

COMPARISON OF THE RATE OF POST MORTEM CHANGES IN PIG MUSCLES AS AFFECTED BY HEREDITY, PRESLAUGHTER WEIGHT AND SEASON IN WHICH THEY ARE SLAUGHTERED

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INTRODUCTION

Continuous improvement of selection, management and breeding practices results in obtaining pigs characterised by a very well developed muscular system allowing to meet the growing demand for animal protein. On the other hand all these practices lead to intensification of certain phenomena and properties which reduce considerable the slaughter value in pigs. It is associated with an increased susceptibility to stress and the occurrence of muscle defects in the form of wateriness /PSE/ or DFD meat. The frequency of occurrence of muscle defect depends on both genetic [5,6,8,10,11,14,17,26] as well as environmental factors, during pig growing and preparation of animals for slaughter [1,3,19,24,29]. The results of the majority of studies emphasize the determining effect of genetic factors and refer usually to the influence of particular breeds [5,20,23]. One or two papers report the possibility of a much deeper influence e.g.individual strains or lines of pigs [5,12], however the effect of other factors on meat quality after slaughter is usually not taken into account. Therefore, the aim of this study was to examine the rate of post mortem changes in the pig muscle tissue derived from one breed /White Złotnicka/ which constituted the progeny of six boars of separate breeding lines. Furthermore, the effect of pre-slaughter weight as well as the

season in which the pigs were slaughtered was studied.

MATERIAL AND METHODS

The study was carried out on pigs of White Złotnicka breed. Animals were fed on commercial feed mixtures to eliminate the possibility of nutritional changes. The experiment compared 161 pigs, a progeny of 6 boars and 30 sows. Only females were selected for the study in order to eliminate the influence of sex.

Usually 5 pigs were selected from each litter of a given boar and sow which were then divided into 5 groups differing by their pre-slaughter weight. The first group comprised animals weighing about 90 kg and then successively 100, 110, 120 and 130 kg. Pigs were of the meat type from the point of view of exterior as well as the amount of muscle tissue. This was evidenced by high meat yield in the ham and also by a high ratio of muscle tissue to fat tissue in the basic meat cuts /shoulder, loin and ham/.

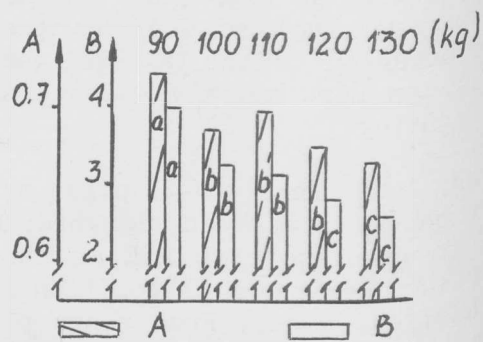


Fig.1 Meat content in the ham /A/ and the ratio of meat to fat in the basic meat cuts /B/ of the White Złotnicka pigs depending on their pre-slaughter weight  
a, b ...- various letters display significant differences  
P = 0.05

Boars whose progeny was assessed in this study demonstrated in addition to their good meatness, a high value of selection indi-

ces. This assessment takes into account mean daily weight gains, thickness of fat from 5 measurements, surface area of loin eye and muscle yield in the ham. Differences in the inbred and relation coefficient of individual boars varied slightly.

The experimental pigs were slaughtered throughout the year after the required preslaughter weight has been reached. Simultaneously, the air temperature on the day of slaughter was registered. One day before slaughter the pigs were transported from the farm to the slaughter-house /distance about 30 km/. The following day, after about 16 h rest, they were slaughtered in a normal production cycle.

Blood was collected at slaughter for analysis. Muscle samples /m.longissimus dorsi/ were taken from the left side of each carcass between the 7th and 11th thoracic vertebra 1 to 2 h after slaughter, and between the last rib and 4th lumbar vertebra 16 h post mortem after cooling @ 4°C.

Examinations carried out in the muscle tissue directly after slaughter comprised pH<sub>1</sub> value determined 45 minutes after slaughter [3], glycogen content determined by anthrone method [16], lactic acid, by colour reaction with hydroquinone in an acid medium [9], myofibrillar ATP-ase activity activated by calcium and magnesium ions [17] and visual assessment of colour according to 5-point scale [27].

After 16 h cooling m.longissimus dorsi was analysed with regard to the following parameters: pH value /pH<sub>1</sub>/ [3], levels of lactic acid [9] and glycogen [16] as well as free water content [22]. Blood analysis included determination of the pH value and the content of free and bound 17-hydroxycorticosteroids [2]. The obtained results were subject to statistical analysis. Furthermore, the analysis of variance was used to determine the LSD between mean values of the

studied parameters [4].

