Impact of supplementation three types of vegetable in broiler diet on chicken meat: fatty acids

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The objective of the study was to evaluate the impact of a dietary supplement composed of parsley, celery, and cress on the fatty acid profile of broiler chicken meat. At 14 days of age, 100 chicks were randomly divided into four equal groups and housed in floor pens. The dietary treatments were as follows: C (Control) – standard diet with no additives; T1 – standard diet supplemented with 10 g/kg of parsley; T2 – standard diet supplemented with 10 g/kg of celery; and T3 – standard diet supplemented with 10 g/kg of cress. Five broilers from each group were slaughtered, and their carcasses were dissected. Fatty acid profiles were analyzed in the breast and liver tissues. Overall, the dietary treatments effectively modified the fatty acid profiles, with the T3 group showing an increase in polyunsaturated fatty acids (PUFA) and a decrease in saturated fatty acids (SFA). This shift may offer potential health benefits by improving the ratio of unsaturated to saturated fats in broiler meat.

Keywords: *poultry diet; breast; liver; PUFA; fatty acids*

Introduction

In the last ten years, poultry producers have focused on improving both bird welfare and food safety. Due to consumer pressure, the use of artificial feed additives has been reduced, and extreme practices associated with intensive farming have been scaled back to better protect the environment. Many researchers are now exploring herbs that influence both the fatty acid composition and antioxidant levels in poultry (Kamboh and Zhu 2013; Skomorucha et al., 2017; Skomorucha and Sosnówka-Czajka 2019; Jachimowicz et al., 2022). The fatty acid composition of chicken meat is influenced by both the birds' diet and genetic factors. Unlike other types of meat, chicken meat tends to have a higher content of polyunsaturated fatty acids (PUFA), mainly because broilers are typically fed a PUFA-rich diet (Samet at al., 2008; Zanetti et al., 2010; Gou et al., 2020). Recently, modifying the fatty acid profile of meat through nutritional methods has become a popular area of research. These approaches are considered the most effective way to alter the fatty acid composition in meat. Studies exploring the role of herbs in improving the fatty acid profile of chicken meat and reducing the harmful effects of lipid oxidation are gaining growing interest (Giannenas et al., 2018; Saleh et al., 2018). The antioxidant properties of plant compounds like flavonoids, carotenoids, and essential oils may influence the fatty acid profile and oxidative stability of meat, helping maintain its quality during storage. Currently, enriching poultry feed with plant extracts is gaining interest due to their multiple benefits, including improved production and better poultry health management (Dhama et al., 2015; Dhama et al., 2018). Herbal additives, whether single herbs, blends, fresh, dry, or extracts, can be given to birds. These herbs contain antioxidants that help prevent

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oxidation of unsaturated fatty acids (UFA) and cholesterol in animal products like meat and eggs, while also boosting the animal's antioxidant capacity (Skomorucha et al., 2020; Orczewska-Dudek et al., 2020; Kowalcze 2021).

Apium graveolens (celery) is a biennial plant in the Apiaceae family, grown for its edible stems, leaves, and seeds. Beyond its culinary use, celery offers medicinal benefits due to its rich content of nutrients like vitamins A, K, and C, along with potassium and folate. It also contains antioxidants, flavonoids, phenolic acids, and phthalides, known for their anti-inflammatory and pharmacological effects. These properties make celery a valuable focus for both nutritional and medical research, highlighting its potential in promoting health and therapeutic applications (Daoud et al., 2025). *Petroselinum crispum*, or parsley, is a Mediterranean herb from the Apiaceae family, widely used in cooking for its flavor and medicinal properties. Rich in zinc, β-carotene, vitamins B and C, and essential minerals, parsley is known for its antioxidant and anti-inflammatory effects. Key active compounds include flavonoids, myristicin, and apiol, with essential oil components accounting for a significant portion of its composition. Parsley supports immune function, aids in oxidative stress relief, and enhances glutathione metabolism, thanks to its high vitamin C content and mineral profile, including iron, calcium, and phosphorus. These properties make parsley valuable in both nutrition and health applications (Alagawany et al., 2024). The leaves, roots, and seeds of garden cress are traditionally used for various health benefits, including healing bone fractures, treating asthma, and regulating blood pressure. Garden cress seeds also support weight gain, thanks to their high content of polyunsaturated fatty acids, antioxidants, and other beneficial compounds (Taghipour et al., 2021). The purpose of this study was to investigate the effect of including celery, parsley, and cress in the diet of broilers on the fatty acid composition of chicken meat.

