Tropical Agricultural Research Vol. 26 (1): 39 – 47 (2014)

Effects of the Level of Dietary Rice Bran with or without Phytase, on Performance and Egg Parameters of Laying Japanese Quail

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ABSTRACT: *Cost of quail feed formulations can be reduced substantially by using cheap cereal by-products such as rice bran (RB) at higher levels. The objective of this study was to determine the maximum inclusion levels of dietary RB with or without exogenous phytase, for laying Japanese quail. In a completely randomized design with a 3 x 2 factorial arrangement, 108 quails in 36 cages received six experimental diets ad libitum from 8 to 15 week. Experimental factors were three dietary RB inclusion levels (20, 30 and 40%) and two phytase levels (0 and 1000 FTU/kg). The level of dietary RB, phytase supplementation and their interaction had no significant effects on live weight or feed intake. The total egg production of the quail fed 40% RB was significantly lower than that of quail fed 20 and 30% RB. Egg laying rate of the quail fed 40% RB was significantly lower than those of the quail fed 20 or 30% RB from 6th week onwards. By eighth week, 30% RB resulted in significantly lower egg laying rate compared to the quail fed 20% RB. Feed conversion ratio (FCR) of the quail fed 40% RB was significantly higher than those of 20 or 30 % RB fed. Adverse effects of phytate in 30 or 40% RB on egg number, egg mass and FCR were not mitigated by the supplemental phytase. It is concluded that inclusion of more than 20% RB in the diets of laying Japanese quail reduces the production performances.*

Keywords*: Egg, feed, performance, quail, rice bran*

INTRODUCTION

Japanese quail is an important poultry species reared for meat and eggs and as a laboratory model (Siyadati *et al*., 2011). Feed cost accounts for more than 70% of the total recurrent cost of production and thus greatly influences the profitability of quail production and the affordability of meat or eggs to consumers. In order to reduce the cost of feed formulations, it is important to use cheap, locally available agricultural by-products such as rice bran. The *in vitro* nutritive value of RB is superior to or at least comparable with other cereal by products (Farrell, 1994). In areas where rice is grown, RB is a cheap feed ingredient and thus the unit costs of many nutrients and energy are lower than those of other cereals and their by-products. Oladunjoye and Ojebiyi (2010) found that the feeding cost of broilers given diets with 20% RB was significantly lower than those fed 10% RB. Therefore, strategies to increase the usability of RB in quail diets are of importance. Only a limited number of studies have been conducted to evaluate the feeding value of RB for Japanese quail. Performance of meat (Attia *et al*., 2006; Ismail *et al*., 2006) and layer (Aggoor *et al*., 2006;

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Amoah and Martin, 2010) type quail fed 20% full fat RB was comparable with those fed 0% RB. Bhanja and Verma (2001) fed diets containing 10, 20 and 30% de-oiled RB to layer quail and concluded 20% to be the maximum inclusion level for defatted RB.

Studies with other poultry species have shown that layer chickens and ducks can tolerate as high as 40% dietary RB while broilers can tolerate a maximum of 20% (Farrell, 1994). These differences may be attributed to the extent to which respective species/type of poultry can tolerate the anti-nutrients such as phytate, fibre, anti-proteolytic substances and lipase present in RB. No attempt has been made to test the possibility of using higher than 20% full fat RB in quail diets. Positive effects of exogenous phytase on phosphorus (P), energy and protein utilization efficiencies are well documented (Woyengo *et al*., 2011). Since phytate is among the main anti-nutrients that reduce the *in vivo* nutritive value of RB (Farrell, 1994), it was hypothesized that maximum inclusion levels of RB in Japanese quail diets could be increased by phytase supplementation. The objective of this study was to determine the maximum inclusion levels of dietary RB, with or without phytase in laying Japanese quail diets.

MATERIALS AND METHODS

4-week-old female Japanese quail (n=108) were allocated into 36 cages arranged in three tiers. For three weeks of the acclimatization period, birds were fed commercial grower crumbles. At the end of the seventh week of age, birds were weighed and cages were randomly allocated into 6 dietary treatments so that among cages live weight variation was minimum. The experiment followed a complete randomized design with a 3 x 2 factorial arrangement. Treatment factors were three dietary RB levels (20, 30 or 40%) and two phytase (Phytazag, Zagro, Singapore) levels (0 or 1000 FTU/kg). Each treatment combination had six replicate cages, each holding three birds. All diets met the nutrient requirements of Japanese quail as set out by NRC (1994). Ingredient composition and calculated nutrient composition of the experimental diets are given in Table 1.

