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Comparison of Effects of Using Different Levels of Animal and Vegetable Fats and Their Blends on Performance of Laying Hens

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ABSTRACT

Four experiments were conducted to investigate the effects of dietary fat type with different inclusion levels on performance of laying hens. In each of these experiments, 288 Hy-Line (W36) laying hens from 50-62 weeks old were used in a completely randomized design in eight treatments and three replicates (12 birds per replicate). The experimental diets in the first study were control (no oil), 4% soybean oil, 4% sunflower oil, 4% canola oil, 2% soybean oil+2% sunflower oil, 2% soybean oil+2% canola oil, 2% sunflower oil+2% canola oil and 1.33% soybean oil+1.33% sunflower oil+1.33% canola oil. The supplemental fats that were used in the experiment 2 were beef tallow, sheep tallow and poultries fat, in the experiment 3, were canola oil, beef tallow and sheep tallow and in the experiment 4, were beef tallow, soybean oil and sunflower oil. There were significant differences between treatments on performance among all experiments ($P<0.05$). In the first experiment, the highest amount of egg weight was observed in treatment contain 2% sunflower oil+2% canola oil, in the second experiment the highest amounts of egg weight, egg mass and better feed conversion were observed in the control group, whereas the highest percent of egg production was obtained in treatment containing 4% of sheep tallow, in the third experiment the highest amount of daily feed intake was observed in treatment containing 4% of sheep tallow and finally in the fourth experiment the highest amounts of egg weight and daily feed intake were observed in treatments containing 2% of soybean oil+2% of sunflower oil and 4% of sunflower oil.
KEY WORDS: Fatty acids, Animal fats, Vegetable oils, Egg yolk.

INTRDUCTION

The term of "fat" (animal or vegetal) is used as a synonym for lipid in the human food as well as in the ingredients for animal nutrition (Lehninger *et al.,* 2000). The addition of fat to diets, besides supplying energy, improves the absorption of fat-soluble vitamins, increases the palatability of the rations, and increases the efficiency of the consumed energy (lower caloric increment) (National Research Council, 1994). The carbon atoms of the fatty acids are chemically more reduced than carbon atoms found in sugar; therefore, the oxidation of triglycerides releases about twice as much as energy from carbohydrates. The deposition of 1g of energy from carbohydrates or protein by an animal requires higher quantities of these nutrients in comparison to the deposition of 1 g of energy from fat. Moreover, carbohydrate and protein reserves would be larger in function of the polar characteristic of theses substances, which would include water in these deposits (Lehninger *et al.,* 2000). Several factors can influence the quality of fat used in animal feed, including free fatty acid levels, moisture, insoluble and unsaponifiable substance, and rancidity (Craspo and Esteve-Garcia 2001). Free fatty acids are fatty acids that are not involved in ester linkage to glycerol. Free fatty acids are produced as a byproduct of hydrolysis in fat. It has been thought that high levels of FFA (>20%) usually indicated a possible issue with rancidity (Pearl, 2004; Dozier, 2003; Zumbado *et al.,* 1999; Gray and Robinson, 1941; Branion *et al.,* 1938) and may result in poor performance. Reported that addition 5% of poultry fat to broiler breeder diets, egg production improved and feed intake reduced (Brake, 1990). Digestibility of dietary fats is affected by its fatty acid (FA) profile. As unsaturated fats contain higher metabolisable energy (ME), so has shown that better utilization of compared to saturated fats (Craspo and Esteve-Garcia, 2001).