## RESULTS AND DISCUSSION

The criterion of Kortz and his co-workers [15] with regard to the determination of meat quality on the basis of pH<sub>1</sub> as well as Scheper's data [25] for border values of pH<sub>2</sub> were applied. It was found that of the total of 161 experimental pigs 33 i.e. 53 pigs had m.longissimus dorsi of pH<sub>1</sub> < 6.0; 18% pH<sub>1</sub> = 6.0 to 6.3 and only one pig with pH<sub>2</sub> > 6.2 which means that its meat was of DFD type, while the remaining 48% pigs had normal muscles of pH<sub>1</sub> > 6.3.

Mean values of pH<sub>1</sub> and pH<sub>2</sub> for the entire population amounted to 6.19 and 5.59 respectively. The highest acidity was found in muscles of pigs obtained from the boar D /Fig.2/.

It differs significantly from values found in the remaining groups. Such of considerable decrease of pH<sub>1</sub> value in the group of animals from the above mentioned boar was caused by the fact that of the 30 pigs constituting its progeny 26 i.e. 87% had watery or partially watery muscles. The amount of PSE meat in the progeny of the remaining boars was almost three times lower. On the basis of genetic information such as the size of inbred and relation coefficient as well as the value of selection index it is difficult to determine the cause of unfavourable influence of boar D on the characteristic of its progeny. So it is evident, that such information would not allow for the prediction of such an unfavourable influence of the above mentioned boar and consequently its elimination from breeding. The analysis of pH<sub>1</sub> and pH<sub>2</sub> values depending on preslaughter weight of the examined pigs /Fig.2/ showed that within the 5 experimental groups, the animals weighing 90 kg demonstrated the highest concentration of

hydrogen ions in the meat and were followed by animals weighing 120 and 100 kg. The least acidity of meat was found in the pigs of 130 kg live weight. The largest number of pigs with PSE symptoms was found in the group of animals weighing 90 kg /53%/ while in 120 kg group there was 41% of such animals. These findings are inconsistent with results of other experiments [7, 11] which suggested that meat of young pigs has superior cooking and technological properties, though Sreckovic and co-workers [26] found better meat quality in older pigs.

A probable cause of the poor quality of pigs' muscles of different preslaughter weight and, consequently, of the above mentioned discrepancy is, in the case of the first group of pigs, the change of feed given to animals /higher caloric value/ as suggested by Janicki [10] and Osińska and Kielanowski [21] while in the case of heavier sows /120kg/ it was probably a change in metabolism in the later period of their growth.

Data concerning  $pH_1$  and  $pH_2$  in the muscles of animals slaughtered in various season /Fig.2/ showed that the lowest pH value was observed in summer and winter. The highest mean pH was found in autumn - 6.36. These values varied significantly. Similar results were obtained by other authors [7,14]. The unfavourable effect of summer and winter which was reflected by an increased share of pigs with PSE muscles was primarily associated with different climatic conditions, particularly the temperature. In summer the temperature varied from 6 to 20°C while in winter it ranged from -11°C to +11°C. In the remaining season these changes were much smaller. Only a slight differentiation occurred in blood pH value of the examined pigs. A significantly lower pH value of blood was observed in autumn [7,28]. This difference ranged from 0.07 to

0.08 unit in relation to other seasons. The level of blood pH was lower in the pig carcasses with meat of PSE type and partially watery. This is in agreement with the results of Topel [28]. A significant differentiation in  $pH_1$  value found in the muscle of C and D progeny and no differences between mean pH values of blood in these two groups indicate that blood pH belongs to those parameters which are influenced not only by boar [2] but also by season and others factors [13]. A similar situation was observed when analysing the level of 17-hydroxycorticosteroids in blood. However, pigs which had watery muscles after slaughter contained more free corticosteroids as confirmed by others authors [23, 28]. Simultaneously it was observed that besides the measurements of muscle pH, particularly  $pH_1$ , also the determination of the free water content in the muscle, and the level of glycogen and the activity of ATP-ase activated with Ca ions can be helpful in the assessment of muscle tissue quality. The correlation coefficient between  $pH_1$  and the above traits was usually high and attained  $0.6094^{**}$  and  $0.5231^{**}$  respectively.

