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THE NUTRITIONAL VALUE OF MEAT AS SEEN THROUGH THE VARIOUS POULTRY FOOD SPECIES – A COMPARATIVE ANALYSIS WITH A FOCUS ON PROTEINS, FATTY ACIDS AND MINERAL CONTENT

Mihai COSTACHE, Ioan CUSTURĂ, Minodora TUDORACHE, Ilie VAN

University of Agronomic Sciences and Veterinary Medicine of Bucharest,
59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: costachemihai91@yahoo.com

Abstract

Poultry meat represents a very important part of the human diet, being preferred to „read" meat due to the low content in cholesterol and the high digestibility. Further on, it provides a valuable source of proteins, their quality being reflected in a high content of essential amino acids. The paper represents a review of the main sources cited recently considering the nutritional value of poultry meat. The various poultry species has been mentioned, in comparison to the well-known and preferred chicken and turkey: duck, goose and ostrich. Their nutritional value is presented by highlighting mostly the amino acids, fatty acids and mineral content.

Key words*: poultry meat, nutritional value, amino acids, fatty acids.*

INTRODUCTION

Meat represents "the edible parts removed from the carcass of animals used for food […]". It is considered an important part of the human diet, providing energy, vitamins, minerals and fatty acids.

The main so-called "white" meat comes from poultry, among the species currently chosen more and more would be chicken and turkey. However, duck, goose and ostrich meat have different nutritional aspects that could be taken into consideration in order to complete the human diet with a sufficient source of fatty acids and proteins (amino acids).

In this paper, the aim was to highlight the importance of poultry meat through the essential amino acids, fatty acids and mineral content, for the main species, chicken and turkey, and to mention, in comparison, what other species might have to offer as nutritional source: duck, goose and ostrich.

MATERIALS AND METHODS

In order to obtain the main data presented in this paper, a number of articles and books have been consulted online and on paper. Further on, information has been analysed and withdrawn as to make sure the comparison is as objective and accurate as possible.

The main method through which this bibliographic study has been obtained is by starting with the reviews presented recently on the subject and further on analysing several other complementary sources, mainly articles.

RESULTS AND DISCUSSIONS

A. Poultry meat as nutritive source in comparison to meat obtained from other food species

According to Wood (2017), on average, for each 100 g meat, the human body will receive 20 g of high biological-value protein and 8 g of fat. Compared to beef and lamb, chicken and turkey have the lowest content of fat, thus being highly recommended for a healthier diet (Lopez-Bote, 2017) (Table 1).

The fat content, which is a subject of great concern for meat consumption, might vary with the species, feeding system and the analysed cut. Therefore, leaner cuts obtained from pork or beef could be included in the human diet for their richness in vitamins and minerals, as they will not differ significantly from the skinless turkey or chicken cuts (Pereira and Vicente, 2013). Indeed, it seems that the presence of the skin is causing the fat content (g/100 g edible portion) to reach 8.9 in raw chicken breast, while the same skinless cut will only amount to about 1.2 g/100 g. Also, the same authors mention in this paper that the turkey leg portions tend to have a higher fat content than the chicken legs.

Table 1. Content of protein and fat of the most common meat varieties (100 g edible portion) (Wood, 2017)

	Beef	Pork	Lamb	Rabbit	Chicken	Turkey	Duck
Protein (g)	18.7	21.4	17.5	20	20.3	21.8	18.3
Total (g)fat	17.1	5.7	18.7	5.5	2.7	2.9	5.9
SFA (g)	6.9	1.9	8.1	1.7	0.7	0.9	2.3
MUFA (g)	7.4	2.6	7.6	1.5	0.8	0.6	1.5
PUFA (g)	0.6	0.6	1.5	1.1	0.7	0.8	0.7

SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.

The leanest cut in chicken and turkey is known to be the breast meat (when skin is not considered). In comparison, beef presents a lower fat content in the round section than the sirloin and flank, while pork meat is lower in fat content on the ribs and leg meat, compared to loin (Wood, 2017) (Table 2).

The mineral and trace elements' content of meat is evident through its richness in iron, zinc and selenium (table 4).

Probst (2009) compared the nutrient values of chicken, beef, lamb and pork cuts.

The author also included tuna as reference for fish (Table 5). Chicken seems to be closer to tuna as cholesterol content, as well as total fat content, compared to the other species presented.

