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Effect of Different Dietary Levels of Rapeseed Meal on Reproductive Performance of Iranian Indigenous Breeder Hens

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ABSTRACT
This experiment was conducted to evaluate the effect of feeding diets containing 0, 5, 10, 15 and 20% of rapeseed meal on the performance of Iranian indigenous breeder hens in intensive condition. One hundred and fifty indigenous hens were randomly divided into 30 groups of 5 female and 1 male each. All experimental diets containing 2500 kcal Metabolizable Energy/kg and 15% crude protein were fed from 22 to 24 weeks as the adaptation period and 25 to 41 weeks of age as recording period. Lighting regimen also was a 16 h photoperiod during production period (25-41 weeks). Feed allocation trend for all groups was 90 g feed/bird/day at 20 weeks and then given weekly increment to reach a maximum of 120 g/bird/day during peak egg production period (27 to 35 weeks of age). Rapeseed meal inclusion at dietary levels of 15 or 20% had no significant effects on egg production, egg weight, egg mass and feed conversion ratio. There was also no significant effect of feeding rapeseed meal on reproductive performance of indigenous hens. However, these parameters were almost higher in 15% rapeseed meal group. All of the aforementioned traits except fertility and hatchability were significantly affected by hen age ($p<0.05$). Interaction of rapeseed meal and period was not significant for all traits. The obtained results showed that rapeseed meal can be incorporated in Iranian indigenous breeder hens diet up to 15% without inducing any adverse effects on their reproductive performance.

Key words: Rapeseed meal, indigenous hens, breeder hen, hatchability, egg production, performance

INTRODUCTION
The use of canola meal in poultry rations is limited as this feed ingredient has lower Crude Protein (CP), Metabolizable Energy (ME) and available lysine contents than soybean meal (Bell, 1993; Pottguter, 2006) Additionally, the presence of some antinutratives such as high crude fiber, glucosinolate, polyphenoles and phytate cause lower desirability of this feed ingredient (El-Batal and Abdel, 2001).

Nowadays, most of the scientists apply several ways to improve nutritive value of rapeseed meal, including supplementation of some exogenous enzymes to ration, application of different processing methods, genetic selection and production of new varieties with thinner hulls. However, they cannot make an economic solution for these problems.

The vitamin content of rapeseed meal showed higher values for all the B vitamins, except for pantothenic acid and also mineral contents compared to soybean meal (Riyazi *et al*., 2008). Breeder diet (Peebles *et al*., 2002) and age (Shim *et al*., 2008; Yilmaz-Dikmen and Sahan, 2009), influence subsequent performance and also embryogenesis and hatchability of broiler eggs that are associated with changes in egg (O'Sullivan *et al*., 1991) and eggshell quality characteristics (Peebles *et al*., 2000).

Kiiskinen (1989) evaluated canola meal at dietary inclusion rates of 0, 5 and 10% in leghorn breeders and observed that high percentage of canola meal caused significant reduction in average weight of day-old chicks. In addition, weight of the thyroid gland in one-week-old chicks increased accompanied by increasing dietary canola meal levels. They also reported that the decrease in chick weight did not result in impairment of productive function of the chicks during their subsequent egg production. In their experiment canola meal had no negative effect on egg fertility or hatchability for leghorn breeders. Ahmadi *et al*. (2007) used up to 30% canola meal in broiler breeder ration and reported a significant decrease in egg weight, but canola meal inclusion rate had no negative effect on hatchability.

Indigenous hens used in present study have been genetically improved for body weight, egg weight and egg production rate during 11 continual generations. This population produces about 400000-600000 day-old chicks annually for distributing in rural area as double purpose chickens.

The present research was conducted to evaluate the effects of feeding diets containing various levels of rapeseed meal on reproductive performance of the indigenous hens during the laying period in intensive condition.

