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Ecological and Consumer Properties of Pig Meat from Different Breeds Produced in Technogenic Zone

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Abstract.

The Republic of North Ossetia-Alania belongs to the most polluted by heavy metals territories in Russia due to high concentration of manufacturing plants in Vladikavkaz. ***The research aims*** to make comparisons of ecological and consumer properties of pig meat from different breeds when fattening on diets containing high heavy metal concentration. ***The research methods.*** The subject of research was young fattening pigs of the following breeds: North Caucasian (Severokavkazskaya), Landrace, Large White and specialized meat breed (SM-1). By the analogue scale the piglets of the compared breeds at 2 months of age were divided into four gilt groups of 10 animals each. All experimental indices were processed by mathematical analysis using software "Microsoft Excel". ***The research results.*** In the course of studies the highest slaughter weight had animals of SM-1 breed having surpassed in this index their North Caucasian counterparts by 14,2 %. By dry matter content in meat, Landrace, Large White and SM-1 breeds had an advantage over North Caucasian gilts. At that the highest protein content in the longissimus dorsi had young pigs of SM-1 breed having surpassed in this index North Caucasian gilts by 1,49 %. Protein quality index of meat from Landrace and SM-1 young pigs was higher than that of North Caucasian breed by 6,3 and 8,2%. The highest concentration of cadmium, lead and zinc was in the meat of North Caucasian young pigs but the lowest – in animals of SM-1 breed, yielding them to meat saturation with toxicants – by 38,4; 36,1 and 30,5%. When boiling there remains less heavy metals in meat than in fried one. In boiled and fried meat of Landrace and SM-1 young pigs the heavy metal content was below the maximum permissible concentration (MPC).

Key words: *young pigs of different breeds, heavy metals, meat productivity, chemical composition of meat, ecological and consumer pork qualities.*

Relevance of the problem. The productivity and physico-chemical properties of meat products from pigs are significantly influenced by pollutants of chemical and biological nature. Among the numerous pollutants heavy metals have a special place [1, 2].

Heavy metals have high biological activity, tend to accumulate in separate links of the biological cycle and through the trophic chains enter the animal bodies, and accumulating negatively affect their vital functions. They are characterized by both mineral and organic distribution forms, which is associated with the ability of metals to form a large number of organic and metal-organic compounds. Among heavy metals lead, zinc and cadmium top a number of pollutants due to high rate of their technogenic accumulation in the environment. The toxic effect is explained by the fact that they form insoluble compounds with proteins, changing properties and inactivating a number of vital enzymes [3, 4, 5].

The Republic of North Ossetia-Alania belongs to the most polluted by heavy metals territories in Russia due to high concentration of manufacturing plants in Vladikavkaz. The main environmental pollutants are non-ferrous metallurgy enterprises JSC "Electrozinc", JSC "Pobedit" and others [6].

The biological and medical significance of heavy metals is determined by their high toxicity and accumulating in the body have negative polytropic effect. This accumulation also occurs at levels of toxic metals in natural environments far below the maximum permissible concentrations (MPC) [7].

The research aims to make comparisons of ecological and consumer properties of pig meat from different breeds when fattening on diets with high heavy metal concentration.

The research methods. The experimental part of the work was performed on the pig farm of the agricultural production cooperative "Vesna" in Digorsky District of the Republic of North Ossetia-Alania. The subject of research was young fattening pigs of the following breeds: North Caucasian (Severokavkazskaya), Landrace, Large White and specialized meat breed (SM-1).

In accordance with the scheme for the study (Table 1), and by the analogue scale taking the live weight, age and sex into account the piglets of the compared breeds at 2 months of age were divided into four groups of clinically healthy gilts (10 animals each).

Experimental animals were fed twice a day in accordance with the existing feeding norms. Access to water was free. The housing conditions for animals of the compared groups were the same. The fattening period for experimental animals was limited when they gained the live weight of 140 days.

The heavy metal content in samples of feeds, organs and tissues of experimental animals was determined by atomic absorption spectrophotometer AAS-3.

To study the meat productivity following fattening we performed by the practical standard the control slaughter, for which 5 animals from each group were selected.

All provided during the research indices were processed by mathematical analysis using software "Microsoft Excel".

The research results. By recognizing that the territory of North Ossetia-Alania is not favourable due to the present heavy metals, we studied their content in these feeds (Table 2).

In farm-made feeds: corn grain, triticale grain, clover, mangold, vetch-oats grass, the cadmium content exceeded the maximum permissible concentrations (MPC), respectively, by a factor of 1,52; 1,73; 2,27 and 1.6.

