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RESEARCH ARTICLE

# The Influence of Turmeric Powder (*Curcuma longa*) on Fatty Acid Composition and Shelf Life of Broiler Chicken Meat

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**ABSTRACT**

The objective of this study was to determine the appropriate concentration of dietary supplementation of turmeric powder, and its effect on thiobarbituric acid reactive substance (TBARS) and fatty acid composition in thigh and breast meat of broiler chickens. Three hundred fifty (175 male and 175 female), one day old Ross-308 broiler chicks were used in this study. A corn-soybean meal based diet containing different levels of turmeric powder (0, 2, 4, 6, 8, 10 g/kg) and a single dose of chlortetracycline (10 mg/kg) was used. The result revealed that dietary supplementation of 2, 4, 6, 8 and 10 g/kg of turmeric powder decreased TBARS in thigh meat at 5$^{th}$ day when compared with control. The addition of 4 g/kg turmeric powder to the basal diet increased DHA, SFA and omega-3 in breast meat. DHA and SFA were increased by dietary 2 g/kg turmeric powder in thigh meats. Under the conditions of this experiment, it was concluded that turmeric powder may positive effects on tissue fatty acid compositions and shelf life of meat (TBARS). As a result, it was observed that there were positive effects on tissue fatty acid compositions and shelf life of meat (TBARS) by adding 4 g/kg turmeric powder.

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## Introduction

*Curcuma longa*, which is a tropical plant of Zingiberaceae family, was used as a feed additive. Curcumin is the most important active ingredient of *Curcuma longa*, and has been widely used in Asian and middle-Eastern (Gowda et al. 2009; Chattopadhyay et al. 2004). *Curcuma longa* has been reported to perform a number of biological activities, like antioxidant, antimicrobial, antifungal, antimutagenic and antidiabetic (Araujo and Leon, 2001; Gowda et al. 2009). It has also been reported to increased weight gain, and improved nutrients digestibility in farm animals (Al-Sultan and Gameel, 2004; Mehala and Moorthy, 2008, Urusan and Bolukbasi, 2017). On the other hand the use of turmeric in broiler diets has been successfully demonstrated with antimicrobial activity on *E.coli* and coliform bacteria (Samarasinghe et al. 2003; Urusan and Bolukbasi, 2017). In recent years, researchers have focused their studies on phytogenics. It was determined with the studies that alfalfa (Ponte et al. 2004), and thyme (Bolukbasi et al. 2006) decreased the serum cholesterol and lipoproteins; mentha pulegium had positive effects on TBARS (Erhan et al. 2015); and adding turmeric decreased the SFA rates in tissues (Daneshyar et al. 2011). It is also turmeric had strong antioxidant effects and were more powerful in preventing lipid oxidation than Vitamin E (Jayaprakasha et al. 2005). Again, it was determined by many authors that curcumin has an antioxidant activity that was comparable with that of Vitamin C and E (Sharma, 1975; Shukla et al. 1997; Thiyagarajan and Sharma, 2004; Karami et al. 2011). Turmeric also prevents the

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formation of peroxide in foods and increases the preservation period.

The purpose of this study was designed to investigate the possible effect of turmeric as feed additive on the amount of oxidation in tissues and on the fatty acid composition.

## Materials and Methods

### *Experimental Design and Animals*

In this study, a total number of 350 (175 male-175 female) one-day-old broilers (Ross 308) were randomly allocated to 7 treatments with 5 replicates and each replicate contained 10 birds. The study was conducted with 7 groups (1 control, and 6 treatment groups) each of which included 50 chicks. Treatments were 0, 2, 4, 6, 8, 10 g/kg of turmeric and 10 mg/g antibiotic added into the feeds during experiment (42 days). Turmeric (70.79% Beta Tumerone, 9.65% Alpha-Tumerone, 2.06% Isocumene, 2.04% BetaSesquıphellandrene, and 2% Zingiberene) was purchased from a commercial company (Erzurum, Turkey). Composition of the experimental diets is presented in Table 1. Feed and water were given ad libitum.

