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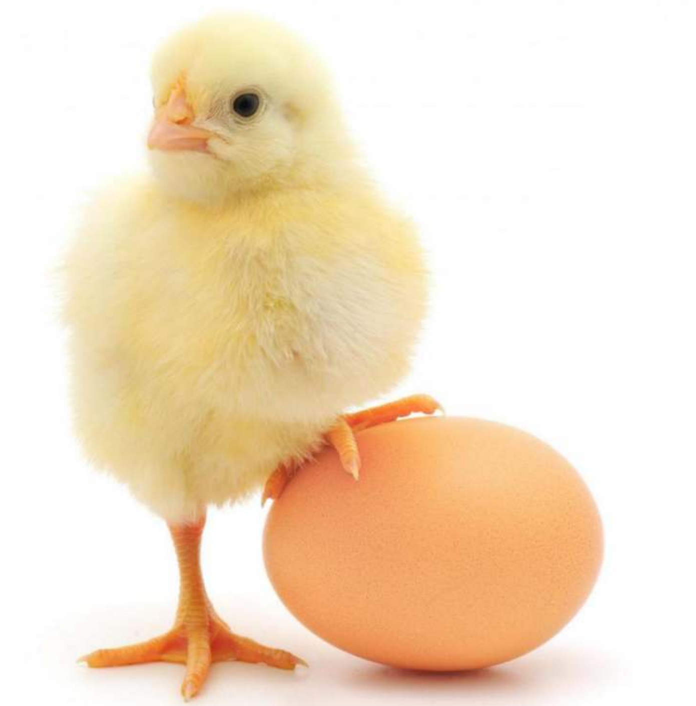

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Performance of Dual Purpose Quails Fed with Canola Oil and Organic Selenium and the Productivity Traits in their Offspring

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Abstract: Recent results suggest that the nutrition of quail breeders could influence not only their own performance but also the performance of their progeny. To test this hypothesis the dual purpose breeders (*Coturnix coturnix coturnix*) were fed six dietary treatments: T1-Control; T2-Soybean oil +0.3ppm organic Se; T3-Canola oil; T4-Canola oil +0.3 ppm organic Se; T5-½ soybean oil +½ canola oil; T6-½ soybean oil +½ canola oil +0.3 ppm organic Se. The organic Se was added on top of experimental diets (30 g/100 kg). The performance of 252 was evaluated from 52 to 136 days of age. A total of 344 eggs from the quails fed the experimental diets during 84 days was incubated. Later, egg weight, egg production and body weight from the first generation offspring were evaluated. A basal corn-soybean meal diet of the progeny was the same to all birds and was formulated to contain 22% crude protein and 2780 kcal/kg/ME. A total of 167 female's quails was hatched and their performance during the initial laying cycle (50 to 80 days of age) was evaluated. Treatment means were compared by orthogonal contrasts and Duncan's test at 5% level. The performance of breeders was not significantly affected. The results showed differences ($p<0.05$) in body weight of the progeny. Egg production and egg mass were not significantly affected by nutritional treatments of the breeders. These results indicate that canola oil diet with organic selenium supplementation brought about benefits for the first progeny of quails, without influencing breeder performance.

Key words: Breeders, *coturnix*, eggs, nutrition, progeny

INTRODUCTION

The replacement of soybean oil by canola oil in the diet of animals is performed to induce changes in fatty acid profile of eggs so they become healthier for human consumption. Several authors have recently demonstrated the possibility of changing the fatty acid profile of yolk eggs (Baucells *et al*., 2000; Grobas *et al*., 2001; Mazalli *et al*., 2004). However, changing the fatty acid profile may have implications in the characteristics of embryonic development of the offspring. Cherian and Sim (1993) discovered that eggs and embryos produced by hens fed a diet of flax seed contained higher levels of omega 3 fatty acids than diets with high oleic acid or regular sunflower seed. Peebles *et al*. (1999ab) noted that there was little information available relating the effects of fat supplementation in breeder hen diet on progeny performance and carcass traits. More recently, Calin and Sirri (2007) stated that there was little information on the effect of breeder nutrition on performance of progeny. This is even more evident in quails, since this species has not reached the same economic importance that layers and broilers. Given this reality, functional foods have been less widely studied in quail than in laying hens and broilers.

