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Effect of Dietary Fat Sources on Blood and Tissue Biochemical Factors of Broiler

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Abstract: An experiment was conducted to study the effect of different levels of dietary fat source (canola oil and poultry fat) on blood and tissue biochemical factors of broiler chickens. A total of 180 day-old broilers chicks (Ross 308) were randomly assigned in to 5 dietary treatments (3 replicates of 12 birds per treatment) fed experimental diets. The experiment was performed in a Completely Randomize Design (CRD) and birds were fed with experimental diet for the period of 3 weeks (21-42 d-old). The experimental treatment included) basal diet without fat supplementation) basal diet with 3% canola oil) basal diet with 6% canola oil) basal diet with 3% poultry fat) basal diet with 6% poultry fat. The criteria measured were the levels of cholesterol, triglyceride, HDL and LDL in blood, also levels of cholesterol and triglyceride in tissue (breast and thigh). Blood biochemical factors were not significantly influenced by dietary fat. Adding 3% poultry fat to the diet, significantly decrease levels of cholesterol and triglyceride in thigh tissue ($p<0.01$) and at the level of 6% decrease level of cholesterol in breast tissue ($p<0.01$). The highest triglyceride was found in breast tissue of control group compared with other groups ($p<0.05$). These results suggest that poultry fat supplementation induced a significant decrease in triglyceride and cholesterol concentrations in tissue (breast and thigh) in comparison with that receiving canola oil.

Key words: Cholesterol, triglyceride, blood, tissue, dietary fat and broiler

INTRODUCTION

One of the potentially most important sections of the branch of animal science dealing with animal nutrition is the study of the effect of diet on tissue fatty acid composition. This information is mainly of value because an imbalance in the human dietary intake of various types of fatty acids has become apparent. There is much interest in the relative merits of monounsaturated, Omega-6 polyunsaturated and Omega-3 polyunsaturated fatty acids in the human diet and the role they play in the lessening of cardiovascular related diseases. Several sources of information suggest that modern Western diets are deficient in Omega-3 fatty acids compared with the diet on which humans evolved and their genetic parameters were established. It is thus important for human health to increase the consumption of Omega-3 fatty acids (Louw Hoffman, 2002). An increase in the human dietary Omega-3/Omega-6 fatty acid ratio is essential in today's Western diet to help prevent coronary heart disease by reducing plasma lipids.

Cholesterol and triglyceride tests are blood tests that measure the total amount of fatty substances (cholesterol and triglycerides) in the blood. A high level of Low-Density Lipoprotein (LDL) cholesterol combined with a low level of High-Density Lipoprotein (HDL) cholesterol is a potent risk factor for heart disease. Independent research has shown that canola oil supplementation is highly effective in reducing triglyceride levels and lowering the triglyceride/LDL ratio.

Supplementation with canola oils (Eicosapentaenoic Acid, EPA and Docosahexaenoic Acid, DHA) is highly effective in lowering the blood level of triglycerides. High triglyceride levels are a major risk factor for heart disease.

Research by the University of Stellenbosch showed that supplementation of broiler diets with Canola oil can increase the ratio of Omega-6 to Omega-3 fatty acids. Overall, in view of the prevalence of human coronary heart disease, consumption of Omega-3 polyunsaturated fatty acids enriched broilers could be considered as a useful complementary option for the amelioration of coronary vascular disease. Dietary fatty acids are absorbed by monogastric animals and deposited in tissues without significant modification. There is therefore considerable potential for the manipulation of the fatty acid profiles of poultry tissue by dietary means so as to increase the supply of Omega-3 polyunsaturated fatty acids suitable for human consumption. Canola oil is an excellent source of good fat. It is very high in monounsaturated fat, contains, Omega-6 and Omega-3 polyunsaturated fatty acids, Linoleic Acid (LA), Alpha-Linolenic Acid (ALA) and is very low in saturated fat.