MATERIALS AND METHODS

General: This study was performed from March 1 to August 15, 2009 at the Isfahan Center for Production and Breeding of Indigenous Hens, Isfahan, Iran. One hundred and fifty uniform indigenous pullets aged 20 weeks were selected from the aforementioned flock and randomly divided into 30 pens (140×120 cm) of 5 birds each. Then one 20 weeks rooster was randomly assigned to each pen. All female and male birds were fed on a restricted feeding program based on target body weight from 20 to 24 weeks of age. The breeder pens were located in an environmentally controlled house equipped with a heater system. Average room temperatures were maintained at 16 to 22°C by controlled ventilation and heating. Each pen was equipped with a bell drinker, trough feeder and one 4-hole galvanized nest box. The prelaying period (20 to 24 weeks) was considered as adaptation period to diets and experimental pens. The experimental period began at 25 weeks followed by 4 periods of 28 day to 41 weeks. The photoperiod was 10L:14D during rearing period. It increased to 11L:13D at 22 weeks and by weekly increment of 1 h to 16L:8D at 27 weeks. Feed ration for all the treatments were 105 g/bird/day at the initiation of laying (25 weeks) and by weekly increment of 5 g/bird/week to 125 g/bird/day at 29 weeks. Feed allocation of 125 g/bird/day continued to 35 weeks and then reduced to 120 g/bird/day to the end of the experiment (41 weeks of age).

Experimental diets: Five rations were adjusted to examine the effects of different dietary levels of rapeseed meal during laying period on reproductive performance of the indigenous breeder hens. Five experimental diets were used in the study (Table 1) including a control diet (without rapeseed meal) and four diets containing 5, 10, 15 and 20% rapeseed meal. The dietary treatments were isocaloric and isonitrogenus (2500 kcal ME kg^{-1} and 15% CP) and were formulated to meet nutrient

Table 1: Composition and calculated analysis of the experimental diets

	Dietary rapeseed meal inclusion rates (%)				
Ingredients (%)	0	5	10	15	20
Corn	51	51	51	51	51
Soybean meal (42.5%)	22	18.73	15.2	12	8.5
Rapeseed meal[(2)]	0	5	10	15	20
Barley	7	7	7	7	7
Wheat Bran	8.87	7.08	5.71	3.94	2.47
Monocalcium phosphate (17%P)	1.1	1.1	1.1	1.1	1.1
$CaCO_3$	9	9	9	9	9
Sodium chloride	0.3	0.3	0.3	0.3	0.3
Vitamin-mineral Premix[(3)]	0.52	0.52	0.52	0.52	0.52
DL- Methionine	0.11	0.08	0.06	0.03	0
L-Lysine hydrochloride	0	0	0.01	0.01	0.01
Vitamin D_3	0.1	0.1	0.1	0.1	0.1

[1]All diets Contain 2500 kcal ME kg^{-1}, 15% CP, 3.2% Ca, 0.4% Available P, 0.6% Methionine+Cystein and 0.7% Lysine. [2]Contains 86.4% dry mater, 33.9% crud protein, 1% crnde fat and 12.8% crnde fibre, [3]Supplied per 2.5 kilogram of diet: 9500000 IU vitamin A; 2000000 IU vitamin D_3; 20000 IU vitamin E; 2500 mg vitamin K; 1970 mg vitamin B1; 60000 mg vitamin B2; 11760 mg vitamin B3; 24750 mg vitamin B5; 2955 mg vitamin B6; 800 mg vitamin B9; 14 mg vitamin B12; 100 mg vitamin H2; 500000 mg vitamin choline chloride; 99200 mg Mn; 60060 mg Zn; 80000 mg Fe; 6000 mg Cu; 868 mg I; 200 mg Se

requirements obtained from previous results related to the examined indigenous hens in intensive conditions (Gheisari, 2005). All birds received the same quantities of ME and CP during the laying period, 312.5 kcal/hen/day and 18.75g/hen/day, respectively at the peak of egg production.