Table 2. Total fat content and fatty acids content in several cuts of beef pork, chicken and turkey (edible portion of 100 g) (Wood, 2017)

	Beef cuts			Chicken cuts	
	Sirloin	Flank	Round	Breast	Leg
Total (g)fat	5.6	7.2	4.3	1.2	3.8
SFA (g)	1.7	3	1.5	0.3	1
MUFA (g)	2.5	2.9	1.8	0.3	1.2
PUFA (g)	0.2	0.3	0.2	0,3	0,9
6PUFAω (mg)	20	169	145	170	730
3PUFAω (mg)	187	81	10	40	100
	Pork cuts			Turkey cuts	
	Loin	Ribs	Leg	Breast	Leg
Total (g)fat	8.2	5.6	15.7	0,7	2,4
SFA (g)	2.8	2	5.4	0,2	0,8
MUFA (g)	3.7	2.5	7	0,1	0,5
PUFA (g)	0.9	0.6	1.7	0,2	0,7
6PUFAω (mg)	720	565	1400	110	570
3PUFAω (mg)	30	24	120	2050	

Table 3. Vitamin content of different types of meat, according to the species of origin (100 g edible portion) (Wood, 2017 from USDA, 2011)

Specification	Beef	Pork	Lamb	Rabbit	Chicken	Turkey	Duck
Vitamin A (IU)	0	7	0	0	45	0	79
Vitamin C (mg)	0	0.6	0	0	0	0	5.8
Vitamin D (IU)	0	0	0	0	0	0	0
Vitamin E (mg)	0	0.2	0.2	0	0.2	0.4	0.7
Thiamine (mg)	0.1	1	0.1	0.1	0.1	0.1	0.4
Riboflavin (mg)	0.2	0.3	0.2	0.2	0.1	0.2	0.5
Niacin (mg)	3.2	4.9	6	7.3	7.9	4.5	5.3
Vitamin B6 (mg)	0.4	0.5	0.2	0.5	0.4	0.5	0.3
Folate (mcg)	6	5	23	8	7	9	25
Vitamin B12 (mcg)	3	0.6	0.7	7.2	0.4	0.4	0.4

Table 4. The content of minerals for several meat varieties, displayed for a quantity of 100 g (edible portion) (Wood, 2017)

Specification	Beef	Pork	Lamb	Rabbit	Chicken	Turkey	Duck
Calcium (mg)	7	17	12	13	10	14	11
Iron (mg)	1.9	0.8	1.6	1.6	1	1.5	2.4
Magnesium (mg)	19	23	22	19	23	25	19
Phosphorous (mg)	177	211	166	213	198	195	203
Potassium (mg)	306	389	239	330	238	296	271
Sodium (mg)	58	52	59	41	75	70	74
Zinc (mg)	3.7	1.8	3.5	1.6	1.2	2.4	1.9
Selenium (μg)	22.4	36.1	19.7	23.7	16.9	26.5	13.9

Table 5. Comparison of nutrient content for different types of meat, obtained from food species (100 g edible portion) (Probst, 2009)

Specification	Chicken (breast, raw)	Lamb (tenderloin, raw)	Beef (eye fillet, raw)	Pork (fillet, raw)	Tuna (raw)
Total fat (g)	1.6	4	3	2.3	1
Total protein (g)	22.25	19.8	22.3	22	23.4
Cholesterol (mg)	59	70	58	95	45
Sodium (mg)	41	69	57	54	37
Potassium (mg)	300	330	380	405	444
Magnesium (mg)	28	24	27	26	50
Calcium (mg)	12	8	6	4	16
Phosphorous (mg)	231	240	230	237	191
Iron (mg)	0.4	2.1	2.2	1.1	0.7
Zinc (mg)	0.7	2.9	3.8	1.7	0.5
Selenium (μg)	21.4	10	12	15	37
Copper (mg)	0.03	0.13	0.15	0.09	0.06
Manganese (mg)	1.64	0.02	-	-	0.02
Vitamin A (IU)	15.5	9	2	-	-
Vitamin C (mg)	0.8	-	1	-	1
Vitamin B-12 (μg)	0.38	1.3	1.9	0.3	0.5

B. Nutritional composition of chicken meat

Chicken meat composition might be different when taking into account factors such as the rearing system. Bogosavljevic-Boskovic et al. (2010) showed that the percentage of protein and fat in the breast muscle is different between the meat from chicken reared in extensive indoor system and the one from chicken reared in free range conditions. More precisely, this study has found that both breast muscle samples from free range males and females contained a higher percentage of protein (23.72 % for males and 23.44 %, in comparison to 22.96 % and 22.57 % respectively).

Moreover, the fat percentage was lower in the breast muscle of free-range chicken.

This might be an indicator that the free-range system could be a more favourable one for the nutritional quality of chicken meat. Chen et al. (2016) studied the composition of chicken meat (breast and thigh cuts) obtained from three different types of genetic lines (817 crossbred chicken, Arbor Acres (AA) broiler and Hyline Brown (HB)).

