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Original Paper

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Quality of european quail eggs (*Coturnix coturnix coturnix*) as influenced by diet including guava meal (*Psidium guajava* L.)

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Abstract

The processing of the guava fruit has generated residues that can be used in animal feed, in order not only to reduce feed production costs, but also to give destinations to industry by-products. This study aimed to evaluate the effect of including guava meal (*Psidium guajava* L.) in european quail diets (*Coturnix coturnix coturnix*) on egg quality, in the first laying cycle. For this, an experiment was carried out at the Rural Federal University of Pernambuco / Academic Unit of Serra Talhada (UFRPE / UAST), in the municipality of Serra Talhada - semiarid region of Pernambuco, Brazil. European quails were used in wire cages arranged on pyramidal stands. The treatments consisted of a reference diet (based on corn and soybean meal, without the inclusion of guava seed meal) and four levels of inclusion of guava seed meal (2, 4, 6 and 8%) to the detriment of inclusion of corn in diets. It was observed that there was no significant difference between the levels of guava bran, included in the european quail diets in terms of: albumen height, yolk height, shell thickness, yolk color and egg weight. Thus, it was concluded that guava bran can be included in diets for european quails in production at the expense of the inclusion of corn without affecting the quality of eggs.

Key-words: Semiarid, Animal Nutrition, Egg Quality, Animal Diet

Introduction

The classic foods, corn and soybean meal, added together represent the largest proportion in the composition of the quail feeds, reaching more than 90% of the diet. However, issues related to the supply and prices of these foods can increase production costs on breeding quails. In order to minimize these effects, alternative foods have been sought more and more to compose feed for birds. The use of these alternative foods aims to reduce costs, give destination to industrial by-products and / or agricultural production, in addition to enabling production in a family farming system, contributing to the reduction of environmental and / or social risks (Cunha, 2009).

Lousada Júnior et al. (2006) state that in the Northeast region of Brazil, due to the low production of corn and soybeans, there is a constant concern on the part of nutritionists to evaluate foods that can be used in poultry feed, in order to reduce production costs. On the other hand, according to Diógenes et al. (2014) agroindustrial residues from fruit growing have high availability in the market and thus arouse interest for use in animal feed in addition to having considerable amounts of essential nutrients for the development of birds.

According to the Ministry of Agriculture, Livestock and Supply (MAPA, 2017) Brazil is one of the largest guava producers in the world with production in 2015 of 424.3 thousand tons. The Northeast region of Brazil reached the leadership, surpassing the Southeast, corresponding, together,

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for 91.1% of the state volume. Pernambuco recorded the highest volume growth among the main states with 49.6% between 2014 and 2015, taking first place in the national ranking with a total production of 144.9 thousand tons.

According to Mantovani et al. (2004), the industrial process of the guava fruit, 8% is composed of residues that have been discarded by the open industries or landfills. Camelo et al. (2015) evaluating the inclusion of guava meal in the diet of european quails present high values of metabolizable energy of 2,900 kcal kg^{-1}; and values of 24% crude protein; 1.22% of mineral matter; 11.71% of ether extract; 0.16% lysine; 0.49% methionine + cystine and 55.2% crude fiber. Thus, in order to obtain better production and profitability through a feeding program, it is essential that there is consistency during the formulation of the feed with the concern, mainly, in relation to the adequate amount of energy used. For this reason, research has been carried out in order to obtain greater precision in the energetic use of the ingredients used in the rations for each species or animal category (Guimarães, 2007).

In this context, this study aimed to evaluate the effect of including guava meal (*Psidium guajava* L.) in european quail diets (*Coturnix coturnix coturnix*) on egg quality, in the first laying cycle.

Material and methods

Characterization of the experimental site

The experiment was carried out from March 10 to April 6, 2017, on the campus of the Rural Federal University of Pernambuco / Academic Unit of Serra Talhada (UFRPE / UAST), in the municipality of Serra Talhada, semiarid of Pernambuco, Brazil. The experimental area is located in the semiarid of Pajeú mesoregion, under the geographical coordinates 7º 59 ’7’ ’South latitude and 38º 17’ 34 ’’ West longitude, with an average altitude of 443 m (Figure 1). According to the Köppen classification, the climate is semi-arid BShw ', hot and dry, with very irregular rainy seasons, with rains occurring between the months of December to May and according to the Department of Atmospheric Sciences at the Federal University of Campina Grande (UFCG-DCA 2013) the highest values occur in March and the

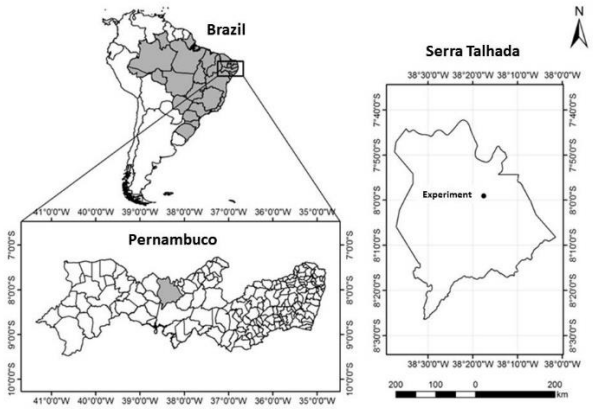

Fig. 1. Location of the Academic Unit of Serra Talhada, in the municipality of Serra Talhada-PE, Brazil.

annual average is approximately 642 mm. The data on temperature, precipitation and relative humidity of the air, according to records of the National Institute of Meteorology (INMET, 2017), for the municipality of Serra Talhada - PE, during the period of the experiment are shown in Table 1.

