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Chemical Composition and Functional-Technological Properties of Mulard Meat

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Abstract: Breeding ducks, both in our country and abroad is mainly focused on the use of peking ducks but the excess fat content in their carcass leads to a decrease in demand for this meat with an alternative source-broiler meat. But with the deficit of meat from other animals, it is to be expected that the demand for meat will require a revision of production to produce a qualitatively different meat product. One of the ways is to use for this purpose Muskovy ducks including obtaining interspecific hybrids with peking ducks. It is important to determine the economic suitability of domestic ducks genes for interspecific crossings with Muskovy ducks, their productivity and meat quality. The study presents the results of researches on the analysis of the chemical composition and functional-technological properties of meat of cross lines Agidel-345, Muskovy ducks and mulards. The optimal combination of Muskovy lines with cross-breed ducks Agidel-345 for obtaining mulards was revealed. The mulard carcasses were low in fat compared to the ducks of the Peking breed. The content of polyunsaturated fatty acids in mulards was slightly higher in comparison with the lines of musk ducks. With respect to essential amino acids, the best indicators were the samples of the meat of mulards obtained by crossing the ducks of the Muskovy ducks of the IO-1 line with the Agidel cross. We revealed the optimum variant of mulards at which qualitative parameters of duck meat are improved.

Key words: Ducks, Muskovy ducks, mulards, cross Agidel, lines, duck meat, amino acids, lipids

INTRODUCTION

At present, the production of poultry meat is booming. The proportion of poultry meat in the Russian Federation is about 47% and its share is increasing annually. It is on poultry farming that the main hopes are placed on the solution of the problem of animal protein not only in Russia but also in other countries of the world. One of the reasons was the doctor's recommendation to limit the consumption of red meat in favor of poultry meat due to the increase in cardiovascular pathologies in humans after consuming mostly beef meat (Pfeuffer, 2001). In this regard in many countries there is an increase in demand for poultry meat from the population.

A certain role in this direction in the general production of meat is allocated to waterfowl. With a general downward trend in the production of duck meat in some countries, their number in the total number of poultry occupies the second place after chickens (Akinola and Essien, 2011; Yakubu *et al*., 2011) and in China more than 80% of world production of duck meat is produced (Thiele, 2016).

The main reason for the non-popularity of duck meat is the high fatness of the carcass of ducks created on the basis of the peking breed while the bird has a good rate of growth and development with meat qualities not inferior to broilers. The alternative is Muskovy ducks, whose meat contains little fat, it is tender, dark with a slightly weakened taste of game but they have a longer growing time (Yakubu, 2013; Yakubu *et al*., 2011) compared to the ducks of the Peking breed.

In the opinion of most researchers (Bagliacca *et al*., 1997; Isguzar *et al*., 2002; Wawro *et al*., 2004) the dietary quality of duck meat is an important aspect and the ducks are kept mainly for their meat. Consequently, the main goal of breeding ducks is to improve meat quality (Pingel and Heimpold, 1983; Shahin *et al*., 2000; Woloszyn *et al*., 2005). Selection of ducks of parental forms is carried out in order to increase the amount of edible parts in the carcass of hybrids and to reduce the fat content (Wawro *et al*., 2004). However, according to Powell (1992) intensive selection can lead to a deterioration in the nutritional value of poultry meat.

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The qualitative composition of poultry meat is largely determined by the morphological and chemical composition of muscle tissue and visible fragments of the skin with subcutaneous and abdominal fat. An essential defect of duck meat is their high fat content for ducks of Peking breed it reaches 45-55%, for cross-breeding of domestic selection 30-45%. The reduction of the level of fat in gutted carcasses can be achieved by longer feeding of poultry and breeding research to improve quality indicators while maintaining viability and productivity. Thus, the fat content of carcasses of new highly productive ducks "Agidel 34" and "Agidel-345" is 4.1 and 6.6% lower than in other ducks crosses (Makhonina, 2016).

