Effect of breeding chickens (gallus gallus l.) of the plymouth rock domestic meat cross "smena 9"

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Abstract. The article is devoted to the assessment of the efficiency of selection of the initial lines of the Plymouth Rock breed of the domestic meat cross "Smena 9". It was found that breeding of meat chickens of lines CM7 and CM9 (from 2016 to 2020) resulted in an increase in the live weight of the young, fleshing of the chest and legs at 35 days of age, the feed conversion for both cockerels and hens by 8.8-10.0%; 0.9-1.9% and 1.0-1.9%; 1.2-1.8%. In 2020, all juveniles of the paternal line CM7 at one day of age were the carriers of the marker gene *K* (100%), the maternal line Cm9 - the carriers of the marker gene *K* (100%). The accuracy of sexing of the maternal parental form CM79 is 99.7%. From one parental pair of the Smena 9 cross, 307.6 kg of meat was obtained, which is 14.2% higher than in the previous cross. The average daily gain of the final hybrid of the cross "Smen. 66 kg/kg; a 9" grown in the production conditions of the SGC "Smena" was 63.5 g; feed costs were at 1.66 kg/kg; preservation rate - 98.8%; the output of the pectoral muscles and the slaughter yield - 23.5 and 73.1% (against 56.3 and 71.4%). The bird of the cross "Smena 9" is competitive.

1 Introduction

Dynamic development of domestic poultry farming causes the necessity of constant creative search of ways and methods of enhancing the efficiency of poultry and the quality of its products [1-3].

Intensive selection of highly productive chickens of meat crosses inevitably leads to a decrease in genotypic diversity in the original lines, which reduces the effect of selection to further increase the genetic potential of the bird. Therefore, after 7-8 years of in-depth breeding work with industrial crosses of meat chickens, it becomes necessary to include new traits in breeding programs that will increase the yield of broiler meat from layers of the parent flock [1,4,5].

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The efficiency of breeders in the line, nucleus stock and breeder flocks is determined by the number of quality eggs obtained for incubation and quality chicks obtained from these eggs. This process begins from SGC, breeding farms, where pure lines are bred, enhanced and crossed. The gene flow then travels through the breeder and breeder flocks to broilers. On this path, there are numerous factors affecting the manifestation of traits determined by genes. The success of the pedigree and industrial poultry farming depends on continuous genetic enhancement and poultry creation at all levels of appropriate feeding conditions, housing, biosafety.

To obtain the effect of heterosis, breeders use a differentiated approach to the issues of directed selection of hens of the parental and maternal forms, which is part of the scheme for the implementation of the cross breeding program [2,4].

The genetic value of the meat cross largely depends on the productive potential of the original lines, which are the basis for the construction of the cross [5,6].

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In recent years, the poultry industry has increasingly begun to use marker genes in breeding work allowing to enhance the economic efficiency in the production [7-11].

Increasing the meat yield from laying hens is one of the most important tasks for breeders. In this regard, the breeding qualities of birds are being enhanced by using new techniques and breeding methods in combination with technological and veterinary programs. One of these techniques is the use of the slow feathering gene when creating initial lines, further crossing of which allows to obtain autosex offspring in the parental form or in the final product - broiler [2,7,10].

Further breeding progress should be based on the study of these markers and other DNA-related methods [12-16]. The use of marker genes greatly facilitates the separation of the day old cockerels and hens. There are genes that determine the autosexuality of chickens by the color of the plumage (colorsex) and by the growth rate of the feathers of the covering and primary plumage (feathersex) [17-23].

2 Material and methods

The research was performed in the production of the SGC "Smena" (Moscow region). The object of research was the poultry of the original lines of the Plymouth rock breed of the breeding of this enterprise (cm7 and CM9), maternal parental forms CM79, B79 and broilers (CM5679) of the Smena 9 cross.

The livestock of the evaluated young stock pursuant to the CM7 line in 2016 amounted to 1182 birds (cockerels) and 1175 birds (hens); on the line CM9 -1235- 1242 birds; in 2020 -5695 -5708 (lines CM7), 7400-7398 birds. (line CM9) for each maternal parental form (CM79 and B79) - 500 birds; for the final hybrid - 1000 birds.

Keeping chickens and raising young stock, broilers - on deep bedding. The adult birds were kept in natural mating.

The main technological parameters, light and temperature-humidity conditions, the poultry feeding program corresponded to the standards used for meat chickens, methodological guidelines for poultry feeding [24].

Linear birds (CM7 and CM9) were kept in breeding nests for 13 chickens and one cockerel, which were completed considering the following indicators: live weight, fleshiness, homozygosity for the rapid feathering gene *kk* and k^- (line CM7); egg production, hatching eggs yield, their weight, hatchability, live weight of poultry, fleshing of the chest, legs, feed costs, homozygosity for the gene for slow feathering *KK* and K^- (line CM9).

