Organoleptic characteristics of eggs produced by Japanese quails fed with levels of by-products from the soybean oil industry

[*Características organolépticas de ovos produzidos por codornas japonesas alimentadas com níveis de coprodutos da indústria do óleo de soja*]

"Scientific Article/Artigo Científico"

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Abstract

By-products of the refining of vegetable oils can be used in the feeding of laying birds. However, they may alter the sensory properties of the eggs. Acidulated soy soapstock oil (ASS) is a by-product containing high amounts of free fatty acids (FFA) which are not well utilized by the animals. Therefore, the use of an emulsifier could help with the absorption of FFA. This study aimed to evaluate the effect of different levels of ASS in association with lecithin on the sensory properties of Japanese quail eggs. Eggs from Japanese quails fed diets with acidulated soy soapstock oil (ASS) and lecithin (LEC) were used. The treatments were: T1 - diet with 4% ASS; T2 - diet with 4% ASS + 1% LEC; T3 - diet with 8% ASS; T4- diet with 8% ASS + 1% LEC; T5 - diet with 4% degummed oil (DSO); T6 - diet whit 4% DSO + 1% LEC; T7- BD with 8% DSO; T8 - diet with 8% DSO + 1% LEC. Ten trained panelists evaluated the organoleptic properties of the eggs and each panelist was considered a replication. A 9 cm structured scale was used for verifying the following variables: intensity, brightness, characteristic odor, texture, fat taste, acid taste, rancid taste and residual taste. Additionally, a triangle test was used for evaluating some combinations of treatments. The use of ASS negatively affects some organoleptic characteristics. However, the association of ASS with LEC reduced such negative effects.

Keywords*:* nutrition; oils; poultry; sensory analysis

Resumo

Subprodutos da indústria do refino de óleos vegetais podem ser utilizados na alimentação de aves de postura, mas podem alterar a qualidade sensorial dos ovos. O óleo ácido de soja (OAS) é subproduto que apresenta grandes quantidades de ácidos graxos livres (AGL), compostos que apresentam baixo aproveitamento pelos animais, contudo o uso de um emulsificante poderia auxiliar na absorção dos AGL. O objetivo do estudo foi avaliar o efeito de diferentes níveis de OAS em associação com a lecitina sobre as características sensoriais dos ovos de codornas japonesas. Foram utilizados 200 ovos de codornas japonesas alimentadas com dietas contendo óleo ácido de soja (OAS) e lecitina (LEC). Os tratamentos foram: T1 - dieta com 4% OAS; T2 - dieta com 4% OAS+ 1% LEC; T3 - dieta com 8% OAS; T4 - dieta com 8% OAS + 1% LEC; T5 - dieta com 4% de óleo degomado de soja (ODS); T6 - dieta com 4% ODS + 1% LEC; T7 - dieta com 8% de ODS; T8 - dieta com 8% DSO + 1% LEC. As características organolépticas foram avaliadas por 10 julgadores treinados, sendo que cada painel foi considerado uma repetição. Utilizou-se uma escala estruturada de 9 cm para verificar as variáveis: intensidade, brilho, odor característico, textura, gosto de gordura, sabor ácido, sabor ranço e sabor residual. Também foi utilizado o teste triangular para avaliar algumas combinações de tratamentos. O uso de OAS afeta negativamente algumas características organolépticas. No entanto, a associação do OAS com LEC foi benéfica para reduzir essas respostas.

Palavras-chave: aves; análise sensorial; óleos; nutrição.

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Introduction

Eggs are an important source of protein, vitamin, phospholipid, and unsaturated fatty acids in human nutrition but are influenced by the nutritional quality of the diets offered to egg-laying poultry (Grobas et al., 2002). On the other hand, the use of byproducts, such as recycled vegetable oils or refined industry waste, can affect the sensory quality of meat and eggs as a result of the development of derivatives from oxidative processes that lead to unpleasant taste (Bou et al., 2006).

