Adaptability — regional aspects

UDC 636.4:636.082.14(470.44/.47)

doi: 10.15389/agrobiology.2017.4.803rus

doi: 10.15389/agrobiology.2017.4.803eng

REPRODUCTIVE AND ADAPTATION QUALITIES OF CANADIAN BREEDING HOGS COMMERCIALY REARED IN LOWER VOLGA REGION

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The authors declare no conflict of interests

Acknowledgements:

Supported by Russian Science Foundation (grant № 15-16-10000 GNUNIMMP)

Received February 7, 2017

Abstract

A purchase of foreign genetic material, including Canadian Yorkshire, Landrace and Duroc pigs, in order to increase the productivity of domestic pig breeds has recently been a steady trend in Russia. The adaptive ability of pigs is the most important feature determining their availability for industrial growing technology. The purpose of our work was to study the adaptiveness and performance of purebred Yorkshire, Landrace and Duroc pigs of Canadian selection under the conditions of OAO Cossack Holding Krasnodonskoe (Ilovinskii Region, Volgograd Province), a large regional commercial farm for growing and fattening pigs. The study was carried out in 2013-2014. In assessing natural resistance, the auto microflora of deep skin layers was estimated. The number of erythrocytes, leukocytes, the percentage of leukocytes, the phagocytic index, total blood proteins, protein fractions, and the concentration of immunoglobulins (Ig) G-, M- and A-isotypes in blood serum were also determined as parameters of natural resistance. The reproductive performance of pigs was assessed according to the data of evaluation and livestock records. On fattening, the early maturity, overall, average per day and relative live weight gain were recorded. Sperm production in boar-producers was estimated using conventional methods, based on the volume of ejaculate and sperm concentration and motility. The economic efficiency of different pig breeds was assessed on the basis of analysis of actual and on-farm annual activities. In 2014, the analysis of populations of different breeds showed that there were 832 Yorkshire breeding sows, 50 Landrace breeding sows and 58 Duroc breeding sows. The Yorkshire sows produced 2028 piglets, their livability by weaning reached 90.83 %; for the Landrace breed, there were 85 piglets and 85.88 %, respectively (4.95 % less compared to that in Yorkshire piglets), and for the Duroc breed, these figures were 88 and 85.30 % (5.53 % less compared to that in Yorkshire piglets). Among the five families of the Yorkshire sows, the largest part of the population belonged to the families of Volga (42.17 %), Soya (17.07 %) and Oka (15.86 %). The Landrace breed sows herd was concentrated in the families of Loga (23.81 %) and Luna (23.81 %). The greatest part of the Duroc sows was related to Dakota (28.00 %) and Dama (28.00 %) families. The Yorkshire boars had a fat thickness above 6-7th thoracic vertebrae equal to 14.8 mm, which was 6.61 % less compared to the Landrace breed, and 5.40 % less compared to Duroc breed. The prolificacy of Yorkshire boars was 12.16 heads, which was 0.23 and 1.46 heads more than in Landrace and Duroc breeds, respectively. In assessing the exterior indices, the Yorkshire boars were superior to the boars of Landrace and Duroc breeds by 0.33 and 0.20 points, respectively. The natural resistance characteristics have shown a higher potential for adaptability of the Yorkshire breed to new climatic conditions and technologies. Calculation of economic efficiency of pork production has shown that the income for the Yorkshire piglet sale by live weight was 1,520 and 10,640 rubles higher compared to that for the Landrace and Duroc piglets, and the profitability was 0.86 and 4.99 % higher, respectively; for the carcasses the income exceeding amounted to 0.92 and 5.30 %, respectively.

