Meat quality of wild boar (*Sus scrofa*) after live capture by different traps in Sweden

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Abstract— **The growing population of wild boar (*Sus scrofa*) in Sweden raises management issues when wild boars cause crop damage and risk of traffic accidents. The objective of this study was to test traps intended for live capture of wild boar, to evaluate effects on wild boar meat quality and animal welfare issues. Six traps (named A to F) were tested and 61 wild boars were evaluated. Necropsies were performed to detect physical injuries. Ten wild boars were shot at feeding sites in the field as control. *Musculus Longissimus dorsi* from one side of the carcass was sampled for meat quality analysis. Animals caught in trap B, C and F had lower ($p<0.05$) myofibrillar and total protein solubility and higher ($p<0.05$) Fibre Optic Probe value than controls, indicating more denatured proteins. Sarcoplasmic protein solubility of wild boars caught in trap F were lower than all other groups ($p<0.05$). The subjective PSE scales were higher in wild boars caught in trap A, B, C and E than in control ($p<0.05$). Mostly mild physical injuries were seen in 32 of the trap caught wild boars, but were more severe in animals caught in trap A than in those caught in the other traps ($p<0.05$). In general, wild boars caught in trap B, C and F showed lower meat quality than those caught in the other traps and in control. Trap A, B, C and F were less animal welfare friendly with our evaluation criteria and could not be recommended.**

Keywords— **Wild boar, Meat quality, Animal welfare**

I. INTRODUCTION

In Sweden, the wild boar (*Sus scrofa*) population has increased dramatically in recent years since its reintroduction in the 1970s [1]. In 2010, it was estimated at 150,000 individuals [2]. With the growing population, management issues arise when wild boar cause damage to crops and traffic accidents. The progressive and detailed legislation related to animal welfare for laboratory, farm and companion animals has a long history in Sweden. Sweden has had a new technology pre-testing system for many years. Any new equipment or invention intended for animal handling has to be tested and evaluated scientifically before it can be sold to farmers or other animal caretakers [3]. In this study, several trap constructions for live capture of wild boar were tested and evaluated for possible animal welfare issues.

Pale, soft and exudative (PSE) meat is one of the major quality problems in meat industry. PSE meat is caused by acute stress around the time of slaughter, which stimulates the rate of glycolysis in the muscle directly after death. Thus low pH value is reached in the muscle when the temperature of the carcass is still high and the combination of low pH and high temperature may lead to denaturation of some muscle proteins. Another important factor contributing to the PSE occurrence is the speed of carcass chilling. Rapid chilling reduces the manifestation of PSE meat [4]. Many studies have been done on PSE meat in domestic pigs [5, 6]. However, no report, to our knowledge, has previously discussed PSE meat in free ranging wild boar. This study investigated meat quality of wild boar mainly from occurrence of PSE, and, together with the necropsies, assessed the effect on wild boars after capture in traps.

II. MATERIALS AND METHODS

A. Animals

Six different traps (named A to F) intended to be used for live capture of free ranging wild boar were tested, and a total number of 77 wild boars were caught and euthanized. Evaluation regarding meat quality and physical injuries were performed on 61 of these. The evaluated trap caught wild boars were yearling animals with carcass weight (after bleeding) ranging from 9.3 kg to 74.0 kg (average weight 35.4

kg, standard deviation 17.3). Necropsies were performed to detect physical injuries judged to be attributed to the animals' stay in the trap. An international standardized protocol [7] was used to grade the severity of physical lesions. According to the protocol a numerical score from 0 (no lesion) to 100 (severe injury or death) were used to describe the severity of the lesions. Ten wild boars were shot at feeding sites in the field as controls. *Musculus Longissimus dorsi* (LD) from one side of the carcass was sampled for meat quality analysis.

B. pH, Fibre Optic Probe (FOP) and subjective PSE scale

The pH was measured at the last rib site of LD using a combination pH gel electrode (SE 104, Knick, Berlin, Germany) connected to a pH meter (Knick Portamess® 913, Berlin, Germany) after delivery to our laboratory (approximately 10 h *post mortem*), and 48 h later.