The lead concentration in farm-made feeds exceeded the MPC in corn grain by a factor of 2,06, in triticale grain — 2,02, in clover — 1,78; in vetch-oats grass — 1,80 and in mangold — 2,04.

According to the zinc content the MPC was exceeded in corn grain — by a factor of 1,39; in triticale grain —1,35; in clover — 1,41; in vetch-oats grass — 1,49 and in mangold — 2,14.

According to heavy metal content fresh skim milk and sunflower cake were good feedstuffs.

In general, in terms of energy value and content of organic and mineral substances feeds used in the experimental animals' diets corresponded to the average regional values.

When control slaughtering, it was necessary first of all to determine how the increased heavy metal content in feeds affected the slaughter indices (Table 3).

In the course of studies animals of SM-1 breed had the highest slaughter weight having significantly 14,2% ($P < 0,05$) surpassed in this index their North Caucasian counterparts that was due to their highest pre-slaughter weight. However, the highest slaughter yield index had Landrace gilts — 69,27% that is significantly 1,71% ($P < 0,05$) more than in the young of North Caucasian breed.

In half-carcasses of North Caucasian and Large White animals the fat content was significantly ($P < 0,05$) more than in the half-carcasses of Landrace gilts – by 3,82 and 2,45% as well as of SM-1 breed – by 5,41 and 4,04% respectively. Hence, the carcasses fat yield in animals of the compared breeds has a direct biological link with animals' pre-slaughter weight.

As for the half-carcasses meat yield, on the contrary, the gilts of Landrace and SM-1 meat breeds significantly ($P < 0,05$) exceeded their North Caucasian counterparts by 3,77 and 6,53% as well as Large White ones by 1,10 and 3,86 % respectively.

A more typical quality rating index is some physical properties of meat (Table 4).

Table 1 – Scheme of scientific and economic experiment

Group	Number of animals	Breed	Features of feeding
I – control	10	North Caucasian	Basic diet (BD) with excessive content of cadmium, lead and zinc
II – test	10	Landrace	BD
III – test	10	Large White	BD
IV – test	10	SM – 1	BD

Table 2 - Heavy metal content in feed, mg/kg

Feed	Elements					
	cadmium		lead		zinc	
	MPC	In fact	MPC	In fact	MPC	In fact
Corn grain	0,4	0,61	5,0	10,3	100	139,3
Triticale grain	0,4	0,57	5,0	10,1	100	134,9
Clover	0,3	0,48	5,0	8,9	50	70,3
Sunflower cake	0,4	0,29	5,0	3,5	100	79,9
Fresh skim milk	0,3	0,21	5,0	3,8	100	71,3
Mangold	0,4	0,91	5,0	10,2	100	214
Vetch-oatsgrass	0,3	0,64	5,0	9,0	50	74,3
Green chopping clover	0,4	0,49	5,0	5,7	100	121,2

Table 3 - Slaughter qualities of experimental pigs.

n=5

Index	Breed			
	North Caucasian	Landrace	Large White	SM-1
Weight, kg:				
Pre-slaughter	99,12±0,33	103,25±0,37	107,37±0,36	111,25±0,28
Slaughter	66,97±0,33	71,52±0,31	73,11±0,17	76,51±0,19
Slaughter yield, %	67,56±0,18	69,27±0,24	68,09±0,18	68,77±0,29
Half carcass contains:				
Half carcass weight, kg	31,62±0,29	33,75±0,19	34,67±0,26	36,49±0,23
meat, kg	17,77±0,15	20,24±0,14	20,41±0,17	22,89±0,19
%	56,20±0,29	59,97±0,12	58,87±0,20	62,73±0,23
fat, kg	7,78±0,04	7,02±0,09	8,06±0,04	7,01±0,09
%	24,62±0,18	20,80±0,19	23,25±0,23	19,21±0,19
bones, kg	3,35±0,16	3,63±0,27	3,38±0,15	3,64±0,18
%	10,57±0,21	10,75±0,15	9,75±0,19	9,97±0,27

Table 4 - Meat physical quality (longissimus dorsi)

n = 5

Index	Breed			
	North Caucasian	Landrace	Large White	SM-1
"eye-muscle" area, cm^2	28,57±0,20	30,60±0,13	28,80±0,12	31,30±0,23
water retention, % for meat	52,9±0,36	53,7±0,26	53,9±0,23	54,3±0,27
pH	5,52±0,05	5,56±0,02	5,54±0,02	5,47±0,03
colour density, extinction×1000	7,97±0,03	8,12±0,05	8,25±0,04	8,25±0,05

