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The Ratio of ω6:ω3 Fatty Acids in Broiler Meat Fed with Canola Oil and Choline Chloride Supplement

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Abstract: To assess the effect of supplying Canola Oil (CO) and Choline Chloride Supplement (CCS) in the diet on Fatty Acid (FA) composition and omega 6 to omega 3 ratio in broiler breast and thigh meat, diets enriched with 0, 2, or 4% CO plus CCS (0 , 500 and 1000 ppm). These diets were isonitrogenous and isoenergetic were given to broiler chickens throughout a 42-d growth period. This trial was conducted in 3×3 factorial experiment. Birds were slaughtered at 56 d of age. After weighing the eviscerated carcass was apportioned into commercial cuts (back, two leg-thigh, two wings and breast). Breast and thigh meat samples were separated and frozen at -20°C until to determine as fatty acid profile. Data was analyzed with one way ANOVA and means compared with Duncan test. Interaction effects of CO and CCS was significant ($p<0.0001$). Results show that using CO with high level of omega 3 fatty acids could influence fatty acid profile and improved meat quality. Means of fatty acids percent for meat samples and ω6/ω3 fatty acids ratio was decrease and quality of fatty acid composition improved with increase CO and CCS levels. For thigh meat samples this ratio was descend from 11.73% for T1(0% CO and 0 ppm CCS) to 3.72 for T9(4 % Co and 1000 md kg^{-1} CCS) and in breast meat samples 9.01 and 3.55%, respectively.

Key words: Broiler, breast, thigh, omega 6, omega 3, fatty acids, canola oil

INTRODUCTION

The number of new product launches in the feed industry aimed at increasing the amount of omega-3 fatty acids in livestock diets is staggering. Omega-3 is polyunsaturated acids. The number 3 refers to the place on the molecule where the first unsaturated double bond is found. The consumption of n-3 Polyunsaturated Fatty Acids (PUFA) and in particular, Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA), has been shown to have beneficial effects on human health (Kinsella *et al*., 1990; Knapp, 1991). Chicken meat is an important component of a modern healthy diet. As a dietary staple, chicken meat should ideally provide the essential fatty acids (n-3 and n-6) that humans cannot synthesize. Insufficient n-3 fatty acid intake negatively influences health. For a healthy diet, there should be a consumption of canola oil and some vegetable oils For this reason, numerous research activities have been devoted to increasing the levels of these Fatty Acids (FA) in widely consumed products of animal origin whose lipid composition is easily modified (Hargis *et al*., 1991; Huyghebaert, 1995). Specifically, the use of vegetable oils in the diet of poultry makes it possible to increase the level of long-chain n-3 FA in meat (Chanmugam *et al*., 1992; Pinchasov and Nir, 1992). Vegetable sources, such as canola oil and Linseed Oils (LO), may clearly increase the n-3 FA content in the form of Linolenic Acid (LNA), the precursor of the whole n-3 family. To enhance the conversion to longer-chain n-3 FA from their precursors and to increase the nutritional quality of poultry meat. Choline and betaine besides methionine are all sources of labile methyl groups and play an important role in methylation reactions and the methyl group metabolism of these two compounds is interrelated (Pesti *et al*., 1980; Kettunen *et al*., 2001a, b). Methyl groups are available after conversion of choline to betaine in the liver. On the other hand, choline and betaine have different specificity in metabolic body functions (Kettunen *et al*., 2001b). Choline has three essential metabolic roles e.g., as a constituent of phospholipids, hepatic lipid metabolism to prevent fatty liver and as a precursor for acetylcholine synthesis (Ghazalah, 1998; Workel *et al*., 1999). Additionally, choline has a further non-essential metabolic function as a labile methyl group as well as prevention of perosis and fatty liver syndrome in broiler chicks (Ghazalah, 1998; Workel *et al*., 1999).

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MATERIAL AND METHODS

Animals and diets: The experiment was conducted of which used 270 male one day old Ross chicks, with completely randomized design of 9 treatments, with 3 repetitions and 10 broiler chicks in each box. The treatments diets of were isonitrogenous and isoenergetic.

