COMPARATIVE STUDY ON THE EFFECTS OF FEEDING CANOLA AND SOYBEAN OILS ON EGG PRODUCTION AND CHOLESTEROL IN COMMERCIAL LAYERS

Shakoor, H.I., M. A. Javed[1], Z. Iqbal[2] , Z. Nasir and N. Mukhtar
Department of Animal Nutrition University of Agriculture, Faisalabad,
[1]PCSIR laboratories Complex, Lahore and [2]Nuclear Institute for Agriculture and Biology, Jhang Road, Faisalabad, Pakistan

ABSTRACT

The purpose of this study was to assess the effect of canola and soybean oils on egg production and cholesterol in layers. For this purpose, 15 experimental units (8 layers per experimental unit) were randomly allotted to 5 dietary treatments (3 experimental units/treatment) containing 2.5% canola oil, 5% canola oil, 2.5% soybean oil, 5% soybean oil and control without any oil (all five rations were isocaloric and isonitrogenous) for a period of 9 weeks. Effect of these treatments on production parameters including egg production, egg mass, weight gain, feed intake and feed conversion ratio and egg quality parameters including shell thickness, albumen quality, yolk index, egg cholesterol level and yolk fatty acid composition were studied. The results indicated that the effect of canola and soybean oils on egg production and egg mass was non-significant. Significantly ($P<0.05$) less yolk cholesterol was found in hens fed diets containing oils compared with the control. Palmitic fatty acid content and total saturated fatty acids (SFA) content decreased as oils percentage increased. Total Polyunsaturated fatty acids (PUFA) content was significantly ($P<0.01$) greater in canola and soybean oil fed hens eggs than the control diet fed hens eggs. Addition of 5% canola oil to the diet resulted in yolk omega-6:omega-3 PUFA being significantly lower ($P<0.01$) than those of the control diets.

Key words: Egg production, egg mass, weight gain, egg cholesterol, fatty acids, omega-6 PUFA, omega-3 PUFA

INTRODUCTION

Fats and oils are included in poultry diets primarily as high-energy ingredients, their energy value being more than twice as high as that of other ingredients. However the effects of fats and oils, when incorporated into diets for poultry, are attributable to the mechanisms of fat digestion and absorption. Oils from plant origin, such as soybean oil, contain high levels of unsaturated fatty acids and are more completely digested by fowl than animal fats such as lard and tallow, which contain higher proportions of saturated fatty acids. (Leeson and Atteh, 1995). Both saturated fat and cholesterol in the overall diet can increase cholesterol concentrations in the blood. Numerous clinical trials have documented that when individuals are fed egg yolks, their blood cholesterol levels rise. Adding two egg yolks to an otherwise low cholesterol and low saturated fat diet causes a 10% increase in blood cholesterol levels. This corresponds to an increase in heart disease risk of 20% (Anonymous, 2001).

Many attempts have been made to reduce egg cholesterol content with only little practical success. An alternative way is to reduce the cholesterogenic effects of eggs by altering yolk fatty acid composition. The cholesterol-lowering effects of n-6 polyunsaturated fatty acids (PUFA), mainly linoleic acid, have been known for decades, whereas the hypocholesteremic properties of monounsaturated fatty acids, such as oleic acid, and especially the n-3 PUFA such as linolenic acid, eicosapentanoic acid, and docosahexaenoic acid, have been recognized only recently (Grundy, 1986). Extensive studies have unequivocally demonstrated that feeding diets rich in oleic, linoleic, or linolenic acid resulted in large increases in their concentration in yolk total lipids (Nwokolo and Sim, 1989; Caston and Leeson, 1990) but the effect of fatty acids was non-significant on egg production and egg weight of laying hens fed diets supplemented with 8% of either palmitic acid or oleic acid or a 50:50 mixture of palmitic and oleic acids (Atteh and Leeson, 1985).