The autosex maternal parental form was obtained by crossing the lines of the Plymouth Rock breed of the paternal line CM7 and the maternal line CM9.

In the original lines (CM7 CM9) and the maternal parental form (CM79), feathering was determined by the development of wing feathers (slow-feathering individuals - coverts longer than flight feathers or equal to them; fast-feathering - coverts are shorter than flight feathers and well developed). In addition, with the use of PCR (PCR-RT), molecular genetic typing of feather pulp samples was performed, which was performed at JSC "Syntol" (g. Moscow), in order to maintain the homozygosity of the original lines for the *K* and *k* alleles.

Anatomical cutting of broiler carcasses was performed pursuant to the method [25].

For biochemical studies, blood was obtained from the jugular vein, sodium citrate solution was added to the test tube, then the blood was centrifuged for 5 minutes (5000 rpm). The obtained plasma was studied on a semi-automatic analyzer Sinnowa BS3000P (China), cholesterol, triglycerides, total protein, calcium, phosphorus were determined.

All experimental data obtained in the course of the research were processed by the method of variation statistics pursuant to Student. The data were also processed using the Statistica 10.0 software package (StatSoft Inc., USA) and Microsoft Excel. The reliability of the differences between the compared indicators was determined by the Student's *t*-criterion within the following levels of significance: *- $P \leq 0.05$; **- $P \leq 0.01$; ***- $P \leq 0.001$.

3 Results and discussion

A feature of the breeding program for the creation of a cross of meat chickens with an autosex maternal parental form based on marker genes of slow and fast feathering was the selection of birds of the paternal line CM7 for fast feathering, and the maternal line CM9 for slow feathering. Evaluation and selection of cockerels in breeding nests by the feathering rate of offspring at one day of age for a number of years was performed in order to consolidate the entire population of the line CM7 (2357-11408 birds - fast-fledging) and CM9 (2477-14797 birds - slow-fledging). Heterozygous cockerels and their offspring were excluded from the breeding process, leaving only homozygous for the *K* and *k alleles.* In addition, molecular genetic typing of chickens for these alleles was performed simultaneously using quantitative PCR (RT-PCR).

The results of assessment and selection for alleles *K* and *k* 1-day-old chickens are presented in Table 1.

Table 1. Feathering of day old young stock of the original lines CM7 and CM9 in the process of selection.

Line	Feathering type of day-old chicks	Gender	Year		
			2016	2018	2020
CM7	wing coverts longer than or equal to flight feathers (slow-feathering)	cockerels	89.1	60.4	0
		hens	99.2	58.9	0
	wing coverts are shorter than flight feathers and well developed (fast feathering)	cockerels	10.9	39.6	100
		hens	0.8	41.1	100

Table 1. Continued.

CM9	wing coverts longer than or equal to flight feathers (slow-feathering)	cock-erels	93.0	10	100
		hens	83.1	100	100
	wing coverts are shorter than flight feathers and well developed (fast feathering)	cock-erels	7.0	0	0
		hens	16.9	0	0

Table 2. Productive qualities of birds in the selection process in the original lines of the Plymouth Rock breed in 2016 – 2020.

Sign	Line			
	paternal (CM7)		maternal (CM9)	
	2016	2020	2016	2020
Live weight at 7 days of age, g: ♂ ♀	211.0±0.367 206.8±0.362	216.0***±0.404 213yu2 ***±0.415	199.8±0.310 194.0±0.311	207.5 ***±0.305 200.9 ***±0.306
Live weight of chickens in 35 days, kg ♂ ♀	2.231±0.004 1.880±0.004	2.428 ***±0.004 2.059 ***±0.003	1.970±0.003 1.700±0.004	2.167 ***±0.004 1.821 ***±0.003
Muscularity at 35 days, score ♂ - chest	4.58±0.006 4.58±0.005	4.63 ***±0.005 4.62 ***±0.004	4.36±0.006 4.40±0.005	4.41 ***±0.005 4.45 ***±0.004
♀ ♂ - legs ♀	2.20±0.002 2.10±0.002	2.24 ***±0.002 2.13 ***±0.002	2.09±0.003 2.08±0.002	2.13 ***±0.002 2.10 ***±0.002
Conversion of forage, kg/kg (for 1-35 days) ♂ ♀	1.67±0.014 1.69±0.016	1.64±0.011 1.67±0.013	1.68±0.012 1.73±0.012	1.66±0.010 1.70±0.012

Note. Significant differences compared to F1 *** - P≤0.001.

The above data indicate that in the process of breeding meat chickens of the Plymouth Rock breed of lines CM7 and CM9 from 2016 to 2020 there was an increase in live weight, fleshing of the chest and legs at 35 days of age, feed conversion for both cockerels and chickens by 8.8-10.0%; 0.9-1.9% and 1.0-1.9%; 1.2-1.8% (Table 2).

