PH DETERMINATION METHODS INFLUENCE PH SLOPES DURING EARLY POST MORTEM AGEING OF PIG MEAT

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Abstract: In meat quality studies pH values are either determined with a pH meter (direct), or indirectly with the iodoacetate method, in which frozen or fresh meat samples are homogenized in an iodoacetate solution before pH analysis. As only few studies have been published yet that directly compared both methods, in the present study pH values of the *Musculus longissimus thoracis* (LM) and *Musculus triceps brachii* (MT) of pigs were determined with both methods within the first six hours post mortem (p.m.). In general, the pH values decrease during p.m. ageing in both muscles. With the iodoacetate method the pH values were higher (P≤0.05) in the LM at all determination times in comparison to the direct methods. The same difference was found in the MT between 40 min to 6 h p.m. However, 10 min p.m. the pH value results were vice versa in the MT (P≤0.05), whereas 20 and 30 min p.m. similar pH values were determined with both methods. The direct and indirect methods were good related (R = 0.62-0.68), but despite this the data also suggest that own pH values should be carefully compared with other studies that used the other method for pH determination.

Key Words – iodoacetate method, pH values, pork

I. INTRODUCTION

The pH values in meat and meat products are often measured directly by insertion of glass electrodes of a pH meter into the products. An alternative is the indirect pH values determination. In this method a meat sample is frozen or directly transferred to an iodoacetate solution after collection. Then the samples are homogenized and the pH value is subsequently determined with a pH meter [1]. The principle of this method is that iodoacetate inhibits the glycolytic enzyme glyceraldehyde-3-phosphate dehydrogenase to prevent a further reduction of the pH values [2]. This method is advantageous, if many meat samples have to be collected. The samples could be easily removed and frozen. For the direct determination method an equilibration time, until the pH value is stable, has to be considered. A disadvantage of the iodoacetate method is that beside the pH meter a homogenisator is necessary.

However, the direct and indirect methods are frequently used in meat quality studies, but only few investigations have been published that directly compared both methods [3, 4, 5, 6]. Therefore in the present study the pH values were analyzed with the two pH measurement methods during early meat ripening in two structurally different pig muscles.

II. MATERIALS AND METHODS

Thirty-five pigs of a commercial crossbreed (Piétrain x F1, malignant hyperthermia syndrome (MHS) homozygote negative) were fattened up to an average body weight of 112 ± 10.3 kg. The pigs were slaughtered in an approved experimental abattoir of the Georg-August-University Goettingen. At different times (10, 20, 30, 45, 60, 120, 180, 240, 300 and 360 min) after slaughter (postmortem, p.m.) the pH values were directly measured in the *Musculus (M.) longissimus thoracis* (LM) and *M. triceps brachii* (MT) using a portable pH meter. At the same times samples were removed from both muscles, frozen in liquid nitrogen and stored at -80°C until analysis. For pH analysis the frozen samples were diluted 1:10 in cold iodoacetate solution (5 mM iodoacetate, 150 mM potassium chloride), homogenized at 4.0 ± 2.0 °C and measured with a pH meter.

For statistical analysis a general linear model was used (SAS Institute, Cary, USA). The model considered the fixed effect of the pH determination method (direct, indirect), the fixed regression coefficients of third (MT) and of forth (LM) polynomial degree of measurement time and the random effect of body weights. $P \leq 0.05$ was considered significant.

III. RESULTS AND DISCUSSION

In the present study a continuous decrease of the pH values of the LM and MT during ageing up to 240 min p.m. could be observed, independent of the pH determination method that was used. This pH reduction is related to metabolic changes within the muscle tissue after slaughter of the animals. Usually before slaughter and during stunning the muscle is "living" and all metabolic systems are functionally competent. During exsanguination and further slaughter the muscle is still active, but the lack of oxygen results in a change of the metabolism to anoxic conditions. This is accompanied with a shift from aerobic ATP production in the mitochondria to the anaerobic glycolysis. The final product in the glycolysis due to the regeneration of NADH is lactate. Therefore the lactate production increases accompanied with decreasing pH values [7].