Birds were given experimental diets and water *ad libitum* for eight weeks from the 8^{th} to 15^{th} week. Daily feed and water intake, egg production and egg weights and live weights of the birds after 2, 4, 6 and 8 weeks from the start of treatment were recorded. Feed conversion ratio was defined as feed intake/total egg mass. Two eggs randomly collected from each cage after 2, 4, 6, and 8 weeks of treatment imposition were used to determine egg component weights and yolk cholesterol contents. After taking the weight, length and width, the eggs were broken and opened. The yolk was gently separated from the albumin, adherent albumin was removed by rolling the yolk over a tissue paper, and the yolk fresh weight was recorded. The yolk and albumin were then dried at 105 ^{0}C for three days to get the dry weights of the respective components.

The fresh weight of the albumin was calculated as egg weight – (shell weight + yolk weight). Shells were air dried for three days and then oven dried at 65 ^{0}C for three days to get shell weight. Oven dried shells were ashed at 550 ^{0}C for 12 hours to determine the shell ash content. Shape index was calculated as; Shape index = maximum width/maximum length x 100. Shell thickness was measured using an egg shell thickness meter (Orawa, Seiki, Japan). Yolk cholesterol contents were determined as described by Lien *et al. (*2012) using a commercial cholesterol assay kit (SPINREACT, S.A. Ctra, Santa Coloma, Spain). Latency to lie times for one randomly selected birds from each cage were determined on 8^{th} week, as described by Bailie *et al*. (2012).

Data were analyzed using SAS (1985). Main effects were compared using the Duncon's Multiple Range Test procedure while interactions were compared using the Least Square (LS) mean comparison procedure.

Table1. Ingredient composition and nutrient composition of the experimental diets

Ingredient	**Dietary rice bran levels (%)**		
	20	**30**	**40**
Maize meal (%)	38.2	29.3	21.8
Rice bran (%)	20	30	40
Soya bean meal (%)	28	26.5	23.3
Coconut oil (%)	3.5	3.9	3.9
Fish meal (%)	3.4	3.4	4.3
Dicalcium phosphate (%)	1.1	1	0.9
Shell powder (%)	5.3	5.4	5.3
Salt (%)	0.25	0.25	0.25
Vitamin mineral mix (%)	0.25	0.25	0.25
Phytase	-/+	-/+	-/+
Price (Rs/Kg)	79.74/79.76	76.92/76.94	75.51/75.53
Nutrient composition			
Energy (Kcal/kg)	2900	2900	2900
CP (%)	20	20	20
Non phyate P (%)	0.35	0.35	0.35
Ca (%)	2.5	2.5	2.5
Lysine (%)	1.1	1.1	1.1
Methionine + Cystine (%)	0.7	0.7	0.7
Crude fibre (%)	5.1	5.9	6.3

RESULTS

Inclusion of 40% (75.52 Rs/kg) or 30% (76.93 Rs/kg) RB lowered cost of feed formulations compared to the diet having 20% RB (79.75 Rs), whereas supplemental phytase incurred only 2 cents of an additional cost per kg (79.74 *vs* 79.76 Rs/kg) (Table 1). The level of dietary RB, supplemental phytase and their interaction had no significant effects on live weights or feed intake of the birds (Table 2). The total egg production of the quail fed 40% dietary RB (35) was significantly lower than that of birds fed 20% (43) and 30% (40) RB (Table 3). Negative effect of 40% RB on egg laying rate commenced as early as 3rd week of feeding (Fig 1). Laying rate of the quail fed 40% RB declined sharply after five weeks of feeding and was significantly lower than those of the quail fed 20 or 30% RB from 6th week onwards. By 8th week, 30% dietary RB resulted in significantly lower egg laying rate compared to the quail fed 20% RB. The FCR of the birds fed 40% RB (5.6) was significantly higher than those of 20 (4.7) or 30 % (5.1) RB fed birds. The negative effects of 40% RB on FCR commenced from 5th week onward and became significant by 7th week (Fig. 2). Poor FCR was evident in 30% RB compared to 20% RB on 8th week.

Table 2. Effects of three dietary RB levels and phytase supplementation on live weight and feed consumption parameters of laying Japanese quail

RB level (%)	20	20	30	30	40	40	SEM	Effect		
Phytase	-	+	-	+	-	+		RB	E	RB* E
Live weight (g) (weeks after treatment imposition)										
0 week	181	179	175	183	167	185	14	NS	NS	NS
8th week	204	188	184	189	204	183	8	NS	NS	NS
Feed intake[1]	35.4	35.7	35.8	35.5	35.8	35.8	0.46	NS	NS	NS
FCR	5.1	4.2	4.8	5.4	5.6	5.6	0.8	*	NS	NS
Feed cost (Rs)	158	160	155	153	152	152	2	**	NS	NS
Feed cost/kg egg mass	408	341	369	422	423	444	69	NS	NS	NS

