ISSN 1682-8356
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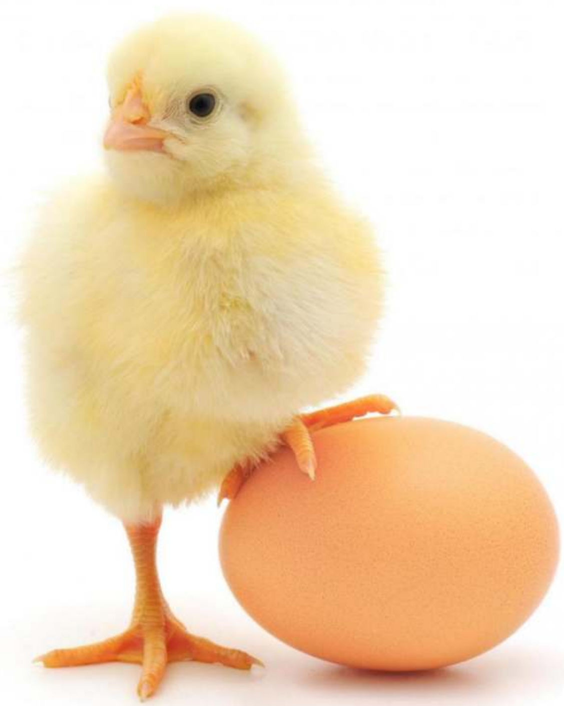

INTERNATIONAL JOURNAL OF POULTRY SCIENCE

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International Journal of Poultry Science 3 (7): 490-496, 2004

The Effect of Incorporating Different Levels of Locally Produced Canola Seeds (*Brassica napus*, L.) In the Diet of Laying Hen

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Abstract: Research in King Faisal University proved that canola seeds can be successfully planted in Al-Hassa area of Saudi Arabia. The objectives of this study were to determine the chemical analysis and metabolizable energy of a locally produced full fat canola seeds (LPFFCS). Also to determine the possibility of using locally produced canola seeds in the layer diet. The chemical analysis of the seeds showed that it contained 95.4% DM, 25.6% CP, 38.2% EE, 4% ash and 6.8% CF. ME, calculated from the determined TME showed a 4128 Kcal/kg value. Essential and non-essential amino acids were also determined as well as Na, Cl, Ca, P, Cu. Zn and Fe. It was concluded that with the exception of protein level canola seeds are very much similar to SBM in many aspects. Five levels of whole canola seeds; 0, 5, 10, 20 and 30% were used in the diets of 100 white leghorn pullets at age of 20 weeks. The results of this experiment showed that including up to 10% whole canola in the layer diet made no harm to the performance of these birds in terms of hen-day egg production, egg mass, feed conversion and egg weight. Feed intake increased with increasing level of canola seeds in the diet. However most of these differences were season dependent. Hen-day production, egg mass and egg weight were very much lower when birds fed 30% canola. The highest production rate was found in the fall season when birds fed 5 and 10% canola seeds (90 and 88%, respectively). No specific trend was observed on the effect of canola on egg specific gravity and yolk index. However, haugh unit was higher, yolk color was darker, weight gain was lower in birds fed 30% canola seeds. It was concluded that incorporating up to 5% LPFFCS in the layer diet might benefit the producer if economically priced.

Key words: Canola seeds, laying hen, egg production

Introduction

Corn and Soybean are considered the most valuable ingredients in Poultry rations when energy and protein are concerned. However, these grains are not grown in Saudi Arabia due to the unfavorable weather conditions, therefore, they are imported from different countries and that usually is subjected to the laws of international trade. The most efficient substitute for these ingredients has not been established yet and the reason that any of the ingredients used as a substitute in tens of research studies was either badly performed or economically not feasible to use. Several ingredients have been tested such as date as a substitute for corn in the layer ration (Najib *et al.*, 1994) and Salicornia as a substitute for SBM in the poultry diet (Glenn, 1994; Al-Batshan *et al.*, 2001).

Canola is a winter crop that is widely grown around the world. There was an increase demands for the oil of this crop which necessitated the increase in production especially in the industrial countries like US and Canada where soybean production is not suitable. However, countries, known for their harsh environment like Saudi Arabia and Egypt are also able to plant the canola.