In their studies, Chartrin *et al.* (2006) found that Muskovy ducks have a higher output of pectoralis and a lower lipid level. Along with this, one of the ways to reduce the real fat content of a carcass of a waterfowl is to obtain mulards as a result of crossing Muskovy ducks with ducks of Peking breed. At the same time, the fat content, chemical composition and functional and technological properties of the meat of mulards depend on the initial parental forms.

Issues related to the integrated assessment of meat raw materials of modern Peking crosses, Muskovy duck lines and mulards obtained from crossing in domestic practice are not fully studied. In this regard, our research goal was to analyze the quality of the meat of Muskovy ducks crosses, the Agidel-345 cross and the mulards obtained as a result of their crossing.

MATERIALS AND METHODS

The research was carried out at the State Unitary Enterprise of the "Blagovarsky" Breeding Poultry Plant in the Blagovarski District of the Republic of Bashkortostan on the lines of Peking ducks of Agidel-345 cross and Muskovy ducks of the IO-1 and IO-3 lines of the "Yubileiny" cross. The scheme of crossing to obtain mulards is shown in Fig. 1.

The conditions of keeping and all technological parameters that were not studied in the present research were identical and corresponded to the recommendations for breeding, keeping and feeding of Muskovy ducks and the Agidel-345 cross (All-Russian Scientific and Research Technological Poultry Breeding Institute). In carrying out the studies, conventional methods were used.

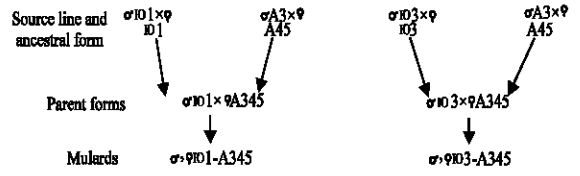

Fig. 1: The scheme for obtaining mulards

RESULTS AND DISCUSSION

According to the analysis of the chemical composition of duck meat (Table 1), it is revealed that the meat of mulards is richer in dry matter than the meat of the original lines. The study of the chemical composition of the thoracic and femoral muscles suggests that the accumulation of dry matter intensified in the muscles of the mulards ducks.

Thus, the content of dry matter in the muscles of the mulards, obtained by crossing ♂IO-1 × ♀ A-345, exceeded the IO-1 line by 0.4%. A similar trend was observed in the analysis of mulards obtained by crossing the Muskovy drakes of the IO-3 line with the ducks of the Agidel-345 cross. The protein content in the muscles was the smallest in hybrid ducklings: the ♂IO-1 × ♀ 45 line was inferior to the peer indicators by 0.3% of the drakes of the IO-1 line. A similar discrepancy was established in the analysis of poultry meat obtained by crossing Muskovy ducks ♂IO-3 with ♀ A345. The dry matter content and fat content in the Agidel-345 cross was significantly higher ($p<0.05$) than in the Muskovy ducks.

The largest fat deposition in muscles was observed in Agidel-345 cross ducks. The difference between this cross and mulards was 12.8%.

The most important indicator characterizing the energy value of meat is its caloric value. The caloric content of the meat of the mulards obtained by crossing the ♂IO-1×♀A-345 hiher than that of the other line by 2.65%.

Based on the analysis, it can be concluded that the chemical composition of the meat of mulards was significantly higher than in Muskovy ducks in terms of dry matter, protein, fat and the energy value of meat.

The determination of the total chemical composition of meat does not give a complete picture of its nutritional value. In this regard, during the research, we studied the amino acid composition of the meat of samples (Table 2).

With respect to the content of essential amino acids, the best indicators were the samples of meat of mulards obtained by crossing ♂IO-1×♀A-345. Thus, their leucine-isoleucine concentration was 0.01, 0.07, 0.11, 0.04% in comparison with the groups ♂IO-1, ♂IO-3, ♀A-345, ♂IO -3×♀A-345, respectively.

A similar dynamics was maintained for such amino acids as lysine, methionine, threonine. According to the content of arginine, the highest indices were the samples of meat of Agidel-345 cross ducks. Their intergroup difference in comparison with the Muskovy drakes IO-1, IO-3 and also mulards with the participation of the line IO-1 and IO-3 was 0.62, 0.12, 0.95 and 0.41%, respectively.

