

## THE AMINO ACID AND FATTY ACID PROFILE OF WILD DUCK (*ANAS PLATYRHYNCHOS*) MEAT

Adriana Pavelková<sup>1</sup>, Peter Haščík\*<sup>1</sup>, Jana Tkáčová<sup>1</sup>, Martin Fik<sup>2</sup>

**Address(es):** Titul(s) Firstname Surname of the corresponding author

<sup>1</sup> Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Sciences, Institute of Food Sciences, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia.

<sup>2</sup> Slovak University of Agriculture in Nitra, Faculty of Agrobiological and Food Resources, Institute of Animal Husbandry, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia.

\*Corresponding author: [peter.hascik@uniag.sk](mailto:peter.hascik@uniag.sk)

<https://doi.org/10.55251/jmbfs.11695>

### ARTICLE INFO

Received 22. 8. 2024  
Revised 9. 3. 2026  
Accepted 9. 3. 2026  
Published 1. 4. 2026

Regular article



### ABSTRACT

The aim of this study was to analyse the amino acid and fatty acid profiles of selected tissues of wild duck (*Anas platyrhynchos* L.) in relation to sex. The research material consisted of breast and thigh muscles obtained from 20 farm-reared wild ducks (10 males and 10 females). The results showed significantly higher ( $p \leq 0.05$ ) concentrations of amino acids in the breast muscle of males compared with females, whereas no significant differences ( $p \geq 0.05$ ) were observed in the thigh muscle between sexes. In terms of fatty acid composition, oleic acid, palmitic acid and stearic acid were identified as the predominant fatty acids in both muscles and sexes. The breast muscle of males also contained significantly higher ( $p \leq 0.05$ ) levels of omega-3 and omega-6 fatty acids. Sex had no significant effect on most of the analysed fatty acids. Based on the obtained amino acid and fatty acid profiles and their comparison with other poultry species, wild duck meat may be considered a nutritionally valuable source of high-quality protein and beneficial fatty acids for the human diet.

**Keywords:** wild duck, meat quality, amino acid, fatty acid

### INTRODUCTION

The mallard (*Anas platyrhynchos*) is a wild swimming duck that is also classified as a domestic duck (Rabe, 2006). Over the past 20 years, global duck meat production has surpassed that of goose and turkey meat, increasing by 67.2%, from 2.91 to 4.86 million tons (Kokoszynski et al., 2020; FAOSTAT, 2021). According to Huang et al. (2013), ducks are an important source of high-quality protein (approximately 22%) for many populations, and information on the nutritional composition of duck meat is essential for consumers and the food industry to consider it as an alternative protein source (Aronal, Huda & Ahmad, 2012). Duck meat is a highly nutritious food due to its high nutrient content, including an optimal balance of essential amino acids, a favourable fatty acid composition with a high concentration of polyunsaturated fatty acids and a balanced ratio of omega-3 and omega-6 (Pingel, 2009). Duck meat also has a high concentration of unsaturated fatty acids, which constitute approximately 60% of its total fatty acids (Baeza et al., 2002).

In terms of nutritional content, the composition of wild duck meat is often considered superior to that of domestic ducks. Wild duck meat typically contains less fat compared to domestic ducks and may exhibit a more favourable fatty acid profile with varying levels of saturated fatty acids (SFA) and polyunsaturated fatty acids (PUFA), depending on environmental conditions and feeding habits (Costa et al., 2016). Compared to other game birds, mallard ducks have a higher fat content (approximately 6%) but also possess a beneficial fatty acid composition and represent an excellent source of polyunsaturated fatty acids (Dzierżyńska-Cybulko & Fruziński, 1997; Ali et al., 2007; Wołoszyn et al., 2009).

Despite the increasing interest in game meat and alternative poultry products, detailed information on the biochemical composition of meat from wild duck populations remains limited. Most previous studies have focused primarily on carcass traits, growth performance, or general meat quality parameters of commercial duck breeds, while comprehensive data describing the amino acid and fatty acid composition of wild duck meat are still scarce. A detailed characterization of amino acid and fatty acid profiles is essential for evaluating the nutritional value of meat and for assessing its potential contribution to human nutrition. Such information may also contribute to a better understanding of the nutritional properties of game bird meat and support the diversification of animal protein sources in the human diet.