On the other hand, several studies have shown the feasibility of enriching eggs using organic selenium. Moreover the activity of glutathione peroxidase is dependent on selenium. The glutathione peroxidase is an antioxidant enzyme that destroys free radicals produced during normal metabolic activity (Maysa *et al*., 2009). Several studies have shown that organic selenium is transferred more efficiently from the diet of hen to the egg than the inorganic form of selenium (Cantor, 1997; Surai, 2000; Paton *et al*., 2002) and to the chick embryo tissue (Surai, 2000; Paton *et al*., 2002). In this way, Surai (2000) stated that the organic selenium protects the embryo against peroxidation, due to improvement in glutathione peroxidase activity. In addition, Pan *et al*. (2004) showed that the replacement of inorganic by organic selenium increases yolk and albumen weight.

The main purpose of this study was to test the hypothesis that the selenium in organic form, as well as canola oil levels added to quail breeder diets may exert effects on quail breeder reproductive performance and on posthatch chick growth, egg weight and egg production in the initial phase of the laying cycle (at 63 days of age).

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MATERIALS AND METHODS

The experiment was performed in the Animal Sciences poultry facilities of the Universidade Federal de Pelotas using quail breeder *Coturnix coturnix coturnix* (252 females and 72 males). The birds were kept in battery cage in climatized poultry house (23°C±1), receiving 50 grams of feed daily and water *ad libitum*.

For breeding, males and female received the same experimental diets. The breeders were fed six dietary treatments during 90 days (Table 1): T1-Control (soybean oil); T2-Soybean oil +0.3 ppm organic Se, Sel-Plex® (Alltech, Inc. Nicholasville, KY, USA); T3-Canola oil; T4-Canola oil +0.3 ppm organic Se; T5-½ Soybean oil +½Canola oil; T6-½Soybean oil +½Canola oil + 0.3 ppm organic Se. The 0.3 ppm Se, as organic Se commercial product (30 g/100 kg) was added on top of experimental diets.

The calculated analysis of all breeder diets were: ME (kcal/kg): 2780; CP (%): 22; Ca (%): 2,7; phosphorus (%): 0,46; amino acids (%): 0,74; methionine (%): 0,38; lysine (%): 1,28; cystine (%): 0,36; choline (MG/kg): 2,04; linoleic acid (%): 2,6; fat (%): 4,78; crude fiber (%): 3,8; sodium (%): 0,2. A total of 344 eggs from 252 quails fed the experimental diets during 90 days were incubated. A total of 167 female's quails was hatched and their performance during the initial laying cycle (50 to 80 days of age) was evaluated. Egg weight, egg production and body weight from the first generation offspring were evaluated. The composition of each experimental diet is as shown in Table 1.

A basal corn-soybean meal diet of the progeny (Table 2) was the same to all birds and was formulated to contain 23.9% crude protein and 2.900 kcal/kg metabolizable energy (Correa *et al*., 2006).

Breeders were individually weighed in the beginning and at the end of the experimental period, during three cycles of production. Egg production per cage was recorded daily. Eggs were collected, individually weighed and an average weight was obtained at the end of each period. The total egg production per experimental unit was calculated as the total number of eggs per cage in each one of the three evaluated periods.

Lipids were extracted from the diet using the Bligh and Dyer (1959) methodology and esterification according to the methodology described by Hartman and Lago (1973). Samples were analyzed by gas chromatography, using Shimadzu GC-2010 chromatograph, with auto-injection AOC-20i (Shimadzu) and SP™ 2560 capylary column (Supelco) with dimension of 100 m×0,25 mm I.D.×0,2 µm. The Frame Mix 100 m SP-2560 of Supelco standard was used, with injection of 1 µL and split 100:1, for detecting up to 37 fatty acids.

All studies were set up as completely randomized designs and data were analyzed by two-way ANOVA with canola oil and organic Se as the fixed factors. When significant interaction effect was found, LSMeans post hoc were performed. Additionally the treatment means were compared by orthogonal contrasts and Duncan's test. A probability value of $p<0.05$ was described to be statistically significant.

RESULTS AND DISCUSSION

No significant interactions were observed by replacing soybean oil by canola oil with or without addition of organic selenium in the diets, except feed intake in the third experimental period (p = 0.001). In this case, an interaction was observed, since with the inclusion of canola oil the consumption decreased. This observation

