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Dietary inclusion of parboiled whole rice bran on production of meat quails[1]

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ABSTRACT - The use of non-conventional feeds in poultry farming can reduce production costs, mainly because of its low cost, availability and chemical composition. Thus, parboiled whole rice bran (PWRB) appears as a potential use in feeding quails. Two experiments were carried out to evaluate the effects of the inclusion of PWRB in the diet of quails. In each experiment, a total of 288 seven-day-old European quails of both sexes, were distributed in a completely randomized design with six treatments and six replicates of eight quails each. The treatments consisted in the inclusion of PWRB in the proportions of 0; 5; 10; 15; 20 and 25% (first) and 0; 8; 16; 24; 32 and 40% (second). In the first experiment, a linear reduction in feed intake and weight gain was observed with the inclusion of PWRB above 5%, with no significant effect on feed conversion and carcass characteristics. However, there was no loss in the performance and carcass characteristics of quails fed with different levels of PWRB in comparison to the control group. In the second, it was observed that the inclusion of PWRB above 8% promoted a linear reduction in feed intake, weight gain and improvement in feed conversion, with no significant effect on carcass characteristics. However, quails fed 40% PWRB showed reduced intake and weight gain when compared to the control group. The use of PWRB provided an improvement in economic viability. Considering the effect on growth, PWRB can be used in the feeding of meat quails up to 32%.

Key words: Agroindustry byproduct. Carcass characteristics. *Coturnix coturnix coturnix. Oryza sativa.* Performance.

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INTRODUCTION

The use of non-conventional feeds in poultry farming can reduce feed costs, however, it should be checked whether the use of these feeds will negatively influence the performance of the quails as well as carcass characteristics or not. In this context, rice bran has been listed among an alternative feeds for animal feeding, mainly because of its availability, since it is produced in large quantities in different regions of the world and also due to its chemical composition, with emphasis on the amount of lipids and protein (QUILEZ *et al.*, 2013).

Different types of rice by-products can be obtained in the processing of rice grain for human consumption (GOPINGER *et al*., 2014). The most common ones on the market for use in animal feeding are: broken rice, whole rice bran, defatted rice bran and parboiled whole rice bran. Unlike the traditional processing that generates whole rice bran, in the parboiling process, the rice grain is subjected to a hydrothermal treatment, with heat supply under pressure before being peeled and polished, which causes physical and chemical changes in the polished grain and bran (PAIVA *et al*., 2016). Thus, because it is a thermal process with pressure, parboiling increases the nutritive value of the bran and causes the inactivation of the enzymes present, which results in an ingredient with greater storage stability (LIU *et al*., 2019).

Santos *et al*. (2017) report that the use of different types of rice bran is limited due to the presence of antinutritional factors, such as the high content of fibers, phytates and enzyme inhibitors, which impair the digestibility of all nutritional components of the feed. Sarkar *et al.* (2011) feeding Japanese quails with the inclusion of 20% parboiled whole rice bran with phytase supplementation, found improvement in performance and meat yield. Freitas *et al*. (2013) found that parboiled whole rice bran can be included in the levels of up to 25% in the growth diet for Japanese quails for egg production. Quevedo Filho *et al.* (2013), checked that parboiled whole rice bran can be included in levels of up to 30% in the laying diet for Japanese quails and Farias *et al*. (2014) observed the feasibility of including up to 20% of parboiled whole rice bran in the diet of quails for meat production, even when the bran was stored for 180 days.

As it is a by-product, PWRB can vary in its nutritional value due to factors such as rice cultivation and type of processing. These changes end up contributing to variation in the results obtained with its including in the feed of each type of bird. Therefore, the greater amount of information on the use of this ingredient can contribute to its better use, including the most appropriate level in the diet. In this context, the objective in this study was to evaluate the effects of including parboiled whole rice bran in the diet of quails for meat production.

MATERIAL AND METHODS

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

To achieve the proposed objectives, two experiments with quails for meat production were carried out, the second one being carried out after obtaining the results of the first one, in order to better characterize the response of the quails to the inclusion of the evaluated feed.

