RELATIONSHIPS BETWEEN LIGHT SCATTERING, pH VALUE AND SOME FIBRE CHARACTERISTICS IN POST MORTEM M. LONGISSIMUS DORSI AND M. SEMIMEMBRANOSUS OF DIFFERENT PIG BREEDS

ŠKORJANC D.*, ŠALEHAR A.*, ERŽEN I.** and KASTELIC M.*

* University of Ljubljana, Biotechnical Faculty, Zootechnical Department, Slovenia ** University of Ljubljana, Medical Faculty, Institute for Anatomy, Ljubljana, Slovenia.

S-IVA.11

SUMMARY

The object of this work was to find if any breed differences exist in light scattering or Fibre Optic Probe (FOP) and pH value in *m. longissimus dorsi* (MLD) and *m. semimembranosus* (MSM) of the four pig breeds. Moreover, we wanted to evaluate the extent of relationships between meat quality indicators and muscle fibre characteristics. With increasing light scattering value (FOP), pH value in meat decreased (r_P = -0.55, P.05). The FOP value in MLD and MSM depended on muscle fibre characteristics in fascicles. With higher area rate of type 1, the FOP values decreased (r_P = -0.12, P.05) and contrary, with higher area rate of type 2A, the FOP values increased (r_P = 0.18, P.05). In MLD boars of D breed had greater FOP value (37.94, P.05) than boars of LW breed (28.48) and lower pH value (5.48, P.05) like boars of LW (5.64) and GL (5.64) breeds. D boars had also the smallest pH value (5.55, P.05) in MSM compared to the other three breeds. Similarly as in MLD, LW boars had lower FOP value (28.43, P.05) than boars of GL breed.
Our results showed breed differences in the FOP and pH values in MLD and MSM, and also indicated that FOP value was influenced by area rate of types 1 and 2A fibres. As documented, the FOP value depended on pH value.

Introduction

Predominant type of muscle fibres with its morphometrical characteristics affect the process of post mortem glycolysis and thus influence also the quality of meat. The colour of meat is influenced by the concentration and chemical status of meat pigments, especially by myoglobine and hemoglobine, together with physical characteristics of meat: light scattering and light absorption characteristics (Kropf, 1993). The final pH value of meat influences the myoglobine form present in meat. High pH causes more deoxymyoglobine, and low pH causes more oxymyoglobine. The structure of fibre proteins affects light scattering and thus the colour of meat (Sybesma, 1993). Weak light scattering occurs at denaturation of muscle proteins (Johansson et al., 1991). The aim of this research was to determine whether there are differences in pig breeds, considering the extent of pH value, light scattering measured in *m. longissimus dorsi* and in *m. semimembranosus*, and if these two indicators for meat quality are someway connected to morphometrical characteristics of fibres.

Material and Methods

Twenty - five boars of each: Duroc (D), Large White (LW), German Landrace (GL) and Swedish Landrace (SL) breeds, were included in the research. When they gained average 100 kg body mass, they were taken to abattoir and were slaughtered according to standard procedure.

Measurements of pH and Light Scattering (FOP) Value

Twenty - four hours after death, FOP value was measured on cross section behind the last rib, on five places. In the centre of *m. longissimus dorsi* (MLD), pH value was measured, and 5 cm from pubis bone, both measurements were taken in *m. semimembranosus* (MSM).

Histochemical Analysis

Muscle tissue samples were dipped to liquid nitrogen for a few seconds and then stored in freezer at - 73C up to the time of histochemical analyses. On 10 m thick serial slices, fibres were grouped to type 1 and 2 at pH 9.4 (Padykula and Herman, 1955) on the base of myosin adenosine triphosphatase activity using Brook and Kaiser (1970) classification system. On the base of acid preincubation media, fibres were classified to type 2A and 2B (Guth and Samaha, 1969).