Canola was originally derived from rapeseed varieties, it's component have been altered through genetic selection which markedly reduced it's detrimental components, erucic acid and the glucosinolates to a negligible level and to less than 20 µg/g, (Leeson and Summers, 2001). These levels are low enough to be of little or no harm to poultry. Other toxins such as tannin, sinapine may also cause some problems if present in high level such in case of sinapine may cause a fishy odor in some brown egg birds (Leeson and Summers, 2001). This fishy flavor may be due to the trimethylamine that resulted from the degradation of sinapine in the intestinal tract, the authors further added. Some of today's brown layers lack the ability to produce trimethylamine oxidase, an enzyme able to degrade the trimethylamine, which resulted in depositing it into the egg.

Full-Fat Canola Seeds (FFCS) are not normally used as feedstuff for poultry due mainly to the pricing of edible oil. However, with 40% fat and 20% protein (Summers and Leeson, 1985) it could be an alternative source of energy and protein for poultry when it is economically priced. Research in the area of its use as feedstuff has been

Table 1: The nutritional composition of the dietary treatments (0, 5, 10, 20 and 30% Canola seeds)

Ingredients	0	5	10	20	30
Yellow corn	60.00	58.33	51.38	37.45	23.45
SBM, 44%	24.0	20.01	19.1	14.45	10.48
Wheat Bran	0.00	1.97	3.55	8.00	14.00
Fish Meal, 72%	3.00	3.44	2.50	2.00	1.00
Limestone	8.28	7.60	7.74	8.00	7.87
MV Mix[1]	0.20	0.20	0.20	0.20	0.20
DL Methionine	0.40	0.25	0.25	0.30	0.40
Dical Phosphate	0.95	0.70	0.80	1.00	1.00
L-Lysine	0.10	0.00	0.00	0.00	0.00
Choline Cl	0.10	0.00	0.00	0.00	0.00
Salt	0.40	0.40	0.42	0.50	0.50
Corn Oil	1.49	0.00	0.00	0.00	0.00
Anti Oxidant	0.08	0.10	0.10	0.10	0.10
Canola seeds	0.00	5.00	10.00	20.00	30.00
Deh. Alfalfa	1.00	2.00	4.00	8.00	11.00
Total	100.00	100.00	100.04	100.00	100.00
Calculated Composition					
Crude protein, %	18.00	18.00	18.00	18.00	18.00
ME, kcal/kg	2800	2800	2800	2800	2800
Calcium, %	3.53	3.25	3.35	3.57	3.57
Av. Phosphorus,%	0.34	0.31	0.32	0.36	0.37
Riboflavin, mg/kg	1.71	1.90	2.08	2.57	2.97
Niacin, mg/kg	24.59	32.15	37.75	51.84	68.08
Pantothenic Acid, mg/kg	7.04	7.56	8.29	9.95	11.81
Choline, mg/Kg	1306	1402	1577	1939	2268
Methionine, %	0.68	0.56	0.55	0.61	0.70
Cystine, %	0.29	0.30	0.30	0.31	0.33
Meth + Cyst, %	0.97	0.86	0.85	0.92	1.03
Lysine, %	1.14	1.05	1.06	1.09	1.10
Tryptophan, %	0.24	0.24	0.25	0.26	0.28
Linoleic Acid, %	1.42	1.81	2.08	2.64	3.23

[1] Vitamin and Minerals mix provided the following per ton of the diet: Vit. A, 6,670,000 IU; Vit. D_3, 1,340,000 ICU; Vit. E, 5000 IU; Vit. K_3, 2,680mg; Vit. B_2, 3000mg; Vit. B_6, 2000mg; Vit. B_{12}, 10000mcg; Nicotinamide, 16,670mg; Ca d-Pantothenate, 5,340mg; Folic Acid, 334mg; Choline Chloride 200,000mg; Manganese, 66,700mg; Zinc, 26700mg; Iron, 33,400mg; Copper, 1600mg; Cobalt, 134mg; Iodine, 234mg; Selenium, 54mg; Antioxidant 2000mg

controversial. Leslie and Summers (1972) reported a decrease in feed intake and egg production with an increase in dietary proportion of raw rapeseeds. Likewise Nwokolo and Sim (1989) reported depressed egg production in hens, fed barely-full-fat canola seeds (FFCS). Shen *et al.* (1983) showed that if the seeds were finely ground or if the seeds were stem pelleted in order to rapture the coat, good results with up to 20% whole canola seeds could be expected. This experiment was conducted to determine the TME of the locally grown Full-fat Canola seeds and their proximate analysis and also to study the effect of including different levels of locally grown Full-fat canola seeds in the diets of layers.