Table 1: Composition of the experimental diets for the breeders

Ingredients (kg)	T1	T2	T3	T4	T5	T6
Corn	48.72	48.72	48.72	48.72	48.72	48.72
Soybean meal -45%	40.20	40.20	40.20	40.20	40.20	40.20
Soy oil	2.4	2.4	-	-	1.2	1.2
Canola oil	-	-	2.4	2.4	1.2	1.2
limestone	5.2	5.2	5.2	5.2	5.2	5.2
Salt	0.4	0.4	0.4	0.4	0.4	0.4
*Vitamin and mineral mix	3.0	3.0	3.0	3.0	3.0	3.0
Inert filler	0.005	0.005	0.005	0.005	0.005	0.005
Organic selenium "on Top"	-	0.03	-	0.03	-	0.03
Fatty acid composition of experimental diets						
Arachidonic acid	0.47	0.55	0.69	0.61	0.57	0.57
Behenic acid	0.49	0.56	0.51	0.39	0.47	0.44
Cis-eicosic acid	0.36	0.19	0.77	0.84	0.44	0.56
Cis-eicosad acid	0.11	0.04	0.09	0.15	0.05	0.09
Estearic acid	3.59	4.17	3.57	2.92	3.62	3.30
Linoleic acid	49.38	45.51	32.38	35.89	40.70	40.47
Linolenic acid	3.43	2.65	2.79	3.64	2.80	3.16
Oleic acid	26.16	28.15	40.18	40.61	33.66	35.07
Palmitic acid	11.73	13.32	10.99	9.41	11.86	11.23
Palmitoleic acid	0.09	0.11	0.18	0.17	0.17	0.15

Núcleo postura (Brastec): Vit A-250.000 UI: D3-50.000 UI: E-175 mg, K3-37 mg, B1-40 mg, B2-110 mg, B6-75 mg, Vit B12-300 mcg, Niacina-650 mg, Ácido fólico-17mg, Ácido pantotênico 10.000 mg, Colina-250 mg, Biotina-50.000 mg, Metionina-25 g, Manganês-1,750 mg, Zinco-1,250 mg, Ferro-1500 mg, Cobre-250 mg, Iodo-9 mg, Selênio-7,6 mg

Table 2: Composition of the experimental diets for the progeny

Ingredients (kg)	Starter	Growing	Laying
Corn	41.31	60.27	56.91
Soybean meal	52.11	36.28	33.12
Oil	3.31	0.34	2.49
limestone	1.07	1.08	5.33
Dicalcium phosphate	0.94	1.01	1.32
Vitamin and mineral mix	0.50	0.50	0.50
Salt	0.25	0.25	0.33
DL-Methionine	0.33	0.19	
DL-threonine	0.16	0.07	
L-Lysine	0.02		

contrasts with those found in birds fed no organic selenium supplementation. That is to say, feed intake increased with the inclusion of canola oil without the supplementation of selenium. This interaction is difficult to explain, because it was not consistent throughout the laying cycle. It was just observed during the third experimental period.

Using multiple and simple contrasts, there was no significant effect of treatments on performance (Table 3). Similar results were obtained by Faitarone (2010), who also did not observe difference in feed intake, egg weight, egg production, egg mass, feed conversion per dozen or per kg of eggs. In layers fed diets containing 2.5% soybean oil or canola oil. Using 3 to 4% canola oil in the layer diets, Pita *et al.* (2006) and Baucells *et al.* (2000), respectively, have shown that the performance of the birds was not affected. In addition, a lower level of polyunsaturated fatty acids (Omega 3) was shown in the yolk.

Several studies indicate that there is a positive correlation between egg weight at incubation and size of the chick at hatch (Shanawany, 1987; Pinchasov, 1991; Wilson, 1991; Rocha *et al.*, 2008). At hatch, chicks show 62-76% egg weight at incubation. In this way, since there is indication that organic selenium increases egg weight (Pan, 2004) and that these is a correlation between egg weight and chick weight, it may be inferred that selenium may be one of the reasons why a heavier chick weight was observed.

Even though the replacement of soybean oil by canola oil was not significantly different, the results might interest the industry, due to alteration in fatty acid profile in the quail eggs. According to Costa *et al.* (2008), the increasing levels of canola oil in the diet influence adversely feed conversion per egg mass, which indicates that the inclusion of canola oil is not recommended in layer diets. However, in this trial the soybean oil and the canola oil containing diets received the addition of BHT, which might have minimized the effect of organic selenium, as a component of glutathione peroxidase, once both act neutralizing the free radicals.

Feed intake was adversely affected in periods one and two (Table 3), in quails fed soybean oil and canola oil supplemented with selenium as compared to those fed soybean oil with addition of selenium. During the third period, feed intake was higher in birds fed a combination of oils without the supplementation of selenium as compared to control ones. No other variables were significantly affected.

Performance results not always agree (Piccinin, 2002; Mori *et al.*, 2005), due to the fact of the use of different levels of nutrient requirements for poultry, genetic background, consumption capacity, as compared with egg-type birds. Layers show lower feed intake capacity, as compared to meat-type birds (Móri *et al.*, 2005). Oliveira (2003) reported that during the first 41 weeks of production, European quails showed of 6.3 eggs/bird/week. This egg production represents 90% egg production.