Keywords: pig breeding, purebred Yorkshire, Landrace and Duroc pigs, Canadian selec-

tion, families, line, sows, boars, reproduction

Pig husbandry is one of the successfully developing sectors of livestock husbandry. Currently, the largest pork producers are China, the EU countries, Brazil, Russia, Vietnam, Canada, Japan, the Philippines, Mexico, and South Korea. Pig husbandry in Canada possesses unique industrial technologies and traditions that allow exporting products to 40 countries. In the structure of pig population in Canada, the Yorkshire breed makes 42 %, Landrace makes 32 %, and Duroc makes 25 %. The main exporter of pigs is Canada Pork International (CPI) agency [1-4]. In order to increase the productivity of domestic pig breeds in recent years, Russia has established a stable trend in buying foreign genetic material. In this, focus is made on specific systems used in breeding, and on the degree of hybridity compared to regional genotypes. Experts conduct a system monitoring of domestic and imported pig breeds which allows breeders to optimize crossings and facilitates an increase in breeding efficiency, particularly, with emphasis on gain of productivity and improved adaptiveness of animals. Adaptation is a necessary precondition for the realization of the genetic potential of productivity, and an important factor in increasing animal resistance and preventing against various diseases [5, 6]. Adaptive abilities are the features of animal vital activity in unaccustomed conditions, behavioral responses, anatomy, natural resistance, responses to external stimuli, associated with a set of conditioned and unconditioned reflexes [5-7].

Long inbred breeding leads to a decrease in genetic diversity within the isolated groups and causes a decrease in productivity. At the same time, traditional breeding techniques are ineffective for the improvement of poorly heritable features, such as fecundity, milk producing ability of sows, livability of piglets [6-9]. In the provinces of Alberta and Ontario, Canadian scientists are working towards preserving the genetic diversity of Duroc, Hampshire, Yorkshire, and Landrace pigs through a system approach to selection. It is established that the average productive longevity of the breeding stock is 6 years. At the same time, some researchers note the high quality of selection and breeding work carried out in specialized farms in Canada. This work can be controlled through the purposeful recording of inbreeding within the breeds [10, 11]. Innovative methods of are needed to produce pigs capable of inheriting the characteristics of several breeds.

Pig stock of Canadian selection is being imported for exploitation in the Volgograd Province. Note, in Canada, the Yorkshire, Landrace and Duroc pigs were intercrossed to obtain a highly productive commercial hybrid with optimal quality indicators, which is crucially important for commercial domestic pig husbandry (10-12).

In 2008, the OAO Cossack Holding Krasnodonskoe (Volgograd Province) imported Yorkshire, Landrace and Duroc pigs of Canadian breeding aged 3-4 months. After an adaptation period, these animals showed early maturity and productivity [12]. The purchase of pedigree material from Canada continued in order to increase the consolidation of the genes of the best Yorkshire, Landrace and Duroc lines [7].

The adaptive abilities of pigs are the most important feature that determines their suitability for commercial rearing. Criteria of the degree of animal adaptation in changing environmental conditions are indicators of the reproductive capacity and natural resistance of sows, as well as the productivity of boars [13-15]. Another approach to studying the adaptive abilities of pigs is markers associated with a number of genes encoding target traits found both in domestic pig breeds [16-20] and in their evolutionary relatives, the wild boars [21].

This research for the first time reported a set of indicators that allowed

exhaustively estimating the physiological state and reproductive capacity of Yorkshire, Landrace and Duroc Canadian breeds while adapting to new climatic and technological factors in the conditions of the large Russian commercial pig breeding farm. The obtained results confirmed the high genetic potential and stable heritability of productive qualities in all three breeds. At the same time, a number of parameters (yield and livability of piglets, natural resistance) revealed the advantage of Yorkshire pigs.

The aim of this work was a comparative assessment of the adaptiveness of different pig breeds of Canadian selection and the realization of their genetic potential of growth, development, productivity and reproductive qualities in the conditions of the Lower Volga region.

Techniques. The research was carried out in 2013-2014 in the commercial pig husbandry complex (108 thousand heads) of OAO Cossack Holding Krasnodonskoe (Ilovinskii Region, Volgograd Province) on Yorkshire, Landras and Duroc pigs. Animal feeding and housing corresponded to those accepted in the farm.

Morphological, biochemical and immunological analyses of blood were carried out on 6 analogue individuals from each group of pigs. The auto microflora of deep skin layers was estimated [22]. The number of blood erythrocytes, leukocytes, percentage of leukocytes, and phagocytic index was determined by conventional methods. The concentration of immunoglobulins (Ig) G, M and A isotypes in blood serum was evaluated by the classical method of radial immunodiffusion with monospecific antisera and monoclonal antibodies to each isotype of immunoglobulins, as well as with the standard blood serum of a pig with a known level of each immunoglobulin isotype [23-25].

