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Performance of european laying quail fed with diets containing maize germ meal

Desempenho de postura de cordornas europeias alimentadas com dietas contendo farelo de gérmen de milho

Rendimiento de la codorniz ponedora europea alimentada con dietas que contienen harina de germen de maíz

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Abstract

The objective of the research was to study the effect of substitution of maize for maize germ meal in laying European quail diets. 240 female quails were used in a randomized design with three treatments and eight replications, containing 10 birds per plot. The treatments consisted of a maize and soybean meal-based reference diet and two levels of substitution of maize for maize germ meal, 50 and 100%. Evaluated parameters were: number of eggs per bird housed, laying rate, feed intake, feed conversion, weight of egg, yolk, albumen and shell, and yolk pigmentation. Parameters were evaluated using analysis of variance and Tukey test, with the significance level set at 5%. In the two laying cycles studied there was a difference in the number of eggs, percentage of laying, feed conversion, weight of egg, yolk and shell and yolk pigmentation. The replacement of maize by maize germ meal in diets for laying European

quail can be carried out up to 100%, producing improvement in the productive performance of the birds and in egg quality.

Keywords: Egg quality; Laying percentage; Yolk weight; Zootechnical performance.

Resumo

O objetivo da pesquisa foi estudar o efeito da substituição do milho pela farinha de gérmen de milho na dieta de codornas europeias em postura. Foram utilizadas 240 codornas fêmeas em delineamento inteiramente casualizado com três tratamentos e oito repetições, contendo 10 aves por parcela. Os tratamentos consistiram de dieta referência à base de milho e farelo de soja e dois níveis de substituição de milho por farelo de gérmen de milho, 50 e 100%. Os parâmetros avaliados foram: número de ovos por ave alojada, taxa de postura, consumo de ração, conversão alimentar, peso do ovo, gema, albumina e casca e pigmentação da gema. Os parâmetros foram avaliados por meio de análise de variância e teste de Tukey, com nível de significância de 5%. Nos dois ciclos de postura estudados houve diferença no número de ovos, porcentagem de postura, conversão alimentar, peso do ovo, gema e casca e pigmentação da gema. A substituição do milho por farelo de gérmen de milho em dietas para codornas europeias poedeiras pode ser realizada em até 100%, produzindo melhora no desempenho produtivo das aves e na qualidade dos ovos.

Palavras-chave: Qualidade do ovo; Percentual de postura; Peso da gema; Desempenho zootécnico.

Resumen

Incluir El objetivo de la investigación fue estudiar el efecto de la sustitución del maíz por harina de germen de maíz en las dietas de las codornices europeas ponedoras. Se utilizaron 240 codornices hembras en un diseño aleatorio con tres tratamientos y ocho repeticiones, conteniendo 10 aves por parcelaLos tratamientos consistieron en una dieta de referencia a base de maíz y harina de soja y dos niveles de sustitución de maíz por harina de germen de maíz, 50 y 100%. Los parámetros evaluados fueron: número de huevos por ave alojada, tasa de puesta, consumo de alimento, conversión alimenticia, peso del huevo, yema, albúmina y cáscara, y pigmentación de la yema. Los parámetros se evaluaron mediante análisis de varianza y prueba de Tukey, con el nivel de significancia establecido en 5%. En los dos ciclos de puesta estudiados hubo diferencia en el número de huevos, porcentaje de puesta, conversión alimenticia, peso del huevo, yema y cáscara y pigmentación de la yema. La sustitución del maíz por harina de germen de maíz en las dietas para la puesta de codorniz

europea se puede realizar hasta en un 100%, produciendo una mejora en el comportamiento productivo de las aves y en la calidad del huevo.

Palabras clave: Calidad del huevo; Porcentaje de puesta; Peso de la yema; Actuación zootécnica.

