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COMPARATIVE ANALYSIS OF LOCAL PIG BREEDS IN CHINA AND RUSSIA

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Abstract
Pork is a favorite type of meat with a large share in the structure of consumption worlwide, including China and Russia. Pork production in China and Russia has been constantly growing over the last years. This type of meat remains to be in high demand due to its sensory properties despite consumer attitude to pork fat content. This review presents the short history of pig farming in China and Russia, as well as the modern trends in the development of this industry. The data on the pork production and consumption in two countries over the last years are compared. Characteristics that consumers consider important when buying pork and negative factors influencing consumer choice are described. Consumer properties of meat products from pork depend on keeping conditions and feeding of animals. Meat composition and functional properties depend greatly on pig breed. Information about pig breeds that are raised in China (depending on a region) and Russia, as well as indicators of productivity of pigs of certain breeds, are presented.

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Introduction

History of pig breeding

Domestication of pigs began 4–9 thousand years ago, taming 7–10 thousand years ago. The development of breeds dates back thousands of years [1]. It is believed that the progenitors of domestic pigs are European wild boar, which lives in the significant part of Europe, Northern Africa and certain regions of Asia, and Asian wild boar (often called Indian wild boar), which is found in the South and East Asia (China, Japan and others). The first group is known under the name of *Sus scrofa* and the second one under the names of *Sus orientalis*, *Sus cristatus*, *Sus vittatus* [2].

China

The history of pig breeding in China can be traced back to 9,000 years ago [3]. A variety of local pig breeds had gradually formed under the complex and diverse ecological environments and socio-economic conditions in China [4]. Before the 20th century, the local breeds accounted for the vast majority of pigs in China. The breeding of pigs was focused on environmental adaptation, disease resistance, meat quality, and local cultural aesthetic preferences and consumption requirement. As a result, many pig breeds with local characteristics were formed, such as the cold-resistant Northeastern native pig, the Jinhua pig, which is suitable for making cured ham, and the prolific Taihu pig [5].

From the 1950s to the early 1970s, China began to adopt intensive pig farming, and pig breeds were gradually optimized mainly through specialized breeding of boars [6]. In particular, a number of foreign breeds were imported, such as the Large White, Duroc and Pietrain pigs. At the same time, breed improvement was also carried out domestically, such as selecting and breeding on the basis of the Taihu pig, resulting in new breeds such as Sutai and Dianlu [7]. From the 1980s to the early 1990s, the pig farming in China gradually moved towards modernization, large-scale, and scientific management, and pig breeds were continuously crossbred, with the high-quality foreign breeds as the mainstay [8]. During this period, based on the comprehensive evaluation system, multiple high-quality pig

breeds were established in China, such the Sanjiang white pig, Hubei white pig, and Duhu [9]. Since the beginning of the 21st century, the pig breeding industry in China has paid more attention to bio-security and sustainable development, as well as the pig breeds with high quality and disease resistance [10].

During this process, the pig farming industry in China confronted many challenges and opportunities. In particular, China experienced an outbreak of swine fever in 2004, and then suffered the African swine fever in 2013 and 2018, which brought the great threat to the pig farming industry [11]. As Chinese economy grows, the demand for pork increases. In 2007, China signed a pork import agreement with the United States of America, and the price of pork constantly increased to a historical peak in 2011. Therefore, to stabilize pork prices in the market and prevent social instability caused by price fluctuations, the Chinese government announced the launch of the pig reserve system.

Russia

Based on the data of ancient literature sources, Russian scientists came to a conclusion that animal husbandry was more significant than hunting on the middle part of the territory of the future Russia and then the USSR as far back as the 1st millennium BCE. After studying ancient settlements and bone remains, researchers presented the following data on the main species of raised livestock: cattle 50.5%, horses 41.5%, pigs 4.05%, sheep and goats 4.0%. In the 2nd millennium CE the ratio between the livestock species changed: cattle from 20 to 60% depending on the location of settlements; pigs from 21 to 58%, sheep and goats from 12 to 35%; horses from 6 to 22% [12].

According to the classification of the German zoologist Hermann von Nathusius, stud breeds are characterized by the following traits: animals that are more productive with regard to the weight of the consumed part of the body (that is, meat and fat) have a shape of the body close to a parallelogram, their head and limbs are smaller, and they are more valuable for a household. Pigs of common breeds have a length of the head (from the eyes to the end of the face) that relates to the length of the whole body as 1:6, this ratio in stud breeds of pigs is 1:9 and sometimes 1:11 [13].

To promote pig farming in Russia, the government organized the state-owned farms, for which foreign breeds were brought into the country at the end of the 19th century. The most common were English stud breeds: Yorkshire and Berkshire. In the 1880s, over 6,000 pigs of the Hungarian breed, Tamworth breed (England) and several heads of the Spanish breed were brought into the country.

According to the census of 1898, the total pig population in the world was 100 million. The highest number was in the United States (about 40 million), the second place was occupied by Germany (14 million), the third place by Russia (11 million), followed by Austria-Hungary (10.5 million), France (6 million), Great Britain (2.5 million), Italy (2 million), Spain (2 million), Romania and the Netherlands (1 million each), Serbia (900 thousand), Denmark (800 thousand), Sweden and Norway (900 thousand) and others [12].