To compare the reproductive ability of pigs, the data of valuation and zoo-technical records were used in the order established for the pedigree reproducer. The physiological state of the animals was established according to blood indices. When fattening, early maturity (days), absolute (kg), average per day (g), and relative (%) live weight gain were recorded. Sperm production in boars was estimated using conventional methods based on the volume of ejaculate and sperm concentration and motility.

The economic efficiency of growing different pig breeds was assessed based on the actual and on-farm annual activities.

The experimental data was processed in Statistica 6.0 software (StatSoft, Inc., USA) using variation statistics methods and determining the reliability criterion for the Student-Fisher difference at three probability levels. The arithmetical mean (M), error of mean ($\pm m$), Student-Fisher reliability t -criterion, and validity coefficient (p) were calculated.

Fig. 1. Age and sex composition of Yorkshire (a), Landrace (b) and Duroc (c) pigs of Canadian selection in OAO Cossack Holding Krasnodonskoe: 1 — main boars, 2 — test boars, 3 — main sows, 4 — test sows, 5 — replacement boar pigs, 6 — replacement sow pigs (Ilovinskii Region, Volgograd Province, 2013).

Results. In OAO Cossack Holding Krasnodonskoe, the number of pedigree animals was 498 for Yorkshire, 50 for Landras, and 58 for Duroc (Fig. 1). The Yorkshire sows were the largest part of the livestock (88.51 %), and the Landrace (50 %) was the leading breed in the number of the main boars served as producers (see Fig. 1).

Bacterial seeding for auto microflora from the deep layers of the skin revealed high-

er values of the analyzed parameter in Landrace and Duroc animals compared to the Yorkshire breed analogues. In Yorkshires, when a decrease of auto microflora count to 3.34 ± 0.31 CFU/cm², the blood erythrocytes, lymphocytes and albumins increased significantly ($P \geq 0.05$) by 5.6 %, 6.9 % and 22,0 %, respectively. The phagocytic index was 20 % higher than that in Landrace and Duroc animals, in which the auto microflora counts were 5.2 ± 0.29 and 6.6 ± 0.39 CFU/cm², respectively.

In Yorkshire sow pigs, the blood concentration of all immunoglobulins was higher than that of Landrace and Duroc animals, i.e. IgG was 11.69 % and 16.13 % higher ($P \leq 0.05$), IgM was 17.76 % ($P \leq 0.01$) and 31.78 % ($P \leq 0.001$) higher, and IgA was 25.76 % ($P \leq 0.01$) and 43.94 % ($P \leq 0.001$) higher (Table 1).

1. Blood immunoglobulin concentration (mg/ml) in pigs of Canadian origin under the conditions of OAO Cossack Holding Krasnodonskoe ($M \pm m$, Ilovinskii Region, Volgograd Province, 2013)

Breed	IgG	IgM	IgA
Yorkshire ($n = 6$)	24.80 ± 1.39	3.21 ± 0.09	1.32 ± 0.08
Landras ($n = 6$)	21.90 ± 0.89	$2.64 \pm 0.13^{**}$	$0.98 \pm 0.06^{**}$
Duroc ($n = 6$)	$20.80 \pm 0.92^*$	$2.19 \pm 0.11^{***}$	$0.74 \pm 0.05^{***}$

*, **, *** Differences with indexes in Yorkshire pigs are statistically significant at $P \leq 0.05$, $P \leq 0.01$ and $P \leq 0.001$, respectively.

