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ANIMAL PRODUCTION

# The use of cinnamon powder in the diet of Japanese laying quail

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**ABSTRACT.** The objective of this study was to evaluate the inclusion of powder cinnamon in the diet of Japanese quails, regarding their performance and egg quality. A total of 360 quails, 18 weeks old, were distributed in a completely randomized design with five treatments and six replicates of 12 animals. The experimental period lasted 84 days. The treatments were the inclusion of 0; 3.0; 6.0; 9.0 and 12.0 g kg$^{-1}$ of cinnamon powder in the diet. The performance and quality of eggs produced were evaluated. A sensorial analysis of the eggs was carried out to evaluate the color of the egg yolk, the taste of the egg and the purchase intention. There was no significant effect on the performance and egg quality variables, except for the specific gravity and color of the yolk, which increased linearly. The evaluators presented a higher intention to purchase eggs from the treatment with 6g kg$^{-1}$ of cinnamon addition in the diet. We concluded that the inclusion of 12.0 g kg$^{-1}$ of cinnamon powder in the diet for laying quail does not affect the performance and the taste of the eggs, nevertheless, this level of inclusion provides an improvement in the specific gravity and color of the yolk.

**Keywords:** Cinnamomum; cinnamaldehyde; eggs quality; natural pigmentation; performance.

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## Introduction

Currently, the quail farming is one of the featured activities in the poultry sector. It is an easy-to-handle activity, which requires low initial investment in facilities when compared to other farming activities. The increase in demand for quail meat and eggs is stimulating farmers to start or increase their productions. This activity is important in the industrial poultry industry due to its rapid development, which provides promising results to investors.

Comparing the consumption of quail eggs in Brazil between 2010 and 2015, there is an increase in the annual intake of 13 eggs inhabitant$^{-1}$ year$^{-1}$ to 27 eggs inhabitant$^{-1}$ year$^{-1}$ (Fernandez et al., 2018). Such behavior has been stimulated by the ease of acquisition and storage of eggs, since they can be consumed cooked, whole or preserved, and these characteristics generate growth opportunities for quail raising (Moura, Fonseca, Rabello, Takata, & Oliveira, 2010). However, as the demand for quail products increases, the consumer concern for product quality also increases. Hence, the demand of the consumer market for products free of chemical residues has become greater. Among the attributes related to egg quality, the color of the yolk is commonly related to nutritional quality; however, its taste is the sensorial characteristic that determines the preference of the consumer for the product. Aiming to meet these market requirements, the researchers have been focusing on alternative foods that, when supplemented to the quail's diet, are capable of improving the quality of the final product without affecting the feed efficiency of the animals (Nunes et al., 2010).

In the additives such as antioxidants, organic acids, probiotics, prebiotics, symbiotics, herbal extracts and essential oils, we can find several characteristics to maintain the quality of the final product. Furthermore, these additives present enhancing performance effects, and improve the health of the gastrointestinal tract of the animals. Consequently, the possibility of extracting active plant compounds with antimicrobial and/or antioxidant properties is essential (Biondo et al., 2017). Thus, we highlight the inclusion of phytogenic additives in diets for farm animals, aiming to maintain productivity and minimize environmental impacts. Within this concept, there are the products obtained from *Cinnamomum*, known as cinnamon, a plant of the *Lauraceae* family, which grows widely in continental Asia, east and Southeast Asia, Australia and in Central and South America. This plant has the Cinnamaldehyde as its active ingredient, which presents antiseptic, antimicrobial and antioxidant properties (Tung, Chua, Wang, & Chang, 2008).

Researches on cinnamon and its active compound have been developed to evaluate its antifungal, antimicrobial and pigmentation effect in broilers and laying hens (Oliveira, Castro, Edwards, & Oliveira, 2010; Sang-Oh, Chae-Min, Byung-Sung, & Jong, 2013). However, these effects, concerning the production and quality of quail eggs, have not been evaluated yet.

The objective of this study was to evaluate the effects of cinnamon powder on the productive performance, quality and sensorial analysis of the eggs of Japanese laying quails, fed with different levels of cinnamon powder inclusion in their diets.

## Material and methods

The experiment was conducted in the rural campus of the Universidade Federal do Sergipe, at the quail farming sector, located in the municipality of São Cristóvão, Sergipe, Brazil. The local ethics committee, under the license number 04/2015, approved the survey.

A total of 360 Japanese quails, with an initial age of 18 weeks, were housed in laying cages equipped with a trough-style feeder and a nipple-type drinking fountain, installed in an experimental masonry shed. The birds were standardized for weight and percentage of posture, and presented, at the beginning of the experiment, a mean weight of 140g (± 7 g) and 84.6% of posture.

