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Katedra Przetwórstwa i Towaroznawstwa Rolniczego Uniwersytetu Rzeszowskiego,
ul. Ćwiklińskiej 2, 35-959 Rzeszów, e-mail: mrudy@uniw.rzeszow.pl

MARIUSZ RUDY, AGATA ZNAMIROWSKA

Dynamics of acidity changes and meat quality deviations of PSE and DFD types in the different pork carcass classes

Dynamika zmian kwasowości oraz odchylenia jakościowe mięsa typu PSE i DFD w różnych klasach tusz wieprzowych

Summary. The objective of the research presented in this paper was to analyze changes in acidity and determine quality deviations of pork in the E, U, R and O carcass quality classes obtained from baconers in the south-eastern region of Poland. Animals were fed full-portion fodder supplied ad libitum in dry condition from automatic devices. It was found that raw product of carcass classes with lower meatiness will require relatively lower processing outlay, connected with bringing of pork with quality deviations to normal level, compared to raw product with higher pork content in carcass.

Key words: meat quality, acidity changes, pork carcasses

INTRODUCTION

A side effect of raising the meatiness of baconers in mass population may be the worsening of pork quality [Koćwin-Podsiadła 1997, Borzuta 1998]. In some research, for example [Borzuta 1999, Borzuta and Pospiech 1999] it was found that losses on that account may constitute even half of the profit obtained from meatiness rise. The authors say that, if losses resulting from pork quality deterioration during its distribution and those in processing and product preparation for sale and use are all summed up, they reach up to PLN 140 million per annum, i.e. approx. 2.4% of pork value in Poland. The calculated sums are lost irretrievably by meat industry and distributors. Those losses are covered partially by the meat industry as well as consumers, because such defects, being well advanced, are hard to eliminate.

Borzuta [1999] reports that the fraction of ASE type pork in Denmark reaches even up to 40% of slaughtered baconers. In Poland, as reported by Pospiech [1997], the share of carcasses with PSE pork was within 14–18% of the mass population of baconers in 1996. However, Koćwiń-Podsiadła and Antosik [2001] report that that unfavorable phe-

nomenon has been halted and this share reached 10% in 1999. Over the recent years one ascertained high variability of the natural outflow from the muscle of the longissimus back determination after 48 hours from the slaughtering, both among laden hogs free from genes causing the defect the meat [Koćwin-Podsiadła *et al*. 2003, Bertram *et al*. 2004, Krzęcio *et al*. 2005].

Despite the above reports, it should be stated that there is no way back in pig breeding from fat reduction in porkhalves at the cost of a larger share of meat tissue. In order to achieve that, it is necessary to optimally utilize the genetic *(crossbreeding)* as well as environmental and technological *(feeding, pig yards)* factors.

A most effective mechanism to assist in pork quality perfection would be to combine pork quality evaluation with the assessment of meatiness and application of these two criteria in financial/cost accounting between breeders and pork processor [Borzuta 1998, Borzuta and Pospiech 1999].

The objective of this paper was to analyze acidity variations and determine quality deviations of pork in the E, U, R and O classes of carcasses obtained from baconers from the south-eastern region of Poland.

MATERIAL AND METHODS

The experiment was performed on 141 crossbred baconers of duroc, hampshire and pietrain breeds. The fattening was run in uniform conditions of environment and feeding in the Swine Fattening House in Hruszowice. The animals were fed full-portions of nutritive fodder supplied ad libitum in dry condition from automatic devices. Once the fattening was finished, the baconers were delivered to the Slaughter House in Jarosław, where, after weighing, they were slaughtered by methods obligatory in the meat industry. Pork content in carcass was determined with the Ultra-Fom 100 apparatus on hanging carcasses. Then, 45 minutes after slaughter moment, the initial pork pH (pH_1) was determined in the longest dorsal muscle (*m. longissimus dorsi*). The pork acidity was measured with microcomputer CI-316 ionometer with integrated electrode of the ESAgP-307W type. The carcasses were subjected to cooling for 24 hours at the temperature of 0–4°C and then pork pH (pH_{24}) was determined in similar manner as for pH_1. Pork samples were taken from the longest dorsal muscle (*m. longissimus dorsi*) from above the last three chest vertebrae in order to determine the pH after 48; 72; 96 and 120 hours after slaughter.

