo *et al*., 2007; Nsa *et al*., 2007; Abd El-Hack *et al*., 2015; Alagawany and Attia, 2015).

Rice by-products, such as rice straw, rice husks, rice bran, rice germ and broken rice, are extensively abundant agricultural wastes from the rice industry and the percentage of their production depends on the milling rate and type of rice (Esa *et al*., 2013). In recent years, rice by-products have received increased attention as functional foods due to their phenolic base compounds, in addition to having high amounts of vitamins, minerals and fiber, which can help to lower cholesterol and enact anti-atherogenic activity (Wilson *et al*., 2002).

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 to presenting similar protein and metabolizable energy contents (Daghir, 2008). Broken rice chemical composition is CP 8%, CF 10.1%, ash 2% and ME 3090 kcal $kg^{-1}$ diet according to Central Laboratory for Food and Feed in Cairo. There are reports of broken rice inclusion in Japanese quail layer diets (Swain *et al*., 2006; Oliveira *et al*., 2007) but little information is available on the evaluation of this feed stuff for meat-type quails.

The poultry industry in many countries, including Egypt, is facing severe challenges due to high prices of yellow corn and soybean meal, both of which are used in poultry feed diets. Thus, there is an urgent need for affordable and nutritious feed. Therefore, this study aimed at evaluating the effect of broken rice as an economic alternative ingredient that partially replaces corn in growing Japanese quail diet to produce low-cost formulae.

## MATERIALS AND METHODS

The present investigation was carried out at Poultry Research Farm, Poultry Department, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. All experimental procedures were carried out according to the Local Experimental Animal Care Committee and approved by the ethics of the institutional committee, Department of Poultry, Faculty of Agriculture, Zagazig University, Zagazig, Egypt.

**Husbandry and experimental design:** A total number of 324 unsexed one week old Japanese quail were randomly assigned in a complete randomized design into 6 treatment groups, (54 chicks in each group). Each group of birds was subdivided into three replicates, each of 18 chicks. Each replicate was housed in one cage (90×40×40 cm). The experimental diets were formulated to cover the nutrient requirements of growing Japanese quails from 1-5 weeks of age according to the NRC (1994). Diets were isocaloric and isonitrogenous and contained six levels of broken rice (0, 10, 20, 30, 40 and 50%) replaced with corn diet in a mach form (Table 1).

Chicks were grown in brooders with raised wire floors and were reared under the same managerial and hygienic conditions. The lighting pattern was 23 h light: 1 h dark. Feed and water were *ad-libitum* throughout the experimental period (1-5 weeks of age). All chicks received feeds from placement until 35 days of age in mash form, according to its treatment.

**Data collection:** Chicks were weighed individually at weekly intervals. Mortality was recorded daily. Average daily Feed Intake (FI), Body Weight Gain (BWG) and feed to gain ratio were

Table 1: Ingredients and chemical composition of the experimental diets

| | Diets | | | | | |
|---|---|---|---|---|---|---|
| Broken rice levels (%) | 0 | 10 | 20 | 30 | 40 | 50 |
| **Ingredients (%)** | | | | | | |
| Yellow corn | 60.00 | 54.00 | 48.00 | 42.00 | 36.00 | 30.00 |
| Broken rice | - | 6.00 | 12.00 | 18.00 | 24.00 | 30.00 |
| Soybean meal (44%) | 27.80 | 27.80 | 27.60 | 26.60 | 26.50 | 25.80 |
| Corn gluten meal (60%) | 2.00 | 2.00 | 2.00 | 3.00 | 3.00 | 3.50 |
| Limestone | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Protein concentrate[1] | 10.00 | 10.00 | 10.00 | 10.0 | 10.00 | 10.00 |
| Soybean oil | - | - | 0.20 | 0.20 | 0.30 | 0.50 |
| **Calculated analysis[2]** | | | | | | |
| CP (%) | 23.50 | 23.50 | 23.50 | 23.40 | 23.40 | 23.30 |
| ME (kcal $kg^{-1}$) | 2960.00 | 2947.00 | 2949.00 | 2947.00 | 2941.00 | 2940.00 |
| Ca (%) | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| Available P (%) | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| Lysine (%) | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 |
| Met.+Cys. (%) | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Price/ton/diet, L.E.[3] | 3393.00 | 3318.00 | 3253.00 | 3201.00 | 3132.00 | 3076.00 |

[1]Protein concentrate (48%) its chemical analysis: Crude protein: 48%, ME: 2533 k cal $kg^{-1}$ deit, Calcium: 6.2%, Phosphorus: 2.9%, Lysine: 2.3% and Methionine+cystine: 2.4%, [2]Calculated according to NRC (1994), [3]Caculated according to the price of feed ingredients when the experiment was started

calculated from these data by period and cumulatively. Feed wastage was recorded daily and the data were used to estimate feed consumption.