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Table 1: Ingredients and nutrient composition of experimental diets (%)

Item	Control	Canola oil(3%)	Canola oil(6%)	Poultry fat (3%)	Puoltry fat (6%)
Ingredient					
Corn	66	61.37	53.92	61.99	55.17
SBM(44%)	28.27	30.19	32.64	30.08	32.39
Starch	2.14	-	-	-	-
Canola oil	-	3	6	-	-
Poultry fat	-	-	-	-	-
Oyster	1.47	1.45	1.43	1.46	1.44
DCP	1.22	1.23	1.25	1.23	1.24
Lysine	0.03	0.015	0.015	0.025	0.025
Methionine	0.12	0.12	0.13	0.11	0.13
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Minera premix	0.25	0.25	0.25	0.25	0.25
Salt	0.23	0.24	0.24	0.23	0.24
Coccidiostat	0.05	0.05	0.05	0.05	0.05
Sand	-	1.89	3.87	1.38	2.87
ME (kcal/kg)	2934	3000	3070	3000	3070
Crude protein	160	160	160	160	160

SBM = Soybean Meal; DCP = Dicalcium Phosphate; ME = Metabolizable Energy, CP = Crude Protein

Table 2: Lipid concentration in serum of broiler

Parameters (mg dL^{-1})	Control	Canola oil (3%)	Poultry fat (3%)	Canola oil (6%)	Poultry fat (6%)
TCOL	160.33	158.83	167.50	161.83	162.66
TG	44.16	64.33	45.00	46.83	43.83
HDL-C	19.66	19.83	24.16	20.16	21.16
LDL-C	141.16	139.00	142.66	140.50	141.50

Furthermore, the omega-6 and omega-3 polyunsaturated fatty acids in canola oil are present in a beneficially low 2:1 ratio. Most vegetable oils contain much more omega-6 fatty acids than omega-3 fatty acids.

MATERIALS AND METHODS

The experiment was carried out using 180 day-old broiler chicks (Ross 308) were weighted and distributed randomly to 5 treatments with 3 replicates (12 chicks in each replicate/pen). Experimental diets included, 0% supplemented fat (basal diet), the basal diet with added 3% Canola Oil (3% CO), the basal diet with added 6% Canola Oil (6% CO), the basal diet with added 3% Poultry Fat (3% PF) and the basal diet added 6% Poultry Fat (6% PF). Diets were formulated according to NRC. Ingredients and nutrient composition of experimental diets were shown in Table 1. Birds were fed with experimental diet for the period of 3 weeks (21-42 d-old). The experiment was carried out in a Completely Randomized Design (CRD).

At 42 days of age 2 chicks from each pen selected and blood samples were obtained from each subject of V. Cuteneaeulnaris. The analysis of serum, Total Cholesterol (TCOL), Triglyceride (TG), High Density Lipoprotein Cholesterol (HDL) were measured on autoanalyzer (ALYSON 300) with using commercially available kits. Low Density Lipoprotein Cholesterol (LDL-C) and very Low Density Lipoprotein Cholesterol (VLDL-C) levels were estimated by the method of the Friedewald Equation (Friedewald *et al*., 1972). Also at the end of experiment, 2 chicks randomly selected from each pen and slaughtered. Tissue samples (breast and thigh) were obtained for analysis cholesterol (TCOL) and Triglyceride (TG) content.

Statistical analysis: Data collected subjected to analysis of variance, and significant differences observed in means subjected to Duncan's multiple range test. All data were analyzed by ANOVA using the General Linear Model (GLM) procedures of the SAS Institute (SAS Institute, 2000).

RESULTS AND DISCUSSION

Blood biochemical factors: Table 2 shows the effects of fat source on blood biochemical factors (TCOL, TG, LDL-C and HDL-C). There was not effect of the fat source on the total serum cholesterol, triglyceride, HDL and LDL. In spite of those result, supplementation with canola oil influenced the serum cholesterol and Low Density Lipoprotein (LDL) cholesterol concentration and decreased, but were not significant. Canola oil is high in monounsaturated fat, low in saturated fat and containing appreciable amounts of phytosterols. Phytosterols are saturated analogs of the cholesterol in animal and humans. The consumption of phytosterols has been shown in numerous studies to lower blood cholesterol levels. Polyunsaturated fatty acids are known to have potent cholesterol-lowering abilities

Table 3: Cholesterol and triglyceride concentration in tissue (breast and thigh) of broiler

Parameters	Control	Canola oil (3%)	Puoltry fat (3%)	Canola oil (6%)	Poultry fat (6%)
Breast					
TCOL	37.33^{ab}	39.66^{a}	42.32^{a}	26.66^{bc}	18.66^{c}
TG	12.66^{a}	6.66^{b}	7.00^{b}	6.00^{b}	6.00^{b}
Thigh					
TCOL	192.66^{b}	124.33^{c}	54.66^{d}	252.00^{a}	81.00^{d}
TG	42.66^{b}	19.33^{c}	9.00^{d}	63.33^{a}	31.66^{bc}

