Original Article

Effects of medium-chain free fatty acids on performance, some biochemical parameters and meat fatty acids profile of broiler chickens

Mehmet DEMİRCİ[1*] Mehmet BAŞALAN[2]

Abstract

In this study, it was aimed to investigate the effects of the addition of caprylic (octanoic, C8:0), capric (decanoic, C10:0) and lauric (dodecanoic, C12:0) acids from medium-chain free fatty acids to broiler diets. A total of 120 one-day-old male broiler chicks (Ross 308) were used and the study was conducted on 4 main groups of broilers; one control and three trials. The birds in the control group was fed an unadulterated basal diet and those in the experimental groups were fed with 0.2% of caprylic, capric and lauric acids (in addition to a basal diet) respectively. In the study, there was no significant difference between the groups in terms of mean live weight gain, feed consumption, feed conversion rate, serum glucose, total cholesterol, total protein and albumin (P>0.05). However, the triglyceride levels were detected to be significantly lower in the experimental groups (P<0.05) than control group. Seventeen different types of fatty acids were determined and were profiled from breast meat samples and it was indicated that most of fatty acid types showed statistically significant differences (P<0.05) among the experimental groups. As a result, it was concluded that the addition of 0.2% of free caprylic, capric or lauric acids to broiler diets generally did not result in specific performance effects among the groups but significant differences occurred in the meat fatty acid profile. The most important changes were the increases of total n-3 levels and the decreases of total n-6 and n-6/n-3 levels, in fatty acid supplemented groups. It was also found that lauric acid was accumulated significantly in poultry meat. The data suggests that the use of medium-chain fatty acid in broiler rations may change poultry meat fat composition in a way that positively affects human health and also prolongs shelf life.

Keywords: Broiler, Capric acid, Caprylic acid, Fatty acid, Lauric acid

[1]*Kırıkkale University, Vocational High School of Delice, Department of Laboratory and Veterinary Health, Kırıkkale, Turkey*
[2]*Kırıkkale University, Faculty of Veterinary Medicine, Department of Animal Nutrition and Nutritional Diseases, Kırıkkale, Turkey*
****Correspondence**: m.demirci.tr@hotmail.com* (M. DEMİRCİ)
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Introduction

Today, the poultry sector has accelerated its development in the field of animal breeding and the industrial management of livestock. To this development process, intensive work on animal nutrition has made great contributions. It is known that physical, biological and chemical factors contribute to the development of animal performance and as time progresses new ones are discovered and maximum efficiency is ensured by optimal blending of these factors. One of the alternative solutions that focuses on this aim is in the use of 'growth promoters' as feed additives because of the effect of animals on reducing health problems and increasing their performance. Antibiotics have been the growth promoters used in the poultry industry for a long time. However, since 2006 in Europe, their use has been prohibited in animal feed because of various drawbacks, especially microbial resistance developments. Since then, alternative additives have been sought in the animal feeding sector. 'Organic acids' are considered to be a solution because of features such as they are not foreign chemical substances to the organism, and they do not cause residual problems (Huyghebaert *et al*., 2011).

Fatty acids have organic acid structures and medium-chain fatty acids (MCFA) are sub-members of those groups. In the MCFA classification, there are caproic, caprylic, capric and lauric acids, which are saturated fatty acids (Ratnayake and Galli, 2009; FAO, 2010). Research studies have begun to understand the healing effects of MCFAs on animal health and performance. In studies, antibacterial, anticoccidial and anticandidal activities of MCFAs (or their triglyceride forms, MCT) have also been examined as have live performance, carcass and egg yield, eggshell quality, nutrient digestibility and other biochemical activities on organisms (Lee *et al*., 2015; Khan and Iqbal, 2016). Because of their important features such as the effects on specific cellular metabolism stages (transport, oxidation, gene-level synthesis, etc.) and due to their lower energy metabolism (compared to long-chain fatty acids, LCFA), MCFAs (or MCTs) are thought to be an alternative solution for the prevention and treatment of lipid-related problems such as cardiovascular disease and obesity, which are the biggest problems in human health especially in today's wealthy societies (Hainer *et al*., 1994; ST-Onge and Jones, 2003). In vitro and in vivo studies have shown that these products may be alternative food supplements that will positively contribute to human health and may also be of use in the area of pharmaceutical-cosmetic industry and in parenteral nutrition (Traul *et al*., 2000).