In their study, they concluded that the crossbred chicken lines were more valuable from the nutritional point of view, as well as for maintaining a well-balanced diet.

In chicken meat, the predominant amino acids were identified to be lysine and leucine, among essential and non-essential types (Table 6).

Table 6. Composition in essential amino acids for breast meat and thigh meat* (g/100g dry weight) – three different lines of chicken (Chen et al., 2016)

Specification	Breast meat			Thigh meat		
	817	AA	HB	817	AA	HB
Arg	4.692±0.133	4.547±0.124	4.668±0.082	4.377±0.208	4.507±0.122	4.207±0.089
His	2.728±0.062	2.474±0.062	3.390±0.051	1.967±0.072	1.999±0.040	2.048±0.045
Ile	3.463±0.063	3.308±0.072	3.396±0.068	3.017±0.070	3.167±0.087	3.004±0.103
Leu	6.128±0.143	5.905±0.132	6.107±0.109	5.442±0.203	5.709±0.115	5.428±0.129
Lys	6.470±0.140	6.268±0.103	6.405±0.117	5.903±0.147	6.123±0.139	5.825±0.140
Met	1.925±0.063	1.880±0.040	1.931±0.068	1.560±0.031	1.756±0.050	1.534±0.056
Phe	3.048±0.074	2.917±0.063	2.976±0.072	2.613±0.051	2.844±0.091	2.691±0.081
Thr	4.172±0.088	3.559±0.083	3.318±0.076	3.466±0.074	3.562±0.100	3.176±0.044
Val	3.637±0.079	3.462±0.094	3.568±0.053	3.122±0.107	3.256±0.085	3.014±0.102

*determined with Amino Acid Analyzer L-8900 Hitachi (freeze-dried meat samples)

The composition in amino acids might be affected by preservation techniques, such as freezing. In a study conducted for the evaluation of the effect of frozen storage on the amino acid composition of dark and light chicken meat, Wladyka and Dawson (1968) found that during frozen storage, the structural proteins will suffer modifications, most probably as a result of proteolysis, therefore exuding in the drip.

C. Turkey meat's nutritional composition and value for human diet

According to the USDA National Nutrient Database (2018), raw turkey meat (skinless) (100 g edible portion) will contain approximately 22.64 g protein and 1.93 g fat (total content).

The fatty acids composition of turkey meat cuts shows the presence of C18:2ω-5, C18:1ω-9, C16:0, C18:0 and C20:4ω-6 (table 7). Due to its low cholesterol content and high polyunsaturated fatty acids content, the turkey meat represents a good choice for diets aiming to control blood cholesterol levels.

Oblakova et al. (2016) observed a statistically significant content of protein in raw turkey breast muscles (23%) and thigh (20.73%). Also, they have confirmed that in the case of turkey meat, as it shows for other poultry meat species, the breast meat has a relatively higher protein and lower fat content than the thigh meat.

Table 7. Fatty acids composition (mg/100 g) in turkey meat portions (Baggio et al., 2002)

Fatty acid	Turkey wing	Turkey leg	Turkey breast
C10:0	1.5±0.2	-	0.5±0.1
C12:0	2.6±0.5	2.6±0.1	-
C14:0	6.5±0.6	7.1±0.8	2.6±0.3
C15:0	40.7±10.2	44.7±9.4	28.8±5.9
C16:0	176.7±12.1	201.7±47.2	91.4±16.8
C17:0	4.9±0.8	10.4±2.6	7.0±1.1
C18:0	107.4±25.7	133.2±25.1	62.1±9.6
C21:0	-	0.5±0.1	0.9±0.2
C22:0	1.3±0.3	1.5±0.2	1.1±0.1
C14:1 ω-9	-	1.0±0.1	0.5±0.2
C16:1 ω-7	20.0±1.6	26.3±6.8	7.0±0.8
C18:1 ω-9	189.2±18.5	228.1±48.8	89.6±8.9
C18:2 ω-6	223.0±90.4	279.1±46.6	127.4±24.3
C18:3 ω-3	5.8±1.8	8.8±2.9	2.6±0.6
C20:2 ω-6	3.1±1.2	3.1±0.5	1.9±0.5
C20:4 ω-6	55.5±3.1	73.9±8.6	40.2±8.3
C22:5 ω-3	3.8±1.4	4.4±0.9	3.0±0.8
C22:5 ω-6	3.5±0.4	4.8±0.9	3.1±0.7
C22:6 ω-3	3.1±0.8	3.2±0.3	2.5±0.7
% SFA	40	39	41
% MUFA	25	25	21
% PUFA	35	36	38
ω-6/ ω-3	0.04	0.04	0.04

In 1968, Essary and Ritchey analysed the amino acid composition of raw turkey meat (light meat, front part; dark meat, back part).

