INFLUENCE OF PRE-SLAUGHTER WELFARE CONDITIONS ON EARLY pH OF PORK IN PIEDMONT (ITALY)

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Abstract – The *ante-mortem* handling procedures could induce stress and, subsequently, influence the acidity of pork. Early *post mortem* pH is an important parameter as it affects most meat quality parameters such as colour, water holding capacity, tenderness and flavour. A survey was performed to investigate the effect of pre-slaughter conditions on pork *Semimembranosus* pH and temperature at 45 min. Eight variables related to animals, loading, transportation and unloading were checked. The pigs were loaded in an average time of 51 min, through no linear paths with different slopes. Social groups were not respected and animals were mixed at loading. The pigs were handled with moderate care by operators, even if in 40% of farms electrical prodder were still used. Carcass pH at 45 min *post mortem* was regular in 89% of animals/farm ($6.0 \geq pH_i \leq 6.8$). One farm had 25.4% of animals with pH_i lower than 6.0. Correlation showed that the risk of PSE is reduced with proper management. Our results suggest that, in intensive heavy pig production in Piedmont, positive human management have major influence on glycolysis *post mortem* trend. Our study reflects also the interesting use of early pH measurements as indicator of pre-slaughter animal welfare and meat quality.

Key Words – Early *post mortem* pH, Muscle temperature, Pork, Pre-slaughter stress

- INTRODUCTION

Pre-slaughter handling includes mixing of unfamiliar animals, loading, transportation, unloading and abattoir lairage. It can induce stress either psychologically or physically [1]. Pre-slaughter stress is both an animal welfare issue and a quality issue, as it has long been recognized that pre-slaughter stress can adversely affect the quality of pork [2]. In particular poor welfare procedures change muscle glycogen concentration, acidity and temperature immediately *post mortem*, leading to aberrant pork eating quality [3]. The acidity of the meat affects most meat quality parameters such as colour, water holding capacity, tenderness and flavour [4, 5, 6].

Normally, pH declines gradually from 7.4 in living muscle to $6.0 \div 6.6$ at 45 min *post mortem* (pH_i) and then to an ultimate pH $5.3 \div 5.7$ at 24 h (pH_u) [7]. However, a number of experiments has shown as the amount of stress imposed on animals in connection with pre-slaughter handling was one of the major causes of the variations observed in pH decline [8], causing two of the most well-known inferior meat quality grades namely dark, firm and dry (DFD) and pale soft and exudative (PSE) meat [9]. In particular, early *post mortem* muscle pH and temperature decline significantly influence some characteristics of pork (colour *e.g.*) even in situation where pH_u was found not to be affected by the pre-slaughter treatment [5, 10]. Early pH and temperature of pork could therefore measure stressors and predict pork quality immediately after stunning.

The purpose of this study was to identify the main stressors during pre-slaughter handling of pigs in Piedmont (Italy) by measuring early *post mortem* pH and temperature.

- MATERIALS AND METHODS

A total of 502 pigs, coming from 11 Piedmontese farms, was chosen to measure their pre-slaughter conditions. The following variables were recorded: lenght and duration of loading, ramp slope, noise level, animal management; distance, speed and duration of transport.

At slaughterhouse the meat pH (pH_i) and temperature (T_i) of the 502 right carcasses were measured at 45 minutes *post mortem* in the *Semimembranosus*, with a portable pH meter PH 25 with a penetration probe 50 T with an integrated temperature sensor (Crison, Spain).

Statistical analysis was carried out with the SAS version 9.3 [11] using the Pearson Correlation analysis among continuous variables. Results are expressed as means and standard deviation (SD).

- RESULTS AND DISCUSSION

A lot of variations among pre-slaughter conditions were observed (Table 1).

Table 1 Means and standard deviation (SD) for pre-slaughter conditions, early pH and temperature.

Variables		Mean	SD
Loading			
Length	m	21.9	2.35
Duration	min	51.5	20.55
Ramp slope	%	19.9	10.09
Noise	1:low-6:high	4.7	1.25
Animal management	1:low-6:high	3.4	1.78
Transport			
Distance	km	48.2	104.14
Speed	km/h	50.5	10.45
Duration	min	45.0	80.29
Carcass measures			
pH_i		6.35	0.06
T_i	°C	39.1	0.64
$6.0 \geq pH_i \leq 6.8$	%	88.8	8.45
$pH_i < 6.0$	%	8.9	7.65
$pH_i > 6.8$	%	2.2	3.6

Pigs were loaded in an average time of 51 min, through no linear paths 21.9±2.35 m long, with different slope (19.9±10.09%). In loading phase a high value of noise was produced and animal management resulted moderate.