In Russia, there were 15,670,000 pigs in 1912 and 21,438,000 pigs in 1916 according to the data of the Veterinary Directorate. The First World War, revolutions of 1905 and 1917, and the Second World War led to problems with food, including a sharp decline in agricultural production. The period of animal husbandry recovery lasted up to 1953 [12].

The number of pigs was 28,341.3 thousand heads in March 2023, which was 5.7% higher than in March 2022. The vast majority of pigs (almost 93%) are raised in agricultural organizations, 6.5% in the households and 0.8% on farms [14].

Materials and methods

Sources. Articles were searched both on the Chinese, Russian and international information and analytical portals and databases like CNKI (China National Knowledge Infrastructure, http://www.cnki.net), Wanfang database (https://www.wanfangdata.com.cn), elibrary.ru, Scopus and Web of Science. The following keywords were used: pig, breed, productivity, carcass quality, pork.

The review includes data from published articles, reviews, thesis, the Russian Encyclopedia, the State Register of Breeding Achievements in Animal Breeding in the Russian Federation, the Federal State Statistics Service, the National Bureau Statistics of China, from 2010 to 2023. Monographs of 1952 and 1985 were used to describe the history of pig breeding.

Inclusion and exclusion criteria were used to define the following indicators: pork production, meat and pork consumption, pig breed composition, pig breed productive popularity profile in Russia and China. The data obtained were summarized in tables. During the selection, attention was paid to sources where information about consumer preferences and factors influencing changes in pork consumption were presented. When identifying publications with the same type of results, later editions were selected. At the next stage, data were combined into tables for comparison and analysis.

The aim of the study was to introduce pig husbandry, consumer attitude to pork and pork consumption in China and Russia, reveal and describe local pig breeds.

The current situation and trends of pork industry development in both countries

Pig farming is one of the most dynamically developing and profitable agricultural branches worldwide, including Russia and China.

According to USDA and EC statistics, the global pork production was 122.4 million tons in 2021. China is the largest pork producer in the world followed by the United States and the European Union, which produced 40 (32.68%), 23 (18.79%), and 12 (9.80%) million tons of

pork per year, respectively [15]. In addition, China is the largest pork food supplier in the world. It has been shown that pork food supply in China reached 385 million tons in 2021, while it was 210 and 124 million tons in the EU and the United States, respectively [16]. In 2021, for the first time, the scale rate of pig farming reached 60% in China.

Table 1. Pork production in China and Russia

Years	Pork production (million tons)		Growth rate of pork production (%)	
	China [17,18]	Russia [19]	China	Russia
2010	51.38	2.34	4.16	7.27
2011	51.32	2.43	–0.12	2.88
2012	54.44	2.56	6.08	5.08
2013	56.19	2.82	3.21	9.22
2014	58.21	2.96	3.59	4.73
2015	56.45	3.08	–3.02	3.9
2016	54.25	3.36	–3.90	8.33
2017	54.52	3.52	0.50	4.76
2018	54.04	3.74	–0.88	5.88
2019	42.55	3.94	–21.26	5.08
2020	41.13	4.28	–3.34	7.94
2021	52.96	4.30	28.76	0.47
2022	55.41	4.53	4.63	5.08

The volume of pork production in China reached 51.38 million tons in 2010, followed by a minor decline in 2011. From 2011 to 2014, pork production was increasing year by year, and reached 58.21 million tons in 2014. Then, a decrement and stagnation of pork production was observed in the following 4 years. In 2019, pork production fell by 21.26% and then gradually recovered to 55.41 million tons in 2022 (Table 1).

In Russia, the volume of pork production of 2.8 million tons was achieved in 1992 with the proportion of industrial pork production accounting for 60% of total (1.684 thousand tons in slaughter weight). Then stagnation came, which lasted more than 10 years. By the beginning of the 2000s, pork production reduced almost by half to 1.5 million tons in slaughter weight with the four-fold decrease in the industrial sector [20].

In 2005, transformations began within the framework of the "National projects on the agro-industrial complex", which was further developed in the "The state program for the development of agriculture in 2008–2012". The main task of the national project "Pig farming" was the modernization of the industry, including construction of new and reconstruction of the existing pig raising complexes based on the modern achievements in the practice of keeping and feeding; the use of modern achievements of genetics in formation of the parent herd of commercial complexes that determine the best quality indicators of productivity; specialization of enterprises in breeding and commercial production, including within agroholdings and their cooperation with personal and farm enterprises.

As a result, the volume of industrial pork production increased by almost three times (by 2.6 million tons) in 2010–2021 compared to 2000, while production increased by more than 8 times [21].

The main strategic challenge of pig farming for the next 10 years is entering the top five world pork exporters [22].

Pork is a favorite product both for the Russians and the Chinese. Pork is the most common animal protein for the Chinese [23]. The muscle fibers of pig are fine and soft, with less connective tissue and intermuscular fat. Pork accounts for close to or more than 60% of domestic meat production and consumption in China. From 2013 to 2022 the meat consumption in China was more than 24 kg/capita/year. The proportion of pork consumption was basically maintained at more than 75%, with a minimum of 73.39% in 2020 and a maximum of 78.13% in 2014 (Table 2).