$^{a, b, c, d}$: Means in a row with different superscripts are significantly different

(Mattson and Grund, 1985; Mensink and Kata, 1987) without significantly altering HDL cholesterol or triglyceride levels (Grundy, 1989; Mensink and Katan, 1987). Saturated fatty acid, raise the blood level of total cholesterol, LDL-cholesterol and also increase HDL-cholesterol levels in the blood (Mensink and Katan, 1989; Judd *et al*., 1994) so an increase intake of monounsaturated fat is therefore often recommended to replace saturated fat in the diet. The highest HDL was absorbed for birds fed poultry fat. Monounsaturated fatty acids and saturated fatty acids increase the amount of High Density Lipoprotein (HDL) cholesterol more than polyunsaturated fatty acids because saturated fatty acids don't oxidized easily compared with unsaturated fatty acids and also their effects are stable, so the amount of HDL cholesterol was higher in birds fed poultry fat compared to that of birds fed canola oil.

Total serum triglyceride was higher in birds fed canola oil when compared to that of birds fed poultry fat. Canola oil would increase absorption and digestion capability because of unsaturated fatty acids that exist in it, so increase free fatty acids concentration in plasma because of increasing biosynthesis of triglyceride in liver (Lambourt and Jacquemin, 1979).

Tissue biochemical factors: Breast cholesterol and triglyceride. Breast cholesterol and triglyceride content of birds was shown a significant interaction between fat sources. Breast cholesterol content was significantly lower ($p<0.01$) when birds were fed 6%poultry fat, also breast triglyceride content was significantly higher ($p<0.05$) in birds fed basal diet when compared to that of birds fed canola oil and poultry fat, so the lowest breast triglyceride content was observed for birds fed canola oil and poultry fat (6%). Result regarding cholesterol and triglyceride content in breast tissue are shown in Table 3.

Monounsaturated fatty acids and omega-3 fatty acids lowers blood LDL-cholesterol (LDL is a factor that transfer cholesterol from liver to tissue), so canola oil decrease cholesterol content in breast tissue because of high levels of Monounsaturated fatty acids in it (Hibbeln and Salem 1995) also saturated fatty acids increase the amount of High Density Lipoprotein (HDL) Cholesterol levels (Ascherio and Willett, 1997) in the blood (HDL is a factor that transfer cholesterol from tissue to liver), so poultry fat has been shown to reduce breast cholesterol content, Saturated fatty acids can increase the amount of High Density Lipoprotein (HDL) more than monounsaturated fatty acids because oxidation of Saturated fatty acids aren't easer than monounsaturated fatty acids and their effects are so stable.

Omega-3 fatty acids, unsaturated fatty acids and monounsaturated fatty acids have been shown to lower LDL cholesterol in the blood (Mattson and Grundy, 1985; Mensink and Katal, 1987), so biosynthesis of triglyceride in liver reduce by adding canola oil in diet, also trans fatty acids can reduce biosynthesis of triglyceride in liver because trans fatty acid act like saturated fatty acid so increased the blood level of HDL in the blood.

Thigh cholesterol and triglyceride: There was a significant effect ($p<0.01$) of the fat source on the thigh cholesterol and triglyceride content of birds. Birds fed 6% canola oil had a higher cholesterol and triglyceride content in thigh tissue, so the lowest cholesterol and triglyceride in thigh was observed for birds fed 3% poultry fat. Result regarding cholesterol and triglyceride content in thigh tissue are shown in Table 3.

Excessive energy can deposit as triglyceride due to the higher amount of metabolizable energy in monounsaturated fatty acids that exist in canola oil and increase free fatty acids concentration.

This result has similar with other results (Mensink and Katan, 1987; Katan, 1995; Talebali and Farzinpour, 2005). Due to muscular work of thigh in body compared with breast, transfer of fatty acids and glucose to that tissue increasing, so the extra amount of fatty acids deposit in thigh and also extra amount of glucose can convert to fatty acids and deposit. The high amount of cholesterol and triglyceride were obtained in thigh from group which was fed canola oil containing high proportion unsaturated fatty acids and omega-3 fatty acids and high amount of metabolizable energy for unsaturated fatty acids and also their effect on digestion, metabolism and transfer of dietary lipids and the effect of dietary canola oil on lipoprotein metabolism (Kinsella *et al*., 1990). The breast muscular has lower fat than thigh muscular because of their function and muscular work.

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