**Carcass criteria:** At the end of growing period (5 weeks of age), five birds from each treatment were randomly taken with an average body weight around the treatment mean, fasted overnight, weighed and slaughtered by sharp knife to complete bleeding, then weighed, followed by plucking the feather and finally weight. The slaughter traits studied were giblets (liver, gizzard and heart) and dressing (%) (carcass weight plus giblets weight)×100/pre-slaughter g).

**Economical efficiency:** Economical efficiency of the product (growth rate) was calculated from the input and output analysis based upon the differences in growth rate and feeding cost (Heady and Jensen, 1954).

**Statistical analysis:** Data was subjected to ANOVA procedure using a completely randomized design using the GLM procedures of SAS (SAS Institute Inc., 2001). The differences among means were determined using the *post-hoc* Tukey's test. Statements of statistical significance are based on $p<0.05$ unless otherwise stated.

## RESULTS AND DISCUSSION

**Growth performance:** The broken rice is comparable to maize in crude protein and energy contents and has been exploited for its feeding value to poultry. Broken rice may be a potential alternative feed ingredient for poultry to substitute maize as energy source due to its continuous availability and low price (Swain and Barbuddhe, 2008).

Results (Table 2) show that growth performance of growing Japanese quail fed the different levels of broken rice replaced with corn maize diet from 1-5 weeks of age. The results indicated that Live Body Weight (LBW) and BWG significantly ($p<0.05$) affected during all the different experimental periods. The highest value of LBW and BWG in growing Japanese quail fed broken rice at level 20 and 30% replaced of yellow corn diet during all the experiment periods1-3, 3-5 and

Table 2: Live body weight and body weight gain of growing Japanese quails fed diets containing broken rice in replacement of yellow corn

| Parameters | Broken rice levels (%) 0 | 10 | 20 | 30 | 40 | 50 | Significance |
|---|---|---|---|---|---|---|---|
| **Live body weight (g) at** | | | | | | | |
| 1 week | 29.84±0.09 | 29.84±0.09 | 29.84±0.090 | 29.84±0.09 | 29.68±0.00 | 30.00±0.00 | NS |
| 3 weeks | 103.90±0.45[c] | 110.31±0.54[a] | 109.68±0.18[a] | 107.65±0.27[b] | 106.40±0.01[b] | 104.84±0.45[c] | ** |
| Final (5 weeks) | 175.78±1035[c] | 185.46±1.35[a] | 189.53±2.61[a] | 184.53±0.09[a] | 181.25±0.46[b] | 180.31±0.30[b] | ** |
| **Body weight gain (g)** | | | | | | | |
| 1-3 week | 5.29±0.03[c] | 5.74±0.03[a] | 5.70±0.00[a] | 5.55±0.01[a] | 5.48±0.08[b] | 5.34±0.07[b] | ** |
| 3-5 weeks | 5.13±0.12[c] | 5.36±0.05[b] | 5.70±0.17[a] | 5.49±0.02[a] | 5.34±0.03[b] | 5.39±0.04[b] | * |
| Overall (1-5 weeks) | 5.21±0.04[c] | 5.55±0.04 [a] | 5.70±0.09[a] | 5.52±0.00[a] | 5.41±0.05[b] | 5.36±0.01[b] | ** |

Means in the same row within each classification bearing different letters are significantly ($p \leq 0.05$) different, NS: Not significant