Table 1: Chemical composition of duck meat

	Line, cross				
Indicator (%)	♂IO-1	♂IO-3	♀A-345	♂IO-1×♀A-345	IO-3×♀A-345
Dry matter content	21.33±0.27	21.13±0.24	21.71±0.25	21.41 ±0.26	21.42±0.23
Fat content	2.61±0.08	2.64±0.09	3.07±0.07	2.72±0.08	2.76±0.09
Protein content	17.73±0.18	17.55±0.17	17.66±0.19	17.68±0.18	17.64±0.16
Ash content	0.96±0.03	0.94±0.02	0.98±0.03	1.01±0.04	1.02±0.03

Table 2: Amino acid composition of the average sample of duck meat

	Line, cross				
Amino acids	♂IO-1	♂IO-3	♀A-345	♂IO-1×♀A-345	♂IO-3×♀A-345
Indispensable lysine	7.03±0.110	6.96±0.090	6.94±0.080	7.07±0.120	6.97±0.100
Phenylalanine	4.21±0.090	4.05±0.050	4.13±0.070	4.18±0.080	4.08±0.060
Leucine-isoleucine	8.77±0.200	8.71±0.180	8.67±0.170	8.78±0.210	8.74±0.190
Methionine	4.17±0.080	3.84±0.070	4.28±0.090	5.10±0.100	3.71±0.060
Valine	3.59±0.090	3.53±0.050	3.57±0.080	3.56±0.070	3.55±0.060
Threonine	3.51±0.050	3.42±0.030	3.21±0.020	3.54±0.060	3.45±0.040
Tryptophane	7.69±0.120	8.16±0.140	7.46±0.110	7.82±0.130	8.33±0.150
Dispensable arginine	6.34±0.180	6.84±0.200	6.96±0.210	6.01±0.170	6.55±0.190
Tyrosine	4.56±0.110	4.16±0.100	4.07±0.080	4.56±0.120	4.39±0.090
Histidine	8.47±0.190	7.75±0.150	7.88±0.160	8.46±0.180	7.99±0.170
Proline	6.34±0.180	6.83±0.200	6.95±0.210	6.22±0.170	6.57±0.190
Serine	7.97±0.180	8.21±0.200	8.35±0.210	7.85±0.170	8.13±0.190
Alanine	10.48±0.800	10.43±0.780	10.38±0.770	10.32±0.760	10.45±0.790
Glycine	12.78±0.850	12.82±0.880	12.95±0.900	12.56±0.840	12.79±0.860
Cystine	2.37±0.070	2.48±0.100	2.51±0.120	2.27±0.060	2.46±0.090
Oxyproline	1.72±0.050	1.81±0.060	1.69±0.030	1.70±0.040	1.84±0.070
Protein quality indicator	4.57±0.087	4.51±0.085	4.41±0.082	4.60±0.089	4.53±0.086

Table 3: Fatty acid composition of lipids of muscle tissue of ducks

	Line, cross				
Fatty acids	♂IO-1	♂IO-3	A-345	♂IO-1×♀A-345	♂IO-3×♀A-345
Saturated	33.06	32.87	30.07	32.07	31.84
Myristic	0.82	0.70	2.80	0.76	5.46
Pentadecanoic	0.38	0.99	0.37	0.48	0.46
Palmitic	29.18	28.02	19.06	27.79	18.94
Stearic	1.16	1.21	2.63	1.84	2.26
Arachic	1.52	1.95	5.21	1.20	4.72
Monounsaturated	43.98	44.84	49.86	45.21	47.49
Myristoleic	0.92	0.67	1.18	0.64	1.90
Palmitoleic	4.42	4.03	2.24	1.52	1.71
Oleic	34.24	35.63	39.07	37.71	38.03
Gadoleic	4.40	4.51	7.37	5.34	5.85
Polyunsaturated	22.96	22.29	20.07	22.72	20.67
Linoleic	17.07	17.76	18.07	20.08	18.25
Linolenic	1.53	2.32	0.71	0.40	0.74
Eicosadienoic	2.68	0.26	0.42	0.28	0.37
Arachidonic	1.68	1.95	0.87	1.96	1.31

Protein-quality indicator of meat of mulards obtained by crossing of ♂IO-1×♀A-345 surpassed the parameters of other lines and crosses of ducks.