The tests also comprised the evaluation of carcasses and meat in respect of the frequency of the occurrence of PSE *(Pale Soft Exudative)* and DFD *(Dark Firm Dry)* changes. Such classification was made on the basis of boundary values of hydrogen ion concentration 45 minutes [Blicharski *et al*. 1996, Ostrowski and Blicharski 1999] and then 24 hours [Sobina and Kondratowicz 1999] after slaughter, as well as on the basis of pork color lightness measured at the wavelength of 555 nm [Kortz *et al*. 1968]. The classification was performed according to the following boundary values:

Specification – Wyszczególnienie	pH_1	Color lightness – Jasność koloru	pH_{24}
Normal meat – Normalne mięso	> 6.30		< 6.00
Partially PSE – Częściowo PSE	5.80–6.30	26–31	-
PSE	< 5.80	> 31	-
Partially DFD – Częściowo DFD	-	< 20	6.00–6.20
DFD	-	< 20	> 6.20

All obtained numerical data were segregated and subjected to statistical and mathematic processing. Table 1 specifies arithmetic means ($\bar{x}$) of each of the studied characteristics as well as the value of standard deviation (S). Analysis of variance (ANOVA) was used in calculations which were then checked with Tukey's confidence intervals, at two significance levels $\alpha \leq 0.01$ and $\alpha \leq 0.05$. The zero hypothesis in ANOVA was verified, using the test constructed by Fisher Snedecor (test F).

Calculations were performed on the basis of the STATISTICA ver. 5.1 software program.

DISCUSSION

Acidity is that characteristic which affects muscle microstructure, bacterial microflora development and, consequently, the pork hardness, enzymatic activity, color, crispness as well as the creation of flavor and taste profile [Domański and Czyżak 1991, Nowak *et al*. 1995]. Fig. 1 shows that carcasses in the E class exhibited the lowest value of pH_1 (6.09), whereas carcasses in class O had the highest pH_1 value (6.29) and these values grew as the meatiness classes lowered. However, statistically significant differences were found only between classes E and O, as well as U and O (refer to Table 1). On the other hand, the values of pH measured 24 hours after slaughter grew only slightly with lowering pork content in carcasses. Buczyński *et al.* [1996], having measured the pH in the longest dorsal muscle of crossbreds derived from sows of wbp breed and pietrain x pbz breed sires,

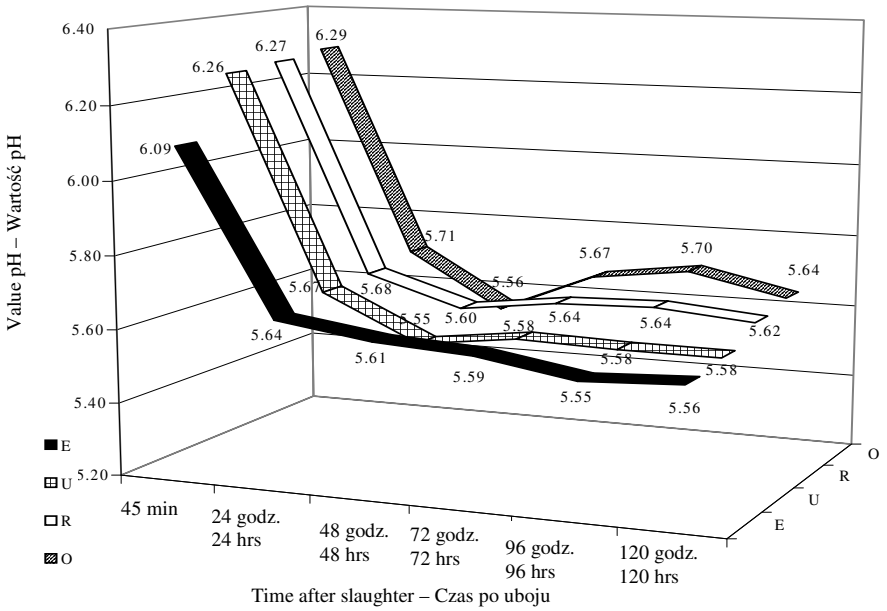

Fig. 1. PH variation over time in individual classes of pork carcass meatiness
Rys. 1. Zmiany pH w czasie w poszczególnych klasach mięsności tusz wieprzowych

