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Research Note

Influence of Pre-Slaughter Environmental Temperature on Meat Quality of Crossbred Pigs of Andhra Pradesh

E. Naga Mallika*, V. Giridhara Rao, M. Prasanna, A. Shilpa Sree, P. Gowtham and B. Eswara Rao

Department of Livestock Products Technology

NTR College of Veterinary Science, Sri Venkateswara Veterinary University, Andhra Pradesh, India

ABSTRACT

This study aimed to investigate the effect of high environmental temperature on meat quality traits of crossbred pigs brought for slaughter to the experimental abattoir of the Department of Livestock Products Technology, NTR College of Veterinary Science, Sri Venkateswara Veterinary University, Andhra Pradesh, India. High pre-slaughter environmental temperature significantly (P<0.05) influenced the meat quality of pigs. Pigs exposed to high environmental temperatures had recorded significantly (P<0.05) lower pH values at 24 hr post-mortem with low heme iron content and recorded significantly higher drip losses. Intramuscular fat and crude protein contents were not affected significantly (P<0.05). Serum lactate, glucose, cortisol, and LDH levels differed significantly with increasing environmental temperatures. A significant correlation was noticed with the levels of LDH to serve as a predictor of meat quality.

Keywords: *Pre-Slaughter care, Environmental temperature, Meat quality, Crossbred pigs, Meat parameters*

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INTRODUCTION

High environmental temperature is one of the most common causes of stress and heat-induced stress can influence muscle metabolism and meat quality (Lewis et al. 2007, Dalla Costa et al. 2019 and Stephens et al. 1982). It is known that thermal stress enhances reactive oxygen species production, leading to cytotoxicity. Pigs are very sensitive to hot weather as they don't have sweat glands. Because of the high environmental temperature prevailing in areas like Vijayawada, the quality of carcass, meat, and fat of pigs might be affected. Pre-slaughter stress due to high environmental temperatures influences body homeostasis and metabolism, resulting in alterations in the physico metabolic blood profile, subsequently decreasing carcass and meat quality.

Cortisol is a useful indicator of the stress level experienced by pigs during the pre-slaughter period. Several studies have reported that the increase in cortisol level was associated with higher meat pH (Rocha et al. 2015, Fernadez et al. 1995 and Henkel et al. 2002), darker meat colour, lower drip loss, and higher occurrence of the dark, firm, and dry (DFD) pork (Warriss (2000), (Viljoena et al. 2002). In contrast, other researchers reported that higher cortisol level was related to a faster muscle pH decline, lighter meat colour, and lower water holding capacity, as a consequence of the occurrence of PSE pork (Warriss, 2000, Barbut et al. 2005 and Swatland, 2008). However, some authors stated that the cortisol concentration had no impact on the pork quality.

Stress enzymes like Lactate Dehydrogenase (LDH) can be of use in monitoring the quality of pre-slaughter conditions, and thus may be of value in the identification of pork with undesirable quality traits. Previous studies reported elevated stress enzyme levels were associated with high muscle pH, darker meat colour, increased water holding capacity, and higher prevalence of DFD pork (Mancini et al. 2005 and Kim et al. 2009).

As there exists very little information regarding the meat quality of the crossbred pigs exposed to high environmental temperatures in this area. Therefore, the present study was undertaken to evaluate the effect of pre-slaughter environmental temperatures on the quality of meat of crossbred pigs available in Andhra Pradesh.[1]

MATERIALS AND METHODS

This study was conducted on ninety slaughtered pigs in three treatments. In all treatments, approximately nine months old, six pigs in five repetitions were used in this study with an average live weight of 110 ± 1.44 kg. All pigs were of the same genetics (Yorkshire × Landrace) and originated from the same geographical area. Pigs were kept in the established social groups over the entire finishing stage. Pigs were not deprived of food or water before being sent for slaughter.

Pigs were slaughtered in months representing traditional environments in South India. February to May (summer), June to September (Rainy), and October to January (winter). The average ambient temperature at unloading were 35 ± 2.1 °C, 33 ± 1.7 °C, and 29.5 ± 1.9 °C in Summer, rainy, and winter seasons respectively.

Pigs were loaded using a metal ramp (5 m length, slope ≤ 15°) in groups of 4–5 pigs on the same commercial single deck truck by the same loading crew and driver between 07:00 and 09:00 on the morning of each shipping day. The average loading time was 53 ± 15.4 min. Trucks departed from the farm immediately after loading. Pigs were transported at the same speed of the truck. The truck had natural ventilation, whereby side panels were 100% open during all seasons. During transportation, the truck was not bedded and showers were not available. Pigs had no access to food or water in the truck. Transportation time lasted about three hours at a mean speed of 60 km/h, with an average stocking density of 0.38 m^2/pig. Upon arrival at the experimental abattoir of the department, trucks waited 9.13 ± 3.5 min on average, whereas unloading took 15.63 ± 6.9 min on average. Pigs were unloaded using a ramp (5-m length, slope ≤ 15°), weighed, and kept in roofed lairage pens. Lairage pens had concrete floors and walls and a solid metallic gate. Lairage pens were not equipped with sprinkling systems; the ambient conditions were regulated by natural ventilation. During lairaging, food was not provided but the water was freely available. Pigs were not

* Corresponding author E-mail address: mallikalpt@gmail.com

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separated by gender during transportation and lairaging. Pigs were inspected and the pigs in the current study were clinically normal. Blood samples were collected. Pig slaughter and carcass processing were performed in compliance with the standard accepted practices at the experimental abattoir of the department.