The differences between the two types of meat are not significant, eleven of the amino acids targeted for analysis showed slightly higher quantities in the dark meat (Table 8).

Table 8. Amino acid composition of raw dark and light turkey meat (g amino acid/100 g protein) (Essary and Ritchey, 1968)

Amino acid	g amino acid / 100 g protein	
	Dark meat	Light meat
Aspartic acid	5.58	5.87
Threonine	1.64	1.80
Serine	1.53	1.56
Glutamic acid	9.33	9.07
Proline	2.87	2.71
Glycine	3.76	3.19
Alanine	3.57	3.46
Valine	3.05	3.06
Cystine	0.96	0.90
Methionine	1.88	1.76
Leucine	4.70	4.27
Tyrosine	2.17	2.09
Phenylalanine	2.75	2.61
Lysine	5.01	4.64
Histidine	2.10	2.16
Arginine	4.80	4.48

D. The potential nutritional role of duck meat

After chicken meat, duck meat is the second most consumed meat in Southeast Asia (Aronal *et al.*, 2012). Duck meat has a higher content oftotal fat, reaching 5.95 g/100 g raw (skinless), while the protein content reaches 18.28 g/100 g for the same type of sample (USDA National Nutrient Database, 2018).

According to Kim and Nam (1977), duck meat presents a general content of protein between 13.61 and 21.19% and 17.32-34.92% fat.

The crude protein percentage determine by the authors was set to 79 %. Except for tryptophan, almost all essential amino acids were analysed. The chosen analysis method was gas chromate-graphy and table 9 includes the results found at the time.

Table 9. Percentage of amino acids from duck meat (results obtained by Kim and Nam in 1977)

Amino acid	Gram (%)
Alanine	6.1
Valine	2.75
Glycine	7.13
Isoleucine	2.2
Leucine	4.54
Proline	4.9
Threonine	5.8
Methionine	1.15
Hydroxyproline	3.2
Phenylalanine	3.01
Aspartic acid	6.7
Glutamic acid	12.71
Lysine	4.95
Arginine	1.11
Histidine	5.6
Cystine + cysteine	4.4

As stated by the study of Aronal et al. (2012), duck meat quality depends on the amino acid and fatty acid profiles.

Among the amino acids, they have detected a high concentration of glutamic acid in both lines selected from analysis: Peking and Muscovy.

The highest concentrations among the essential amino acids were found for lysine and methionine (Table 10).

Table 10. Amino acid composition* (g/100 g protein) of Peking and Muscovy duck meat (Aronal et al., 2012)

Specification	Peking duck meat		Muscovy duck meat	
	Breast	Thigh	Breast	Thigh
Cystine	2.65±0.18	2.07±0.45	0.07±0.05	0.08±0.03
Histidine	3.23±0.35	2.79±0.27	2.96±0.22	2.74±0.29
Isoleucine	7.61±0.28	7.85±0.18	3.44±0.08	3.26±0.16
Leucine	2.79±0.08	2.82±0.04	7.63±0.20	7.24±0.16
Lysine	9.21±0.38	9.12±0.26	9.41±0.00	8.23±0.56
Methionine	7.09±1.76	10.12±1.63	6.15±0.74	12.06±2.65
Phenylalanine	3.22±0.09	3.27±0.01	3.90±0.05	3.72±0.30
Threonine	4.65±0.15	4.70±0.06	4.96±0.14	4.30±0.84
Tyrosine	1.84±0.12	1.85±0.11	3.70±0.09	3.85±0.03
Valine	4.58±0.13	4.57±0.06	3.49±0.12	3.21±0.12
Arginine	7.07±0.21	6.40±0.30	7.28±0.13	8.40±0.55
Alanine	6.21±0.49	6.02±0.08	6.62±0.07	5.85±0.15
Aspartic acid	9.57±0.38	9.55±0.38	10.01±0.30	8.69±0.68
Glutamic acid	15.21±0.18	14.96±0.18	15.62±0.45	13.71±0.00
Glycine	6.26±0.62	5.53±0.33	5.57±0.02	5.68±0.57
Proline	4.23±0.08	3.94±0.05	4.31±0.05	4.29±0.03
Serine	4.56±0.16	4.44±0.30	4.87±0.16	4.67±0.69

Fatty acids composition of meat plays a crucial role in the human diet, as the biological effects of ω-3 long-chain polyunsaturated fatty acids had received a great interest in human nutrition, due to their role in the prevention and management of several pathologies: coronary heart disease, hypertension, type 2 diabetes, renal disease, ulcerative colitis and Crohn's disease.

