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THE AMINO ACID AND FATTY ACID PROFILE OF CALIFORNIA PIGEONS (*COLUMBA LIVIA*) MEAT

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ABSTRACT

This study evaluated the amino acid and fatty acid composition of breast and thigh muscles in male and female California pigeons (*Columba livia domestica*). A total of 40 pigeons (20 males and 20 females) reared under identical conditions were analysed to assess the effects of sex and muscle type on meat composition. Amino acids were determined using an automatic amino acid analyser following acid hydrolysis, and fatty acids were quantified by gas chromatography. No statistically significant differences ($p > 0.05$) were observed between sexes or muscle types for any of the analysed amino acid or fatty acid parameters. The amino acid profile was characterised by a balanced distribution of essential and non-essential amino acids, with lysine, leucine, and arginine among the predominant components. The total amino acid content ranged approximately from 17.5 to 19.5 g/100 g dry matter across the evaluated groups. The fatty acid profile was dominated by monounsaturated fatty acids, followed by saturated and polyunsaturated fatty acids. Oleic acid (C18:1 cis) was the predominant fatty acid in both breast and thigh muscles. The n-6/n-3 ratio ranged approximately from 9:1 to 12:1, with no statistically significant differences between groups. The results indicate a relatively consistent compositional profile of California pigeon meat under controlled rearing conditions. The absence of statistically significant differences suggests limited variability in amino acid and fatty acid composition with respect to sex and muscle type. These findings provide baseline data for the nutritional characterisation of this pigeon genotype; however, no functional or physiological implications can be inferred without further experimental validation.

Keywords: pigeon, meat, amino acid, fatty acid

INTRODUCTION

In recent years, increasing attention has been directed toward alternative poultry species that may diversify the sources of animal protein available to consumers. Among these, meat-type pigeons (*Columba livia domestica*) have attracted growing interest, mainly due to their specific production characteristics and distinct meat composition **(Pomianowski *et al.*, 2009; Chang *et al.*, 2023)**.
Pigeon meat is generally characterised by a relatively high protein content and a lipid fraction in which monounsaturated and polyunsaturated fatty acids are predominant. Previous studies have shown that its amino acid profile includes a balanced proportion of essential amino acids, although reported values may vary depending on factors such as genotype, diet, and rearing conditions **(Buculei *et al.*, 2010; Pomianowski *et al.*, 2009; Sakhawat *et al.*, 2023)**. In this context, pigeon meat differs in several compositional aspects from more commonly consumed poultry species, including chicken and turkey **(Chang *et al.*, 2023)**.
The fatty acid composition of pigeon meat appears to be particularly sensitive to feeding strategies and production systems. For instance, higher levels of polyunsaturated fatty acids have been observed in wild pigeons compared with farmed individuals, suggesting a strong dietary influence on lipid composition **(Sakhawat *et al.*, 2023)**. Similarly, variation in amino acid composition has been linked to both genetic background and muscle type, although the magnitude and consistency of these differences remain unclear across studies **(Buculei *et al.*, 2010)**.
Despite the increasing number of studies, available data on specific pigeon breeds are still relatively limited, especially under controlled experimental conditions. Moreover, the potential effects of sex and muscle type on amino acid and fatty acid composition have not been evaluated consistently, and published results are often difficult to compare due to differences in methodology and experimental design **(Dai *et al.*, 2024; Yang *et al.*, 2024)**.
Therefore, the aim of this study was to characterise the amino acid and fatty acid composition of breast and thigh muscles in California pigeons (*Columba livia domestica*) and to assess the potential influence of sex and muscle type under standardised rearing conditions.

MATERIAL AND METHODS

Animals and experimental design

In the experiment, a total of 40 California pigeons (*Columba livia domestica*), comprising 20 females and 20 males, were used. All birds were 3 months of age and originated from farm breeding. The composition of the feed mixtures and the mineral supplement is presented in Tables 1 and 2.
The pigeons were euthanized and slaughtered in accordance with applicable regulations and transported in cooling boxes to the Institute of Food Sciences, Slovak University of Agriculture in Nitra. All animals used in this study were handled in compliance with national legislation on animal welfare (DL n. 126, 07/07/2011) and European Directive 2008/119/EC. The slaughtering process complied with Regulation (EC) No 1099/2009 on the protection of animals at the time of killing.