Table 2. The meat and pork consumption in China and Russia [17,21,24]

Year	Meat consumption without regard for poultry meat (kg/capita/year)		Pork consumption (kg/capita/year)		Ratio of pork to overall meat consumption (%)	
	China	Russia	China	Russia	China	Russia
2013	25.6	44.9	19.8	26.6	77.34	35.42
2014	25.6	41.4	20.0	23.5	78.13	32.10
2015	26.2	39.4	20.1	23.3	76.72	32.50
2016	26.1	40.0	19.6	24.5	75.10	33.84
2017	26.7	40.8	20.1	25.6	75.28	34.18
2018	29.5	40.8	22.8	25.5	77.29	34.00
2019	26.9	41.7	20.3	26.7	75.46	35.13
2020	24.8	42.7	18.2	27.9	73.39	36.52
2021	32.9	42.6	25.2	28.3	76.60	36.80
2022	/	47.8	/	29.8	/	37.72

In Russia, the proportion of pork in the meat balance was 52% in 1940 [2]. Nowadays, the proportion of pork in the overall consumption is slightly more than 30% (Table 2) and exceeds the corresponding indicator in China (by more than 1.5 times in 2013, and by 1.3 times in 2021). Pork consumption per capita in Russia is higher than in China, but the difference between Russia and China in terms of this indicator is gradually decreasing. For example, it was 6.8 kg in 2013 and 3.1 kg in 2021. In 2022, pork consumption in Russia was 37.72%.

The survey of 2018 showed that more than 70% of the Russians over the age of 14 eat pork several times a week [25].

Curiously, the share of beef, goat meat, lamb and meat from other animal species is slightly more than 6 kg. Thirty five years ago, however, the ratio between pork, beef and poultry meat was 30:30:30%.

Pork consumption specificity in China and Russia

Pork is the major meat commodity consumed by Chinese people, while quality and price are the two most important factors that consumers consider when purchasing pork [26]. In addition, the nutritional content of meat, such as the

content of fat, protein, minerals and vitamins, is also important for consumers [27]. Fresh pork is bright red in color, tender, with white and elastic fat and gray tendon on the surface [28]. Most consumers choose fresh pork, and surveys showed that the vast majority of people (90.77%) accepted fresh pork priced below 40 RMB/kg [29].

Apart from quality and price, consumers also take into account pork cuts. It has been found that consumers have a wide range of choices regarding the cut, with fatty pork and tenderloin being the most popular, followed by front leg meat [30,31].

Russian consumers also consider positively consumption of fatty pork [32].

Pork is widely used in manufacture of meat products in enterprises in Russia. The first and second dishes, sausages, hams, rolls, "buzhenina" (roasted pork), loin, belly, semi-finished products, dried meat and other meat products that are in high demand among the population are produced from pork. Products from speck, especially, "salo" (backfat), are very popular among the Russians.

It is worth noting that the opinion of Russian consumers about pork has changed noticeably. Aggressive pressure of mass media, publications and TV shows have linked the upsurge in cardiovascular diseases and excessive body weight to the presence of cholesterol in animal fat. Physicians and dietarians supported this company. Pork was especially targeted. As a result, consumers began to reject pork explaining rejection by the presence of harmful speck in it. In response to consumer demand, bacon pigs (Landrace) were bought from abroad, and then several local breeds were developed. It is remarkable that in 1935–1940 there were also discussions among pig breeders about the expediency of lean-meat pig development ("baconization"). The opponents of baconization argued that "hound-gutted, flat animals with the weak back" were obtained as a result [2].

Surveys note several groups among consumers: (1) those who eat pork without paying attention to negative publications about it in mass media; (2) those who choose only lean pork and consider pork speck harmful to health and (3) a small group of consumers who understand both positive and negative nutritional characteristics of pork and eat it according to this knowledge.

A survey of consumers carried out in 2022 along with netnographic studies showed that from 39% (for minced pork) to 49% (for chilled meat) of consumers continue to buy pork despite the negative information appearing in mass media. Curiously, the proportion of respondents who answered that they did not buy frozen meat was 59%. With that, respondents prefer to buy meat in specialized farm stores [33].

The optimal ratio of ω-6 to ω-3 PUFA (10.76) in lipids of muscle tissue allows assigning lean pork and food products from it to healthy nutrition products [34].

Pig breeds with marble meat are considered to be very valuable nowadays. It is worth noting that the consumer characteristics of marble meat were already mentioned by A. P. Redkin back in 1952 [2]!

Over the last years, the growth in consumption has been recorded for chilled and frozen semi-finished products, including those from pork. This trend is clearly seen in large and medium-sized cities and is conditioned by the dynamic lifestyle of the Russians [35].

Pork palatability, composition, tenderness and fatness to a large extend depend on a breed, feeding and raising conditions.

Breed composition and productivity of local pig breeds

Local pig breeds in China

Pig industry has a long history in China, and owns rich pig breeds and genetic resources. There were as many as 76 local pig breeds in China in 2011 [36]. Based on their characteristics, such as size, appearance, production performance, distribution location, and ecological and natural conditions, Chinese local pig breeds are roughly divided into North China, South China, Central China, Jianghai, Southwest China and Plateau types [37]. These local pig breeds show diversity in terms of body shape, reproductive performance, intramuscular fat content, and flavor substance content. However, since the 1980s, a large number of foreign pigs have been imported because of their good growth performance and high leanness. Since then, the number of local pig breeds in China has gradually declined.

