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Original Contribution

MEAT QUALITY AND COMPOSITION IN JAPANESE QUAILS

A. Genchev, G. Mihaylova, S. Ribarski, A. Pavlov, M. Kabakchiev

[1] Department of Poultry Science, Faculty of Agriculture, Trakia University, Bulgaria;
[2] Department of Diary Science, Faculty of Agriculture, Trakia University, Bulgaria;
[3] Department of Morphology, Faculty of Agriculture Trakia University, Bulgaria;
[4] Department of Physiological Chemistry, Faculty of Veterinary Medicine, Trakia University, Bulgaria

SUMMARY

The increasing interest of consumers to quality of foods and that of meat in particular, motivated our aim to perform a detailed analysis of the quality and the composition of meat from Japanese quails. The investigation showed that the slaughter yield in Japanese quails ranged between 64-65%. Following grilling proportions of meat differed according to the parts of the animal. 24 hours after slaughter, meat pH was also variable in different parts and so was free water percentage. The water retention capacity of meat was better in female quails – 15.7% and 20.2% for pectoral muscles and leg muscles, respectively. Similarly protein and fat distributions varied in different parts of the animal.

Key Words: Japanese quails, meat quality, amino acid content, fatty acid content

INTRODUCTION

For the last 15 years, poultry breeding became the most extensively developing branch of animal husbandry. Along with the increase in egg and meat production, attempts at assortment diversification have been made. These trends are particularly visible in meat production. Ostrich, pheasant or quail meat is more often available in big retail stores.

The quail production is not an established branch, but nevertheless, occupies a relevant place in poultry breeding and contributes to the variety in poultry meat production. The largest quail meat producers are Europe and the USA (1). In Europe, the highest quail meat consumption is that in France, Italy and Spain (2).

The valuable taste and dietary properties of quail meat are pivotal in determining the growing interest of consumers to this product. The quality and composition of meat are influenced by numerous factors namely, the genotype of birds (3, 4), feeding mode (5, 6) and slaughtering age (7). The research shows that quail meat production is economically most effective when performed at the age of 35 days (8).

Poultry meat quality is determined by two extremely important traits – the appearance and meat consistency (9). The meat appearance depends on the colour of skin and meat, the presence of defects and is largely motivating consumer's choice. Meat tenderness is more important in the final quality determination. It depends on the thickness of muscle fibres and the ratio between the main metabolic types of muscle fibres forming muscle bundles. The quality of meat with regard to storage and processing depends on pH values and the water retention capacity (WRC). Poultry meat is characterized by high pH values that, according to Riegel et al. (10), ranged between 6.02-6.41 in most domestic fowl species. The authors observed that the pectoral muscle in Japanese quails had pH values of 6.2-6.3 on the 20th min *post slaughter*. Having investigated the time course of pH values of pectoral muscle in broiler chickens, Drbohlav and Drbohlavova (11) concluded that the glycolysis in pectoral muscle ended up to the 45th min *post slaughter*, and that afterwards, pH values were almost unchanged.

The investigations on the post-hatching development of skeletal muscles in Japanese quails showed that the pectoral muscle is

*** Correspondence to**: *Atanas Genchev, Department of Poultry Science, Faculty of Agriculture, Trakia University, 6000 Stara Zagora, Bulgaria; Tel.: +359 42 699 383; E-mail: agenchev@abv.bg*

composed of muscle (97.4-98.7%), connective tissue (1.1-2.1%) and fat (0.2-0.6%) (12). The muscle bundles of the pectoral muscle are mainly composed of dark muscle fibres, the ratio between dark (oxidative type) and light (glycolytic type) fibres is 95.1-96.7% to 3.7-4.9%. According to Riegel et al. (10) this ratio was 84.5%: 15.5% dark to light muscle fibres. With growth the relative proportion of glycolytic muscle fibres and the decrease in pH become more enhanced (13, 14).