Duck meat presents a very well-balanced fatty acids' composition, therefore in the future, through the development of specific techniques, the composition in the fatty acids might be improved through the use of dietary oils, such as soybean and fish oils (Schiavone et al., 2010). Qiao et al. (2017) have conducted astudy in order to assess the quality of duck meat destined for processing, in order to obtain meat products.

They have selected Cherry Valley (CV), Spent Layer (SL) and Crossbred (CB) duck lines and have determined the fatty acid composition of breast and thigh muscles, through gas chromatography. In a similar attempt, Aronal et al. (2012) have done a profiling on fatty acid composition on the same cuts, for Peking (PK) and Muscovy (MC) duck meat. Results are included in Tables 11 and 12.

Table 11. Fatty acid composition of breast muscle (% of total fatty acid) for several duck meat lines (after Qiao et al., 2017 and Aronal et al., 2012)

Specification	Breast				
	CV	SL	CB	PK	MC
C14:0	0.26±0.03	0.46±0.04	0.24±0.01	2.74±0.55	2.24±0.08
C16:0	20.81±0.14	22.40±2.09	23.06±0.46	24.11±3.93	22.61±0.06
C16:1	0.33±0.02	0.51±0.06	0.25±0.01	0.75±0.15	2.25±0.18
C18:0	14.21±0.62	8.97±0.87	14.78±0.30	0.00±0.00	10.63±0.25
C18:1 ω-9	26.20±1.16	35.90±1.88	22.27±0.55	26.89±3.19	36.45±1.32
C18:2 ω-6	17.31±0.16	21.86±1.53	13.93±0.55	13.28±0.81	14.69±0.53
C18:3 ω-6	0.04±0.00	0.02±0.00	0.03±0.00	0.03±0.05	0.08±0.13
C20:1	0.38±0.02	0.34±0.02	0.31±0.01	0.03±0.27	0.19±0.17
C20:3 ω-6	1.39±0.13	0.23±0.01	1.19±0.06	0.00±0.00	0.12±0.12
C20:4 ω-6	0.05±0.00	0.02±0.01	0.05±0.00	9.23±1.89	4.74±0.58
C22:6 ω-3	0.27±0.03	0.67±0.06	0.88±0.21	1.60±0.40	0.44±0.38
SFA	46.82±0.95	40.83±3.23	53.18±0.36	26.85±3.38	35.47±0.24
MUFA	33.40±0.87	40.67±1.35	30.05±0.41	30.22±2.65	41.59±1.56
PUFA	20.00±0.28	23.40±1.65	17.03±0.46	42.47±5.97	22.94±1.33
ω-6/ω-3	0.15±0.01	1.52±0.08	0.47±0.04	1.22±0.03	7.48±0.30

Table 12. Fatty acid composition of thigh muscle (% of total fatty acid) for several duck meat lines (after Qiao et al., 2017 and Aronal et al., 2012)

Specification	Thigh				
	CV	SL	CB	PK	MC
C14:0	0.37±0.12	0.45±0.02	0.40±0.02	5.26±1.28	2.64±0.07
C16:0	19.64±0.16	17.78±0.24	22.89±0.24	20.32±0.83	21.38±0.37
C16:1	0.38±0.00	0.39±0.01	0.39±0.01	1.80±0.38	2.37±0.05
C18:0	11.00±0.54	6.55±0.22	9.93±0.19	0.00±0.00	3.91±6.77
C18:1 ω-9	36.00±0.55	41.78±0.79	38.14±0.82	30.36±4.34	40.24±1.07
C18:2 ω-6	18.95±0.12	24.30±0.88	15.32±0.41	17.04±0.31	12.69±0.03
C18:3 ω-6	0.04±0.00	0.03±0.00	0.04±0.00	0.54±0.47	0.00±0.00
C20:1	0.30±0.00	0.49±0.02	0.33±0.01	0.15±0.13	0.21±0.19
C20:3 ω-6	0.70±0.04	0.15±0.00	0.37±0.02	0.17±0.19	0.00±0.00
C20:4 ω-6	0.03±0.00	0.02±0.00	0.02±0.00	6.16±3.65	4.78±0.36
C22:6 ω-3	0.22±0.01	0.37±0.03	0.38±0.03	1.03±0.47	0.95±0.28
SFA	38.80±0.82	30.09±0.36	41.82±1.07	25.58±2.03	27.93±6.69
MUFA	39.93±0.47	44.72±0.72	41.78±0.82	34.67±5.16	42.21±1.21
PUFA	21.40±0.72	25.29±0.86	16.49±0.42	39.75±7.13	26.86±5.68
ω-6/ω-3	0.22±0.04	1.25±0.08	0.75±0.06	1.73±0.17	2.00±1.26