Local pig breeds in north China

North China refers to the north of the Qinling Mountains-Huaihe River line, including North China, Northeast China and Mengxin District [38]. The main farm crops in these areas are winter wheat and summer corn. This region is one of the important grain production bases in China. The major local pig breeds in north China include Laiwu pig, Min pig, Huabei pig, and Dingyuan pig, and their growth performance is shown in Table 3. Among them, Laiwu pig is the representative pig breed, which is mainly found in Laiwu District, Jinan City, Shandong Province, China. The head bones of modern Laiwu pigs and those of ancient Laiwu pigs (lived 5,300–6,500 years ago) are almost identical, providing archaeological evidence of the long history of Laiwu pig, which is more than 5,000 years [39]. The Laiwu pig is famous for its high reproductive and nursing ability, excellent meat quality, and rich flavor substances [40]. In particular, it is characterized by a high intramuscular fat content (with an average of 11.6%), which is 9 times and 2–3 times higher than that of Yorkshire pig and other local pig breeds, respectively [41]. The intramuscular fat can improve the muscle texture by increasing the water-holding capacity and juiciness without affecting tenderness. Therefore, meat of the Laiwu pig has a rich and mellow flavor (Table 3).

Local pig breeds in south China

Local pig breeds in south China are mainly found in the south of Nanling and Pearl River basins in China, including the southwestern and southern border areas of

Table 3. Indicators of productivity of local Chinese pig breeds [36–53]

Characteristic \ Breed	North China type				South China type			
	Laiwu pig	Min pig	Huaibei pig	Dingyuan	Tunchang pig	Luchuan pig	Bama Miniature pig	Diannan Xiaoer pig
								
Body length, cm	94–104	147	129–147	119–128	93–105	124–125	50–75	103–109
Backfat thickness, mm	37–45	37	35	27–37	25–42	36–60	22–24	32
Age to 90 kg body weight, days	180–210	240	240	300	315 (90 kg)	240 (70 kg) 360 (90 kg)	180 (20 kg)	300 (70 kg)
Piglets per litter, number	10–13	13–14	6–12	7–12	8–13	8–10	8–12	7–10
Average weight gain, gram	700–1,000	326	434	533–547	300–450	321	100	155–360
Feed conversion ratio, units	2.6–3.0	4.2	3.5–3.6	3.3–3.4	3.5	4.13	4.7	4.3–5.0
Average carcass yield, %	69–73	72–74	70–73	72–76	69–77	63–68	60–61	68–74
Average lean meat yield, %	41–51	47–58	44–52	46–48	45	36–39	49	35–40
Longissimus dorsi area, cm²	25–36	20	21	26–30	27–30	21	12–19	13

Table 3. (continued) [54–64]

Characteristic \ Breed	Central China type				Jianghai type				
	Jinhua pig	Ningxiang pig	Xiangxihei pig	Fuzhouhei pig	Erhualian pig	Meishan pig	Jiaxinghei pig	Shawutou pig	Shawutou pig
									
Body length, cm	122–127	119–122	127–136	150–164	123–142	143–161	124–139	143–150	136–142
Backfat thickness, mm	38	46	33	33–35	36	36–40	38	37–40	39–42
Age to different body weight, days	300 (75 kg)	240 (70 kg)	240 (70 kg)	240 (70 kg)	210 (70 kg)	300 (100 kg)	240	240	240 (80 kg)
Piglets per litter, number	13	8–11	7–11	10–12	12–16	15–16	11–15	11–13	12
Average weight gain, gram	456–472	368–400	300–354	400–500	350–380	430–480	425	425–451	434–453
Feed conversion ratio, units	3.0–3.6	4.5–4.7	3.5–3.7	3.5–3.9	3.7	3.5–4.0	3.0–4.0	3.7	3.7
Average carcass yield, %	68–72	68–72	73–74	72	61–65	64–68	68	65	66–69
Average lean meat yield, %	43	35–40	41–46	47	43–45	42–45	42–56	46	35–47
Longissimus dorsi area, cm²	19–20	18–22	21–23	21–25	25–29	17	16	18–19	15–19

Table 3. (continued) [65–84]

Characteristic \ Breed	Southwestern type local pig breeds					Tibetan pigs	
	Rongchang pig	Chenghua pig	Yanan pig	Wujin pig	Neijiang pig	Diqing Tibetan pig	Zangxiang pig
							
Body length, cm	139–157	135–138	139–141	120–125	130–152	82–88	68
Backfat thickness, mm	55	25–29	25–33	45–52	33–40	2,1–5,4	2,1
Age to different body weight, days	240 (80 kg)	240 (90 kg)	270 (90 kg)	240 (80 kg)	190 (90 kg)	360 (50 kg)	540 (40 kg)
Piglets per litter, number	6–11	9–12	8–10	8–9	8–12	6–8	5–7
Average weight gain, gram	513–571	358–464	350–400	120–320	373–544	235–342	173
Feed conversion ratio, units	3.2–3.7	4.1–4.6	4.2–4.5	4.5	4.0–4.2	4.3–4.8	—
Average carcass yield, %	69–76	68–70	70–73	72–78	68–71	60–65	65–66
Average lean meat yield, %	40–46	41–46	43–44	45–56	40–44	52	52–55
Longissimus dorsi area, cm²	18–21	17–19	18–23	18–24	18–23	—	10–17

Yunnan, Guangdong, Guangxi, Fujian, Hainan and Taiwan Provinces. Representative pig breeds are the Guangdong-Guangzhou floret pig, Xiang pig, South Yunnan small-eared pig, Hainan pig, Guangdong black pig, Huai pig, Taiwan pig and so on. This type of pig breeds is characterized by the small size, short mouth, concave face, small and erect ears, and mostly black and white coat color. Specifically, the local pig breeds in south China are generally short, broad and round, with a large, pendulous belly, plump and round legs and hips, thin and hairless skin, short bristles, and loose bodies. Local pig breeds in south China are sexually mature at early age with estrus at 3–4 months and bred at 6 months with 8–10 piglets per litter. In addition, the slaughter rate is higher and meat is tender than meat from other breeds.

