Pork water holding capacity parameters measured on muscle and drip

C. Kapper[1, 3*], C. Don[1], R.E. Klont[3] & H.A.P. Urlings[2, 3]
[1]CCL Nutricontrol, N.C.B-.laan 52, 5462 GE, Veghel, The Netherlands.
[2]WageningenUniversity and Research centre, Marijkeweg 40, 6709 PG, Wageningen, The Netherlands.
[3]VION Food Group, Ekkersrijt 8801, 5692 JW, Son, The Netherlands.
*Email: christiaan.kapper@ccl.nl.

Introduction

The objective was to review associations among pork water holding capacity (WHC) parameters on, muscle and drip and evaluate used parameters on their r-value. Postmortem muscle metabolic processes determine pork quality traits like: WHC, drip loss, color and texture (Briskey and Wismer-Pedersen, 1961). WHC is a key parameter and governs overall pork meat quality and processing quality. WHC can be calculated from drip weight loss. Drip is considered to have a negative effect on meat quality. However drip fluid has not received as much attention as muscle to reveal data on postmortem metabolic processes. Postmortem processes mobilize energy from present muscle glycogen reserves and generate H+ ions, which result in an muscle pH decline and protein denaturation to some extent. pH decline can be measured and there is a relation with WHC development. Undoubtedly, pH is a measurable and most often used parameter to predict pork quality. Although it is clear that other post-mortem processes also contribute to WHC development. Therefore we set out to investigate pH and other parameters usefulness for pork quality assessment and prediction. A fast pH decline and a low ultimate pH (<5.4) generally gives a low WHC; a slow pH decline and a high ultimate pH (>5.7) will generally give a high WHC. Pre-slaughter factors are correlated with postmortem metabolic processes and ultimate muscle pH (Eikelenboom, Campion *et al.*, 1974; Klont, Lambooy *et al.*, 1993) and are extensively investigated. Mainly used pork quality parameters are; ultimate muscle pH, color (Minolta L*,a*, b*) and drip loss. Parameters which are associated with WHC can be used to reveal pork WHC in a slaughterhouse. Before a practical application, model parameters need to be evaluated. Williams (Williams, 2007) described how parameters can be evaluated based on their r-value. We expect that WHC parameters, measured on muscle and drip, have different underlying parameters and can be evaluated for a practical application.

Materials and methods

This preliminary dataset consists of 110 pork Longissimus Thoracis muscles (24 hours post mortem), randomly collected on a slaughterhouse during 14 different slaughter days. All animals were commercial slaughtered. Two slices with a thickness of two centimeter were taken at the Lumborum area (repetition). Minolta L*, a*, b*, surface pH (pH initial) (Radiometer Analytical S.A.) and conductivity (Radiometer Analytical S.A.) were measured on these slices. Two circular samples (d =3 cm) were taken from both, all slices for drip loss determination. Circular samples were centrifuged at 40g for 90 minutes (EZ cup). 96 Samples were used for a comparison with 48 hour (Honikel bag method) drip collection (Honikel, 1998). After drip collection muscle surface pH (pH final) and conductivity were again measured at 30 h post mortem. Drip loss was weighed, pH (pH drip) and conductivity were measured on collected drip fluid. WHC was calculated from drip loss and expressed in a percentage of the sample end weight. Data is analyzed with SPSS, using descriptive statistics and correlation matrix. Practicability of used parameters to predict WHC were evaluated by guidelines of Table 1.

Table 1. Evaluation of the correlation (r) between WHC parameters for a practical application

Value of r	Interpretation	
Up to 0.50	Not usable – (further investigation not warranted)	-
0.50 – 0.70	Poor correlation – (further investigation recommended)	+/-
0.71 – 0.80	Rough screening	+
0.81 – 0.90	OK for screening	++
0.91 – 0.95	Usable with caution	+++
0.96 – 0.98	Usable in most applications	++++
0.99 – +	Excellent	+++++

Results

Repetitions on pork quality parameters were averaged (P < 0.05). Mean, SD and number of samples are expressed in Table 2.

Table 2. Mean, standard deviation (SD) and number (N) of measured pork quality parameters

		Surface pH	Conductivity (mV)	Minolta L*	Minolta a*	Minolta b*	WHC
Initial muscle	mean (s.d.)	5.63 (0.15)	81.22 (7.8)	51.57 (3.35)	14.4 (0.87)	3.95 (0.84)	94 (3.28)
	N	110	110	108	110	110	110
Final muscle	mean (s.d.)	5.64 (0.15)	80.65 (8.33)				
	N	110	110				
Drip fluid	mean (s.d.)	5.61 (0.18)	82.36 (8.91)				
	N	110	108				

Table 3 shows a correlation matrix of derived quality parameters from muscle and drip. Minolta L was not recorded on two samples because of a printing failure. pH and conductivity measurements of one day were corrected since these values were consistent lower (uncorrected pH; 5.21, SD; 0.12). Correlations were found between WHC and common used parameters such as pH and Minolta. Muscle pH and pH drip correlate. According to the evaluation scale of Williams; pH and conductivity (mV) appear suiTable for screening; Minolta L needs further research and Minolta a*, b* were not usable for practicable WHC prediction. WHC calculated from drip collected with centrifugation was not usable; WHC calculated from drip collected with 48 hour Honikel method seems to give a better representation of actual meat quality development and needs further investigation. pH drip and pH muscle correlate similar to WHC. WHC measured with 48 hour method has a higher correlation with quality parameters than WHC measured with centrifugation.

Table 3. Correlation of pork quality parameters on muscle and drip

	pH initial	Minolta L*	Minolta a*	Minolta b*	pH final	pH drip	WHC 48h
pH initial	1						.64**
mV initial	-.96**						
Minolta L*	-.53**	1					
Minolta a*	0.04	-.55**	1				
Minolta b*	-.53**	.69**	-.20*	1			
pH final	.98**	-.52**	0.03	-.54**	1		
mV final	-.95**	.47**	-0.03	.41**	-.96**		
pH drip	.93**	-.51**	0.03	-.60**	.94**	1	.62**
mV drip	-.87**	.45**	-0.01	.49**	-.88**	-.90**	
WHC centrifugation	.44**	-.45**	-.03	-.13	,42**	.34**	.63**

** correlation is significant at 0,01 level (2-tailed), Pearson correlation.

Discussion

It can be stated that pH measurements rely on postmortem glycolic metabolic processes, while WHC depends on muscle protein quality. pH measurements reveal the rate of these glycolic processes, while muscle protein quality and muscle protein denaturation is not taken into account. Investigation and prediction of parameters which are based on muscle protein quality might improve WHC prediction. Muscle protein quality might be measurable on muscle and in drip fluid with different measuring methods. Geesink showed that a method as near-infrared spectroscopy (NIRS) is able to reveal muscle quality and WHC (Geesink, 2003) and reflects surface protein structures and molecular bounds. According to the scale of evaluation, NIRS is able to generate in most cases a poor correlation (r = 0.5 – 0.7), hence further investigation of this technology is required.

Conclusions

This data confirms that there is a correlation (r >0.5) between pH and drip loss. pH drip and pH muscle can both be used as model parameters for WHC prediction. It should be kept in mind that WHC depends on muscle protein quality while pH measurements only reveal the rate of glycolic processes. Therefore a more clear distinction between mechanisms underlying WHC and pH must be made in further investigations. Evaluation of used reference methods demonstrate that there is still room for research before certain parameters can be used in a practical application. Discerning between WHC underlying mechanisms and pH underlying mechanisms, strengthens our conviction that other measuring techniques, like NIRS may help to improve predictive models for WHC.

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