The dietary value of meat is mostly defined by the composition and ratio among the different groups of nutrients. One criterion for meat evaluation is its protein content and especially the content of essential amino acids. According to most dieticians, the normally functioning non-trained human organism needs 8 essential amino acids – lysine, valine, leucine, isoleucine, threonine, tryptophan, methionine and phenylalanine (15). According to FAO/WHO specialists in 1973, the "ideal" protein should contain the following concentrations of essential amino acids: lysine – 5.5%, methionine+cysteine – 3.5%, threonine – 4%, leucine – 7%, isoleucine – 4%, valine – 5%, phenylalanine+tyrosine – 6% (16). In its studies, Genchev et al. (7) found that the limiting amino acids lysine and methionine comprised about 11.8% of quail meat protein.

In the recent past, the amount of fat was a restricting and even a repulsing factor for a certain group of consumers. The composition and the ratio between the different groups of lipids in poultry meat are essential in the evaluation of its dietary properties. Poultry meat is rich in polyunsaturated fatty acids (PUFA). The content and especially the ratio of fatty acids of the Ω-3 and Ω-6 groups are also particularly important. It is recommended that the daily intake of Ω PUFA should be approximately 3% of the energy intake, and that Ω-3 fatty acids should provide not less than 0.5% of the energy (17). The PUFA from the Ω-3 and Ω-6 groups are known to reduce arterial blood pressure, to have a beneficial effect in cardiovascular disorders, asthma, oncological diseases etc. (18). According to medical specialists, the frequency of these chronic diseases is considerably increasing in the present day because of the higher Ω-6 and Ω-3 fatty acids ratio in human food. It is reported to change from (2-3):1 in ancient times to (25-30):1 today (19, 20).

The increasing interest of consumers in the quality of foods and meat in particular formed the aim of the present study: to perform a detailed analysis of the quality and composition of meat in Japanese quails.

MATERIAL AND METHODS

The present study summarizes the results from three experiments performed in the Poultry Breeding Section, Trakia University, Stara Zagora in 2003, 2005 and 2006 on Japanese quails of the Pharaon breed. The experimental design and the conditions of experiments are described in earlier publications (6, 7).

Slaughter analysis

The euthanasia of birds and procedures related to processing, parcelling and deboning of birds was performed according to the "Slaughter analysis protocol in experiments using Japanese quails *(Coturnix Japonica)***"**, published in this issue of the journal (21).

Meat quality analysis

The temperature of muscles was determined at post slaughter minute 30 and hour 24 by means of an infrared thermometer "*Testo 830–t_2*".

The pH values of studied muscles were determined on post slaughter min 30 (pH_1) and hour 24 (pH_2) using a pH-metre "*Consort C 532*", supplied with glass electrode and temperature compensation. When determining pH, the electrode of the device is stuck in the centre of the middle third of each muscle. After pH_1 determinations, muscle samples were put in polyethylene bags and stored for 24 hours in a refrigerator at 4°C.

The colour of muscles was determined on post slaughter min 30 and hour 24 in three different locations on each muscle (anterior, medium and posterior) with a "*Lovibond SP60*" spectrophotometer that was calibrated immediately before work. The determination was done on the longitudinal cut surface of each muscle. The CIELAB colour system was used considering the L^*, a^* and b^* colorimetric coordinates as followed:

1. L^* - a value 100 corresponded to absolute white; value) – absolute black;
2. a^* – a+ corresponded to red spectrum; a- corresponded to green spectrum
3. b^* – b+ corresponded to yellow spectrum; b- corresponded to blue spectrum (Fig. 1).

The water retention capacity of meat was determined on post mortem hour 24 by the classical method of Grau & Hamm (22), modification of Petrov (23).