**Table 1.** The composition of the experimental diet (g/kg)

| Item | Starter diet (1-21 d) | Finisher diet (22-42 d) |
|---|---|---|
| Corn | 562.00 | 556.00 |
| Soybean Meal | 189.00 | 120.00 |
| Full-Fat Soybean | 160.00 | 229.35 |
| Poultry Meal | 35.00 | 35.00 |
| Meat and Bone Meal | 34.00 | 34.00 |
| Vegetable Oil | 4.00 | 12.00 |
| Salt | 1.80 | 1.85 |
| Lysine | 3.00 | 2.10 |
| Methionine | 2.00 | 1.30 |
| Limestone | 2.00 | 2.20 |
| Vitamin Mixture | 2.00 | 2.00 |
| Mineral Mixture | 1.50 | 1.50 |
| Soda | 1.50 | 2.20 |
| DCP | 2.20 | 0.50 |
| TOTAL | 1000 | 1000 |
| **Calculated composition (%)** | | |
| ME (kcal/kg) | 3040 | 3240 |
| Ca | 1.05 | 0.99 |
| P | 0.56 | 0.53 |
| Methionine | 1.22 | 0.94 |
| Lysine | 1.50 | 1.25 |
| **Analysed composition (%)** | | |
| Crude Protein | 22.70 | 20.99 |
| Crude Fat | 8.13 | 10.15 |
| Crude Fiber | 3.96 | 4.21 |
| Crude Ash | 5.24 | 5.29 |
| Dry Matter | 88.94 | 90.08 |

1: In each 2 kg mixture; 12 000 000 IU Vitamin A., 3 500 000 IU Vitamin D3, 100 g Vitamin E., 3 g Vitamin K3. 2.5 g. Vitamin B1, 6 g Vitamin B2, 25 g Niacin. 12 g Ca-D-Pantothenate, 4 g Vitamin B6., 15 mg Vitamin B12., 1.5 g Folic Acid,150mg D-Biotin., 100 g Vitamin C., 450 g Colin chloride. 2: each 1.5 kg 100 mg Mangan., 25 g Iron., 65 g Zink., 15 g Copper., 0.25 g Cobalt., 1 g Iodine., 0.2 g Selenium.

### *TBARS (Thiobarbituric Acid Reactive Substance) Analysis*

At the end of the study, ten birds (5 females and 5 males) selected randomly from each treatment were slaughtered and the thigh and breast meats of the animals were separated. Four samples were taken from each sub-group and stored at ± 4ºC; and the TBARS (Thiobarbituric Acid Reactive Substance) values were examined on 1st, 3rd and 5th days (Lemon, 1975). In addition, the fatty acid composition was examined in the samples that were taken from thigh and breast (Anonymous, 2000).

### *Fatty Acid Analysis*

Fatty acid analyses were performed at the Biotechnology Application and Research Centre. After extracting (Folch et al. 1957) meat samples were methlated for gas chromatographic analysis (GC- Agilent 6980 Mass, a fused silica capilllary column, and film thickness of 0.25 µm). Oven temperature was from 165 ºC to 200 ºC at 5 ºC/min. detector temperature was 200 ºC; head pressure was 5 psi.

### *Statistical Analysis*

Differences between groups were analysed with one-way analysis of variance (ANOVA) by using the statistical package SPSS for Windows (1999), version 10.0. Mean values that

significantly differ were separated by Duncan's multiple comparison test at α = 0.01 and 0.05 levels, respectively.

## Results and Discussion

It was reported that TBARS analysis in food is an important quality criterion showing the oxidation of fat. TBARS value should also be less than 3 mg per kilogram of food quality (Cadun et al. 2005). When the TBARS values of the thigh were examined on the first day, it was observed that the highest TBARS value was obtained in the group which had 10 mg/kg antibiotic added to the ration, and the lowest TBARS values were observed in the group which had control, 2, 4, 6, 8 and 10 g/kg turmeric powder added to the ration, and this difference was found to be significant (P<0.001) statistically (Table 2). It was also observed that the highest value was obtained in the antibiotic group on the 3rd day of the storage, and the lowest value was obtained in the groups whose ration had 6 and 8 g/kg turmeric powder added in the ration, and the difference between groups was significant (P<0.001). On the 5th day of the storage, which was the last day, when we examined the TBARS values of the thigh, we determined that the highest value was in the control group, and the lowest level was in the groups whose rations were added 2, 4, 6, 8 and 10 g/kg turmeric powder, and this difference was very significant (P<0.001). Many studies have been conducted in recent years to reveal the antioxidant characteristics of the turmeric (Pulla Reddy and Lokesh, 1994; Sreejayan et al. 1997; Asai et al., 1999; Suvanated et al., 2003; Basavaraj et al., 2011; Hosseini-Vashan et al. 2012). Attia et al. (2017) reported that turmeric is a good unsaturated fatty acid source that is 60 % of the antioxidant activity.

