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Influence of Linseed oil Supplementation on Production Performance in Laying Hens

Promila, Nand Kishore, Jyoti Shunthwal*, Rakesh Verma, and Rakesh Kumar

Department of Animal Nutrition, College of Veterinary Sciences, LLR University of Veterinary and Animal Sciences, Hisar-125004, Haryana, India

*Corresponding Author E-mail: jyotishunthwal@gmail.com

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ABSTRACT

An experiment was conducted to evaluate the effect of supplementing different levels of linseed oil in the laying hens' diet on their production performance and egg quality parameters during a period of 16 weeks. One hundred forty White Leghorn layers were randomly distributed into seven experimental groups having 5 replications of 4 birds in each and sited in individual cages from 22 to 38 weeks of age. The laying hens of control group (T_1) were fed a basal diet formulated as per BIS (2007) standards. The layers of treatment groups T_2, T_3, T_4, T_5, T_6 and T_7 were fed basal diet supplemented with linseed oil at levels of 1, 2, 2.5, 3, 3.5 and 4%, respectively. The main results indicated a significant ($p<0.05$) decrease in feed intake in layers fed @ 3, 3.5 and 4% linseed oil. FCR (kg/dozen eggs and kg/kg egg mass) was significantly better in T_4 (2.5% linseed oil) and T_7 (4% linseed oil) as compare to T_1 (control). Average egg weight differed significantly ($p<0.05$) being higher in T_4, T_5, T_6 and in T_7 it was highest. Dry matter metabolizablity was non-significant, while nitrogen retention values were improved ($P<0.05$) in treatments T_6 and T_7. Also significant ($p<0.05$) effect was observed on nitrogen corrected metabolizable energy and gross energy metabolizablity. Thus, supplementation of linseed oil at different levels in laying hens' diet significantly ($P<0.05$) improved the egg weight and egg mass production, feed conversion ratio, nitrogen retention and gross energy metabolizablity.

Key words: *Linseed oil, Egg production, laying hens, Metabolizablity, Feed conversion ratio*

INTRODUCTION

Poultry farming has undergone a paradigm shift in structure and operation, transforming itself from a mere backyard activity into a major commercial venture. Poultry contributes to 15% of the total food energy and 5% of the dietary protein. Egg production of India was around 78.48 billion during 2014-15 and per capita consumption per year was 63 eggs (Ministry of finance, Govt. of India, 2015-16), which is much lower than the National Institute of Nutrition`s recommendations of 180 eggs. Eggs are considered as an important part of human food since the dawn of recorded history. Good taste and numerous applications in preparing a wide variety of foods lead to increase the egg consumption in the world year after year.

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The egg functional proteins have been recognized as one of the highest quality proteins in digestibility as well as amino acid composition. Hen's egg have been documented as a source of essential fatty acids, and several vitamins and minerals thus, daily intake of hen eggs supply adequate amount of recommended daily allowance of such materials. These advantages qualify hen eggs to be one of the promising functional foods in the coming decades according to their relation to the human health. Although egg is considered a functional food and is an excellent source of protein, essential lipids, vitamins and minerals many people decrease their consumption of eggs because they consider that high egg cholesterol content may result into cardiovascular diseases[19, 21]. Over the last three decades, many researchers have been trying to reduce the egg cholesterol content by genetic selection, inclusion of drugs in the ration, or by dietary manipulation of hen's diet, but the success was limited. Recent efforts have been focused on increasing the n-3 polyunsaturated fatty acids (PUFA) content of eggs by the inclusion of dietary sources of these fatty acids into the hens' ration[10]. Oil plants and some legumes can serve as source of oils to be used for supplementation of diets for poultry. Due to increasing public demand for animal products low in fat and cholesterol, studies have been focusing on improving the quality of foods from animal origin. Cholesterol and fatty acid concentrations of egg yolk vary depending on dietary manipulation and pharmacological agents as well as genetics, age and production level of bird. The purpose of this investigation was to study the effect of supplementation of linseed oil on the egg production and egg quality in layers.