Some earlier studies did not observe any difference in the performance of laying hens fed different oil sources (Yu and Sim, 1987; Nash *et al.,* 1996). Also, Baucells *et al.* (2000) did not observe any differences in the feed intake of layers receiving a diet with 4% linseed oil. Whereas, poor performance, particularly in terms of lighter eggs and reduced feed intake, was reported when linseed and fish oils were included in laying hens diets (Scheideler and Froning, 1996; Van Elswyk, 1997; Gonzales-Esquerra and Leeson, 2000). Fat supplementation affected laying hens performance except for egg weight (Celebi and Utlu, 2006). By addition of 4% of different fat source except beef tallow, the amount of egg weight significantly increased (Harms and Russell, 2004). Grobas et al. (2001) reported that the increased egg weight was associated with the total dietary fat contents 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). Inclusion of 2 or 4% of soybean, canola, linseed and fish oils did not influence egg mass, feed conversion ratio (per kg eggs and dozen eggs), or egg production (Lelis *et al.,* 2009) in laying hens. Recently exported that using 2% of beef tallow with 2% of soybean oil can improve the performance of

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laying hens (Nobakht and Shahryar, 2008) in laying hens. However, the effects of different fats or oils were rarely studied in respect to laying performance and egg weight, so the present study was conducted in order to evaluate the effect of different levels of vegetable oil, animal fat and vegetable oil/animal fat blend on performance of laying hens.

MATERIALS AND METHODS

Four experiments were conducted to investigate the effects of different levels of vegetable oil, animal fat and vegetable oil/animal fat blend on performance of laying hens. In each experiment 288 Hy-Line (W36) laying hens from 50-62 weeks old were used in a completely randomized design in eight treatments and three replicates (12 birds per replicate). The experimental diets in the first study were control (no oil), 4% soybean oil, 4% sunflower oil, 4% canola oil, 2% soybean oil+ 2% sunflower oil, 2% soybean oil+2% canola oil, 2% sunflower oil+2% canola oil and 1.33% soybean oil+1.33% sunflower oil+1.33% canola oil. The supplemental fats that were used in the experiment 2 were beef tallow, sheep tallow and poultries fat, in the experiment 3, were canola oil, beef tallow and sheep tallow and in the experiment 4, were beef tallow, soybean oil and sunflower oil. Two oil sources were used like as the first experiment design (Table 1).

Table 1. The experimental treatments using different source and levels of fats and oils in each treatment in each experiment

Treatments	Experiments			
	1	2	3	4
1	**Control group (no fat)**	**Control group (no fat)**	**Control group (no fat)**	**Control group (no fat)**
2	4% Soybean oil	4% Beef tallow	4% Beef tallow	**4% Soybean oil**
3	4% Sunflower oil	4% Sheep tallow	4% Sheep tallow	**4% Sunflower oil**
4	4% Canola oil	4% Poultries fat	4% Canola oil	**4% Beef tallow**
5	2% Soybean oil+ 2% Sunflower oil	2% Beef tallow+ 2% Sheep tallow	2% Beef tallow+ 2% Sheep tallow	**2% Soybean oil+ 2% Sunflower oil**
6	2% Soybean oil+ 2% Canola oil	2% Beef tallow+ 2% Poultries fat	2% Beef tallow+ 2% Canola oil	**2% Soybean oil+ 2% Beef Tallow**
7	2% Sunflower oil+ 2% Canola oil	2% Sheep tallow + 2% Poultries fat	2% Sheep tallow +2% Canola oil	**2% Sunflower oil+ 2% Beef tallow**
8	**1.33% Soybean oil+ 1.33% Sunflower oil+ 1.33% Canola oil**	**1.33% Beef tallow+ 1.33% Sheep tallow + 1.33% Poultries fat**	**1.33% Beef tallow+ 1.33% Sheep tallow + 1.33% Canola oil**	**1.33% Soybean oil+ 1.33% Sunflower oil+1.33%Beef tallow**

The diets were formulated (Table 2) to meet the requirements of laying hens as established by the NRC (1994).

The diets and water was provided *ad libitum*. The lighting program during experimental period consisted of 15 hrs light and 9 hrs darkness. Egg production, feed intake, egg mass and feed conversion ratio recorded weekly. Mortality was recorded during the trial.