Studies have shown that the addition of various free fatty acids, derivatives (salts, esters, mono- and triglycerides, etc.) or the combination of vegetable oils and animal fats to chicken diets can alter the body fatty acid profiles (Azman *et al*., 2005; Morales-barrera *et al*., 2013; Zeitz *et al*., 2015). With this type of manipulation to animal feeds, the aim has been to develop animal health and yields and to obtain higher quality animal products in terms of human health (Hargis and Van Elswyk, 1993).

The aim of this study was to investigate the effects of MCFAs on animal health and yield performances, as well as the possible contribution to animal food quality and to human health.

Materials and Methods

This study was performed at the poultry breeding unit of Veterinary Faculty in Kırıkkale University (Turkey). For the experiment, the necessary approvals were obtained from the Kırıkkale University Local Ethics Committee of Animal Experiments (15/02-15/12).

Experimental design and feeding: In the study, 120 one-day-old male broiler chicks (Ross 308) were used. Four main groups were formed including one control and three trials. In each group there were thirty chicks and each main group was divided into three subgroups with 10 chicks in each. The feeding period lasted for 42 days and basically all groups were given periodically formulated isocaloric-isonitrogenic feed for broiler feeding in *ad libitum* style. In the diet formulations, the NRC 1994 nutritional recommendation was applied. The basal ration contained corn, soybean meal, wheat by-products and vegetable blend oil. The animals in the control group were fed with basal diets (non-additive added) and the experimental groups' diets were supplemented with 0.2% caprylic (W279900, Sigma-Aldrich, Germany), capric (W236403, Sigma-Aldrich, Germany) and lauric (W261408, Sigma-Aldrich, Germany) acids as free fatty acids respectively.

Performance parameters: The mean live weights (LW) and feed consumption (FC) of the experimental groups were determined by weekly weighing. By using those measurements, the live weight gains (LWG) and feed conversion ratios (FCR) were calculated. AOAC (2005) methods were used for determination of the nutrient contents of feed rations.

Sampling: At the end of the feeding process 10 samples of broilers were selected randomly from each group. These samples were slaughtered at 42 days of age. Blood samples were taken from the jugular vein of the chicks before the slaughtering for determining the biochemical blood parameters. Each sample was numbered and the data obtained from these samples was recorded individually.

Blood analysis: Serum was separated by centrifugation at 3000 rpm for 10 minutes after being kept at room temperature for 1 hour and stored at -20 °C until analysis. Serum biochemical parameters such as glucose, triglyceride, total cholesterol, total protein and albumin levels were determined by auto-analyzer (Chem 200, Gesan, Italy) using commercial test kits (Gesan, Italy).

Fatty acids analysis: Meat samples were taken from the carcass breast muscles (m. pectoralis major and minor) and tissue fats were extracted using the method developed by Folch *et al*., (1957) and the resulting samples were esterified using boron trifluoride (BF_3)

reagent according to the AOAC (2005) method 969.33. Peak definitions and area measurements of fatty acid methyl esters were performed using Gas chromatography - Mass spectrometry (GC-MS) technology (QP2010 Plus, Shimadzu, Japan; Column: Agilent J & W HP-88 GC, USA). The Supelco® 37 Component FAME Mix CRM47885 reagent (Sigma-Aldrich, St. Louis, Missouri, USA) was used as the analytical standard. The chromatographic peak areas of the determined fatty acids were considered to be 100%, and then proportional calculations were made for the value corresponding to each fatty acid peak area.

Statistical analysis: The data obtained from the experimental design were calculated with "SPSS 15.0 for Windows" package program, One-way ANOVA was constructed for the determination of the main effects' significances of randomized blocks. Data was analyzed at $P<0.05$ level of significance. Duncan test methods were used for pairwise comparisons of means.

Results

The chemical or nutrient compositions of MCFA supplemented diets were used in the experiment and are given in Table 1 and the fatty acid profiles of the diets are presented in Table 2.