Table 1: Percentage composition of experimental diet in starter period

Ingredients	(%)
Corn	53.5
Soybean	34
Canola oil	0.5
Starch	8
Wheat bran	0
DL-Methionine	0.54
Lysine	0
Choline (60%)	0
DCP	1.38
Oyster	1.33
Vitamin[1]	0.25
Mineral[2]	0.25
Salt	0.25
Coccidiostat	0
Sand	0
	100
Calculated nutrient content	
ME kcal kg^{-1}	2919.594
Crude protein (%)	20.901
Calcium (%)	0.942
Available P (%)	0.434
ME/CP	139.685
Ca/P	2.169

1Vitamin content of diets provided per kilogram of diet: Vitamin A,D, E and K, 2 Composition of mineral premix provided as follows per kilogram of premix: Mn, 120,000mg; Zn, 80,000 mg; Fe, 90,000 mg; Cu, 15,000 mg; I, 1,600 mg; Se, 500 mg; Co, 600 mg

T1 Control (Soybean+corn)
T2 0% CO+500 mg kg^{-1} CCS
T3 0% CO+1000 mg kg^{-1} CSS
T4 2% CO+0 mg kg^{-1} CCS
T5 2% CO+500 mg kg^{-1} CCS
T6 2% CO+1000 mg kg^{-1} CCS
T7 4% CO+0 mg kg^{-1} CCS
T8 4% CO+500 mg kg^{-1} CCS
T9 4% CO+1000 mg kg^{-1} CCS

Randomly arranged in 27 replicates and distributed among nine different dietary treatments in a controlled environment. In length of experiment, the chicks were given *ad libitum* access to water and to the diets described in Table 1-3.

Diets were formulated by adding 0, 2 and 4% canola oil to basal diet (corn and soybean meal) that met the requirements recommended by the National Research Council (1994). The control diet, which was not enriched with canola oil and was administered throughout the 21 days of experimental period(starter). The levels of canola oil were replaced with corn in diets during 2 different periods (grower and finisher). At the age of 8 week, all the

Table 2: Percentage composition of experimental diets in growth period

	Experimental diets (percent)								
Ingredients	T1[3]	T2	T3	T4	T5	T6	T7	T8	T9
Corn	64	64	64	60	60	60	55	55	55
soybean	27.4	27.4	27.4	28	28	28	27.1	27.1	27.1
Canola oil	0	0	0	2	2	2	4	4	4
Starch	3.74	3.74	3.74	2.06	2.06	2.06	1.22	1.22	1.22
Wheat bran	1	1	1	2	2	2	5.5	5.5	5.5
DL-Methionine	0	0	0	0	0	0	0	0	0
Lysine	0	0	0	0	0	0	0	0	0
Choline (60%)	0	0.000084	0.000168	0	0.000084	0.000168	0	0.000084	0.000168
DCP	1.13	1.13	1.13	1.14	1.14	1.14	1.16	1.16	1.16
Oyster	1.5	1.5	1.5	1.48	1.48	1.48	1.46	1.46	1.46
Vitamin[1]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mineral[2]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Coccidiostat	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Sand	0.33	0.33	0.33	2.42	2.42	2.42	3.66	3.66	3.66
	100	100	100	100	100	100	100	100	100
Calculated nutrient content									
ME kcal kg^{-1}	2920	2920	2920	2920	2920	2920	2920	2920	2920
Crude protein (%)	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
Calcium (%)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Available P (%)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
ME/CP	160.1	160.1	160.1	160.8	160.8	160.8	160.7	160.7	160.7
Ca/P	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

1Vitamin content of diets provided per kilogram of diet: Vitamin A, D, E and K, 2 Composition of mineral premix provided as follows per kilogram of premix: Mn, 120,000mg; Zn, 80,000 mg; Fe, 90,000 mg; Cu, 15,000 mg; I, 1,600 mg; Se, 500 mg; Co, 600 mg, 3 T1 = 0% Canola Oil (CO)+ 0% Choline Chloride Supplement (CCS); T2= 0%CO+500 mg kg^{-1} CCS; T3=0% CO+1000 mg kg^{-1} CCS;T4=2%CO+0% CCS; T5=2%CO+500 mg kg^{-1} CCS; T6 = 2%CO+1000 mg kg^{-1} CCS; T7 = 4% CO+0 % mg kg^{-1}; T8 = 4% CO+500 mg kg^{-1} CCS; T9 = 4% CO+1000 mg kg^{-1} CCS 1000 Mg kg^{-1} CCS