**Table 2.** The influence of dietary turmeric supplementation on TBARS values (mg MDA/kg tissue) in thigh and breast of the broilers

| Groups | TBARS | | | | | |
|---|---|---|---|---|---|---|
| | Thigh | | | Breast | | |
| | 1st Day | 3rd Day | 5th Day | 1st Day | 3rd Day | 5th Day |
| **Control** | 0.91$^{bc}$ | 2.01$^{bc}$ | 4.71$^{a}$ | 0.71 | 2.27 | 3.12 |
| **Turmeric 2 g/kg** | 1.19$^{b}$ | 2.61$^{ab}$ | 3.12$^{bc}$ | 0.82 | 1.65 | 2.84 |
| **Turmeric 4 g/kg** | 0.85$^{bc}$ | 1.42$^{cd}$ | 2.95$^{c}$ | 0.91 | 1.67 | 3.09 |
| **Turmeric 6 g/kg** | 0.77$^{c}$ | 1.25$^{d}$ | 2.38$^{c}$ | 0.91 | 1.76 | 2.92 |
| **Turmeric 8 g/kg** | 0.65$^{c}$ | 1.05$^{d}$ | 2.18$^{c}$ | 0.85 | 1.67 | 2.72 |
| **Turmeric 10 g/kg** | 0.71$^{c}$ | 1.53$^{cd}$ | 3.03$^{bc}$ | 0.34 | 1.50 | 3.09 |
| **Antibiotics 10 mg/kg** | 1.81$^{a}$ | 3.12$^{a}$ | 4.17$^{ab}$ | 0.68 | 1.81 | 2.92 |
| **SE** | 0.082 | 0.154 | 0.206 | 0.055 | 0.113 | 0.068 |
| **P value** | 0.000** | 0.000** | 0.001** | ns | ns | ns |
| **Day** | 0.000** | | | 0.000** | | |
| **Group x Day** | 0.003** | | | ns | | |

a, b, c, d: The differences between the group average values shown with different letters on the same column
SE: The standard error of the difference between the averages **:P<0.01, ns: not significant.

In this study, it was determined that adding turmeric powder, which had antioxidant effects, to the ration decreased the amount of the oxidation in thigh at a significant level. It is considered that this decrease in the lipid oxidation rate is caused by curcumin, which is the main component of turmeric, and which was reported to be a phenolic antioxidant (Sreejayan et al. 1997).

It was reported by Fellenberg and Speisky (2006) that the shelf life of meat products extended due to the continuing effects of some antioxidant at postmortem period. We indicated in the current study that meat shelf life increased and lipid oxidation rates reduced as a result of the postmortem effects of turmeric dietary supplementation. This effect may be due to the accumulation of the main components of turmeric in tissues. Several researchers reported decreased TBARS value when turmeric was added to the diet (Botsoglou et al. 2002; Daneshyar, 2012; Hosseini-Vashan et al. 2012). Hosseini-Vashan et al. (2012) claimed that adding 0.4 and 0.8% turmeric to broiler feed decreased the TBARS values in the serum at a significant level.

The effect of the applications on the TBARS values of the breast on the 1st, 3rd and 5th days was found to be insignificant (P>0.05). This situation may stem from the total fat amount in breast being lower (Table 3). The TBARS values of the breast and thigh tissue showed an increase in all the study groups with the increase in storage period and was found to be very significant statistically (P<0.01).