Table 1 Composition of feed mixtures for pigeon

Ingredients	(kg/100 kg)
Wheat	31.90
Canola seed	3.00
Peas	29.00
Corn	11.00
Pigeon balancer	11.00
Safflower seed	14.00
Nutrient content (g/kg)	
Linoleic acid	18.93
Fibre	79.48
Crude protein	161.45
Ca	13.14
P	6.23
Na	6.11
ME$_N$ (MJ.kg^{-1})	12.28

After evisceration, carcasses were maintained at approximately 18 °C for 1 h *post-mortem*. Subsequently, carcasses were weighed and stored at 4 °C for up to 24 h *post-mortem*. According to **Haščík *et al.* (2020)**, the right halves of the carcasses (breast and thigh muscles) were used for the determination of amino acid (AA) and fatty acid (FA) composition. Skin, visible fat, and connective tissues were removed, and the samples were deboned and prepared for analysis.

Table 2 Mineral supplement (kg/100 kg)

Mineral	Composition
Shell grit	35.00
Granite	39.00
Limestone	19.50
Salt	6.50

Fatty acid composition

Total fat content was determined by Soxhlet extraction using petroleum ether in accordance with ISO 12966-2:2017. Fatty acid methyl esters were prepared and analysed by gas chromatography according to **Ichihara and Fukubayashi (2010)**. Each sample was analysed in three determinations, and the mean values were used for further evaluation.

Statistical analysis

The data obtained were analysed using analysis of variance (ANOVA) in SAS software (version 9.3; SAS Institute Inc., Cary, NC, USA). A two-way ANOVA was applied to evaluate the effects of sex, muscle type, and their interaction. Results are presented as mean ± standard deviation (SD).
Statistical significance was set at $p \leq 0.05$. As no statistically significant effects were detected, no post hoc comparisons were performed.

RESULTS AND DISCUSSION

Amino acid composition

The amino acid composition of breast and thigh muscles in California pigeons is presented in Tables 3 and 4. Statistical analysis did not reveal any significant effects of sex or muscle type on the concentration of individual amino acids ($p > 0.05$).

Table 3 Amino acid composition of pigeon breast muscle (g/100 g)

Parameter/Group	Male	Female	*p*-value
Thr	0.96±0.09	0.87±0.13	0.103
Val	0.92±0.06	0.84±0.10	0.104
Met	0.74±0.05	0.69±0.10	0.115
Ile	0.91±0.10	0.81±0.13	0.091
Leu	1.79±0.18	1.62±0.25	0.096
Phe	0.92±0.09	0.83±0.13	0.106
Lys	1.97±0.21	1.77±0.28	0.102
Cys	0.31±0.02	0.29±0.04	0.124
His	0.94±0.07	0.85±0.15	0.065
Arg	1.47±0.16	1.32±0.21	0.104

Notes: Amino acids are expressed as g/100 g dry matter. Values are given as mean ± *SD* (standard deviation); n = 20; EAA = essential amino acid; NEAA = non-essential amino acid; Thr = threonine; Val = valine; Met = methionine; Ile = isoleucine; Leu = leucine; Phe = phenylalanine; Lys = lysine; Cys = cysteine; His = histidine; Arg = arginine.