The most important stage in studying adaptive capabilities of sows is the evaluation of their productivity, including such parameters as prolificacy, size of piglets, their livability, milk producing capacity estimated by the weight of 21-day old piglets in a litter. According to the records of 2014, Yorkshire sows produced 2028 piglets, their number by weaning reduced to 1842, i.e. livability by weaning was 90.83 %. As for the Landrace sows, there were 85 piglets, 73 of them left alive by weaning with livability of 85.88 % which was respectively 4.95 % less compared to that in Yorkshire piglets. The Duroc sows produced 88 piglets, 75 of them surviving by weaning with livability of 85.30 % which was 5.53 % less compared to that in Yorkshire piglets. The milk producing capacity of sows at weaning estimated by weight of 21-day old piglets was 87.5 kg in the Yorkshire breed, which exceeded the index of the Landrace and Duroc animals by 1.2 and 9.5 kg, respectively. Former studies reported on the impact of adaptive abilities of animals on their productive indicators [6, 13, 14, 17].

Analysis of the data on the main sows showed that of 16,728 piglets derived from the Yorkshire animals in 2014, 15,195 survived by weaning, the livability being 90.84 %. These figures for the Landrace sows were 678 and 610 pigments, respectively, the livability of 89.8 % or 1.04 % less than in the Yorkshire piglets. As for the Duroc breed, the figures were 755 and 646, the livability of 85.56 %, being 5.28 % compared to that for the Yorkshire breed. The data obtained indicates that Yorkshire sows showed higher reproducing ability compared to the Landrace and Duroc peers, which characterizes their pedigree features.

Figure 2 shows the division of the OAO Cossack Holding Krasnodonskoe the sow population in 2013 into families (Fig. 2). Among the five families of Yorkshire sows, the largest part of the population belonged to the families of Volga (42.17 %), Soya (17.07 %) and Oka (15.86 %) sows. The Landrace breed sow herd was concentrated in the families of Loga (23.81 %) and Luna (23.81 %) sows. The greatest part of the Duroc sows was related to Dakota (28.00 %) and Dama (28.00 %) families.

In general, Yorkshire sows surpassed the Landrace and Duroc analogues according to their reproductive qualities. However, the fattening indicators in Duroc and Landrace pigs were higher than those of Yorkshire ones. Such differences are explained by the fact that the Yorkshire breed has a com-

bined type of productivity, the Landrace breed has a bacon type, and the Duroc breed is of a meat type.

Fig. 2. The structure of sow populations (heads) of Yorkshire (A), Landrace (B) and Duroc (C) breeds of Canadian origin in OAO Cossack Holding Krasnodonskoe as divided into families of sows: a — Volga, b — Oka, c — Rona, d — Sena, e — Soya; f — Lavla, g — Leya, h — Lipa, i — Loga, j — Luna; k — Dakota, l — Dama, m — Dvina, n — Diva (Ilovinskii Region, Volgograd Province, 2013).

Pedigree boar pigs of Yorkshire, Landrace and Duroc breeds belonged to the genealogical lines 4, 4 and 3, respectively. Yorkshire boars reached a body weight of 100 kg at the age of 149.8 days, and their maturity rate was 1.02 % higher than that of Landrace boars, and 4.14 % higher than that of Duroc boars. In this, Yorkshire boars needed 0.06 and 0.06 less feed units, or by 2.36 and 2.36 %, respectively, per 100 kg body weight compared to Landrace and Duroc peers. The Yorkshire boars had a fat thickness above thoracic vertebrae 6–7 equal to 14.8 mm. It was 6.61 % less compared to the Landrace breed, and 5.40 % less compared to Duroc breed. In assessing the exterior indices, the Yorkshire boars were superior to the Landrace and Duroc boars by 0.33 and 0.20 points, respectively, and had the prolificacy index of 12.16 heads, which was 0.23 and 1.46 heads more than in Landrace and Duroc breeds, respectively. Thus, the Yorkshire boars of the combined productivity stand out with their high growth rate, which was characterized by a faster achievement of 100 kg body weight at a relatively low feed cost, and also had a high prolificacy index compared to the Landrace and Duroc boars.

Breeding and intensification of pork production needs the best producers, for which the young boars from highly productive breed lines are purchased. It is necessary to take into account the reproductive ability and sexual activity of animals, as well as their own productivity [13, 14].