In general, the refining of vegetable oils may be defined as a set of steps for removing components that impair the appearance, odor and flavor of crude oil, including free fatty acids, oxidized products, colorful substances (xanthophylls and carotenoids), aldehydes, ketones, etc. During the degumming step, a dreg is generated, resulting from the treatment of crude oil with an aqueous solution of alkali, which removes undesirable compounds (Mandarino et al., 2015). From the acidification of the dreg, the acidulated soy soapstock oil (ASS) is formed (Raber et al., 2009).

Acidulated soy soapstock oil has a lower proportion of total fat in the form of triglycerides (TG) and a higher concentration of free fatty acids (FFA), which are recognized for their low digestibility. The lack of sufficient monoglycerides (MG) and diglycerides (DG) to promote adequate absorption leads to a reduced performance of the animals, since 50% to 70% of the fat absorption in poultry occurs in the form of MG and DG (Lesson and Summer, 2001).

To get around this situation and minimize the negative effects of ASS use, an alternative is to add fat emulsifiers to the diet supplied to poultry. They are often used in feeds to increase the digestibility of nutrients, in addition to promoting weight gain and enhancing egg color and egg production, but they may also affect the taste and odor of eggs (Mandalawi et al., 2015; Surech et al., 2014).

Soybean lecithin (LEC), a coproduct of soybean oil refineries, is considered an emulsifier because of its composition consisting of a mixture of phospholipids, triglycerides, and glycolipids (Mandalawi et al., 2015). Soybean lecithin is widely available in the market, and its action is based on the increase of the active surface in the dietary fats for the action of lipase, as well as participating in the formation of micelles, potentiating absorption (Raber et al., 2009).

In the poultry feeding, degummed soybean oil (DSO) is the main source of fat for energy supplementation, but alternative energy sources in the form of by-products of the soybean oil refining process (Peña et al., 2014), such as ASS, can be used in poultry diets. However, the modification of the lipid source in the diets may influence the sensory properties of the eggs, as the egg yolk is highly susceptible to organoleptic changes due to their lipid richness. Thus, the study aims to evaluate the influence on quails of diets containing different levels of ASS (4% or 8%) in association with lecithin on the sensory attributes of eggs.

Material and Methods

Animals and experimental diets

One hundred and ninety-two 54-day-old Japanese quails (Coturnix coturnix japonica, n = 192 eggs) were housed in pairs in 96 metal cages equipped with nipple drinkers and trough feeders. The experimental unit was the cage with two birds, totaling 12 replicates per treatment. Experimental diets were formulated based on corn and soybean meal to meet the nutritional requirements of the Japanese quails according to the Brazilian Tables for Poultry and Swine (2011) (Table 1). A 2×2×2 factorial was used, in a completely randomized design that included two types and levels of oils and the presence or absence of lecithin. The birds were fed for 168 days, with the experimental diets containing acidulated soy soapstock oil (ASS) and degummed soybean oil (DSO) (4% or 8%) with or without the supplementation of 1% lecithin and a negative control treatment (without oil), resulting in the following treatments: T1 – diet with 4% ASS, T2 – diet with 4% ASS + 1% lecithin (LEC), T3 – diet with 8% ASS, T4 – diet with 8% ASS + 1% LEC, T5 – diet with 4% DSO, T6 – diet with 4% DSO + 1% LEC, T7 – diet with 8% DSO, and T8 – diet with 8% DSO + 1% LEC.

Selection of panelists

The selection of panelists for odor evaluation was performed according to the method described by Seibel et al. (2010). Twenty-two panelists analyzed samples from four odor groups: egg (at 1:1, 1:2, 1:3, and 1:4 dilutions); fruit (orange, powdered soap, marcela (Achyrocline satureioides), and coconut detergent); oil (margarine, soybean oil, butter, and mayonnaise);

and spices (yerba mate, coffee, chocolate, and cinnamon). The panelists were asked to express the perceived response using a 0–5 scale (0 – do not perceive; 1 – perceive but do not recognize; 3 – perceive and recognize; 5 – perceive, recognize, and describe). The evaluation of the responses obtained was made through the amplitude ratio. The statistical evaluation of the results was performed using ANOVA with 95% confidence. After the selection, 10 panelists were selected.

