3:2

Application of rapid tests for early prediction of DFD-condition in pre-rigor beef carcasses.

DEZEURE-WALLAYS, B., VAN HOOF, J. and PENSAERT, R.

Laboratory of Hygiene and Technology of Food from Animal Origin, Faculty of Veterinary Medicine, University of Ghent, I.W.O.N.L., Wolterslaan 16 B-9000 GENT, Belgium

Introduction

An early post mortem detection of DFD meat would be desirable as an additional parameter of carcass quality.
The meat processor can then decide,before chilling, to divert the DFD-carcasses to a more profitable end product, e.g. hot boning and processing for cured and cooked meat products in which a high water-holding capacity is of great advantage.
In the present paper two techniques for determining the ultimate pH of carcass meat within approximately 60 minutes after slaughter were tested.
Furthermore the feasibility of a rapid method for determination of glycogen stores in hot carcass meat to predict DFD-beef has also been examined.

Materials and Methods

a. Materials

The animals used in this study were young bulls (1 year old) with a mean carcass weight of 280 kg and were slaughtered in the experimental abattoir of the Faculty of Agricultural Sciences (RUG). The breeds were East Flanders White Red (53%), West Flanders Red (25%) and Belgian Red Tied (22%).
They were supplied by the same farm (Experimental Station for Cattle-breeding at Scheldewindeke) located at a distance of approximately 10 km from the slaughter plant.
The animals were not tethered during transport nor during their stay in the lairage.
The lairage time before slaughter varied from 0 to 6.5 hours.

b. Muscle sampling and pH_{24} measurements

Forty-five minutes p.m., samples of the m. adductor (15g) from 57 young bulls were randomly collected on the slaughterline.
PH_{24} measurements were made in the m. longissimus dorsi (LD) (8th-9th vertebra) and the m. adductor (A) using a Knick Portamess 902 pH meter connected with an Ingold meat electrode (Lot 406-M3).
From another 52 young bulls samples of the m. ischiocavernosus (Is) were taken in the same way as for the A muscle.
PH_{24} measurements were made in the m. longissimus dorsi, the m. biceps femoris (BF) and the m. ischiocavernosus (Is).

c. Methods

Two techniques for determining the ultimate pH of the muscle were applied on the pre-rigor muscle samples :

- a freeze-thaw technique (FT) (2)

A part of the muscle sample (4g) was frozen in liquid nitrogen.
After freezing the tubes were immediately transferred into a water bath at 43°C until thawing has been accomplished.
Ultimate pH-values were reached within 20-30 minutes after freezing.
After homogenizing in cold sodium iodoacetate (a glycolytic poison) and temperature equilibration, pH-values were measured.

- a technique based on the acceleration of pH decline following addition of Ca- and Mg-ions to the pre-rigor muscle sample ($CaCl_2$) (6)

A second part of the muscle sample (7g) was homogenized in 10ml of a 20mM $CaCl_2$, 20mM $MgCl_2$ and 100mM KCl solution.
The pH-value of the homogenate was measured 10 minutes after addition of the solution.

The rapid method for determination of glycogen stores in hot carcass meat was performed on the remaining part of the muscle sample which had previously been packed and frozen in methanol (-70°C) until the time of examination.
At the laboratory 4 grams of the frozen sample were homogenized with 0.6N perchloric acid (1).
After filtration of the homogenate two techniques for glycogen determination in the extract were used :

- the usual phenol method (4)
- a semi-quantitative technique based on the hydrolisation and neutralisation of the extract followed by a glucose determination by use of a Haemo glukotest 20-800 test-strip (Boehringer 318710)

Results and Discussion

Muscles with a $pH_{24} \geq 6.20$ were classified as being DFD. Muscles with $5.80 \leq pH_{24} < 6.20$ were classified as being intermediate. All other carcasses were considered to be of normal meat quality ($pH_{24} < 5.80$) (3).
For the A muscle correlations between the real pH_{24}-values and the pH-values of the freeze-thawed and of the $CaCl_2$-$MgCl_2$ homogenized pre-rigor samples respectively were low (r=0.75 and r=0.73 respectively) (Figures 1 and 2).
Moreover the figures in Table 1 show that by classification of the pH_{24}-values of the LD muscle 19 animals were dark cutting while classifying the pH_{24}-values of the A muscle only 7 animals did.