Canola and soybean oils have the best fatty acid ratio: these are low in salurated fatty acids (SFA) which increase blood low density lipoprotein cholesterol (LDL-c) levels, high in monounsaturated fatty acids (MUFA) which may lower blood LDL-c levels and

PUFA which also lower blood LDL-c levels. Canola oil has the lowest level of saturated fat. This research project has been planned to study the effect of canola and soybean oils on the egg production and feed efficiency, egg cholesterol level, serum cholesterol, triglycerides, LDL-c and HDL-c, fatty acid composition of egg yolk and the ratio of n-6 n-3 PUFA.

MATERIALS AND METHODS

In this study, 120 layers of same weight (av. 1605 g) and age (41 weeks) were divided into 15 experimental units (8 layer per replicate) and were randomly allotted to 5 different dietary treatments (A, B, C, D and E) containing no oil, 2.5% canola oil, 5% canola oil, 2.5% soybean oil and 5% soybean oil respectively (3 replicates per treatment). These birds were kept at Poultry Research Center University of Agriculture, Faisalabad and were fed the experimental rations for a period of 9 weeks. The rations were formulated according to National Research Council (1994) nutrient requirements of laying hens (Table-1) and analyzed for their proximate composition (AOAC, 1990).

Egg production was recorded and egg mass was calculated daily. Feed intake was calculated weekly and body weights of layers were determined after every two weeks. The egg yolk cholesterol was determined at 0, 21, 42 and 63 days and the egg yolk fatty acid composition was determined only at the end of experiment (at 63rd day). Six eggs from each treatment (two eggs per replicate) were randomly selected for analysis. The eggs were weighed and broken to weigh their yolks. Total lipids present in a homogenized sample of egg yolk were extracted according to the method of Folch *et al.* (1957) and egg yolk cholesterol was determined according to Abeel *et al.* (1952). For fatty acid determination the lipids extracted were esterified and identified according to Javed *et al.* (1991).

Statistical analysis

The data collected were analyzed by completely randomized design with factorial arrangements (Steel and Torrie, 1980). The Least Significant Difference test was used to determine significant differences between mean values obtained from different treatments.

RESULTS AND DISCUSSION

Egg production

Effect of canola and soybean oils on egg production in layers was non-significant. Maximum eggs were produced by hens fed ration containing 5% canola oil i.e. 5.07 eggs per bird per week as compared to 4.75 eggs per bird per week by control group (Table 2). Roth-Maier *et al.* (1998) also showed that egg production was not influenced by the use of oil seeds.

Table 1: Feed composition (%) and calculated nutrient analysis

Ingredient	Control	2.5% Canola oil	5% Canola oil	2.5% Soybean oil	5% Soybean oil
Maize	27	27	27	27	27
Wheat	8.5	8	8	8	8
Wheat bran	0	7	13	7	13
Rice	18	12	6.5	12	6.5
Rice polishing	8	5.5	2	5.5	2
Canola meal	6	6	5.5	6	5.5
Soybean meal	15	15	15	15	15
Corn gluten 30%	3	2.5	3	2.5	3
Molasses	5	4.5	4.75	4.5	4.75
Dicalcium phosphate	1.5	1.5	1.5	1.5	1.5
Limestone	7.75	8.25	8.5	8.25	8.5
Canola oil	0	2.5	5	0	0
Soybean oil	0	0	0	2.5	5
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated nutrient analysis					
Crude pretein	16.13	16.18	16.16	16.18	16.16
Metabolizable energy	2733	2731	2736	2731	2736
Crude fat	2.6	2.5	2.2	2.5	2.2
Crude fibre	4.7	4.9	4.8	4.9	4.8

Egg mass

The result showed that effect of canola and soybean oils on egg mass was non-significant. Maximum egg mass was produced by hens fed ration containing 5% canola oil (0.276 kg/bird/week) as compared to control (0.265 kg/bird/week). Our results corroborate with findings of Roth-Maier *et al.* (1998), who reported that egg mass was not influenced by the inclusion of fat source. But Shafey, (1998) reported that hens fed fat diet produced more egg mass than control.