Table 1. Selected physico-chemical properties and pork content in carcasses in individual classes of meatiness

Tabela 1. Wybrane właściwości fizyczno-chemiczne i zawartość mięsa w tuszy w poszczególnych klasach mięsności tusz wieprzowych

Specification Wyszczególnienie	Statistical measures Miary statystyczne	Carcasses class – Klasa tuszy				Statistical differences among classes Różnice statystyczne między klasami
		E	U	R	O	
Number Liczba		22	34	64	21	-
pH_1	$\bar{x}$ S	6.09 0.36	6.26 0.35	6.27 0.25	6.29 0.28	E < R*
pH_{24}	$\bar{x}$ S	5.64 0.20	5.67 0.20	5.68 0.20	5.71 0.20	-
pH_{48}	$\bar{x}$ S	5.61 0.10	5.55 0.11	5.60 0.21	5.56 0.13	-
pH_{72}	$\bar{x}$ S	5.59 0.09	5.58 0.13	5.64 0.19	5.67 0.28	-
pH_{96}	$\bar{x}$ S	5.55 0.08	5.58 0.14	5.64 0.25	5.70 0.30	E. U < O*
pH_{120}	$\bar{x}$ S	5.56 0.09	5.58 0.15	5.62 0.25	5.64 0.29	-
Brightness at the length of waves 555 nm, % Jasność przy długości fali 555 nm	$\bar{x}$ S	25.18 5.46	26.29 8.69	28.45 8.07	28.90 7.26	-
Content of meat in carcass, % Zawartość mięsa w tuszy	$\bar{x}$ S	57.27 1.38	52.21 1.28	47.54 1.51	43.26 1.36	E > U. R. O** U > R. O** R > O**

* – statistical difference between classes significant at $\alpha \leq 0.05$ level,
** – statistical difference between classes significant at $\alpha \leq 0.01$ level
* – statystyczna różnica między klasami istotna przy $\alpha \leq 0,05$
** – statystyczna różnica między klasami istotna przy $\alpha \leq 0,01$

as well as pietrain x złotnicka pstra, found a negative relationship between carcass meatiness and pork quality characteristics. It is connected with pietrain breed swine blood addition. The RYR1 stress sensitivity gene, whose frequency in pietrain breed swine population ranges from approx. 31 to 100%, is responsible for pork quality. The research showned that pH ranged from 5.94 in baconers with 50% share of pietrain breed swine to pH 6.35 in the pietrain × złotnicka pstra crossbred sires. In purebred baconers the average pH was 6.26. It appeared in that case that pietrain × złotnicka pstra crossbred sires were a very favorable fathering component for crossbreeding because of lack of PSE defect in pork of złotnicka pstra breed swine. Blicharski *et al.* [1996] carried out similar tests on pietrain purebred baconers – group I, as well as on crossbreds ♀ wbp × ♂ pietrain – group II, ♀(pbz × wbp) × ♂(wbp × pietrain) – group III, ♀(pbz × wbp) × ♂(pbz × pietrain) – group IV and on crossbreds of ♀(pbz × wbp) × ♂(duroc × pietrain). Among those tested groups the purebred baconers exhibited the lowest pH values. On the

other hand, the crossbreds derived from wbp sows and pietrain sires showed better pork quality than the pure pietrain breed, but the average pH value in loin (5.77) indicated PSE pork.

We find from our analysis of the number of carcasses with pork quality changes of PSE and DFD types that the first defect occurred in 5.88% of carcasses in U class and in approx. 4.50% of carcasses in E and R classes, whereas a partial PSE deviation occurred in pork of carcasses in classes: E – 18.18%, O – 14.28%, R – 6.25% and U – 5.88% (Fig. 2). The DFD type defect, on the other hand, occurred only in 1.5% in pork of carcasses in R class. The highest level of partial DFD deviations, 5.88%, was discovered in pork of carcasses in U class. A general analysis of the quality of obtained raw product shows that carcasses in R class had the highest share of normal pork (87.46%), while the E class had the lowest number of carcasses with normal pork (72.74%). Processing of pork with quality deviations requires application of additional technological measures, which raise the cost absorbed for producing a finished product of such raw pork. Therefore, the above results show that raw product from classes with lower meatiness will require a relatively lower processing outlay (related to bringing the qualitatively changed pork to normal level).