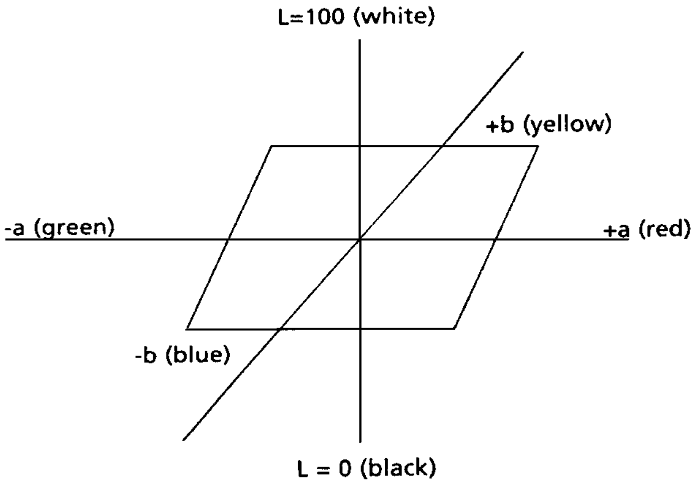

Figure 1. *Colour scale for determination of meat colour*

Chemical analysis

The determinations of total protein, water, fat and mineral contents were performed by the classical method of chemical analysis (24) using chilled samples.

The amino acid content was determined following acid hydrolysis of samples with 6 N HCl at 110 °C for 24 h, and amino acid separation was done with an a*mino acid analyzer T339M* (Mikrotechna – Praha). Mineral element contents were determined after dry ashing of samples at 550 °C and preparation of hydrochloric solution. The concentrations of K^+ and Na^+ were assayed on a flame photometer *"Flamon B"*, P content – spectrophotometrically by the molybdate-vanadate method and the other elements – on an atomic absorption spectrophotometer "*Perkin Elmer*".

Fatty acid composition of meat was determined by fat extraction according to the method of Bligh and Dyer (25) with methanol/chloroform mixture (2:1), followed by thin-layer chromatography and fatty acid separation on a gas chromatograph *"Pay Unicam* 304*"*, equipped with flame-ionisation detector and capillary column EC^{TM} WAX (Alltech, 30 m x 0.25 mm, i.d., 0.25 μm film), using H_2 as a carrier gas.

Statistical analysis

The obtained data were statistically analysed by routine statistical methods by means of *Microsoft Excel* software.

RESULTS

The relative grill weight was 64-65%, male quails being higher by about 1.5% (**Table 1**). The relative proportion of breast meat was 20.4% of the live weight or 33.10±0.47% of grill weight. Leg meat comprised 12.17% of live weight or 20.60±0.18% of grill weight. The accumulation of abdominal fat is a considerable problem in the production of poultry meat. Its amount depends on the gender and slaughter age of birds; it is often a subject of controversy. The **Table** outlines the lower share of abdominal fat in male birds – by 25%. The difference was significant ($p>0.05$).

The relative proportion of deboned breast and leg meat was 34.6% of live body weight or 53.7% of grill weight, with insignificant gender-related differences.

Table 1. Slaughter characteristics of 35- day old Japanese quails, % of body weight

Indications	*Male*	*Difference between genders,%*	*Females*	*Males + Females*
Carcass with skin	64.97±0.30	1.5 n.s.	64.03±0.52	64.50±0.31
Carcass without skin	60.13±0.36	2.0 n.s.	58.97±0.53	59.55±0.33
Abdominal fat	0.43±0.13	25.6 n.s.	0.54±0.19	0.52±0.08
Breast with bones	25.42±0.28	0.3 n.s.	25.35±0.47	25.38±0.26
Thighs/	16.63±0.20	4.1 *	15.97±0.22	16.30±0.16
Breast meat	20.80±0.77	2.5 n.s.	20.30±1.53	20.41±0.47
Leg meat	12.62±1.41	4.6 n.s.	12.06±1.29	12.17±0.53
Total meat (breast and legs)	34.94±0.49	1.7 n.s.	34.34±0.60	34.64±0.38

*Note: n .s. – the difference is not significant; *- the difference is determined at P<0.05*

The pH values of meat depended on glycogen content in muscles, and glycogen stores are highly influenced by the locomotor activity and the presence of stress factors in the pre-slaughter period (**Table 2**). The pH values determined on the 24^{th} *post slaughter* hour varied between 6.1 and 6.3, being slightly lower in breast meat.