Therefore applying the pH_{24} predicting tests, the A muscle of young bulls was less DFD-susceptible in comparison with the LD muscle which generally was found to be the most reliable indicator muscle for establishing DFD-condition (5).
However, to avoid unacceptable carcass damaging by sampling the LD muscle in its pre-rigor state, efforts were made to look for other non-commercial muscles suitable for control of DFD-condition in some major muscles of the hindquarter.

For that reason pH_{24} measurements were made in the m. longissimus dorsi (LD), the m. biceps femoris (BF) and the m. ischiocavernosus (Is) from another 52 young bulls (Table 2).
Classifying the pH_{24}-values of the BF muscle and the Is muscle 12 and 13 animals respectively were DFD while by classification of the pH_{24}-values of the LD muscle only 3 animals did.
By classification of the pH_{24}-values of the BF muscle 15 animals belonged to the intermediate group against 26 when classification occurred according to the pH_{24}-values of the Is muscle.
However the BF muscle and the Is muscle of young bulls are more DFD-susceptible than the LD muscle.
Sampling the BF muscle, a major muscle of the hindquarter, in its pre-rigor state is out of the question.
For that reason samples of the Is muscle, a non-commercial muscle, were taken.

For the Is muscle correlations between the real pH_{24}-values and the pH-values obtained with the two described predicting techniques were high and amounted to r=0.95 and r=0.93 respectively (Figures 3 and 4).
The correlations for the Is muscle were much higher than for the A muscle and this may be explained by the greater available surface of the A muscle by which pH variations can occur between different muscle sites within the same muscle.
The standard error of estimate for both techniques applied on pre-rigor samples of the Is muscle was low amounting to 0.10 pH-units (FT-method) and 0.13 pH-units ($CaCl_2$-method) respectively.
Moreover the constant of both regression equations is mainly caused by the difference between direct pH measurements in the muscle and pH measurements in a meat homogenate (±0.15 pH-units).
However both techniques were proved to be useful in practice for predicting the pH_{24}-values of the Is muscle.

The average glycogen content of pre-rigor A muscle samples differred very significantly according to the final pH measured in the A muscle (Table 3) ; using the quantitative phenol-method pH_{24}-values $\geq$ 6.20 yielding 28 μmoles glucose/gram versus 62 μmoles glucose/gram for pH_{24}-values $<$ 5.80 and using the semi-quantitative test-strip-method pH_{24}-values $\geq$ 6.20 yielding 21 μmoles glucose/gram versus 59 μmoles glucose/gram for pH_{24}-values $<$ 5.80.
The correlation between the results of the two methods for glycogen determination was high and amounted to 0.88 (Figure 5).

In this respect the quantitative glycogen determination can be substituted by a rapid semi-quantitative technique.

Conclusions

Applying pH_{24} predicting tests, the A muscle of young bulls is less DFD-susceptible in comparison with the LD muscle whereas the BF muscle and the Is muscle are most susceptible.
The freeze-thaw technique and the technique based on the acceleration of pH decline following addition of Ca- and Mg-ions to the pre-rigor muscle sample are both of practical use for predicting the pH_{24}-values of the Is muscle.
The average glycogen content of pre-rigor A muscle samples differred very significantly according to the final pH measured. In this respect the quantitative glycogen determination can be substituted by a rapid semi-quantitative technique.

References

1. DALRYMPLE, R. and HAMM, R., 1973. A method for the extraction of glycogen and metabolites from a single muscle sample. J. Food Technol., 8, 439.

2. DAVEY, C. and GRAAFHUIS, A., 1980. Early identification of the DFD condition in pre-rigor beef carcasses. In: The Problem of Dark-cutting in Beef. Current Topics in Veterinary Medicine and Animal Science, 10, 231-247. Edited by Martinus Nijhoff Publishers.

3. DEZEURE-WALLAYS, B., VAN HOOF, J. and PENSAERT, R., 1984. Incidence and quality characteristics of dark cutting in Belgian beef. Proceed. 30th Eur. Meet. Meat Res. Workers, Bristol. 152-153.