Feed conversion ratio

The results of the present study showed that effect of canola and soybean oil in layer rations on feed conversion ratio (FCR) was non-significant. However, FCR per dozen of egg was better in birds fed ration containing 5% soybean oil (1.49) as compared to control (1.60), while ration containing 2.5% canola oil, 5% canola oil and 2.5% soybean oil have almost similar FCR i.e. 1.55, 1.56 and 1.58, respectively. Similarly, FCR/Kg egg mass was better in birds fed ration containing 5% canola oil (2.23) as compared to control (2.33). However, the difference was non-significant (Table 2). Our results are in agreement with the work of Roth-Maier *et al.* (1998), who reported that FCR was not significantly affected by addition of fats and oils in layer diet.

Body weight

The results showed that inclusion of canola and soybean oils in layer ration did not affect their body weight significantly. Since increase in body weight of layers was negatively correlated with egg production, so reduction of body weight in layers by inclusion of oils was favourable factor in increasing egg production. Maximum weight was recorded in control i.e. 1601.06 gm while the lowest weight was in layers fed ration containing 2% canola oil i.e. 1573.30 gm. (Table 2). Our results are in agreement with work of An and Kang, (1999), who reported a non-significant difference between live weight gain in layers fed sunflower, linseed and fish oil. Baucells *et al.* (2000) also reported similar results.

Physical properties of eggs

Egg weight

The results of present study showed that oils in layer rations did not improve egg weight, although feeding of ration containing 5% canola oil showed higher egg weight (57.75 gm) compared to control (56.84 gm).

Table 2: Means for fortnight live body weight, egg production, egg mass, feed consumption/bird/week, feed conversion ratio/doze eggs and feed conversion ratio/kg egg mass of layers of five groups

	Control 0% oil	2.5% Canola oil	5% Canola oil	2.5% Soybean oil	5% Soybean oil
Live body weight (gm)	1601.06	1573.30	1573.40	1582.72	1594.72
Egg production egg no./bird/week	4.750	4.77	5.07	4.83	4.87
Egg mass/bird/week (kg)	0.265	2.66	0.276	0.266	0.275
Feed consumption/bird/week (kg)	0.640	0.639	0.64	0.641	0.640
Feed conversion ratio/dozen eggs	1.600	1.55	1.56	1.58	1.49
Feed conversion ratio/kg egg mass	2.330	2.29	2.23	2.24	2.24

Values of all parameters among five groups did not differ statistically

Table 3: Mean values for egg weight, egg shell thickness, egg albumin quality (H.U), yolk index and egg yolk cholesterol for layers of five groups

	Control 0% oil	2.5% Canola oil	5% Canola oil	2.5% Soybean oil	5% Soybean oil
Egg weight (gm)	56.84a	57.11a	57.75a	57.66a	57.68a
Egg shell thickness (mm)	0.329a	0.33a	0.335a	0.33a	0.337a
Egg albumin quality (Haugh unit)	78.44a	78.72a	79.04a	78.53a	78.83a
Yolk index	0.424a	0.427a	0.435a	0.425a	0.435a
Egg cholesterol (mg/egg)	219.56b	210.78a	201.00a	207.56a	211.89a

Values with different letters within a row differ significantly ($P < 0.05$)

When the concentrations of oil was increased the gg weight also increased i.e. in 2.5% soybean oil it is 57.66 gm and in 5% soybean it is 57.68 gm (Table 3). The results in the current study corroborate with work of Roth-Maier *et al* (1998) who reported that egg weight was not influenced by dietary fats. Similarly, Baucells *et al.* (2000) showed that egg weight was not influenced by inclusion of dietary oils. But Shafey (1998) reported that oil supplementation increased the egg weight as compared to control diet.

Shell thickness

The results showed that effect of inclusion of canola and soybean oils on shell thickness was non-significant (Table 3). Maximum shell thickness that is 0.337 mm was in eggs of layers fed ration containing 5% soybean oil while the lowest shell thickness was 0.329 mm in control. These results are in agreement with the studies of Roth-Maier, *et al.* (1998), who showed that dietary oils did not influence egg quality characters.

Albumin quality

The results of the present study showed that effect of rations on albumin quality (Haugh unit) was non-significant, although layers fed ration containing 5% canola oil showed maximum value of haugh unit i.e. 79.04 as compared to control i.e. 78.44 (Table 3). Our results are in agreement with Roth-Maier *et al.* (1998), who showed that haugh unit was not changed by the addition of oils in layers diet.