Table 1 Ingredients of feed used during the trial (%)

Feedstuffs	Feeding Period		
	Starter (0. - 14. day)	Grower (15. - 28. day)	Finisher (29. - 42. day)
Wheat	17	20.9	24.4
Corn	33	34	35.8
Soybean meal (44%)	33.2	27.3	22.5
Full-fat soybean	10	10	8.5
Sunflower oil	3.5	4.5	5.5
DCP	1	1	1
Limestone	1.55	1.55	1.55
Salt	0.25	0.25	0.25
Vitamin - Mineral premix[1]	0.25	0.25	0.25
DL-Methionine	0.25	0.25	0.25
Analyzed composition of feed used during trial (%)			
Dry matter	87.19	88.40	88.75
Crude protein	23.44	21.95	19.68
Crude fiber	5.9	6.66	6.62
Ether extract	6.87	9.43	8.76
Starch	34.78	33.7	37.5
Sugar	4.18	4.27	4.85
Ash	5.24	5.46	4.82
Metabolic energy (Kcal/kg)[2]	2950	3064	3095

[1]Participates 2.5 kg to a ton diet. Content of each 2.5 kg premix: 15 000 000 IU vitamin A, 3 000 000 IU vitamin D_3, 100 000 mg vitamin E, 5 000 mg vitamin K_3, 3 000 mg vitamin B_1, 6 000 mg vitamin B_2, 6 000 mg vitamin B_6, 20 mg vitamin B_{12}, 50 000 mg vitamin PP, 50 000 mg niacin, 150 mg d-biotin, 15 000 mg cal. d-pantothenate, 1 500 mg folic acid, 2 500 mg apocarotenoid acid, 5 000 mg Cu, 60 000 mg Fe; 80 000 mg Mn, 200 mg Co, 1 000 mg I, 60 000 mg Zn, 150 mg Se.
[2]Have been found with calculations (NRC, 1994)

Table 2 Fatty acid profiles of basal diets used in trial period (% total fatty acids)

Fatty Acids	Starter (0.-14. day)	Grower (15.-28. day)	Finisher (29.-42. day)
C12:0	ND	ND	0.01
C14:0	0.12	0.21	0.29
C16:0	19.46	21.81	28.82
C16:1	0.45	0.71	0.93
C18:0	5.42	7.24	2.15
C18:1	29.41	24.44	26.28
C18:2n-6	38.82	38.36	31.48
C18:3n-3	5.71	6.52	9.09
C20:0	0.24	0.27	0.36
C20:1	0.02	0.02	0.02
C20:2	0.05	0.07	0.09
C20:3	0.01	0.1	0.02
C20:4	0.08	0.07	0.11
C20:5	0.04	0.06	0.06

ND: Not detected

The experimental group members were named as Control, C8, C10 and C12. Average LW, LWG, FC and FCRs of control and treatment groups are shown in Table 3. The mean LWG values of the experimental groups in the 42-day period were 2917.69, 2926.50, 2908.37, 3021.96 grams respectively and there were no statistically significant differences between the groups in terms of this parameter (P>0.05). According to 42-day data, the FC means of the groups were 4398.43, 4354.78, 4333.21, 4391.09 g and FCRs were calculated as 1.52, 1.49, 1.50, 1.46, respectively and according to these results it was determined that there were no statistical differences between groups with respect to either parameter (P>0.05).

Biochemical parameters are listed in Table 4. When the data of the samples was examined, there were no statistically significant differences between the groups in terms of serum glucose, total cholesterol, total protein and albumin levels (P>0.05) but only in terms of triglyceride values where there were found to be significant differences between the groups (P<0.05). Mean triglyceride value in the control group (233.33 mg/dL) was found to be significantly higher than the other groups (192.50, 154.17, 190.83 mg/dL, respectively). When the data obtained in the present study was evaluated, it was seen that different types of MCFA additives applied to the experimental groups at a rate of 0.2% showed a decrease in the serum triglyceride levels of the other groups compared to the control group.

The values of breast meat fatty acid profiles are given in Table 5. Sixteen different types of fatty acids were detected and profiled in the sample breast meats. If the fatty acids were evaluated separately, it was determined that some types of fatty acids changed at relative levels (P>0.05) and some of them showed statistically significant changes (P<0.05) in the experimental groups compared to the control group. There were no significant differences in terms of total SFA, UFA, MUFA and PUFA levels (P>0.05) but total n-3 levels were significantly higher and n-6/n-3 ratios were lower in the MCFA groups than the control group (P<0.05).