The pH and temperature of the *Musculus longissimus dorsi* muscles were measured 24 h after slaughter between 10th and 11th ribs using a pH meter with a digital identification system, temperature compensation sensor, and a proper glass electrode. The pH meter was calibrated with pH 4.00 and 7.00 phosphate buffers before each series of measurements and the electrode was rinsed with distilled water between each measurement. Values of pH were measured in triplicate, and the average of the three measurements was taken as a final result. At the same anatomical location where pH was measured, two boneless loin samples (each 2.54 cm thick, 100 g) were taken from each selected carcass, was used for marbling, and to measure drip loss, thawing loss, and cooking loss. Water holding capacity was measured using three methods.

Drip loss measurements were performed based on the bag method, with the samples weighed individually and placed in a net enclosed in a polyethylene bag under atmospheric pressure, ensuring that the sample was not in contact with the bag. At the end of the 48 h storage period at 4 °C, the samples were removed from the bag, surface moisture was carefully dabbed with tissue paper, and then re-weighed. Drip loss was expressed as a percentage of the initial sample weight. The thawed samples were weighed and were put in a plastic (Ziploc) bag and then placed in a continuously boiling water bath until the internal temperature reached 75 °C (Cho et al. 2015). When the endpoint temperature was attained, the bags were removed from the water bath. After that, the samples were cooled in ice slurry and kept under chilled conditions (1–5 °C) until equilibration. The cooled samples were taken from the bag, gently blotted dry with tissue paper, and then re-weighed. Cooking loss was estimated by weighing them before and after cooking.

The crude protein content and intramuscular fat (IMF) were estimated through AOAC (1995) method. Blood was collected into an anticoagulant added vial, and they were carried on ice and blood lactate levels were determined in a commercial laboratory. All the measurements were analyzed through SPSS (version 17.0).

RESULTS AND DISCUSSION

The Serum and meat parameters of pigs slaughtered in different seasons were presented in Table1.

The Serum lactate levels were non-significantly affected by the season and environmental temperature. The levels of cortisol and LDH differed significantly with environmental temperatures. LDH levels changed significantly and were increased with increasing environmental temperatures of slaughter.

Table 1: Serum and meat parameters of pigs slaughtered in different seasons

Serum parameters	**Season**			
	Summer	**Rainy**	**Winter**	**P-Value**
Lactate (m mol/l)	8.54 ± 0.44	8.46 ± 0.39	8.37 ± 0.09	NS
Cortisol (µg/dl)	6.19 ± 0.14	5.43 ± 2.60	4.14 ± 0.14	**
LDH (IU/l)	396 ± 0.38	256 ± 0.64	212 ± 0.38	**
Meat Parameters				
pH	5.47 ± 0.01	5.59 ± 0.88	5.64 ± 0.01	**
Drip loss (%)	3.97 ± 0.46	3.01 ± 0.58	2.23 ± 0.29	**
Cooking loss (%)	29.32 ± 0.43	28.02 ± 0.95	27.42 ± 0.14	**
IMF (g/100 g of meat)	4.92 ± 0.71	4.64 ± 0.56	4.58 ± 0.72	NS
Protein (g/100 g of meat)	20.81 ± 0.27	20.49 ± 0.39	21.10 ± 0.56	NS
Haeme Iron (ppm)	9.47 ± 0.06	10.79 ± 0.08	11.25 ± 0..74	**

The effect of high pre-slaughter environmental temperature on pH, drip loss, cooking loss, Intramuscular fat, haeme iron content, and protein content are presented in Table 1. In muscles of pigs exposed to high environmental temperatures, the hot season had recorded significantly ($P< 0.05$) lower pH values and higher lactate content This could be due to the exposure of pigs to heat and conversion of more pyruvate to lactate leading to lower pH values.

The meat from pigs slaughtered in the hot season had higher drip loss and cook loss when compared to the other seasons. The parameters had an increasing tendency with increasing environmental temperatures. Protein and fat contents were not significantly affected by season. Hansen et al. (2009) also observed lower pH in hot seasons in pork. The levels of protein and IMF are not in line with other researchers who reported lower protein values due to reduced feed intake (Witte et al. 2000). This could be due to the adaptability of the cross-bred pigs in this region to the environmental temperatures prevailing in this region. Myoglobin content was significantly lower for meat obtained in hot seasons in our study.

Studies showed lower muscle pH was associated with higher stress parameters as reported by Perre et al. (2010). This could be attributed to the activation of the first stage of the stress response which in turn stimulates the sympathetic–adrenal–medullary axis, causing the release of catecholamines including nor-adrenaline and adrenaline. The adrenergic stress response increases blood glucose levels through rapid muscle and hepatic glycogenolysis. Consequently, skeletal muscles of acutely stressed pigs show a sharp drop in pH, and this in combination with high meat temperature induces denaturation of sarcoplasmic and myofibrillar proteins and reduction in their water holding capacity, subsequently resulting in pork with PSE characteristics.

CONCLUSION

During this investigation, pigs slaughtered in summer were exposed to extreme weather conditions in the coastal region of Andhra Pradesh wherein the temperature touches 43-45 oC during midsummer. When the environmental temperature exceeds the upper threshold of thermal tolerance, the resting time is interrupted and pigs start to search for cool areas to lie down without contact with other individuals. If this is not possible, pigs become agitated, which increases aggression between pen-mates. Therefore, heat stress could provoke fighting behaviour in pigs, resulting in carcass lesions, muscle damage, and pork quality deterioration. This finding is further supported by the fact that the highest LDH levels were recorded in pigs slaughtered in summer, which confirmed that levels of stress enzymes increase as a consequence of heat stress.

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