In our studies, Yorkshire boars, as compared to the Landrace and Duroc analogues, had higher ejaculate volume (by 13.64 and 12.44 %, respectively); the sperm concentration was 7.69 and 7.69 % higher; the motility of the sperm was 3.22 and 5.0 % higher; the total number of spermatozoa with linear motion was 8.95 and 8.33 % higher (Table 2). That is, as for sperm production, Yorkshire boars exceeded the Landrace and Duroc peers.

2. Sperm production in boars of Canadian origin under the conditions of OAO Cossack Holding Krasnodonskoe ($M \pm m$, Ilovinskii Region, Volgograd Province, 2013)

Boar name and number	Ejaculate volume, ml	Sperm concen- tration, bln/ml	Sperm motili- ty, %	Spermatozoa with linear motion	
				bln	%
Yorkshire (n= 6)					
Reyn 61834	165.00±7.40	0.26±0.03	85.00	28.00±0.63	84.20
Don 67305	170.00±6.40	0.28±0.02	90.00	26.00±0.58	85.40
Khoper 67455	128.00±5.90	0.25±0.01	80.00	31.00±0.62	85.60
Khoper 72030	155.00±6.20	0.26±0.02	90.00	29.00±0.56	82.60
Nil 72031	170.00±7.30	0.25±0.03	85.00	30.00±0.59	81.20
Averaged	157.60±7.89	0.26±0.01	86.00	28.80±0.86	83.80

Landrace (n=6)					
Lev 2705	150.00±5.40	0.25±0.06	85.00	28.00±0.54	85.00
Lev 3381	120.00±4.80	0.23±0.04	80.00	24.00±0.49	84.00
Lev 3384	150.00±5.50	0.22±0.05	80.00	24.00±0.56	80.00
Lider 2986	135.00±4.60	0.25±0.07	85.00	28.00±0.62	84.00
Lider 3377	150.00±5.60	0.23±0.08	80.00	24.00±0.54	80.00
Lot 2690	110.00±4.70	0.25±0.04	85.00	28.00±0.61	85.00
Lot 1004	150.00±4.90	0.25±0.06	85.00	28.00±0.59	85.00
Lot 1006	130.00±4.70	0.23±0.03	80.00	24.00±0.62	80.00
Lir 1007	130.00±4.60	0.25±0.05	85.00	28.00±0.61	85.00
Averaged	136.11±4.98	0.24±0.00	82.78	26.22±0.70	83.11
Duroc (n=6)					
Dok 3444	150.00±5.60	0.26±0.03	85.00	26.00±0.64	80.00
Dok 4023	150.00±5.40	0.25±0.05	80.00	24.00±0.56	85.00
Dinar 445809	130.00±4.60	0.23±0.04	75.00	28.00±0.63	85.00
Dinar 4022	150.00±4.90	0.23±0.02	80.00	28.00±0.61	80.00
Denver 246	110.00±3.90	0.25±0.06	85.00	26.00±0.58	85.00
Averaged	138.00±8.00	0.24±0.01	81.00	26.40±0.75	83.00

In Yorkshire breed, when fattening piglets from one sow (10.9 heads) not heavier than 100 kg, a yield of 1090.00 kg body weight and 843.66 kg for carcass can be averagely produced. The production costs when growing Landrace and Duroc pigs is higher than that of the Yorkshires, since their fattening to the same body weight takes 1 to 6 days more. The income for the Yorkshire piglet sale by body weight was 1,520 and 10,640 rubles higher compared to that for the Landrace and Duroc piglets, and the profitability was 0.86 and 4.99 % higher, respectively; for the carcasses, the income exceeding amounted to 0.92 and 5.30 %, respectively.

Thus, in the Lower Volga region in pig breeding commercial complex, pigs of Yorkshire, Landrace and Duroc Canadian breeds as a whole had high productivity. It is shown that animals of these breeds have high genetic potential with a stable inheritance of productive qualities by descendants. At the same time, the Yorkshires produced more piglets with higher livability, which ensured a greater yield of products per sow. The natural resistance characteristics of this breed have shown a higher potential for their adaptability to new environment and technologies. In order to increase biodiversity and improve the domestic production of pork, it is advisable to use pedigree animals of Yorkshire, Landrace and Duroc breeds from both already existing, and new lines.

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