Table 3 Trial groups average live weight gains, feed consumption and feed conversion ratios (Mean±SEM)

Parameter	Age (Day)	Trial Groups				
		Control	C8	C10	C12	P
LW (g)	1st day	40.50 ±0.63	40.63 ±0.48	40.37 ±0.51	40.37 ±0.56	0.983
	14	456.63 ±5.99	464.9 ±4.36	462.77 ±5.08	455.23 ±6.45	0.545
	28.	1547.47 ±20.09	1569.33 ±12.92	1549.67 ±14.72	1571.07 ±18.22	0.641
	42.	2958.34 ±37.93	2967.13 ±22.75	2948.73 ±36.46	3062.5 ±41.43	0.093
LWG (g)	0-14	416.13 ±5.45	424.27 ±3.92	422.40 ±4.66	414.87 ±5.98	0.480
	14-28	1090.83 ±14.88	1104.43 ±9.13	1086.90 ±11.14	1115.83 ±12.07	0.306
	28-42	1407.72^{b} ±21.00	1397.80^{b} ±13.47	1399.07^{b} ±22.87	1481.93^{a} ±28.17	0.022
	0-42	2917.69 ±37.40	2926.50 ±22.32	2908.37 ±36.11	3021.96 ±40.93	0.086
FC (g)	0-14	519.75 ±11.17	518.06 ±2.92	511.08 ±5.38	512.52 ±9.79	0.843
	14-28	1500.61 ±30.78	1469.64 ±10.63	1452.36 ±23.05	1476.25 ±8.50	0.457
	28-42	2378.07 ±3.38	2367.09 ±16.23	2369.77 ±28.72	2402.31 ±25.47	0.640
	0-42	4398.43 ±27.72	4354.78 ±28.44	4333.21 ±54.01	4391.09 ±31.58	0.584
FCR (kg FC / kg LWG)	0-14	1.26 ±0.02	1.22 ±0.01	1.21 ±0.01	1.24 ±0.02	0.208
	14-28	1.38^{a} ±0.02	1.33^{b} ±0.01	1.34^{ab} ±0.01	1.32^{b} ±0.01	0.026
	28-42	1.70 ±0.03	1.70 ±0.02	1.71 ±0.03	1.64 ±0.04	0.290
	0-42	1.52 ±0.02	1.49 ±0.01	1.50 ±0.02	1.46 ±0.02	0.247

^{a,b,c}: Values in rows with different letters differ significantly (P≤0.05)

Table 4 Trial groups' average serum biochemical parameters (Mean±SEM)

Parameter	Trial Groups				P
	Control	C8	C10	C12	
Glucose (g/dL)	262.08 ±5.06	258.00 ±4.48	250.33 ±3.43	260.08 ±3.26	0.215
Total Protein (g/dL)	4.38 ±0.14	3.98 ±0.14	4.19 ±0.17	4.46 ±0.25	0.241
Albumin (mg/dL)	2.11 ±0.04	2.01 ±0.06	2.08 ±0.05	2.14 ±0.08	0.510
Total Cholesterol (mg/dL)	170.91 ±2.83	167.50 ±2.38	168.58 ±3.79	163.82 ±5.09	0.597
Triglyceride (mg/dL)	233.33^{a} ±15.64	192.50^{b} ±10.09	154.17^{b} ±9.88	190.83^{b} ±16.58	0.002

^{a,b,c}: Values in rows with different letters differ significantly (P≤0.05)

Table 5 Trial groups' average breast fatty acid profiles (% total fatty acids) (Mean±SEM)