MATERIAL AND METHODS

A total of one hundred and forty single comb White Leghorn hens of commercial strain, 22-23 weeks of age, in the first phase of their production cycle with an average weight of 1737 ± 44.28 g were randomly divided in to seven treatment groups, having five replications with four birds in each replication. The laying hens of control group (T_1) were fed a basal diet formulated as per BIS (2007) standards, its ingredient and composition has been given in Table 1. The layers of treatment groups T_2, T_3, T_4, T_5, T_6 and T_7 were fed basal diet supplemented with linseed oil at levels of 1%, 2%, 2.5%, 3%, 3.5% and 4%, respectively. Hens were fed the experimental diet for sixteen weeks of experimental period beginning at 22 weeks of age and continued up to 38 weeks of age. The hens were offered feed and water *ad libtum* through linear feeder and waterers. For each replicate group, feed intake was measured on weekly basis whereas egg production data was recorded daily. Random samples of 5 eggs from each treatment (1egg per replicate) were collected at weekly intervals for measurement of egg weight and egg mass production. Feed conversion ratio was expressed as kilogram of feed consumed per dozen egg produced and per kg of egg mass produced. A metabolism trial was conducted at the end of experiment for each treatment for nutrient retention and energy metabolizablity. Five birds from each treatment were randomly selected and transferred to metabolic cages. After three days of adaption period, a collection period of four days was provided for collection of faeces samples and feed consumption of each hen was recorded. The excreta on each polythene sheets were thoroughly mixed and homogenous samples were stored in plastic bottles in deep freeze. On last day of collection, the excreta samples were kept at room temperature. All the diets were analyzed for proximate principles and also excreta samples for moisture and nitrogen contents[1]. The dried samples were kept for energy estimation. The data were analyzed using completely randomized design[1].

RESULTS AND DISCUSSION

The data pertaining to average feed intake (g) per bird per day during progressive age of layers in different dietary treatments are presented in Table 2. The results of the study depicted that there was a significant ($P<0.05$) difference among different dietary treatments, showing that feeding of different levels (1%, 2%, 2.5%, 3%, 3.5% and 4% linseed oil) affect feed consumption (g/hen/day) and decreased portionately with the increase in inclusion level of linseed oil. These findings are in full agreement with findings who reported an increase in feed intake in hens given the flaxseed in the diets. While, here were no change in feed intake in laying hens at the diet with 4% inclusion of linseed oil[15]. While, in a study the hens fed with 5 or 10 % linseed oil showed a decrease in feed intake. Based on the results of the present and previous studies, the influences of dietary linseed oil on feed intake could be said to be variable, but no deleterious effect on performance was observed in this case[9].

Feed conversion ratio in terms of Kg feed per dozen egg productions and Kg feed per Kg egg mass production were used as a measure of efficiency of utilisation of feed for egg production. The FCR values of progressive weeks of age and cumulative (22-38weeks) are presented in Table 3 and 4, respectively. The results of study revealed that the feed conversion ratio was significantly (P<0.05) lower in the treatment group T_4 (2.5% linseed oil) and T_7 (4% linseed oil) as compared to other treatment groups, i.e.

Table 1: Ingredient and chemical composition of ration for layers of control group

Feed ingredients	**Percentage**
Maize	50
Groundnut cake	7
Soybean Meal	13
DORP	12
Rice Polish	5
Fish Meal	6
Mineral Mixture	3
Salt	0.5
Shell Grit	3.5
Chemical composition	**%DM basis**
CP	19.04
CF	6.74
EE	3.61
NFE	62.81
Ash	7.80
Metabolizable energy*(Kcal/Kg)	2697.17

* calculated value (BIS,2007) , Feed additive included Spectromix-10g (Each g contained vitamin A- 82,500 IU, vitamin D_3 12,000 IU, vitamin B2- 50mg, and vitamin K- 10mg.), Spectrimix-BE-10g (Each g contained vitamin B1- 80mg, vitamin B_6 –16mg, Niacin- 120mg, vitamin B_{12}- 80mg, Calcium Pantothenate- 80mg, vitamin E -160mg, L-lysine HCl- 10mg, DL-Methionine -10mg, and Calcium- 260mg) per 100 Kg of ration.