## CONCLUSIONS

It may be concluded, that of a number of factors which might affect the rate of post mortem changes in m. longissimus dorsi it was the boar influence that had the most significant effect. The progeny of boar D was characterized by the worst quality of muscle tissue which was the results of a very rapid course of glycolysis processes post mortem. The next factors having a significant effect on the rate of post mortem changes in muscles were preslaughter weight and season. In the experimental conditions the influence of these



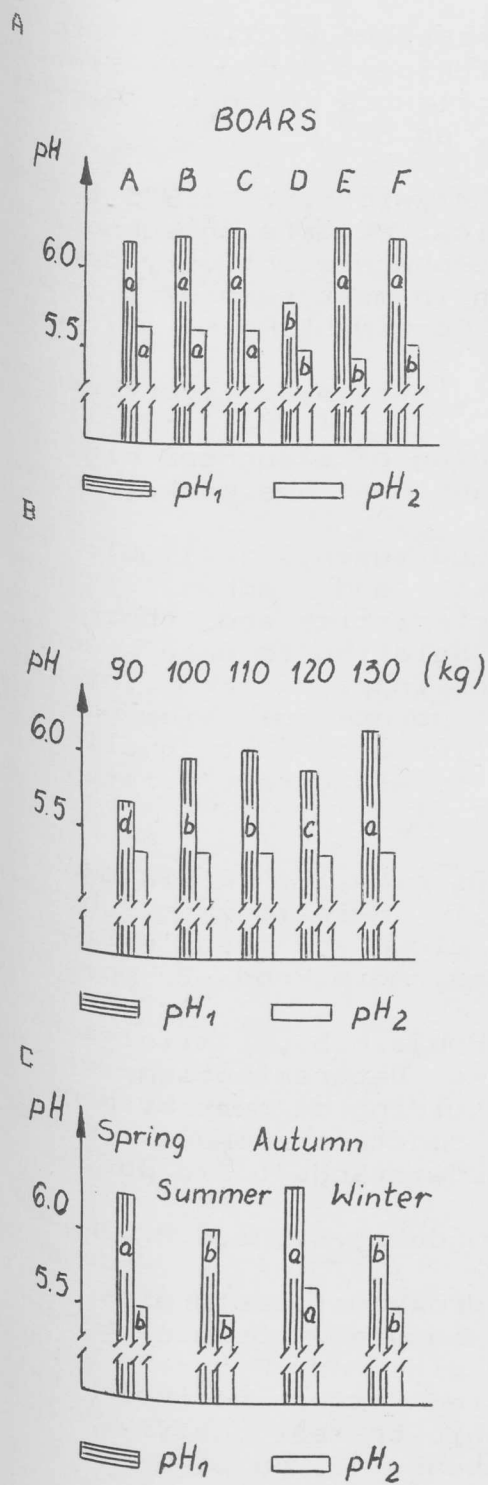


Fig. 2 pH<sub>1</sub> and pH<sub>2</sub> value of pigs depending on:  
 /A/ - their progeny,  
 /B/ - preslaughter weight, and  
 /C/ - season  
 a, b... various letters display significant differences  
 P = 0.05

two factors was quite the same, though, from the statistical analysis, a slightly more pronounced effect on the basic quality characteristics of meat pH<sub>1</sub> value, colour, water-holding capacity /free water content/ was exerted by the preslaughter weight of the examined pigs. The present study indicates that it is possible to improve the quality of pig meat by the control of the genetic factor. However, the importance of other factors such as preslaughter weight of animals and season in which they are slaughtered should not be overlooked. Their influence is also significant and requires careful attention.

#### REFERENCES

1. Buchwald, W. (1976): Injuries and deaths of slaughter animals. *Gosp. mięs.* 28, pp.7
2. Ceresa, F., Cravetto, C.A. (1958): A method for the simultaneous assay of 17-hydroxycorticosteroids and 17-ketosteroids both forms on the same plasma sample. *Acta Endocr.* 29, pp.321
3. Dzierżyńska-Cybulko, B., Pospiech, E. (1978): pH of meat as the index of pig fatigue before the slaughter. *Mjas. Ind. SSSR* 9, pp.39
4. Eland, R. (1964): Statistical methods in investigations of animal husbandry. PWN, Warszawa
5. Elizondo, G., Addis, P.B., Rempel, W.E., Madero, C., Antonik, A. (1977): An approach to determine the relationship among breed composition, skeletal muscle properties and carcass qualitative traits. *J. Anim. Sci.* 45, pp.1272
6. Fewson, D. (1974): Evaluation of boars from purebreds and from hybrid programmes. *Tierzüchter* 26, pp.506