Table 1. Feed composition of experimental diets

Ingredients (kg)	Treatments[4]							
	T1	T2	T3	T4	T5	T6	T7	T8
Corn grain	42.60	40.68	32.37	30.36	41.50	39.53	30.08	28.14
Soybean meal (45%)	35.70	36.00	37.55	37.66	35.83	36.20	37.98	38.33
Inert[1]	6.35	6.97	10.71	11.36	7.31	7.92	12.62	13.21
Vitaminic and mineral premix[2]	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Limestone	4.50	4.50	4.40	4.45	4.50	4.50	4.45	4.45
Dicalcium phosphate	1.17	1.17	1.30	1.20	1.17	1.17	1.20	1.20
BHT[3]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
DL- methionine	0.37	0.37	0.38	0.38	0.37	0.37	0.38	0.38
L- lysine	0.11	0.11	0.09	0.09	0.12	0.11	0.09	0.09
Acidulated soy soapstock oil	4.00	4.00	8.00	8.00	-	-	-	-
Degummed soybean oil	-	-	-	-	4.00	4.00	8.00	8.00
Lecihin	-	1.00	-	1.00	-	1.00	-	1.00
Total	100	100	100	100	100	100	100	100
Nutritional Profile								
AME_n (kcal/kg)	2800	2800	2800	2800	2800	2800	2800	2800
Crude protein (%)	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Calcium (%)	3.10	3.10	3.09	3.09	3.10	3.10	3.09	3.09
Chlorine (%)	0.04	0.04	0.03	0.03	0.04	0.04	0.03	0.03
Available Phosphorus(%)	0.32	0.33	0.32	0.33	0.32	0.33	0.32	0.33
Available metionine + cystine (%)	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Available lysine (%)	1.08	1.08	1.10	1.10	1.09	1.09	1.10	1.10
Available threonine (%)	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Potassium (%)	0.77	0.77	0.78	0.78	0.77	0.77	0.78	0.78
Sodium (%)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19

[1]Sand; [2] Composition per kg of product: vitamin A, 207 000 IU; vitamin D3, 43 200 IU; vitamin E, 540 mg; vitamin K3 ,51.5mg; vitaminB1, 40 mg; vitamin B2, 120 mg; vitamin B6, 54 mg; vitamin B12, 430 mg; niacin, 840 mg; folic acid, 16.7 mg; pantothenic acid, 204.6 mg; choline, 42 mg; biotin, 1.4 mg; methionine, 11 g; manganese, 1485 mg; zinc, 1535 mg; iron, 1695 mg; copper, 244 mg; iodine, 29 mg; selenium, 3.2 mg; zinc bacitracin, 600 mg; BHT, 700 mg; calcium, 197.5 g; cobalt, 5.1 mg; fluorine (maximum), 400 mg; phosphorus, 50 g; sodium, 36 g. [3]Butylated hydroxytoluene.[4]Treatments T1: 4% ASS; T2: 4% ASS+1% LEC; T3: 8% ASS; T4: 8% ASS+1% LEC; T5: 4% DSO; T6:4% DSO+1% LEC; T7: 8% DSO; T8: 8% DSO+1%LEC.

Sensory analysis of eggs

Sensory analysis was performed at the end of 168 experimental days, when around 24 eggs/treatment were collected daily until a total of 160 eggs were obtained. They were identified according to the corresponding treatment and sent daily to the Meat and Sensory Analysis Laboratory of the Department of Animal Science, where they were stored in cardboard boxes for seven days under refrigeration at 10°C until evaluation.

The eggs were removed from refrigeration for conducting the sensory analysis and were weighed for determination of mean weight/treatment. Only the eggs which were within the average (±10%) were used for the evaluations. For determining the sensory characteristics of the eggs, each panelist tasted one egg/treatment, totaling 80 eggs/treatment. During the triangle test application, ½ egg/treatment was offered to the panelists, therefore totaling the number of eggs/treatment as follows: (T1) = 15; (T2) = 10; (T3) = 15; (T4) = 10; (T5) = 20; (T6) = 15; (T7) = 20; (T8) = 15.