Table 2. Quality characteristics of meat from breast and legs at 35 day old Japanese quails

Indications	*Male*	*Difference between genders ,%*	*Females*	*Males + Females*
pH_{24h} (breast)	6.23±0.08	1.8	6.12±0.07	6.17±0.05
WRC (breast)	22.39±0.74	3.3	21.68±1.06	22.08±0.61
pH_{24h} (legs)	6.31±0.057	1.3.	6.23±0.02	6.27±0.03
WRC (legs)	26.91±0.60	7.3.	25.08±1.02	25.51±0.80

The water retention capacity (WRC) of pectoral muscle was better compared to leg muscles. The differences between WRC values of *m. Pectoralis* and *m. Iliofibularis* were from 15.7% in females and 20.2% in males. The better WRC (with 15.5% on the average) of pectoral muscle combined with the higher yield and the easier way of separation and deboning of the muscle, make breast meat very attractive as a source for production of gourmet products.

In this connection, the time course of changes in some quality traits of meat during storage, up to the 7^{th} *post slaughter* day, deserve attention (**Table 3**). Subsequent to the *post slaughter* anaerobic metabolic changes, the glycogen stores of pectoral muscles are gradually depleted, leading to lactic acid accumulation and thus, to decrease in pH from 6.42 on the 30^{th} min after slaughter to 6.17 by the 24^{th} hour.

Table 3. Dynamics of quality changes in parameters of m. pectoralis in regard to preservation term at cooled condition

Indications	*30' after slaughter*	*24 h after slaughter*	*7 days after slaughter*
Temperature, ^oC	14.3±0.25	6.4±0.15	6.3±0.12
pH	6.42±0.07	6.17±0.05	6.47±0.08
Color of the meat			
l*	43.22±1.11	40.81±1.00	45.67±1.73
a*	8.02±0.78	10.16±0.55	11.68±0.64
b*	11.04±0.43	9.55±0.67	14.48±1.26

Table 4 presents data about the chemical composition of whole carcasses with bones. The big difference (2.6 times) in crude fat content between carcasses with and without skin is impressive. As a result, the total cholesterol content between genders was different –29.3% in males and 38.2% in females.

The comparison of parameters from the chemical analysis between males and females also showed some differences but, except for the significantly higher lipid content in female carcasses with skin ($p< 0.001$), the other differences were insignificant. **Table 4** also

Table 4. *Chemical composition of whole carcass (with bones)*

Indications	***Male***	***Difference between genders,%***	***Females***
Carcass with skin			
Dry matter %	32.03±0.12	2.19 n.s.	32.73±0.24
Protein,%	19.29	0.83	19.45
In this number essential amino acids	8.15	9.38	7.45
Fat, %	8.99±0.23	12.01 ***	10.07±0.22
In this number – Phospholipids	0.194	4.86	0.185
Cholesterol	0.097	3.19	0.094
NFE , %	0.49±0.09	68.97 n.s.	0.29±0.01
Ash, %	3.26±0.08	12.03 n.s.	2.91±0.20
Carcass without skin			
Dry matter,%	30.18±0.18	1.38 n.s.	29.77±0.39
Protein,%	22.7	3.61	21.91
In this number essential amino acids	9.10	6.56	8.54
Fat, %	3.45±0.15	11.01 n.s.	3.83±0.18
In this number – Phospholipids	0.158	22.48	0.129
Cholesterol	0.075	10.29	0.068
NFE , %	0.45±0.11	7.14 n.s.	0.42±0.15
Ash, %	3.58±0.06	0.84 n.s.	3.61±0.44

*Note: n .s. – the difference is not significant; ***- the difference is proved at P<0.001*