The Fibre Optic Probe (FOP) was measured at the last rib site and the hind site of LD using a Fibre Optic Meat Probe (TBL Fibre Optics Group LTD., Leeds, England). Two measurements were made on each site. The indication of PSE was calculated as the proportion of individuals with FOP values higher than 60.

The subjective PSE scale was used to assess PSE status of meat according to visual characteristics. A numeral scale from 1 (normal meat, with normal pork colour, elastic structure and a little exudate) to 5 (high-grade PSE, showing very pale colour, very soft structure with no elasticity and very much exudate) was used.

C. Protein solubility

To determine the sarcoplasmic protein and total (sarcoplasmic + myofibrillar) protein solubility, the method described by Joo et al. [8] was used. Generally, sarcoplasmic protein was extracted from 1 g muscle tissue by 10 ml of ice-cold 0.025 M potassium phosphate buffer (pH 7.2); total protein was extracted from 1 g muscle tissue by 20 ml of ice-cold 1.1 M potassium iodide in 0.1 M phosphate buffer (pH 7.2). All the extractions were conducted in duplicate. The homogenates were shaken at 4℃ overnight and then centrifuged at 1500×g at 4℃ for 20 min. Protein concentrations in the supernatant were measured using BCA (bicinchoninic acid) Protein Assay Kit (Pierce®, Thermo Fisher Scientific Inc., Rockford, USA). The absorbance at 562 nm was measured and the protein concentration was calculated according to the standard curve. Myofibrillar protein concentration was calculated as the difference between total and sarcoplasmic protein solubility.

D. Statistical analysis

Statistical analysis was carried out with the Statistical Analysis System (SAS), version 9.2 (SAS Institute, Cary, NC, USA). The GLM procedure was used with trap as fixed factor. The LSMEANS statement was used for calculating least-squares means (LSM); the PDIFF option was used for calculating *P*-values for differences between traps.

III. RESULTS AND DISCUSSION

The pH values at 10 h and 58 h *post mortem*, Fibre Optic Probe (FOP) values and subjective PSE scales were significantly different among wild boars captured by different traps (Table 1). The pH values of wild boars caught in trap A, B and D were higher than in the other groups, including controls, at 10 h *post mortem*. Animals in the control group had significantly lower pH values at 58 h *post mortem* than those captured in traps except in trap D; wild boars caught in trap A had higher pH values at 58 h *post mortem* than animals caught in trap E and F. Animals caught in trap B and C had higher FOP values and subjective PSE scales than control. The FOP values of wild boars caught in trap F and subjective PSE scales of animals caught in trap A and E were higher than in control. Wild boars caught in trap C and F had the highest percentage of indication of PSE compared to animals caught in the other traps.

A rapid pH decline at early post mortem is a typical characteristic of PSE meat, however, the ultimate pH could be similar between PSE and normal pork [9]; meat should not be divided into PSE and normal quality categories only based on pH ultimate value. It is necessary to measure FOP value as confirmation of the pH measurement [10]. The FOP values predict PSE meat more accurately than pH and can even

Table 1 Effect of capture traps on meat quality of wild boar

Trap	N	pH_{10h}	pH_{58h}	FOP	Indication of PSE (%)[1]	Subjective PSE scale[2]
A	12	5.45±0.01 ab	5.49±0.01 a	47±3.7 cd	8.3	2.3±0.3 abc
B	8	5.47±0.02 a	5.48±0.02 ab	57±4.5 abc	25.0	3.1±0.4 a
C	5	5.40±0.02 cd	5.46±0.02 abc	62±5.7 a	60.0	2.9±0.5 ab
D	12	5.42±0.01 bc	5.42±0.02 cd	41±3.7 d	8.3	1.8±0.3 cd
E	12	5.39±0.01 cd	5.43±0.01 c	47±3.7 bcd	25.0	2.1±0.3 bc
F	12	5.39±0.01 cd	5.45±0.01 bc	57±3.9 ab	41.7	1.8±0.3 bcd
Control	10	5.35±0.01 d	5.37±0.01 d	40±4.3 d	0.0	1.0±0.3 d
P-value		<.0001	<.0001	0.003	---	0.002

Values were present as least-squares means (LSM) ± standard error (SE).
Different letters in the same column indicate significant difference (P<0.05) between values.
[1] Indication of PSE was the proportion of individuals with FOP value higher than 60.
[2] Subjective PSE scale indicated the PSE status of meat using numerical scale from 1 (normal meat) to 5 (high-grade PSE).

replace traditional pH measurements after 45 min *post mortem* [11]. The FOP measures PSE status by internal light scattering of the meat [11] and high FOP values indicate PSE [10]. In this study, FOP values which were higher than 60 indicated PSE meat, thus wild boars caught in trap B, C and F showed PSE meat characteristics based on the FOP measurements.