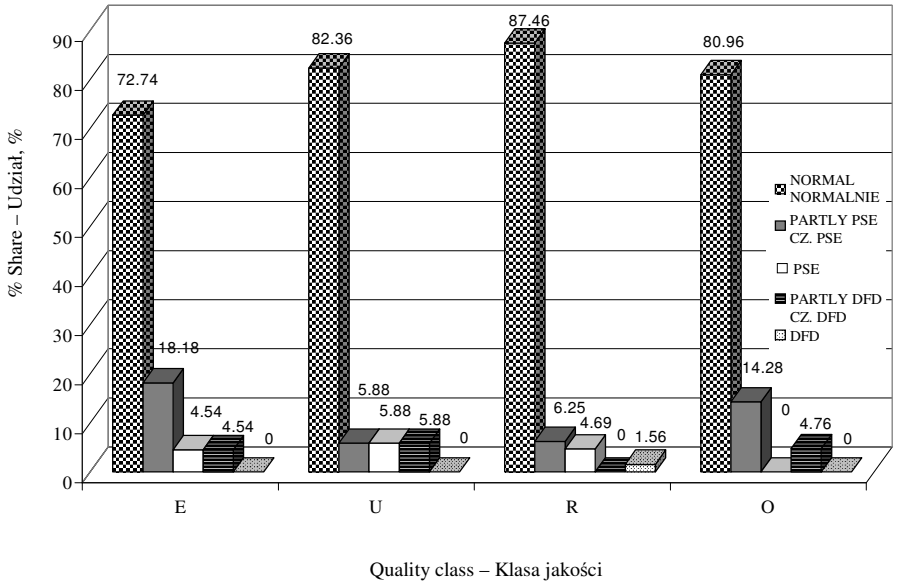

Fig 2. Percentage of pork with PSE and DFD changes
Rys. 2. Procentowy udział mięsa ze zmianami PSE i DFD

The research of Koćwin-Podsiadła and Kurył [1990] on the three-breed (pbz-23 × wbp) × pietrain crossbreds, as well as crossbreds of pbz-23 × wbp and (pbz-23 × wbp) × pbz-23 showed a dramatic worsening of pork quality characteristic, compared to wbp and pbz-23 purebred animals, with consequential high share (approx. 43.8%) of carcasses with PSE symptoms. The quality of pork of baconers of the pbz-23 line was found to be not

too good, either (35.8% carcasses with PSE symptoms). Eckert and Żak [1997], on the other hand, found pork with DFD in as much as 6.67–16.67% of carcasses of crossbreds derived from sows of wbp breed and sires of pietrain breed and 990 line. Kortz *et al.* [1996] found more normal pork in carcasses of purebred (wbp – 80%) swine than in crossbreds.

CONCLUSIONS

Analysis of the obtained results permits formulation of the following conclusions:

1. Carcasses in E class exhibited the lowest pH values, measured 45 minutes and 24 hours after slaughter. The pH values tended to be higher and higher with lowering meatiness class.

2. The most normal pork (i.e. the least pork with PSE and DFD changes) was obtained from carcasses of R class, whereas the least pork came from those in class E.

REFERENCES

Bertram H.C., Engelsen S.B., Busk H., Karlsson A.H., Andersen H.J. 2004. Water properties during cooking of pork studied by low – field NMR relaxation, effects of curing and the RN^- gene. Meat Sci. 66, 437–446.

Blicharski T., Mróz K., Ostrowski A. 1996. Wpływ stosowania świń rasy pietrain w niektórych układach krzyżowań na jakość mięsa produkowanych tuczników. Przegl. Hod. 8, 20–22.

Borzuta K. 1998. Zalety i mankamenty surowca wieprzowego pochodzącego od tuczników o wysokiej mięsności. Trzod. Chlew. 11, 81–84.

Borzuta K. 1999. Osiągnięcia i porażki wdrażania systemu klasyfikacji tusz wieprzowych EUROP w Polsce. Trzod. Chlew. 6, 66–70.