Therefore, the aim of this study was to evaluate the amino acid and fatty acid profiles of the breast and thigh muscles of farm-reared wild ducks (*Anas platyrhynchos*) with respect to sex, and to determine whether sex influences the nutritional composition of these muscles.

### MATERIAL AND METHODS

#### Object of research

Twenty mallard ducks (*Anas platyrhynchos*) (10 females and 10 males) were used as biological material in the experiment. Mallard ducks were reared semi-intensively on a farm and the composition of their feed mixture, which was used until the 4<sup>th</sup> week of rearing, is shown in Table 1.

**Table 1** Composition of feed mixtures for wild duck (kg/100 kg)

Ingredients	Feed supplied from 1 <sup>st</sup> to 21 <sup>st</sup> day	Feed supplied from 22 <sup>nd</sup> to 133 <sup>rd</sup> day
Wheat meal	55.40	57.60
Soybean meal (48% CP)	17.40	10.00
Maize	17.00	17.40
Rapeseed oil	1.00	1.60
Calcium carbonate	0.80	6.00
Dicalcium phosphate	2.00	2.00
Premix Euromix <sup>1</sup>	1.00	1.40
Fish meal (71% CP)	5.40	4.00
<b>Nutrient content (g/kg)</b>		
ME <sub>N</sub> (MJ.kg <sup>-1</sup> )	11.89	12.34
Crude fibre	30.30	36.43
Crude protein	205.20	179.40
Lysine	10.85	9.33
Methionine + Cystine	8.45	7.52
Tryptophan	2.31	2.02
Threonine	7.05	6.45
Ca	9.98	8.78
P	5.21	4.07

Notes: CP = crude protein; Ca = calcium; P = phosphorus; ME<sub>N</sub> = nitrogen-corrected metabolizable energy; MJ = megajoule; <sup>1</sup>active substances per kilogram of premix: vitamin A 15 000 IU; vitamin E 20 mg; vitamin D<sub>3</sub> 2 000 IU; riboflavin 6 mg; cobalamin 20 µg; Mn 60 mg; Zn 40 mg; Fe 40 mg; Cu 6 mg; I 1 mg; Se 0.2 mg.

Water and feed were provided ad libitum. The first 4 weeks were reared under standard warm rearing conditions, and the second phase of rearing was carried out semi-intensively, where ducks were fed ad libitum with cereals (50% wheat, 50% barley) with access to green pasture.

Mallard ducks were slaughtered at the end of the 133-day rearing period, when they were mature for slaughter, i.e. suitable for joint hunting. Ducks were weighed and slaughtered using conventional methods including neck cutting, bleeding, feather removal and evisceration at the slaughterhouse of the Slovak University of Agriculture in Nitra.

All animals used in this study were handled in accordance with national legislation on animal welfare (DL n. 126, 07/07/2011, EC Directive 2008/119/EC). The slaughtering process complied with Regulation (EC) No. 1099/2009 concerning the protection of animals at the time of killing.

After evisceration, the carcasses were maintained at approximately 18 °C for 1-hour *post-mortem*. Subsequently, the carcasses were weighed and stored at 4 °C for up to 24 hours post-mortem. After chilling, the skin, visible fat and connective tissues were removed, and the breast and thigh muscles were excised and prepared for further analyses. From each carcass two muscle samples (breast and thigh) were obtained, resulting in a total of 40 muscle samples that represented the biological replicates used for chemical analyses.

**Chemical analysis**

Samples weighing approximately 50 g were taken from each analysed muscle. Prior to analysis, all visible connective tissue and residual fat were carefully removed. The muscle samples were subsequently homogenized using an Ultra-Turrax T 25 digital homogenizer (Germany) at a speed of 10,000 to 12,000 rpm for 2–3 minutes to obtain a uniform sample matrix. In total, 40 muscle samples (20 breast and 20 thigh muscles) were analysed. Each muscle sample was analysed in three analytical replicates to ensure the repeatability and reliability of the analytical measurements. Consequently, the total number of analytical determinations used for statistical evaluation corresponded to n = 60 for each muscle type and sex group.

**Amino acid composition**

According to the methods employed by **Straková et al. (2015)**, the Automatic Amino Acid Analyzer AAA 400 (Ingos a.s., Prague, Czech Republic) was used to determine the content of amino acids after acid hydrolysis in 6 N HCl at 110 °C for 24 hours. This method is based on the colour-forming reaction of amino acids with the oxidative agent ninhydrin. Quantification of individual amino acids was performed using calibration with certified amino acid standards supplied by the manufacturer. Quality control samples were analysed periodically to verify the accuracy and repeatability of the measurements. After recalculation to 100% dry matter, the resultant amino acid values were expressed as grams of amino acid content per 100 grams of muscle.

