COMPARISON OF ISFET AND GLASS ELECTRODE INSTRUMENTS FOR DETERMINATION OF PH IN PIG MEAT IN RELATION TO WATER-HOLDING CAPACITY

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Background

It is well known that the post mortem decrease in pH (its rate and ultimate value) influences the important technological meat quality traits, such as colour and water-holding capacity (WHC). A low pH value within the first hour after slaughter, while carcass temperature is still high, may result in denaturation of muscle proteins, which can produce PSE meat (pale, soft and exudative).
An early prediction of WHC on the basis of pH and temperature implies that they can be measured with certain accuracy. The rate of the decrease of pH is also important for the development of WHC, and therefore a continuous registration would contribute to a better prediction of drip loss.

Objective

To compare ISFET and glass electrode for determination of pH and the possibility for prediction of drip loss using interval and continuous registration of pH and temperature.

Methods

pH in the muscle was measured with a combined glass electrode (Metrohm no. 6.0226.100, Switzerland) coupled to a Metrohm 704 pH Meter. The ISFET (ion sensitive field effect transistor) probe (Sentron hot-line, The Netherlands) coupled to an ARGUS handheld portable meter measures both pH and temperature. Measurement of temperature alone is carried out by a probe (Testo 110, Germany). Temperature and pH were measured in the middle of m. longissimus dorsi between the second last rib and last rib. For determination of WHC a muscle sample of approx. 100 g was cut off just behind the last rib. WHC was determined using the bag method described by Honikel (1998), and expressed as drip loss.
pH and temperature were measured continuously with the ISFET probe from 30 min. to 60 min. after bleeding of the carcasses. The probe was set into m. longissimus dorsi at least 25 minutes after bleeding to secure a steady measurement before the registration of pH and temperature was started. pH and temperature were logged each minute. pH and temperature were also measured using interval measurements, which means measurement at 30 min. 45 min. and 60 min after bleeding. These interval measurements were carried out both by ISFET probe and by glass electrode, and they were carried out in the same hole, but the probe was moved between the measurements. Both the ISFET probe and the glass electrode were calibrated to 35°C before measurement.
A total of 92 pigs selected randomly at a farm and at the experimental farm at the Research Centre was slaughtered at the research slaughterhouse. All carcasses were measured continuously with the ISFET probe, while 62 of the carcasses also were measured with the glass electrode (pH) and the temperature probe, and 30 carcasses were measured using the ISFET probe by interval measurement.

Results and discussions

In average the results show that glass electrode interval measurements compared to ISFET electrode measurements were about 0.1 pH unit lower, and that the ISFET continuous measurement had a lower standard deviation at 30, 45 and 60 minutes after bleeding (Fig 1). If ISFET is used as the glass electrode interval measurements, no difference between the two measuring methods was found (fig. 2).

Figure 1. pH (means and SE) measured with glass electrode or ISFET electrode

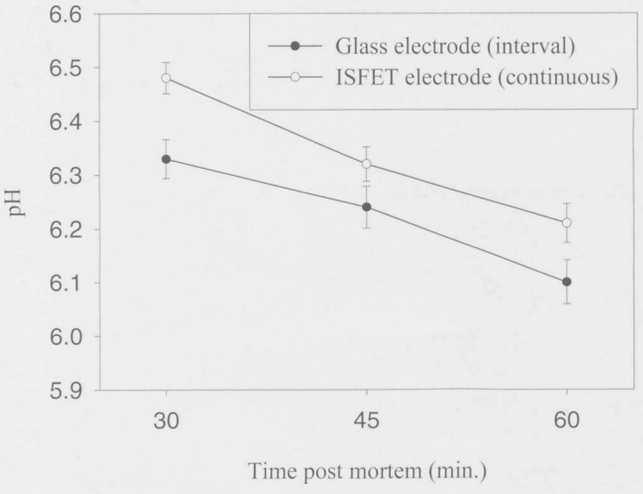
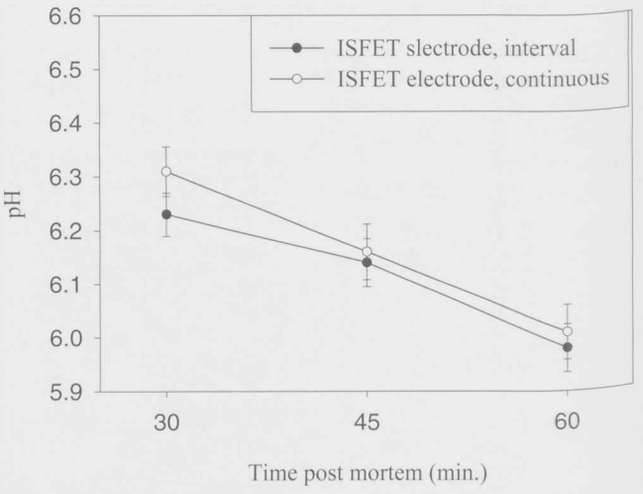