Materials and Methods

Chemical analysis: Samples of ground Canola seeds were subjected to proximate chemical analysis according to the method of American Association of Cereal Chemists (AACC, 1994). This method was described in Najib *et al.*, 2004. True metabolizable energy (TME) was determined and estimated according to the method developed by Sibbald, 1976. Details of the procedure was reported in Najib *et al.*, 2004.

Plantation: Canola seeds (*Brassica napus*, L.) were planted successfully in the lands of King Faisal University Experimental Station. This plant was proven to resist drought and can be planted in semi arid regions like Saudi Arabia (Leela *et al.*, 2002). Brassica Napus is one of three types of Canola, however, this type considered the best since it's level of erucic acid and Glucosinolates do not exceed 2% and 30 micromole/gm of the meal, respectively). This type called (00) and has 3 cultivars, namely; Bactool, Al-Serwa 4, and Al-Serwa 8. Bactool was the one used in this experiment. Plantation process lasted for 5 months. Canola is a seasonal plant.

Table 2: The Chemical and Amino Acids analysis of Canola seeds

Nutrients	Canola in this study	Canola in other studies	Reference	Corn[1]	SBM[1]
Moisture, %	4.62	7.17	Nwokolo and Sim, 1989	11.00	11.00
Crude Protein, %	25.58	22.0	Leeson and Summers, 1991	8.50	44.00
Ether Extract, %	38.18	40.0	Leeson and Summers, 1991	3.80	0.80
Crude Fiber, %	6.84	6.0	Leeson and Summers, 1991	2.20	7.00
Ash, %	4.00	3.86	Nwokolo and Sim, 1989	NA	NA
ME, kcal/kg	4128[2]	4460	Lee *et al*., 1995	3350	2230
Aspartic Acid, %	1.78	NA	Leeson and Summers, 1991	NA	NA
Serine, %	1.11	NA	Leeson and Summers, 1991	0.37	2.29
Glutamic Acid, %	5.24	NA	Leeson and Summers, 1991	NA	NA
Glycine, %	1.26	NA	Leeson and Summers, 1991	0.33	1.90
Alanine, %	1.10	NA	Leeson and Summers, 1991	NA	NA
Valine, %	1.19	NA	Leeson and Summers, 1991	0.40	2.07
Methionine, %	0.54	0.50	Leeson and Summers, 1991	0.18	0.62
Isoleucine,%	0.94	0.80	Leeson and Summers, 1991	0.29	1.96
Leucine, %	1.67	1.60	Leeson and Summers, 1991	1.00	3.39
Tyrosine, %	0.63	0.50	Leeson and Summers, 1991	0.30	1.91
Phenylalanine, %	1.06	0.90	Leeson and Summers, 1991	0.38	2.16
Histidine, %	0.68	0.60	Leeson and Summers, 1991	0.23	1.17
Lysine, %	1.66	1.30	Leeson and Summers, 1991	0.26	2.69
Arginine, %	1.13	1.30	Leeson and Summers, 1991	0.38	3.14
Therionine, %	1.11	1.00	Leeson and Summers, 1991	0.29	1.72
Salt as NaCl, %	0.18	0.04	Leeson and Summers, 1991	0.06	0.07
Calcium, %	0.38	0.38	Leeson and Summers, 1991	0.02	0.29
Av. Phosphorus, %	0.38	0.47	Leeson and Summers, 1991	0.08	0.27
Potassium, %	0.71	0.81	Leeson and Summers, 1991	0.30	1.98
Sodium, %	0.02	0.01	Leeson and Summers, 1991	0.02	0.02
Magnesium, %	0.32	0.31	Leeson and Summers, 1991	0.12	0.30
Manganese, mg/kg	37.40	35.00	Leeson and Summers, 1991	7.00	43.00
Copper, mg/Kg	6.97	6.00	Leeson and Summers, 1991	3.00	15.00
Zinc, mg/Kg	50.65	26.00	Leeson and Summers, 1991	18.00	55.00
Iron, mg/Kg	92.39	0.02*	Leeson and Summers, 1991	45.00	170.00

[1]NRC, National Research Council,1994. [2]ME was calculated from the determined TME using the correction factor (1.097) as reported in "Scott *et al*., 1982". Italic = non-essential amino acids, bold = essential amino acids, * = measured in %. NA, Not Available