According to these results, duck meat seems to be rich in palmitic acid (16:0), the most abundant SFA, followed by stearic acid (18:0). Among monounsaturated fatty acids, the predominant one is oleic acid (C18:1 ω-9), while for the polyunsaturated category, the highest concentration was that of linoleic acid (C18:2 ω-6). In order to assess further on the quality of duck meat, the ratio of ω-6 and ω-3 was calculated for both breast and thigh samples. The ω-3 and ω-6 fatty acids have a very important role in human nutrition, as they are precursors of eicosanoids, protaglandines, leukotrienes and thromboxanes, which regulate crucial physiological (Qiao et al.., 2017). In the scientific literature, authors have agreed that the value of this ratio should be lower than 5.

E. Nutritional composition of goose meat and its potential for nutrients source in human diet

The USDA National Nutrient Database (2018) mentions that 100 g of goose raw meat (skinless) has a high content of protein (22.75 g) and a total fat content of 7.13 g. Also, goose meat seems to be rich in potassium (420 mg/100 g) and phosphorous (312 mg/100 g).

Isguzar and Pingel (2003) analyzed the protein and fat content of breast and leg muscle of different goose genotypes, their findings suggesting that the protein content varies between 18 and 22% (for three different local genotypes). The percentage of fat reached 1,4 % in one of the genotypes, but all three are considered suitable for meat production, as well as usage in commercial crossbred programs.

In an attempt to quantify the nutritional value of the Egyptian goose (*Alopochen aegyptiacus*), Geldenhuys et al. (2013) have evaluated its nutritional value by comparison with other food species, the meat samples being cooked in the oven until the core temperature reached 75°C. The samples were then analyzed, parallels being drawn between the breast portions of Egyptian goose, guineafowl, Pekin duck and broiler chicken. As a reference, ostrich meat was used, of which two different cuts were selected: fan fillet (*M. iliofibularis*) and moon steak (*M. femorotibialis*).

The data showed that the lowest protein content was identified in broiler chicken breast, while the highest was of the ostrich fan fillet. On the other hand, Egyptian goose and Pekin duck showed a higher percentage of intramuscular fat, compared to broiler chicken, ostrich cuts and guineafowl (Table 13).

Table 13. Results of analyses (g/100 g cooked meat cuts) for nutritional quality of Egyptian goose breast compared to other poultry meat cuts (Geldenguys et al., 2013)

Specification	Egyptian goose breast	Guineafowl breast	Ostrich fan fillet	Ostrich moon steak	Pekin duck breast	Broiler chicken breast
Protein[1]	30.9±2.6	31.9±1.9	32.7±2.2	32.5±1.6	31.4±0.6	29.8±1.4
Fat[1]	5.9±1.9	3.2±0.9	3.8±0.7	3.8±0.8	5.8±0.6	3.7±0.8
SFA[2]	37.91±2.22	43.63±2.8	43.85±1.4	45.9±3.92	40.87±1.63	33.27±4.58
MUFA[2]	22.24±5.93	26.70±3.58	27.54±2.39	25.71±2.19	34.00±2.31	22.71±3.06
PUFA[2]	39.70±3.93	29.47±2.99	28.33±2.59	27.79±3.91	24.89±2.40	43.86±7.06
ω-6/ω-3[2]	9.94±1.79	8.56±2.37	9.60±2.60	7.06±1.03	17.78±8.09	21.83±10.17
P[3]	192.5±15.6	182.4±18.4	179.3±9.8	181.7±6.5	186.5±6.4	208.7±16.0
K[3]	180.1±19.1	162.5±15.0	171.5±9.6	180.1±8.3	169.3±13.8	189.5±20.8
Ca[3]	12.3±1.74	11.9±1.8	11.6±1.8	11.6±2.0	17.3±1.4	10.7±1.5
Mg[3]	32.5±2.3	30.2±5.0	32.6±1.3	30.7±1.0	31.4±2.0	36.7±2.7
Na[3]	22.0±6.0	15.8±2.2	20.6±0.6	24.5±1.9	29.0±1.9	18.9±2.2
Fe[3]	7.5±0.59	1.8±0.6	4.2±0.4	3.6±0.4	4.6±0.8	1.4±0.2
Cu[3]	0.5±0.14	0.2±0.1	0.3±0.03	0.3±0.03	0.4±0.2	0.1±0.02
Zn[3]	2.1±0.40	1.2±0.3	2.3±0.2	5.5±0.4	1.9±0.2	1.2±0.2
Mn[3]	0.1±0.01	0.04±0.01	0.04±0.01	0.03±0.002	0.04±0.01	0.03±0.004
B[3]	0.03±0.004	0.03±0.01	0.03±0.01	0.03±0.003	0.03±0.004	0.03±0.003
Al[3]	2.8±2.2	3.1±1.9	4.3±0.9	4.4±1.0	2.7±1.8	3.2±1.6

[1] g/100 g edible portion (sample); [2] % out of total fatty acids composition; [3] mg/100 g dry basis.