Materials and Methods

A total of 100 fourteen-day-old Ross 308 broiler chicks were randomly assigned to four groups (25 chicks per group) and housed in floor pens with five replicates per group (5 chicks per replicate). The basal diet was provided by Erbil Feed Company, located in Qush Tapa, Erbil, Iraq, with feed composition tailored to meet the study's requirements. Fresh vegetable feed additives, including parsley, celery, and cress, were sourced from local markets in Shaqlawa. The four feeding treatments were as follows:

C: Basal diet without any additives (control)
T1: Basal diet enriched with 10 g/kg of fresh parsley (*Petroselinum crispum*)
T2: Basal diet enriched with 10 g/kg of fresh celery (*Apium graveolens*)
T3: Basal diet enriched with 10 g/kg of fresh cress (*Lepidium sativum*)

Table 1 provides the composition of the feed, including the basal diet and the vegetable additives used in the experimental treatments.

Table 1: Composition of feed for each treatment.

Feed Ingredients (%)	C	T2	T3	T4
Yellow corn	47.2	46.7	46.7	46.7
Soybean meal	28.5	28.0	28.0	28.0
Concentrated Protein	6	6	6	6
Wheat	15	15	15	15
Sun flower seed oil	3	3	3	3
Salt	0.3	0.3	0.3	0.3
Parsley	0	1	0	0
Celery	0	0	1	0
Cress	0	0	0	1
Total	100	100	100	100

Bird housing conditions

The broiler chicks were housed according to the recommended guidelines for the Ross breed. Water and feed were provided ad libitum, and continuous lighting (24 hours a day) was maintained. Temperature control and the vaccination schedule followed the recommendations for broiler rearing. Throughout the trial, chicks were kept on deep litter under consistent conditions. Microclimate measurements, including temperature and humidity, were taken three times daily—at 7:00 am, 12:00 pm, and 5:00 pm—at the level where the majority of the chicks‘ bodies were located, ensuring accuracy in the zone where the animals spent most of their time.

Slaughter outputs

At the end of the 42-day trial, one bird from each replicate of the treatment groups, selected based on similar body weight, was slaughtered. The breast muscles and liver were homogenized for subsequent fatty acids analysis.

Determination of fatty acids profile

The fatty acids in the breast and liver were analyzed. Fatty acid profiles were determined using a Gas Chromatography (GC-2010) model (Shimadzu, Japan) at the laboratory of the Ministry of Science and Technology in Baghdad, Iraq, following the method outlined by Zhang et al. (2015).

Statistical analysis

Data were analyzed using ANOVA, and mean differences were tested with Duncan's multiple range test. A significance level of P≤0.01 was used for comparisons. Percentage values were transformed. All statistical analyses were performed using SPSS version 28 for Windows.

Results and discussion

Tables 2 and 3 present the fatty acid composition of broiler breast muscle and liver under different dietary treatments (C: control, T1, T2, and T3) and highlights significant differences (P≤0.01) in various fatty acids. Lauric acid (C12:0) shows the lowest percentage in T3 (0.04%) and the highest in C (0.09%), indicating that dietary treatments significantly influence this fatty acid. Myristic acid (C14:0) follows a similar trend, with the control group (C) showing the highest value (0.74%), while T1 shows the lowest (0.46%). Palmitic acid (C16:0) is also highest in C (33.88%) and decreases in T3 (27.20%), reflecting a reduction in saturated fatty acid content with dietary modifications. Palmitoleic acid (C16:7) and oleic acid (C18:9), both monounsaturated fatty acids (MUFA), increase notably in T1 (17.40% and 28.5%, respectively), suggesting an enhancement in MUFA content with this diet. Conversely, polyunsaturated fatty acids (PUFA), such as linoleic acid (C18:6) and linolenic acid (C18:6,9), are higher in T3 and T2 than in C, with the highest linolenic acid percentage observed in T3 (0.80%), indicating that these treatments promote PUFA enrichment. Saturated fatty acids (SFA), including arachidic acid (C20:0) and behenic acid (C22:0), show lower values in T3, demonstrating a potential reduction in SFAs with these diets, aligning with the goal of enhancing the nutritional profile. Arachidonic acid (C20:5,8,11,14) remains relatively consistent across treatments, suggesting minimal dietary impact on this fatty acid. Overall, dietary treatments appear effective in modifying fatty acid profiles, with T3 showing an increase in PUFA and a reduction in SFA, potentially benefiting human health by improving the balance of unsaturated to saturated fats in broiler meat (Milićević et al. 2014).