The experiment lasted 84 days, and it was divided into three cycles of 28 days. Throughout the experimental period, the quails received water and feed at will, and were submitted to a light program of 16 hours daily.

The experimental arrangement was a completely randomized design, consisting of five treatments and six replicates of 12 quails each. The treatments were composed by a reference diet, based on corn and soybean meal, and four test diets, which contained increasing levels of cinnamon powder, at 3.0; 6.0; 9.0 and 12.0 g $kg^{-1}$, which replaced the inert material.

The cinnamon used for the composition of the feed was acquired in bark form, and then grounded in a knife mill. The feed for all treatments were isoenergetic and isonutritive. To formulate the diets, we considered the chemical compositions of the ingredients and the nutritional requirements of the animals, in accordance with the recommendations suggested by Rostagno et al. (2011), as described in Table 1.

The ambient temperature was recorded daily, with the aid of a digital thermo-hygrometer, with a maximum and minimum average temperature of 33.39° C and 21.42°C, respectively. The maximum and minimum relative humidity were of 72 and 34%, respectively.

Every day, the eggs were collected, stored in containers identified by an experimental unit, counted and weighed. All the eggs that were broken and shell-less were also counted as total egg production. The amount of feed provided and its leftovers were weighed weekly. The performance variables analyzed were: percentage of posture (%), mean weight of eggs (g), egg mass (g), feed intake (g $animal^{-1}$ $day^{-1}$), feed conversion per dozen eggs (g $dz^{-1}$) and feed conversion per mass of egg produced (g $g^{-1}$). In the last three days of each 28-day period, we separated six eggs with average plot weight for quality analysis, in which the following parameters were assessed: specific gravity (g $mL^{-1}$), albumen height (mm), yolk weight (g), shell weight (g), shell thickness (mm) and albumen weight (g). The Haugh Unit (UH), the percentages of yolk, bark and albumen were calculated based on these data.

All the selected eggs were weighed and identified individually. Then, they were evaluated for specific gravity, with the use of saline solutions with increasing densities from 1.060 to 1.090, with 0.005 intervals, measured by a densimeter. The gravity determination was performed by immersing the eggs in each solution, and the density was determined by the solution in which the egg floated (Moreng & Avens, 1990). Afterwards, the eggs were broken on a smooth, flat surface with a white background, to measure the height of the albumen with a digital caliper (0.01mm scale). The color of the yolk was determined with the help of a colorimetric fan. The egg yolks were then separated from the albumen and weighed into a scale with accuracy of 0.01 g.

We dried the eggshells at room temperature for 48 hours. After that, the shells were weighed, and the thickness was evaluated using a digital caliper. The thickness of the eggshell was measured in two different parts of the equator region of the egg, and using these values, we calculated the arithmetic mean of the eggshell thickness.

With the values of the weights from the egg, yolk and shell, we determined the weight of the albumen by the difference and we calculated the percentages of the parts of the egg.

The Haugh Unit was calculated using the formula:

$$UH = 100 \log (H + 7.57 - 1.7W^{0.37})$$

in which H is albumen height (mm) and W is weight of the egg (g).

At the end of the performance experiment, eggs of three treatments (0.0, 6.0 and 12.0 g $kg^{-1}$ of cinnamon powder) were selected for sensory analysis. For this purpose, 35 non-trained tasters performed the evaluation of perception of yolk color, flavor intensity and buying intention, which were evaluated by means of the ordering test. Each evaluator received an evaluation form and a disposable plastic dish with three boiled eggs randomly identified by a three-digit numbering. Between the tests of each egg, the evaluators were instructed to ingest a salt cracker and mineral water at room temperature, to remove the residual taste contained in the mouth.

The results obtained for the variables of performance and quality of the eggs were submitted to analysis of variance. When the data was significant, a regression analysis at the level of 5% of probability was performed. The Friedman test analyzed the sensorial analysis results, and the table of Newel and MacFarlane, considering 5% of probability, were also used.