**Fatty acid composition**

The total fat content was determined using Soxhlet extraction with petroleum ether according to **ISO 12966-2:2017**. Subsequently, the fatty acid profile was analysed using gas chromatography of fatty acid methyl esters according to **Bobková et al. (2022)**. Identification and quantification of individual fatty acids were performed using external calibration with a standard mixture of fatty acid methyl esters (FAME). The efficiency of lipid extraction and analytical repeatability were verified by duplicate extraction of randomly selected samples. The resulting values of fatty acids were recalculated to 100% dry matter and expressed as grams of fatty acid content per 100 g of muscle.

**Statistical analysis**

The obtained data were subjected to analysis of variance (ANOVA) using SAS software (version 9.3, Enterprise Guide 4.2, USA). Sex (male vs female) was considered the main fixed factor in the statistical model. Breast and thigh muscles were analysed separately due to their different physiological functions and metabolic characteristics. Prior to ANOVA, the normality of data distribution was verified using the Shapiro–Wilk test, and the homogeneity of variances was assessed using Levene’s test. The results are presented as mean values with standard deviation (SD). When statistically significant differences were detected, multiple comparisons between groups were evaluated using Scheffe’s post-hoc test. Differences were considered statistically significant at  $p \leq 0.05$ .

**RESULTS AND DISCUSSION**

The basic chemical composition of the breast and thigh muscles of mallard ducks is presented in the paper by **Haščík et al. (2024)**.

Amino acids are fundamental determinants of the nutritional value of meat and play a crucial role in human diet quality (**Pereira & Vicente, 2013**). In the present study, the content of essential (EAA) and non-essential amino acids (NEAA) was evaluated in the breast and thigh muscles of wild ducks (*Anas platyrhynchos*) with respect to sex (Tables 2 and 3).

Table 2 shows that in the breast muscle statistically significant differences ( $p \leq 0.05$ ) were found between males and females in all analysed amino acids, with males consistently exhibiting higher values. The highest levels were recorded for

lysine (1.89 g/100 g in males vs. 1.62 g/100 g in females) and arginine (1.41 vs. 1.21 g/100 g). These findings emphasize that sex has a clear impact on the amino acid profile of breast muscle. Similar patterns were reported by **Kim et al. (2015)** in ducks and by **Haščík et al. (2021)** in Japanese quails, where males showed higher amino acid concentrations in breast tissue. **Straková et al. (2016)** also demonstrated that the amino acid composition of breast muscle in wild birds is more susceptible to sex- and metabolism-related variation than thigh muscle.

The higher amino acid levels observed in males may reflect sex-related physiological differences in muscle development and metabolism. However, the present study did not directly investigate the biological mechanisms responsible for these differences, and therefore such explanations should be interpreted with caution.

In contrast, Table 3 shows that no statistically significant differences ( $p \geq 0.05$ ) were found between sexes in thigh muscle amino acid composition. The concentrations of lysine (1.64 vs. 1.59 g/100 g), arginine (1.23 vs. 1.20 g/100 g), and methionine (0.61 vs. 0.57 g/100 g) were comparable between males and females. This lack of difference suggests that the thigh muscles, which are primarily responsible for locomotion, are subject to similar functional demands in both sexes and thus display a more uniform amino acid profile. Comparable results were observed by **Sabow (2019)** in quails and **Melnik et al. (2023)** in geese, where no sex-related variation was reported in thigh muscles. This confirms that the influence of sex on amino acid composition is muscle-specific, affecting breast but not thigh tissue.