Egg production, egg weight and feed conversion ratio: The egg production, egg weight and feed conversion ratio were closely monitored throughout the laying period, until 41 weeks of age. Eggs were collected 3 times a day 730, 1000 and 1330 from the nest boxes and were weighed once a week during the experimental period. The egg mass production and feed to egg mass ratio were also calculated from the data every week.

Hatchability, fertility, chick weight and egg weight: During the 4 months period of the experiment all eggs were collected daily over a 7 days period at 29, 33, 35, 37 and 40 weeks of age. All eggs were stored in egg storage room having 15-16°C ambient temperature with 70% relative humidity until setting in the incubator. The eggs of each replicate were weighed just before the incubation and randomized within each replicate by the day of collection at each week. The experimental egg trays were also randomly placed on the same trolley and incubated in an electronically controlled, single stage incubator (Bekoto Lemonnier, Les Fossiles, Saint Jean Sur Mayenne, France- 53240) for 18 days. Eggs were incubated at 37.8°C dry bulb and 53% relative humidity. The eggs were turned hourly through 90° during 18 days incubation. On the 19th day of incubation the eggs were transferred to hatching baskets according to treatment replicate group and randomly distributed in the same trolley. The incubator was set at 37.2°C and 70% relative humidity for hatching. All chicks were removed in the morning on 22th days of incubation. The numbers and weights of salable chicks and culls were recorded. Unhatched eggs were opened, examined macroscopically and assigned to one of the following categories, as outlined in Lapao *et al.* (1999): infertile eggs, early dead (<7 days), mid-dead (8 to18 days), late-dead (after 19 days), pips (i.e., pipped shell but not emerged). From the data, total hatchability (number of salable chicks hatched per all eggs set ×100), fertile hatchability (number of salable chicks hatched per number of fertile eggs set ×100) and fertility rate were calculated for each replicate.

Statistical analysis: Since, the plot of hen layers performance for all these traits against the period of time is curve-linear, the correlation between each two adjacent time points are more likely to be higher than two further points. Here, we applied a repeated record model to consider association between repletion. The following mixed model was used for data analysis.

$$y_{ijk} = \mu + TRT_i + PRD_j + TRT \times PRD(ijk) + \delta_{ijk} + e_{ijk}$$

where, μ, TRT, PRD and TRT*PRD were the fixed effects of trait mean, treatment, period of time and the interaction of treatment and period, respectively. δ and e were error random effects between and within subjects, respectively. Least Square Means (LSM) were compared by Tukey hoc considering $p<0.05$ as significant level.

RESULTS

There was no significant effect due to dietary inclusion of various levels of rapeseed meal for egg production, egg weight, egg mass and feed conversion ratio (Table 2). However, the group fed diet containing 15% rapeseed meal showed the highest egg production rate, egg weight, total egg mass and the lowest feed conversion ratio compared to other groups. On the other hand, indigenous hens fed diet containing 20% rapeseed meal had a lower percentage of egg production, egg weight, total egg mass and higher fed conversion ratio than the groups fed 10 and 15% rapeseed meal. In this experiment, time periods had a significant effect ($p<0.05$) on egg production, egg weight, egg mass and feed conversion ratio (Table 2). Egg weight increased significantly between all time periods ($p<0.05$).

Total average egg production, egg weight and egg mass were the lowest and feed conversion ratio was the highest for 25 to 28 weeks-old hens. On the other hand, percentage of egg production,

Table 2: Effect of different levels of rapeseed meal and age on Means±SE of some productive traits of Iranian indigenous hens during the laying period (25-40 weeks)