Preparation of the samples

Eggs were boiled for seven minutes. When they reached room temperature, they were mechanically peeled and served in plastic containers, coded with three random digits. Samples were served with water crackers and mineral water at room temperature to remove the residual flavor between the samples. The eggs from the eight treatments were presented simultaneously to the panelists, who were guided by proving one at a time, from left to right, along with the questionnaire.

Assessments

The informed consent form was signed by all the panelists of the applied sensory tests. For the sensory characterization of eggs, the following variables were evaluated: intensity, brightness, characteristic odor, texture, fat taste, acid taste, rancid taste, and residual taste. A 9 cm structured scale was used, anchored at the extreme left by the term "weak" and to the right by the term "strong" (Stone and Sidel, 1998). Each of the 10 panelists was considered a replicate, who evaluated each of the eight treatments.

The eight treatments from the association of the three study factors, namely oil type (ASS and DSO) and level (4% and 8%) in the presence or absence of LEC were considered, forming a 2×2×2 factorial.

Triangular test

The panelists were challenged through two discrimination triangle tests (difference test) (ABNT, NBR 12995, 1993). The first test is to distinguish between the eggs of quails fed with diets supplemented with or without LEC (1%) associated with ASS and DSO (4% and 8%). To this end, two equal samples of eggs of quails fed with the same level of oil and a third sample differing only by the supplementation of 1% LEC were simultaneously given to the panelists. In this way, the following tests were conducted: Test A (4% ASS vs. 4% ASS+LEC), Test B (4% DSO vs. 4% DSO+LEC), Test C (8% ASS vs. 8% ASS+LEC), and Test D (8% DSO vs. 8% DSO+LEC).

The second test aimed to verify whether the panelists were able to differentiate the type of oil used (ASS or DSO) when supplemented or not with LEC (1%). Thus, two samples of DSO-fed quail eggs at one level of oil supplementation and a third sample differentiated by ASS were simultaneously served to the panelists. In this way, the following tests were conducted: Test E (4% DSO vs. 4% ASS), Test F (4% DSO+LEC vs. 4% ASS+LEC), Test G (8% DSO vs. 8% ASS), and Test H (8% DSO+LEC vs. 8% ASS+LEC).

Statistical analysis

Data from the complete factorial were analyzed according to a 2×2×2 factorial randomized block design. For the evaluations, the statistical package R (R Core team 2015) was used according to the following model: Yijk = μ + di + wk + xj+ lv + dwjk + eijk, where μ = overall mean; di = effect of block (i = 1 to 10 panelists); wk = fixed effect of oil type (k = ASS and DSO); xj = fixed effect of oil level (j = 4 and 8%); lv = fixed effect of lecithin (V = 0 and 1%); dwxl = interaction between oil type, level, and lecithin; and eikjv = random error (residual error). The interaction between the study factors was considered a fixed effect.

To evaluate the triangle test, the results were obtained based on the number of hits and misses in relation to the total judgments, where the probability of random hits ($P < 0.05$) was checked directly in the ABNT, NBR 12995 (1993).

Results and Discussion

The evaluation of the color and appearance of the products is of extreme importance since these are the first parameters with which consumers have contact. The sensory characteristics used to evaluate the color of an object include three distinct categories (Teixeira, 2009), but in this paper only two were evaluated: intensity and brightness.

As observed in Table 2, in the evaluations of egg yolk intensity and brightness, we detected significant double interactions between oil type and level ($P < 0.0001$) and level and lecithin ($P = 0.01$).

Table 3 lists the data of the significant interactions. For the intensity, when the quails were given ASS, the highest level of supplementation (8%) provided yolks with more intense color. When using the DSO, an opposite behavior was found; the lowest level of supplementation (4%) produced eggs with more intense yolk color.