Table 2. Composition of control and experimental diets

Ingredients	Control group	Diets with fat source
Corn	69.71	**40.21**
Wheat	0.00	**19.81**
Soybean meal	15.21	**16.83**
Wheat bran	5.70	**5.00**
Fat source*	0.00	**4.00**
Inert (sand)	0.00	**4.00**
Oyster shell	7.28	**7.36**
Bone meal	1.3	**1.52**
Salt	0.26	**0.25**
Vitamin premix[1]	0.25	**0.25**
Mineral premix[2]	0.25	**0.25**
Calculated composition		
Metabolisable energy (Kcal/Kg)	2750	**2750**
Crude protein (%)	13.75	**13.75**
Calcium (%)	3.22	**3.32**
Available phosphorous (%)	0.30	**0.30**
Sodium (%)	0.14	**0.14**
Lysine (%)	0.64	**0.65**
Methionine+Cysteine (%)	0.52	**0.52**
Threonine (%)	0.57	**0.55**
Thryptophan (%)	**0.17**	**0.18**

[1]Supplied per kilogram of diet: 3520000 IU vit. A, 1000000 IU vit. D_3, 4400 IU vit. E, 880 mg vit. K_3, 738.5 mg vit. B_1, 1600 mg vit. B_2, 3136 mg vit. B_3, 13860 mg vit. B_5, 984.8 mg vit. B_6, 192 mg vit. B_9, 4 mg vit. B_{12}, 60 mg biotin, 80000 mg choline chloride, 400 mg anti oxidant,

[2]Supplied per kg of diet: 25870 mg Zn, 30000 mg Fe, 29760 mg Mn, 2400 mg Cu, 346.8 mg I, 80 mg Se.

* Average calculated metabolisable energy content of experimental diets with three sources of vegetable oils was 2750 Kcal/Kg, experimental diets with three sources of animal fats was 2730 Kcal/Kg, experimental diets with two sources of animal fats and one source of vegetable oil was 2717 Kcal/Kg, and experimental diets with one source of animal fats and two sources of vegetable oils was 2723 Kcal/Kg.

The data were subjected to analysis of variance procedures appropriate for a completely randomized design using the General Linear Model procedures of SAS Institute (2005). Means were compared using the Duncan multiple range test. Differences were considered significant at $P<0.05$.

RESULTS AND DISCUSSION

The effects of different sources and levels of oils (experiment 1) on laying hens performance in are summarized in Table 3. Different sources and levels of vegetable oils significantly affected the egg weight ($P<0.05$) of laying hens. Laying hens fed 2% sunflower oil+2% canola oil showed the highest egg weight (57.29 g) compared to the laying hens fed 2% soybean oil+2% canola oil. Replacing 2% of soybean oil with 2% of sunflower oil may be supply good profiles of fatty acids especially linoleic acid, resulting in the highest egg weight. The result of heavier eggs in the treatment 7 is in agreement with the finding of Harms and Russell (2004) whereas there is not match with the report of Celebi and Utlu (2006). In terms of numerical values, the highest percent of egg production, the highest amount of feed intake and the best feed conversion were observed in the treatment 5.

Table 3. The effects of different levels of vegetable oil, animal fat and vegetable oil/animal fat blend on laying hens performance (experiment 1)

Treatments	Performance				
	Egg weight (g)	Egg production (%)	Egg mass (g/bird/day)	Feed intake (g/bird/day)	Feed conversion ratio
Control group (no fat)	56.82^{ab}	64.21	36.51	94.71	2.64
(2) 4% Soybean oil	55.39^{ab}	63.79	35.26	97.02	2.77
(3) 4% Sunflower oil	56.61^{ab}	63.88	35.90	94.30	2.66
(4) 4% Canola oil	55.64^{ab}	66.66	37.20	91.23	2.57
(5) 2% Soybean oil+ 2% Sunflower oil	56.28^{ab}	68.21	37.06	97.61	2.57
(6) 2% Soybean oil+ 2% Canola oil	54.70^{b}	61.24	33.68	97.36	3.09
(7) 2% Sunflower oil+ 2% Canola oil	57.29^{a}	64.84	37.24	95.84	2.67
(8) 1.33% Soybean oil+ 1.33% Sunflower oil+ 1.33% Canola oil	57.08^{a}	59.18	33.79	95.74	2.92
SEM	0.73	3.51	1.99	1.62	0.17

^{ab}Values in the same column not sharing a common superscript differ significantly ($P<0.05$).