In the LM at all times significantly ($P \leq 0.05$) higher pH values could be found, if the pH values were determined with the indirect method instead of the direct method (Figure 1, A). This method-dependent effect could also be found in the MT of the pigs between 40 min and 360 min p.m. However, 10 min p.m. the pH values, measured indirectly, were lower ($P \leq 0.05$) in comparison to the direct determination, whereas 20 min and 30 min p.m. no significant ($P > 0.05$) differences between the pH determination methods could be found in the MT (Figure 1, B). The presented effects of the pH determination method agree with data of Dutson [3] in beef, whereas other authors found no differences between the methods in lamb [4] or pig meat [6]. A possible reason for the effect could be that iodoacetate induces a slight alkalization of the solution [5].

Independent of the described differences, in the present study the direct and indirect pH determination methods are closely related with correlation coefficients of 0.66 for both muscles, 0.68 for the LM and 0.62 for the MT. These values were lower than the results presented by Solomon [4] in lamb or Allison et al. [6] in pig meat, but slightly higher than the values presented by Dutson [3] in beef.

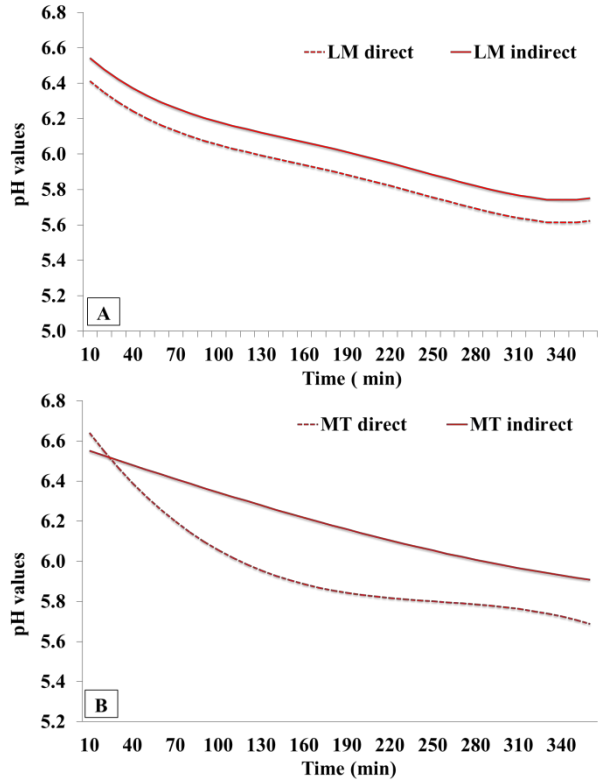

Figure 1. Slopes of pH values measured either with a pH meter (directly), or using the iodoacetate method (indirectly) in the *Musculus (M.) longissimus thoracis* (LM, A) and *M. triceps brachii* (MT, B) of 35 pigs.

IV. CONCLUSION

The study shows that the pH values of pig meat are not only influenced by the time postmortem, but also by the pH determination method with principally higher pH values, if the iodoacetate method is used. This effect is independent of the muscle type. Despite a good correlation between both pH determination methods, own pH values should be carefully compared with other studies that used the respectively other method.

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REFERENCES

1. Bendall, J. R (1973). Post mortem changes in muscle. In G.H. Bourne, Structure and function of muscle (pp 243-309), New York: Academic Press.
2. Schmidt, M. M., & Dringen, R. (2009). Differential effects of iodoacetamide and iodoacetate on glycolysis and glutathione metabolism of cultured astrocytes. Frontiers in Neuroenergetics 1: 1-10.
3. Dutson, T. R. (1983). The measurement of pH in muscle and its importance to meat quality. In Proceedings 36th Reciprocal Meat Conference (pp. 92-97), Fargo, USA.
4. Solomon, M. B. (1987). Comparison of Methods Used for Measuring pH in Muscle Tissue. Journal of Food Science 52: 1428-1429.
5. Santé, V., & Fernandez, X. (2000). The measurement of pH in raw and frozen turkey Pectoralis superficialis muscle. Meat Science 55: 503-506.
6. Allison, C. P., Bates, R. O., Booren, A. M., Johnson, R. C., & Doumit, M. E. (2003). Pork quality variation is not explained by glycolytic enzyme capacity. Meat Science 63: 17-22.
7. England, E. M., Scheffler, T. L., Kasten, S. C., Matarneh, S. K., & Gerrard, D. E. (2013): Exploring the unknowns involved in the transformation of muscle to meat. Meat Science 95: 837-843.