Yolk index

The results showed that the effect of inclusion of canola and soybean oils on yolk index was non-significant (Table 3). However, dietary level of 5% canola and 5% soybean oil both had maximum yolk index that is 0.435 and lowest yolk index was in control diet fed group which was 0.424.

Chemical properties of eggs

Egg yolk cholesterol

Results of the present study showed that egg yolk cholesterol decreased significantly ($P<0.05$) from 219.5 to 200.4 mg/egg from 0 to 63 days. Inclusion of 5% canola oil in layer rations resulted in 201.00 mg/egg yolk cholesterol as compared to 219.56 mg/egg from birds fed control diets (Table 3). The LDL cholesterols are the principle carriers of cholesterol in the blood stream (Grundy, 1987). The LDL receptor activity was increased by MUFA (Mattson and Grundy, 1985). Since liver and serum cholesterol were decreased by inclusion of vegetable oils (Grundy, 1989), so deposition of cholesterol in egg yolk may also be decreased. The decrease in egg yolk cholesterol by inclusion of canola oil may be due to less deposition of cholesterol by liver in egg yolk during yolk synthesis.

Our results are in agreements with the work of An and Kang (1999), who showed that serum cholesterol decreased by inclusion of MUFA and PUFA in layers diet. But Shafey *et al.* (1998) and Botsoglou *et al.* (1998) reported that yolk cholesterol and lipoproteins were not affected by dietary oils.

Egg yolk fatty acid composition (total lipids)

Incorporation of 5% canola oil in the laying hen diet increased the n-3 fatty acids in the egg yolk lipids to 1.33% as compared with 0.607% for eggs from control diets ($P<0.01$). Addition of 5% canola oil resulted in reduction of n-6: n-3 ratio to 8.75 as compared with 19.42 for control, which corroborates with previous findings of Cherian and Sim (1991). Todd and Jerry (1996) reported that the n-3 PUFA content increased and n-6 PUFA content decreased as the dietary n-6:n-3 ratio decreased. Similarly, Phetteplace and Watkins (1989) and Channugam *et al.* (1992) reported increased level of n-3 PUFA in the brest and thigh muscle lipid of chicken fed 5% linseed oil compared with control.

Palmitic acid and oleic acid constituted the major saturated and major monounsaturated fatty acid in the yolk lipids respectively, and both were lower ($P<0.01$) in 5% canola oil fed group eggs i.e. 22.32 and 12.49 as compared with control i.e. 29.44 and 16.50, respectively. The total saturated fatty acids and monounsaturated fatty acids were lower ($P<0.01$) in canola oil fed group eggs. Friedman and Sklan (1995) and Lopez-Ferrer *et al.* (1999) reported that saturated fatty acid content of yolk lipids decreased when dietary concentration of canola oil was increased.

LITERATURE CITED

A.O.A.C., 1990. Official Methods of Analysis, Association of official Analytical Chemists. 15th Ed. Alrington. Virginia, USA.

Abell, L., B.B. Levy, B.B. Brodie and F.E. Kendall, 1952. A simplified method for estimation of total cholesterol in serum and demonstration of its specificity. J. Biol. Chem., 195: 357.

An B. K. and C. W. Kang, 1999. Effects of dietary fat sources containing omega-3 or omega-6 polyunsaturated fatty acids on fatty acid composition of egg yolk in laying hens. Korean J. Anim. Sci., 41: 293-310.

Anonymous. 2001. American Medical Association Journal. http: www. amaassn. org/public journals jama jamahome.htm. Accessed October 26. 2001.

Atteh. J.O. and S. Lesson. 1985. Response of laying hens to dietary saturated and unsaturated fatty acids in the presence of varying dietary calcium levels. Poultry Sci.. 79: 51-59.

Baucells. M.D.. N. Crespo. A.C. Baroeta. S. Lop:ez-Ferrer and M.A. Grashorn. 2000. Incorporation of different polyunsaturated fatty acies into eggs. Poultry Sci.. 79: 51-59.