Table 5*.Chemical composition of meat from 35 day old Japanese quails, %*

Indications	***Male***	***Difference between genders, %***	***Females***
Breast			
Dry matter	27.51±0.302	2.19 n.s.	26.92±0.067
Protein	23.38±2.14	5.17 n.s.	22.23±3.02
Fat	2.21±0.22	24.43 n.s.	2.75±0.188
NFE	0.40±0.27	21.21 n.s.	0.33±0.10
Ash	1.51±0.10	6.62 n.s.	1.61±0.08
In this number…Ca. %	0.019±0.002	15.8 n.s.	0.022±0.002
P. %	0.222±0.005	4.5 n.s.	0.212±0.005
Na. %	0.061±0.002	12.2 n.s.	0.069±0.004
K. %	0.402±0.002	0.2 n.s.	0.401±0.003
Mg. %	0.018±0.001	0 n.s.	0.018±0.001
Fe. mg%	1.882±0.140	20.7 n.s.	1.492±0.080
Cu. mg%	0.362±0.058	2.1 n.s.	0.355±0.046
Zn. mg%	2.002±0.026	1.9 n.s.	2.040±0.082
Legs			
Dry matter	26.50±0.133	0.70 n.s.	25.86±0.107
Protein)	20.49±2.27	2.05 n.s.	20.91±0.13
Fat	3.39±0.114	3.99 n.s.	3.26±0.370
NFE	0.58±0.05	20.00 n.s.	0.40±0.02
Ash	1.64±0.06	1.23 n.s.	1.62±0. 90
In this number Ca, %	0.019±0.002	1.3 n.s.	0.020±0.001
P, %	0.227±0.006	5.5 n.s.	0.215±0.006
Na, %	0.061±0.002	10.2 n.s.	0.067±0.004
K, %	0.397±0.002	1.9 n.s.	0.390±0.007
Mg, %	0.017±0.001	0 n.s.	0.017±0.001
Fe, mg%	1.895±0.078	16.2 n.s.	1.587±0.107
Cu, mg%	0.392±0.051	8.9 n.s.	0.357±0.073
Zn, mg%	1.980±0.050	3.4 n.s.	2.047±0.011

Note*: Note: n .s. – the difference is not significant.*

demonstrates that carbohydrate content in carcasses with skin from female quails was lower. This could be explained by the possibly higher sensitivity of tested female quails to stress. Consequent to stress, a major part of glycogen stores could be depleted. This assumption is further supported by the lower meat pH values in female carcasses (**Table 2**).

In evaluating the dietary properties of breast and leg meat, it could be concluded that they were superior in breast meat (**Table 5**). It contained by 1.32-2.89% more protein and by 0.51-1.18% less fat. Carbohydrate content of leg meat was by 0.07-0.18% more than that of breast meat. This is predictable provided that the relative proportion of oxidative muscle fibres in thigh muscles was higher compared to that in pectoral muscle and thus, a precondition for slower depletion of glycogen stores.

The amino acid analysis showed that quail meat was very rich in essential amino acids. They accounted for about 41% of meat protein (**Table 6**). The limiting amino acids for males (lysine and methionine) comprised 12.36% and 12.71% of breast and leg meat protein, respectively. In general, the content of essential amino acids in breast meat was by 6.5% higher than in leg meat with significant differences for isoleucine ($P<0.05$) and valine concentrations ($P<0.01$). The sum of essential amino acids + cysteine and tyrosine was significantly different ($P<0.05$) between breast and leg quail meat.

***Table 6**. Amino acids content of meat from 35 days old Japanese quails, %*

Amino acids		***Breast***	***Legs***
Essential amino acids	lysine	2,19±0,064	2,12±0,055
	Methionine	0,56±0,040	0,52±0,044
	Isoleucine	1,22±0,034	1,11±0,027
	Leucine	2,09±0,048	1,96±0,047
	Phenylalanine	0,97±0,010	0,97±0,023
	Threonine	0,74±0,038	0,69±0,020
	Valine	1,29±0,035	1,15±0,036
	Cysteine	0,20±0,015	0,16±0,012
	Tyrosine	0,61±0,022	0,54±0,019
Non-essential amino acids	Histidine	1,13±0,032	0,70±0,023
	Arginine	1,40±0,036	1,31±0,048
	Glutamic acids	3,96±0,094	3,81±0,226
	Glycine	1,02±0,028	1,11±0,041
	Serine	0,43±0,047	0,38±0,007
	Alanine	1,34±0,042	1,30±0,043
	Proline	0,99±0,031	0,99±0,025
	Asparagine acids	2,05±0,044	1,93±0,051
Protein content		22,21±0,519	20,74±0,486
Total essential amino acids		9,07±0,208	8,52±0,216
Essential+Cystine and tyrosine**		9,88±0,211	9,22±0,235
Ratio nonessential: essential*		1,36 : 1	1,35 : 1
Ratio essential:nonessential**		1,25 : 1	1,25 : 1
Protein: essential		2,45 : 1	2,44 : 1

