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Performance and Egg Weight of Laying Hens Fed on the Diets with Various By-Product Oils from the Oilseed Extraction Refinery

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Abstract: To test the changes in laying performance and egg weight, four diets were added with 30 g/kg of soya oil (control), sunflower acid oil, stearin and Bergafat (acid oil). Totally hundred and ninety two brown layer hens at the age of 31 weeks were randomly allocated to 48 cage replicates. Egg production, egg weight, feed intake and feed conversion ratio of the hens receiving the diets of acid oil, stearin and Bergafat was not significantly (P>0.05) different from that of the hens receiving the diet of soya oil. The diet with Bergafat insignificantly (P>0.05) leads to reduced egg weight being 59.3 g compared to the other diets with 61.2, 61.2 and 61.9 g values, respectively. The reduced egg weight with Bergafat might be associated with the low level of unsaturated fatty acid which resulted in less lipid deposition in the egg yolk. The linoleic acid contents of studied oils ranged from 23.9, 23.0, 21.4 and 11.6 g/kg for soya oil, sunflower acid oil, stearin and Bergafat, respectively. The results indicated that the diet linoleic acid content over 12 g/kg is not critical for egg weight.

Key words: By-product oils, egg weight, performance, layers

Introduction

The production and extraction of oilseed are of economic importance in the countries of Eastern Europe. A great proportion of the produced vegetable oil is being used for the human consumption in the food industry. Apart prom the vegetable oil meals, various by-products such as soapstock, acid oil and stearin obtained during the processing oil seeds are being used as animal feed ingredients in the feed industry. However, soapstock and stearin among by-products have traditionally been used, mainly in the soap and detergent industry. On the other hand, the acid oils of sunflower and soybean are considered to be one of the beneficial energy sources for poultry nutrition since the market prices for these by-products are relatively lower.

In poultry nutrition, a number of research studies have been conducted to study the effects of fat inclusion on energy utilization (Sell *et al.*, 1979), diet AME_n (Ketels *et al.*, 1987; Senköylü *at al.*, 1987; Huyghebaert *et al.*,1988) and on the attempts to improve egg weight by protein (Parsons *et al.*, 1993), lysine (Zimmerman, 1997), methionine (Schutte and DeJong, 1994), linoleic acid (Jensen and Shutze, 1963; Balnave, 1972; Whitehead, 1981) or fat inclusion (Sell *et al.*, 1987; Scragg *et al.*, 1987). However, only a few of the studies are related with the effects of by-product oils. It may not be rational to incorporate the layer feeds with vegetable oils, such as soybean, corn or sunflower which are highly valuable oil sources in the food industry. Therefore, the acid oils or stearins, the refined by-products of oilseeds (soybean, sunflower, or palm), appeared to be the good sources of dietary energy and linoleic acid, particularly in the favor of better performance and heavier eggs. However, conflicting results have been reported on dietary linoleic acid concentrations in relation to egg weight. Some authors observed an increase in the egg weight with the dietary linoleic acid levels of over 2% (Guenter *et al.*, 1971; Scragg *et al.*, 1987), whereas some others (Whitehead, 1981; Summers and Leeson, 1983) did not find the beneficial effect of dietary linoleic acid level of over 1%.

Recent research conducted by Grobas *et al.* (2001) clearly indicated that the increased egg weight was associated with the total dietary fat contents of diet rather than the linoleic acid content over 1.0%. Comparing the effects of various dietary energy sources on egg weight, it was suggested that the corn oil significantly increased the egg weight compared to poultry fat (Bhonzack *et al.*, 2002). However, Balevi and Coskun (2000) previously reported no significant differences in the egg weights between various dietary oils and fats. Thus, the effects of blended fats or acid oils as well as stearin of different vegetable origin, were rarely studied in laying hens in respect to laying performance and egg weight.

Therefore, we now aimed to examine the effects of by-products from the oilseed extraction refinery with different fatty acid content on laying performance and egg weight.