## Results and discussion

**Table 1.** Percentage composition and nutritional values of the experimental diets.

| Ingredients | levels of cinnamon powder (g $kg^{-1}$) | | | | |
|---|---|---|---|---|---|
| | 0 | 0.3 | 0.6 | 0.9 | 12.0 |
| Corn | 577.920 | 577.920 | 577.920 | 577.920 | 577.920 |
| Soybean meal, 45% | 304.500 | 304.500 | 304.500 | 304.500 | 304.500 |
| Soybean oil | 15.610 | 15.610 | 15.610 | 15.610 | 15.610 |
| Dicalcium phosphate | 10.910 | 10.910 | 10.910 | 10.910 | 10.910 |
| Limestone | 68.020 | 68.020 | 68.020 | 68.020 | 68.020 |
| Salt (NaCl) | 3.230 | 3.230 | 3.230 | 3.230 | 3.230 |
| L-lysine HCl, 78.8 | 2.610 | 2.610 | 2.610 | 2.610 | 2.610 |
| DL-methionine, 99 | 3.960 | 3.960 | 3.960 | 3.960 | 3.960 |
| L-threonine, 98.5 | 0.240 | 0.240 | 0.240 | 0.240 | 0.240 |
| Vit. + min. premix [1] | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Inert[2] | 12.000 | 9.000 | 6.000 | 3.000 | 0.000 |
| Cinnamon powder | 0.000 | 3.000 | 6.000 | 9.000 | 12.000 |
| Total | 1000 | 1000 | 1000 | 1000 | 1000 |
| Calculated composition | | | | | |
| Metabolizable Energy (kcal $kg^{-1}$) | 2807 | 2807 | 2807 | 2807 | 2807 |
| Crude protein, (g $kg^{-1}$) | 188 | 188 | 188 | 188 | 188 |
| Calcium, (g $kg^{-1}$) | 29.22 | 29.22 | 29.22 | 29.22 | 29.22 |
| Available phosphorus (g $kg^{-1}$) | 3.04 | 3.04 | 3.04 | 3.04 | 3.04 |
| Sodium, (g $kg^{-1}$) | 1.46 | 1.46 | 1.46 | 1.46 | 1.46 |
| Chlorine, (g $kg^{-1}$) | 2.42 | 2.42 | 2.42 | 2.42 | 2.42 |
| Potassium, (g $kg^{-1}$) | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 |
| Digestible aminoacids (g $kg^{-1}$) | | | | | |
| Methionine | 6.42 | 6.42 | 6.42 | 6.42 | 6.42 |
| Methionine + Cystine | 9.00 | 9.00 | 9.00 | 9.00 | 9.00 |
| Lysine | 10.97 | 10.97 | 10.97 | 10.97 | 10.97 |
| Threonine | 6.58 | 6.58 | 6.58 | 6.58 | 6.58 |
| Tryptophan | 2.06 | 2.06 | 2.06 | 2.06 | 2.06 |

[1]Quantity $kg^{-1}$ of product: vit. A 8,000,000 IU; vit. D3 2,000,000 IU; vit. E 15,000 mg; vit. k3 1,960 mg; vit. B2 4,000 mg; vit. B6 1,000 mg; vit. B12 10,000 mcg; niacin 19,900 mg; pantothenic acid 5,350 mg; folic acid 200 mg; manganese 75,000 mg; zinc 5,000 mg; iron 20,000 mg; copper 4,000 mg; iodine 1,500 mg; selenium 250 mg; cobalt 200 mg. [2] caulin.

Table 2 describes the results of the productive performance of quails as a function of the levels of cinnamon powder in the diet. It can be observed that, during the whole period of the experiment, there was no significant effect ($p > 0.05$) for the variables of feed intake, posture percentage, mean egg weight, egg mass, feed conversion/dozen eggs produced, and feed conversion/egg mass.

The feed intake was not influenced ($p > 0.05$), since all treatments were isoenergetic and isonutritive. According to Leeson, Caston, and Summers (1996), one of the factors that alter the consumption of feed by poultry is the energy content. The palatability might have not been affected either, since there was no difference for consumption between the treatments. According to Nunes et al. (2008), birds have a lower number of taste buds in the papillae and, for this reason, their gustatory perceptions less developed, which could explain the lack of effect of cinnamon inclusion on feed intake.

The absence of effect on feed consumption also justifies the similarities of production, weight, and mass of the eggs between treatments, since the intake of nutrients by the quails did not differ. An increased intake of nutrients from the diet could allow a higher deposit of them in the egg yolks, and thus provide larger egg yolks and heavier eggs. Since the inclusion of cinnamon powder probably did not interfere with the deposition of nutrients in the eggs, the weight and egg mass were not affected. Due to these factors, the feed conversion by mass and dozen eggs did not change either.

Moura et al. (2011), when evaluating the inclusion of natural dyes to the diet of quails, did not observe differences on animal performance. This is in accordance with what was observed by Garcia et al. (2009) that evaluated the inclusion of urucum in the diet of commercial laying hens, and did not obtain significant results. The results obtained by these authors demonstrate that pigment additives, such as cinnamon powder, when included in the diet, may not provide positive or negative effects on the performance of quails, which allows them to be added to the feed.

