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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 10 (10): 1747-1750, 2007
ISSN 1028-8880

Effect of Dietary Fish Meal on Production Performance and Cholesterol Content of Laying Hens

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Abstract: The effect of dietary fish meal (FM) on production and egg yolk cholesterol of commercial Hyline White Leghorn hens (24-week old) was studied for four weeks. Eighty birds were given a corn-wheat-soyabean meal diet that contained either 0% (control diet, C) or 3% fish meal (DM basis). Hens were randomly divided into two experimental treatments with four replicates (10 hens per replicate). Egg weight, daily egg production (g/hen/day), daily feed consumption and feed conversion ratio were recorded. At the end of each week, 12 eggs from each group were randomly collected and egg yolk cholesterol, egg volume, shell thickness and Haugh unit (HU) were measured. There was no significant ($p>0.05$) effect of feeding 3% FM on egg yolk cholesterol concentration (mg/100 g yolk or mg/yolk) compared with the control diet, but 3% FM, tended to decrease egg yolk cholesterol concentration (1930.93 vs 2021.48 mg/100 g yolk). Hens fed on 3% FM had higher ($p<0.05$) egg production, egg weight, egg volume, shell thickness, HU and better feed conversion ratio. It was concluded that under the condition of the study, feeding 3% fish meal improved egg production traits but was not able to reduce cholesterol concentration of the egg yolk although tended to reduce cholesterol concentration.

Key words: Egg, fish meal, cholesterol, laying hens

INTRODUCTION

Health recommendations encourage a reduction in the consumption of total lipids, cholesterol and saturated fatty acids and to increase the proportion of mono-unsaturated and polyunsaturated fatty acids (PUFAs) in their diets (Walsh *et al*., 1975). Dietary mono-unsaturated fatty acids were very effective in lowering blood cholesterol concentration and may be important in preventing coronary heart disease (Grundy, 1986; Ramaswamy *et al*., 2001). Cholesterol metabolism in the laying hen has been reviewed by McDonald and Shafey (1989). Dietary and genetic factors can affect egg cholesterol deposition (Sutton *et al*., 1984; Hargis, 1988). Different feed such as flax seed, safflower oil, fish and vegetable oil have been added to chicken feeds to increase the n-3 fatty acid content in the egg yolk (Jiang *et al*., 1991; Kim *et al*., 1997; Chae *et al*., 1998). Fish lipids are highly digestible by all species of animals and are excellent sources of the essential PUFAs in both omega-3 and omega-6 families of fatty acids. The predominant omega-3 fatty acids in fish meal and fish oil are linolenic acid, docosahexaenoic acid (DHA)and eicosapentaenoic acid (EPA)(Kitessa *et al*., 2001). Fish meal and oil contain more omega-3 than omega-6 fatty acids. In contrast, most plant lipids contain higher concentrations of omega-6 fatty acids. Scheideler and Froning (1996) observed higher omega-3 content of eggs with feeding fish oil or flax oil to hens.

The beneficial effects of omega-3 fatty acids, such as their anti-thrombotic and anti-inflammatory properties have been established by clinical and epidemiological studies (Herod and Kinsella, 1986; Baguma-Nibasheka *et al*., 1999; Constant, 2003). Also, fish oil may inhibit the desaturation of n-6 fatty acids with subsequent lowering of plasma lipids (McDonald and Shafey, 1989). In addition, oxidation of cholesterol to bile acids (Barbara *et al*., 1977) changing lipids metabolism to phospholipids formation (Wong *et al*., 1985) or decreasing the activity of esterifying enzymes (Rustan, 1988) may result in hypocholestrolemic effect of fish oil. The amino acid profile of fish meal is what makes this feed ingredient so attractive as a protein supplement. Overall protein digestibility values for fish meal are consistently above 95%.

This study was designed to investigate the effects of feeding fish meal to laying hens on production performance and cholesterol concentration of egg yolk.

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MATERIALS AND METHODS

The study was performed using eighty Hyline White Leghorn layers (24-week old). This experiment was carried out from August to September 2006, at Besat Education and Research Center, Shiraz, Iran.

Diets (Table 1) were formulated to meet the nutrient requirements of laying hens (NRC, 1994). Dietary treatments consisted of either 0% Fish Meal (FM) (control diet, C) or 3% FM. Hens were kept in wire cages, given feed and water for *ad libitum* intake and subjected to a photoperiod of 14 h light and 10 h dark day. The house was maintained at a temperature of 25±2°C and at 45 to 65% relative humidity. Birds were divided randomly into two groups of 10 birds with four replicates. Diets were fed for 4 weeks. A 3-week acclimation period was performed prior to the onset of the experiment. Egg production and feed consumption were recorded daily and egg weight was determined by collecting the eggs of each cage weekly. Daily feed consumption and feed conversion ratio were calculated. During 4 weeks of experiment, 12 eggs were randomly collected from each group, broken and weighed and the yolk separated and weighed yolks were homogenized before analysis at the end of each week. Cholesterol was determined by the method of Zak (1977).

Also, shell thickness, egg volume and Haugh unit (HU) were determined. Data were analysed according to procedures of SAS (1996). Differences between treatments were tested using student's t-test.