Protein solubilities were significantly different among wild boars caught in different trap constructions (Table 2). Sarcoplasmic protein solubility of wild boars caught in trap F was lower than all other groups. Total and myofibrillar protein solubility were lower in wild boars captured in trap B, C and F than in trap A, D and control.

Table 2 Protein solubility (mg/g) of wild boar captured by different traps

Trap	N	Sarcoplasmic protein	Total protein	Myofibrillar protein
A	12	55.79±1.91 a	157.49±6.83 a	101.70±5.70 a
B	8	53.79±2.34 a	135.35±8.36 bc	81.56±6.98 bc
C	5	54.17±2.96 a	131.35±10.57 bc	77.18±8.82 c
D	12	56.64±1.91 a	165.65±6.83 a	109.01±5.70 a
E	12	54.05±1.91 a	152.62±6.83 ab	98.57±5.70 ab
F	12	46.35±1.91 b	124.97±6.83 c	78.62±5.70 c
Control	10	56.76±2.09 a	165.94±7.48 a	109.18±6.24 a
P-value		0.0054	0.0002	0.0004

Values were present as least-squares means (LSM) ± standard error (SE).
Different letters in the same column indicate significant difference (*P*<0.05) between values.

Protein solubility is an indicator of protein denaturation, and low protein solubility represents high protein denaturation [8]. Previous studies showed that PSE pork had lower protein solubility compared to normal or DFD (Dark Firm Dry) pork [12, 13]. In this study, wild boar caught in trap B, C and F had lower protein solubility, indicating more denatured proteins, which were in accordance with the higher FOP values. Thus, animals caught in trap B, C and F showed lower meat quality as they had a higher PSE occurrence.

Physical injuries were seen in 32 of the trap caught wild boars according to necropsies, and all but two were mild injuries. One wild boar captured in trap A was observed an injury score of 100, but the FOP values and protein solubility of this animal were in normal range without any PSE indication. The injury score differed significantly among wild boars captured in different traps (Fig. 1). Higher injury score was observed in animals caught in trap A than in those caught in the other traps.

Physical injuries by restrained animals and mortality of trapped animals are two principle considerations for assessing welfare performance of restraining traps [14]. Other factors, such as behaviour, physiology and immunology are important, but more difficult to assess. In this study, higher values on the injury score were seen in wild boars caught in trap A, B, C and F which meant more severe injuries and

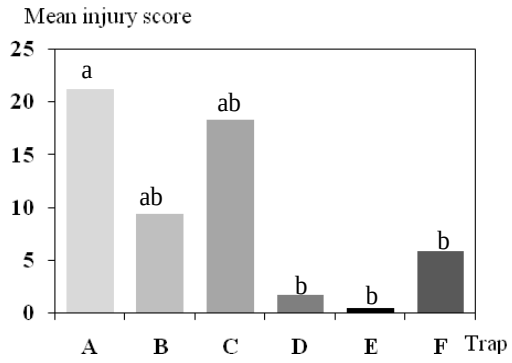

Fig. 1 Mean injury score of wild boars captured in different traps. Different letters indicate significant difference (P<0.05) between values.

lower animal welfare for animals captured in these traps. The wild boar caught in trap A with an injury score of 100, but with normal meat characteristics could have been in a transitional status from PSE to DFD meat, and therefore showing normal meat characteristics.

IV. CONCLUSION

Wild boars caught in trap B, C and F showed lower meat quality than those caught in the other traps and for control, and these traps were among those not recommended for live trapping wild boar than the controls. Traps A, B, C and F were less animal welfare friendly, according to the used evaluation criteria for physical injuries, and were not recommended to be used to trap wild boars.

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