Table 2: Mean values of feed consumption (g/hen/day) during progressive age (weeks) under different dietary treatments

Weeks/ Treatment	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**C.D.**
22 – 24	107.76 ±2.60	104.18 ±3.14	111.24 ±1.27	107.17 ±3.98	106.02 ±2.93	107.78 ±4.33	112.52 ±2.12	NS
24 – 26	114.75^{b} ±2.30	121.55^{a} ±1.58	121.22^{a} ±1.05	116.52^{ab} ±2.14	113.28^{b} ±2.19	111.56^{b} ±2.56	111.27^{b} ±1.59	5.57
26 – 28	111.73^{a} ±2.14	110.75^{a} ±4.33	118.72^{a} ±0.88	117.16^{a} ±1.65	119.48^{a} ±1.66	101.19^{b} ±3.60	104.92^{ab} ±4.08	7.63
28 – 30	117.69^{abc} ±3.32	114.78^{bc} ±3.91	122.09^{ab} ±1.33	123.04^{a} ±1.27	110.95^{cd} ±3.40	110^{cd} ±2.91	103.78^{d} ±2.66	8.24
30 – 32	123.52^{a} ±3.82	120.34^{ab} ±1.64	124.72^{a} ±1.56	122.71^{a} ±4.08	112.84^{bc} ±3.71	112.66^{bc} ±3.66	105.20^{c} ±3.00	9.32
32 – 34	126.69^{ab} ±0.81	120.99^{ab} ±5.96	127.11^{a} ±2.00	124.79^{ab} ±3.59	117.07^{b} ±3.85	118.08^{ab} ±2.51	102.15^{c} ±2.90	9.76
34 – 36	127.11^{a} ±2.87	124.83^{ab} ±3.89	126.32^{ab} ±1.11	123.65^{abc} ±3.22	116.30^{bc} ±5.25	113.09^{cd} ±5.36	102.86^{d} ±2.20	10.73
36 – 38	116.28^{abc} ±3.16	118.83^{a} ±1.55	117.30^{ab} ±1.96	112.41^{bc} ±2.03	112.54^{ab} ±2.24	110.10^{c} ±2.58	96.91^{d} ±1.27	6.34
Mean	118.07^{a} ±1.40	117.03^{ab} ±1.52	121.09^{a} ±0.92	118.43^{a} ±1.36	113.56^{b} ±1.23	108.93^{c} ±2.77	104.95^{c} ±1.12	4.38

The mean values in same row with different superscripts differ significantly (P< 0.05)

Table 3: Mean values of feed intake (kg) per dozen egg production during progressive age (weeks) under different dietary treatments

Weeks/ Treatment	T_1	T_2	T_3	T_4	T_5	T_6	T_7	CD
22 – 24	2.06^{ab} ±0.80	2.08^{ab} ±0.01	2.11^{ab} ±0.20	1.70^{b} ±0.07	1.75^{b} ±0.26	1.94^{ab} ±0.15	2.26^{a} ±0.09	0.47
24 – 26	1.87^{b} ±0.04	2.37^{a} ±0.15	2.05^{ab} ±0.16	1.89^{b} ±0.07	1.94^{b} ±0.14	1.98^{b} ±0.07	2.00^{b} ±0.12	0.32
26 – 28	2.29^{ab} ±0.29	2.66^{a} ±0.25	2.08^{ab} ±0.13	2.17^{ab} ±0.10	2.31^{ab} ±0.17	1.91^{b} ±0.43	2.00^{ab} ±0.19	0.70
28 – 30	2.46^{ab} ±0.20	2.46^{ab} ±0.07	2.58^{a} ±0.14	2.16^{bc} ±0.17	2.29^{abc} ±0.21	2.20^{abc} ±0.03	2.02^{c} ±0.09	0.41
30 – 32	2.48 ±0.08	2.45^{ab} ±0.08	2.59^{a} ±0.21	2.12^{b} ±0.15	2.33^{ab} ±0.11	2.40^{ab} ±0.18	2.31^{ab} ±0.10	0.40
32 – 34	2.61^{a} ±0.08	2.46^{a} ±0.18	2.29^{ab} ±0.12	2.13^{b} ±0.11	2.40^{ab} ±0.11	2.39^{ab} ±0.08	2.30^{ab} ±0.06	0.32
34 – 36	2.66^{a} ±0.14	2.46^{ab} ±0.16	2.48^{ab} ±0.10	2.13^{b} ±0.08	2.34^{ab} ±0.25	2.20^{b} ±0.14	2.34^{ab} ±0.09	0.42
36 – 38	2.72^{a} ±0.21	2.66^{ab} ±0.11	2.45^{abc} ±0.12	2.14^{c} ±0.08	2.49^{abc} ±0.08	2.50^{abc} ±0.15	2.31^{bc} ±0.07	0.36
Mean	2.39^{ab} ±0.07	2.45^{a} ±0.06	2.33^{abc} ±0.06	2.04^{d} ±0.06	2.23^{bc} ±0.07	2.19^{cd} ±0.07	2.19^{cd} ±0.04	0.16