The different stages of refining crude soybean oil aim to improve the appearance, odor, and taste of the oil by removing several components, among them are colored substances such as pigments. This could explain the higher concentration of pigments in ASS, since the product is obtained during the degumming step, which removes colorful substances (xanthophylls and carotenoids) (Mandarino et al., 2015), among several compounds responsible for the egg yolk pigmentation. However, is necessary a highest level of supplementation (8%) with ASS to provide the production of greater color intensity eggs.

Table 2. Effect of the quality association with different levels of acidulated soy soapstock supplementation (ASS) and degummed soybean oil (DSO) on yellow color intensity and brightness of quail eggs.

Type oil	Oil level	Intensity		Brightness	
		Lecithin (%)			
		0	1	0	1
ASS	4	3.34±1.60	2.76±1.69	4.16±1.67	3.72±1.52
ASS	8	6.56±1.70	5.46±1.39	4.33±1.19	5.51±1.64
DSO	4	4.94±1.01	4.67±1.24	4.89±1.43	3.92±2.05
DSO	8	2.86±2.01	3.49±1.63	3.52±1.87	4.62±2.55
Effects		Probabilities (P≤0.05)			
Taster		<0.0001		0.003	
Oil		0.05		0.59	
Level		0.01		0.37	
Lecithin		0.23		0.54	
Oil*Level		<0.0001		0.06	
Oil*Lecithin		0.07		0.01	
Level*Lecithin		0.73		0.66	
Oil*Level*Lecithin		0.20		0.75	

Table 3. Breakdown of the interaction between oil type and level on the yellow color of quail eggs and oil type of acidulated soy soapstock (ASS) and degummed soybean oil (DSO) with and without lecithin on intensity and brightness.

Type oil	Intensity		Brightness	
	Oil level (%)		Lecithin (%)	
	4	8	0	1
ASS	B 3.05± 0.41 b	A 4.80± 0.77 a	A 4.53± 0.51 a	A 3.82± 0.14 b
DSO	A 6.00± 0.19 a	B 3.17± 0.44 b	B 3.92± 0.57 a	A 5.06± 0.62 a

Means followed by different lowercase letters, in the same column, are significantly different according to *t*-test at 5% probability. Means followed by different capital letters, in the same row, are significantly different according to *t*-test at 5% probability.

For brightness, diets without LEC showed no significant difference between ASS and DSO, but when the emulsifier was added with ASS, it reduced the brightness; while in the presence of DSO, the effect was the opposite, that is, the brightness of the eggs increased.

The brightness associated with the amount of light reflected by an object, suggests that an object with lower brightness reflects a lower quantity of light for being more opaque. Thus, the data showed that LEC associated with ASS improved the absorption of nutrients, reducing the brightness of the eggs.

For the characteristic odor, a significant triple interaction was found (P = 0.006). Data are shown in Figure 1. Without LEC supplementation, the treatment with 8% DSO showed a lower mean value for odor of the eggs, and when the emulsifier was introduced in the diets, this difference was not found.

In a study conducted by Parpinello et al. (2006), replacing lard with vegetable oils (palm, grape, and flax), detected a significant difference for egg odor (P = 0.01). The eggs of birds fed with grapes had a milder odor than those fed with lard. This may be related to the fatty acid composition of the oils. According to Goldberg et al. (2013), there is a high ratio between omega-3 polyunsaturated fatty acids (PUFA) and saturated fatty acids (SFA) and egg aroma, while the amount of omega-6 PUFA is associated with flavor.

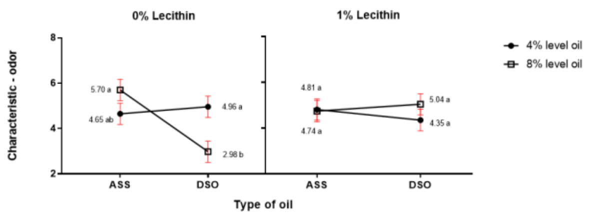

Figure 1. Interaction between lecithin and supplementation of 4 and 8% ASS and DSO on the characteristic odor of quail eggs. Means followed by different letters within each level of lecithin are significantly different according to Tukey's test at 5% probability.