Items	Hen-day egg production (%)	Egg weight (g)	Egg mass production (g/hen/day)	Feed conversion ratio (RCR)
Rapeseed meal (%)				
0	61.44±0.028	51.30±0.582	31.35±1.50	4.08±0.216
5	61.88±0.028	51.61±0.582	32.23±1.50	3.90±0.216
10	65.73±0.028	51.41±0.582	34.05±1.50	3.79±0.216
15	66.31±0.025	51.76±0.582	34.59±1.37	3.75±0.197
20	64.38±0.028	50.55±0.582	32.73±1.50	3.84±0.216
Age (week)				
25-28	45.82±0.017^{d}	47.95±0.429^{d}	21.92±0.869^{d}	5.16±0.229^{a}
29-32	77.08±0.015^{a}	50.89±0.371^{c}	39.26±0.871^{a}	3.21±0.074^{b}
33-36	71.36±0.014^{b}	52.60±0.231^{b}	37.59±0.744^{b}	3.33±0.074^{c}
37-40	61.53±0.018^{c}	53.85±0.332^{a}	33.20±0.114^{c}	3.63±0.114^{b}

SE: Standard error, Means with different superscript within a column are significantly different ($p<0.05$)

Table 3: Effect of different level of rapeseed meal and age on means ±SE[1] of some hatching parameters of indigenous breeder hens during laying period (25-40 weeks)

Items	Fertility rate	Fertile hatchability	Total hatchability	Day-old chicken weight (g)	Chicken weight/egg weight (%)
	----------(%)----------				
Rapeseed meal (%)					
0	90.80±0.029	84.97±0.027	77.13±0.039	35.56±0.624	67.59±0.004
5	88.83±0.026	81.02±0.025	71.85±0.036	35.56±0.570	67.75±0.004
10	87.70±0.026	81.78±0.025	71.53±0.036	35.86±0.570	68.00±0.004
15	90.30±0.026	85.64±0.025	77.86±0.036	36.11±0.570	67.50±0.004
20	89.73±0.026	84.40±0.025	75.33±0.036	34.54±0.570	67.31±0.004
Age (week)					
29	90.47±0.014	79.77±0.022[b]	72.09±0.021	34.83±0.316[c]	69.24±0.004[a]
33	89.13±0.015	82.23±0.019[ab]	73.08±0.017	34.98±0.374[c]	67.60±0.005[bc]
35	90.71±0.016	84.42±0.022[ab]	76.91±0.028	36.06±0.317[ab]	68.64±0.002[ab]
37	87.59±0.025	86.28±0.026[a]	76.10±0.035	36.48±0.312[a]	67.44±0.003[c]
40	89.46±0.021	85.02±0.023[ab]	75.52±0.028	35.59±0.378[bc]	65.23±0.006[d]

[1]SE: Standard error. Means with different superscript within a column are significantly different ($p<0.05$)

Table 4: Effect of different levels of rapeseed meal and hen age on Means±SE[1] of embryonic mortality in different days of incubation period

Items	Days (0-7)	(8-18)	(19-21)	Pipped egg[(2)]
Rape seed meal (%)				
0	7.63±0.019	2.84±0.014	3.00±0.014	2.34±0.010
5	5.82±0.017	4.31±0.013	5.23±0.013	3.58±0.009
10	7.35±0.017	4.92±0.013	3.66±0.013	2.28±0.009
15	3.55±0.017	3.97±0.013	4.06±0.013	2.76±0.009
20	4.19±0.017	3.81±0.013	5.80±0.013	1.78±0.009
Age (week)[(3)]				
1	5.85±0.008[ab]	4.85±0.010[a]	5.07±0.009[a]	4.44±0.009[a]
2	4.71±0.012[ab]	5.34±0.008[a]	5.68±0.012[a]	1.93±0.005[bc]
3	4.21±0.012[b]	2.15±0.010[b]	5.58±0.020[a]	3.61±0.009[ab]
4	6.65±0.018[ab]	4.38±0.018[ab]	1.46±0.006[b]	1.21±0.006[c]
5	7.12±0.016[a]	3.13±0.008[ab]	3.96±0.017[ab]	1.55±0.010[c]