The mean values in same row with different superscripts differ significantly (P< 0.05)

Table 4: Mean values of feed intake (Kg) per Kg egg mass production during progressive age (weeks) under different dietary treatments

Weeks/ Treatment	T_1	T_2	T_3	T_4	T_5	T_6	T_7	CD
22 – 24	3.27^{ab} ±0.13	3.31^{ab} ±0.33	3.37^{ab} ±0.41	2.64^{b} ±0.12	3.45^{a} ±0.31	3.11^{ab} ±0.26	3.59^{a} ±0.12	0.76
24 – 26	2.93^{b} ±0.06	3.74^{a} ±0.21	3.30^{ab} ±0.34	2.89^{b} ±0.09	2.99^{b} ±0.21	3.03^{b} ±0.13	3.07^{b} ±0.20	0.57
26 – 28	3.71^{ab} ±0.41	4.27^{a} ±0.43	3.30^{ab} ±0.25	3.38^{ab} ±0.12	3.34^{ab} ±0.22	2.80^{b} ±0.63	2.90^{b} ±0.29	1.07
28 – 30	3.86^{abc} ±0.26	3.91^{ab} ±0.13	4.12^{a} ±0.29	3.11^{d} ±0.28	3.34^{bcd} ±0.28	3.24^{cd} ±0.08	2.86^{d} ±0.14	0.64
30 – 32	3.97^{a} ±0.09	3.84^{a} ±0.10	3.96^{a} ±0.28	3.24^{c} ±0.23	3.60^{abc} ±0.18	3.60^{abc} ±0.25	3.29^{c} ±0.13	0.55
32 – 34	4.06^{a} ±0.11	3.77^{ab} ±0.20	3.55^{bc} ±0.19	3.27^{c} ±0.15	3.64^{abc} ±0.19	3.44 ±0.13	3.24^{c} ±0.11	0.46
34 – 36	4.26^{a} ±0.28	3.88^{ab} ±0.25	3.83^{abc} ±0.08	3.04^{d} ±0.05	3.43^{bcd} ±0.40	3.22^{cd} ±0.18	3.30^{bcd} ±0.12	0.65
36 – 38	4.22^{a} ±0.36	4.10^{ab} ±0.17	3.88^{abc} ±0.18	3.31^{cd} ±0.13	3.82^{abcd} ±0.17	3.64^{bcd} ±0.18	3.25^{d} ±0.11	0.57
Mean	3.78^{a} ±0.11	3.85^{a} ±0.09	3.66^{ab} ±0.10	3.11^{d} ±0.06	3.45^{bc} ±0.09	3.26^{cd} ±0.10	3.19^{d} ±0.06	0.24

The mean values in same row with different superscripts differ significantly (P< 0.05)

The feed consumption per dozen egg production and per kg egg mass production was significantly (P<0.05) reduced in treatment T_4 (2.5%), followed by T_7 (4%) as compared to other treatments. Laying hens receiving supplemented diets exhibited improvements in feed conversion ratio 14.64 % and 8.36%, in treatment groups T_4 and T_7, respectively, compared with hens fed the control diet. These findings indicate that the linseed oil used in the present study led to more efficient conversion of feed to egg mass. These findings are supported by many studies who observed that the linseed oil was beneficial in improving feed conversion ratio[3,2, 4, 9, 14,].