NS; P>0.05, *; P<0.05, **; P<0.01
[1] g/bird/day
E; Enzyme

Table 3. Effects of three dietary RB levels and phytase supplementation on egg production and relative weights of egg components of laying Japanese quail

RB level (%)	20	20	30	30	40	40	SEM	Effect		
Phytase	-	+	-	+	-	+		RB	E	RB*E
Total no of eggs/ bird	40	47	44	38	36	34	6.2	*	NS	NS
Total egg mass (g)	401	469	428	384	359	345	62	**	NS	NS
Egg weight (g)										
Initial			9.8				0.47			
Week 8	10.4	9.6	9.8	10.5	9.8	9.8	0.63	NS	NS	*
Egg components										
Yolk (%)	32.2	30.9	32.7	32.9	32	32.9	1.6	NS	NS	NS
Albumin (%)	60.2	60.8	58.9	59.3	60	60.3	1.7	NS	NS	NS
Shell (%)	7.5	8.2	8.2	7.7	7.8	7.7	0.6	NS	NS	NS
Shell ash (%)	70	61	64	60	54	75	7	NS	NS	NS
Shell thickness (mm)	0.31	0.31	0.31	0.29	0.29	0.31	0	NS	NS	NS
Shape index	85	82	81	78	85	85	5.9	NS	NS	NS

NS; P>0.05, *; P<0.05, **; P<0.01
E; Enzyme

Effect of dietary treatments on egg weight was erratic. In the 4th week, 20% (10.2 g) and 40% (9.7 g) RB resulted in significantly heavier eggs than 30% RB (9.0 g). Meanwhile, supplemental enzyme produced heavier eggs in the 4th and 6th week. There was a significant RB x phytase enzyme interactive effect on egg weight in week eight, where phytase supplementation significantly reduced the egg weight at the 20% RB level but had no effect at 30 or 40% RB levels.

Reduction in feed cost was observed when dietary RB level increased from 20 (159 Rs), through 30 (154 Rs) to 40% (152 Rs). However, feed costs per kg of egg mass production of the quail fed 30 (395.5 Rs) or 40% (433.5 Rs) were higher than those fed 20% RB (374.5 RS). The negative effects of higher RB on financial returns were also not corrected by phytase.

Percentage egg component weights were not significantly affected by the treatments (Table 3). Egg yolk cholesterol contents and the latency to lie times were also not affected by treatment (Table 4).

Table 4. Effects of three dietary RB levels and phytase supplementation on yolk cholesterol level and latency to lie (min) of laying Japanese quail

RB level (%)	20	20	30	30	40	40	SEM	Effect		
Phytase	-	+	-	+	-	+		RB	E	RB*E
Cholesterol (mg/ g dry yolk)	11.8	11.4	11.4	12.7	12.5	12.1	0.48	NS	NS	NS
Latency to lie (min)	209	229	225	219	217	207	21	NS	NS	NS

NS; P>0.05
E; Enzyme

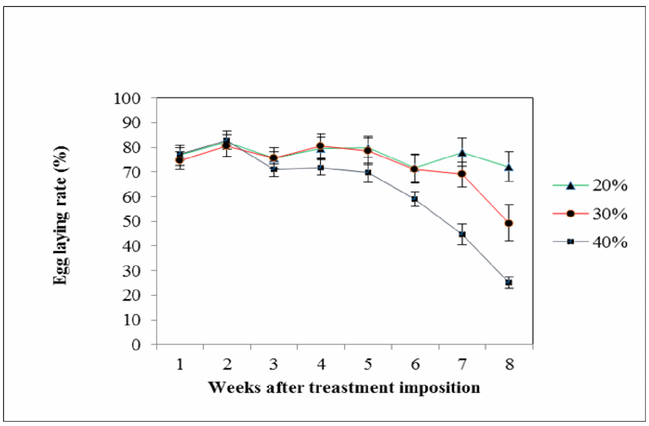

Fig. 1. Effects of dietary rice bran levels on egg laying rate of laying Japanese quail

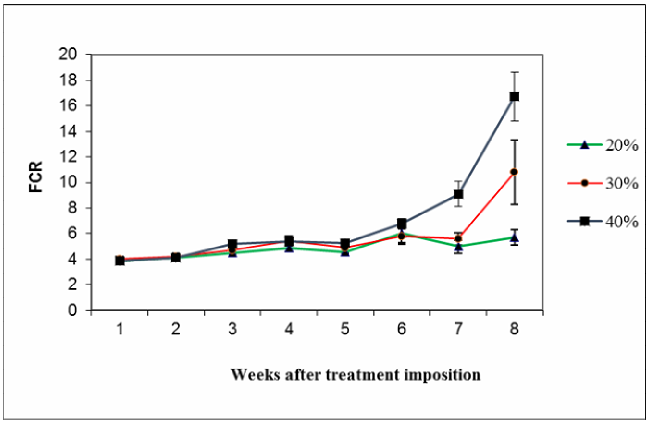

Fig 2. Effects of dietary rice bran levels on feed conversion ratio of laying Japanese quail