Tunchang pigs, a type of Hainan pig, are native to Tunchang County, Hainan Province, China. They have the advantages of early puberty, high fertility, resistance to rough feeding, strong disease resistance, and good meat quality. However, Tunchang pigs grow slowly and have low birth weights. Therefore, Duroc boars are usually used for cross-breeding with Tunchang sows. The pig is also named "Tunchang black pig" because of the all-black fur [46,47]. The typical rearing regime of Tunchang pigs is mainly a combination of indoor and outdoor rearing. The feed formula for housed Tunchang pigs mainly consists of corn, cassava, sweet potato, rice bran, peanut cake and so on. At the same time, fresh stems and leaves of cassava or sweet potato, sweet elephant grass, and king grass are used as green fodder. At the medium pig stage (body weight 30–65 kg), green fodder may account for more than 15% of the diet; at the large pig stage (body weight 66–100 kg), grazing may be practiced [46] (Table 3).

Local pig breeds in central China

Local pig breeds in central China include Ningxiang pigs, Jinhua pigs, Jianli pigs, and Dahuabai pigs, which are mainly found in the vast area between the Yangtze River and the Pearl River. The growth performance of local pig breeds in central China is between the North China and South China types, while the reproductive performance is above average. Meat is tender and of good quality.

The Jinhua pig, also known as the Jinhua two-headed black pig, has a long history and is one of the four famous local pig breeds in China. Jinhua pigs have excellent characteristics such as early sexual maturity, good meat quality, and high reproductive rate. The cured "Jinhua ham" is of excellent quality and famous at home and abroad.

The marbling score of meat from Jinhua pigs at 35, 80, and 125 days of age was 50.48%, 50.00%, and 28.92%, respectively, which was higher than that of meat from their Landrace pig counterparts. The drip loss in meat of Jinhua pigs at the same ages was 34.43%, 34.00%, and 33.08%, respectively, which was lower than that in meat of their Landrace pig counterparts [56]. In addition, the intramuscular fat content of meat from Jinhua pigs reached 4.45%, which was 3.11 times higher than that of meat from Landrace pigs at 180 days of age [57]. However, Jinhua pork pigs grow slowly in the late period, and the feed utilization rate is low (Table 3).

Jianghai type local pig breeds

The Taihu pig, also known as the Taihu Black pig, is a Jianghai type pig breed. Native to the Taihu Lake Basin in Jiangsu and Zhejiang, the Taihu pig is one of the most productive breeds in the world and enjoys the reputation of "national treasure". Taihu pigs have many excellent characteristics, such as ideal meat quality, high disease resistance and good adaptability to the local environment [53]. Taihu pig includes six varieties: Erhualian (EH), Meishan (MS), Fengjing (FJ), Jiaxing Black (JX), Mizhu (MI), Shawutou (SW), and Hengjing (a currently extinct variety), which have been collectively referred to as "Taihu pig" since 1974. The MS breed is further divided into two strains, called Zhongmeishan (MMS) and Xiaomeishan (SMS) [53,62].

Erhualian pigs are known for their high fertility and hold the highest farrowing record worldwide. They are one of the representative populations of high-yielding pig breeds in the Taihu Lake basin of China. The average litter size of multiparous sows is about 16, of which 14 piglet survive. Erhualian pigs are native to Jiangyin, Wujin, Xishan, Changshu and other cities in Jiangsu province, China. At the same time, Erhualian pigs also have excellent characteristics such as long reproductive life, early sexual maturity, large number of teats, good meat quality, docile temperament, tolerance to rough feeding, and good hybridization effect [63] (Table 3).

Local pig breeds in southwestern China

Local pig breeds in southwestern China are mainly found in Yunnan-Guizhou plateau, most of the Sichuan Basin, and western Hunan and Hubei province. The coat color of southwestern pig breeds is mostly black, with a considerable number of black and white, and a small number of red-haired pigs. Southwestern type pigs have large heads, thick and short legs, and the litter size is usually 8 to 10. The slaughter rate of southwestern type pigs, such as Neijiang pigs, Rongchang pigs, and Wujin pigs, is low and the fat content is high.

Rongchang pig is a high-quality local pig breed in China. It is mainly produced in Chongqing Rongchang and Sichuan Longchang [69]. It is one of the eight excellent pig breeds in the world. Rongchang pigs are typical fat-type pig breeds, which have the advantages of early sexual maturity, fast growth, resistance to rough feeding, strong adaptability, docile temperament, stable genetic performance and excellent meat quality [69,70]. Studies have shown that compared with Duroc pork, Rongchang pork has significantly higher intramuscular fat content, lower shear force, and richer monounsaturated fatty acids [71] (Table 3).