7. Forrest, I.C., Gundlach, R.F., Briskey, E.J. (1963): A preliminary survey of the variations in certain pork ham muscle characteristics. Proc. 15th Res. Conf. Am. Meat Inst. Found, pp.81
8. Gallwey, W.J., Tarrant, P.V. (1979): Influence of environmental and genetic factors on ultimate pH in commercial and purebred pigs. Acta Agric. Skand. Suppl. 21, pp.32
9. Homolka, I. (1961): Biochemical diagnostic. PZWL, Warszawa
10. Janicki, M.A., Kołaczyk, S., Kortz, J. (1963): Colour of meat as influenced by plane of nutrition in pigs. 9th Conf. Eur. Meat Res. Work., Budapest, pp.3
11. Janicki, M.A., Kortz, J., Różycka, J. (1966): Meat quality in relation to age and live in pigs. Technologija Mesa 3, pp.73
12. Janicki, M.A., Różycka, J., Kortz, J. (1970): Introductory research on the heritability of pale, soft and exudative /PSE/ meat in pigs. Zeszyty Prob. Post. Nauk Roln. 103, pp.199
14. Kallweit, E., Mäder, H.P., Steinhilber, D., Weniger, J.H. (1975): Untersuchungen zur Ursache mangelhafter Fleischbeschaffenheit im Zusammenhang mit dem Adaptationsvermögen beim Hausschwein 2. Belastungsreaktionen von Schweinen unterschiedlicher Fleischbeschaffenheit. Z. Tierzucht Zuchtgsbiol. 92, pp.188
15. Kortz, J., Grajewska, S., Różycka, J., Barzdo, R. (1968): Diagnostical value of pH value measured 45 min after the slaughter to evaluation of watery meat appearance in pigs. Medycyna Wet. 24, pp.325
16. Krylowa, N.N., Ljaskowskaja, I.N. (1961): Physico-chemical methods of investigation of animal origin products. Pishtcheprom., Moscow
17. Krzywicki, K. (1972): Studies on wateriness and means limiting its incidence in pork. Roczniki IMP 9, pp.5
18. Krzywicki, K. (1975): Some methodical remarks on adenosinetriphosphatase activity determination in meat samples. Zeszyty Probl. Post. Nauk Roln. 167, pp.139
19. Logtestijn, J.G., Cortiaensen, G.P., Kruijf de, J.M. (1977): Showering of slaughter pigs. 23rd Eur. Meat Res. Work., Moscow
20. Ludvigsen, J. (1968): Some thyroid and adrenal characteristics and their possible relation to pale exudative muscles in pigs. Proc. Int. Symp. Recent points of view on the condition and meat quality of pigs for slaughter. Zeist. pp.113
21. Osińska, Z., Kielanowski, J. (1960): Relationship between meat colour and feed efficiency in pigs. Anim. Prod. 2, pp.209
22. Pohja, M.S., Niinivaara, F. (1957): Deteremination of the waterholding of meat by means of the constant-pressure method. Fleischwirtschaft 37, pp.193
23. Rogdakis, E., Haid, H., Faber, H.V. (1975): Endogenous in 11-hydroxycorticosteroids in Pietrain pigs, German Large White pigs and Pietrain x Large White crosses and their relationship to meat quality. Züchtungskunde 47, pp.311
24. Scheper, J. (1968): Relation between pH value, water-binding capacity and colour of pork after different transport stress. Proc. Int. Symp. Recent points of view on the condition and meat quality of pigs for slaughter. Zeist, pp.201
25. Scheper, J. (1971): Research to determine the limits of normal and aberrant meat quality /PSE and DFD/ in pork. Proc. 2nd

Int.Symp. Condition and meat  
quality of pigs. Zeist, pp.271

26. Sreckovic,A., Niklic,M.,  
Bokorov,T. (1979): Breed varie-  
ties, slaughter weight and pro-  
tein level as related to porcine  
meat quality. Acta Agric.Scand.  
Suppl. 21, pp.210

27. Tilgner,D.J (1957): Sensory  
investigation of food. WPLiSp.,  
Warszawa

28. Topel,D.G., Stam,H., Riis,  
H.M. (1974): Relationship  
between stress adaptation  
starins in swine with skeletal  
muscle characteristics. Wld Rev.  
Anim.Prod. 10, pp.53

29. Wal van der,P.G. (1971):  
Stunning procedures for pigs and  
their physiological consequences  
Proc. 2nd Int.Symp. Condition  
and meat quality of pigs. Zeist,  
pp.145