All experimental procedures followed the protocols approved by the Ethics Committee on the Use of Animals (CEUA 20/2013) of the Federal University of Ceará (UFC).

In each experiment, 288 European quails of both sexes were selected based on live weight and distributed in the experimental plots. The average weight of the quails at the beginning of the experiments, at seven days of age was 34.08 ± 2.17 g and 38.88 ± 2.10 g, in the first and second experiments, respectively.

The quails were housed in galvanized wire cages (26 cm x 52 cm x 20 cm) containing a trough-type feeders and pressure drinkers, and distributed in a completely randomized design with six treatments and six replicates of eight quails each. The treatments consisted of a control diet based on corn and soybean meal, and five other diets with inclusion of parboiled whole rice bran (PWRB) in the proportions of 5, 10, 15, 20 and 25% in the first experiment and 8, 16, 24, 32 and 40% in the second.

In each experiment, the experimental diets (Table 1 and 2) were formulated to be iso-energetic and iso-nutrient according to the nutritional requirements recommended by National Research Council (1994) for growing quails. Also, the feed composition values presented by Rostagno *et al.* (2017) were considered, with correction of the proportion of nutrients as a function of their dry matter, determined in laboratory, according to Silva and Queiroz (2002). However, in the second experiment, the same procedure of the first one was adopted regarding the composition of the feed, but the PWRB's metabolizable energy value (AMEn) was corrected to 3,065 kcal/kg on as fed basis, which was determined in a metabolism assay with quails.

In the first experiment, the experimental period was from 7 to 49 days of age, and in the second, from 7 to 42. In each experiment, the quails were vaccinated at seven days of age to prevent from Newcastle disease via ocular and throughout the experimental period the quails were provided with natural light and had feed and water at will.

The temperature and air relative humidity data were collected daily at 8am and 4pm, the temperature being recorded by maximum and minimum thermometers, and the air relative humidity by a psychrometer.

During the first experiment, the averages of minimum and maximum ambient temperature and air relative humidity in the shed were 26.22 ± 1.53 ºC, 30.61 ± 2.16 ºC and 78%, respectively. In the second, the averages of minimum and maximum ambient temperature and air relative humidity were 26.7 ± 1.23 ºC; 30.9 ± 1.36 ºC and 77%, respectively.

At the end of each experiment, it was evaluated: feed intake (g/bird), weight gain (g/bird), feed conversion ratio and yield (%) of carcass, breast and drumstick + thigh.

To evaluate the carcass characteristics, at the end of the experimental period, a male and a female from each plot were selected and after a 6-hour fasting, those quails were weighed and euthanized, with stunning electronarcosis followed by bleeding. Subsequently, scalding, plucking and evisceration were carried out.

The weighing of fasting quails, carcasses without neck, feet and edible viscera and cuts (chest and drumstick + thigh) were carried out on a scale with precision of 0.01g. The carcass yield (%) was calculated in relation to the live weight of the fasting quails and the yields of breast and drumstick + thigh in relation to the weight of the hot eviscerated carcass.

Table 1 - Composition and nutritional levels calculated in the experimental diets for meat quails