Note:*Amount of essential amino acids is without tryptophan; cosine and tyrosine can be essential at determined conditions*

Data about the fatty acid composition of lipids are presented on **Table 7**. It shows that the lipid profile of quail meat is determined by four fatty acids: oleic ($C_{18:1}$), palmitic ($C_{16:0}$), linoleic ($C_{18:2}$) and stearic ($C_{18:0}$). The sum of these fatty acids accounted for 88.26% of total lipid content of breast meat and 88.28% of lipids in leg meat. It also could be seen that the relative proportion of the oleic acid ($C_{18:1}$) was the highest and that its share in quail meat lipids was over one-third. Out of saturated fatty acids (SFA), the highest content was that of the palmitic acid ($C_{16:0}$), and leg meat was shown to contain more of it than breast meat. From the group of polyunsaturated fatty acids (PUFA), the proportion of linoleic acid ($C_{18:2}$)

was higher and it accounted for about 20% of total lipids. The sum of unsaturated fatty acids (UFA) in quail meat ranged between 65.68% in breast meat to 66.05% in leg meat. The sum of PUFA was 24.5-25% of total lipids with no significant differences between breast and leg muscles. The content of α-linolenic acid ($C_{18:3}$) was 1.75% in breast meat and 1.47% in leg meat. The ratio of Ω-6/Ω-3 PUFA was rather high– 15.3:1 in breast meat and 16.65:1 in leg meat. The ratio of linoleic ($C_{18:2}$) and α-linolenic ($C_{18:3}$) fatty acids was lower: 11.26:1 and 13.75:1 for breast and leg meats, respectively. The ratio of PUFA/SFA was 0.73 in both breast and leg meats.

Table 7. *Fatty acids content of meat from 35 days old Japanese quails, % from total lipids*

Fatty acids	***Breast/***	***Legs***
14:0	0.95±0.04	1.17±0.06
16:0	24.39±0.71	24.54±0.48
16:1	5.32±0.48	6.05±0.54
18:0	8.79±0.47	8.01±0.52
18:1	35.38±1.43	35.52±1.15
18:2 (Ω-6)	19.70±0.58	20.21±0.71
18:3 (Ω-3)	1.75±0.22	1.47±0.10
20:4 (Ω-6)	2.69±0.31	1.94±0.15
22:4 (Ω-6)	0.84±0.08	0.87±0.07
∑ Saturated fatty acids (SFA)	34.13±0.90	33.72±0.80
∑ Unsaturated fatty acids (UFA)	65.68±0.89	66.04±0.79
∑ Monounsaturated fatty acids (MUFA)	40.70±1.27	41.57±0.92
∑ Polyunsaturated fatty acids (PUFA)	24.98±0.53	24.48±0.72
Ratio: SFA/UFA	0.52:1	0.51:1
Ratio: PUFA/SFA	0.73:1	0.73:1
Ratio Ω-6 : Ω-3	15.30:1	16.65:1
Ratio C18:2 (Ω-6) : C18:3 (Ω-3)	11.26:1	13.75:1

DISCUSSION

Japanese quails are not a species with a high slaughter yield. Our results are similar to values reported by Panda & Singh (26) – 65.2% for males and 66% for females at the age of 35 days. According to Riegel et al. they are somewhat lower, but the slaughter analysis in their experiments was made at the age of 170 days (10). Comparing our results for the proportions of meat from various topographic regions vs. the weight of grill, it could be concluded that our values were slightly higher than those of other investigators. According to Panda & Singh, the relative share of meat was 30.6-31.3% for breast and 17.8-18.1% for legs (26). Lower values were reported by Riegel et al. (10) – 23.9-24.4% for breast meat that could be explained by the more advanced slaughter age. Results similar to ours were communicated by Afanasiev et al. (27).