### *Fatty Acid Composition*

When Table 3 is examined, it is observed that the addition of turmeric powder to broiler rations at different levels did not affect the lipid contents of the breast meat; however, changed the fatty acid composition at a significant level. Compared with the control group, almost all the SFAs in breast were significantly altered in the groups which were given dietary turmeric, except for the arachidic acid (20:0). Broilers fed with 4 g/kg turmeric had significantly higher palmitic acid (16:0), heptadecanoic acid (17:0) and total SFA in breast compared with the other groups. The stearic acid (18:0) rate in the breast meat was increased to a certain dosage by the addition of turmeric powder to the rations, and the highest value was observed in the group which received 6 g/kg turmeric powder in the ration; and as the dosage increased the stearic acid rate decreased (Table 3).

Adding 6 g/kg Turmeric to the ration decreased the total MUFA rate at a significant level (P<0.05). The highest

myristoleic acid (14:1), heptadecenoic acid (17:1) and eicosenoic acid (20:1n-9) rate, which are among the mono-unsaturated fatty acids, were observed in the control, 4g/kg and 8g/kg turmeric-consuming group, respectively. No influence of adding turmeric on the palmitoleic acid (16:1n-7) and linoleic acid (18:2n-6) rate was observed (Table 3).

It was determined that adding turmeric did not affect the total PUFA rate at a significant manner; however, the lowest numerical values were determined in the 4 g/kg turmeric group. The highest linoleic acid (18:2n-6) rate was observed in the group whose basal feed contained 10 g/kg turmeric powder, and the lowest linoleic acid rate was observed in the group which received 4 g/kg *Curcuma longa* to the basal feed. In terms of linoleic acid (18:3n-3), the highest rate was determined in 10 g/kg turmeric group, again; and the lowest rate was determined in the group which received 4 and 6 g/kg turmeric. It is consistent with some studies that reported there was increase in breast meat linoleic acid level (Coetzee et al. 2002). Unlike linoleic acid, eicosadienoic acid (20:2n-9) and arachidonic acid (20:4n-6) rate was determined as being the highest in the group which received turmeric powder to basal feed at a rate of 4 and 6 g/kg, and as being the lowest in the group which received 10 g/kg turmeric powder.

Supplementation of 10 g/kg turmeric powder in the diet of broilers increased the ratios of linoleic and decreased the ratio of arachidonic acid in breast tissue. This mechanism may be explained as Δ-6 desaturase, as a rate-limiting enzyme in the conversion of linoleic acid to arachidonic acid, is inhibited by the main components of turmeric.

It was determined that the eicostrienoic acid (20:3n-6) rate was the highest in the group which received 6 g/kg turmeric powder to the basal feed. It was observed that adding 4 g/kg turmeric powder to the basal feed increased the DHA (22:6n-3), total omega 3 (Σ ω-3) and omega-3/omega-6 rate at a significant level (P<0.05) (Table 3).

**Table 3.** Effect of dietary supplementation of turmeric powder (*Curcuma longa*) on fatty acid composition in breast meats of broiler