Ingredients (kg)	Experiment 1					
	Levels of parboiled whole rice bran (%)					
	0	5	10	15	20	25
Corn	52.10	47.01	41.94	36.85	31.77	26.67
Soybean meal	42.99	42.46	41.93	41.39	40.86	40.33
Parboiled whole rice bran	0.00	5.00	10.00	15.00	20.00	25.00
Soybean oil	1.91	2.56	3.20	3.86	4.51	5.17
Calcite limestone	1.20	1.22	1.25	1.27	1.29	1.32
Dicalcium phosphate	0.94	0.88	0.82	0.77	0.71	0.65
Mineral/vitamin supplement1	0.40	0.40	0.40	0.40	0.40	0.40
Common salt	0.44	0.44	0.44	0.44	0.44	0.44
DL – methionine	0.02	0.02	0.02	0.02	0.02	0.02
Total	100.00	100.00	100.00	100.00	100.00	100.00
	Calculated nutritional level					
Metabolizable energy (kcal/kg)	2.900	2.900	2.900	2.900	2.900	2.900
Crude protein (%)	23.80	23.80	23.80	23.80	23.80	23.80
Ether extract (%)	4.49	5.67	6.85	8.06	9.25	10.45
Acid detergent fiber (%)	5.35	5.75	6.16	6.56	6.97	7.38
Neutral detergent fiber (%)	12.08	12.47	12.86	13.26	13.65	14.04
Calcium (%)	0.80	0.79	0.80	0.80	0.80	0.80
Available phosphorus (%)	0.30	0.30	0.30	0.30	0.30	0.30
Sodium (%)	0.22	0.22	0.22	0.22	0.22	0.22
Total lysine (%)	1.32	1.32	1.32	1.32	1.32	1.32
Methionine + total cystine (%)	0.87	0.87	0.87	0.87	0.87	0.87
Total methionine (%)	0.50	0.50	0.50	0.50	0.50	0.50
Total threonine (%)	0.92	0.92	0.92	0.92	0.92	0.92
Total tryptophan (%)	0.30	0.30	0.30	0.30	0.30	0.30

[1]Composition per kg of product: folic acid - 138.00 mg; calcium pantothenate - 2,750.00 mg; antioxidant - 500.00 mg; biotin - 13.80 mg; cobalt - 25.00 mg; copper - 2,500.00 mg; choline - 111,450.00 mg; iron - 6,250.00 mg; iodine - 260.00 mg; manganese - 13,000.00 mg; methionine - 300 g; niacin - 6,875.00 mg; pyridoxine - 550.00 mg; colistin - 1,750 mg; riboflavin - 1,375.00 mg; Selenium - 45.00 mg; thiamine - 550.00 mg; vit. A - 2,150,000.00 IU; vit. B12 - 2,750.00 mcg; vit. D3 - 555,000.00 IU; vit. E - 2,750.00 IU; vit. K - 400.00 mg; zinc - 11,100.00 mg; silicates - 20,000.00 mg

Table 2 - Composition and nutritional levels calculated in the experimental diets for meat quails

Ingredients (kg)	Experiment 2					
	Levels of parboiled whole rice bran (%)					
	0	8	16	24	32	40
Corn	52.32	45.17	38.03	30.88	23.73	16.58
Soybean meal	42.96	41.92	40.89	39.86	38.83	37.80
Parboiled whole rice bran	0.00	8.00	16.00	24.00	32.00	40.00
Soybean oil	1.83	2.00	2.95	2.51	2.73	2.97
Calcite limestone	1.05	1.11	1.16	1.21	1.27	1.33
Dicalcium phosphate	0.98	0.88	0.78	0.69	0.59	0.49
Mineral/vitamin supplement1	0.40	0.40	0.40	0.40	0.40	0.40
Common salt	0.44	0.44	0.44	0.44	0.44	0.44
DL – methionine	0.02	0.02	0.01	0.01	0.01	0.01
Total	100.00	100.00	100.00	100.00	100.00	100.00
	Calculated nutritional level					
Metabolizable energy (kcal/kg)	2.900	2.900	2.900	2.900	2.900	2.900
Crude protein (%)	23.80	23.80	23.80	23.80	23.80	23.80
Ether extract (%)	4.46	5.59	6.72	7.86	8.98	10.13
Acid detergent fiber (%)	5.24	5.92	6.60	7.28	7.96	8.64
Neutral detergent fiber (%)	12.17	12.87	13.59	14.29	15.00	15.71
Calcium (%)	0.80	0.79	0.80	0.80	0.80	0.80
Available phosphorus (%)	0.30	0.30	0.30	0.30	0.30	0.30
Sodium (%)	0.22	0.22	0.22	0.22	0.22	0.22
Total lysine (%)	1.32	1.32	1.32	1.32	1.32	1.32
Methionine + total cystine (%)	0.87	0.87	0.87	0.87	0.87	0.87
Total methionine (%)	0.50	0.50	0.50	0.50	0.50	0.50
Total threonine (%)	0.92	0.92	0.92	0.92	0.92	0.92
Total tryptophan (%)	0.30	0.30	0.30	0.30	0.30	0.30