**Table 2** Amino acid composition of wild duck breast muscle (g/100 g)

Parameter/Group	Male	Female	p-value
<b>EAA</b>			
Thr	0.96±0.05 <sup>a</sup>	0.84±0.04 <sup>b</sup>	0.01
Val	0.89±0.04 <sup>a</sup>	0.81±0.03 <sup>b</sup>	0.01
Met	0.72±0.04 <sup>a</sup>	0.62±0.02 <sup>b</sup>	0.00
Ile	0.87±0.04 <sup>a</sup>	0.74±0.04 <sup>b</sup>	0.00
Leu	1.74±0.07 <sup>a</sup>	1.50±0.07 <sup>b</sup>	0.00
Phe	0.89±0.04 <sup>a</sup>	0.77±0.04 <sup>b</sup>	0.00
Lys	1.89±0.08 <sup>a</sup>	1.62±0.08 <sup>b</sup>	0.00
<b>NEAA</b>			
Cys	0.32±0.02 <sup>a</sup>	0.28±0.01 <sup>b</sup>	0.01
His	0.93±0.07 <sup>a</sup>	0.78±0.02 <sup>b</sup>	0.01
Arg	1.41±0.06 <sup>a</sup>	1.21±0.06 <sup>b</sup>	0.00

Notes: Amino acids are expressed on a dry matter basis (g/100 g). Values are given as mean ± SD (standard deviation); n = 60; a-b = means within the same row with different superscripts differ significantly ( $p \leq 0.05$ ); 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.

**Table 3** Amino acid composition of wild duck thigh muscle (g/100 g)

Parameter/Group	Male	Female	p-value
<b>EAA</b>			
Thr	0.87±0.05	0.84±0.03	0.41
Val	0.86±0.03	0.83±0.03	0.31
Met	0.61±0.04	0.57±0.03	0.12
Ile	0.76±0.05	0.75±0.03	0.66
Leu	1.53±0.10	1.48±0.05	0.44
Phe	0.79±0.05	0.76±0.03	0.35
Lys	1.64±0.11	1.59±0.07	0.47
<b>NEAA</b>			
Cys	0.26±0.02	0.24±0.01	0.06
His	0.85±0.06	0.78±0.04	0.10
Arg	1.23±0.08	1.20±0.05	0.54

Notes: Amino acids are expressed on a dry matter basis (g/100 g). Values are given as mean ± SD (standard deviation); n = 60; 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.

Regarding fatty acids, our results demonstrated that in the breast muscle no significant differences were observed between sexes for most individual fatty acids, except for omega-3, omega-6, and total PUFA, which were higher in males ( $p \leq 0.05$ ). Oleic acid (C18:1 cis-9) was identified as the predominant fatty acid, followed by palmitic (C16:0) and stearic acid (C18:0). These findings are consistent with **Kim et al. (2015)** and **Li et al. (2024)**, who also reported oleic acid as the most abundant fatty acid in duck meat. The higher PUFA content in males may reflect differences in lipid metabolism between sexes.

In thigh muscle, significant sex-related differences were observed in oleic acid (higher in males), eicosenoic acid (higher in females), and PUFA (higher in females). While males exhibited higher MUFA and SFA, females had a higher proportion of PUFA. This pattern contrasts with breast muscle and indicates that sex affects lipid metabolism in a muscle-dependent manner. **Woloszyn et al.**

(2011) similarly demonstrated that genotype and sex strongly influence fatty acid composition in duck thigh muscles.

**Table 4** Fatty acid composition of wild duck breast muscle (g/100 g)

Parameter/Group	Male	Female	p-value
Lauric (C12:0)	0.10±0.01	0.10±0.01	0.74
Myristic (C14:0)	1.35±0.03	1.38±0.02	0.27
Palmitic (C16:0)	24.41±0.12	24.38±0.09	0.67
Heptadecanoic (C17:0)	0.30±0.02	0.30±0.04	0.76
Stearic (C18:0)	10.81±0.19	10.70±0.25	0.49
Oleic (C18:1 cis)	39.24±2.52	37.82±4.36	0.58
Vaccenic (C18:1 trans-11)	4.77±0.12	4.84±0.07	0.34
Linoleic (C18:2 cis)	7.11±0.62	6.19±0.93	0.13
Conjugated Linoleic (C18:2 n-6)	0.14±0.01	0.14±0.01	0.24
α-Linolenic (C18:3 n-3)	0.27±0.01	0.25±0.01	0.10
Eicosenoic (C20:1 n-9)	0.69±0.08	0.71±0.04	0.65
Arachidonic (C20:4 n-6)	1.74±0.20	1.90±0.27	0.35
Eicosapentaenoic (C20:5 n-3)	0.10±0.01	0.10±0.01	0.09
Docosapentaenoic (C22:5 n-3)	0.14±0.01	0.14±0.02	0.88
Docosahexaenoic (C22:6 n-3)	0.04±0.01	0.03±0.01	0.21
Omega 3	0.58±0.04 <sup>a</sup>	0.51±0.04 <sup>b</sup>	0.04
Omega 6	10.76±0.56 <sup>a</sup>	9.67±0.24 <sup>b</sup>	0.01
∑ SFA	34.32±1.27	35.22±1.04	0.32
∑ MUFA	49.33±1.20	49.50±0.98	0.84
∑ PUFA	13.69±1.07 <sup>a</sup>	12.17±0.51 <sup>b</sup>	0.04