Table 1: Ingredient (%) and nutrient content of control (C) and fish meal (FM) diets

	Diets	
Item	C	3% FM
Yellow corn	29.43	30.50
Soyabean meal	27.5	23.40
Wheat	30.00	30.00
Alfalfa meal	0.70	0.70
Oyster shell	10.00	10.00
Dicalcium phosphate	1.80	1.80
Salt	0.43	0.43
Vitamin and mineral premix[1]	0.06	0.06
Methionine	0.01	0.10
Fish meal	--	3.00
Nutrient content		
Metabolizable energy (kcal kg^{-1})	2756	2750
Crude protein (%)	16.10	16.27
Methionine+cysteine (%)	0.60	0.63
Methionine (%)	0.33	0.35
Cholesterol (mg/100 g DM)	80.00	46.00

[1]Vitamin and mineral premix provides per 2.50 kg of product:Vit, A,7700000 IU; 15000 mg B_1; 4400 mg B_2; 55000 mg B, 3000 mg B_6; 8.8 mg B_{12}; 3300000 IU D_3; 6600 IU E; 550 mg K3; 110 mg B_9; 22000 mg B_5; 55 mg H_2; 275 mg colin chloride; 100 mg antioxidant; 66 mg Mn; 33000 mg Fe; 66000 mg Zn; 8800 mg Cu; 300 mg Se and 900 mg

Table 2: Production performance, Haugh unit , shell thickness and cholesterol concentration of egg yolk from hens fed control (C) or 3% fish meal (3% FM) diets (Mean±SE)

	Diets	
Item	Control	3% FM
Egg weight (g)	65.96±4.50[b]	69.62±4.55[a]
Egg production (g/hen/day)	47.80±6.53[b]	50.57±0.17[a]
Food conversion (g feed/g egg)	2.74+0.06[a]	2.55±0.43[b]
Shell thickness (mm)	0.35±0.012[b]	0.38±0.016[a]
Haugh unit	83.99±1.61[b]	85.16±0.25[a]
Egg volume (cm^3)	83.99±1.61[b]	85.16±0.25[a]
Cholesterol (mg/100 g yolk)	2021.48±90.51[a]	1930.93±164.5[a]
Cholesterol (mg/yolk)	399.18±35.21[a]	371.13±86.2[a]

[a,b]Means in the same row with different letter differ ($p<0.05$, t-test), SE = Standard Error of means

RESULTS AND DISCUSSION

The effects of feeding fish meal had no effect ($p>0.05$) on cholesterol concentrations of egg yolk expressed as mg/100 yolk or mg/yolk, but tended to decrease cholesterol content as compared with the control diet (Table 2). This is in agreement with Daghir *et al.* (1960), Weiss *et al.* (1967) and Bartov *et al.* (1971) who found that supplementation of 120, 160 or 200 g/kg of soyabean oil to diet of laying hens did not affect yolk concentration. Wang (1996) reported lower egg yolk cholesterol content with feeding 8% safflower to laying hen. Higher egg yolk cholesterol was reported with adding fish oil as compared with adding poultry fat, tallow, corn oil or soya oil to hens diets (Melluzzi *et al.*, 1996). Watkins and Elkin (1992) reported that, olive oil, soya oil and tallow did not affect the egg yolk cholesterol content of laying hens. Variations in yolk weight did not affect cholesterol concentrations between diets (Sheriden *et al.*, 1982). Sheriden *et al.* (1982) reported differences in yolk cholesterol concentrations between strains. Jiang and Sim (1994) reported lower liver and plasma cholesterol concentrations in rats fed diets containing dried egg yolk enriched with n-3 PUFAs than that in rats fed control diets. Barbara *et al.* (1977) attributed the hypocholesterolemic effect of fish oil to the oxidation of cholesterol to bile acids. The 3% fish meal used in this study might not be enough to reduce cholesterol concentration of egg yolk. Another factor for differences in the results of cholesterol content in other studies, might be due to the strain differences (Sheriden *et al.*, 1982). The magnitude decreased of egg cholesterol with feeding FM was expected as its concentration in 3% FM diet was lower than control diet (Table 1). Fish meal had significant ($p<0.05$) effect on production traits of laying hens (Table 2). Feeding of vegetable oils have shown to increase egg number (El-Katcha, 1990; March and MacMillan, 1990) and improved feed conversion (Sell *et al.*, 1976; Al-Sultan, 2005). In other study, feeding 4, 8 and 12% menhaden meal to laying hens, increased (linearly,

($p<0.05$) egg production expressed as both hen-day or hen-housed and improved feed conversion but Haugh units and egg weight were not affected ($p>0.05$) by dietary treatments (Nash *et al*., 1996). In contrast, Farrel (2002) did not find any significant increase in egg weight by feeding canola oil to laying hen. Egg shell thickness was higher ($p<0.05$) for 3% FM diet. This property simplifies the handling and distributing of these eggs. Fish meal of high quality provides a balanced amount of all essential amino acids, fat-soluble vitamins, steroid hormones, phospholipids and fatty acids (e.g., DHA and EPA) for optimum development, growth and a variety of physiological processes (Clandinin and Van Aerde, 1990; Baguma *et al*., 1999). Any complete diet must contain some protein, but the nutritional value of the protein relates directly to its amino acid composition and digestibility, which is the case in the present study for 3% FM diet as compared with the control diet. Based on the results of this experiment, supplementing laying hen diet with 3% fish meal can improve production.

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