1-5 weeks of age compared to the control diet and other levels of broken rice. Our results are in agreement with those obtained by Medugu *et al*. (2011), who pointed out that using rice is potential energy source and feeding trials using broken rice in poultry diets have yielded good results. On the same context, Swain and Barbuddhe (2008) reported that in Japanese quail chicks, broken rice (rice kani) can replace maize up to a level of 20% in the diet without any adverse effect on their performance with appreciable reduction in the feed cost. While, 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 amylase and non-starch polysaccharide contents of this feedstuff. On the contrary, Edwin *et al*. (2002) reported that no significant differences were noticed on body weight at eight weeks of age of broiler chicks, birds fed on the diet with 75% replacement of maize with broken rice recorded 9.8% higher body weight than the control. FI was significantly ($p<0.05$ or 0.01) affected by broken rice replacement during all the different experimental periods. Feed Conversion Ratio (FCR) was statistically ($p<0.05$) influenced by broken rice levels during the period of 1-5 weeks of age only (Table 3). The highest FI was recorded in quail fed broken rice at level of 50% replaced by corn maize diet, whereas the lowest FI recorded with the group fed control diet and 30% of broken rice. The quail fed broken rice at level of 30% replaced by corn maize diet had the best FCR compared to all treatments. The results of the current study are in line with the findings of Vicente *et al*. (2008), who stated that feedstuffs that stimulate relatively high glucose and insulin postprandial responses, such as broken rice, may increase feed intake and weight gain higher feed intake by animals fed diets containing increasing levels of this feedstuff was observed in the present study. On the other hand, Edwin *et al*. (2002) reported that feed consumption and feed efficiency did not show any significant variation among treatments contained different levels of broken rice. Also, Filgueira *et al*. (2014) found that 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 7-49 days old meat type quails did not affect feed intake, weight gain or feed conversion ratio ($p>0.05$). When evaluating the replacement of corn by broken rice in broiler diets at the levels of 0, 20 and 40%, by Brum *et al*. (2007), who did not find any significant effects ($p>0.05$) on feed intake, weight gain, or feed conversion ratio.

In the present study, the improvement in FCR and increase in BWG had resulted from group fed 20 and 30% of broken rice replaced by corn maize diet in overall period 1-5 weeks of age may

Table 3: Feed consumption and feed conversion ratio of growing Japanese quails fed diets containing broken rice in replacement of yellow corn

| | Broken rice levels (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameters | 0 | 10 | 20 | 30 | 40 | 50 | Significance |
| **Daily feed intake (g)** | | | | | | | |
| 1-3 week | 12.29±0.21[c] | 13.32±0.26[a] | 13.34±0.24[a] | 12.47±0.23[b] | 12.25±0.08[c] | 12.19±0.40[c] | ** |
| 3-5 weeks | 23.59±0.34[c] | 24.75±0.01[b] | 24.76±0.97[b] | 23.33±0.08[c] | 24.19±1.12[b] | 26.77±0.17[a] | * |
| Overall (1-5 weeks) | 17.94±0.28[b] | 19.04±0.14[a] | 19.05±0.36[a] | 17.90±0.16[b] | 18.22±0.02[b] | 19.48±0.06[a] | * |
| **Feed conversion ratio (g feed $g^{-1}$ gain)** | | | | | | | |
| 1-3 week | 2.32±0.05 | 2.31±0.06 | 2.33±0.04 | 2.24±0.04 | 2.23±0.01 | 2.28±0.02 | NS |
| 3-5 weeks | 4.59±0.04 | 4.61±0.05 | 4.36±0.30 | 4.25±0.00 | 4.52±0.18 | 4.96±0.00 | NS |
| Overall (1-5 weeks) | 3.44±0.02[b] | 3.42±0.05[b] | 3.34±0.11[cb] | 3.24±0.02[c] | 3.36±0.07[cb] | 3.62±0.02[a] | * |

Means in the same row within each classification bearing different letters are significantly ($p \leq 0.05$) different, NS = not significant

be due to, rice by products receiving increased attention as functional foods on account of their phenolic base compounds, in addition to having high amounts of vitamins, minerals and fiber, which can help to lower cholesterol and enact anti-atherogenic activity (Wilson *et al*., 2002).

In addition to these, rice germ also contains a substantial concentration of vitamins (B1, B2 and B6), fiber and neurotransmitter γ-amino butyric acid (GABA), which is believed to have many beneficial health effects, such as lowering the blood pressure, improving cognition and lowering blood glucose levels. The level of γ-oryzanol in rice germ, however, was 5 times lower than the level in rice bran (Yu *et al*., 2007). Another additional advantage is that broken rice is not associated with aflatoxins which pose threat to the survivability of poultry and other livestock's (Swain and Barbuddhe, 2008). The combined effects of these constituents may have increased vitality. The growing Japanese quail receiving broken rice increased their LBW and BWG advantage even more at 5 weeks of age compared to control diet, indicating the effect in digestive tract was probably continuous throughout grow out. Since, chemical structures have surfactant properties; they might be conditioning the cell membranes and reducing surface tension which could aid in better absorption of nutrients across the cell membranes. All these mechanisms can lead to improvement in LBW, BWG and FCR of growing Japanese quails.

