Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2019, 9(1), 183-186

ORIGINAL ARTICLE *UDC 636.4. 033.083*

Pork quality as an ecological index of the "organism-environment" interaction

I.B. Bankovska[1], S.A. Manyunenko[1], V.M. Kondratiuk[2], Yu.V. Zasukha[2], S.M. Grishchenko[2], I.S. Mytiai[2], N.P. Hryshchenko[2]

[1]Institute of Pig Breeding and Agro-Industrial Production, NAAS of Ukraine, Shvedska Mohyla street 1, Poltava, Ukraine.
[2]National University of Life and Environmental Sciences of Ukraine, Heroes of Defense st 15, Kyiv, Ukraine.
E-mail: nat.tychina@gmail.com (or) gloryir2017@gmail.com
Received: 12.02.2019. Accepted: 15.03.2019

The article presents the results of the analysis of the connection between the intensive growing conditions and feeding of highly productive commercial pig combinations with the indices of their meat quality in the ecological aspect of the "organism - environment" interaction. It is established that the pork quality is an important complex index that determines the ecological status level of important interrelated processes of pork production, human nutrition and the natural environment functioning. It has been proved that high-producing pigs have a different level of meat quality indices under the same conditions of keeping and feeding, which is important for the improvement of ecological and technological systems of pork production.

The conclusion is made on the need to control improving of feeding rations for high-producing meat-type pigs grown with intensive technologies, by amino acid and mineral composition. The emphasis is made on improving the availability of nitrogen and phosphorus in the plant-based fodder for pigs and reducing the negative impact of residual metabolites on the ecological status of the environment.

Keywords: Pigs; commercial breed combinations; intensive fattening; meat quality; improvement; lysine; calcium; phosphorus

Introduction

Recently, consumer demand for lean pork has increased significantly. The capacity of intensive breeding and fattening of commercial breeds and interbreeding combinations of meat pigs is growing, with the prospect of further general increase in animals' meat productivity due to genetic and technological factors. However, rigid conditions of intensive growth and fattening of pigs, aimed at increasing of the meat yield in carcasses, negatively affect the pork quality, which is confirmed by our previous studies (Bankovska , 2015).

Recently, the processing industry faces the problem of the defects manifestation in pork - PSE (pale, soft, exudative) and DFD (dark, firm, dry), which is the cause of a number of the intensive production negative effects and is officially recognized as the major economic risk factor for fresh and processed pork (Monin, 1987, Kuo & Chu, 2003). Researchers of today tend to conclude that both defects gradually progress in the muscle tissue of all farm animals and poultry species that are intensively fed and undergo pre-slaughter stress period (Adzitey & Nurul, 2011).

On the other hand, the operation of pig enterprises of various capacities is often accompanied by the problem of manure accumulation, pollution of air, soil and water by animal excrements and their degradation products (Kalinchik, etc.).

The purpose of our studies was to analyze the connection of intensive conditions in growing and feeding high-performance commercial pig combinations with meat quality indices in the aspect of "organism - environment" interaction.

Materials and methods

The study was carried out on the basis of TOV "Dnipro-Hybrid" in the Dnipropetrovsk Region using pigs of three commercial combinations obtained from American meat breeds: two-breed Yorkshire - Landras sows (Y × L), which were artificially fertilized with sperm of Yorkshire breed boars (Y), two-breed Berkshire - Duroc (B × D) and Hampshire - Duroc (G × D) boars. The total number of the studied animals was 90 goals.

Store pigs feeding was carried out according to the three-phase system with standard fodders prepared using the "Agrtronix" automatic equipment in accordance with the recommendations of the leading firms and modern norms for store animals fattening (National Research Council, 2012). Premixes were used with protein-mineral-vitamin and enzyme complexes, intended

for better fiber digestion and protein assimilation, increasing the availability of phosphorus and calcium. Pigs were fed to the pre-slaughter live weight of 100 ± 5 kg.