Table 3: Percentage composition of experimental diets in finisher period

	Experimental diets (%)								
Ingredients	T1[3]	T2	T3	T4	T5	T6	T7	T8	T9
Corn	66.5	66.5	66.5	57.5	57.5	57.5	56	56	56
Soybean	24.1	24.1	24.1	25.85	25.85	25.85	24	24	24
Canola oil	0	0	0	2	2	2	4	4	4
Starch	3.81	3.81	3.81	4.34	4.34	4.34	1.94	1.94	1.94
Wheat bran	0	0	0	5	5	5	6	6	6
DL-Methionine	0.44	0.44	0.44	0.45	0.45	0.45	0.45	0.45	0.45
Lysine	0.043	0.043	0.043	0.015	0.015	0.015	0.08	0.08	0.08
Choline (60%)	0	0.000084	0.000168	0	0.000084	0.000168	0	0.000084	0.000168
DCP	0.89	0.89	0.89	0.92	0.92	0.92	0.89	0.89	0.89
Oyster	1.38	1.38	1.38	1.36	1.36	1.36	1.31	1.31	1.31
Vitamin[1]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mineral[2]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Coccidiostat	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Sand	1.937	1.937	1.937	1.665	1.665	1.665	4.43	4.43	4.43
	100	100	100	100	100	100	100	100	100
Calculated nutrient content									
ME kcal kg^{-1}	2920	2920	2920	2920	2920	2920	2920	2920	2920
Crude protein (%)	16.5	16.5	16.5	16.4	16.4	16.4	16.5	16.5	16.5
Calcium (%)	0.79	0.79	0.79	0.79	0.79	0.79	0.77	0.77	0.77
Available P (%)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.29	0.29
ME/CP	176.8	176.8	176.8	177.4	177.4	177.4	176.6	176.6	176.6
Ca/P	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6

1Vitamin content of diets provided per kilogram of diet: Vitamin A, D, E and K, 2 Composition of mineral premix provided as follows per kilogram of premix: Mn, 120,000mg; Zn, 80,000 mg; Fe, 90,000 mg; Cu, 15,000 mg; I, 1,600 mg; Se, 500 mg; Co, 600 mg 3 T1 = 0% Canola Oil (CO)+ 0% Choline Chloride Supplement(CCS); T2 = 0% CO+500 mg kg^{-1} CCS; T3 = 0% CO+1000 mg kg^{-1} CCS; T4 = 2% CO+0% CCS; T5 = 2%CO+500 mg kg^{-1} CCS; T6 = 2% CO+1000 mg kg^{-1} CCS; T7 = 4% CO+0 % mg kg^{-1}; T8 = 4% CO+500 mg kg^{-1} CCS; T9 = 4% CO+1000 mg kg^{-1} CCS

Table 4: Least square means for fatty acid profiles in broilers breast meat fed canola oil and choline chloride supplement

	Treatments										
	1	2	3	4	5	6	7	8	9	SEM	p>F
C14:0	0.59cd	0.62c	0.65c	0.51e	0.59cd	0.59cd	0.54de	0.75b	0.98a	0.021	<0.0001
C14:1n5	0.11e	0.2d	0.19d	0.11e	0.46b	0.12e	0.55a	0.27c	0.45b	0.009	<0.0001
C16:0	28.5ab	29.23a	29.00a	27.02abc	25.91bcd	26.29bcd	22.72e	24.61cde	24.29de	0.773	<0.002
C16:1n7	6.48c	6.73bc	5.29d	6.60bc	7.89a	6.55bc	5.26d	7.17b	6.13c	0.189	<0.0001
C18:0	6.60bcd	6.83bcd	8.11a	6.22d	7.05b	6.21d	6.35cd	6.98bc	6.84bcd	0.199	<0.0019
C18:1n9	33.65ab	34.17a	33.28abc	30.00d	29.02d	30.34cd	30.82bcd	31.32 abcd	29.57d	0.917	<0.0217
C18:1n7	2.40d	3.39b	2.71c	2.94c	1.12e	2.87c	2.73c	2.35d	3.92a	0.082	<0.0001
C18:2n6cis	15.35a	14.96ab	14.48abc	13.54cd	13.68bcd	13.46cd	12.33de	11.64e	12.50d	0.400	<0.0017
C18:3n3	0.72b	0.72b	0.63c	0.75b	0.75b	0.63c	0.88a	0.88a	0.85a	0.022	<0.0001
C20:0	0.75a	0.70b	0.64c	0.24e	0.25e	0.26e	0.24e	0.26e	0.34d	0.013	<0.0001
C20:5n3	0.37c	0.48c	0.43c	1.19b	1.26b	1.91a	2.03a	1.91a	1.97a	0.043	<0.0001
C20:1n9	0.18e	0.96a	0.13gf	0.24d	0.21d	0.15ef	0.31c	0.11g	0.36b	0.011	<0.0001
C22:6n3	0.62c	0.53d	0.53d	0.62c	0.52d	0.52d	0.75b	0.77b	0.65a	0.019	<0.0001
C22:0	0.93c	0.30d	0.98c	1.96b	1.99b	2.02b	1.93b	1.99b	2.42a	0.051	<0.0001