Materials and Methods

Processing by-product oils: The dietary oil sources used in the study were: soya oil as control treatment and sunflower acid oil, stearin and Bergafat (commercial blend of acid oil) as experimental treatments. Oils used in the present study are the refinery by-products obtained from the oil seed extraction plants where mainly sunflower and partly soybean oil seeds are crashed and extracted for vegetable oil production. Sunflower acid oil is a processed by product of sunflower soapstock which is a product obtained after the neutralization of crude oils and afterwards treated with sulfuric acid and this followed the separation from the precipitated sodium sulfate as oil phase (Senköylü, 1991). Stearin is also a residue of sunflower seeds oil extraction process, which is an oily part remaining on the filter after winterization of the extracted and stored crude oil at 5-6 ^{o}C for 2-3 days. Stearin is being utilized in the soap and detergent industry. Since stearin contains an appreciable amount of linoleic acid it appeared to be worthwhile to test it as an energy source in the laying hens. The fatty acid profile of the by-product oils used in the present study were analyzed in a private laboratory (Kalite Sistem Analiz Laboratuari, Istanbul, Turkey) and shown in Table 1. Bergafat is a commercial name of an acid oil mixture manufactured in Germany and obtained from soybean, rapeseed, palm and chea acid oils. This feed grade fat is vegetable acid oil mixture tailored for broiler production and mainly used in broiler feeds in Turkey. As can be noted, the saturated fatty acid content of Bergafat is considerably higher than the others.

Diets, Housing and Animals: The experiment was carried out to determine the effects of adding various by-product oils to commercial laying hen diets in comparison to soybean oil. Hundred and ninety two laying hens of H&N Brown Nick Chick at the age of 31 wk were confined in the compact type wire cages (50x44x46 cm) equipped with nipple drinkers and trough feeders, as to place 4 hens in each cage. Laying hens were kept in an experimental house and received an additional artificial lighting to adjust daily 16 h light and 8 h dark.

Table 1: Fatty acid profile of the dietary fats (%)

Fatty acid profile	Soya oil	Acid oil	Stearin	Bergafat
Lauric C12:0	-	-	-	3.0
Miristic C14:0	0.4	0.4	0.7	2.8
Palmitic C16:0	9.0	11.0	34.6	20.8
Stearic C18:0	2.0	0.9	2.1	13.0
Oleic C18:1	20.0	18.7	15.8	40.3
Linoleic C18:2	54.6	66.5	46.2	13.7
Linolenic C18:3	12.2	0.8	-	1.3
Others	1.8	1.2	0.6	5.1

The basal diet to which the test oils were added was mainly consisted of maize, wheat, barley, sunflower meal (42% CP) and soybean meal (44% CP) obtained from locally available feed ingredients. Four layer diets were added with the soybean oil, sunflower acid oil, stearin and blended acid oils (Bergafat) a rate of 30 g/kg diet which was an adequate inclusion level of fats normally practiced in the field conditions (Table 2). All the diets were isonitrogenic and isocaloric and formulated according to NRC (1994) to provide 170 g/kg crude protein and 11.51 MJ/kg. Metabolizable energy (ME) contents of the by-product oils were assumed to be identical to ME content of soybean oil which was considered to have 36.84 MJ ME/kg.

Experimental diets were prepared in the feed mixing unit at the Department of Animal Science of Trakya University in Tekirdag, Turkey. The feed ingredients were ground by a hammer mill to pass 3 mm sieve and mixed through a horizontal mixer (200 kg capacity). Prior to adding the test fats into the mixer they were heated up to 60 ^{o}C to ensure a homogenous mixing.

Four dietary treatments were randomly allocated to 12 cages, each containing 4 hens. Thus, there were 48 hens received each of the four treatments. The experiment was a completely randomized design and lasted for 14 wks. Laying performance was determined by daily control and records. Egg production was recorded daily whereas feed intake and egg weight were determined once a week, regularly in the same day of week. Egg mass was calculated by multiplying egg weight by egg production percentage. Feed conversion ratio, FCR, was calculated as gram feed consumption per day per hen divided by gram egg mass per day per hen.