1. Introduction

Use Nutrition studies proposing the replacement of maize and soybean meal by unconventional foods, such as broken rice (Ashour et al., 2015), and sorghum (Freitas et al., 2014; Silva et al. 2018) have been gaining prominence, because it reduces the cost of formulating feed for Japanese quails (Coturnix coturnix japonica) (Edache et al., 2005; Niamat, 2017; Lucena et al., 2019) and European quail (Coturnix coturnix) (Silva et al., 2019; Severo et al., 2020).

The price of maize grain has fluctuated considerably, causing poultry producers to search for alternative foods for use in poultry diets (Swain et al., 2006; Ashour et al., 2015; Niamat, 2017). Under such circumstances, one option is maize germ meal, obtained as a residue from the production of precooked cornmeal for couscous.

Because it has high levels of lipids, proteins and fibers in its composition, maize germ meal is already widely used as an ingredient in animal feed (Brito et al., 2005). Maize germ meal has 4,700 kcal/kg of apparent metabolizable energy (AME), making it possible to decrease the inclusion of vegetable oil in poultry diets.

Some authors have evaluated the zootechnical performance of commercial laying hens fed with maize germ meal, reporting that it does changes neither their yield or performance, as measued by egg production and feed conversion (Brito et al., 2005; Brunelli et al., 2012).

Given the above, the objective of the current study was to evaluate the effects of using whole maize germ meal on the production parameters of European quail (Coturnix coturnix) laying.

2. Methodology

The study was carried in an aviary at the Fazenda São João, located in the district of Santa Rita, municipality of Serra Talhada, Pernambuco State, Brazil (latitude 08º 04 '03 "S, longitude 34º 55' 00" W), under license number 087/2016 of the ethics committee on the use of animals of the Federal Rural University of Pernambuco.

A total of 240 female quails (Coturnix coturnix) were used. All were 107-day old when the experiments began. Experimental design was completely randomized with three treatments and eight replications, with animals housed in 24 metal cages (experimental plot), with 10 birds per plot. The experiment was divided into two laying cycles, each with 28 production days.

The aviary was equipped with ventilation and nebulization equipment. Throughout the experimental period, maximum and minimum temperatures, and air relative humidity were recorded daily at 9 am and at 4 pm with digital thermohygrometers located in the aviary.

Each experimental plot was provided with an automatic waterer, trough type feeder, and egg collection spout. Water and feed were provided ad libitum. Birds were kept under a 17-hour photoperiod light program, controlled by an automatic timer, and received experimental diets according to the treatments.

The maize germ meal used in to construct the experimental diets was analyzed in the animal nutrition laboratory of UFRPE zootechnics department, with the following results: 92.3% dry matter, 7.7% humidity, 10.26% crude protein, 54.81% ether extract, 7% mineral matter, 6.35% crude fiber, 27.14% neutral detergent fiber, 6.89% acid detergent fiber.

Posteriorly a quail digestibility test was carried out, which determined the content to have 7,380 kcal/kg crude energy and 3,790 kcal/kg apparent metabolizable energy.

Treatments consisted of a reference diet based on maize and soybean meal and two experimental diets where maize was replaced by 50 and 100% maize germ meal, respectively. Table 1 shows the analysed composition of the standard and two experimental diets following the nutritional recommendations of Rostagno et al. (2017).

Table 1. Composition of experimental diets for European quails used in current study.

	Dietary maize levels (%)		
Ingredients	0.00	50.00	100.00
Corn	58.000	29.000	0.000
Soybean meal	31.510	29.200	27.922
Maize germ meal	0.000	29.000	58.000
Dicalcium phosphate	1.165	0.940	1.390
Calcitic limestone	7.208	7.800	7.800
L-lysine 99%	0.181	0.140	0.380
DL-methionine 99%	0.209	0.210	0.280