The fatty acid composition showed that broiler chicken breast and Egyptian goose breast were Similar in their concentration of monounsaturated fatty acids and polyunsaturated ones, the latter being the highest among all types of samples subject to analysis.
Considering the mineral composition of the Egyptian goose meat, its iron content is significantly higher than the other's. According to the authors, this might be related to the higher degree of physical activity, compared to the other species. It might be known that the fat content and the fatty acids composition can be influenced by the muscle type fiber, therefore leading to differences between cuts, Because the red muscles have a higher concentration of phospholipids, they will have a higher percentage of polyunsaturated fatty acids. After analyzing this parameter, Oz and Celik (2015) found that indeed the total polyunsaturated fatty acids content (19,97%) was higher in raw leg meat than in the breast cut (14.79%).
Goose breast meat content of saturated fatty acids is 31.38%, 53.81% in monounsaturated fatty acids and 14.79% in polyunsaturated fatty acids (total). Linoleic acid represented a high proportion of the total PUFA content (73%) (Oz and Celik, 2015) The same team mentioned that the leg meat had a content of SFA reaching 38.79%, MUFA 41.24% and PUFA 19.97%, for the latter the biggest portion being taken by docosapentaenoic acid.
Geldenhuys et al. (2015) later on evaluated the differences between the Egyptian goose cuts, breast, drumstick and thigh, considering the fatty acid composition.
They observed that the breast portion contained a higher percentage of polyunsaturated fatty acids, while the thigh portion had the lowest. The drumstick showed a high content of short-chain saturated fatty acids, such as the myristic acid (C14:0).
The authors suggest that these differences are caused firstly by the muscle fiber composition, with consequences on phospholipids.
Further on, the composition of the main lipid fractions (tryacylglycerols) might have an effect on these differences, the physical structure of the thigh, for example, allowing an increased fat deposition, therefore a higher content of tryacylglycerol adipocytes.

F. Ostrich meat nutritional quality, as reflected through its value for human diet

Compared to the meat species mentioned so far in this study, ostrich meat seems to have an even higher fat content for 100 g raw portion (skinless) – 8.7 g. The protein content remains high, 20.22 g/100 g (USDA National Nutrient Database, 2018).
Jukna et al. (2012) have evaluated the chemical composition of ostrich by comparison to turkey and broiler meat. By using classical methods of analysis, they have obtained the protein and fat percentage, their results showing just a slight difference between the species considering the protein percentage. The intramuscular fat percentage was higher in broiler chicken (2.20%), compared to ostrich (1.82%), while turkey seems to be the leaner of the three types of meat included in the study (1.21%).
In 1996, Sales and Oliver-Lyons wrote a report on the knowledge of nutritional composition of different muscles which could be included in the human diet, obtained from ostrich. They have included the protein and intramuscular fat percentages for several muscles, as included in Table 14. It seems that there are no significant differences between the types of targeted ostrich muscles.

Table 14. Composition of protein and intramuscular fat (%) as seen in different samples of ostrich muscles (%) (Sales and Oliver-Lyons, 1996)

Muscle	Protein (%)	Intramuscular fat (%)
M. gastrocnemius pars interna	20.6	0.26
M. femorotibialis medius	20.6	0.31
M. ambiens	21.5	0.44
M. iliotibialis lateralis	21.2	0.40
M. iliofibularis	20.9	0.42
M. iliofemoralis	21.9	0.69
M. fibularis longus	21.0	0.24
M. iliotibialis cranialis	20.0	0.52
M. flexor cruris lateralis	21.0	0.82

Concerning the amino acid composition, the ostrich meat seems to have a high nutritive value. Also, except for a few amino acids, there has been consistency of the pattern between the analyzed muscles (Sales and Oliver-Lyons, 1996) (Table 15).
In a paper aimed to evaluate the fatty acid composition of two different types of ostrich muscles (*M. gastrocnemius* and *M. iliofibularis*), Horbanczuk and Sales (1998)

found a total percentage of saturated and monounsaturated fatty acids to be similar between muscles. They did find differences in palmitic (16:0) and palmoleic (16:1) acids between the two types of muscles.