The data was statistically analyzed by the analyses of variance using GLM (General Linear Model) in a windows-based statistical package program, SAS (1996). The differences between the means of groups were separated by Duncan's Multiple Range Test. Significant level used in the group comparisons was set at $p<0.05$.

Results

The results of present study indicated that dietary by-products oil did not significantly ($P>0.05$) affect laying performance and egg weight of commercial brown layers (Table 3). Egg production of the groups fed with acid oil, stearin or Bergafat did not differ from the control group fed with soybean oil. The means of egg production ranged from 86.6 to 89.6%, as acid oil group being the lowest. In addition, Feed intake, egg mass and FCR did not differ significantly ($P>0.05$) between the dietary treatments. Feed consumption of laying hens kept in the treatment groups appeared to be 7 to 9 gram higher than the standard recommendations of the commercial layer company (H&N Brown Nick Chick). This was probably due to the climatic conditions during which the experiment carried out since the trial was run during winter time where the experimental room temperature dropped sometimes down to 15 ^{o}C.

The egg weight was not significantly ($P>0.05$) affected by the dietary oils, except that the egg weight of the group

Table 2: The ingredients and chemical composition of the experimental diets (as fed)

Ingredients, g/kg diet	Experimental diets			
	Soya oil	Acid oil	Stearin	Bergafat
Soya oil	30.0	-	-	-
Acid oil	-	30.0	-	-
Stearin	-	-	30.0	-
ergafat	-	-	-	30.0
Corn	284.7	284.7	284.7	284.7
Wheat	260	260	260	260
Barley	100	100	100	100
Sunflower meal (42%CP)	100	100	100	100
Soybean meal (44%CP)	91.5	91.5	91.5	91.5
Meat and bone meal	43	43.0	43.0	43.0
Limestone	84.5	84.5	84.5	84.5
Common salt	2.4	2.4	2.4	2.4
Vitamin and mineral premix*	2.5	2.5	2.5	2.5
L-lysine Hcl	2.2	2.2	2.2	2.2
Dl-Methionine	1.7	1.7	1.7	1.7
Total	1000	1000	1000	1000
Calculated analysis, g/kg diet				
Dry matter	905.9	905.9	905.9	905.9
ME, MJ/kg	11.5	11.5	11.5	11.5
Kcal/kg	2750	2750	2750	2750
Crude protein	170	170	170	170
Crude fiber	40.5	40.5	40.5	40.5
Ether extract	53.8	53.8	53.8	53.8
Linoleic acid	23.9	23.9	21.4	11.6
Lysine	9.4	9.4	9.4	9.4
Met + Cys	7.0	7.0	7.0	7.0
Methionine	4.3	4.3	4.3	4.3
Calcium	38.1	38.1	38.1	38.1
Available phosphorus	4.3	4.3	4.3	4.3
Sodium	1.6	1.6	1.6	1.6
Chlorine	2.4	2.4	2.4	2.4

*Provides per kg of diet: vitamin A, 12000 IU; vitamin D_3, 2400 IU; vitamin E, 30 mg; vitamin K_3, 2.5 mg; vitamin B_1, 3 mg; vitamin B_2, 7 mg; vitamin B_6, 4 mg; vitamin B_{12}, 0.015 mg; nicotine amide, 40 mg; calcium-D-pantothenate, 8 mg; folic acid, 1 mg; D-biotin, 0.045 mg; choline chloride, vitamin C, 50 mg; Mn, 80 mg; Fe, 80 mg; Zn, 60 mg; Cu, 8 mg; I, 0.5 mg; Co, 0.2 mg; Se, 0.15 mg

Table 3: Changes in Dietary by-product oils on hens laying performance (31-42 wk of age)