Parameter	Trial Groups				P
	Control	C8	C10	C12	
C8:0	ND	ND	ND	ND	-
C10:0	ND	ND	ND	ND	-
C12:0	0.03^{b} ±0.01	0.06^{b} ±0.01	0.06^{b} ±0.01	1.06^{a} ±0.10	0.001
C14:0	0.26^{c} ±0.01	0.41^{b} ±0.04	0.35^{b} ±0.01	0.58^{a} ±0.04	0.001
C16:0	22.75^{b} ±0.20	25.95^{a} ±1.06	23.70^{b} ±0.45	24.06^{ab} ±0.80	0.024
C18:0	10.40 ±0.46	9.76 ±1.32	11.91 ±0.24	10.08 ±0.95	0.405
C20:0	0.05^{b} ±0.00	0.09^{a} ±0.01	0.07^{ab} ±0.00	0.08^{a} ±0.01	0.013
C16:1	1.11^{b} ±0.10	1.65^{a} ±0.23	1.51^{ab} ±0.08	1.69^{a} ±0.13	0.029
C18:1	26.55 ±0.39	24.11 ±1.62	27.98 ±0.96	24.50 ±0.94	0.060
C20:1	0.09 ±0.02	0.12 ±0.02	0.11 ±0.03	0.13 ±0.03	0.650
C18:2n-6	32.04^{a} ±0.32	29.07^{ab} ±1.38	26.09^{b} ±1.46	28.59^{ab} ±1.64	0.028
C18:3n-3	2.62^{b} ±0.12	3.79^{a} ±0.53	2.97^{ab} ±0.23	3.61^{ab} ±0.33	0.033
C18:3n-6	0.11 ±0.01	0.16 ±0.02	0.15 ±0.01	0.17 ±0.01	0.060
C20:2n-6	0.35^{c} ±0.02	0.45^{b} ±0.03	0.38^{c} ±0.01	0.55^{a} ±0.03	0.001
C20:3n-6	0.21^{c} ±0.01	0.30^{b} ±0.01	0.24^{c} ±0.01	0.34^{a} ±0.01	0.001
C20:4n-6	3.02 ±0.21	3.56 ±0.26	3.58 ±0.24	3.80 ±0.23	0.114
C20:5n-3	0.05^{c} ±0.00	0.08^{b} ±0.01	0.08^{b} ±0.01	0.10^{a} ±0.00	0.001
C22:6n-3	0.37^{b} ±0.03	0.45^{ab} ±0.04	0.63^{a} ±0.07	0.65^{a} ±0.11	0.020
∑SFA	33.49 ±0.44	36.26 ±1.05	36.27 ±0.57	35.86 ±1.03	0.065
∑MUFA	27.75 ±0.37	25.88 ±1.72	29.61 ±0.98	26.32 ±0.93	0.118
∑PUFA	38.76 ±0.22	37.86 ±1.30	34.13 ±1.31	37.82 ±1.46	0.060
∑UFA	66.51 ±0.44	63.74 ±1.05	63.73 ±0.57	64.14 ±1.03	0.065
SFA/UFA	0.50 ±0.01	0.57 ±0.02	0.57 ±0.01	0.56 ±0.03	0.057
∑n-3	3.04^{b} ±0.11	4.32^{a} ±0.53	3.68^{ab} ±0.25	4.36^{a} ±0.30	0.018
∑n-6	35.73 ±0.27	33.53 ±1.27	30.45 ±1.51	33.46 ±1.56	0.053
n-6/n-3	11.96^{a} ±0.53	8.86^{b} ±1.11	8.67^{b} ±0.85	8.14^{b} ±0.72	0.006

∑SFA: Caprylic (C8:0), Capric (C10:0), Lauric (C12:0), Myristic (C14:0), Palmitic (C16:0), Stearic (C18:0), Arachidic (C20:0)
∑MUFA: Palmitoleic (C16:1), Oleic (C18:1n-9), Eicosanoic (Gondoic -C20:1)
∑PUFA: Linoleic (C18:2n-6), α-Linolenic (C18:3n-3), ɣ-Linolenic (GLA - C18:3n-6), Eicosadienoic (C20:2n-6), Eicosatrienoic (C20:3n-6), Arachidonic (C20:4n-6), Eicosapentaenoic (EPA - C20:5n-3), Docosahexaenoic (DHA - C22:6n-3)
^{a,b,c}: Values in rows with different letters differ significantly (P≤0.05)
ND: Not detected