Birds and feeding: Three hundred white leghorn chicks were obtained from local hatchery. After the chick's arrival, they were weighed by groups and fed commercial starter diets, containing 19.8% crude protein and 2850 Kcal/Kg metabolizable energy (ME). The chicks were kept on the commercial starter diet till reached the breeder's target weight at week 9 when they were switched to the commercial grower diets. During the first ten weeks, the chicks were vaccinated against the most prevailing diseases in the area and debeaked. Chicks were exposed to continuous lighting during the first week of their life then decreased by one hour weekly till reached 9 hours, at which time it was held constant. On week 18, 100 pullets were moved to cages in a house where cooling device was installed. Starting week 21, the feeding trial was commenced. Four treatment levels of whole Canola seeds, 5, 10, 20 and 30% and a control (0% canola) replaced part of the grains in the ration. The calculated composition of the experimental diets is presented in Table 1. The treatments were fed to the birds-in-cages at a rate of 5 cages (reps) per treatment, each containing 4 birds. Lighting hours were maintained to 14 hours daily in the house.

Eggs were collected daily however, calculation of hen-day egg production and egg weight were made on bi-weekly basis. At the end of each 28-day period, three days of egg collection were used for shell quality determination, haugh unit (albumin height) and yolk color. Specific gravity method was used to measure the shell quality of the eggs. This method was described in (North, 1984). Eggs in-baskets were consecutively immersed in nine salt solutions of different specific gravities ranging from 1.060 to 1.10 with an increment of 0.005. Eggs that float were given the designated specific gravity value of that bucket. The higher the specific gravity values the better the shell quality. Feed was given *ad-*

libitum daily. Feed left was weighed at the end of each week to determine feed intake. The feeding trial continued for 24 weeks

Statistical analysis: Summarized data for all response variables were subjected to combined analysis in Completely Randomized Design (CRD) where Level of canola (TRT) was considered the main effect on traits while season of the year (P) was the secondary effect. Replication within period P(R) was the first error term carrying 8 degrees of freedom (Steel and Torrie, 1984). The mathematical model of this arrangement is presented in the next paragraph. General Linear Models procedure in the PC-SAS® (SAS Institute, 1988) was used to estimate the variations among the means. Variable means showing significant differences in the analysis of variance table were compared using the Duncan Multiple Range Test (DMRT) (Steel and Torrie, 1984).

The mathematical model used to estimate the effect of treatment levels and period of the year on traits was as follows:

$Y_{ijk} = \prod + T_i + P_j + P(R)_{jk} + T_i{*}P_j + e_{ijk}$

Where:

Y_{ijk}	is the effect of $_i$th treatment and $_j$th period on $_k$th pen
$\prod$	is the overall mean
T_i	is the effect of treatment, i = 1......5
P_j	is the effect of period, j = 1.....2
$P(R)_{jk}$	is the random effect of period within replication, considered to be error I
$T_i{*}P_j$	is the effect of interaction between treatments and periods
e_{ijk}	is the error II

Results and Discussion

Chemical analysis: The chemical analysis of the canola used in this study was presented in Table 2.

It is obvious from the table that the dry matter content of the canola used in this study was higher than the ones reported in other studies and that has contributed to the higher protein, fiber and ash content of the canola. Fat content, on the other hand, was lower which resulted in a lower metabolizable energy as compared with the study of Lee *et al.* (1995). Nevertheless, the energy content of the canola was much higher than that of the corn or SBM (NRC, 1994). On the other hand, the protein level of the canola was much higher than that of the corn and much lower than that of the SBM (Leeson and Summers, 1991).

Most of the amino acids level of this canola was in a close proximity to those reported by others (Leeson and Summers, 1991). However, lysine, the second most limiting amino acid was conceivably higher than other studies. This indeed would compensate the lower lysine content of corn. Methionine, the first limiting amino acid, was comparable to that of the SBM (Leeson and Summers, 1991 and NRC, 1994). Calcium and Phosphorus levels were higher in the canola compared to that of the SBM and Corn (NRC, 1994).

Layer experiment: The results of the layer experiment were presented in Table 3 and 4. The duration of this study continued for two seasons, fall and summers, therefore, season of the year was considered as a factor, which might interact with the canola level to affect performance.