DISCUSSION

Attia *et al*. (2006) showed that feed intake of quail fed a diet with 20% RB from 14-42 days was lower than that of the birds fed RB free control diet. Bhanja and Verma (2001) found no significant difference in feed intakes and weight gains of quail fed 10, 20 or 30% de-oiled rice bran. The latter study has also reported that the nutrient utilization efficiencies of older Japanese quail (10 weeks old) were significantly better than those younger counterparts (6 weeks old). It is suggested that relatively mature birds used in this experiment could tolerate higher levels of RB without feed intake and live weight being negatively affected.

Inferior laying performance of the quail fed 30 or 40% RB indicates that utilization efficiency of ingested nutrients has been reduced. Furthermore, the resulting adverse effects on production parameters could not be mitigated by supplemental phytase. It has been well established that anti-nutrients such as phytate, fibre, anti-proteolytic substances present in RB reduced *in vivo* protein, energy and mineral value of the diets and thereby the performance of poultry (Farrell, 1994). Therefore, it is hypothesized that an integrated approach/es aiming many or all anti-nutrients simultaneously is/are needed to increase the level of RB in quail feeds. This hypothesis is supported by the findings of Attia *et al.* (2003) that the RB level could be increased up to 30% when a broiler diet formulated on available amino acid levels is supplemented simultaneously with phytase and phospholipase.

Lack of positive response to supplemental phytase on the shell thickness, shell ash content and the latency to lie may be due to the use of an adequate level of dietary Non Phytate Phosphorus (NPP) level. As in the present experiment, supplementation of a quail diet having 0.3% (Vali and Jalali, 2010) and 0.35% (Sacakli *et al*., 2006) of NPP with phytase has not improved growth performance, carcass yield, percentage of tibia ash or tibia phosphorus of Japanese quail.

Significant reduction in feed cost observed with increasing dietary RB levels reflects the lower feed formulation costs of the respective diets. Indicating the negative effects of higher RB levels on financial returns, feed costs per kg of egg mass production of the quail fed 40% or 30% were 15.6 and 5.4% higher, compared to those fed 20% RB. Even though the negative effects of higher RB (30 and 40%) on financial returns were also not corrected by phytase, the lowest feed cost per kg of egg mass production was recorded by the quail fed 20% RB with phytase supplementation.

Interestingly, increasing RB levels had negative effects on egg production parameters, but not on egg quality parameters such as shell thickness and shell ash and on bone status as determined by the latency-to-lie. In line with our findings, it has been reported that increase of RB level up to 10% (Nobakht, 2007) or 15% (Samli *et al*., 2006) reduced the egg production parameters but not the egg quality traits of layer chicken. Contrary to the findings of the study, Gallinger *et al*. (2004) reported that increasing RB level from 0-40% with 0.67% available P, significantly reduced the mineral status of laying hens. Results of the present experiment suggest that adverse effects of high RB levels on mineral utilization efficiency in quail may not be as strong as in layer chicken. Differences in phosphorus utilization efficiency among species, as shown by Rodehutscord and Dieckmann (2005) and lower maintenance P requirements of quail may be the reasons for such variations.

Egg component weights were comparable with values reported by Aggroor *et al*. (2006). The same research also reported that dietary RB did not change the relative proportions of the egg components. Cholesterol values reported in this study were similar to those reported by Bragagnolo and Rodriguez-Amaya (2003). Even though a number of human (Prasad, 2011; Lai *et al*., 2012; Mäkynen *et al*., 2012) and animal (Mobarak *et al*., 2010) studies have shown that RB and RB oil have hypocholesterolemic effects, results of this experiment suggest that such an effect does not exist in quail.

CONCLUSION

It is concluded that the inclusion of more than 20% RB in laying Japanese quail diets reduces the production performance. Supplemental phytase does not mitigate the adverse effects of high RB levels on the production performance of laying Japanese quail.

ACKNOWLEDGEMENT

Prof J.M. Forbes, University of Leeds, UK for his comments on the draft.
Mr. P.K. Lal and Mr Kapila Premakumara for their excellent technical support.
University of Ruhuna, Sri Lanka for providing financial assistance
Advanced Technological Institute, Labuduwa, Galle, Sri Lanka for providing experimental cage facilities and Quail birds.

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