Tibetan pig

Tibetan pigs mainly live in the Qinghai-Tibet plateau, including Diqing Tibetan pigs in Yunnan, Aba and Ganzi Tibetan pigs in Sichuan, Juema pigs in Gansu, and Tibetan pigs in Shannan, Linzhi, and Qamdo in the Tibet Autonomous Region. Tibetan pig is the rarest plateau pig breed in the world, and it is also a precious local breeding resource in China. Tibetan pigs have been living for a long time in pollution-free and pure natural alpine mountainous areas. They have the characteristics of adapting to the harsh climatic environment at high altitudes, disease resistance and ruggedness, but the fertility is low.

The Diqing Tibetan pig is a unique plateau pig breed in China. It has advantages of strong stress resistance and good meat quality, including the pH value of meat from commercial fattening pigs (≥ 80 kg) of 5.8–6.8, the ash content of less than 1.0%, the thawing water loss rate of less than 5%, and the total amino acid content of more than 15%. However, it has disadvantages of slow growth and few litters [80]. At present, reports on Diqing Tibetan pigs mainly focus on hypoxia adaptation, growth and succulence [81–84] (Table 3).

Pig breed profile in Russia

Soviet zootechnicians developed several pig breeds such as Ukrainian Steppe White, North Siberian, Mirgorod, Breitovo, Livny, Kemerovo, Prudishchenskaya, Kalikin, Urzhum and some others. By 1952, pigs of the following breeds were raised in the Soviet Union: Large White, Ukrainian Steppe White, Mirgorod, North Siberian, Breitovo, Livny, Berkshire, White Short-Eared, White Long-Eared, Large Black, Mangalitsa [2]. By 1980, there were 32 pig breeds in the USSR, including 22 breeds that were developed and registered during 1917–1980 (Figure 1) [85]. The number of pigs of 22 breeds at that time was 29 million heads out of the total number of livestock in the USSR of 79 million.

At present, the breeding base of pig farming in Russia is presented by a small number of breeds. Pigs of four main breeds are raised in industrial pig farming, namely, Large White, Yorkshire, Landrace and Duroc, which account for 98% of total stock. The structure of the stock of the main pig breeds raised in the enterprises of the Russian Federation is as follows: Large White 56.9%, Yorkshire 18.52%, Landrace 18.18% and Duroc 5.83%. According to various data, other breeds (Pietrain, Livny) account for 0.56 to 2% [86]. Three breeds are raised in pig farming on the homestead: Altai Meat-type, Short-Eared White and Tsivislk [87].

Pigs are raised in 53 pedigree pig farms and 40 reproducing farms in 38 regions of the RF. The "State Register of Breeding Achievements Approved for Use. Volume 2. Breeds of animals" in edition of 2022 contains 20 breeds, 23 types and one line [86,88].

Pigs of fat-type and meat-and-fat type breeds have not been in high demand during the last years. The exclusion is the population living in cold regions that prefer fatter meat with high amounts of saturated fatty acids and cholesterol and at the same time, has a healthy lifestyle. In Russia, the preference is given to breeding universal pigs because these