Table 5 - Chemical composition of meat and biological value of its protein

n = 5

Index	Breed			
	North Caucasian	Landrace	Large White	SM-1
Chemical composition of meat, %:				
dry matter	25,22±0,12	26,33±0,15	26,02±0,13	26,46±0,16
protein	21,03±0,13	22,47±0,11	21,81±0,11	22,52±0,10
fat	3,18±0,03	2,67±0,04	3,20±0,06	2,72±0,03
ash	1,01±0,03	1,19±0,02	1,01±0,02	1,22±0,03
Meat contains, mg/kg:				
tryptophan	324,1±0,53	339,7±0,46	328,7±0,63	342,1±0,55
oxyproline	40,4±0,22	39,8±0,10	40,0±0,12	39,4±0,22
Protein qualityindex	8,02±0,06	8,53±0,04	8,22±0,05	8,68±0,07
Cadmium, mg/kg(MPC=0,05)	0,151±0,001	0,112±0,002	0,137±0,001	0,093±0,002
Lead, mg/kg(MPC=0,5)	1,08±0,003	0,73±0,003	0,99±0,002	0,69±0,004
Zinc, mg/kg(MPC=70)	137,9±0,14	103,8±0,16	133,5±0,19	95,8±0,12

Table 6 - Heavy metal content in boiled and fried meat

n = 5

Index	Breed			
	North Caucasian	Landrace	Large White	SM-1
Boiled meat contains:				
Cadmium, mg/kg (MPC=0,05)	0,063±0,002	0,039±0,003	0,062±0,002	0,037±0,003
Lead, mg/kg(MPC=0,5)	0,66±0,002	0,28±0,002	0,63±0,001	0,31±0,002
Zinc, mg/kg(MPC=70)	79,8±0,10	51,5±0,10	78,5±0,12	46,1±0,11
Fried meat contains:				
Cadmium, mg/kg (MPC=0,05)	0,073±0,001	0,049±0,003	0,077±0,002	0,048±0,001
Lead, mg/kg(MPC=0,5)	0,76±0,001	0,48±0,002	0,074±0,003	0,046±0,002
Zinc, mg/kg(MPC=70)	89,5±0,12	71,5±0,11	88,5±0,23	68,7±0,12

The analysis of the provided data showed that in animals of compared breeds the increased heavy metal level in feeds had no significant effect on the water-retaining capacity, pH and colour density of muscle tissue.

Large fat deposit in half-carcasses of North Caucasian and Large White animals resulted in increasing the 6^{th}-7^{th} thoracic vertebrae fatback thickness and reducing the "eye-muscle" area. Therefore, the gilts of these breeds significantly ($P < 0,05$) yielded to the young Landrace pigs in the "eye-muscle" area by 2,03 and 1,80 cm^2 as well as SM-1 — by 2,72 and 2,50 cm^2, respectively.

Among the most important indices of the meat nutrition value are the chemical composition and biological value of muscle protein (Table 5).

In terms of dry matter content in meat, Landrace, Large White and SM-1 animals had a significant (P <0,05) advantage over the North Caucasian gilts, respectively, by 1,11; 0,80 and 1,24%. Moreover, the highest protein content in longissimus dorsi belonged to the young of SM-1 breed, which in this index exceeded the North Caucasian gilts by 1,49% (P <0,05).

It is known that the amino acid composition in the muscle tissue is quite stable, although it can somewhat be corrected under various toxicants effect, which can inhibit the protein synthesis in the body. Therefore, along with the meat protein content we studied its biological value (BV) relative to the amount of the essential amino acid tryptophan to oxyproline. It was determined that meat BV of young Landrace and SM-1 meat pigs was significantly (P <0,05) higher than that of North Caucasian gilts, respectively, by 6,3 and 8,2%. Moreover, concerning the North Caucasian breed products the significant 5,5% (P <0,05) increase of tryptophan content in longissimus dorsi contributed to the highest meat BV index of SM-1 young.

Between the fat and protein content in animals' meat of the compared breeds there existed a proportional feedback. According to the fat concentration in the longissimus dorsi, the North Caucasian and Large White gilts significantly (P <0,05) exceeded the Landrace animals by 0,57 and 0,53% as well as SM-1 breeds by 0,48 and 0,46 % respectively.

It was found that the heavy metal level in meat is directly proportional to its fat concentration. The heavy metal content in animals' meat of all tested breeds turned out to be higher than the MPC. The highest concentration of cadmium — 0,151 mg/kg, lead — 1,08 mg/kg and zinc — 137,9 mg/kg was in the meat of young North Caucasian pigs but the lowest in SM-1 animals having significantly 38,4; 36,1 and 30,5% (P <0,05) yielded to them in longissimus dorsi saturation with these toxicants.