Common salt	0.462	0.375	0.550
Vegetable oil	1.060	0.000	0.000
L-tryptophan	0.040	0.040	0.040
L-threonine	0.004	0.015	0.190
Premix vit. + min *Posture*[1]	0.200	0.200	0.200
Inert	0.321	3.080	3.248
Calculated composition of diets			
Linoleic acid (%)	1.330	1.69	2.05
Calcium (%)	3.180	3.395	3.61
Metabolizable energy (kcal/kg)	2.900	2.949	2.998
Crude fiber (%)	2.662	3.386	4.110
Available phosphorus (%)	0.321	0.375	0.430
Fat (%)	3.490	17.985	32.480
Digestible lysine (%)	1.055	1.155	1.255
Methionine+digestible cystine (%)	0.746	0.779	0.813
Digestible methionine (%)	0.483	0.520	0.558
Crude protein (%)	19.620	19.750	19.880
Sodium	0.233	0.240	0.247
Digestible threonine (%)	0.657	0.730	0.803
Digestible tryptophan (%)	0.219	0.239	0.259

[1]Mineral vitamin supplement per kg of product: vit. A - 2,500,000 IU; vit. B1 - 350 mg; vit. B12 - 2,750 mcg; vit. B2 - 1,250 mg, vit. B6 - 500 mg; vit. D3 - 625,000 IU; vit. E - 1500 mg; vit. K 400 mg; folic acid - 100 mg; pantothenic acid - 2,500 mg; copper - 2,000 mg; iron - 12,500 mg; zinc - 12,500; iodine 187.5 mg; manganese - 18,750 mg; niacin - 6,250 mg; selenium - 75 mg; antioxidant - 2.5 g; vehicle Q.S.P. - 1,000 g. Source: Authors.

The following metrics were quantified during the experiment: feed intake (g/bird/day), feed conversion per egg mass (gram of feed per gram of egg), egg number per plot, egg production per bird/day (%) (laying rate), egg weight (g), yolk weight (g), albumen weight (g), shell weight (g) and yolk pigmentation (value scale from 1 to 5, from light to intense yellow).

An analysis of variance was used to compare the effect of diets on the tested variables, after differences analysed with a Tukey test at the 5% level ($P \leq 0.05$). The data were entered into an Excel spreadsheet, and analyzes performed with the R-Project software version 2.13.1 for Windows.

3. Results

Analysis of results from the first European quail 28-day laying production cycle showed a statistically significant difference in egg number (P≤0.05), percentage of laying (P≤0.05), and feed conversion (P≤0.05), between the different diets provided to experimental birds (Table 2).

Table 2. Egg number, laying percentage, feed intake and feed conversion of birds in relation to the levels of maize substitution by maize germ meal in both laying cycles.

	Maize substitution levels (mean±SEM)			
	0%	50%	100%	P-value
First Laying Cycle				
Egg number (und.)	23.69±0.26b	25.95±0.42a	25.33±0.40a	0.012
Laying percentage (%)	84.64±5.25b	92.50±8.51a	90.48±8.08a	0.003
FI (g)	30.33±0.48	30.23±0.53	30.57±0.44	0.375
FC	2.34±0.10b	2.28±0.06a	2.20±0.10a	0.007
Second Laying Cycle				
Egg number (und.)	26.53±0.238	27.37±0.231	26.63±0.400	0.121
Laying percentage (%)	84.64±4.77b	92.50±4.63a	90.48±8.01a	0.014
FI (g)	32.76±0.23	32.90±0.10	33.01±0.02	0.228
FC	2.40±0.06c	2.23±0.04b	2.17±0.06a	<0.001

a, b, c- values in rows with different letters differ significantly (P≤0.05), acoording to Tukey test. SEM= standard error of the mean. FI = feed intake; FC = feed conversion. Source: Authors.

In the first laying cycle, the number of eggs per birds housed and the laying percentage were higher for birds fed maize germ meal, while the highest feed conversion was recorded for birds that were not fed maize germ meal, Table 2.