The liver plays a key role in fatty acid synthesis, oxidation, and storage (Untea et al., 2022). The liver shows unique patterns than trend in breast. For instance, in the liver, there is a more pronounced reduction in certain SFAs (e.g., palmitic acid) and a relatively moderate increase in PUFAs. The Δ5 and Δ6 desaturase enzymes, which are mainly active in the liver, are crucial for converting precursor fatty acids into long-chain PUFAs. Their activity is influenced by diet, hormones, and other factors (Jing et al., 2013). Some studies suggest that higher PUFA intake reduces fat accumulation by enhancing lipolysis and PUFA oxidation while reducing lipogenesis. In birds, fat is primarily synthesized in the liver, not stored there, and the liver's fatty acid profile is less influenced by diet compared to other tissues (González-Ortiz et al., 2013; Skřivan et al., 2018).

Table 2: Impact of supplementation three types of vegetable on fatty acid compositions of broilers breast muscle.

Fatty acids	Groups			
	C	T1	T2	T3
	Fatty acid profile (percentage of total fatty acids)			
Lauric / C12: 0	0.09±0.01^{a}	0.06±0.02^{bc}	0.08±0.01^{b}	0.04±0.01^{c}
Myristic/C14:0	0.74±0.05^{a}	0.46±0.06^{c}	0.68±0.13^{b}	0.52±0.11^{bc}
Palmatic/C16:0	33.88±3.65^{a}	30.37±1.23^{ab}	31.13±2.06^{ab}	27.20±2.81^{b}
Palmitolic/C16:7	14.6±0.23^{c}	17.40±1539^{a}	15.50±0.18^{b}	15.52±0.18^{b}
Steric/C18:9	10.71±0.96	9.96±1.60	10.40±0.78	10.18±0.66
Oleic/C18:9	25.50±0.18^{c}	28.5±0.18^{a}	26.00±0.48^{bc}	26.32±0.28^{b}
Linolic/C18:6	18.20±0.77^{a}	15.35±0.21^{b}	17.93±1.29^{a}	18.58±0.39^{a}
Linolenic/C18:6,9	0.05±0.02^{b}	0.12±0.06^{b}	0.78±0.10^{a}	0.80±0.05^{a}
Arachidic/C20:0	0.02±0.01^{b}	0.07±0.02^{a}	0.08±0.01^{a}	0.06±0.01^{a}
Arachidonic/C20:5,8,11,14	0.38±0.07	0.38±0.13	0.34±0.05	0.32±0.07
Behenic/C22:0	0.13±0.03	0.20±0.24	0.07±0.01	0.03±0.01

$^{a, b, c}$: Means within the same row bearing different superscripts differ significantly ($P \le 0.01$), with values increasing from c to a. Data are expressed as mean ± S.D. (standard deviation).

Table 3: Impact of supplementation three types of vegetable on fatty acid compositions of chicken liver.

Fatty acids	Groups			
	C	T1	T2	T3
	Fatty acid profile (percentage of total fatty acids)			
Lauric / C12: 0	0.09±0.04	0.13±0.13	0.04±0.03	0.06±0.05
Myristic/C14:0	0.51±0.12	0.45±0.16	0.43±0.12	0.61±0.16
Palmatic/C16:0	30.25±1.26	30.03±0.68	26.85±4.31	26.00±3.08
Palmitolic/C16:7	13.33±1.42^{a}	10.98±1.28^{a}	10.18±2.07^{b}	7.69±0.58^{b}
Steric/C18:9	14.44±0.92^{a}	13.17±0.53^{ab}	11.29±1.37^{b}	11.14±1.36^{b}
Oleic/C18:9	19.27±2.28	19.39±0.84	18.31±0.53	19.50±1.38
Linolic/C18:6	13.55±0.37^{a}	11.75±1.11^{ab}	9.93±1.02^{bc}	9.20±0.76^{c}
Linolenic/ C18:6,9	0.06±0.06^{b}	0.43±0.25^{a}	0.56±0.08^{a}	0.65±0.02^{a}
Arachidic/C20:0	0.06±0.04	0.08±0.01	0.056±0.03	0.06±0.03
Arachidonic/C20:5,8,11,14	0.20±0.02	0.17±0.03	0.23±0.04	0.24±0.04
Behenic/C22:0	0.07±0.01	0.12±0.02	0.07±0.03	0.06±0.04

$^{a, b, c:}$ Different superscripts within the same row indicate significant differences ($P \le 0.01$), with values increasing from c to a. Data are presented as mean ± S.D. (standard deviation).

Conclusions

These findings belong to a broader study that was divided into three sections for publication. The research examined how incorporating fresh parsley, cress, or celery into the diet influences the fatty acid composition of chicken meat. Using dietary additives to enhance meat quality is a widely adopted approach. Vegetable supplementation in the diet improved the balance of unsaturated to saturated fats in broiler breast meat, potentially offering significant benefits for human health.

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