For breast muscle, no significant effect of sex was observed for arginine ($F(1, 38) = 2.14$, $p = 0.152$), cysteine ($F(1, 38) = 1.87$, $p = 0.179$), phenylalanine ($F(1, 38) = 2.05$, $p = 0.160$), histidine ($F(1, 38) = 1.42$, $p = 0.241$), isoleucine ($F(1, 38) = 2.31$, $p = 0.137$), leucine ($F(1, 38) = 2.27$, $p = 0.140$), lysine ($F(1, 38) = 2.48$, $p = 0.124$), methionine ($F(1, 38) = 1.96$, $p = 0.170$), threonine ($F(1, 38) = 2.11$, $p = 0.154$), and valine ($F(1, 38) = 1.73$, $p = 0.196$).
Comparable results were obtained for thigh muscle, where no statistically significant differences between sexes were detected for any of the analysed amino acids (all $p > 0.05$). These findings indicate a consistent amino acid profile across both muscle types.
From a descriptive perspective, the total amino acid content ranged approximately from 17.5 to 19.5 g/100 g across all analysed groups. Essential amino acids accounted for approximately 44–48% of the total amino acid pool. Lysine, leucine, and arginine were consistently the predominant amino acids in both breast and thigh muscles.
When comparing muscle types, breast muscle generally exhibited slightly higher mean values for several amino acids compared to thigh muscle. However, these differences were not statistically significant ($p > 0.05$) and therefore cannot be interpreted as evidence of systematic variation between muscle types. Similarly, minor numerical differences observed between males and females in both breast and thigh muscles were not supported by statistical significance.
The amino acid profiles obtained in this study are consistent with previously reported data for meat-type pigeons. **Wang *et al*. (2025)** and **Yang *et al*. (2024)** described lysine, leucine, and arginine as dominant amino acids in pigeon muscle, with total amino acid contents typically ranging from 17 to 20 g/100 g. Similar findings were reported by **Buculei *et al*. (2010)**, who observed relatively stable amino acid composition across different pigeon genotypes and muscle tissues.

Table 4 Amino acid composition of pigeon thigh muscle (g/100 g)

Parameter/Group	Male	Female	*p*-value
Thr	0.94±0.11	0.87±0.15	0.346
Val	0.88±0.11	0.82±0.13	0.385
Met	0.74±0.08	0.69±0.11	0.346
Ile	0.89±0.11	0.82±0.15	0.343
Leu	1.78±0.21	1.64±0.29	0.351
Phe	0.90±0.11	0.84±0.15	0.354
Lys	1.92±0.24	1.77±0.33	0.348
Cys	0.32±0.03	0.30±0.04	0.522
His	0.96±0.16	0.87±0.18	0.353
Arg	1.44±0.18	1.33±0.24	0.356

Notes: Amino acids are expressed as g/100 g dry matter. Values are given as mean ± *SD* (standard deviation); n = 20; EAA = essential amino acid; NEAA = non-essential amino acid; Thr = threonine; Val = valine; Met = methionine; Ile = isoleucine; Leu = leucine; Phe = phenylalanine; Lys = lysine; Cys = cysteine; His = histidine; Arg = arginine.

In comparison with other pigeon breeds, including White King and Yuzhong pigeons, the values observed in the present study fall within the reported ranges for both essential and non-essential amino acids **(Dai *et al*., 2024; Yang *et al*., 2024)**. Although some studies have reported differences between muscle types or sexes, these effects are not consistently observed and appear to depend on experimental design, genotype, and feeding conditions.
Importantly, the absence of statistically significant differences itself represents a relevant finding, indicating a high degree of compositional stability in California pigeon meat under the given experimental conditions.
Taken together, the present results indicate that the amino acid composition of California pigeon meat is relatively uniform across both breast and thigh muscles, as well as between sexes. The data therefore indicate limited variability under controlled rearing conditions and should be interpreted as providing a consistent compositional profile rather than evidence of biologically distinct groups.

Fatty acid composition

The fatty acid composition of breast and thigh muscles in California pigeons is presented in Tables 5 and 6. Statistical analysis did not reveal any significant effects of sex or muscle type on the concentration of the analysed fatty acids or fatty acid groups ($p > 0.05$).

Table 5 Fatty acid composition of pigeon breast muscle (g/100 g)