Table 1. Climatic characterization of the municipality of Serra Talhada-PE, during the period of the experiment.

Month	Aver. Temp (ºC)	Max Temp (ºC)	Min Temp (ºC)	RH (%)	AP (mm)
March	27.13	34.56	25.01	62.77	97.50
April	25.44	31.92	20.93	73.25	118.50

RH = Relative Humidity; AP = Average Precipitation.

Experimental cages

Wire cages were used in pyramidal stands, with capacity for 200 birds, with the following dimensions: 52 cm long x 28 cm wide x 32 cm high, with an approximate capacity of 42 cm^2 per bird. The feeders used were of the gutter type coupled to the cage, and the automatic nipple drinkers with piped water supply. The birds were submitted to a lighting program lasting 17 hours and 30 minutes of daily photoperiod, being artificial.

Treatments and experimental design

The treatments consisted of a reference diet (based on corn and soybean meal, without the inclusion of guava seed meal) and four levels of inclusion of guava seed meal (2, 4, 6 and 8%) to the detriment of inclusion of corn in diets. The experimental design was completely randomized, with five treatments and five repetitions, totaling 25 experimental units. Each experimental unit consisted of six birds housed in wire cages suitable for breeding quails in production, the cages were identified with a plate containing the appropriate treatments and repetitions (Figure 2).

Fig. 2. Stocking of quails in experimental cages.

Experimental rations

In the composition of the diets, guava seed bran partially replaced corn, as can be seen in (Table 2).

Table 2. Proximate composition of experimental diets supplied to quails during the 28 days of evaluation.

Ingredients (%)	**Levels of inclusion of guava meal in diets (%)**				
	0	**2**	**4**	**6**	**8**
Corn	44.289	42.273	40.256	38.240	36.223
Soybean meal	38.754	37.730	36.706	35.682	34.658
Guava bran	0.000	2.000	4.000	6.000	8.000
Limestone	7.752	7.753	7.355	7.157	6.958
Soy oil	6.065	6.583	7.101	7.619	8.137
Meat meal	0.000	1.250	2.500	3.750	5.000
Dicalcium phosphate	1.680	1.270	0.870	0.720	0.060
Common salt	0.478	0.450	0.430	0.310	0.400
Threonine	0.408	0.373	0.337	0.302	0.266
Methionine	0.267	0.022	0.176	0.131	0.086
Lysine	1.102	0.077	0.051	0.025	0.000
Mineral Premix	0.100	0.100	0.100	0.100	0.100
Vitamin Premix	0.100	0.100	0.100	0.100	0.100
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100,00**
	Chemical composition				
Linoleic acid (%)	5.000	5.400	5.800	6.200	6.6
Starch (%)	32.91	31.50	30.10	28.70	27.30
Arginine Dig.(%)	1.4	1.6	1.9	2.1	2.4
Cálcium (%)	3.5	3.5	3.5	3.5	3.5
Chlorine (%)	0.32	0.31	0.31	0.30	0.30

Energy Mcal Kg^{-1}	2.9	2.9	2.9	2.9	2.9
Fenil Dig.(%)	0.9	0.9	1.05	1.12	1.2
Fenil+Tiros.(%)	1.66	1.62	1.58	1.54	1.5
Crude fiber (%)	3.15	3.06	2.97	2.88	2.80
Phosphorus Av.(%)	0.4	0.4	0.4	0.4	0.4
Fat (%)	8.0	8.6	9.6	10.4	11.2
Histidine (%)	0.5	0.5	0.5	0.5	0.6
Isoleucine (%)	0.8	0.8	0.9	0.9	1.0
Leucine (%)	1.6	1.7	1.8	1.9	2.0
Lysine (%)	1.15	1.13	1.12	1.11	1.10
Met.+Cist.(%)	0.8	0.85	0.9	0.9	1.0
Metionine Dig.(%)	0.50	0.47	0.45	0.42	0.40
Potassium (%)	0.8	0.7	0.7	0.7	0.7
Crude protein (%)	22	22	22	22	22
Sodium (%)	0.23	0.22	0.21	0.20	0.20
Threonine Dig.(%)	1.1	1.1	1.1	1.1	1.1
Tryptophan Dig.(%)	0.25	0.23	0.22	0.21	0.20
Xanthophyll (%)	11.00	10.62	10.25	9.87	9.5

[1] Premix Vitamin (composition per kilo of product): Folic Acid 106 mg; Pantothenic 2.490 mg; Antifungal 5.000 mg; Antioxidant 200 mg; Biotin 21 mg; Coccidiostatic 15.000 mg; Colina 118.750 mg; Vitamin K3 525,20 mg; Niacin 7.840 mg; Pyridoxine 210 mg; Riboflavin 1.660 mg; Thiamine 360 mg; Vitamin A 2.090.000 UI; Vitamin B12 123.750 mcg; Vitamin D3 525.000 UI; Vitamin E 4.175 mg.
[2] Premix Mineral (composition per kilo of product): Cu 2.000 mg; I 190 mg; Mn 18.750 mg; Se 75 mg; Zn 12.500 mg.