Pig carcasses assessment was carried out in a slaughter shop of the holding after 24 hours of gradual cooling in the temperature regime of +2-4°C in accordance with sanitary and veterinary requirements. The content of lean meat in the carcasses (MF, %) was studied using the "two-measurements" method (EU, 2011).

Samples for analysis were selected from the longest muscle of the back (*m. longisimus dorsi*) 24 hours after the pigs slaughter at the level of 9th-12th thoracic vertebrae. Electrical conductivity (LF) and active acidity (pH) indices were measured by the "LF-Star CPU-Pistole" portable device (Germany).

Assessment of physical and chemical parameters of pig muscle tissue quality was carried out according to the methodology guidelines of VASGNIL (1987) and according to DSTU ISO 2917-2001. Chemical analysis of meat and fodder samples was carried out according to generally accepted procedures (Laboratory Methods of Research, 2012).

The processing of the experimental studies results was carried out using descriptive statistics methods and one-factor dispersion analysis (ANOVA) by means of Statistics 6.0 for Windows software. The difference reliability was taken for the significance levels: $p \le 0.05$, $p \le 0.01$ and $p \le 0.001$.

Results of the study and their discussion

The study revealed that the indices of lean meat (MF) yield calculated by the "two measurements" method in pig carcasses obtained from the combinations (Y × L) × (B × D) and (Y × L) × (G × D) under the EUROP (S) European system had a high level of S class ("superior" - the highest quality): 60.8 and 62.5% ($p \le 0.001$) respectively. Pigs with a greater proportion of the Yorkshire breed (Y × L) × Y had an average meat content of carcasses that met the requirements of the E class ("excellent" - excellent) - 59.0%.

Assessment results of pH, electrical conductivity, moisture capacity and heat treatment losses indicate that meat of the three high-producing meat pig combinations manifested pronounced or moderate PSE-myopathy in the longest back muscle highly valuable for further processing. (Table 1).

Table 1. Quality indices of various breed combinations pork, (*n*=30), $\overline{X} \pm S_{\overline{X}}$

Index	Breed combination		
	(Y × L)× Y	(Y × L)×(B × D)	(Y × L)×(G × D)
pH 24	5.55±0.016	5.53±0.015	5.48±0.020
LF 24 , мСм/см	8.45±0.330	9.37±0.219	9.23±0.224
Softness, g/cm^2	92.73±0.424	84.57±0.306	104.89±0.578*
Cooking losses, %	22.85±0.766	23.00±0.362	24.66±0.433
Water-retention capacity, %	52.90±1.038	51.87±0.766	45.52±0.613***
Total moisture, %	74.29±0.192	73.97±0.263	74.37±0.233
Protein, %	22.94±0.199	23.26±0.307	23.16±0.245
Intramuscular fat, %	1.81±0.121	1.57±0.160	1.31±0.097**
Ash, %	1.073±0.0180	1.194±0.0110	1.162±0.0170
Ca, %	0.050±0.0020	0.046±0.0020	0.044±0.0010
P, %	0.099±0.0040	0.105±0.0010	0.104±0.0030

Note: * – $p \le 0.05$, ** – $p \le 0.01$, *** – $p \le 0.001$.

In accordance with the quality standards, the water-retention capacity of pork must be within the range of 53-65%; softness ranged within 58.04-84.30 g/cm^2 (Reference book, 1979). The muscle tissue of the longest back muscle in the interbred combinations (Y × L) × (G × D) has the highest difference with the norm: softness - by 19.63%, water-retention capacity - by 11.53%.

Regarding the chemical composition, the meat samples of the studied pig groups answered to the present-day level of lean pork. With high protein content the fat content was low. In meat obtained from the four-breed pig combinations, the significantly higher protein content was detected than in that from the two-breed analogues ($p \le 0.001$). Thus, at the same level of feeding, pigs of various commercial combinations had different levels of muscle tissue quantity and quality.

Particular attention is drawn to the lower content of total phosphorus in pork: 0.099-0.105% compared to the norm of 0.160-0.180%, which may indicate its insufficient amount as part of the ration's feed components, deviation in the Ca: P ratio or a low level of phosphorus recovery by the animal organism.