Also, they have observed a high proportion of 18:1, with no differences between the samples. The same panel of fatty acids has been targeted by Girolami et al. (2003), the results of both studies being included in Table 16.

Table 15. Amino acid composition of ostrich raw muscles (g/100 g edible portion) (Sales and Oliver-Lyons, 1996)

Component	Muscle		
	M. iliofibularis	*M. femorotibialis medius*	*M. gastrocnemius pars interna*
Lysine	1.65	1.67	1.61
Threonine	0.78	0.75	0.74
Valine	1.05	0.91	0.96
Methionine	0.57	0.54	0.53
Isoleucine	0.97	0.88	0.89
Leucine	1.79	1.69	1.64
Phenylalanine	0.99	0.91	0.92
Histidine	0.38	0.40	0.40
Arginine	1.48	1.30	1.30
Aspartic acid	1.96	1.85	1.88
Serine	0.59	0.59	0.58
Glutamic acid	3.17	3.15	3.31

Table 16. Total lipid and fatty acid composition of two different ostrich muscles
(Horbanczuk and Sales, 1998; Girolami et al., 2003)

Study	Horbanczuk and Sales (1998)		Girolami *et al*. (2003)	
Muscle	*Musculus gastrocnemius*	*Musculus iliofibularis*	*Musculus gastrocnemius*	*Musculus iliofibularis*
12:0	0.11 ± 0.02	0.13 ± 0.02	0.04 ± 0.001	0.05 ± 0.001
14:0	0.91 ± 0.08	0.91 ± 0.05	0.48 ± 0.02	0.70 ± 0.02
16:0	23.15 ± 4.84	21.43 ± 1.44	17.48 ± 0.71	22.89 ± 0.71
18:0	13.52 ± 0.89	12.81 ± 1.12	11.02 ± 0.37	8.87 ± 0.37
18:1	33.13 ± 1.10	31.07 ± 1.01	29.36 ± 0.56	31.58 ± 0.56
18:2 ω-6	14.72 ± 1.80	15.76 ± 2.09	16.63 ± 0.70	16.24 ± 0.70
18:3 ω-3	0.65 ± 0.07	5.81 ± 0.29	1.50 ± 0.09	2.14 ± 0.09
20:4 ω-6	5.38 ± 0.52	5.63 ± 0.46	11.34 ± 0.54	6.50 ± 0.54
20:5 ω-3	0.49 ± 0.06	0.39 ± 0.05	0.54 ± 0.04	0.28 ± 0.04
22:5 ω-3	0.99 ± 0.08	0.79 ± 0.10	1.40 ± 0.06	0.74 ± 0.06
22:6 ω-3	0.80 ± 0.08	0.72 ± 0.09	0.39 ± 0.03	0.21 ± 0.03
SFA	37.8 ±1.58	35.36 ± 1.59	29.88 ± 0.47	33.31 ± 0.47
MUFA	36.68 ± 1.35	35.51 ± 1.23	35.52 ± 0.85	39.05 ± 0.85
PUFA	23.5 ± 1.55	29.11 ± 2.96	34.60 ± 1.18	27.64 ± 1.18

CONCLUSIONS

The sources cited so far lead us to the following conclusions:

1. Compared to beef and lamb, chicken and turkey meat are leaner, therefore much more suitable for diets aiming to lower the cholesterol blood level.
2. Poultry meat cuts which include the skin might have a close level of total fat compared to skinless cuts of pork or beef, thus poultry meat skinless cuts being the only ones suitable when aiming to lower the fat content of human diet.
3. The leanest cut in chicken and turkey is the breast meat (skinless). Compared to that, beef meat presents the lowest fat content in the round cut, while pork has a low-fat content in the ribs and leg meat.
4. Chicken meat is a valuable source of niacin, while duck meat is known to be rich in vitamin A and folate.
5. Chicken meat has a high content of lysine and leucine.
6. Turkey meat presents a high content of PUFA and differences in protein and fat content between the cuts (with higher

amount of protein and lower content of fat in the breast cut).

7. Duck meat is rich in glutamic acid, lysine and methionine. It also represents a well-balanced meat type when considering the fatty acids composition. It is predominantly rich in linoleic acid, oleic acid and palmitic acid.
8. Goose breast meat is rich in linoleic acid as well, this representing 73 % of the total content of PUFA in this type of meat. On the contrary, goose leg meat seems to have a high content of docosapentaenoic acid.
9. Ostrich meat amino acids' composition, analysed on different muscle groups is very consistent, therefore no statistically signify-cant differences have been observed. Its fatty acids' composition is also consistent, overall the amount of oleic acid being higher when compared to poultry species.

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