Meat of animals, in which the heavy metal level exceeds the MPC is dangerous for consumers' health so it should be subjected to various heat treating methods to reduce toxicants in meat products. We studied cadmium, lead and zinc content in animals' meat of the compared groups both in boiled and fried form (Table 6).

It has been determined that when boiling less heavy metals are left in the meat than in the fried product, since a considerable part of the toxicants passes into the broth. In addition, in the boiled and fried meat from the young of Landrace and SM-1 meat breeds the heavy metal content was below the MPC except the zinc concentration in fried meat of Landrace animals. This is due to the fact that in the slaughterwarm and chilled gilts' meat, the concentration of toxicants was initially lower.

Discussion of research results. According to energy value and content of organic and mineral substances, the feeds used in the experimental animals' diets corresponded to the average regional values. At the same time, they had the MPC excess in zinc, lead and cadmium content.

In the course of studies animals of SM-1 breed had the highest slaughter weight having significantly 14,2% (P <0,05) surpassed in this index their North Caucasian counterparts that was due to their highest pre-slaughter weight. However, the highest slaughter yield index had Landrace gilts — 69,27% that is significantly 1,71% (P <0,05) more than in the young of North Caucasian breed. The highest meat yield had half-carcasses of SM-1 animals.

Large fat deposit in half-carcasses of North Caucasian and Large White animals resulted in increasing the 6^{th} -7^{th} thoracic vertebrae fatback thickness and reducing the "eye-muscle" area. Protein quality index of meat from Landrace and SM-1 young pigs was higher than that of North Caucasian breed by 6,3 and 8,2%.

In the conditions of technogenic tension the meat from animals of specialized meat breeds SM-1 and Landrace had the best ecological and food qualities. When boiling less heavy metals are left in the meat than in the fried product, since a considerable part of the toxicants passes into the broth. In addition, in the boiled and fried meat from the young of Landrace and SM-1 meat breeds the heavy metal content was below the MPC.

CONCLUSIONS.

1). To improve the ecological and consumer qualities of pork produced on pig farms located in the technogenic zone of the Republic of North Ossetia-Alania with the increased level of heavy metals in the soil, it is more expedient to fatten the young pigs of the specialized meat breed SM-1.

2). During heat treatment, the content of heavy metals in meat is significantly reduced. Moreover, during boiling the highest level of detoxifying pork from heavy metals is observed.

REFERENCES

1. Temiraev, R.B. The effective way to increase pork / R.B. Temiraev, V.V. Tedtova, G.K. Vasiliadi, E.S. Dzodzieva, I.M. Kulova // Meat industry. - 2015. - №10. - pp. 42-43.
2. Tedtova, V.V. Reserves for raising pork production. / V.V. Tedtova, L.V. Tsalieva, B.M. Markaryan // Pig breeding. - 2006. - № 6. - pp. 22-24.
3. Tmenov I.D. Soy milk-based probiotic preparation with pectin additives in piglets' diets. I.D. Tmenov, V.V. Tedtova, E.S. Khamitsaeva // - Vladikavkaz. - Publishing house FSBEI HVE "Gorsky State Agrarian University". - 2008. - p. 56
4. Tedtova V.V. Ways to reduce feed toxicity. / V.V. Tedtova, M.A. Gubieva, E.S. Khamitsaeva // Materials of the V^{th} International conference "Sustainable development of mountain territories: problems and prospects of integrating science and education". - Vladikavkaz. - 2004. - pp. 507-508.
5. Temiraev V.Kh. Experience in improving pork quality by feed additives / V.Kh. Temiraev, E.S. Khamitsaeva, Z.V. Savvoeva, Z.M. Mamukaev // Collected scientific works of the scientific-practical conference "Scientific fundamentals of increasing farm animals' productivity". - Krasnodar. - 2009. - Part 2, pp. 231-233.
6. Ibragimova, Z.R. Biological resources of young pigs in conditions of technogenic tension / Z.R. Ibragimova, V.V. Tedtova, R.B. Temiraev, L.V. Tsalieva, O.T. Ibragimova. // Materials of the IV^{th} International scientific conference "Relevant problems of biology in animal husbandry". - Borovsk. - 2006. - pp. 267-270.
7. Kairov, V.R. Zootechnical and ecological reasoning for the norms of pigs' vitamin A nutrition depending on the cadmium concentration in feeds //V.R. Kairov//. Thesis abstract of Doctor in Agricultural Sciences. - Krasnodar. - 2001. - p. 48