Morphometric Analyses

On photos (68x - 98x magnification) of serial slices using computer - aided morphometric analyses (Pernu_ et al., 1986), the percentage and relative area of type 1, 2A and 2B fibres were measured in three, randomly chosen, the smallest well distinguished muscle fascicles.

Statistical Analyses

Analysis of variance was used to test breed effects by the GLM procedure of SAS (1990). With the method of contrasts it was possible to establish which breeds differ among themselves in the studied traits. Between the morphometrical traits and meat quality indicators, correlation coefficients were calculated.

Results and Discussion

In table 1, the FOP and pH values in MLD and MSM are presented for different breeds. There are differences among breeds in FOP and pH values in MLD and MSM. In this respect D boars were exceptional; they had the lowest pH values in MLD and MSM, and the highest percentage of fibre area in type 1 and 2A, but the lowest percentage of fibre area in type 2B (Table 2). In the studied depth (2 cm in our case) the percentage of fibre area for type 1 and 2A ($rp = -0.12$, $r_p = 0.18$, $P<.05$) influenced the light scattering value. This can possibly be explained by the statement (Offer and Knight, 1988) that light scattering is influenced by the fibre types in a tissue and by the gaps, being small in white and bigger in red fibres. If post mortal glycolysis is taking place at too high temperature, the enzymes use more oxygen. Thus the muscle has less oxygen for the myoglobine oxygenation (Hunt and Kropf, 1987). In table 1 it is clearly seen that pH values for our case in MLD and MSM for all four breeds are in the limits reported by Warris et al. (1989), Brown (1990), Sewald et al. (1993) and Stecchini et al. (1990) for normal muscle tissue. Values of pH measured 24 hours after death, does not provide accurate determination for meat quality categories and it thus just one of indicators for meat quality. Low pH value in a tissue is accompanied by two processes: denaturation of myosin and sarcoplasm proteins, and increased light scattering (Hunt and Kropf, 1987; Offer and Knight, 1988; Sybesma, 1993). This process is confirmed by high light scattering value in MLD and MSM, measured in boars of our trial, where it was in negative correlation with pH value ($r_p = -0.55$, $P<.05$), measured in the mentioned muscles. Meat, light in colour had higher light scattering value, but it was more acid.
Boars of D breed had also the highest ($P<.05$) FOP value in MLD than boars of other three breeds. In contrast to the our results, it has been reported that the extent of FOP value in MLD is not affected by breed (Edwards et al., 1992), sensibility of Yorkshire pigs to stress (Campion et al., 1976), and the rearing temperature (Lefaucheur et al., 1991). The extent of FOP value, measured in MLD of Swedish Landrace (31) (Johansson et al., 1991), corresponds to our results for this breed (31.79). Contrary to Edwards et al. (1992), Johansson et al (1991) established statistically significant differences in the extent of FOP value between the studied pig breeds. Seth et al. (1991) reported that crossbreeds (Hampshire (Yorkshire x Landrace) have lower FOP in MLD than in MSM, yet our results do not confirm such differences.

The pH value measured 45 min. or 24 hours after death indicates the extent of post mortem muscle metabolism. Falling of pH value in meat of pigs in the time unit is affected by various factors like sex, age at slaughter, feeding, waiting before slaughter, and glycogen store (Fernandez and Tornberg, 1991).
Considering all these points it can be concluded that pH value is affected by numerous factors either separate or in combination with one another.

Conclusion

Boars of D breed had in MLD and MSM the highest percentage of fibre area for type 1 and 2A, and the lowest percentage of fibre area for type 2B. The percentage of fibre area for type 1 and 2A is related to light scattering or FOP value ($r_p = -0.12$, $r_p = 0.18$, $P<.05$). Twenty - four hours after death, the value of FOP and pH were in

negative correlation (r_p = -0.55, P<.05). Among the studied breeds, D boars were exceptional, as they had the highest FOP value in MLD, and the lowest pH value in MLD and MSM.