| Groups / Fatty acids | Control | Turmeric 2 g/kg | Turmeric 4 g/kg | Turmeric 6 g/kg | Turmeric 8 g/kg | Turmeric 10 g/kg | Antibiotics 10 mg/kg | SE | P |
|---|---|---|---|---|---|---|---|---|---|
| Lipid contents | 1.70 | 1.73 | 1.68 | 1.79 | 1.64 | 1.60 | 1.80 | 0.02 | ns |
| Myristic acid (14:0) | 2.00$^{a}$ | 0.38$^{c}$ | 0.80$^{b}$ | 0.31$^{c}$ | 0.42$^{c}$ | 0.74$^{b}$ | 0.41$^{c}$ | 0.154 | 0.000** |
| Myristoleic acid (14:1n-5) | 1.50$^{a}$ | 0.39$^{b}$ | 0.29$^{b}$ | 0.05$^{b}$ | 0.11$^{b}$ | 0.17$^{b}$ | 0.29$^{b}$ | 0.132 | 0.000** |
| Palmitic acid (16:0) | 18.18$^{bc}$ | 18.24$^{bc}$ | 20.85$^{a}$ | 19.95$^{ab}$ | 15.94$^{cd}$ | 15.14$^{d}$ | 16.55$^{cd}$ | 0.574 | 0.006** |
| Palmitoleic acid (16:1n-7) | 2.87 | 2.39 | 1.72 | 1.91 | 3.19 | 2.88 | 4.02 | 0.238 | ns |
| Heptadecenoic acid (17:0) | 0.21$^{b}$ | 0.45$^{b}$ | 1.08$^{a}$ | 0.34$^{b}$ | 0.18$^{b}$ | 0.28$^{b}$ | 0.21$^{b}$ | 0.086 | 0.003** |
| Heptadecenoic acid (17:1n-7) | 0.25$^{b}$ | 0.56$^{b}$ | 2.11$^{a}$ | 0.45$^{b}$ | 0.28$^{b}$ | 0.32b | 0.31$^{b}$ | 0.187 | 0.012* |
| Stearic acid (18:0) | 6.21$^{bc}$ | 6.25$^{bc}$ | 6.81$^{ab}$ | 8.10$^{a}$ | 5.44$^{bc}$ | 4.50$^{c}$ | 4.78$^{c}$ | 0.351 | 0.020* |
| Oleic acid (18:1n-9) | 27.38 | 24.55 | 23.81 | 21.98 | 24.69 | 28.89 | 29.23 | 0.819 | ns |
| Linoleic acid (18:2n-6) | 30.44$^{ab}$ | 31.37$^{ab}$ | 21.08$^{c}$ | 27.62$^{bc}$ | 26.53$^{bc}$ | 36.27$^{a}$ | 32.89$^{ab}$ | 1.402 | 0.027* |
| Linolenic acid (18:3n-3) | 2.76$^{ab}$ | 2.17$^{bc}$ | 1.51$^{c}$ | 1.43$^{c}$ | 1.83$^{bc}$ | 3.48$^{a}$ | 2.73$^{ab}$ | 0.213 | 0.022* |
| Arachidic acid (20:0) | 0.23 | 0.18 | 0.16 | 0.16 | 0.19 | 0.11 | 0.16 | 0.016 | ns |
| Eicosenoic acid (20:1n-9) | 0.31$^{c}$ | 0.41$^{bc}$ | 0.58$^{ab}$ | 0.44$^{bc}$ | 0.78$^{a}$ | 0.22$^{c}$ | 0.43$^{bc}$ | 0.051 | 0.015* |
| Eicosadienoic acid (20:2n-9) | 0.80$^{bc}$ | 0.70$^{bc}$ | 1.73$^{a}$ | 1.47$^{a}$ | 0.86$^{b}$ | 0.28$^{c}$ | 0.64$^{bc}$ | 0.136 | 0.003** |
| Eicosatrienoic acid (20:3n-6) | 0.43$^{c}$ | 0.78$^{b}$ | 0.35$^{c}$ | 1.15$^{a}$ | 0.79$^{b}$ | 0.46$^{bc}$ | 0.54$^{bc}$ | 0.094 | 0.001** |
| Arachidonic acid (20:4n-6) | 3.65$^{bc}$ | 5.24$^{ab}$ | 6.37$^{a}$ | 6.26$^{a}$ | 5.60$^{ab}$ | 2.58$^{c}$ | 3.76$^{bc}$ | 0.416 | 0.027* |
| EPA (20:5n-3) | 0.56 | 0.87 | 0.49 | 0.48 | 0.62 | 0.32 | 0.29 | 0.060 | ns |
| DHA (22:6n-3) | 0.78$^{b}$ | 1.12$^{b}$ | 2.87$^{a}$ | 1.49$^{b}$ | 0.91$^{b}$ | 0.59$^{b}$ | 0.68$^{b}$ | 0.216 | 0.004** |
| SFA | 26.84$^{b}$ | 25.49$^{b}$ | 29.70$^{a}$ | 28.87$^{b}$ | 22.17$^{c}$ | 20.76$^{c}$ | 22.12$^{c}$ | 1.439 | 0.000** |
| MUFA | 32.31$^{a}$ | 28.30$^{ab}$ | 28.51$^{ab}$ | 24.81$^{b}$ | 29.06$^{ab}$ | 32.47$^{a}$ | 34.28$^{a}$ | 0.762 | 0.038* |
| PUFA | 40.13 | 42.25 | 35.41 | 39.89 | 37.13 | 43.99 | 41.54 | 0.961 | ns |
| n-3 (omega3) | 4.10$^{abc}$ | 4.15$^{abc}$ | 4.88$^{a}$ | 3.40$^{c}$ | 3.35$^{c}$ | 4.39$^{ab}$ | 3.70$^{bc}$ | 0.161 | 0.044* |
| n-6 (omega6) | 36.20 | 38.10 | 30.53 | 36.50 | 33.78 | 39.59 | 37.83 | 0.953 | ns |
| n-3/n-6 | 0.11$^{b}$ | 0.11$^{b}$ | 0.16$^{a}$ | 0.09$^{b}$ | 0.10$^{b}$ | 0.11$^{b}$ | 0.10$^{b}$ | 0.007 | 0.028* |