Considering the amount of these fatty acids in the composition of oils used in the present study for ASS and DSO, the values were, respectively, 4.52% and 7.71% omega-3 PUFA, 24.55% and 16.06% SFA, and 41.54% and 52.92% omega-6 PUFA. Thus, when the LEC was added to diets containing 8% DSO, it might have improved nutrient uptake, including omega-6 PUFA, providing the eggs of this treatment with a stronger characteristic odor than the eggs of birds fed with 8% DSO, without the emulsifier in the feed.

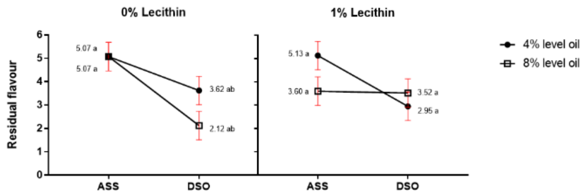

Figure 2. Interaction of lecithin with 4 and 8% supplementation of ASS and DSO on the residual flavor of quail eggs. Means followed by different letters within each level of lecithin are significantly different according to Tukey's test at 5% probability.

In the evaluation of texture, no significant differences were detected between the studied factors and their interactions.

For the fat taste, the effect of oil type was verified (P = 0.0001). The eggs of quails fed with ASS presented a mean of 3.74 ± 0.41 versus 2.28 ± 0.51 of the eggs of quails fed with DSO.

For the acid taste, once again, the effect of oil type (P = 0.05) was detected, in which ASS-fed birds showed a mean value of 3.09 ± 1.01 versus 2.22 ± 0.26 in the eggs of birds that received diets containing DSO. This can be explained by the higher free acidity index (mg of NaOH/100g oil) found in the diets formulated with ASS (5.90 ± 1.7) versus 1.03 ± 0.1 DSO.

The attribute rancid taste also showed a significant effect from oil type (P = 0.002), with the highest mean observed in the eggs of quails fed with ASS (1.80 ± 0.38), while birds fed with DSO presented lower values (1.00 ± 0.40).

In a study conducted by Caston et al. (1994) cited by Leeson et al. (1998), the overall perception of the panelists was that the taste of the eggs of flax-fed birds had a slight unpleasant taste, and this response may be the result of the occurrence of oxidative rancidity in the long-chain fatty acids. In agreement with in the process of oxidation occurs the forming the primary oxidation products which are very unstable and degrade to form of the ketones, aldehydes and alcohols, causing unpleasant taste and odor to oils and fats.

Accordingly, the ASS in an oil derived from the treatment of acid sludge from the neutralization of soybean oil thus presents larger amounts of oxidation products (long-chain fatty acids), which result in the formation of hydroperoxides, giving the eggs a stronger taste of fat, acid, and rancidity.

In the evaluation of residual flavor, there was a significant triple interaction among the studied factors (P = 0.04).

In the absence of supplementation with LEC, the inclusion of 8% DSO presented the lowest mean for residual taste. However, when LEC supplementation was provided with the highest DSO level, this difference was not verified, considering a positive effect, since this characteristic is related to the taste that remains in the mouth for sometime after the food is swallowed.

Table 4 presents the results of the triangle tests in which the probability of the panelists randomly choosing the different sample is 33.3% (1/3). Seven panelists in the A test could correctly recognize the different sample. Thus, lecithin inclusion (1%) combined with 4% ASS on the sensory attributes of eggs has a significant effect (P < 0.05). Observing that six panelists correctly distinguished the sample supplemented with lecithin when associated with 8% ASS, indicating a probability value close to the level of significance. The other tests did not evidence any significant effect; that is, the panelists were not able to distinguish sensorially any effect of LEC supplementation in diets containing DSO.