Figure 2. pH (means and SE) measured with ISFET electrode



There was also a difference in the temperature measurements when using the glass electrode of about 0.6^{0}C, but not if the ISFET probe was used for interval measurement (data not shown).
The correlation between the different pH and temperature methods is shown in table 1.

Table 1. Correlation between pH measurements or temperature measurements carried out with different types of equipment or different methods.

	Minutes after bleeding		
	30	45	60
PH. ISFET (continuous) *Glass (interval)	0.49	0.55	0.54
PH. ISFET (continuous) * ISFET (interval)	0,47	0,74	0,45
Temp. ISFET (continuous) * Glass (interval)	0.84	0.59	0.56
Temp. ISFET (continuous) * ISFET (interval)	0.64	0.64	0.75

The correlations were similar, even between the two different pH electrodes (ISFET and Glass), and between two different measurement methods (ISFET continuous and ISFET interval). The same tendency was seen for the temperature measurements.

The objective was to predict the drip loss by measuring pH and temperature, and the rate of the pH decrease is important for the development of drip loss. Therefore a continuous measurement is expected to contribute to a better estimation of the drip loss at an early stage of the slaughtering (within one hour after bleeding). In a multivariate statistic analysis of the data (PLS procedure), using the program package Unscrambler (Version 7.6, Camo A/S, Norway), it was examined, with which accuracy it is possible to predict the drip loss. The results are shown in table 2.

Table 2. Explained variance for X and Y, the multivariate validation correlation coefficient (R) and the root mean square error of prediction (RMSEP). Temperature and pH included in all shown models.

Variable in X	X-var	Y-var	R	RMSEP
62 carcasses				
ISFET. Continuous. All variables between 30 and 60 minutes.	80%	36%	0.58	3.05
Glass electrode. Interval. Variables 30, 45 and 60 minutes	91%	56%	0.72	2.55
ISFET. Continuous. Only variable 30, 45 and 60 minutes were used.	71%	38%	0.52	3.15
30 carcasses				
ISFET. Continuous. All variables between 30 and 60 minutes.	93%	42%	0.55	2.28
ISFET. Continuous. Only variable 30, 45 and 60 minutes were used	87%	43%	0.51	2.33
ISFET. Interval. Variable 30, 45 and 60 minutes	70%	36%	0.49	2.37

The best determination of drip loss seems to be with glass electrode where 56% of the variation in drip loss could be explained. Continuous measurements of pH using the ISFET equipment were only slightly better than if it was only used for interval measurements.

Conclusions

1. The level of the ISFET electrode was 0.1 to 0.2 pH units higher than the glass electrode.
2. The correlation between pH measurements or between temperature measurements were at the same level, either it was compared between different electrodes (ISFET and glass) or between measuring methods (continuous and interval).
3. Prediction of drip loss was best using the glass electrode (highest validation R and lowest RMSEP).
4. Changing the measuring method by using the ISFET probe from interval to continuous does not change the accuracy of the prediction value of the drip loss.

Pertinent literature

Honikel, K.O. 1998. Reference method for the assessment of physical characteristics of meat. Meat Science 49, 447-457