[1]Composition per kg of product: folic acid - 138.00 mg; calcium pantothenate - 2,750.00 mg; antioxidant - 500.00 mg; biotin - 13.80 mg; cobalt - 25.00 mg; copper - 2,500.00 mg; choline - 111,450.00 mg; iron - 6,250.00 mg; iodine - 260.00 mg; manganese - 13,000.00 mg; methionine - 300 g; niacin - 6,875.00 mg; pyridoxine - 550.00 mg; colistin - 1,750 mg; riboflavin - 1,375.00 mg; Selenium - 45.00 mg; thiamine - 550.00 mg; vit. A - 2,150,000.00 IU; vit. B12 - 2,750.00 mcg; vit. D3 - 555,000.00 IU; vit. E - 2,750.00 IU; vit. K - 400.00 mg; zinc - 11,100.00 mg; silicates - 20,000.00 mg

In the economic viability assessment of the inclusion of PWRB in the diets, the cost of the ration (CR) per kilogram of live weight gain was determined, according to the equation proposed by Bellaver *et al.* (1985): Yi = (Qi × Pi) / Gi, where Yi = feed cost per kilogram of live weight gained in the i_{th} treatment; Pi = price per kilogram of the feed used in the i_{th} treatment; Qi = amount of feed consumed in the i_{th} treatment and Gi = weight gain in the i_{th} treatment. The economic efficiency index (EEI) and the cost index (CI) proposed by Fialho *et al.* (1992) were also calculated as: EEI = (MCei / CTei) × 100 and IC = (CTei / MCei) × 100, where MCei = lowest feed cost per kilogram gained, observed between treatments and CTei = cost of treatment i considered.

When calculating the cost of feed in the first experiment, the values of U$ 0.30; U$ 0.47; U$ 0.94; U$ 0.17; U$ 0.09 and U$ 1.10 were considered for the kilogram of corn, soybean meal, soybean oil, PWRB, limestone and dicalcium phosphate, respectively. In experiment 2, for those same ingredients, the values considered were: U$ 0.39; U$ 0.68; U$ 1.19; U$ 0.17; U$ 0.06 and U$ 1.15.

The statistical analyses of the data were performed using the software Statistical Analysis System, version 9.2. The degrees of freedom regarding the levels of inclusion of parboiled whole rice bran, excluding the zero level of inclusion (control), were divided into polynomials, in order to establish the curve that best described the behavior of the data. To compare the results obtained in each level of inclusion in relation to those found in the control group, the Dunnet's test (5%) was used.

RESULTS AND DISCUSSION

The performance results of meat quails fed with different levels of inclusion of PWRB in the rations (Table 3) indicate a significant influence of the level of inclusion on intake and weight gain in both experiments, however, the feed conversion varied significantly only in the second experiment. According to the regression analysis, in the first experiment, the inclusion of PWRB at levels above 5% promoted a linear reduction in feed intake (Y = 1051.33 - 7.83X; R^2 = 0.92) and in weight gain (Y = 235.47 - 0.76X; R^2 = 0.77), while the feed conversion did not vary significantly between the tested levels. In the second experiment, the inclusion of this feed at levels above 8% promoted a linear reduction in feed intake (Y = 990.7 - 7.0793X; R^2 = 0.70) and in weight gain (Y = 265.31 - 1.3481X; R^2 = 0.66) and improvement in the feed conversion (Y = 3.78 - 0.011X; R^2 = 0.67).