Comparing the pH values of muscles of different topographic regions, it could be seen that they were higher for leg meat. Although not significant, (1.3-1.8%), this difference is sustainable and is due to the different morphological structure that determines the functional affiliation of both muscles (28). Unlike other avian species (chicken and turkeys), where the pectoral muscles is entirely from the glycolytic type, in Japanese quails, the dark muscle fibres of oxidative type prevail (10, 12). This is one of the main reasons for higher pH values of quail meat compared to data for broiler chickens (11). The muscles of the glycolytic type are characterized by high glycogen and low creatine phosphate content (29). This supposes a more rapid depletion of glycogen stores of the muscle without possibility for re-synthesis of ATP. The muscles of the typical oxidative type as the femoral muscle (*m. Iliofibularis*) and the deep pectoral muscle (*m. Supracoracoideus*) are quite on the opposite. They possess a big reserve of creatine phosphate that supplies the energy for ATP re-synthesis, and the higher content of mitochondria provides oxygen for the slower aerobic glycolysis. As a result, these muscles are characterized by a slower development of *rigor mortis*, and therefore, higher pH values. These assumptions are supported by Drbohlav and Drbohlavova, that showed a twice more enhanced glycolysis in the pectoral muscle in broiler chickens compared to that of the supracoracoideus muscle (11). Depending on the functional type of muscles, they found a difference of 1.7% in initial pH values determined by the 15^{th} *post slaughter* minute (pH 5.78 for *m. pectoralis* and 5.88 for *m. supracoracoideus*).

The value of poultry meat is determined by its nutrient content. The nutritive and dietary value of meat depends not only on the content, but also on the ratio of protein and fat it contains. The observed significant differences in fat content (**Table 3**) provide evidence that the skin of Japanese quails is an important fat depot. Due to the type of avian lipids and the occurring processes of oxidation of PUFA, the skin could be considered as subject of potential risk during long storage, even frozen (29). PUFA of the phospholipid fraction of cell membranes are especially susceptible to oxidation. A cause for this enhanced oxidation is the impaired equilibrium between pro-oxidative and antioxidative *post slaughter* processes. In the first hours after the slaughter, pro-oxidative processes predominate. Thus, the lower by 23-43% phospholipid content in carcasses without skin allows us to assume that this type of carcass processing, although not traditional in poultry industry, has advantages with regard to grill quality and the options of meat storage. All that could be a sound reason for consumers to prefer carcasses without skin as more appealing from the point of view of dietetics and the potential for a longer storage in frozen state.

Quail meat like most fowl meats is a valuable source of protein with very good amino acid profile. The ratio between non-essential and essential amino acids is 1.35-1.36:1, i.e. a proof of the high biological value of the meat. The daily consumption of 2 quails is equal to the intake of 125-130 g pure meat on the average that provide a total of 27-28 g protein, including 11 g essential amino acids, that is equivalent to 40% of human protein needs (15). Taking into consideration the recommendations of Hristov (30), that animal protein should not exceed 50% of daily human needs, it could be accepted that the meat of two 35-day-old Japanese quails satisfies the needs of animal protein. The detailed analysis of amino acids shows that the amount of lysine was 2.7 g, methionine + cysteine – 0.93 g, including 0.7 g methionine , isoleucine– 1.47 g, leucine – 2.54 g, phenylalanine +tyrosine– 1.99 g, including 1.21 g phenylalanine and valine – 1.54 g. The sum of consumed essential amino acids plus cysteine and tyrosine, presented as percentage of meat protein, is equivalent to 43.6% that is by 24.6% more than the requirements for "ideal protein" – 35% (15, 16). Deviations from the etalon are present only in methionine + cysteine content (96.5% of the ideal content) and threonine (81.2%). The consumption of meat from two quails satisfies human minimal daily needs of lysine, leucine, phenylalanine +tyrosine and valine, that, depending on the age, physiological status and physical workload of men are estimated at 1.6-5.6 g; 2.8-4.8 g; 1.2-3.2 g and 0.8-2.8 g respectively (15).

Comparing our results for the fatty acid profile of meat with available data for the meat from other species, it is evident that the principal part of lipids consists of four fatty acids – $C_{16:0}$, $C_{18:0}$, $C_{18:1}$ and $C_{18:2}$. The published data demonstrate that the sum of these fatty acids provides about 81% of total lipids in broiler chicken meat (31) and 73.35-74.5% of lipids in meat of ducks (32). The same four fatty acids account for up to 97% of total lipids of pork meat (33), and in *m. Longyssimus dorsi* this sum was 93.4% (34).
The sum of saturated fatty acids (SFA) in avian meat varies from 31.6. and 42% (31, 32, 35). SFA content in pork meat is reported to be similar – 38.3-41.2% (33, 34, 36).