The effects of different levels of animal fat and animal fat blend on laying hens performance in experiment 2 are summarized in Table 4.

Table 4. The effects of different levels of vegetable oil, animal fat and vegetable oil/animal fat blend on laying hens performance (Experiment 2)

Treatments	Performance				
	Egg weight (g)	Egg production (%)	Egg mass (g/bird/day)	Feed intake (g/bird/day)	Feed conversion ratio
Control group (no fat)	57.32^{a}	67.26^{a}	38.56^{a}	97.54	2.54^{b}
(2) 4% Beef tallow	55.1^{b}	61.90^{ab}	34.09^{ab}	95.59	2.83^{ab}
(3) 4% Sheep tallow	55.63^{ab}	69.24^{a}	38.49^{a}	99.45	2.61^{b}
(4) 4% Poultries fat	55.62^{ab}	56.73^{b}	31.64^{b}	96.54	3.17^{a}
(5) 2% Beef tallow+2% Sheep tallow	55.56^{ab}	66.27^{ab}	36.82^{ab}	97.56	2.68^{ab}
(6) 2% Beef tallow+2% Poultries fat	56.89^{ab}	59.42^{b}	32.62^{b}	96.56	3.03^{ab}
(7) 2% Sheep tallow+2% Poultries fat	54.98^{b}	62.13^{ab}	35.35^{ab}	95.91	2.75^{ab}
(8) 1.33% Beef tallow+ 1.33% Sheep tallow+1.33% Poultries fat	56.19^{ab}	64.18^{ab}	36.08^{ab}	98.18	2.78^{ab}
SEM	0.63	2.98	1.67	1.31	0.16

^{ab}Values in the same column not sharing a common superscript differ significantly ($P<0.05$).

Using of different sources and blends of animal fats had adverse effects on performance of laying hens by decreasing the egg production parameters when compared with the control group ($P<0.05$). The highest amounts of egg weight (57.32g), egg mass (38.56g) and the best feed conversion (2.54) were recorded in the control group. The highest percent of egg production (69.24) was observed in the treatment 3. However, there were no significant difference of egg production among the control, treatments 2, 3, 5, 7 and 8. Decreasing production parameters with using some animal fats sources and fat blend may be mainly related to the low levels of unsaturated fatty acids and less digestible of animal fat sources when compared with vegetable oil sources. In these circumstances, the amount of energy provided is less, resulting in adverse effects on egg production traits. Several studies have shown better utilization of unsaturated fats by chicken, leading to higher ME for unsaturated fats than for saturated fats (Craspo and Esteve-Garcia, 2001). Some investigators did not find any differences in the performance of layers fed different oil sources (Yu and Sim, 1987; Nash *et al.,* 1996)

The effects of different levels of vegetable oil, animal fat and vegetable oil/animal fat blend on laying hens performance in experiment 3 are summarized in Table 5.

The application of two sources of animal fats with one source of vegetable oil and blends of them significantly affected the amounts of daily feed intake ($P<0.05$). The highest amount of daily feed intake (99.45 g) was observed in

the treatment 3. However, the feed intake of chickens in the treatment 3 only had significant different with that in the treatment 4. The main explanations for this difference may be related to different fatty acid profiles between the treatment diets. In fact, canola oil are rich in unsaturated when compared with high proportion of saturated fatty acids found in fat. The unsaturated fatty acids in canola oil can be easily digested and provided more energy for hens, causing reduction of daily feed intake of hens fed the canola oil. The results of feed intake in this experiment is in accordance with the report of Craspo and Esteve-Garcia (2001) while in disagreement with the report of Brake (1990) who found lowering feed intake after addition 5% of fat to laying hens diets.