When assessing the nutritional value and taste of meat, the qualitative composition of lipids is important (Table 3). The content of unsaturated (mono-and polyunsaturated) and saturated fatty acids (Kokoszynski *et al*., 2002) also provides qualitative indicators of meat.

The results of the analysis of the fatty acid composition of lipids in the muscle tissue of ducks indicate some differences in the content of saturated and unsaturated fatty acids in the test samples. Thus with respect to the content of unsaturated acids, the indices of the meat samples of the Agidel-345 crosses were the highest in their concentration. The value of this indicator exceeded the analogues of the original forms. At the same time, the reverse dynamics was observed in the content of saturated fatty acids. The best results for this feature were samples of meat of Muskovy drakes of the IO-1 line.

One of the main aspects determining the conditions for the formation of quality and yield of meat raw materials are autolytic transformations taking place during the storage of meat.

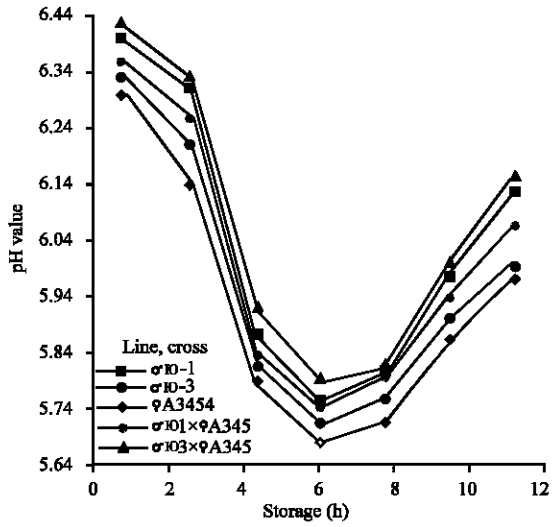

Fig. 2: Dynamics of the pH of duck meat

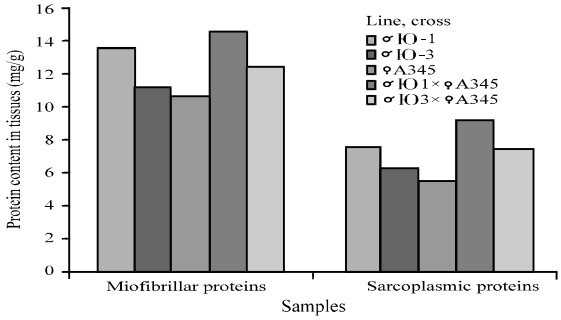

Fig. 3: Fractional composition of proteins in the average meat sample

The nature of changes in the composite components of muscle tissue during autolysis reflects the change in pH (Fig. 2). In meat of mulards, the pH value has lower values ($p<0.01$) which may be due to a lower concentration of hydrogen ions. At the same time throughout the study period, there was a uniform character autolytic changes in mulard which indicates that the crossing of peking and Muskovy lines has no negative influence on metabolic processes in meat systems.

In the analysis of the qualitative composition of the proteins there was revealed the superiority of the content of the myofibrillar and sarcoplasmic proteins of muscle tissue in mulard obtained by crossing ♂IO-1×♀A-345 (Fig. 3).

This advantage compared with the baseline for myofibrillar proteins ranged from 1.0 -.9 mg/g. Acconrding to the content of sarcoplasmic proteins, the difference was from 1.6-3.7 mg/g.

Functional and technological properties of meat raw materials which are important in determining the suitability of meat for the production of food products from meat raw materials are presented in Table 4.