Assessment of the nutrition and chemical composition of mixed fodders showed that in general the level of pigs feeding was sufficiently high and mostly correlated with the requirements of the current regulatory guidelines (Ryadchikov, 2008) (Table 2).

Table 2. Chemical composition and energy value of fodders for pigs on nursery and fattening, %.

Index	Name of fodder and fattening periods

	Starter 77-89 days	Grower 89-110 days	Finisher 110-167 days
Dry matter	90.66	90.64	88.95
Total moisture	9,34	9,36	11,05
EU, MJ/kg	12.68	12.51	12.23
Crude ash	6.60	7.05	5.15
Nitrogen	2.83	2.72	2.31
Crude protein	17.69	16.97	14.41
Crude fat	3.71	4.37	3.51
Crude fiber	4.85	5.57	5.64
NFE (nitrogen-free extracts)	57.82	56.69	60.24
Total Ca	0.45	0.51	0.48
Total P	0.48	0.49	0.51
Total lysine, g	11.1	10.0	8.40

However, comparison of the meat and fodder analysis results indicates the need for additional improvement of dietary rations for commercial pig combinations with high intensity of muscle tissue synthesis in carcasses. It particularly concerns the content of the essential lysine amino acid and its relation to metabolic energy, which turned to be somewhat higher in fodders for pigs on nursery and fattening and was 0.88, 0.80 and 0.69 g/MJ, respectively, as compared to the norm (0.82, 0.71 and 0.62 g/MJ).

It should also be noted that in animal fodders the calcium-phosphorus ratio did not meet the normative levels and was 0.9: 1.0. The results of our study confirmed the current general tendency that pigs with a high content of lean meat in carcasses, obtained in the intensive fattening conditions, have a high level of free moisture and increased rigidity of meat.

Studies have shown that with a low level of energy intake, the protein component of the fodder is absorbed more poorly in the body and excessive nitrogen is released into the environment. And at a high level of fodder energy value, metabolic processes in the animal body contribute to a greater fat growth in carcasses (Ryadchikov, 2008).

Optimizing the lysine content in relation to the metabolic energy in fodders is also an important moment in reducing fodder costs per unit of growth of fattening stores.

It is known that a low percentage of phosphorus in the meat of the studied pigs is a sign of the need to improve the content of calcium and phosphorus elements in fodders that directly participate in the synthesis of muscle tissue and its normal functioning. These elements are deposited in animal tissues and organs, therefore their lack in the fodder is compensated by the latter, which affects the health and productivity of pigs, as well as the pork quality (Podobed, 2014). We believe that the increased intensity of high-productive meat pigs' stores fattening requires improvement of the calcium-phosphorus ratio to the norm (Ca:P=1.2-1.3: 1.0). Moreover, laboratory studies have found the lowered phosphorous content in the muscle tissue of commercial pigs. At the same time, it is necessary to consider the availability of these minerals for absorption in the animal body.

The results of our study also confirm the fact of the lack of phosphorus absorption by animals due to the action of phytase enzyme on plant fodders; in pigs with a high intensity of metabolic processes for the normal synthesis of muscle tissue, there is a need for additional attention paid to solving this problem (Podobed, 2016). Otherwise, the proportion of phosphorus that is not absorbed by the body is excreted with feces into the environment.

Conclusion

The pork quality is an important complex index of the ecological level of a number of interconnected processes, such as pork production, human nutrition and the environment.

Highly productive commercial pig combinations have different levels of meat quality indices under the same conditions of keeping and feeding, which is important for improvement of ecological and technological systems of pork production.

The issue of feeding high-productive meat pigs grown under intensive technologies requires a comprehensive solution: rations improvement by amino acid and mineral composition, emphasis on improving the availability of nutrients for pigs, increasing the priority of quality pork production and reducing the negative effects of residual metabolic substances for the ecological state of the environment.