The cumulative average egg weights in different treatments were given in Table 5. The perusal of the data obtained clearly indicate that linseed oil supplementation in feed in treatment groups T_2,T_3,T_4,T_5,T_6 and T_7 led to significant (P<0.05) increase in egg weight, in comparison to the no-added control group. The egg weights of hens fed highest level of linseed oil were highest (57.47 g), whereas the egg weights of hens given the control diet were lowest (52.71g). Present findings are fully in agreement with the various studies[11,20] who reported an increase in egg weight in hens fed 3 % linseed oil. There was no change in egg weight in laying hens at 4 % linseed oil in the diet[16]. No change in egg weight in the hens fed 5 % linseed oil as compared to the controls[8]. On contrary, some studies reported that feeding linseed to hens resulted in decreased (P < 0.05) egg weight[4,6,18].

The results of percent dry matter metabolizablity pertaining to different dietary treatments was non-significant are presented in Table 6.

The results of the percent nitrogen retention under different dietary treatments are given in Table 6, and was significantly (P<0.05) higher in hens of treatment groups T_6 (3.5% linseed oil) and T_7 (4% linseed oil) as compared with control diet. Thus, the result findings revealed that dietary inclusion of linseed oil resulted in positive nitrogen retention values in hens of supplemental group as compared to non added control regime.

The data regarding average gross energy of feed and excreta, apparent metabolizable energy (AME), nitrogen corrected metabolizable energy and gross energy metabolizablity is presented in Table 7. The lowest (2697.17) value of N corrected ME was found in hens of treatment group T_1 fed non supplemented diet and highest (2931.89) value of N corrected ME was found in hens of treatment group T_7 fed linseed oil at the rate of 4%. There was statistical increase in the the N corrected ME values with the increasing levels of linseed oil. The GE metabolizablity values were affected by different levels of linseed oil inclusion in the diet of laying hens and were significantly higher in comparison to maize based control non supplemented diet. Gross energy of nitrogen retained per Kg of feed was non-significant.

Organic matter retention and AME value of diet containing whole linseed was lower than diet containing linseed oil (P≤0.05)[12].

Table 5: Mean values of egg weight (g) during progressive age (weeks) under different dietary treatments

Weeks/ Treatment	T_1	T_2	T_3	T_4	T_5	T_6	T_7	CD
22 – 24	52.54 ±0.32	52.42 ±0.78	52.88 ±1.55	53.66 ±1.22	51.21 ±1.52	52.09 ±1.14	52.36 ±1.15	NS
24 – 26	53.15 ±0.94	52.81 ±1.26	52.35 ±2.05	54.54 ±0.82	54.06 ±0.77	54.56 ±0.56	54.55 ±1.00	NS
26 – 28	51.26^{b} ±0.13	52.02^{b} ±0.40	52.75^{b} ±0.76	53.29^{b} ±1.11	57.70^{a} ±0.80	57.64^{a} ±1.13	57.73^{a} ±0.84	2.75
28 – 30	52.96^{b} ±1.60	52.46^{b} ±0.78	52.41^{b} ±0.86	58.09^{a} ±1.06	56.96^{a} ±0.74	56.73^{a} ±1.18	58.89^{a} ±0.36	2.91
30 – 32	52.00^{d} ±1.22	53.14^{cd} ±1.08	54.30^{bc} ±0.64	54.36^{bc} ±0.37	54.07^{bcd} ±0.37	55.53^{b} ±0.55	58.50^{a} ±0.53	2.16
32 – 34	53.51^{b} ±0.60	54.16^{b} ±1.02	53.82^{b} ±0.40	54.17^{b} ±0.46	54.98^{b} ±0.44	57.83^{a} ±0.45	59.13^{a} ±0.43	1.68
34 – 36	52.40^{c} ±1.57	52.91^{c} ±0.77	53.95^{bc} ±1.71	58.38^{a} ±1.42	57.15^{ab} ±0.66	56.84^{ab} ±1.21	59.11^{a} ±1.19	3.68
36 – 38	53.89^{c} ±0.49	53.98^{c} ±0.50	52.70^{c} ±1.00	54.01^{c} ±0.08	54.65^{bc} ±1.60	57.00^{ab} ±0.86	59.49^{a} ±1.04	2.65
Mean	52.71^{c} ±0.38	52.99^{c} ±0.30	53.14^{c} ±0.41	55.06^{b} ±0.41	55.10^{b} ±0.44	56.03^{b} ±0.42	57.47^{a} ±0.48	1.40