Treatments	Egg Production (%)	Feed Intake (g/hen/day)	Egg Weight (g/egg)	Egg mass (g/hen/day)	FCR (g feed/g egg)
SOYA OIL	89,6	119,6	61,2	54,7	2,19
ACID OIL	86,6	118,9	61,2	52,8	2,26
STEARIN	88,5	118,6	61,9	54,7	2,17
BERGAFAT	88,6	117,9	59,3	52,6	2,24
Pooled SEM	1,0	0,8	0,5	0,4	0,02
P-level	0,8028	0,9229	0,3544	0,1553	0,3751

Means in the same column did not differ significantly (P>0.05)

fed with Bergafat tended to be low, 59.3 versus 61.2, 61.2 and 61.9 gram to the other groups fed with soybean oil, acid oil or stearin, respectively. The similar trend was also observed in FCR data. No difference was found between the dietary treatments (P>0.05) concerning FCR. Relatively higher feed intake caused by lower room temperature reflected in higher FCR values, ranging from 2.17 to 2.26.

Discussion

The results obtained from the present study revealed that laying hens did not show any specific requirement to over 12 g/kg linoleic acid in the diet as no significant differences were detected between the dietary linoleic acid levels (12 to 24 g/kg) with respect to egg weight. No difference seen between the treatment groups concerning the feed intake suggested that the laying hens consumed similar quantities of soybean oil, acid oil, stearin or bergafat which resulted in approximately equal amount of lipid deposition in the egg yolk. Therefore, this effect might be attributed to the similar energy intake obtained by the test oils regardless of the level of linoleic acid of the diet. The reduced egg weight with Bergafat can be explained with the lowered content of unsaturated fatty acid in Bergafat, compared to the other dietary fats (Table 1). Unsaturated fatty acids are more easily absorbed and upon entering the portal blood may supply a readily available source of lipid for direct deposition in the egg yolk (Freeman, 1984; Griffin *et al*., 1984) which may help to increase egg weight. This result was in the agreement with some of the previous reports (Whitehead, 1981; Summers and Leeson, 1983; Grobas *et al*., 2001; Balevi and Coskun, 2000). Whitehead (1981) fed to the layer hens with 4 isocaloric diets containing 0, 4, 30 and 30 g/kg added oil and 6.1, 8.8, 8.7 and 22.8 g/kg linoleic acid respectively. It was evident that the two diets containing higher levels of added oil resulted in larger eggs (58.8 and 59.2 g) than those with little or no added oil (57.3 and 56.7 g respectively). This was because the diet containing 30 g/kg of olive oil (linoleic acid level 8.7 g/kg) gave similar results to that the same quantity of maize oil (linoleic acid level 22.8 g/kg). It was suggested that hens do not appear to have specific requirement for linoleic acid approximately over 9 g/kg of the diet. However, the direct incorporation of well absorbed dietary lipids into the yolk would increase the egg size and, consequently, egg weight. Similarly, Grobas *et al*. (2001) concluded that hens fed a diet containing 30.5 g/kg oil and 7.9 g/kg linoleic acid had a feed intake, egg production and feed efficiency similar to the hens fed on the diets containing 62 g/kg oil and 10.3 g/kg or more linoleic acid at the beginning of lay (20-32 wk of age). Increasing dietary fat significantly increased egg weight; however, egg weight was not affected by linoleic acid level at the same dietary fat content (62 g/kg).

When comparing the effects of corn oil with poultry fat on egg weight, Bhonzack *et al*. (2002) concluded that corn oil resulted in increased egg weight compared to poultry fat. The authors reported that addition of fat to the diet increased egg weight as the level of fat was increased to 4%. Therefore, it became evident that the increase in egg weight was likely due to increased energy intake by oil addition rather than the increased linoleic acid content of the diet (Whitehead, 1981; Grobas *et al*., 2001; Bohnsack *et al*., 2002).

Conclusions: In conclusion, the present results suggested that there was no significant difference in laying performance and egg weight between the by-product oils used in the experiment. Furthermore, egg weight is likely to be affected by the energy intake resulted from the absorbed lipids, regardless the level of linoleic acid above 12 g/kg in the diet.

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