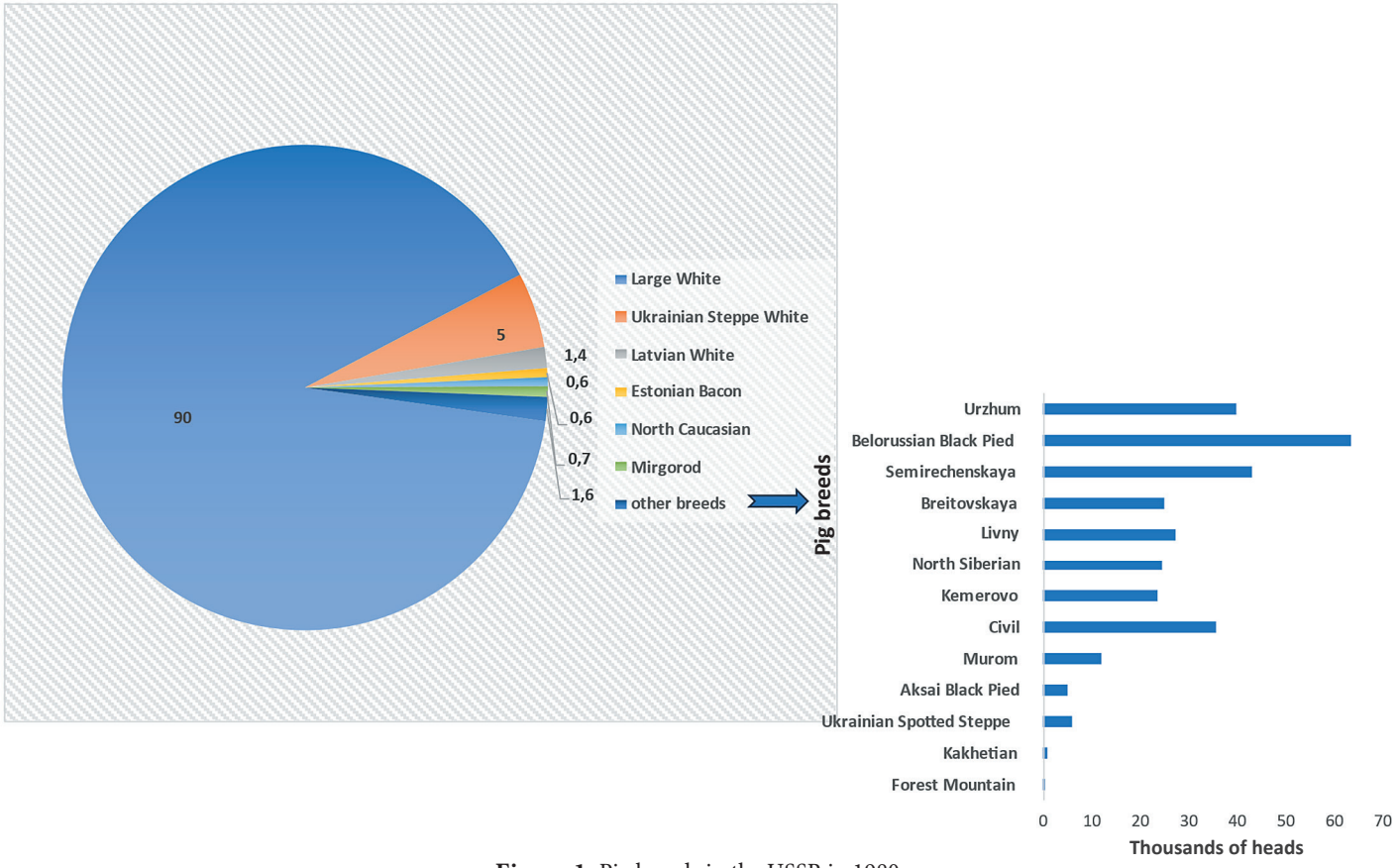


Figure 1. Pig breeds in the USSR in 1980

animals are grown both for meat and for backfat depending on the type of feeding (meat, bacon, fat types).

Recently, the meat-type direction of pig farming has been in demand; therefore, pig stock of the Landrace, Duroc, Pietrain and other breeds has been growing. Meat-type or bacon-type pigs are distinguished by the elongated body (some breeds, for example Landrace, has an increased number of vertebrae), their front part has a smaller size than the back part, the head is small, rump is large, hams are meaty, sides are roundish and resilient. Some meat-type pigs are distinguished by the genetic predisposition to accumulation of muscle mass rather than fat (the fat interlayer is thin, 18–20 mm and is located under the skin).

The majority of breeds have been developed by crossing several breeds on the basis of targeted choice of the best animals, selection for a desired type and targeted raising of new generations. The following breeds have played an important role in the breed development process: Large White, Berkshire, Landrace and Duroc. Nowadays, these breeds are widely used and are specialized in the meat direction.

Currently, the lean meat content is one of the main traits for pig selection on local basis [86,89].

Unlike China, there is now no pronounced regional distribution of breeds in Russia. The livestock' breed profile is about the same everywhere: crosses based on the Large White, Landrace and Durok. Several breeds still exist with strict regional localization.

Large White

A. P. Redkin (1952) states that the exact time of the development of the Large White breed is unknown [2]. He writes that the breed was obtained by long-term crossing, which involved English breeds (Long-Eared, Leicester and Yorkshire from Sus ferus), pigs of the Romance group and even Chinese pig breeds — Siamese and small Sus vittatus. In 1885, the National Pig Breeders' Association developed the standard for the Large White breed.

The Large White breed was brought into Russia for the first time in 1887–1888; that is, only two years after the creation of the standard for the breed in England.

Pigs that are raised in our country are assigned to three directions of productivity (production types): meat, meat-and-fat (or universal) and fat. It is quite possible that this classification was formed in the process of improvement of the Large White breed in Russia in the 1930s. In the process of crossing, productive and economic traits of the breed in general changed. Only the type (fat or bacon) did not change. Then, the third (meat-and-fat) type of Large White pigs was developed.

The Large White breed improved in the USSR became an important tool for developing many domestic pig breeds. For example, the following breeds were produced based on Large White pigs: Ukrainian White Steppe (in Askania Nova, the breed was approved in 1932); North Siberian (1942, Novosibirsk); Urzhum (1957, Kirov region); Kemerovo (1961, Kemerovo region), Breitovo (1948, Yaroslavl region), Latvian White and Lithuanian White (both approved in 1967), Semirechensk (firstly approved in 1968 as Kazakh hybrid, approved in 1978 as Semirechensk/Semirechenskyaya), Mirgorod (1940), Tsivilsk (a cross of native Chuvash pigs with Large White boars, the breed is not registered), Mangalitsa, Altai (registered in 2017), and others that were created by multiple crossbreeding procedures.

Brief description of several local pig breeds that are raised nowadays in the RF is given below.

Livny (Livenskaya)

The Livny breed was officially recognized in 1949 and was produced by crossing of the long-eared pigs with boars of the Yorkshire, Large White, Berkshire breeds [90,91]. The breed is assigned to the meat-fat type and was produced for pasture raising. Pigs are sturdy and undemanding to feed.

Tsivilsk (Tsivilskaya, Civilian, Civil'skaya)

The breed was developed in Chuvashiya by crossing pigs of local breeds and Large White. It was registered in 1951 as the Tsivilsk breed group. It is undemanding to feed and resistant to climatic variations. The undeniable advantage of this breed is the capacity of maximum transfer of the genetic potential of the breed in terms of production and economic traits. According to the expert opinion, meat from pigs of this breed is distinguished by good taste and aroma [92]. The breed is assigned to the meat-and-fat type.

Altai (Altaiskaya)

The Altai meat-type breed was registered in 2017. The White Large and Landrace breeds as well as boars of the MAXGRO™ Terminal Line were used in its development. The breed is adaptive to environmental conditions, stress resistant, has good zootechnical and technological characteristics [93,94]. The breed was developed as the meat type. Nevertheless, speck from pigs of the Altai breed is interesting in terms of its composition as it has the high content of unsaturated fatty acids, in particular omega 3 and omega 6 PUFA [32].