Comparing the results obtained with the different levels of inclusion of PWRB to the control, it was observed that there were no significant differences in the parameters evaluated in the first experiment, however, in

Table 3 - Performance of meat type quails fed diets containing different levels of parboiled whole rice bran

Level of inclusion (%)	Parameters		
	Feed Intake (g/bird)	Weight Gain (g/bird)	Feed Conversion
Experiment 1 (7 to 49 days of age)			
0	976.58	229.81	4.25
5	1024.68	231.51	4.44
10	948.61	231.55	4.10
15	951.62	219.07	4.35
20	882.36	219.59	4.03
25	862.02	218.41	3.96
Mean	940.98	224.99	4.19
SEM[1]	15.52	1.79	0.07
Statistical effects	P-value		
ANOVA[2]	0.0200	0.0300	0.2700
Linear regression	0.0010	0.0070	0.0700
Quadratic regression	0.7700	0.5000	0.9600
Experiment 2 (7 to 42 days of age)			
0	888.50	237.00	3.75
8	903.88	249.67	3.62
16	873.40	239.15	3.66
24	846.52	241.61	3.51
32	845.54	238.02	3.56
40	634.64*	196.31*	3.23*
Mean	832.08	233.63	3.56
SEM[1]	16.47	3.40	0.04
Statistical effects	P-value		
ANOVA[2]	0.0001	0.0001	0.0006
Linear regression	0.0001	0.0001	0.0019
Quadratic regression	0.1600	0.2700	0.0794

[1]Standard error of the mean; [2]Analysis of variance; *Different from control by the Dunnett test (P < 0.05)

the second, it was observed a significant difference only in the level of inclusion of 40% of PWRB, as the quails fed with this level of inclusion presented lower feed intake and weight gain and better feed conversion in comparison to the quails fed with the control diet.

Since the diets were formulated to be iso-nutrient, it was expected that the feed intake by the meat quails would not vary between treatments. However, as in the present study, some reports in the literature have shown an intake reduction with the increase of rice bran in the diet of growing (FREITAS *et al*., 2013) and laying (ABEYRATHNA *et al*., 2014; AMOAH; MARTIN, 2010) Japanese quails as well as broilers (GALLINGER *et al*., 2004; PIYARATNE *et al*., 2009; ZARE-SHEIBANI *et al*., 2015).

Usually, the intake reduction might be associated with the effects of the increase in the fibrous fraction and non-starch polysaccharides that constitute this fraction in the diet with the highest level of inclusion, since the greater presence of these polysaccharides can increase the viscosity of the intestinal chyme and volume occupied by the digesta in the digestive tract, decreasing the feed passage rate, causing greater satiety feeling, which determines less feed intake (GALLINGER *et al*., 2004; PIYARATNE *et al*., 2009; ZARE-SHEIBANI *et al*., 2015). This effect was more evident when the quails were fed the diet with 40% of PWRB, which had lower intake in comparison to the quails of the control group.

The lower weight gain of quails fed with rice bran has been reported by some researchers (GALLINGER *et al*., 2004; PIYARATNE *et al*., 2009; ZARE-SHEIBANI *et al*., 2015). The reduction in weight gain with the highest inclusion of rice bran in the feed has been associated, mainly, with the lower feed intake due to the satiety feeling promoted by the increase in fiber in the feed. However, when the intake is not significantly affected, the lower weight gain has been attributed to the lesser use of nutrients due to the negative effects of fiber and other anti-nutritional factors, such as phytic acid and trypsin inhibitor. In this context, the results obtained in the present study show that the reduction in feed intake with the increase of PWRB levels was the factor responsible for the lower weight gain of the quails, since, in the second experiment, the feed conversion improved with the inclusion of PWRB in the feed, to the point of obtaining the best result for quails fed 40% of PWRB, which could not have occurred if the anti-nutritional effects had influenced the use of nutrients by the quails.