The rations were calculated to be formulated to meet the nutritional requirements of the birds. The nutritional composition of the guava seed meal used to formulate the experimental diets was used as established by Camelo et al. (2015).

Bird management

Management was carried out according to the recommendations described by Albino and Barreto (2003). From the sixty-fifth day of life, the birds were subjected to a 17-hour and 30-minute light program, and received the experimental diets twice a day, in the morning at 7:30 am, and at the end of afternoon, at 16:00 h, according to the treatments, in the amount of 30 grams / bird / day.

Studied variables

The egg quality variables evaluated were: albumen height (g), yolk height (g), shell thickness (µm) and yolk color (colorimetric score and reflectance colorimetry). The eggs were collected daily in the morning at 8:00 am, and in the late afternoon, at 4:30 pm.

To determine the yolk height, albumen height and shell thickness, four whole eggs from each consecutive plot were randomly collected on the last and penultimate day. After identification and weighing on a scale with a precision of 0.01 g, the eggs were broken and their yolks and whites separated manually.

The peel thickness, with the removal of the membranes, was measured by reading at two different points in the equatorial region using a LEE Stainless Steel Pachymeter, with 150 mm DIGITAL stroke, 0.01 mm resolution and 0.02 mm precision.

The color analysis of the gem was performed using four gems per repetition and two methodologies, one subjective and the other direct (instrumental). In the first method, the DSM colorimetric score (fan or fan) was used, in which

the color of the gem was compared to a fan color scale, and according to the visual similarity, obtained by three evaluators. At the time, an average value between 1 and 15 was assigned, as described by Galobart et al. (2004).

Data analysis

The effects of the levels of substitution of corn for guava meal were evaluated by analysis of variance, at 5% probability, using version 16.0 of the Statistical Package for the Social Sciences - SPSS.

Results and discussion

It was found that the inclusion of guava meal in the tested diets did not affect the quality of quail eggs. It was observed that there was no significant difference between the levels of guava bran, included in the european quail diets in terms of: albumen height, yolk height, shell thickness, yolk color and egg weight (Table 3).

Table 3. Egg quality of european quails fed diets containing guava bran to replace corn.

Variable	Level of inclusion of guava meal in the feed (%)					CV	P
	0	2	4	6	8	(%)	value
Albumen weight (g)	3.93 a	3.87 a	4.07 a	4.51 a	3.75 a	11.87	0.1
Yolk weight (g)	11.44a	8.77 a	11.86 a	11.38 a	11.96 a	20.36	0.2
Shell thickness (mm)	0.22 a	0.21 a	0.22 a	0.21 a	0.23 a	4.71	0.2
Gem color	5.10 a	5.65 a	4.40 a	4.35 a	4.47 a	13.75	0.3
Egg weight (g)	13.85a	13.37 a	13.81 a	13.57 a	13.67 a	3.98	0.1

CV = coefficient of variation, at 5% probability.

These results corroborate those observed by Oliveira (2016), who carried out an evaluation of the inclusion of an antioxidant extract produced from the residue of the guava processing on the performance of Japanese quails (*Coturnix japonica*) in the laying phase, did not find significant effects of the treatments on production indexes and concluding that it does not affect the internal and external characteristics of fresh eggs.

For the yolk (weights and percentage), bark and albumen, the non-statistical difference present in this work corroborates the results observed by Móri et al. (2005), who evaluated the internal and external quality of quail eggs from four genetic groups and indicated that the genetic groups of broiler quails have the capacity to produce quality eggs, indicating that females have skill as broiler chickens of quails.

Similar result also when used by Freitas et al. (2013) who do not select specific differences for the weight of yolk, bark and albumen in commercial laying hens fed diets, which are extrac ted produced from the core and shell of the manga, according to Huber et al. (2012) are fractions of fruits rich in phenolics that are bioactive compounds with great antioxidant potential, the same present in guava bran used in this experiment.

Although guava has significant levels of total carotenoids, in particular lycopene, an element, in effect, pigment and antioxidant, the values observed for yolk color did not show significant differences. Oliveira (2016) comments that although the color of the gem is a criterion of quality evaluation by the consumer or industry. The quail egg is usually eaten cooked and whole, unlike the chicken egg, which is subjected to cooking, frying or processing by the food industry. This makes the color of the quail egg yolk an attribute of secondary economic importance or of little relevance.

Conclusion

The inclusion of guava meal in european quail diets does not affect the quality of eggs, and may

be included in the production process to the detriment of the inclusion of corn.

Conflict of interest: All authors declare no conflict of interest.

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