Kemerovo (Kemerovskaya)

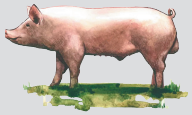
The breed was produced by the complex reproductive crossing of sows of local breeds and boars of the Large White breed, and then by using boars of the Berkshire and Large Black, North Siberian and Siberian Black Pied breeds. The breed was approved in 1960/1961. Presumably, individual animals are raised on the territory of the Kemerovo Oblast and the Far East, as well as in Kazakhstan [95].

The breed was produced with consideration for Siberian climate. It is adapted to it and is distinguished by cold resistance. Pigs are undemanding to feed. According to the opinion of V. A. Bekenev et al. [96,97], meat and speck from pigs of the Kemerovo breed differ from that of other breeds, in particular commercial breeds, by a ratio of unsaturated to saturated fatty acids. Speck is distinguished for

Table 4. Indicators of productivity of Russian pig breeds [2,90–97,99]

Characteristic \ Breed	Large White	Landrace	Duroc	Yorkshire	Livny	Altai	Kemerovo	Tsivilsk
								
Body length, cm	167–182	140–180	160–180	169–180	162–180	110–112	160–180	160–177
Backfat thickness, mm	28	20–27	17–21	9.5–13. 3	34	20–23	23–35	24–28
Age to 100 kg body weight, days	165–189	167–194	160–180	153–168	150–196	160	175–180	178–185
Slaughter age, days	185	160–170	159	160–168	160	152–155	180–182	160
Piglets per litter, number	11–12	11–12	9–11,5	10–13 (up to 14)	10–11	14–15	10–11	11–12
Milk, kg	58	55–64	43	54.6–65	51–70	—	58–65	47
Average weight gain, gram	720	700–730	715–820	750–850	700–800	750–800	730–780	700–800
Feed conversion ratio, units	3.4–3.85	2.97–4.05	2.7–3.75	2.6–3.1	3.8–4.11	2.6–2.8	3.7–3.9	3.5–4.5
Average carcass yield, %	82	75	86	82	75	75–82	72–75	70
Average lean meat yield, %	57–63	65–68	60–69	64	54–55	58–59	53–60	50–55

Table 5. Breeds mentioned in the text [2,90,98–100]

Characteristic \ Breed	White Short-Eared	White Long-Eared	Pietrain	Mirgorod	Breitovo	Berkshire	Mangalitsa	Ukrainian Steppe White
								
Body length, cm	162–180	165–175	—	—	155–180	—	141	
Backfat thickness, mm	31–40	25–35	7–10	30–37	31–38	33–36	65–90	25–36
Age to 100 kg body weight, days	195–210	179	160–210	154–182	191–230	180	160–180	192–209
Piglets per litter, number	9–11	10–12	7–9	10–11	10–12	6–9	5–9	10–12
Milk, kg	51	70–80	60	48–50	52–70	48–55	—	55–60
Average weight gain, gram	650	765–770	500–550	700	680–770	670–750	700–800	
Feed conversion ratio, units	4.11	3.91	2.5–3.4	4.2–4.5	3.8–4.5	2.5–4.0	3.9–4.0	
Average carcass yield, %	80	—	78–80	80–85	74–77,9	84–88	up to 70	77–84
Average lean meat yield, %	60	47–53	62	53–55	54–58	—	54	54–55

its high-melting properties and at the same time for good sensory characteristics.

Many breeds have not stood the test of time as they did not correspond to the requirements for industrial raising. For example, the Chukhonskaya breed gradually disappeared. The main reason for the lack of demand for it was the fact that pigs of this breed grow very slowly and parameters suitable for the manufacturing process are formed only after two years [13].

Changes in exterior, productivity, biological, morphological and physiological features of animals have occurred under an effect of long-term selective breeding [1]. Tables 4 and 5 present parameters of productivity for breeds that are prevalent in Russia and some other breeds that are mentioned in this paper.

Conclusion

The majority of breeds comprising the stock of pigs in the RF are commercial breeds (Landrace, Duroc, Yorkshire and Large White), which proportion prevails in the overall breed profile (more than 60%). These breeds became a basis for the development of practically all pig breeds that exist today in the RF.

Selective breeding has been carried out in our country from the beginning of the 20th century and was intensified in the period from 1935 to 1975. The result was a successful development and registration of 22 pig breeds. Unfortunately, only less than 30% of local breeds remained in the pig stock in Russia in the first quarter of the 21st century. This is determined, primarily, by the insufficient productive characteristics of pigs: insignificant fertility, low milking capacity of sows, and low yield of muscle tissue.

Consumers required more lean meat and less fat. In response to their demands many crosses of pigs, which carcasses corresponded to these requirements, were produced.

At the same time, animals of the meat type especially those with a thickness of backfat less than 10 mm turned to be quite sensitive to feeds, water, stress and temperature fluctuations, contrary to pig breeds developed in Russia.

In addition, meat of such pigs is characterized by the low water binding capacity and low color stability; their speck is low-melting and, as a result, its technological processing is more difficult.

As the experience of Chinese zootechnicians show, preservation of local breeds and their diversity allows varying both zootechnical and technological characteristics to develop new breeds and increase manufacturability of meat raw materials.

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