4. HERBERT, D., PHIPPS, P. and STRANGE, R., 1971. Chemical analysis of microbial cells. In: Methods in Microbiology, vol 5 B. Edited by Norris J. and Ribbons D., Academic Press, London.

5. TARRANT, P., 1980. The occurrence, causes and economic consequences of dark- cutting in beef - A survey of current information. In: The Problem of Dark-cutting in Beef. Current Topics in Veterinary Medicine and Animal Science, 10, 3-35. Edited by Martinus Nijhoff Publishers.

6. VADA-KOVACS, M., 1981. Rapid glycolysis test for detection of DFD meat. Proceed. 27th Eur. Meet. Meat Res. Workers, Vienna. 27-30.

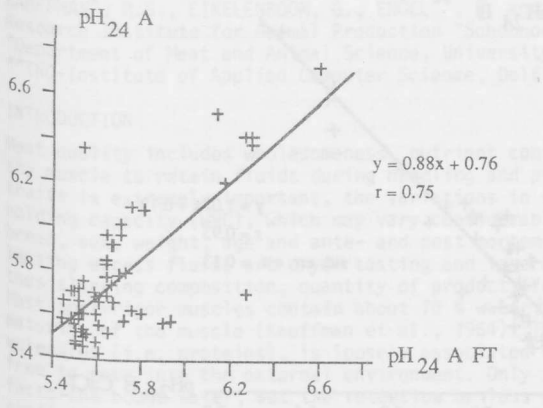

Figure 1 : The relationship between the real pH_{24}-values and the freeze-thaw (FT) pH-values for the adductor (A) muscle from 57 young bulls.

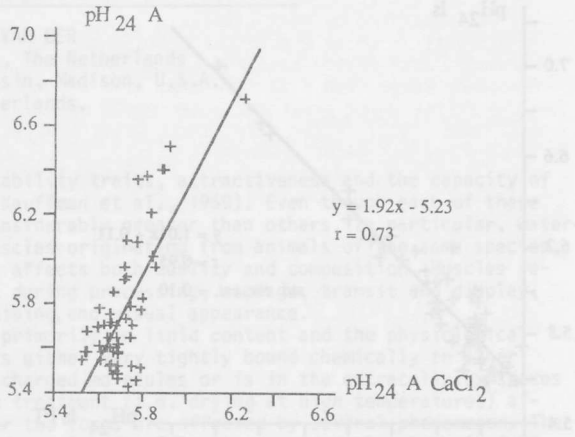

Figure 2 : The relationship between the real pH_{24}-values and the pH-values of the $CaCl_2$-$MgCl_2$ homogenized pre-rigor samples of the adductor (A) muscle from 57 young bulls.

	m.adductor (A)		m.longissimus dorsi (LD)	
	number	$\overline{pH}_{24} \pm s$	number	$\overline{pH}_{24} \pm s$
$pH_{24} < 5.80$	41	5.61 ± 0.10	29	5.61 ± 0.06
$5.80 \leq pH_{24} < 6.20$	9	5.95 ± 0.09	9	6.06 ± 0.07
$pH_{24} \geq 6.20$	7	6.42 ± 0.16	19	6.57 ± 0.19

Table 1 : The number of animals and their mean pH_{24} - values for the 3 pH_{24} -groups of the m. adductor (A) and the m. longissimus dorsi (LD) respectively.

	m.longissimus dorsi (LD)		m.biceps femoris (BF)		m.ischiocavernosus(Is)	
	number	$\overline{pH}_{24} \pm s$	number	$\overline{pH}_{24} \pm s$	number	$\overline{pH}_{24} \pm s$
$pH_{24} < 5.80$	37	5.66 ± 0.07	25	5.66 ± 0.09	13	5.69 ± 0.07
$5.80 \leq pH_{24} < 6.20$	12	5.91 ± 0.11	15	5.92 ± 0.06	26	5.96 ± 0.12
$pH_{24} \geq 6.20$	3	6.42 ± 0.20	12	6.48 ± 0.27	13	6.49 ± 0.29

Table 2 : The number of animals and their mean pH_{24} -values for the 3 pH_{24} -groups of the m. longissimus dorsi (LD), the m. biceps femoris (BF) and the m. ischiocavernosus (Is) respectively.