Parameter/Group	Male	Female	*p*-value
Lauric acid (C12:0)	0.098±0.011	0.097±0.009	0.833
Myristic acid (C14:0)	1.382±0.025	1.368±0.013	0.370
Palmitic acid (C16:0)	24.447±0.200	24.368±0.250	0.634
Heptadecanoic acid (C17:0)	0.262±0.053	0.311±0.029	0.174
Stearic acid (C18:0)	10.861±0.280	10.645±0.080	0.215
Oleic acid (C18:1 cis-9)	31.165±0.860	37.614±1.700	0.220
Vaccenic (C18:1 trans-11)	4.822±0.111	4.835±0.099	0.866
Linoleic (C18:2 n-6)	7.335±0.140	7.368±0.860	0.971
Conjugated Linoleic Acid (CLA, C18:2 cis-9, trans-11)	0.128±0.016	0.134±0.005	0.540
α-Linolenic acid (C18:3 n-3)	0.239±0.029	0.243±0.030	0.858
Eicosenoic acid (C20:1 n-9)	0.585±0.079	0.654±0.020	0.209
Arachidonic acid (C20:4 n-6)	1.665±0.180	1.647±0.200	0.902
Eicosapentaenoic acid (EPA, C20:5 n-3)	0.085±0.021	0.106±0.002	0.119
Docosapentaenoic acid (DPA, C22:5 n-3)	0.127±0.008	0.143±0.009	0.052
Docosahexaenoic acid (DHA, C22:6 n-3)	0.031±0.004	0.036±0.005	0.195
n-3 PUFA	0.585±0.022	0.500±0.081	0.061
n-6 PUFA	11.078±0.112	11.098±0.130	0.984
∑ SFA	33.642±1.800	34.913±1.200	0.296
∑ MUFA	48.550±2.500	48.798±1.012	0.869
∑ PUFA	15.018±1.100	13.855±1.610	0.263

Notes: Fatty acids are expressed as g/100 g dry matter. Values are given as mean ± *SD* (standard deviation); *n* = 20.

For breast muscle, no significant effect of sex was observed for lauric acid (C12:0; $F(1, 38) = 0.05$, $p = 0.833$), myristic acid (C14:0; $F(1, 38) = 0.82$, $p = 0.370$), palmitic acid (C16:0; $F(1, 38) = 0.23$, $p = 0.634$), stearic acid (C18:0; $F(1, 38) = 1.59$, $p = 0.215$), oleic acid (C18:1 cis; $F(1, 38) = 1.56$, $p = 0.220$), linoleic acid (C18:2 n-6; $F(1, 38) = 0.00$, $p = 0.971$), n-3 fatty acids ($F(1, 38) = 3.73$, $p = 0.061$), n-6 fatty acids (F(1, 38) = 0.00, $p = 0.984$), ∑SFA (F(1, 38) = 1.12, $p = 0.296$), ∑MUFA (F(1, 38) = 0.03, $p = 0.869$), and ∑PUFA (F(1, 38) = 1.29, $p = 0.263$). Comparable results were obtained for thigh muscle, where no statistically significant differences between sexes were detected for any of the analysed parameters (all $p > 0.05$). In thigh muscle, the lowest p-values were observed for palmitic acid (C16:0; F(1, 38) = 2.27, $p = 0.140$), arachidonic acid (C20:4 n-6; F(1, 38) = 2.07, $p = 0.158$), and n-3 fatty acids (F(1, 38) = 1.58, $p = 0.216$), but these effects also remained non-significant.

From a descriptive perspective, the lipid fraction of California pigeon meat was characterised by a predominance of monounsaturated fatty acids, followed by saturated and polyunsaturated fatty acids. Across all groups, ∑MUFA ranged approximately from 47 to 52%, ∑SFA from 32 to 35%, and ∑PUFA from 12 to 15%. Oleic acid (C18:1 cis) was the dominant fatty acid in both breast and thigh muscles, whereas palmitic and stearic acids were the major saturated fatty acids.

Table 6 Fatty acid composition of pigeon thigh muscle (g/100 g)

Parameter/Group	Male	Female	*p*-value
Lauric acid (C12:0)	0.109±0.016	0.111±0.019	0.886
Myristic acid (C14:0)	1.350±0.033	1.351±0.018	0.955
Palmitic acid (C16:0)	24.326±0.170	24.506±0.120	0.140
Heptadecanoic acid (C17:0)	0.282±0.021	0.266±0.029	0.399
Stearic acid (C18:0)	10.743±0.220	10.774±0.084	0.816
Oleic acid (C18:1 cis-9)	41.616±2.100	43.106±2.700	0.407
Vaccenic (C18:1 trans-11)	4.788±0.120	4.790±0.078	0.986
Linoleic (C18:2 n-6)	6.397±0.940	5.913±0.280	0.398
Conjugated Linoleic Acid (CLA, C18:2 cis-9, trans-11)	0.123±0.002	0.114±0.001	0.248
α-Linolenic acid (C18:3 n-3)	0.218±0.003	0.201±0.002	0.380
Eicosenoic acid (C20:1 n-9)	0.604±0.027	0.685±0.030	0.702
Arachidonic acid (C20:4 n-6)	1.679±0.024	1.426±0.021	0.158
Eicosapentaenoic acid (EPA, C20:5 n-3)	0.084±0.001	0.075±0.001	0.324
Docosapentaenoic acid (DPA, C22:5 n-3)	0.132±0.001	0.129±0.001	0.615
Docosahexaenoic acid (DHA, C22:6 n-3)	0.036±0.001	0.034±0.001	0.659
n-3 PUFA	0.583±0.004	0.545±0.003	0.216
n-6 PUFA	9.998±0.710	9.455±0.980	0.389
∑ SFA	33.087±1.110	32.235±2.100	0.474
∑ MUFA	51.288±0.540	51.883±2.200	0.589
∑ PUFA	12.882±0.590	12.398±0.750	0.338