**Carcass characteristics:** Dressing, carcass, giblets, heart, liver and gizzard yield percentage of meat-type quails insignificantly affected by replacement of corn by broken rice in the diets compared to control diet (Table 4). The highest dressing and carcass yield values were observed in quail chicks fed broken rice at levels of 30 and 50%. On the contrary, the lowest values were recorded by quails fed broken rice at level of 20% replaced by corn diet. 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 *et al*., 2007).

Results of the present work are in agreement with those of Filgueira *et al*. (2014), who revealed 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, is underestimated or overestimated, its inclusion in the diet may change energy: Protein ratio, consequently changing carcass and cuts composition.

Table 4: Carcass characteristics of growing Japanese quails fed diets containing broken rice in replacement of corn at the end of the experiment

| | Broken rice levels (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameters (%) | 0 | 10 | 20 | 30 | 40 | 50 | Significance |
| Carcass yield | 75.89±0.92 | 76.81±0.96 | 74.37±0.58 | 77.55±0.16 | 75.75±1.64 | 76.97±1.69 | NS |
| Heart | 1.02±0.04 | 0.86±0.00 | 1.08±0.09 | 1.08±0.03 | 1.02±0.07 | 1.06±0.-36 | NS |
| Liver | 3.59±0.04 | 2.21±0.09 | 2.58±0.22 | 2.89±0.40 | 3.39±0.50 | 3.06±0.19 | NS |
| Gizzard | 2.35±0.17 | 2.40±0.23 | 2.03±0.13 | 1.89±0.03 | 2.13±0.01 | 2.16±0.00 | NS |
| Giblets | 6.98±0.26 | 5.48±0.32 | 5.69±0.45 | 5.86±0.40 | 6.55±0.41 | 6.28±0.22 | NS |
| Dressing | 82.87±0.65 | 82.29±0.63 | 80.07±0.13 | 83.42±0.58 | 82.31±1.22 | 83.26±1.91 | NS |

NS: Not significant

Table 5: Economic efficiency of growing Japanese quails fed diets containing broken rice in replacement of corn at the end of the experiment

| | Broken rice levels (%) | | | | | |
|---|---|---|---|---|---|---|
| Parameters (%) | 0 | 10 | 20 | 30 | 40 | 50 |
| Price kg/feed (LE) | 3.393 | 3.318 | 3.253 | 3.201 | 3.132 | 3.076 |
| Price/kg meat (LE) | 23.000 | 23.000 | 23.000 | 23.000 | 23.000 | 23.000 |
| Feed conversion ratio | 3.440 | 3.420 | 3.340 | 3.240 | 3.360 | 3.620 |
| Price of feed to produce one kg meat (LE) | 11.670 | 11.670 | 11.670 | 11.670 | 11.670 | 11.130 |
| Net revenue (LE) | 11.320 | 11.320 | 11.320 | 11.320 | 11.320 | 11.320 |
| Economical efficiency (EEF) | 0.970 | 0.970 | 0.970 | 0.970 | 0.970 | 0.970 |

Means in the same row within each classification bearing different letters are significantly ($p \leq 0.05$) different. NS: Not significant, Price of feed to produce 1 kg meat (LE): Price $kg^{-1}$ feed (LE)*Feed conversion ratio, Net revenue (LE): Price $kg^{-1}$ meat (LE)-Price of feed to produce one kg meat (LE), Economical efficiency (EEF): Net revenue (LE)/Price of feed to produce one kg meat (LE)

The carcass yield results of quails are consistent with those reported for broilers (Brum *et al*., 2007), who found that 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. 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). Therefore, reductions in crude fiber levels as broken rice inclusion in the present study were not sufficient to reduce gizzard weight.

**Economical evaluation:** The economic feasibility evaluation (Table 5) showed that feed cost per kilogram of live weight gain, net revenue and economic efficiency were not influenced by broken rice inclusion in replacement of corn in quail diets. It was also observed that the economic feasibility was not different between broken rice inclusion levels and the control group. Evaluating increasing levels of maize substitution by broken rice up to 40% for growing chickens, Swain *et al.* (2006) concluded that feed cost was reduced when 30% of corn was replaced. On the other hand, Rao *et al*. (2000) pointed out 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% of corn price. This difference allowed increasing the proportion of oil in the feed to maintain the same level of nutrients and energy.

## CONCLUSION

Based on the present findings, broken rice can be considered a potential substitute of corn up to 50% in growing Japanese quail diets. Since, it is a by-product of rice processing which may which may cause variations in 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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