The breeding progress in one year for the main breeding traits of the lines CM7 and CM9 was: live weight at 35 days of age in cockerels - 39.4 g; chickens - 35.8-24.2 g; fleshing of the chest, legs - 0.22-0.38% (cockerels); 0.17-0.28% (chickens); feed conversion - 0.36-0.24% (cockerels); 0.24-0.35 (chickens).

During 60 weeks of life, 136 heads were obtained from layers of the parental CM79 line, which is 27.1% higher than for the CM7 line (107 birds), for the CM9 line (12 birds) - by 9.7%, and compared to the parental form of the cross "Smena 8" (B79 - 134 head) - by 1.5%, and in terms of meat yield from one parental pair - by 14.2% (CM79 -307.6; B79 - 209.5)

The average daily gain of the final hybrid of the Smena 9 cross was 63.5 g; feed costs were at 1.66 kg/kg; safety - 98.8%, the yield of pectoral muscles and slaughter yield - 23.5 and 73.1% (versus 56.3g; 1.78 kg/kg; 97.7%; 21.4% and 71.4%) corresponding to the indicators of broilers of the Smena 8 cross.

Table 3. Biochemical blood parameters in meat chickens of the Smena 9 cross at different age periods (n = 20, M ±SEM).

Line and form	Indicators				
	cholesterol, mmol/l	triglycerides, mmol/l	Total protein, g/l	calcium, mmol/l	phosphorus, mmol/l
1 day					
CM7 line	5.4±0.03	2.2±0.06	28.0±0.33	3.2±0.12	3.6±0.12
CM9 line	5.3±0.05	2.3±0.07	28.4±0.40	3.4±0.11	3.8±0.15
MPF SM79	5.3±0.07	2.3±0.06	29.7±0.51	3.4±0.10	4.2±0.16
1 week					
CM7 line	5.2±0.04	2.2±0.04	39.5±0.61	4.6±0.10	2.2±0.08
CM9 line	5.1±0.03	2.4±0.08	41.0±0.57	4.6±0.08	2.3±0.06
MPF SM79	5.1±0.04	2.2±0.06	39.3±0.74	4.7±0.07	2.5±0.13
2-week					
CM7 line	5.4±0.06	3.2±0.06	34.3±1.12	4.6±0.12	2.8±0.06
CM9 line	5.3±0.06	3.2±0.08	34.0±1.24	5.1±0.11	2.8±0.10
MPF SM79	5.7±0.12	3.5±0.12	35.2±0.61	4.4±0.08	2.4±0.08
3 week					
CM7 line	3.5±0.04	3.1±0.05	35.0±0.77	3.9±0.09	1.9±0.07
CM9 line	3.6±0.03	3.0±0.07	34.9±1.02	4.4±0.11	1.9±0.15
MPF SM79	3.6±0.04	3.1±0.06	33.5±0.51	4.5±0.11	1.8±0.11
4 week					
CM7 line	3.7±0.05	3.2±0.05	39.8±1.01	3.4±0.12	2.0±0.08
CM9 line	3.8±0.05	3.2±0.06	41.7±0.88	4.6±0.14	2.0±0.06
MPF SM79	4.1±0.11	3.4±0.08	40.9±1.07	4.5±0.07	2.5±0.11
5 week					
CM7 line	4.4±0.10	3.1±0.11	42.6±1.02	2.9±0.04	2.4±0.05
CM9 line	4.6±0.04	2.9±0.12	42.9±0.80	3.1±0.06	2.3±0.04
MPF SM79	4.4±0.06	3.3±0.16	41.9±1.07	3.2±0.12	2.4±0.06

Table 3 shows the biochemical parameters of blood in meat chickens at different age periods (1-day-old, 1-, 2-, 3-, 4-, 5-week old) along the lines CM7, CM9 and the maternal parental form CM79.

In day-old chickens, the level of cholesterol and triglycerides did not differ significantly from that of older chicks. A decrease in cholesterol indices was established at 3 weeks of age in chickens of the CM7 paternal line by 35.2%, in the CM9 maternal line and the maternal parental form (CM79-MPF) - by 30.3% compared with the daily age and practically remained at the same level until 5 weeks of age. At this age, an increase in cholesterol values was noted as compared with the 4-week age by 18.9%; 21.1%; 7.3% pursuant to lines

and shape. Our data on changes in cholesterol with age are consistent with other researchers [26-28]. Lipid metabolism is influenced by limited feeding of young meat chickens [29]. The amount of triglycerides in the blood of young animals of the initial lines CM7, CM9 and two-line combination CM79 remained at the same level until 2 weeks of age. In chickens of the CM7 line at 2 weeks of age, an increase in this indicator was observed by 45.5%, in the CM9 line - by 39.1%, and in the MRF - by 52.2% compared to the one-day-old age. This level of triglycerides in the blood was maintained up to 5 weeks of age of the young. According to a number of authors, the level of triglycerides in broiler chickens changes with age [30,31].