[1]SE: standard error. Means with different superscript within a column are significantly different ($p<0.05$) [(2)] piped shell out not emerged. [(3)]The time of collection eggs for first, second, third, fourth and fifth period of incubation was 29, 33, 35, 37 and 40 weeks of hen age

egg mass and feed conversion ratio improved significantly between weeks 29 and 32 but decreased significantly between weeks 33 and 36 and particularly between weeks 37 and 41. According to the results (Table 3, 4) rapeseed meal inclusion in the diets had no significant effect on fertility, hatchability, hatchability of fertile eggs, day-old chicken weight, chicken weight to egg weight ratio and embryonic mortality, although, the groups that consumed the control and 15% rapeseed meal diets gave the best values numerically. Although, not significant, increasing the rapeseed meal up to 20% decreased hatchability and day-old chicken weight slightly.

Hatchability of fertile eggs, chicken weight, chicken weight to egg weight ratio and embryonic mortality were significantly influenced ($p<0.05$) by hen age (Table 3, 4). Hatchability of fertile eggs and day-old chicken weight were significantly lower at 29 weeks compared to the higher values for laid eggs by 37 weeks-old indigenous breeder hens ($p<0.05$). Chicken weight to egg weight ratio was the highest at 29 weeks which was significantly ($p<0.05$) higher than weeks 33, 37 and 40.

Fertility and hatchability were not affected by hen age. There is not also specific trend on the effect of hen age on embryonic mortality during different stages of incubation period, however this parameter was higher and lower at 29 and 35 weeks, respectively. It should be noted that, there were not any significant dietary treatment by age interactions for all measured parameters.

DISCUSSION

The results of this experiment showed that including different levels of rapeseed meal in the indigenous breeders' diet induced no adverse effects on their performance in terms of hen-day egg production, egg mass, feed conversion ratio and egg weight. Total average of egg production for the entire flock was about 64% for 25 to 41 weeks of age. However, average of hen-day egg production for control group was 61.4 for 25 to 41 weeks of age (Table 2), but interestingly, all groups fed diets containing rapeseed meal, especially 15% group, had better performance than the control group (Table 2). It means that feeding indigenous breeder hens with diets containing various levels of rapeseed meal cause to improve their performance. This effect may have been due in part to the higher metabolizable energy value attributable to rapeseed meal (Leslie and Summers, 1972).

These results suggest that the utilization of rapeseed meal diets was similar to that of corn-soybean control and support the supposition that the nutrients in rapeseed meal are being well-utilized by the animal. Lesson *et al.* (1986) reported that there was no significant effect of replacing all dietary soybean meal with canola meal on performance, nutrient retention and bone mineralization in laying hens. However, in their experiment there was a significant increase in diet ME when 25 or 50% of the soybean meal was replaced with canola meal. March and Macmillan (1979) also showed that birds fed a rapeseed diet excreted less soap than those offered a soybean diet. This situation would have some beneficial effects on energy utilization, as exemplified by the results with adult hens. On the other hand, Leslie and Summers (1972) reported that feeding diets containing 0, 5, 10 and 15% ground raw rapeseed to laying hens caused to depress egg production and egg weight at two higher levels of rapeseed inclusion.

Recently, Riyazi *et al.* (2008) also reported that egg weight was significantly higher when birds were fed 10% rapeseed meal diet. They observed a depressed egg production followed by increasing rapeseed meal inclusion rate up to 15%. Furthermore, in present study also birds fed diet containing 20% rapeseed meal showed a reduction in percentage of egg production, egg weight and egg mass production compared to 10 and 15% rapeseed meal groups. Najib and Al-Khateeb (2004) also observed that hen-day egg production, egg mass and egg weight were much lower in birds fed diet containing 30% canola seeds compared to 5 and 10% diets. They reported that with including 5 and 10% whole canola in the layer diets the highest production rate was found in the fall season.