Values in the same row with no common superscript are significantly different

birds were weighed before being slaughtered and then eviscerated. Weights air-chilled carcasses after cutting off their heads and feet and after removing abdominal fat (considered as the fat extending within the ischium, surrounding the cloaca and adjacent to the abdominal muscle) to obtain ready-to-cook carcasses were recorded. In order to reduce variation in the cutting procedure, all dissections were carried out by one operator. After weighing the eviscerated carcass, it was apportioned into commercial cuts as back, two leg-thigh, two wings and breast (Hudspeth *et al*., 1973; Orr *et al*., 1984). Breast was obtained after removing wings by cutting through the shoulder joint at the proximal end of humerus and by cutting through the ribs, thereby separating the breast from the back (excluding skin). The resulting cut pieces (breast meat, wings and thighs with drumsticks) were then weighed. After quartering, breasts and thighs were separated and frozen at -20°C until to determine as fatty acids profile. The lipid composition was determined by gas chromatography (Model 6890N American Technologies Agilent). The composition of meat samples fatty acid of supplemented lipids is shown in Table 4-7 data were statistically analyzed using one-way ANOVA, and means with significant F ratio were compared by Duncan multiple range test.

Table 5: Least square means for fatty acid profiles in broilers thigh meat fed canola oil and choline chloride supplement

	Treatments										
	1	2	3	4	5	6	7	8	9	SEM	p>F
C14:0	0.600c	0.600c	0.650b	0.135d	0.945a	0.155d	0.165 d	0.175 d	0.155 d	0.0148	<0.0001
C14:1n5	0.195e	0.260d	0.195e	0.865a	0.875a	0.255d	0.465 b	0.305 c	0.215 de	0.0138	<0.0001
C16:0	26.215 a	26.06a	26.595 a	22.370b	21.940 b	23.040 b	21.875b	21.310 b	21.270 b	0.6865	<0.0009
C16:1n7	6.20d	7.18bc	6.90c	7.825ab	7.125bc	7.325bc	6.170d	8.145a	7.795ab	0.2097	<0.0008
C18:0	8.28b	8.98b	8.33b	8.96b	8.63b	7.33c	10.06a	9.105b	8.32b	0.2533	<0.0001
C18:1n9	35.235ab	35.80ab	34.67ab	37.245a	34.515ab	33.08b	35.76ab	36.82a	34.60ab	1.0301	<0.2672
C18:1n7	2.525b	2.895a	2.44bcd	2.48bc	2.225de	2.145e	2.265ced	2.145e	2.370bcde	0.0704	<0.0007
C18:2n6cis	13.14cd	14.11bc	15.865a	11.525e	121.805 cde	12.895 cd	12.00de	13.82bc	15.09ab	0.3953	<0.0005
C18:3n3	0.525c	0.575c	0.545c	0.660b	0.670b	0.665b	0.740a	0.785a	0.745a	0.0194	<0.0001
C20:0	0.81a	0.71b	0.595cd	0.535e	0.565de	0.640c	0.630c	0.640c	0.425f	0.0180	<0.0001
C20:5n3	0.34e	0.435e	0.33e	1.425d	2.48ab	2.145c	2.355b	2.565a	2.565a	0.0549	<0.0001
C20:1n9	0.12f	0.145e	0.13ef	0.205d	0.295a	0.280ab	0.135ef	0.255c	0.265bc	0.0053	<0.0001
C22:6n3	0.255e	0.175f	0.370cd	0.495b	0.410c	0.410c	0.465b	0.340d	0.740a	0.0121	<0.0001
C22:0	0.760d	0.605e	0.855d	1.935bc	1.795c	2.035b	1.995b	1.905bc	2.195a	0.0479	<0.0001

Values in the same row with no common superscript are significantly different

Table 6: Least square means for different traits in broilers breast meat fed canola oil and choline chloride supplement