In our studies, the concentration of total protein in the blood plasma of 1-day-old chickens of lines CM7, CM9 and MRF CM79 was lower than at 1-, 2-, 3-, 4-, 5- weeks of age, which is consistent with the data of a number of authors (27.28). B.I. Kuznik [33] associates this with a low function of protein biosynthesis [32,33]

The index of total blood protein at 1 week of age was higher than in 1 day old chickens by 32.3-44.4%. The juveniles of the CM9 line exceeded this indicator in the blood plasma of the CM7 poultry by 3.8% and the MRF - by 4.3%. At 2 weeks of age, the amount of total protein in the blood plasma of chickens of this line was 34.0 g/L and remained at this level until 3 weeks of age. Then this indicator increased to 41.7-42.9 g/L ($P < 0.05$). In broilers, the authors of [34] note the growth of total protein from 14 to 42 days of age.

The indicator of calcium in the blood plasma of chickens at the age of 1 day had a low level, then in the first week it increased in the CM7 line by 43.8, in the CM9 line - by 35.3%; in the MPF - by 38.2%.

In our studies, it was found that in chickens MPF CM79 and chickens of the CM9 line at 2 weeks of age there were differences in the content of calcium in the blood plasma, in the CM9 line the calcium content was 15.9% higher than in the MPF CM79 ($P < 0.001$) and chickens. CM7 - by 10.9% ($P < 0.01$). At 4 weeks of age, an increase in the calcium content in the blood of chickens of the CM9 line was noted by 35.3% and the MPF - by 32.4% in comparison with the CM7 line. By the age of 5 weeks, the plasma calcium level reached 2.9 - 3.2 mmol/l.

Day-old chicks showed a high level of phosphorus, then it decreased 1.6-1.7 times (1 week), then (4 and 5 weeks) there was an increase in this indicator. At 2 weeks of age in chickens of lines CM7 and CM9, it was higher by 16.7% compared to the combination of CM79, and after 2 weeks, the phosphorus content in the blood plasma of MPF was 25.0% higher than in chickens of lines CM7 and CM9.

The ratio between calcium and phosphorus at the day-old age of the bird was within 1:0.8 - 1:0.9, which is associated with the embryonic period [35]. At 1 week of age, the ratio changed in the direction of increasing calcium up to 1.9: 1 - 2.1: 1; in the subsequent age period up to 2.5:1 (MPF); 2.3:1 (line CM9); 2.1:1 (line CM7). At 4 weeks, the calcium-phosphorus ratio changed in chickens of the CM9 line (2.3:1), and at 5 weeks of age it decreased to 1.2: 1 - 1.4:1.

The level of total protein in blood plasma increases with the age of the experimental bird, which was associated with the enhancement of the protein-educational function (27). Triglyceride levels rise by 33.3-59.1 by 2 weeks of age. There are differences in the level of calcium, phosphorus, and cholesterol at 2- and 4 weeks of age, and triglycerides - at 1-week of age between the MPF chickens and the parental lines.

For the first time, we obtained data on the biochemical parameters of blood plasma in birds of the original lines CM7, CM9 and the maternal parental form CM79 of the new cross "Smena 9", which are consistent with the data of other authors [30-32,34,35].

4 Conclusions

In the course of breeding meat chickens of lines CM7 and CM9 (from 2016 to 2020), there was an increase in live weight of young birds, fleshing of the chest and legs at 35 days of age, feed conversion for both cockerels and chickens by 8.8-10.0%; 0.9-1.9% and 1.0-1.9%; 1.2-1.8%. To maintain cockerel homozygosity for the *K* and *k* alleles, the offspring were evaluated annually by phenotype and using PCR. In 2020, all juveniles of the paternal line CM7 at one day of age were the carriers of the marker gene *K* (100%), the maternal line Cm9 - the carriers of the marker gene *K* (100%). The accuracy of sexing of the maternal parental form CM79 is 99.7%. From one parental pair of the Smena 9 cross, 307.6 kg of meat was obtained, which is 14.2% higher than in the previous cross.

The average daily gain of the final hybrid of the cross "Smen. 66 kg/kg; a 9" grown in the production conditions of the SGC "Smena" was 63.5 g; feed costs were at 1.66 kg/kg; preservation rate - 98.8%; the output of the pectoral muscles and the slaughter yield - 23.5 and 73.1% (against 56.3 and 71.4%).

The bird of the cross "Smena 9" is competitive.

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