However, it should be also considered the possibility that the improvement in feed conversion observed in the present study may be associated with the addition of oil with the increased inclusion of PWRB in the feed and the greater exposure of PWRB's lipids due to the thermal processing undergone during the rice grain processing stages (PASCUAL *et al*., 2013), which may have contributed to increase the availability of fat for digestion. In addition to being great suppliers of readily available energy, the inclusion of fats to the feed brings benefits due to the effects extra caloric and extra metabolic, contributing to a greater availability of feed energy and nutrients for the quails.

Considering that, in the second experiment, the inclusion of up to 32% of PWRB made it possible to obtain results statistically similar to those obtained with the control diet, it is recommend the inclusion of PWRB up to this level in the diet of meat quails. This recommended level is higher than those indicated by other studies that recommended dietary inclusion for Japanese quails in the growth phase of 25% parboiled rice bran (FREITAS *et al*., 2013); for laying Japanese quails of 30% parboiled whole rice bran (QUEVEDO FILHO *et al*., 2013), 20% whole rice bran (GOPINGER *et al*., 2016) and 25% rice bran (ZEWELL *et al*., 2016); and for quails 20% parboiled rice bran (FARIAS *et al*., 2014).

For the carcass characteristics (Table 4), no significant effect of the inclusion of PWRB was observed in both experiments, on the yield of carcass, breast, and drumstick + thigh.

Since the diets used were calculated to be iso-nutritive, the absence of variation on the carcass characteristics observed in the present study can be considered an expected result, because if the nutritional value of the feed is well assessed, it is unlikely that carcass characteristics are influenced by the inclusion of this feed in iso-nutrient diets.

The absence of significant influence from the inclusion of parboiled whole rice bran on broilers and meat quail's carcass yield has been reported by some researchers. Studying the inclusion of up to 40% (PIYARATNE *et al*., 2009) or up to 20% (OLADUNJOYE; OJEBIYI, 2010) the researchers checked that, although the performance was affected by the increased level of inclusion of the rice bran, the chicken carcass yield was not influenced. Farias *et al*. (2014), observed that the carcass yield and parts of the carcass of the quail were not influenced by the inclusion of up to 20% of PWRB in the feed. However, Bonato *et al*. (2004), observed that, although there was no influence on carcass yield, quails fed with 30% of rice bran showed lower breast yield, without any influence of this level on the yield of drumstick and abdominal fat.

The results for the economic viability variables of the inclusion of PWRB in the diets (Table 5) indicated that, in the first experiment, the inclusion of PWRB at levels above 5%, promoted a linear reduction in the cost of

Table 4 - Carcass characteristics of quails fed diets containing increasing levels of parboiled whole rice bran

Level of Inclusion (%)	Yield (%)		
	Carcass	Breast	Drumstick + Thigh
	Experiment 1 (49 days of age)		
0	78.93	34.37	20.14
5	78.27	33.56	19.50
10	77.43	32.72	18.46
15	77.95	32.58	18.95
20	77.40	33.14	19.26
25	77.76	32.18	19.05
Mean	77.96	33.09	19.23
SEM[1]	0.32	0.27	0.19
Statistical effects		P-value	
ANOVA[2]	0.77	0.20	0.20
Linear regression	0.68	0.21	0.93
Quadratic regression	0.66	0.83	0.32
	Experiment 2 (42 days of age)		
0	77.99	40.77	24.45
8	78.02	40.50	23.53
16	79.66	40.51	24.17
24	77.18	41.28	24.29
32	78.15	39.81	24.39
Mean	77.97	40.72	24.14
SEM[1]	0.41	0.26	0.16
Statistical effects		P- value	
ANOVA[2]	0.4390	0.5162	0.6191
Linear regression	0.2173	0.5413	0.3537
Quadratic regression	0.4954	0.6759	0.2001

[1]Standard error of the mean; [2]Analysis of variance; *Different from control by the Dunnett test ($P < 0.05$)

the feed per kilogram of live weight gain (Y = 4.27 - 0.03X; R^2 = 0.74), linear improvement in the economic efficiency index (Y = 85.82 + 0.56X; R^2 = 0.67) and linear reduction in the cost index (Y = 118.5 - 0.73X; R^2 = 0.74). In the second experiment, inclusion at levels above 8% promoted a linear reduction in the cost of the feed per kilogram of live weight gain (Y = 4.91 - 0.03X; R^2 = 0.91), and a linear improvement in the economic efficiency index (Y = 67.62 + 0.71X; R^2 = 0.87) and cost index (Y = 141.84 - 0.93X; R^2 = 0.92).