	Treatments										
	1	2	3	4	5	6	7	8	9	SEM	p>F
Satur f.a	37.37ab	37.67ab	39.38a	35.94b	35.78b	35.37b	31.76 c	34.58 bc	34.86 bc	0.986	<0.0147
MUFA	42.80 b	45.43 a	41.60 bc	39.87 cd	38.69 d	40.02 cd	39.65 cd	41.20 bcd	40.43 bcd	0.793	<0.0053
PUFA	16.33 a	15.96 a	15.43 ab	15.33 ab	15.45 ab	15.88 a	15.11 ab	14.30 b	15.12 ab	0.382	<0.1086
Total n-6	15.35 a	14.96 ab	14.47 abc	13.53 cd	13.68 bcd	13.46 cd	12.33 de	11.63 e	13.00 d	0.399	<0.0017
Total n-3	1.70 d	1.72 d	1.58 d	2.55 c	2.52 c	3.05 b	3.66 a	3.55 a	3.66 a	0.045	<0.0001
n-6/n-3	9.01 a	8.70 a	9.15 a	5.31 b	5.43 b	4.41 c	3.37 d	3.28 d	3.55 d	0.289	<0.0001

Values in the same row with no common superscript are significantly different, MUFA: Monounsaturated Fatty Acid; PUFA: Polyunsaturated Fatty Acid

Table 7: Least square means for different traits in broilers thigh meat fed canola oil and choline chloride supplement

	Treatments										
	1	2	3	4	5	6	7	8	9	SEM	p>F
Satur f.a	36.655 a	36.95 a	37.05 a	33.94 ab	33.87 ab	33.20 b	34.73 ab	33.14 b	32.31 b	0.950	<0.0385
MUFA	44.28cd	46.28 abc	44.33 cd	48.62 a	45.04 bcd	43.09 d	44.79 bcd	47.67 ab	45.24 bcd	0.875	<0.0265
PUFA	13.74 ef	14.72 de	16.56 bc	13.45 f	15.69 bcd	15.44 cd	14.81 de	16.72 b	18.40 a	0.361	<0.0001
Total n-6	13.14 cd	14.11 bc	15.86 a	11.52 e	12.08 cde	12.89 cd	12.00 de	12.82 bc	15.09 ab	0.395	<0.0005
Total n-3	1.12 e	1.18 e	1.24 e	2.58 d	3.56 b	3.22 c	3.56 b	3.69 b	4.05 a	0.062	<0.0001
n-6/n-3	11.73 a	11.93 a	12.78 a	4.47 b	3.60 b	4.00 b	3.37 b	3.75 b	3.72 b	0.353	<0.0001

Values in the same row with no common superscript are significantly different, MUFA: Monounsaturated Fatty Acid; PUFA: Polyunsaturated Fatty Acid

Gas chromatography of fatty acids methyl esters sample preparation

Fatty acids: Total lipid was extracted from breast and thigh according to the method of Folch *et al.* (1957). Approximately 0.5 g of meat weighed into a test tube with 20 mL of (chloroform: Methanol = 2:1, vol vol^{-1}) and homogenized with a polytroon for 5 to 10 s at high speed. The BHA dissolved in 98% ethanol added prior to homogenization. The homogenate filtered through a Whatman filter paper into a 100 mL graduated cylinder and 5 mL of 0.88% sodium chloride solution added, stopper and mixed. After phase separation, the volume of lipid layer recorded and the top layer completely siphoned off. The total lipids converted to Fatty Acid Methyl Esters (FAME) using a mixture of boron-trifluoride, hexane and methanol (35:20:45, vol/vol/vol). The FAME separated and quantified by an automated gas chromatography equipped with auto sampler and flame ionization detectors, using a 30 m´ 0.25 mm inside diameter fused silica capillary column, as described previously. A (Model 6890N American Technologies Agilent) (U.S.A) Gas chromatography used to integrate peak areas. The calibration and identification of fatty acid peak carried out by comparison with retention times of known authentic standards. The fatty acid results form gas chromatography with Chem Station software analyzed and expressed as weight percentages.

Statistical analyses: Data were analyzed in a complete randomized design using the GLM procedure of SAS version 12 (SAS Inst. Inc., Cary, NC).

$$y_{ijk} = \mu + a_i + b_j + (a \times b)_{ij} + \varepsilon_{ijk}$$

Where
y_{ijk} = All dependent variable
μ = Overall mean
a_i = The fixed effect of oil levels (i = 1,2,3)
b_j = The fixed effect of CCS levels (j = 1,2,3)
ε_{ijk} = The random effect of residual

The three oil levels (0, 2 and 4% canola oil) and three choline chloride supplement levels (0, 500 and 1000 mg kg^{-1}) were analyzed as a 3×3 factorial. When interactions occurred ($p<0.05$), interaction means were separated using Duncan multiple range test to compare different treatment means.