Effect of dietary treatments on feed consumption and conversion was significant (P<0.05). This effect was interacted by season of the year on this trait (highly significant interaction in case of feed conversion and significant at 10% in case of feed consumption.

Since feed consumption was not significantly (P>0.05) affected by the interaction with season, therefore a significant independent effect of the treatment was demonstrated by the higher consumption of the birds fed higher levels of canola seeds in the diet (Table 3). However the differences were not significant (P>0.05) between the control and, 5 and 10% canola seeds. Higher levels of the seeds may impose a palatability problem. Leslie and Summers (1972) and Summers *et al.* (1982) and Clement and Renner (1977) reported lower feed consumption when 15 - 17% canola seeds were used in the layer diet. This lower consumption could be due to the lower amount of fine feed in the ration (Leeson *et al.*, 1987) explained. To the contrary, Shen *et al.* (1983) used up to 20% of full-fat canola and found it to be acceptable. In the same line, Summers *et al.* (1982) observed increased consumption in birds fed increased canola seeds.

Regardless of treatments, feed intake in this study was highly (P<0.01) affected by season of the year (Table 3). This phenomenon is known for some time. Scott *et al.* (1982) reported higher consumption in the winter opposing summer time. Tanor *et al.* (1984) reported lower consumption of individual birds with heat stress.

Feed conversion, egg weight, egg production and egg mass were significantly (P<0.05) affected by (season X diet) interaction (Table 3). Feed conversion was higher in birds fed higher levels of canola seeds (20 and 30%) in both seasons. The best feed conversion was found in birds fed 5 and 10% canola seeds. This of course was due to the better egg mass of summer and winter birds receiving 5% canola seeds.

The negative effect of adding 30% canola seeds in the summer birds was less pronounced than in those raised in the winter time (79 vs 68%, production). This could be due to the fact that canola seeds contain high level of fat (42%), (Nwokolo and Sim, 1989) and also to the fact that fat produce lower heat increment than either carbohydrates or protein (Scott *et al.*, 1982) which probably put less burden on birds during the hot season

Table 3: Effect of incorporating different levels of canola seeds on some traits of layers during two seasons of the year[1]

Source of variation	GBD gm	FC kg/kg	EW gm	HD %	LIV %	EM gm/HD
Period X TRT	NS	**	*	**	NS	**
Sum 0	103.2±10.9	2.38±0.60	54.81±5.3	82.28±13.0	99.86±0.76	45.25±8.75
Sum 5	102.9± 9.9	2.32±0.60	54.74±4.1	84.22±14.2	100.0±0.00	46.38±9.46
Sum 10	102.0±12.5	2.39±0.48	53.86±4.2	81.65±13.7	99.76±1.84	44.08±8.31
Sum 20	106.5±12.2	2.70±0.55	51.65±3.4	78.31±11.4	99.58±3.23	40.62±7.29
Sum 30	101.6±12.9	2.65±0.61	49.93±3.0	78.92±12.9	99.58±2.29	39.46±7.08
Fall 0	115.4±15.1	2.17±0.52	62.88±3.6	86.57±11.1	99.84±1.23	54.38±7.24
Fall 5	115.3±7.2	2.06±0.20	61.48±2.2	91.61± 6.7	100.0±0.00	56.33±4.76
Fall 10	114.3±7.9	2.14±0.37	61.74±1.8	87.98±10.4	100.0±0.00	54.43±6.86
Fall 20	116.8±11.4	2.92±0.66	57.94±2.0	72.10±15.3	100.0±0.00	41.26±8.91
Fall 30	120.8±12.8	3.53±1.10	55.02±2.4	67.56±18.9	100.0±0.00	37.29±10.8
P =	0.0649	0.00001	0.0318	0.0001	0.6657	0.0001
Among TRT	**	**	**	**	NS	**
0	109.3^{ab}	2.278^{c}	58.85^{a}	84.42^{b}	99.85^{a}	51.36^{a}
5	109.1^{ab}	2.192^{c}	58.11^{ab}	87.92^{a}	100.00^{a}	49.82^{a}
10	108.2^{b}	2.266^{c}	57.80^{b}	84.81^{ab}	99.88^{a}	49.26^{a}
20	111.7^{a}	2.812^{b}	54.80^{c}	75.21^{c}	99.79^{a}	41.19^{b}
30	111.2^{ab}	3.094^{a}	52.47^{d}	73.24^{c}	99.79^{a}	38.37^{c}
P =	0.0010	0.00001	0.0001	0.0001	0.6657	0.0001
Among Periods	**	NS	**	NS	NS	**
Summer	103.2^{a}	2.491^{a}	53.00^{a}	81.16^{a}	99.76^{a}	43.16^{a}
Fall	116.5^{b}	2.566^{a}	59.81^{b}	81.08^{a}	99.97^{a}	48.84^{b}
P =	0.0001	0.122	0.0001	0.9364	0.0766	0.0001