Discussion

In previous studies, Del Alamo *et al.,* (2007) reported that the chicks fed with 0.1 - 0.2% of MCFA added rations did not result in a significant change in average body weight and LWG. Also, Skřivan *et al.,* (2010) used 0.25% of caprylic acid and Molatová *et a.,* (2011) used 0.25% of caprylic + capric acids, Świątkiewicz and Arczewska-Wlosek (2012) used 0.2% of MCFA (caproic + capric acid) or 0.3% SCFA (Propionic + Acetic acids) + 0.2% MCFA (caproic + capric acids) and Mohammadzade *et al.,* (2013) used 0.1 - 0.2% of Caproic acid and Shokrollahi *et al.,* (2014) used between 0.1% and 0.3% of MCFA (Lodestar™ C8-C10) and they reached similar results. Hejdysz *et al.,* (2012) reported that when adding to diets 0.85% of caproic acid or caprylic acid separately or at the same rate of a mixture of caproic + caprylic + capric acid obtained similar results with the control group fed with coccidiostats (Salinomycin). It is understood that the levels of fatty acids used in the study and the total data obtained during the six-week trial period are similar to the results of the studies listed above. According to the results, it can be said that the addition of C12 to the diet in the last two weeks of the trial might have increased the performance of the animals. However, this effect did not exist throughout the six weeks. On the other hand, Skřivan *et al.,* (2010) reported that addition of 0.5% of caprylic acid and to Hejdysz *et al.,* (2012) 0.85% of capric acids to diets reduced the live weight of chickens.The present study did not produce any specific effect when using caprylic, capric and lauric acids at the levels of 0.2%.

Molatová *et al.,* (2011) reported that when 0.25% caprylic + capric acids was added to the diets, also according to Świątkiewicz and Arczewska-Wlosek (2012) 0.3-0.4% SCFA and/or 0.2% MCFA and to Mohammadzade *et al.,* (2013) 0.1-0.2% MCFA and to Shokrollahi *et al.,* (2014) 0.1-0.3% MCFA, the additions resulted similarly between the groups in terms of the FCs and FCRs of chicks. On the other hand, Hejdysz *et al.,* (2012) reported that the addition of 0.85% of caproic acid induces the chicks' FCs but they also reported that this group was also the group with the most negative results in term of FCRs. From the data obtained in this study, it is understood that FCR values were more positive in fatty acids supplemented groups in the 3rd and 4th weeks of the trial period. However, it is understood that the differences in this parameter between the trial groups did not persist in a stable order for six weeks. In conclusion, it is understood that the feed additives used in this study have no specific effect on the total results of FCs and FCRs of the trial groups. Therefore, it is not possible to say precisely which additive increased the conversion rates of feed more.

In other respects, Del Alamo *et al.,* (2007) reported that the live performance data of chickens had similar results when fed with 0.1-0.2% of MCFAs (C6-C12) but the combinations of SCFA (C1-C4) and MCFA in the same proportions yielded more effective results. Khosravinia (2015) reported that the use of commercial products with MCFA content at 0.08-0.2% did not affect FC but increased FCRs. Zeitz *et al.,* (2015) reported that 1.4% of lauric or myristic acid additives

increased FCRs in the experimental groups compared to the control group. Bapeer and Shamau (2016) also reported significant increases in body weight gain when using MCFA mix (Aromabiotic® Poultry, etc.) additives in similar proportions. Based on these evaluations, it can be understood that the use of various free fatty acids or specially crafted MCFA combinations can obtain synergistic effects and more positive results with lower contribution rates (compared to the use of fatty acids alone).

In the present study, the number of chicks that died during the production period was 3 in total. One of these deaths was in the control group and the other two were in the C12 group. In the C8 and C10 groups, no deaths were encountered. It has been stated by many researchers that MCFAs display antimicrobial activity and may be an alternative growth promoter factor option that may be preferred in the poultry sector (Chotikatum *et al.,* 2009; Kim and Rhee, 2013; Lee *et al.,* 2015; Gracia *et al.,* 2016). However, there is fairly limited information about the effects of MCFAs on the immune system metabolism in the organism. Saeidi *et al.,* (2016) reported that MCFA did not cause a significant change in body antibody levels. In this study, no test studies were performed to determine the antimicrobial activity of MCFAs.