References

Brooke, M. H. and Kaiser, K. K., (1970). Muscle fiber types: how many and what kind? Arch. Neurol., 23:369 - 376.

Brown, S. N., (1992). A note on the use of subjective methods for assesing pig meat quality on the slaughterline. Meat Sci., 32:195 - 202.

Campion, D. R., Topel, D. G., Christian, L. L., (1976). In vitro studies of mitochondrial and sarkoplasmic reticulum function in muscle stress susceptible pigs. J. Anim. Sci., 43:426 - 431.

Edwards, S. A., Wood, J. D., Moncrieff, C. B., Porter, S. J., (1992). Comparison of the Duroc and Large White as terminal sire breeds and their effect on pigmeat quality. Anim. Prod., 54:289 - 297.

Fernandez, X. and Tornberg, E., (1991). A review of the causes of variation in muscle glycogen content and ultimate pH in pigs. J. Muscle Foods, 2:209 - 235.

Guth, L. and Samaha, F.J., (1969). Qualitative differences between actomyosin ATP of slow and fast mammalian muscle. Exp. Neurol., 25:138 - 152.

Hunt, M. C. and Kropf, D. H., (1987). Color and appearance.(Ed): Pearson, A. M. in Dutson, T. R. In: Advances in meat research volume 3 restructed meat and poultry products. New York, An avi Book, 1987, Chapter 4.

Johansson, G., Tornberg, E., Lundström, K., (1991). Meat colour in loin and ham muscles of normal meat quality from Hampshire, Swedish Landrace and Yorkshire pigs. In: 37th Int. Con. Meat Sci. Technol., Kulmbach, 1991-09-01/06, 394 - 397.

Kropft, D. H., (1993). Colour stability. Factors affecting the colour of fresh meat. Meat Focus, 2:269 - 275.

Lefaucheur, L., Dividich, J., Mourot, J., Monin, G., Ecolan, P., Krauss, D., (1991). Influence of enviromental temperature on growth, muscle and adipose tissue metabolism, and meat quality in swine. J. Anim. Sci., 69:2844 - 2854.

Offer, G. and Knight, P., (1988). The structural basis of water - holding in meat. Part 1: general principles and water uptake in meat processing. The structural basis of water - holding in meat. Part: 2 Drip losses. (Ed): Lawrie, R. In: Developments in meat science - 4. Essex, Elsevier science publishers LTD, Chapter 3.

Padykula, H. A. and Herman, E., (1955). The specificity of the histochemical method for adenosine triphosphatase. J. Histochem. Cytochem., 3:170 - 195.

Pernu_, F., Er_en, I., Bjelogrliè, Z., (1986). A computer - aided method for muscle fibre type quantification. Acta Stereol., 5:49 - 54.

SAS/STAT®, (1990). User's Guide Version 6, Fourth Edition Volume 2, Cary, SAS Institute Inc., 891 - 996, 1135 - 1194.

Seewald, M. J., Iaizzo, P. A., Heisswolf, E., Eichinger, H. M. (1993). Effects of meat quality and storage on the breakdown of adenosin triphosphate in muscle from swine. Meat Sci., 35:47 - 61.

Seth, G., Tornberg, E., Mooller, B. M., (1991). Influence of constant rigor temperature and storage time on the internal reflectance (FOP) in pork muscle. In: 37th Int. Con. Meat Sci. Technol., Kulmbach, 1991-09-01/06. Kulmbach, 481 - 484.

Stecchini, M. L., Mascarello, F., Falaschini, A., (1990). Influence of breeding systems on pH and histochemical properties of muscle fibres in porcine m.semimembranosus. Meat Sci., 28:279 - 287.

Sybesma, W., (1993). Making light of colour assesment. Meat Focus, 2:211 - 212.

Warris, P. D., Brown, S. N., Lopez - Bote, C., Bevis, E. A., Adams, S. J. M., (1989). Evaluation of lean meat quality in pigs using two electronic probes. Meat Sci., 25:281 - 291.