[1]Means Within columns carrying different superscripts are significantly different, P<0.05. NS = Not significant, P>0.05 * = significant, (P<0.05), ** = significant, P<0.01). GBD, gram per bird per day, daily feed intake; FC, Kg feed per Kg eggs, feed conversion; EW, gram egg weight; HD, hen-day egg production; LIV, livability; EM, gram per hen-day egg mass = (% HD * EW) TRT = 0, 5, 10, 20 and 30% of Canola seeds.

consequently producing more eggs.

Egg weight was significantly affected by the interaction between diet and period of the year (Table 3). Increasing level of canola seeds in both seasons significantly (P<0.05) decreased egg weight. Fat content of the yolk is a major factor to determine the size of the egg. Study by Leeson *et al.* (1987) and by others suggested that chicken might not make maximum utilization of the fat provided by the full-fat canola seeds. Birds fed diet fortified with 20% full-fat canola retained only about 50% of the dietary fat, they further added. It was assumed that formation of insoluble soaps involving fatty acids and minerals could lead to reduced retention (Hakansson, 1975; Kussaibati *et al.,* 1983; Atteh and Leeson, 1983, 1984). In our case, the small amount of erucic acid in the canola seeds could be the fatty acid that formed soap with minerals.

Best production rate was found in birds fed 5% in both summer and winter seasons (84.2 and 91.6%), (Table 3). The depression in performance of hens fed 20 and 30% full-fat canola seeds could be due to the presence of low levels of glucosinolates in canola seeds. Bell and Weaver (2002) reported that when canola meal was fed in levels higher than 5% could cause liver degeneration, thyroid hypertrophy, reduced feed efficiency and loss of egg production as they contain high level of glucosinolates and erucic acid. Canola seeds (00), used in this study were not tested for such compounds but it was assumed to have very low erucic acid and glucosinolates (less than 2%) (Leela *et al.*, 2002). Nwokolo and Sim (1989) drew similar conclusion on hens fed raw full-fat canola seeds.

Birds fed high levels of locally grown full-fat canola seeds (LPFFCS) in this experiment produced smaller eggs in both seasons (Table 3). The differences were significant (P<0.05) and mostly relative to the treatments and some to the seasons.

Egg mass is a function of egg weight and egg production and was probably affected by any changes occurred on either of them. Lower egg mass was found in birds fed 20 and 30% LPFFCS. Similar result was found in hen-day egg production and egg weight (Table 3).

Mortality was not affected by treatment/season interaction or by either of them independently (Table 3). Because of the low mortality, diagnosis was not done on the dead birds. Leslie and Summers (1972) observed no differences in mortality when feeding diets fortified

Table 4: Effect of incorporating different levels of Canola seeds on some traits of layers during two seasons of the year[1]

Source of variation	SPG	HU	YC	YI	WG
Period X TRT	NS	NS	NS	NS	NS
Summer 0	1.091±0.004	100.6±4.52	2.254±0.98	0.985±0.21	NA
Summer 5	1.090±0.004	102.6±4.40	2.583±0.91	1.008±0.21	NA
Summer 10	1.090±0.004	101.8±2.88	2.900±0.88	1.048±0.22	NA
Summer 20	1.092±0.003	102.0±2.78	3.567±0.98	1.178±0.23	NA
Summer 30	1.092±0.003	102.6±2.77	3.733±0.95	1.046±0.25	NA
Fall 0	1.088±0.003	101.3±3.19	2.417±1.11	1.251±0.14	NA
Fall 5	1.087±0.003	102.8±2.65	3.000±0.97	1.284±0.14	NA
Fall 10	1.087±0.003	102.8±2.57	3.300±0.91	1.344±0.12	NA
Fall 20	1.088±0.003	103.6±2.66	3.433±1.03	1.436±0.15	NA
Fall 30	1.090±0.003	104.1±2.36	3.833±1.03	1.370±0.24	NA
P =	0.0787	0.5087	0.2224	0.3469	
Among TRT	**	**	**	**	**
0	1.090^{ab}	101.0^{c}	2.336^{e}	1.118^{c}	338.2^{a}
5	1.088^{b}	102.7^{ab}	2.792^{d}	1.146^{c}	218.6^{ab}
10	1.088^{b}	102.3^{b}	3.100^{c}	1.200^{b}	118.2^{bc}
20	1.090^{ab}	102.8^{ab}	3.500^{b}	1.307^{a}	40.6^{c}
30	1.091^{a}	103.4^{a}	3.783^{a}	1.208^{b}	35.2^{c}
P =	0.0001	0.0001	0.0001	0.0001	0.0001
Among Periods	**	**	*	**	
Summer	1.091^{a}	101.9^{a}	3.010^{a}	1.053^{a}	NA
Fall	1.088^{b}	102.9^{b}	3.200^{b}	1.337^{b}	NA
P =	0.0001	0.0001	0.0183	0.0001	NA