a, b: The differences between the group average values shown with different letters on the same column are important.
SE: Standard error of the difference between the averages *: P<0.05, **:P<0.01, ns: not significant

It was observed that the thigh tissue total lipid content and the saturated fatty acids are affected at a significant level by the addition of turmeric powder (Table 4). It was determined that adding 2 and 4 mg/kg turmeric to the ration increased the SFA and stearic acid (18:0) rate at a significant level. The lowest SFA values were determined at the higher levels of turmeric 8 and 10 g/kg.

Daneshyar et al. (2011) conducted a study and reported that adding turmeric to the broiler rations at high levels (0.75%) decreased the total SFA amount and plasma triglyceride rate at a significant level, which is similar to our results. They claimed that the triglycerides that were produced with the hepatic lipogenes in the liver (Lanza-Jacoby, 1986; Herzberg and Rogerson, 1988) decreased with the effect of the turmeric, and depending on this, the SFA rate may have decreased in the tigh tissue. Salah et al. (2019) reported that supplementation of 100 mg curcumin /kg broiler diet significantly decreased SFA contents in the breast meat. However, Hang et al. (2018) reported that no significant changes in the SFA contents of breast and thigh meats of chickens were fed curcuminoids-supplemented diets.

The myristic acid (14:0) and arachidic acid (20:0) rates were not affected by the treatments; but the palmitic acid (16:0) rate was observed to reach the lowest level at 2 g/kg turmeric level, and to the highest level at 10 g/kg level (P<0.05).

Daneshyar et al. (2011) reported that the palmitic acid rate decreased with the addition of turmeric at a significant level. Palmitic acid is the fatty acid that is responsible for the increase of LDL cholesterol that causes cardiovascular diseases (Rowe et al. 1999; Muchenje et al. 2009a; b). For this reason, the palmitic acid being lower in the tissues that are consumed is a positive development for health (Daneshyar et al. 2011). Asai and Miyazawa, (2001) reported that curcumin supplementation inhibited hepatic fatty acid synthase (FAS) activity and increased beta oxidation of fatty acids.

**Table 4.** Effect of dietary supplementation of turmeric powder (*Curcuma longa*) on fatty acid composition in thigh meats of broilers