Regarding the means obtained for egg quality, there was no significant effect of the levels of cinnamon for shell thickness, albumen height and Haugh Unit. However, the specific gravity and color of the yolk showed an increasing linear behavior.

For the specific gravity, the addition of cinnamon powder to the diets improved the quality of the eggs, since they presented greater gravity when compared to the eggs of quails fed by a diet without cinnamon. According to Souza, Souza, Barbosa, Gardini, and Neves (1997), right after laying, there are changes in eggs such as water and carbon dioxide losses through the shell, which leads to a decrease in the egg quality. However, the results obtained in this research, with the inclusion of cinnamon in the diets, suggested that cinnamon reduces these losses by the shell, which leads to eggs with greater gravity. The equation obtained for the specific gravity (SG) of the eggs was:

$$\text{Specific gravity} = 1.078233 + 0.003167\,X,$$

indicating the level of 12.0 g $kg^{-1}$ of inclusion of cinnamon powder to the feed.

The integrity of the egg shell has a great influence on the quality of the eggs, and this is one of the factors that have most worried the producers (Trindade, Nascimento, & Furtado, 2007).

Since the egg weight and albumin height values were not influenced by the addition of cinnamon powder, there was no effect of the levels added in the diets on the Haugh Unit (UH), which is obtained as a function of these variables. The values found in this research meet the AA quality class (>72 UH), following the egg quality standard from the United States Department of Agriculture (USDA, 2000).

**Table 2.** Performance of Japanese quails as a function of increasing levels of cinnamon powder in the diet.

| Variables | levels of cinnamon powder (g $kg^{-1}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 | 3.0 | 6.0 | 9.0 | 12.0 | P | Mean | CV (%) |
| FI (g $bird^{-1}$ $day^{-1}$) | 24.94 | 24.46 | 24.74 | 25.02 | 24.59 | 0.68 | 24.75 | 3.07 |
| PP (%) | 93.76 | 88.95 | 92.77 | 95.43 | 93.07 | 0.17 | 92.80 | 4.81 |
| MEW (g) | 10.63 | 10.73 | 10.63 | 10.68 | 10.75 | 0.87 | 10.68 | 2.30 |
| EM (g $bird^{-1}$ $day^{-1}$) | 9.97 | 9.54 | 9.87 | 10.17 | 10.00 | 0.29 | 9.91 | 5.01 |
| FC/ Dz (g $dozen^{-1}$ eggs) | 3.81 | 4.01 | 3.81 | 3.74 | 3.79 | 0.48 | 3.83 | 6.89 |
| FC/EM (g $g^{-1}$ egg mass) | 2.506 | 2.590 | 2.510 | 2.461 | 2.466 | 0.64 | 2.507 | 6.35 |

P: probability; CV: coefficient of variation; FI: feed intake; PP: posture percentage; MEW: mean egg weight; EM: egg mass; FC/Dz: feed conversion/dozen eggs produced; FC/EM: feed conversion/egg mass.

**Table 3.** Quality of quail eggs as a function of the inclusion levels of cinnamon powder to the diets.

| Variables | levels of cinnamon powder (g $kg^{-1}$) | | | | | EQ | Mean | P | $R^2$ | CV (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 3.0 | 6.0 | 9.0 | 12.0 | | | | | |
| SG (g $mL^{-1}$) | 1.078 | 1.078 | 1.080 | 1.080 | 1.082 | L1 | 1.080 | 0.00 | 94.23 | 0.09 |
| ST (mm) | 0.20 | 0.20 | 0.21 | 0.21 | 0.20 | Ns | 0.20 | 0.66 | - | 3.28 |
| AH (mm) | 4.92 | 4.94 | 4.98 | 5.02 | 4.95 | Ns | 4.96 | 0.76 | - | 2.78 |
| HU | 92.61 | 92.57 | 92.87 | 93.03 | 92.71 | Ns | 92.76 | 0.72 | - | 0.71 |
| CY | 4.98 | 4.91 | 5.09 | 5.09 | 5.20 | L2 | 5.06 | 0.04 | 76.48 | 3.25 |

EQ: equation; P: probability; CV: coefficient of variation; $R^2$: coefficient of determination; ns: not significant; L: Significant in the regression analysis - linear equation; SG: specific gravity; ST: shell thickness; AH: albumen height; HU: Haugh Unit; CY: color of the yolk; L1 = 1.078233 + 0.003167 X; L2 = 4.936000 + 2.206667 X.