[1]Means Within columns carrying different superscripts are significantly different, P<0.05. NS = Not significant, P>0.05 SPG, specific gravity of the egg; HU, haugh unit; YC, Yolk color (graded from 1 to 5 where 5 is the darkest); YI, yolk index (yolk height ÷ yolk diameter); WG, weights of the birds were taken twice, one at the beginning of the experiment and again at the end of it. Weight gain was determined according to that . TRT = 0, 5, 10, 20 and 30% of Canola seeds; NA, Not available

with canola seeds.

Although higher feed intake was obtained with the high levels of canola seeds (20 and 30%), a significant (P<0.001) depression of weight gain was observed in the birds fed 20 and 30% (Table 4). This would not be very much surprising if most of the feed was used to produce more and larger eggs. However, that was not the case in this study. Lower egg weight and production rate were found in the birds fed these diets. It is conceivable that toxicity from the erucic acid and glucosinolates could have been the reason for the weight depression in these birds. It was also noticed that in feces of birds fed higher levels of FFCS, higher levels of these seeds passed the intestine undigested which means lower nutrients were utilized by the birds, fed those diets and consequently lower performance and birds weight. Summers *et al*. (1982) reported lower body weight gain when 17.5% full-fat canola seeds were used in broiler diets.

Effect of dietary treatments on egg characteristics was highly significant (P<0.01) (Table 4). Inclusion of 30% LPFFCS in the diets significantly (P<0.01) improved the specific gravity of the eggs comparing to 5 and 10% but not to the control or 20% (Table 4). Summer birds produced better shell quality eggs. This is against the odd since normally eggs produced in the summer have less shell (Bell and Weaver, 2002). The differences in summer temperature and winter were not large enough to cause changes on shell quality (30 in the summer vs 25 in the fall). These birds were housed in a closed house with some cooling management, practiced there. Albumen height (haugh unit) was significantly (P<0.05) higher in birds fed 30% LGFFCS than the control. However, no significant differences (P>0.05) were observed between 30 and the rest of the treatments (Table 4).

The effect of LPFFCS levels on yolk color was highly significant (P<0.01) (Table 4). Darker yellow color was found in eggs of hens fed higher levels of canola seeds. As level of LPFFCS increased from 0 to 30% there was an increasing levels of colour darkness of the yolk with strong linearity (r = 0.97). This result was in agreement with the study of Nwokolo and Sims (1989) who observed that yolk color index was significantly increased in eggs from hens fed diets containing increasing amounts of full-fat canola seeds. Fall birds laid eggs that have significantly darker color yolk than summer eggs (Table 4). Fall birds also consumed significantly more feed than summer birds.

Although egg size was not the smallest in hens fed 20% LPFFCS, yolk index was the best in eggs of these birds which indicate that Albumen play a major role in making the bulk of these eggs. Fall eggs have better yolk index and in the same time larger egg size.

Conclusion: There was some evidence in this experiment to conclude that adding up to 10% LGFFCS in the layer diet cause no harm effect on performance of layers. However, adding only 5% has significantly improved the performance of the layers comparing to the control.

It is suggested that incorporating up to 5% of LPFFCS in the layer diet may be beneficial to the producer of this country if economically priced.

Acknowledgment

The financial support of the Deanship of Scientific Research at King Faisal University to this project is highly appreciated. Thanks are also extended to Technician and labors of the poultry and crops units at the experimental station of King Faisal University for their help in conducting this research.

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