The distance of transport was an average of 48.2±104.14 km, with a speed of 50.5÷61 km/h. The duration of transport varied between 3 to 270 min.

Carcass pH at 45 min *pm* was regular in 89% of animals/farm ($6.0 \geq pH_i \leq 6.8$). One farm had 25.4% of animals with pH_i lower than 6.0, typical of PSE syndrome. Carcass temperature at 45 min was 38.4÷40.4°C. Early *post mortem* high carcass temperatures can be considered normal. pH and temperature interact continuously during rigor development, but the rate of pH decline is independent of temperature above approximately 37°C [12].

PSE meat occurs when pigs suffer from acute stress before slaughter and this is a major issue in pork industry. Stress reaction to the slaughter procedure influence *ante* and *post-mortem* muscle metabolism and consequently the rate and extent of glycogen breakdown and pH decline [13]. When pigs are stressed glycolysis rate increases and poor meat quality after slaughter can be obtained ***i.e.*** pale soft and exudative (PSE) meat. We observed (Figure 1) that pork pH_i was influenced by animal management.

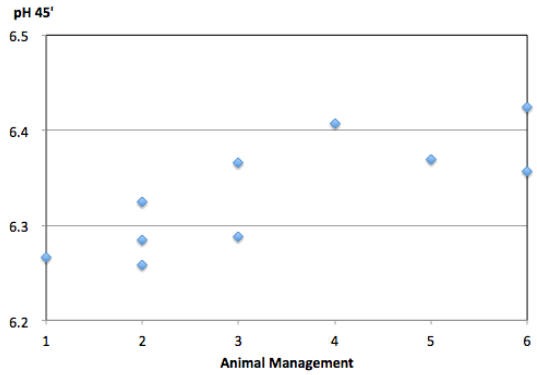

Figure 1. Correlation between animal management and pH_i

In particular, the frequent use (40% of farms) of an electric prod while driving pigs to the loading could have a significant effect. No other significant effects during pre-slaughter on pH_i were found (Table 2).

Table 2 Correlations among pre-slaughter conditions and early pH and temperature

Pre-slaughter conditions	pH_i	T_i
Length of loading	NS	NS
Duration of loading	NS	NS
Ramp slope	NS	NS
Noise	NS	NS
Animal management	0.80**	NS
Distance of transport	NS	NS
Speed of transport	NS	NS
Duration of transport	NS	NS

** *P<0.01; * P<0.05*

Nevertheless other important acute stressor can influence glycolysis *post mortem*. In particular, as confirmed by other authors [14], early pH was influenced by four main risk factors: noise level produced during unloading, the percentage of panting pigs, the use of electric prod and season. Important effects of road transport (duration, distance, season) on the welfare, carcass and meat quality were also demonstrated [15]. In particular, a study of Yu *et al.* [16] confirmed an adaptation of pigs when transported longer than 3h. In fact 1h and 2h transported pigs had lower pH_i values compared to 4h of transport. So pigs subjected to short transport duration showed a more intense stress response than pigs subjected to a transport duration of 3h when they were immediately slaughtered on arrival at slaughterhouse. No lairage or excessive lairage at slaughterhouse might compromise animal welfare and meat quality [17]. Short and long lairage can result in increasing incidence of PSE and DFD pork, respectively [18]. The recommended period of lairage, to allow the pigs to recover from transport and associated handling, was of 3h for pigs transported for 4h in winter. During lairage is also necessary to ensure the animals with sufficient space, under controlled environmental conditions (optimum temperature for pigs ranges between 22 and 25°C). Considering colour, in the 25.4% of pigs, with low early pH and high temperature values, lightness and yellowness will increase due to inactivation of oxygen-consuming enzymes and protein denaturation, independent of animal genotype origin. In these pigs a higher redness on the meat surface is obtained when the meat is cut 24 h *post*-slaughter, even if the effect of early *pm* pH and temperature on this parameter is more complex [5]. About the tenderness we must consider that faster decrease in early pH resulted in reduced level of μ-calpain activity, increased autolysis of the enzyme and faster myofibril fragmentation at 24 h [6]. Finally, in pigs with low pH_i values, the capability of meat to retain water decrease [19].

- CONCLUSION

Immediately pre-slaughter acute stress is the inevitable consequence of the process of animal transport from farm to slaughterhouse. However, appropriate pre-slaughter handling of pigs is very important not only from the animal welfare point of view, but also from the pork quality with consequently economic implications. Early pH could be influenced by different pre-slaughter stressors. In Piedmont we found that pre-stunning stress was mainly caused by animal management. It is necessary to continue research in order to improve animal welfare and minimize losses in product yield and quality.

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