According to the ABNT standards (1993), when the triangle test is applied to 10 panelists, the minimum number of hits to have a statistical difference at a 5% level of significance should be seven. Thus, the inclusion of lecithin on the sensory quality of eggs, only when the birds were fed with ASS at a level of 4% inclusion, has a significant effect (P < 0.05). A similar trend was found at the 8% level of ASS inclusion.

According Barroso and Filho (2013), the triangle test is used to determine if there is a difference between two samples. They are quick and viable techniques when these even small differences need to be detected, but they do not evaluate the degree of difference, the evaluation is only to differentiate the samples in a global way. For this reason, determining whether lecithin accentuated or attenuated the taste present in the eggs of ASS-fed quails was not possible. Thus, despite checking the differences between the treatments, it is not possible to precisely conclude whether the effect of LEC was positive or negative on the acceptance of the eggs. Nevertheless, in the judgment of all the treatments in the same panel, the panelists did not detect anomalous taste in the diets with LEC, suggesting that the ability to distinguish the presence or absence of the emulsifier was only made possible by the triangle test once it directed the panelist to identify a possible expected difference.

Table 4. Triangle test for the determination of differences in eggs of quails fed diets with ASS and DSO with or without LEC.

Panelists	Hits				Misses			
	Test A[1]	Test B[2]	Test C[3]	Test D[4]	Test E[5]	Test F[6]	Test G[7]	Test H[8]
1	1*	0*	1	0	1	1	0	0
2	1	0	1	0	1	0	0	0
3	1	0	1	1	0	0	0	0
4	1	1	1	0	0	0	1	1
5	0	1	0	0	1	1	0	1
6	1	1	1	0	0	0	1	0
7	1	0	1	0	0	0	1	1
8	0	0	0	1	0	0	0	0
9	1	1	0	0	0	0	1	0
10	0	0	0	0	0	0	0	1
Total	7	4	6	2	3	2	4	4

A= (4% ASS vs. 4% ASS+LEC)[1]; B= (4% DSO vs. 4% DSO+LEC)[2]; C= (8% ASS vs. 8% ASS+LEC)[3] and D= (8% DSO vs. 8% DSO+LEC)[4]. E= (4% DSO vs. 4% ASS)[5]; F= (8% DSO vs. 8% ASS)[6]; G= (4% DSO+LEC vs. 4% ASS+LEC)[7] and H= (8% DSO+LEC vs. 8% ASS+LEC)[8]. *The number 0 means that the panelist was not able to identify the different sample in the triangle test, while the number 1 means that the panelist was able to identify the different sample.

In the evaluation of the E, F, G, and H tests, the panelists were not able to differentiate the ASS from the DSO. These data corroborate those reported by Irandoust and Ahn (2015), who tested three oils in the diet for laying hens (soybean oil – SO, recycled soybean oil – RSO, and acidulated soy soapstock oil – ASS) at a 3.5% level in the feed, applied the triangle test, and observed that approximately 80% and 63% of the panelists claimed that the eggs of the RSO and ASS treatments had a taste similar to the eggs of the birds fed with SO.

Conclusion

The inclusion of ASS accentuated some organoleptic characteristics: acid taste, fat taste, and rancid taste of quail eggs. However, in the significant interactions between oil and LEC, or triple interaction, the emulsifier showed attenuated negative effects of the ASS, improving the characteristic odor and reducing the residual taste of eggs.

The action of LEC was confirmed from the results of the triangle test, where the panelists could identify the sample with LEC, and could suggest that in the analysis of the complete factorial, the LEC improved the sensorial characteristics of the eggs.

As expected, DSO, which is the lipid source commonly used in the feeding of birds, did not adversely affect the sensory properties of the eggs.

Conflict of Interest

The authors declare no conflict of interest.

Ethics Committee

The experiment was conducted in the Poultry Sector of the Laboratory of Zootechnical Teaching and Experimentation (LEEZO), Department of Animal Science, the Federal University of Pelotas, Rio Grande do Sul, Brazil. The project was approved by the Animal Ethics and Experimentation Committee and registered with the number 3772.

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