Table 5. The effects of different levels of vegetable oil, animal fat and vegetable oil/animal fat blend on laying hens performance (Experiment 3)

Treatments	Performance				
	Egg weight (g)	Egg production (%)	Egg mass (g/bird/day)	Feed intake (g/bird/day)	Feed conversion ratio
Control group (no fat)	57.32	67.26	38.56	97.54[ab]	2.54
(2) 4% Beef tallow	55.02	61.9	34.23	95.59[ab]	2.83
(3) 4% Sheep tallow	55.63	69.24	38.49	99.45[a]	2.61
(4) 4% Canola oil	58.76	65.97	36.78	95.29[b]	2.62
(5) 2% Beef tallow+2% Sheep tallow	55.55	66.27	36.82	97.56[ab]	2.68
(6) 2% Beef tallow+2% Canola oil	55. 02	62.20	34.23	96.75[ab]	2.88
(7) 2% Sheep tallow+2% Canola oil	55.34	64.91	35.86	96.67[ab]	2.71
(8) 1.33% Beef tallow + 1.33% Sheep tallow+1.33% Canola oil	55.04	66.17	36.44	96.19[ab]	2.66
SEM	1.19	2.32	1.39	1.2	0.12

[ab]Values in the same column not sharing a common superscript differ significantly (P<0.05).

The effects of different levels of vegetable oil, animal fat and vegetable oil/animal fat blend on laying hens performance in experiment 4 are summarized in Table 6.

Table 6. The effects of different levels of vegetable oil, animal fat and vegetable oil/animal fat blend on laying hens performance (Experiment 4)

Treatments	Performance				
	Egg weight (g)	Egg production (%)	Egg mass (g/bird/day)	Feed intake (g/bird/day)	Feed conversion ratio
Control group (no fat)	56.82[ab]	64.21	36.51	94.71[b]	2.64
(2) 4% Soybean oil	55.32[b]	63.79	35.26	97.02[ab]	2.77
(3) 4% Sunflower oil	55.63[ab]	69.24	38.49	99.45[a]	2.61
(4) 4% Beef tallow	56.58[ab]	63.88	36.78	98.30[ab]	2.63
(5) 2% Soybean oil+2% Sunflower oil	57.20[a]	68.61	39.32	96.20[ab]	2.47
(6) 2% Soybean oil+2% Beef tallow	56.25[ab]	68.21	38.39	97.59[ab]	2.57
(7) 2% Sunflower oil+2% Beef tallow	56.57[ab]	66.49	37.60	97.54[ab]	2.66
(8) 1.33% Soybean oil+ 1.33% Sunflower oil+1.33% Beef tallow	56.55[ab]	67.23	38.37	96.13[ab]	2.54
SEM	0.50	2.45	1.2	1.47	0.02

[ab]Values in the same column not sharing a common superscript differ significantly (P<0.05).

The Using of two sources of vegetable oils and one source of animal fat significantly affected the egg weight and daily feed intake (P<0.05). The highest egg weight (57.20 g) was observed in the treatment 5 (2% soybean oil+2% sunflower oil) whereas the lowest amount of it (55.32 g) was recorded the treatment 2 (4% soybean oil). The heavier eggs in the treatment 5 may be the results of supplying the proper profiles of fatty acids by blending two sources of vegetable oils, whereas these results may not be found in the other treatments, This result about egg weight is in agreement with finding of (Harms and Russell, 2004). There reported that by adding 4% of different fat source except beef tallow the eggs weight significantly increased, whereas in disagreement with the report of Costa et al. (2008) there did not observe worse performance in heavy layers fed a diet containing 2% linseed oil as compared to those fed a control diet based on corn and soybean meal. The highest amount of daily feed intake (99.45g) was recorded in the treatment 2 whereas the lowest weight of eggs was observed in the control group. There were no significant differences in feed intake among the other treatments, except the control group. This increase in feed intake with inclusion of sunflower oil may be related to palatability of the diets. This result about feed intake is in agreement with finding of Nobakht and Shahyar (2008) those reported that using different levels of fat and oil don't have any significant effects on feed intake in laying hens.

CONCLUSION

The overall results indicated that in laying hens using 4% of different sources and blends of vegetable oils can improve their performance when compared with animal fat sources and blends.

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