Notes: Fatty acids are expressed on a dry matter basis (g/100 g). n = 60; Values are given as mean ± SD (standard deviation); a-b = means within the same row with different superscripts differ significantly (p ≤ 0.05).

**Table 5** Fatty acid composition of wild duck thigh muscle (g/100 g)

Parameter/Group	Male	Female	p-value
Lauric (C12:0)	0.11±0.01	0.11±0.01	0.67
Myristic (C14:0)	1.37±0.03	1.40±0.03	0.40
Palmitic (C16:0)	24.48±0.14	24.37±0.28	0.49
Heptadecanoic (C17:0)	0.30±0.02	0.28±0.03	0.25
Stearic (C18:0)	10.64±0.23	10.45±0.30	0.35
Oleic (C18:1 cis)	36.42±2.39 <sup>a</sup>	29.38±4.49 <sup>b</sup>	0.02
Vaccenic (C18:1 trans-11)	4.87±0.12	5.04±0.10	0.06
Linoleic (C18:2 cis)	5.10±0.54	4.56±0.63	0.23
Conjugated Linoleic (C18:2 n-6)	0.14±0.01	0.13±0.01	0.23
α-Linolenic (C18:3 n-3)	0.23±0.01	0.23±0.01	0.69
Eicosenoic (C20:1 n-9)	0.57±0.05 <sup>b</sup>	0.67±0.05 <sup>a</sup>	0.02
Arachidonic (C20:4 n-6)	1.75±0.29	1.92±0.10	0.34
Eicosapentaenoic (C20:5 n-3)	0.10±0.01	0.10±0.01	0.43
Docosapentaenoic (C22:5 n-3)	0.13±0.01	0.14±0.01	0.11
Docosahexaenoic (C22:6 n-3)	0.03±0.01	0.03±0.01	0.51
Omega 3	0.49±0.04	0.45±0.04	0.14
Omega 6	8.80±0.37	8.51±0.72	0.48
∑ SFA	34.25±0.44	33.50±0.83	0.13
∑ MUFA	49.21±0.96	48.61±1.04	0.43
∑ PUFA	10.96±0.49 <sup>b</sup>	11.71±0.29 <sup>a</sup>	0.04

Notes: Fatty acids are expressed on a dry matter basis (g/100 g). Values are given as mean ± SD (standard deviation); n = 60; a-b = means within the same row with different superscripts differ significantly (p ≤ 0.05).

Overall, the present findings demonstrate that sex has a significant effect on amino acid composition in breast muscle, but not in thigh muscle, and affects the fatty acid profile in a muscle-dependent way. The higher concentrations of amino acids and PUFA in male breast muscle highlight its superior nutritional quality, whereas the higher PUFA content in female thigh muscle suggests a complementary dietary value.

From a broader nutritional perspective, the favourable amino acid profile together with the presence of nutritionally important polyunsaturated fatty acids indicates that wild duck meat may represent a valuable source of high-quality dietary protein and beneficial lipids in the human diet. The results of this study therefore contribute to the growing body of knowledge on the nutritional properties of game bird meat and provide additional information that may support its utilization as an alternative source of animal protein.

## CONCLUSION

Based on the results of the experiment, we can conclude that the most abundant amino acids (AAs) in the breast and thigh muscles of wild ducks of both sexes reared on the farm were lysine, leucine, and arginine. Regarding fatty acids (FAs), oleic, palmitic, and stearic acids were the most prevalent. A higher content of all AAs was found in the pectoral muscle of males compared to females. The breast muscle of both sexes of wild ducks was characterized by a relatively higher content of important FAs compared to the thigh muscle. The favourable composition of AAs and FAs in the meat of farm-raised wild ducks suggests that this type of meat could enrich the human diet alongside other types of poultry meat.

**Acknowledgments:** This work was supported with VEGA no. 1/0402/23 and APVV under grant no. 23-0077.

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