| Groups / Fatty acids | Control | Turmeric 2 g/kg | Turmeric 4 g/kg | Turmeric 6 g/kg | Turmeric 8 g/kg | Turmeric 10 g/kg | Antibiotics 10 mg/kg | SE | P value |
|---|---|---|---|---|---|---|---|---|---|
| Lipid contents | 3.24$^{bc}$ | 3.33$^{bc}$ | 3.43$^{bc}$ | 3.22$^{c}$ | 3.26$^{c}$ | 3.00$^{d}$ | 3.65$^{a}$ | 0.04 | 0.05* |
| Myristic acid (14:0) | 0.48 | 0.46 | 1.00 | 0.37 | 1.31 | 0.35 | 0.42 | 0.118 | ns |
| Myristoleic acid (14:1n-5) | 0.13$^{bc}$ | 0.05$^{c}$ | 0.18$^{ab}$ | 0.15$^{b}$ | 0.25$^{a}$ | 0.13$^{bc}$ | 0.12$^{bc}$ | 0.017 | 0.013* |
| Palmitic acid (16:0) | 18.08$^{ab}$ | 19.21$^{a}$ | 18.39$^{ab}$ | 18.27$^{ab}$ | 17.00$^{bc}$ | 16.24$^{c}$ | 17.69$^{bc}$ | 0.276 | 0.022* |
| Palmitoleic acid (16:1n-7) | 3.07 | 2.24 | 2.43 | 2.64 | 3.06 | 2.34 | 2.74 | 0.098 | ns |
| Heptadecenoic acid (17:0) | 0.19$^{bc}$ | 0.12$^{d}$ | 0.37$^{a}$ | 0.17$^{cd}$ | 0.24$^{b}$ | 0.18$^{bc}$ | 0.18$^{c}$ | 0.021 | 0.000** |
| Heptadecenoic acid (17:1n-7) | 0.25$^{b}$ | 1.01$^{a}$ | 0.46$^{b}$ | 0.44$^{b}$ | 0.24$^{b}$ | 0.34$^{b}$ | 0.28$^{b}$ | 0.077 | 0.021* |
| Stearic acid (18:0) | 5.79$^{b}$ | 7.62$^{a}$ | 7.57$^{a}$ | 5.69$^{b}$ | 5.26$^{b}$ | 6.86$^{ab}$ | 5.34$^{b}$ | 0.292 | 0.025* |
| Oleic acid (18:1n-9) | 32.35 | 23.70 | 24.33 | 31.25 | 29.32 | 21.35 | 31.64 | 1.449 | ns |
| Linoleic acid (18:2n-6) | 31.48$^{ab}$ | 28.39$^{b}$ | 28.04$^{b}$ | 32.62$^{a}$ | 32.92$^{a}$ | 32.58$^{a}$ | 33.26$^{a}$ | 0.641 | 0.047* |
| Linolenic acid (18:3n-3) | 2.83$^{a}$ | 1.90$^{bc}$ | 1.69$^{c}$ | 3.11$^{a}$ | 2.88$^{a}$ | 2.48$^{ab}$ | 2.83$^{a}$ | 0.148 | 0.006** |
| Arachidic acid (20:0) | 0.19 | 0.21 | 0.18 | 0.25 | 0.15 | 0.12 | 0.12 | 0.024 | ns |
| Eicosenoic acid (20:1n-9) | 0.28 | 0.35 | 0.36 | 0.55 | 0.33 | 0.38 | 0.32 | 0.036 | ns |
| Eicosadienoic acid (20:2n-9) | 0.48$^{c}$ | 1.08$^{a}$ | 0.97$^{a}$ | 0.81$^{ab}$ | 0.43$^{c}$ | 0.54$^{bc}$ | 0.52$^{bc}$ | 0.071 | 0.005** |
| Eicosatrienoic acid (20:3n-6) | 0.47 | 0.78 | 0.87 | 0.86 | 0.45 | 0.47 | 0.34 | 0.068 | ns |
| Arachidonic acid (20:4n-6) | 2.03 | 4.73 | 5.88 | 2.09 | 2.44 | 4.58 | 3.51 | 0.471 | ns |
| EPA (20:5n-3) | 0.23 | 0.70 | 0.39 | 0.37 | 0.24 | 0.14 | 0.26 | 0.056 | ns |
| DHA (22:6n-3) | 0.22$^{d}$ | 1.58$^{a}$ | 1.29$^{ab}$ | 1.43$^{ab}$ | 1.01$^{bc}$ | 0.75$^{c}$ | 0.30$^{d}$ | 0.143 | 0.001** |
| SFA | 24.72$^{b}$ | 27.62$^{a}$ | 27.51$^{a}$ | 24.74$^{b}$ | 23.95$^{b}$ | 23.74$^{b}$ | 23.74$^{b}$ | 0.673 | 0.015* |
| MUFA | 36.09 | 27.35 | 27.77 | 35.04 | 33.09 | 24.53 | 35.09 | 1.370 | ns |
| PUFA | 37.73 | 39.15 | 39.12 | 41.30 | 40.37 | 41.53 | 41.015 | 0.455 | ns |
| n-3 (omega3) | 3.28$^{b}$ | 4.17$^{ab}$ | 3.36$^{b}$ | 4.91$^{a}$ | 4.12$^{ab}$ | 3.37$^{b}$ | 3.38$^{b}$ | 0.178 | 0.033* |
| n-6 (omega6) | 34.45 | 34.98 | 35.76 | 36.39 | 36.24 | 38.16 | 37.63 | 0.421 | ns |
| n-3/n-6 | 0.10$^{bc}$ | 0.12$^{ab}$ | 0.09$^{bc}$ | 0.14$^{a}$ | 0.11$^{abc}$ | 0.09$^{c}$ | 0.09$^{c}$ | 0.005 | 0.025* |