Feed conversion improved linearly in birds that consumed diets containing corn germ bran. As shown in Table 2, during the first laying cycle of the birds, there was no difference in feed intake for the different diets (P>0.05).

In the second laying cycle, no significant effects were observed for either egg number per housed bird (P>0.05) or mean daily feed intake (P>0.05) (Table 2). However, there was a significant difference (P≤0.05) for the laying percentage, with a significant increase in production by 7.86%, from 84.64% to 92.5% with the introduction of maize germ meal. Feed

conversion was highest for birds that were not fed maize meal (P≤0.05) (Table 2).

In the first laying cycle, egg weight, yolk weight, shell weight and yolk pigmentation differed significantly (P≤0.05) between the different diets offered to the birds (Table 3).

Table 3. Egg weight, yolk weight, albumen weight, shell weight and yolk pigmentation index in relation to the levels of substitution of maize by maize germ meal in both laying cycles.

	Maize substitution levels (mean±SEM)			
	0%	50%	100%	P-value
First Laying Cycle				
Egg weight (g)	13.20±0.45b	13.96±0.27a	13.55±0.60ab	0.019
Yolk weight (g)	4.54±0.15b	5.19±0.25a	4.63±0.23b	<0.001
Albumen weight (g)	6.97±0.41	7.12±0.48	7.23±0.41	0.373
Shell weight (g)	1.81±0.15ab	1.91±0.16a	1.75±0.12b	0.014
Yolk pigmentation	3.62±0.29a	1.84±0.36b	1.00±0.00c	<0.001
Second Laying Cycle				
Egg weight (g)	13.65±0.32b	14.72±0.27a	15.21±0.40a	<0.001
Yolk weight (g)	4.37±0.23b	4.88±0.54a	5.08±0.30a	<0.001
Albumen weight (g)	7.47±0.38	7.82±0.54	7.79±0.53	0.172
Shell weight (g)	1.66±0.10c	2.06±0.43b	2.30±0.94a	<0.001
Yolk pigmentation	4.75±0.32a	4.06±0.47b	1.531±0.24c	<0.001

a, b, c- values in rows with different letters differ significantly (P≤0.05), acoording to Tukey test. SEM= standard error of the mean. Source: Authors.

In the first laying cycle, egg weight increased by an mean of approximately one gram per egg for both the 50% and 100% replacements of maize by maize germ meal in quail diets. It also altered yolk weight, which increased linearly with increase of maize germ meal the in the diets, Table 3.

For the first laying cycle, no significant difference was detected in albumen weight between the different diets (P>0.05). In the first laying cycle the yolk pigmentation index decreased linearly with the replacement of maize by maize germ meal (Table 3).

In the second laying cycle, the egg weight increased significantly (P≤0.05) when the birds were fed diets containing 50 and 100% maize germ meal (Table 3). An increase in shell weight (P≤0.05) was observed in the second laying cycle with the replacement of maize by maize germ meal. Additionally, in the second laying cycle there was a decrease in the yolk

pigmentation index (P≤0.05) as a function of the increase of maize germ meal (Table 3).

4. Discussion

Laying percentage was higher for birds fed with maize germ meal, this may have occurred, as the birds also produced more eggs. However, Severo et al. (2020) found that, when fed with up to 43% maize meal and 1.233% digestible lysine. European quail have a maximum of 77.79% in their laying. Silva et al. (2019) reported that, in European quail fed up to 50% maize meal, feed conversion and feed intake negatively influenced egg production, with a rate of 0.3%, respectively.

Sultana et al. (2007) reported a laying percentage 60% in Japanese quail fed with a 60% maize diet. The Posture percentage for commercial laying birds did not change with the introduction of maize germ meal into their diets (Brito et al., 2005; Brunelli et al., 2012). Li et al. (2011) found that laying percentage in yellow quail decreased as corn in the diet decreased.