When comparing the means, it was observed that in the first experiment for all parameters of economic viability, the results obtained with the different levels of inclusion of PWRB did not present significant differences in comparison to those obtained for the control group. However, in the second experiment, all PWRB inclusion levels differed from the control ration, which had the highest cost per kilogram produced and, consequently, the worst rates of economic efficiency and cost.

Although comparing the results between the experiments is not the objective of the studies, it is important to emphasize that the difference in the magnitude of the responses of the economic viability variables for the inclusion of PWRB between the experiments may have occurred due to the influence of factors that should be considered. The first one is that there was an increase in the prices of corn, soybean meal and oil from the first to the second experiment, while the PWRB value was stable. The other is that the AMEn value considered for PWRB in the first experiment was 2,534 kcal/kg and in the second it was 3,065 kcal/kg. Thus, in the second experiment, it was possible to include a greater quantity of the evaluated feed with less inclusion of oil in the rations, contributing to reduce food costs with the inclusion of PWRB. These results make it evident that the economic viability of including alternative feeds may vary throughout the year, with the price variability of the main ingredients that makes up the feed, in this case, corn and soybean meal.

In general, the results obtained indicated the economic viability of including PWRB in the quail diet and corroborate the reports of other researchers (OLADUNJOYE; OJEBIYI, 2010; PIYARATNE *et al*., 2009; QUEVEDO FILHO *et al*., 2013), that it is possible to reduce feed costs by including this ingredient in the poultry feed.

According to the results, the lowest feed cost and the best economic and cost efficiency indexes occurred with the level of 25% and 40% of PWRB in the feed, in the first and second experiments, respectively. However, the 40% inclusion level also provided the least weight gain, as the high fiber content limited feed intake, making the growth of quails unfeasible. Thus, the best level of inclusion depends on obtaining adequate performance for the species. Therefore, parboiled whole rice bran can be used to feed meat quails at levels of up to 32%, without compromising performance and carcass characteristics, and for being economically viable.

Table 5 - Economic viability of the inclusion of parboiled whole rice bran in the feed of meat quails

Level of Inclusion (%)	Parameters		
	Feed Cost (U$/Kg of gain)	Economic Efficiency Index (%)	Cost Index (%)
Experiment 1 (7 to 49 days of age)			
0	1.73	89	112
5	1.79	88	117
10	1.64	95	106
15	1.72	90	112
20	1.58	98	103
25	1.54	100	100
Mean	1.66	93	108
SEM[1]	0.07	1.55	1.89
Statistical effects	P-value		
ANOVA[2]	0.09	0.08	0.08
Linear regression	0.02	0.03	0.02
Quadratic regression	0.97	0.81	1.00
Experiment 2 (7 to 42 days of age)			
0	2.06	71	142
8	1.94*	76*	132*
16	1.88*	78*	128*
24	1.79*	83*	121*
32	1.72*	86*	117*
40	1.48*	100*	100*
Mean	1.82	82	123
SEM[1]	0.09	1.77	2.46
Statistical effects	P-value		
ANOVA[2]	0.0001	0.0001	0.0001
Linear regression	0.0001	0.0001	0.0001
Quadratic regression	0.1200	0.1763	0.5688

[1]Standard error of the mean; [2]Analysis of variance; *Different from control by the Dunnett test ($P < 0.05$)

CONCLUSIONS

The parboiled whole rice bran can be used in the feeding of meat type quails at levels of up to 32%, no loss of growth performance and carcass characteristics.

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