According to Mori *et al.* (2005), the genetic groups of meat-quails show capacity to generate good chicks due to high quality eggs. Breeder fed organic selenium produced heavier chicks than those fed inorganic selenium (10.27 vs 9.97), as indicated (Table 4), regardless of oil source used in the diet (contrast 1 p = 0.055).

The supplementation of selenium in canola oil containing diets for breeders (contrast 4) brought about an improvement in offspring body weight at hatch, as compared to birds fed canola oil diet without selenium. This effect was not observed during the intermediate phases of the growth of the progeny, but was significant (p = 0.09) at 56 days of age (Table 4). Chicks from breeders fed soybean oil and selenium showed higher body weight gain at 7 days of age, as compared to those fed only soybean oil. However, this effect was not maintained as the birds aged (Table 4). Duncan test indicated that breeders fed canola oil supplemented with selenium (T4) generated heavier chicks at 7 days, as compared to control (T1) and at 35 and at 56 days of age of offspring, as compared to T5.

According to Rahn and Paganelli (1991), the oxidation of fatty acids is the primary source of energy and water for the embryo to develop. During the development of the embryo, in the final phase of incubation, the embryonic tissue intakes and mobilizes 80% of the total content of fat found in eggs (Noble and Cocchi, 1990). In this way, Paton *et al.* (2002) concluded that selenium, as a component of glutathione peroxidase (Surai, 2000) protects embryo tissue against peroxidation. On the other hand, Pan *et al.* (2004) and Xavier *et al.* (2004) showed that the replacement of inorganic by organic selenium brings about an increase in yolk and albumen weight. Studies have shown that there is a positive correlation between egg weight and chick weight at hatch (Shanawany, 1987; Pinchasov, 1991; Wilson, 1991; Rocha *et al.*, 2008).

Chick weight corresponds to 62-76% of egg weight at hatching (Lopez and Leeson, 1994). Therefore, if birds

Table 3: Performance of quails fed diets containing canola oil and organic selenium

	Period 1 (52 to 80 days of age)				Period 2 (81 to 108 days of age)				Period 3 (109 to 136 days of age)			
Treat	CON	CA	PO	TP	CON	CA	PO	TP	CON	CA	PO	TP
1	873.8^{ab}	3.72	13.2	83.8	1085.7^{ab}	4.0	14.5	84.1	1147.6^{c}	3.90	14.6	85.6
2	917.1^{a}	4.29	13.7	84.5	1157.1^{a}	4.0	14.3	85.9	1229.2^{ab}	4.02	14.3	86.8
3	883.3^{ab}	3.99	13.4	82.3	1069.1^{ab}	4.2	14.0	83.7	1200.0^{abc}	3.92	14.0	85.5
4	850.0^{ab}	4.27	13.7	80.5	1038.1^{ab}	3.9	14.3	82.1	1198.6^{abc}	4.09	14.2	84.3
5	865.8^{ab}	3.86	13.8	85.5	1107.1^{ab}	3.9	14.2	84.2	1235.9^{a}	3.89	14.4	87.9
6	845.1^{b}	3.95	13.5	76.5	980.9^{b}	3.6	14.4	83.6	1170.2^{bc}	3.84	14.3	85.8
Contrasts												
C1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

C1: T2 T4 T6 vs T1 T3 T5 (Effect of selenium supplementation)
C2: T3 T4 vs T1 T2 (soybean oil vs canola oil)
C3: T1 vs T2 (Effect of selenium supplementation in soybean oil diets)
C4: T3 vs T4 (Effect of selenium supplementation in diets containing canola oil)
C5: T5 vs T6 (Effect of selenium in soybean and canola oil diets)
T1:Soybean oil (control) T2: Soybean oil+selenium T3: Canola oil,
T4: Canola oil+selenium T5: ½ Soybean oil+1/2 canola oil T6: ½ soybean oil+1/2 canola oil+selenium
CON: Feed consumption (g) CA: Feed conversion PO: Egg weight (g)
TP: Egg production (%)

Table 4: Weight gain of offspring from Quail breeders fed canola oil and organic selenium