References

Adzitey, F., & Nurul, H. (2011). Pale soft exudative (PSE) and dark firm dry (DFD) meats: causes and measures to reduce these incidences-a mini review. International Food Research Journal, 18(1), 11-20.
Bankovska, I. B. (2015). Otsinka myasa svyney za yakisnymy rivnyamy. Visnyk Sumskoho natsionalnoho ahrarnoho universytetu. Sumy, 6(28): 79-82 (in Ukrainian).
Effektivnoye Zhivotnovodstvo. (2008). 5(30): 48-51 (in Russian).
Ostapchuk, P. P. (1979). Spravochnik po kachestvu produktsii zhivotnovodstva. Kiyev : Urozhay, pp: 152-195 (in Russian).
EU (2011). Commission implementing Decision 2011/258/EC of 27 April 2011 amending Decision 89/471/EC authorising methods for grading pig carcasses in Germany (notified under document number C(2011) 2709). Official Journal of the European Union, L75, pp: 24-25.
Kalinchyk, S. M,, Alyeksyeyenko, I. M., & Kalinchyk, M. V. (2018). Problemy svynarstva Ukrayiny v seredovyshchi svitovoho rynku. Ahrosvit 12, 9-14 (in Ukrainian).
Kuo, C. C., & Chu, C. Y. (2003). Quality characteristics of Chinese sausages made from PSE pork. Meat Science, 64, 441-449.
Fesinina, V. I. (1987). Metodicheskiye rekomendatsii po otsenke myasnoy produktivnosti, kachestva myasa i podkozhnogo zhira sviney. Moskva: VASKHNIL, 64 s (in Russian).
Monin, G., Mejenes-Quijano, A., & Talmant, A. (1987). Influence of breed muscle metabolic type on muscle glycolytic potential and meat pH in pigs. Meat Science, 20: 149-158.
Myaso ta Myasni Produkty. (2002). Vyznachennya rN (kontrolnyi metod) (ISO 2917:1999, IDT) : DSTU ISO 2917:2001. (Chynnyi vid 2003-01-01). Kyiv: Derzhavnyy komitet Ukrayiny z pytan tekhnichnoho rehulyuvannya ta spozhyvchoyi polityky, 6 s. (Natsionalnyi standart Ukrayiny) (in Ukrainian).
National Research Council. (2012). Nutrient Requirements of Swine: Eleventh Revised Edition. Washington, DC: The National Academies Press. doi: 10.17226/13298.
Ostapchuk, P. P. (1979). Spravochnik po kachestvu produktsii zhivotnovodstva; pod red. Kiyev: Urozhay, pp: 152-195 (in Russian).
Podobyed, L. I. (2014). Kormy ta hodivlya svyney. Svynarstvo: kol. monohr. nauk. red. Voloshchuk VM. Kyiv : Ahrarna nauka, pp: 392-508 (in Ukrainian).
Podobed, L. I. (2008). Otsenka effektivnosti primeneniya kormovykh fosfatov vo vzaimosvyazi s faktorami fermentativnogo povysheniya dostupnosti fosfora zernovykh kormov (Elektronnyy resurs). URL: http://podobed.org/_otsenka_effektivnosti_primeneniya_kormovyh_fosfatov_vo_vzaimosvyazi_s_faktorami_fermentativnogo_povyshe.html (in Russian).
Ryadchikov, V. G. (2008). Normy potrebnosti sviney myasnykh porod i krossov v energii i perevarimykh aminokislotakh. Effektivnoye Zhivotnovodstvo, 5 (30), 48-51 (in Russian).
Vlizlo, V. V. (2012). Laboratorni metody doslidzhen u biolohiyi, tvarynnytstvi ta veterynarniy medytsyni: dovidnyk; za red. V. V. Vlizlo. Lviv : SPOLOM, p: 767 s (in Ukrainian).

Citation: Bankovska, I.B., Manyunenko, S.A., Kondratiuk, V.M., Zasukha, Yu.V., Grishchenko, S.M., Mytiai, I.S., Hryshchenko, N.P. (2019). Pork quality as an ecological index of the "organism – environment" interaction. *Ukrainian Journal of Ecology, 9*(1), 183-186.