It should be noted that, the specific effects of high levels of rapeseed meal in different experiments can be related to meal processing conditions, season, diet composition, rapeseed varieties, birds' age and strain.

As shown in Table 2, Hen day egg production, egg weight and feed conversion ratio were significantly affected by hen age ($p<0.05$). Total average egg production and egg mass production were higher between week 29 to 32 than other periods. Since birds reached peak egg production at 30 weeks (78.6%), feed conversion ratio was minimum between 29 to 32 weeks of age. On the other hand, egg weight increased with hen age between 25 to 41 weeks. Egg weight also has been shown to increase between weeks 26 to 58 in commercial layers (Fletcher *et al.*, 1981). Peebles *et al.* (2000) reported that eggs from broiler breeders increased in weight between weeks

26 to 47. Their result showed that the yolk:albumen ratio of the eggs increased between weeks 26 to 35. Furthermore, in broiler breeders, O'Sullivan *et al.* (1991) demonstrated that yolk and albumen weights of eggs increased with egg weight between 29 and 62 weeks but the increased yolk to albumen ratio during that period was due to a larger increase in yolk relative to albumen.

According to results shown in Table 3 and 4, no effect of feeding rapeseed meal was observed on overall percentage of fertility, total hatchability, fertile hatchability, day-old chicken weight, chicken weight to egg weight ratio and embryonic mortality. In agreement with Kiiskinen (1989) and Nasser *et al.* (1985), the results suggested that rapeseed meal can be incorporated into the indigenous breeder hens' diet up to 15% without any deleterious impacts on their reproductive performance. Kiiskinen. (1989) also reported that feeding diets containing 0, 5, 10% canola meal had no negative effects on egg fertility or hatchability for leghorn breeders. Interestingly, similar to our results for feeding diet containing 20% rapeseed meal they reported that average weight of the day-old chicks decreased with increasing dietary canola meal inclusion rate. This effect may be explained by the slight decrease in egg weigh produced by breeder hens fed 20% rapeseed meal (Table 2). In another research Ahmadi *et al.* (2007) reported that feeding diets containing 0, 10, 20 and 30% rapeseed meal had no negative effect on hatchability in broiler breeders. It can be noted that total and fertile hatchability rate in the Iranian indigenous hens is almost equal to that for indigenous hens in Uganda (Ssewannyana *et al.*, 2008).

There was a significant ($p<0.05$) main effect due to breeder age on hatchability of fertile eggs, one-day-old chicken weight, chicken weight to egg weight ratio and embryonic mortality (Table 3, 4). According to these results, hatchability of fertile eggs was lower for the first time incubation at 29 weeks and reached a maximum rate (86.3%) at 37 weeks. However, in spite of no specific trend on the effect of hen age on embryonic mortality (Table 4), it seems that higher rate of mortality in piped eggs is a main reason incorporated to this reduction in hatchability. Parker and MacDaniel (2002) also observed a markedly decline in hatch of eggs set for 29 weeks-old broiler breeders compared to upper ages during 29 to 54 weeks of age. Lapao *et al.* (1999) reported that embryo viability (hatchability of fertile eggs) was affected by an interaction between flock age and length of egg storage. In another study Brake *et al.* (1997) reported that the effects of preincubational egg storage on embryonic viability depended on storage time, environmental conditions, hen age and strain.

In the present experiment day-old chicken weight increased among all ages except for hatched chicks from 40 weeks-old breeder hens. It could be due to a potential association between incubator condition, length of egg storage or feeding rapeseed meal and one-day-old chicken weight (Kiiskinen, 1989). Proportion of chicken weight to egg weight was higher in 29 weeks, since, the lowest egg weight was found in this week.

Finally, the results of this study suggest that rapeseed meal can be fed to indigenous breeder hens up to 15% of the diet without any unfavorable effects on egg production, egg weight, hatchability and one-day-old chicken weight.

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