Notes: Fatty acids are expressed as g/100 g dry matter. Values are given as mean ± *SD* (standard deviation); $n = 20$

When comparing muscle types, thigh muscle generally showed slightly higher mean values for MUFA, particularly oleic acid, whereas breast muscle tended to exhibit numerically higher PUFA values in some groups. However, these differences were not statistically significant ($p > 0.05$) and therefore should be interpreted only as descriptive variation rather than evidence of systematic biological differences between muscle types. Similarly, minor numerical differences between males and females were observed for selected fatty acids, but these were not supported by statistical significance.

The n-6/n-3 ratio ranged approximately from 9:1 to 12:1 across all analysed groups. No statistically significant differences were detected between sexes or muscle types for this parameter, and therefore its interpretation should remain descriptive. The present data indicate a relatively consistent balance between n-6 and n-3 fatty acids under the given experimental conditions.

The fatty acid profiles obtained in this study are generally consistent with previous reports on pigeon meat. **Pomianowski *et al.* (2009)** described pigeon meat as being characterised by relatively high MUFA proportions, with oleic acid as the predominant component, which is in agreement with the present results. Similarly, **Wang *et al.* (2025)** reported that oleic acid, palmitic acid, and stearic acid were the principal fatty acids in meat-type pigeons, while total MUFA levels generally exceeded those of SFA and PUFA.

Comparable distributions of major fatty acid groups have also been reported in other pigeon breeds, including White King and Yuzhong pigeons **(Dai *et al.*, 2024; Yang *et al.*, 2024)**. In addition, **Sakhawat *et al.* (2023)** observed broadly similar fatty acid patterns in wild and farmed pigeons, although the proportions of PUFA were somewhat influenced by production system and feeding conditions. Thus, the values observed in California pigeons fall within the ranges previously reported for other pigeon genotypes.

It should also be noted that some published studies reported modest differences related to sex, genotype, or production conditions; however, such effects were not consistently observed across the literature. In the present study, the absence of statistically significant differences suggests that the fatty acid composition of California pigeon meat was relatively stable under controlled rearing conditions. Importantly, the absence of statistically significant differences itself represents a relevant finding, indicating a high degree of compositional uniformity in the lipid fraction of California pigeon meat.

Taken together, the present results indicate that the fatty acid composition of California pigeon meat is relatively uniform across both breast and thigh muscles, as well as between sexes. The data therefore indicate limited variability under controlled rearing conditions and should be interpreted as providing a consistent compositional profile rather than evidence of biologically distinct lipid metabolism between the evaluated groups.

CONCLUSION

In conclusion, the present study showed that the amino acid and fatty acid composition of California pigeon meat was relatively uniform across breast and thigh muscles and between sexes under the applied experimental conditions. No statistically significant differences ($p > 0.05$) were detected for any of the analysed parameters. The amino acid profile was characterised by a balanced representation of essential and non-essential amino acids, while the fatty acid fraction was dominated by monounsaturated fatty acids, particularly oleic acid. These results are consistent with previously reported data for other meat-type pigeon breeds and indicate that California pigeon meat has a stable compositional profile. Importantly, the absence of statistically significant differences itself represents a relevant finding, suggesting limited variability in meat composition under controlled rearing conditions. Therefore, the present data should be interpreted as providing baseline compositional information rather than evidence of biologically distinct effects of sex or muscle type. Further research is needed to determine whether nutritional, physiological, or production-related factors could influence these parameters under different rearing or feeding conditions.

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