The mean values in same row with different superscripts differ significantly (P< 0.05)

Table 6: Mean values of dry matter metabolizablity (%) and nitrogen retention (%) of different dietary treatments in laying hens

Treatment	Dry Matter metabolizablity (%)	Nitrogen retention (%)
T_1	68.71 ± 0.37	65.06^{b} ± 0.26
T_2	68.98 ± 0.70	65.59^{ab} ± 0.38
T_3	68.84 ± 0.27	65.93^{ab} ± 0.42
T_4	69.40 ± 0.33	65.50^{ab} ± 0.36
T_5	69.46 ± 0.35	65.87^{ab} ± 0.45
T_6	69.66 ± 0.42	66.46^{a} ± 0.22
T_7	69.01± 0.16	66.33^{a} ± 0.39
CD	NS	1.04

The mean values in same column with different superscripts differ significantly (P< 0.05).

Table 7: Mean values of metabolizable energy (Kcal/kg feed) and gross energy metabolizablity (percent) of different rations in laying hens

Treatments	GE (Kcal/kg dried feed)	GE (Kcal/kg dried excreta)	Apparent ME (Kcal/kg)	N retention/kg feed x 8.22	N corrected ME	Calculated ME	GE metabolizablity
T_1	3946^{f} ±0.03	1393.55 ±8.25	2552.45^{f} ±8.27	154.75 ±0.58	2397.70^{f} ±8.00	2697.17	60.76^{d} ±0.20
T_2	4010^{e} ±14.18	1396.21 ±14.26	2613.80^{e} ±3.16	155.00 ±0.93	2458.80^{e} ±2.48	2757.59	61.31^{c} ±0.22
T_3	4077^{d} ±10.51	1396.88 ±11.85	2680.12^{d} ±3.33	155.68 ±0.47	2524.44^{d} ±3.31	2816.83	62.30^{b} ±0.21
T_4	4119^{c} ±6.49	1397.06 ±4.27	2721.94^{c} ±3.20	155.46 ±0.83	2566.48^{c} ±3.44	2846.01	62.30^{ab} ±0.07
T_5	4130^{c} ±10.90	1404.53 ±10.80	2725.48^{c} ±2.55	154.92 ±0.48	2570.56^{c} ±2.73	2874.92	62.24^{b} ±0.14
T_6	4180^{b} ±7.88	1409.12 ±6.12	2770.89^{b} ±2.61	155.91 ±0.89	2614.98^{b} ±2.35	2903.54	62.55^{ab} ±0.09
T_7	4228^{a} ±10.42	1409.97 ±7.74	2818.03^{a} ±3.23	155.37 ±0.86	2762.66^{a} ±2.62	2931.89	65.34^{a} ±0.10
CD	27.761	NS	12.171	NS	11.626		0.45

The mean values in same column with different superscripts differ significantly (P< 0.05).

CONCLUSION

It was concluded that supplementation of different levels of linseed oil in hens' diet along with the improvement of quality of eggs also improved production performance, egg quality and feed conversion efficiency. So inclusion of omega-3 PUFA rich linseed oil in the diet of layers seems to be beneficial in many terms.

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