Feed conversion was better for birds fed with maize germ meal, this probably occurred as a function of the significant increase in the content of essential unsaturated fatty acids present in the maize germ meal. Severo et al. (2020) reported that European quails fed with 43% maize meal and 1.417% digestible lysine showed a feed conversion ratio of 2.98, a value much higher than that found in this research (< 2.41 to all diets). For laying hens, Brunelli et al. (2010) noted that the inclusion of up to 21.2% of maize germ meal greatly improved feed conversion. Parizadian et al. (2011) reported feed conversion of 3.58 for Japanese quail fed with 50% maize.

Feed intake showed no difference between treatments, even with an increase in the fiber content of the diets, which could increase the feed intake of birds as a result of a potential decreases in diet component digestibility, so reducing the nutrients available to the study animals. in addition, there was an increase in the energy content of the diets with the replacement of maize by maize germ meal, which is the first limiting factor for food consumption by the organism. Parizadian et al. (2011) found that feed intake of Japanese quail was of 41.97 when fed a diet containing 50% maize. Ashour et al. (2015) reported that that quail increase feed intake when the percentage of corn in the diet decreases.

Birds fed with maize germ meal had heavier eggs, a result which agrees with Severo et al. (2020), who found that the weight of the European quail egg reached a maximum of 23.92 g when fed with 43% maize meal and 1.417% digestible lysine. Sultana et al. (2007) found Japanese quail produced egg weighing 9.74g when fed with a 60% maize diet, while

Parizadian et al. (2011) reported mean egg weights of 11.91g for Japanese quail fed a diet of 50% maize. However, yellow quail fed different levels of corn in their diets showed no difference in egg weight (Li et al., 2011). The eggs weight of commercial laying did not change wheb of maize germ meal was introduced into their diets (Brito et al., 2005; Brunelli et al., 2012). This fact may have occurred because quails are better adapted to the physiological condition of the breeding environment than commercial laying hens as a function of the relative body size, mainly due to the increase in water consumption.

No significant difference in albumen weight was detected between the different diets in the first and second laying cycles, this is probably due to the significant increased availability of essential unsaturated fatty acids due to their enhanced levels in maize germ meal (mainly as linoleic acid), which directly contributes to the formation and nutrition of the egg yolk resulting in larger and heavier eggs. Parizadian et al. (2011) found that albumen weight of Japanese quail was of 6.18g when fed with a 50% maize diet.

Differences in weight of the shell occurred because diet substitution was accompanied by an increase in the calcium levels of the available food, as shown in Table I. The increase in the bird's dietary calcium promoted an increase in the quality of the egg shell, compared to the other egg components. Sultana et al. (2007) noted shell weight of 0.77g for Japanese quail fed with 60% maize diets, while Parizadian et al. (2011) reported that shell weight of Japanese quail was of 1.04g when fed with 50% maize diets. In the current study the shell weight was 1.91 (first cycle) and 2.06 (second cycle).

For Japanese quail, Parizadian et al. (2011) reported mean yolk weights of 3.70g when feed was 50% maize, in the current study shell weight was 5.19g (first cycle) and 4.88g (second cycle). Oberved differences in yolk pigmentation possibly resulted from the reduced amounts of xanthophyll present in the maize germ meal compared to ground maize (Moros et al., 2002). The yolk pigmentation index in commercial hens decreased with the inclusion of maize germ meal in their diets (Brunelli et al., 2012). The decrease in yolk pigmentation in the second cycle occurred with greater intensity than in the first laying cycle, likley due to the decrease in the accumulation of β-carotene within the birds' bodies.

Overall, results observed for both the increase in the laying percentage and the egg weights indicates that the birds laid a greater quantity of eggs, and that these were heavier, which was directly related to feed conversion, causing improvement.

5. Conclusions

The substitution of maize for maize germ meal in diets of egg producting European quails can occur up to 100%, producing improvement in both bird productive performance, and in the quality of eggs produced.

To improve the results found, new studies can be used with more levels substitution of maize for maize germ meal in diets of European quails.

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