	Days of age								
Treatment	1	7	14	21	28	35	42	49	56
1	10.3	42.6^{b}	104.2	178.6	244.1	280.9^{ab}	326.7	308.0	352.2^{ab}
2	10.3	46.6^{ab}	108.0	177.8	240.9	272.6^{ab}	317.7	309.3	335.4^{ab}
3	9.8	44.6^{ab}	105.7	179.4	241.4	274.0^{ab}	316.9	307.9	337.6^{ab}
4	10.4	47.6^{a}	112.1	184.6	250.9	283.1^{a}	325.3	329.5	358.4^{a}
5	9.8	46.2^{ab}	106.6	176.1	238.6	263.3^{b}	306.5	307.4	330.2^{b}
6	10.1	45.17^{ab}	105.3	175.6	235.7	268.3^{ab}	310.1	317.1	341.3^{ab}
Contrasts									
C1	0.055	NS	NS	NS	NS	NS	NS	NS	NS
C2	NS	NS	NS	NS	NS	NS	NS	NS	NS
C3	NS	0.04	NS	NS	NS	NS	NS	NS	0.09
C4	0.07	NS	NS	NS	NS	NS	NS	NS	0.09
C5	NS	NS	NS	NS	NS	NS	NS	NS	NS

C1: T2 T4 T6 vs T1 T3 T5 (Effect of selenium supplementation)
C2: T3 T4 vs T1 T2 (soybean oil vs canola oil)
C3: T1 vs T2 (Effect of selenium supplementation in soybean oil diets)
C4: T3 vs T4 (Effect of selenium supplementation in diets containing canola oil)
C5: T5 vs T6 (Effect of selenium in soybean and canola oil diets)
T1: Soybean oil (control) T2: Soybean oil+selenium T3: Canola oil
T4: Canola oil+selenium T5: ½ Soybean oil+1/2 canola oil T6: ½ soybean oil+1/2 canola oil+selenium

fed organic selenium produce heavier eggs, it is reasonable to infer that they will produce heavier chicks. It is also possible to hypothesize that unsaturated fatty acids in combination with organic selenium may have an epigenetic effect by up-regulating or down-regulating genes, without causing an alteration in the DNA sequence. Kidd (2006) observed that selenium was the only mineral that once supplemented to breeder diets could influence the performance of the progeny. This effect lasted up to 14 days of age. Broiler breeders fed polyunsaturated fatty acids may produce heavier chick size. This effect can be observed up to 21 days of age (Peebles *et al*., 1999b) and at the same time increase body weight at slaughtering time (Peebles *et al*., 1999a). Higher body weight of offspring from breeders fed organic selenium in the beginning of egg production (12.34 vs. 11.94) was observed. In addition, by contrast analysis and Duncan test, it is observed that selenium had its effect more pronounced (T4 = 12.71 vs. T3 =11.77) in egg weight, when breeders were fed canola oil, which is rich in unsaturated fatty acids (Table 4).

The reason why this combination of factors have shown better results may be explained by the higher body weight at hatching and at 56 days of age, confirming the correlation between egg weight and body weight. However, the difference observed in egg weight has not influenced egg mass during the total egg production.

Table 5: Average egg production and egg weight from the beginning of egg production period to peak production of offspring of quail breeders fed canola oil and organic selenium

Treatment	Egg weight	EP[1]	EW[2]
1	12.15[ab]	15.10	197.2
2	11.89[b]	14.28	173.7
3	11.77[b]	15.04	192.7
4	12.71[a]	15.14	191.0
5	11.90[b]	13.96	168.28
6	12.42[ab]	14.03	175.45
Contrasts			
C1	0.038	NS	NS
C2	NS	NS	NS
C3	NS	NS	NS
C4	0.013	NS	NS
C5	NS	NS	NS

C1: T2 T4 T6 vs T1 T3 T5 (Effect of selenium supplementation)
C2: T3 T4 vs T1 T2 (soybean oil vs canola oil)
C3: T1 vs T2 (Effect of selenium supplementation in soybean oil diets) C4: T3 vs T4 (Effect of selenium supplementation in diets containing canola oil)
C5: T5 vs T6 (Effect of selenium in soybean and canola oil diets)
T1: Soybean oil (control)
T2: Soybean oil+selenium
T3: Canola oil
T4: Canola oil+selenium
T5: ½ Soybean oil+1/2 canola oil
T6: ½ soybean oil+1/2 canola oil+selenium
[1]EP: Egg production (39 to 63 days of age)
[2]EW: Egg weight, g (39 to 63 days of age)

The total egg number produced by the progeny since the beginning of egg cycle up to the pick production has also not been influenced by dietary breeder treatments. In conclusion soybean oil can be partly or totally replaced by canola oil up to 2.4%, with or without addition of organic selenium, without influencing performance. The canola oil diet in combination with organic selenium supplementation bring about benefits for the first progeny of quails.

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