RESULTS

We used various regimens with increasing levels of canola oil and choline chloride supplement to study oil effect and these supplement effects of meat fatty acid profiles.

Meat quality parameters: Table 4 and 6 show the objective meat quality parameters of the breast samples of chicks according to the amount of canola and choline chloride supplement in the diet.

Fatty acid composition: Table 4-7 show the fatty acids content of the chicken thigh and breast samples. No fatty acids larger than 22 carbon atoms were detected. The data of each experimental plan were analyzed separately.

Saturated fatty acid: In breast and thigh meat in T1, T2 and T3 treatment with 0, 500 and 1000 mg kg^{-1} choline chloride supplement without canola oil compared with other treatment saturated fatty acid content were significantly and is higher, respectively. This condition indicated with application canola oil or high level of unsaturated oil in poultry diets could decreased content of saturated fatty acid and this tissues concentration of C14:0, C16:0, C18:0, C20:0, C22:0 were correlated with dietary fatty acid composition.

Monounsaturated fatty acids: According to these results indicated T2 and T4 viewpoint of MUFA content in breast and thigh meat were significant. The other treatment MUFA content is same level and compared with saturated fatty acid is higher.

Polyunsaturated fatty acids: In thigh meat T9 with 4% canola oil and 1000 mg kg^{-1} choline chloride supplement about of Poly unsaturated fatty acids (C18:2n6cis, C18:3n3, C20:5n3 and C22:6n3) was significant and in breast meat T1and T2 without canola oil and inclusion of 0 and 500 mg kg^{-1} choline chloride supplement was significant and had higher percent of PUFA compared with other experimental treatments.

Total of omega 6 fatty acid: According to results usage canola oil and choline chloride supplement in all experimental diets content omega 6 fatty acid with increase oil level have descend rate. The lowest omega 6 fatty acid belong of T8 treatment for breast meat with 4% oil and 500 mg kg^{-1} choline chloride supplement and T4 with 2% oil and without choline chloride supplement. Whereas in thigh meat sample T3 with 15.86 ($p<0.05$) was significant and T1, T2 were 13.14, 14.11, respectively but did not significant, however, the content of omega 6 fatty acid with increase canola oil have descend rate and in T7, T8 reached to 12, 12.8%. With compared broiler chick tissue indicated omega 6 fatty acid in breast meat is higher than thigh meat.

Total omega 3 fatty acids: The content of omega 3 (C18:3n3, C20:5n3 and C22:6n3) fatty acid in T1, T2 and T3 experimental diet in breast and thigh meat is higher than other treatment and was significant. With graduate increase canola oil the content of omega 3 fatty acids in composition of breast and thigh meat fatty acid profile was increased. The highest effects of this fatty acid content belong for 4% canola oil and was significant ($p<.0001$).

The ratio of omega 6 to omega 3 fatty acids: With compared breast and thigh ω6/ω3 fatty acid profile indicated with increase oil level this ratio is decrease and the quality of fatty acid composition is improved. For thigh meat sample the this ratio is 11.73% for T1 and reach to 3.72 for T9 and for breast meat sample 9.01 reach to 3.55% in T9 treatment. This indicate canola oil with high level of unsaturated fatty acids and omega 3 fatty acid could influence this good fatty acid content and improved meat fatty acids profile and quality.

DISCUSSION

A number of studies have examined the effects of dietary long- chain PUFA, such fish oil, linseed oil and rape seed oil, on the fatty acid composition of the broiler carcass (miller and robisch, 196 of these studies were conducted with the aim of enhancing the human dietary intake of long chain n-3 PUFA and the specific aim of conferring beneficial effects to human health and resistance to disease. These studies have shown that the deposition of n-3 polyunsaturated in muscle and adipose

tissues should be increased by supplementing the diet with sources reach in these FA9; Hulan *et al*., 1988; Phettleplace and Watkins, 1990). Many of these studies were conducted with the aim of enhancing the human dietary intake of long chain n-3 PUFA and the specific aim of conferring beneficial effects to human health and resistance to disease. These studies have shown that the deposition of n-3 polyunsaturated in muscle and adipose tissues should be increased by supplementing the diet with sources reach in these FA. In the present experiments, the presence of canola oil produced an increase in the accumulation of n-3 long chain PUFA in the muscle tissues, as compared with the other experimental diet. These FA were deposited in the breast and thigh meat with 2 and 4% canola oil to a greater extent than treatment without canola oil.

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