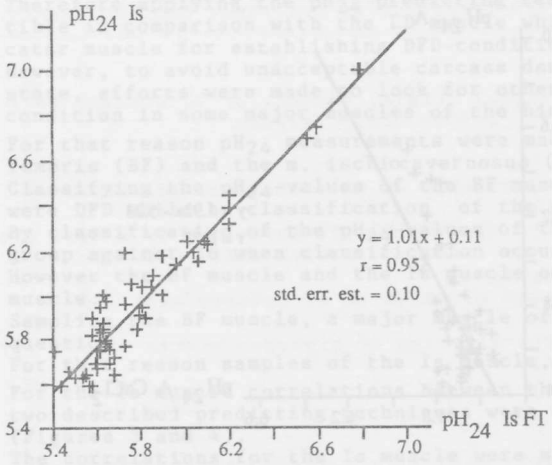

Figure 3 : The relationship between the real pH_{24}-values and the freeze-thaw (FT) pH-values for the ischiocavernosus (Is) muscle from 52 young bulls.

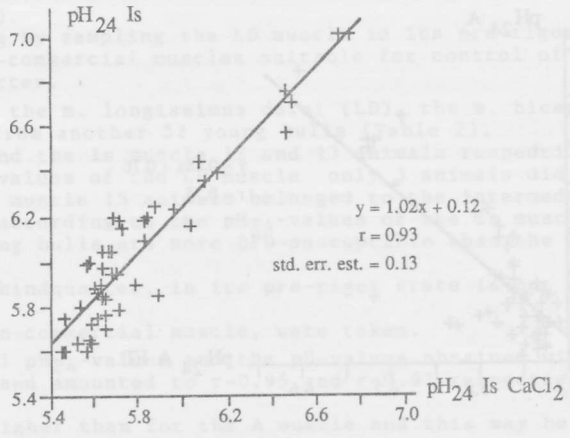

Figure 4 : The relationship between the real pH_{24}-values and the pH-values of the $CaCl_2$-$MgCl_2$ homogenized pre-rigor samples of the ischiocavernosus (Is) muscle from 52 young bulls.

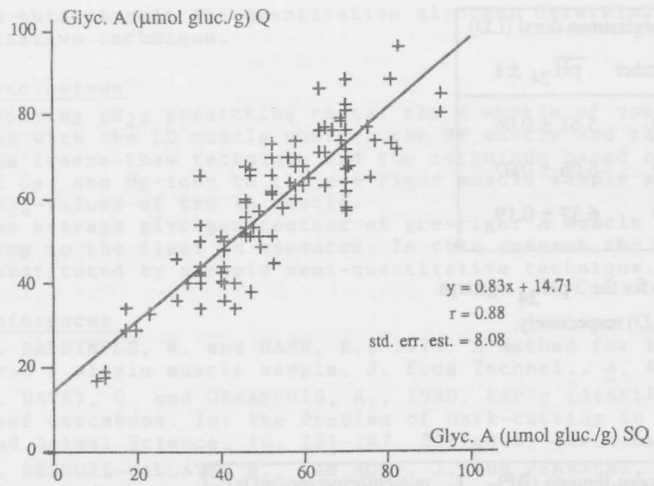

Figure 5 : The relationship between the amount of glycogen in the pre-rigor adductor (A) muscle samples determined with a quantitative (Q) and a semi-quantitative (SQ) method.

	number	$\overline{pH_{24}}$ A ± s	$\overline{\text{Glyc. A}}$ ± s (Q) (µmol gluc./g)	$\overline{\text{Glyc. A}}$ ± s (SQ) (µmol gluc./g)
pH_{24} A < 5.80	41	5.61 ± 0.10	62 ± 14	59 ± 13
5.80 ≤ pH_{24} A < 6.20	9	5.91 ± 0.05	48 ± 23 *	36 ± 21 ***
pH_{24} A ≥ 6.20	7	6.42 ± 0.16	28 ± 11 ***	21 ± 13 ***

Table 3 : Average pH_{24}-values and glycogen contents determined with a quantitative (Q) and a semi-quantitative (SQ) method in the pre-rigor A muscle samples of young bulls.