Comparing the fatty acid content of quail meat to other avian species, it could be seen that the lipids of quail meat are richer in oleic acid ($C_{18:1}$) by 47.7% compared to broiler chicken meat and by 37.1% compared to duck meat (32). Higher concentrations of oleic acid ($C_{18:1}$) in quail meat are reported by Panda and Singh (26), the result being close to oleic acid content of pork found by Doychev – 41.6-51.2% (33, 34, 36).

The published fatty acid profiles of meat from different animal species show that avian meat are relatively rich in the essential Ω-3 α-linolenic fatty acid ($C_{18:3}$). Our data are similar to those of Rondia et al. (31) about its content in chicken meat – 1.74%. The α-linolenic acid content in the meat of the different duck populations varies in a wider range – 0.8-1.62% (32).

During the last years, the scientific literature emphasizes the importance of the lipid content of foods and lipid nutrition of humans. A special attention is paid on polyunsaturated fatty acids (PUFA) of the Ω-3 and Ω-6 classes. According to Doncheva, the ration of Bulgarians is mainly composed of foods rich in Ω-6 fatty acids (18) and in the view of the author, this is the main reason for the increased percentage of plasmaphospholipids of Ω-6 fatty acids and the higher Ω-6/Ω-3 PUFA ratio in the blood of Bulgarian people, estimated by now to be

7.79 vs the recommended levels of 1.5-2.3.

The ratio of Ω-6/Ω-3 PUFA in meat is one of the principal criteria for evaluation of dietetic properties of food. It should however be stated that in the meat of Japanese quails this ratio is not very favourable– 15.3:1 in breast meat and 16.65:1 in leg meat. According to Rondia et al. the meat of broiler chickens exhibits a similar ratio– 18.5:1, but it is reported that birds are able to deposit increasing amounts of α-linolenic acid when their ration is rich in this Ω-3 PUFA (31). The studies of these investigators showed that the supplementation of flaxseed to broilers diet for 14 days prior to slaughter increases the accumulated α-linoleic acid by 68.4%, whereas the supplementation for 27 days – more than twice, thus reducing the Ω-6/Ω-3 PUFA ratio to 7.63:1.

The ratio of PUFA/SFA in the meat of Japanese quails was found to be 0.73, i.e. within the allowed range of 0.4-0.7 (18).

CONCLUSIONS

1. The slaughter yield in Japanese quails ranged between 64-65%. The relative proportion of breast meat was 33.10±0.47%, and that of leg meat – 20.60±0.18% of grill weight.
2. On the 24^{th} *post slaughter* hour, meat pH was between 6.1-6.3, with lower values in breast meat. Free water percentage in pectoral muscles was 21.68-22.39%, whereas in leg muscles – 25.08-26.91%. The water retention capacity of meat was better in female quails – by 15.7% and 20.2% for pectoral muscles and leg muscles, respectively.
3. Breast meat contained 22.23-23.38% protein, whereas leg meat – 20.49-20.91%. The fat content in breast meat was 2.21-2.75% vs 3.26-3.39% in leg meat.
4. The meat of Japanese quails was found to be very rich in essential amino acids. Their sum was 8.52% in leg muscles and 9.07% in breast meat, i.e. about 41% of meat proteins. The content of essential amino acids in breast meat was by 6.5% higher than that of leg meat. The limiting amino acids for men (lysine and methionine) comprised 12.36% and 12.71% of breast and leg meat protein, respectively.
5. The lipid profile of quail meat is formed by four fatty acids: oleic (C18:1), palmitic (C16:0), linoleic (C18:2) and stearic (C18:0). Their sum accounts for 88.26% of total lipids in breast meat and 88.28% of lipids in leg meat. The ratio between Ω-6 and Ω-3 PUFA was 15.3:1 in breast meat and 16.65:1 in leg meat. The ratio of PUFA/SFA in quail meat was 0.73.

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