a, b: The differences between the group average values shown with different letters on the same column are important.
SE: Standard error of the difference between the averages *: P<0.05, **:P<0.01, ns: not significant

It was determined that adding turmeric powder did not affect the MUFA, palmitoleic acid (16:1n-7), oleic acid (18:1n-9) and eichosenoic acid (20:1n-9) at a significant level. However, it was determined that the turmeric 2 g/kg level decreased the myristoleic acid (14:1n-5) rate at a significant level, and increased the heptadecenoic acid (17:1n-7) rate.

It was observed that adding turmeric powder to the ration had no influence on the ΣPUFA, eichosatrienoic acid (20:3n-6), arachidonic acid (C20:4n-6), EPA (20:5n-3), and n-6 (omega-6) fatty acids in the thigh tissues. The effect of turmeric powder on linoleic and eichosadienoic acids were significant statistically. Linoleic acid (C18:2n-6) rate in 2 and 4 g/kg turmeric was determined as the lowest, and the eichosadienoic acid (C20:2n-9) rate was observed as the highest. Linoleic acid (18:3n-3) rate was determined in the 4 g/kg turmeric group with the lowest level, 1.69%; and the 2 g/kg turmeric group followed this. It was observed that the DHA (22:6n-3) rate increased at a significant level with the addition of turmeric (P<0.01) when compared with the control group, and the highest value was determined at the 2 g/kg level. It was observed that the total omega-3 and omega-3/omega-6 rates were affected by the addition of turmeric at a significant level (P<0.05) and these rates reached peak values at 6 g/kg level. Similarly, these findings, Hang et al. (2018) reported that supplementation of curcumin (20 mg/kg curcuminoids) to broiler diets significantly increased the linoleic acid and total n-6 PUFA contents in the breast meats. The enzyme Δ-6 desaturase promotes the desaturation of linoleic acid into arachidonic acid and α-linolenic into docosohexaenoic acid (DHA) and eicosapentaenoic acids (EPA) (Pereira et al. 2011). The main component of turmeric powder may promote the transformation of α-linolenic into its derivate DHA. We can associate the reason of the n3/n6 increase in total omega 3 fatty acids to this. Carrillo-Dominguez et al. (2005) conducted a study and determined that the increase in the long-chain n-3, and the DHA in the tissues might be because of the desaturation and the elongation of α-linoleic acid in the livers of hens. It was reported that DHA had a significant impact on brain and retinal neonatal development (Simopoulos, 2000). Humans can synthesize long-chain omega-3 fatty acids, such as eicosapentaenoic acid (EPA; 20:5n-3) and docosahexaenoic acid (DHA; 22:6n-3), from alpha linolenic acid, but this synthesis capability is limited. For this reason,

the meats of the animals that are fed with the turmeric-added feed have the quality of being an alternative dietary source for these fatty acids.

In conclusion, the results of our experiment show that the dietary supplementation of turmeric (2, 4, 6, 8, 10 g/kg) decreased the TBARS values in thigh tissues on the 5$^{th}$ day of the storage. This result shows that turmeric powder might have an effect that increases the shelf life in broiler carcass. It was determined that 4 g/kg turmeric in breast, and 2 g/kg turmeric in thigh tissues increased the DHA (22:6n3) rate at a significant level. 6 and 8 g/kg turmeric decreased the SFA rate both in thigh and in breast at a significant level. As a conclusion, it was determined that the 2, 4, 6 and 8 g/kg levels of turmeric powder, whose possible uses as an alternative to antibiotics is investigated, influenced the fatty acid composition and the TBARS of the meat except for the 10 g/kg level. Based on the results of this study, it can be recommended to supplement broiler feed with 4 g/kg turmeric.

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