Sato *et al.,* (2005), Wein *et al.,* (2009) and Wang *et al.,* (2015) reported that MCFAs stimulate the synthesis of triglycerides less than LCFAs and decreased the accumulation of triglycerides in tissues. It is understood that the results obtained in the present study support the results obtained by Sato *et al.,* (2005), Wein *et al.,* (2009) and Wang *et al.,* (2015). However, Shokrollahi *et al.,* (2014) reported that the addition of MCFA at a rate of 0.1-0.3% did not result in a significant change in serum triglyceride levels and serum glucose, total cholesterol and LDL cholesterol levels decreased significantly, while the HDL cholesterol level increased. Saeidi *et al.,* (2016) reported that there was a significant decrease in LDL, total cholesterol and triglyceride levels and an increase in HDL levels with the addition of 0.1-0.4% MCFAs to diets. In the present study, it was observed that there was no significant difference between the groups with respect to other parameters except triglycerides and the data obtained in this study did not match the data of the above studies. For this difference, it is suggested that the use of combined MCFAs in the related studies may be more effective than individual adding of FA. In the present study, a different medium chain fatty acid was applied to each experimental group. As a matter of fact, researchers such as Del Alamo *et al.,* (2007), Hejdysz *et al.,* (2012), Khosravinia (2015) and Bapeer and Shamau (2016) reported that MCFA combinations may obtain more effective results.

Researchers including Azman *et al.,* (2005), Smink *et al.,* (2008), Morales-Barrera *et al.,* (2013), Zeitz *et al.,* (2015) reported that the body fatty acid profiles of animals may vary depending on the diet fatty acid profile. It is understood that the general aim of the studies to change the meat fatty acid profile is to produce more healthy animal products in human nutrition. In order to achieve this, there is an attempt to reduce the saturated fatty acid (SFA) ratios and to enrich the unsaturated fatty acid (USFA) ratios in animal products.

In the present study, 16 different types of fatty acids were detected and profiled in the sample breast meat. If fatty acids evaluated separately, it was determined that some types of fatty acids changed only numerically ($P>0.05$) and some of them showed significant changes ($P<0.05$) in the experimental groups compared to the control group. However, there were no significant differences in terms of total SFA, UFA, MUFA and PUFA data ($P>0.05$). It is understood that the findings obtained in the present study support the opinion that the fatty acid content of diets can change the meat fatty acid profile of the chicks. When the levels of omega fatty acids were analyzed, it was understood that the total n-3 levels were significantly higher in the MCFA groups compared to the control group and the n-6 / n-3 ratios were lower ($P<0.05$). In fact, this is an important finding both for the animals' own health and for the production of healthy animal goods. It is recommended that the n-6 / n-3 ratio should be below 10/1 for humans to be able to consume healthy foods (Molendi-Coste *et al.,* 2011). However, it has recently been known that this rate has been steadily rising in Western diets and that n-3 levels have fallen, which in turn has led to an increase in obesity problems and cardiovascular or inflammatory diseases (Holub, 2002; Simopoulos, 2016). According to the data obtained in the present study, it can be surmised that feeding chickens with MCFA supplemented diets can enrich omega fatty acids in chicken meats and improve meat quality.

Another interesting finding in the present study was the detection of 1.06% lauric acid content in the C12 group. The fact that lauric acid which is not normally found in chicken meat fatty acid profile was detected in the samples presented in this study suggests that this fatty acid may be caused by its ability to accumulate (or residues) in the specimens as a result of its use as an additive in the trial. Caprylic and capric acids were not found in any experimental group, so it is understood that there is no accumulation feature in the organism of broilers. Zeiger *et al.,* (2017) also reported similar findings about lauric acid. The accumulation (or residue forming) of lauric acid in chicken meat suggests that this may increase acidification in the carcass and extend the shelf life of the meat as well.

In conclusion, it was determined that the addition of 0.2% free caprylic, capric or lauric acids to the broiler diet did not have any specific effects or produce distinct differences between the groups in terms of live performance. However, no adverse effects were encountered. In terms of the composition of the meat fatty acids, it was determined that there were significant differences between the experimental groups, which were important for the health and shelf-life of chicken meat. In order to determine the specific effects of these fatty acids and also to determine the possible statistical differences between the groups with respect to the other parameters examined, it is considered that it may be meaningful to work with higher contribution diets and with broilers of different genotypic features and physiological periods. Considering the positive data obtained on the effects on performance and some health parameters it is

advisable to investigate the possible effects of these additives on microorganisms in the intestine as well as their absorption characteristics and pharmaco-kinetics. In addition, new studies can be designed by blending various medium-chain fatty acids and some feedstuffs, thereby demonstrating the beneficial or synergistic effects of fatty acids.

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