Botsoglou. N.A.. L.A. Yannakopoulos. D.J. Fletouris. A.S. Tserveni-Goussi and I.E. Psomas. 1998. Yolk fatty acid composition and cholesterol content in response to level and form of dietary flaxseed. J. Agri. Food. Chem.. 46: 4652-4656.

Caston. L. and S. Leeson. 1990. Dietary flaxseed and egg composition. Poultry Sci.. 69: 1617-1620.

Chanmugam. P.. M. Boudreau. T. Boutte. R.S. Park. J. Hebert. L. Berrio and D. H. Hwang. 1992. Incorporation of different types of n-3 fatty acids into tissue lipids of poultry. Poultry Sci.. 71: 516-521.

Cherian. G. and J.S. Sim. 1991. Effect of feeding full fat flax and canola seeds to laying hens on the fatty acid composition of egg. embryos and newly hatched chicks. Poultry Sci.. 70: 917-922.

Folch. J.. M. Less and G. H. S. Sloane-Stanley. 1957. A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem.. 226: 497-509.

Friedman. A. and C. Sklan. 1995. Effect of dietary fattyacids on antibody production and fatty acid composition of lymphoid organs in broiler chickens. Poultry Sci.. 74: 1463-1469.

Grundy. S.M.. 1986. Comparison of monounsaturated fatty acids and carbohydrates for lowering plasma cholesterol. N. Engl. J. Med.. 314: 745-748.

Grundy. S.M.. 1987. Monounsaturated fatty acids. Plasma cholesterol and coronary heart disease. Amer. J. Clin. Nutr.. 45: 1168.

Grundy. S.M.. 1989. Monounsaturated Fatty Acids and Cholesterol Metabolism: Implications for Dietary Recommendations. Amer. Inst. Nutr.. 119: 529.

Leeson. S. and J.O. Atteh. 1995. Utilization of fats and fatty acids by turkeys poults. Poulty Sci.. 74: 2003-2010.

Lopez-Ferrer. S.. M.D. Baucells. A.C. Barroeta and M.A. Grashorn. 1999. N-3 Enrichment of chicken meat using fish oil: Alternative substitution with rapeseed and linseed oils. Poultry Sci.. 78: 356-365.

Mattson. F.H. and S.M. Grundy. 1985. Comparison of effects of dietary saturated. monounsaturated and polyunsaturated fatty acids on plasma lipids and lipoproteins in man. J. Lipid Res.. 26: 194.

National Research Council. 1994. Nutrient requirements of poultry. 9th Ed. National Academy Press. Washington. DC.

Noble. R.C.. 1987. Egg lipids. In : Egg Quality-Current Problems and Recent Advances. R. G. Wells and C.G. Belyavin. ed.. Buttreworths and Co.. Ltd.. London. England.

Nwokolo. E. and J. S. Sim. 1989. Omega-3 fatty acid enrichment of broiler and layer tissues. and egg yolk by feeding flax and canola seed diets. Poultry Sci.. 68(Suppl.1): 106.

Phetteplace. H.W. and B. A. Watkins. 1989. Effects of various n-3 lipid sources on fatty acid compositions in chicken tissues. J. Food Compos. Anal.. 2: 104-117.

Roth-Maier. D.A.. K. Eder. and M. Kirchgessner. 1998. The effects of various levels of dietary sunflower seed on performance of laying hens and fatty acid compositon of egg yolk lipids. Agribiol. Research. 51(3): 237-244.

Shafey. T.M.. 1998. Effects of dietary retinol and sunflower oil on the performance. and on the lipoproteins. lipids. cholesterol and retinol concentraitons of plasma and eggs of laying hens. Arab Gulf. J. Sci. Res. 16(2): 331-345.

Steel. R.G. G. and J. H. Torrie. 1980. Principles and Procedures of Statistics. A Biomedical Approach. McGraw-Hill. New York. NY.

Todd. J.A. and L. S. Jerry. 1996. Effect of dietary linoleic to finolenic acid ratio and vitamin E supplementation on vitamin E status of poults. Poultry Sci.. 75: 881-890.