The color of the yolk was influenced by the addition of cinnamon powder in the feed, which proved to have pigmentation effect, possibly due to the greater presence of carotenoids, responsible for the coloration. According to Oliveira et al. (2010), cinnamon contains high levels of carotenoids; thus, the diets that contained cinnamon probably had higher levels of pigments than the rations containing only corn, which would justify the linear increasing effect observed for the yolk color variable. These results are in agreement to those found by García et al. (2009), who observed a higher yolk color in eggs of chickens that consumed urucum in the diet, and to those obtained by Moura et al. (2011), who observed that natural dyes had effect on the yolk coloration of quail's egg's. The color of the yolk can be demonstrated by the equation: Yolk color = 4.936000 + 0.206667 X, with R2 of 76.5%.

The treatments did not significantly affect the weight values for yolk, eggshell and albumen, nor the proportions of egg parts (Table 4).

These results indicate that the addition of cinnamon powder did not affect the deposition of nutrients in egg yolks or eggshells, nor did it alter the proportions of egg parts. However, Vali and Mottaghi (2016) worked with 1 and 2% levels of cinnamon powder in the diet of laying quails, for a period of 63 days, and they obtained higher eggshell weight, albumen weight, higher shell thickness and lower weight of egg yolk.

Although the cinnamon powder has had no effect on the productive performance of the quails, its inclusion in the diet was effective in improving the specific gravity and egg yolk color, which are variables that qualify the product and may increase its acceptance by the consumer market. However, further researches should be performed in order to determine the effects of cinnamon inclusion on Japanese quail diets and its effects on egg production and quality, as well as studies aiming to analyze the feasibility of adding this additive to the diets of these animals.

The results for the sensorial analysis are in Table 5. There was no perception of the testers for the color of the yolk, so we can observe that despite the higher pigment concentration in the diets containing cinnamon, these pigments were not deposited at a level to allow visible alteration of the color of the egg yolks after cooking. Likewise, there was no significant difference in flavor intensity, which indicates that the presence of cinnamaldehyde in the cinnamon did not cause residual effect on the egg flavor, even at the different levels of cinnamon inclusion in the diet. However, there was a significant difference between the treatments for purchase intention, which most of the tasters demonstrated a buying intention for the egg from the treatment containing 6.0 g $kg^{-1}$ of cinnamon in the diet, when compared to the treatment without cinnamon inclusion. This feature considers the general appearance of the product and not just specific variables, which indicate that eggs from quails fed with cinnamon powder may present general appearance with greater acceptability by some consumers.

**Table 4.** Weight and percentage of parts of quail eggs as a function of the levels of cinnamon powder in the feed.

| Variables | levels of cinnamon powder (g $kg^{-1}$) | | | | | Mean | P | CV (%) |
|---|---|---|---|---|---|---|---|---|
| | 0 | 3.0 | 6.0 | 9.0 | 12.0 | | | |
| WY (g) | 3.41 | 3.35 | 3.31 | 3.30 | 3.30 | 3.33 | 0.82 | 5.46 |
| WE (g) | 0.91 | 0.93 | 0.92 | 0.93 | 0.92 | 0.92 | 0.62 | 2.08 |
| WA (g) | 6.21 | 6.43 | 6.32 | 6.36 | 6.39 | 6.34 | 0.54 | 3.74 |
| %Y (%) | 32.48 | 31.68 | 31.44 | 31.42 | 31.25 | 31.65 | 0.74 | 5.38 |
| %E (%) | 8.73 | 8.79 | 8.82 | 8.85 | 8.76 | 8.79 | 0.82 | 2.21 |
| %A (%) | 59.16 | 60.69 | 59.98 | 60.55 | 60.35 | 60.15 | 0.59 | 2.97 |

P: probability; CV: coefficient of variation; WY: weight yolk; WE: weight eggshell; WA: weight albumen; %Y: proportions of yolk; %E: proportions of eggshell; %A: proportions of albumen.

**Table 5.** Differences between the sum of the orders of egg samples from quails fed with three levels of cinnamon powder

| Variables | levels of cinnamon powder (g $kg^{-1}$) | | |
|---|---|---|---|
| | 0 | 6.0 | 12.0 |
| Perception of difference on color of yolk | 87 | 86 | 89 |
| Flavor intensity | 89 | 88 | 81 |
| Buying intention | 79a | 87b | 86ab |

## Conclusion

The cinnamon powder may be included in the diet of Japanese laying quails up to the level of 12.0 g $kg^{-1}$ without affecting the parameters of production performance. It improves the specific gravity of the eggs and provides more pigmented yolks, in addition to not altering the sensorial characteristics of the eggs.

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