As can be seen from the data presented in the table in the meat of mulards obtained by crossing the Muskovy drakes of the lines IO-1 and IO-3 with the ducks of the Agidel-345 cross, the pH indicator after slaughter was less than 0.90-1.05% in the musk ducks of the original lines. In the meat of mulards, the moisture-binding capacity of meat was significantly higher by 1.60-2.30% than that of the father lines of IO-1 and IO-3 and the moisture-retaining capacity by 0.90%, this is because the connection of natural moisture with biopolymers are destroyed less in hybrid individuals. In this regard, the functional and technological properties of meat raw mulards has the best quality indicators for further use in the production of meat products.

Discussion of the obtained results: The main direction in selection and breeding research with ducks is to improve the quality of their meat (Pingel and Heimpold, 1983; (Shahin *et al*., 2000; Woloszyn *et al*., 2005). Selection of ducks of the original forms for crossing many scientists Mazanowski *et al*. (2001), Wawro *et al*. (2004), Roiter and Kutushev (2013) conducted to increase the yield of meat and reduce its fat content.

In our studies conducted on a comprehensive assessment of the meat raw materials of hybrids obtained by crossing the lines of Muskovy ducks with Peking breed, an improvement in the quality of meat has been established. Thus, as a result of the quality assessment and functional and technological properties of duck meat, the superiority of these hybrids over parental forms was revealed. The dry matter content in hybrids meat increased by 0.4%, protein by 0.3% with a significant decrease in carcass fat content by 11.4% ($p<0.001$). In mulards, obtained by crossing the ♂IO-1×♀A-345, the amino acid composition of the meat exceeded the parameters of other lines and crosses of ducks both in the content of indidpensable and dispensable amino acids. The amino acid composition of the mulards meat is consistent with the results obtained by the researchers Woloszyn *et al*. (2005), Woloszyn (2001, 2002) and Galin *et al*. (2017).

And the content of saturated fats in mulards was higher by 6.6%, polyunsaturated by 13.2%, compared with the peers of the baselines. In their studies, Turi *et al*. (1994), Smith *et al*. (1993) and Woloszyn (2001) also note a similar trend.

Table 4: Functional and technological properties of duck meat

	Line, cross				
Indicator (%)	♂IO-1	♂IO-3	♀A-345	♂IO-1×♀A-45	♂IO-3×♀A-345
pH	05.74	05.76	05.78	05.68	5.71
Moisture retaining capacity	47.3	47.1	46.7	48.2	48.0
Moisture binding capacity to whole moisture content	68.5	68.2	67.5	70.8	69.8

In assessing the qualitative composition of proteins, the superiority of hybrids in the content of myofibrillar and sarcoplasmic proteins of muscle tissue was established. The meat of mulards was characterized by the best functional and technological properties, the moisture-binding capacity of meat was higher by 2.30%, the water-retaining capacity was 0.90%. Improvement of these indicators provides high quality raw materials for use in the production of meat products. The initial results were obtained in the studies of Galin *et al.* (2017) and Makhonina (2016). The researchers of the cited researchar indicate a special value for a set of meat indices of ducks of mulards for the production of meat products.

It should be noted that the improvement of individual meat quality indicators depended in our opinion, on their level in the baselines, according to the data of Roiter and Kutusheva (2013), the domestic cross of the Peking ducks "Agidel-345" has a lower carcass fatness than in other common ducks crosses, by 3.1-6.6% which undoubtedly affected the level of this indicator in the crossed ducks-mulards.

CONCLUSION

Further intensification of growing ducks in order to obtain high-quality commercial meat in our opinion is possible due to the interspecific hybrids-mulards which have sufficiently high quality of meat. To improve the quality of duck meat, it is advisable to grow for meat mulards obtained by crossing the Muskovy drakes of the Þ-1 line with the ducks of the Agidel-345 cross. At the same time, mulards significantly reduced carcass fatness with the preservation of unique meat quality indicators. The chemical composition of the meat of mulards exceeded the original forms for the content of dry matter, protein, fat and energy value as well as for essential amino acids and unsaturated fats. Meat of mulberries ensured improvement of functional and technological properties of meat raw materials which is also important from the position of using it in the technology of production of functional food products.

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