Borzuta K., Pospiech E. 1999. Analiza korzyści związanych ze wzrostem mięsności tuczników oraz strat spowodowanych pogorszeniem jakości mięsa. Gosp. Mięs. 9, 36–40.

Buczyński J.T., Krupiak S., Dudziak P. 1996. Wyniki krzyżowania loch rasy wbp z knurami rasy pietrain, pietrain × pbz i pietrain × złotnicka pstra. Zesz. Nauk. Przegl. Hod. 26, 161–167, Warszawa.

Domański J., Czyżak G. 1991. Związek stanu zdrowotnego tuczników z procesem niektórych przemian endogennych mięsa. Gosp. Mięs. 2, 23–26.

Eckert R., Żak G. 1997. Porównanie użytkowości rzeźnej oraz pH_{45} i pH_{24} mięsa tuczników pochodzących po lochach rasy wbp i knurach rasy pbz, pietrain oraz mieszańcach linii 990 i pietrain. [In] Aktualne problemy jakości mięsa wieprzowego. Międzynarodowa Konferencja, Jastrzębiec październik 1997, Inst. Genet. i Hod. Zwierz. PAN, Jastrzębiec.

Koćwin–Podsiadła M. 1997. Wykorzystanie genu HAL^n w programach krzyżowania towarowego świń. Trzod. Chlew. 1, 17–19.

Koćwin-Podsiadła M., Antosik K. 2001. Rynek mięsa wieprzowego w Polsce i wyzwania w procesie integracji z Unią Europejską. Trzod. Chlew. 5, 46–53.

Koćwin-Podsiadła M., Kurył J. 1990. Jakość mięsa wieprzowego w Polsce. Przegl. Hod. 4/5/6.

Koćwin-Podsiadła M., Kurył J., Krzęcio E., Zybert A., Przybylski W. 2003. The interaction between calpastatin and RYR1 genes for some pork quality traits. Meat Sci. 65, 731–735.

Kortz J., Gardzielewska J., Jakubowska M., Karamucki T., Natalczyk-Szymkowska W., Wójcik A. 1996. Wpływ płci, masy i stopnia otłuszczenia tusz na jakość mięsa tuczników z ferm wielkostadnych, Zesz. Nauk. Przegl. Hod. 26, 187–197.

Kortz J., Różycka J., Gajewska S. 1968. Methodical aspects of objective colour determination in fresh pork meat. Rocz. Nauk Rol. 90, B-3, 333–334.

Krzęcio E., Kurył J., Koćwin-Podsiadła M., Monin G. 2005. Association of calpastatin (*CAST*/*Msp*I) polymorphism with meat quality parameters of fatteners and its interaction with *RYR1* genotypes. J. Anim. Breed. Genet. 122 (4), 251–258.

Nowak B., Kłosowska D., Blicharski T., Ostrowski A., Komender P. 1995. Zależność między mięsnością tuszy, jakością mięsa oraz budową mikrostrukturalną tkanki mięśniowej świń. IGiHZ PAN Jastrzębiec, Mat. Konf. 25–26 maja, sek. B.

Ostrowski A., Blicharski T. 1999. Problemy poprawy jakości tusz wieprzowych. Mięso i Wędliny 3, 46–50.

Pospiech E. 1997. Analiza możliwości przetwarzania mięsa o obniżonej jakości. Gosp. Mięs. 6, 34.

Sobina I., Kondratowicz J. (1999). Różnice w budowie ultrastrukturalnej normalnych mięśni świń oraz z wadami PSE i DFD. Medycyna Wet. 55 (8), 542–545.

Streszczenie. Celem badań przedstawionych w niniejszej pracy było przeanalizowanie zmian kwasowości i wyznaczenie odchyleń jakościowych mięsa wieprzowego w klasach E, U, R, O tusz pochodzących od tuczników z regionu Polski południowo-wschodniej. Zwierzęta żywione były pełnoporcjową paszą treściwą, zadawaną z automatów na sucho do woli. Stwierdzono, że surowiec z klas tusz o niższej mięsności będzie wymagał stosunkowo mniejszych nakładów, związanych z doprowadzeniem mięsa ze zmianami jakościowymi do poziomu normalnego, w porównaniu z surowcem o wyższej zawartości mięsa w tuszy.

Słowa kluczowe: jakość mięsa, zmiany kwasowości, tusze wieprzowe