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CHRONICAL HEAT STRESS MODIFIES MUSCLE METABOLISM AND IMPROVES MEAT QUALITY TRAITS IN PIGS

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I. INTRODUCTION

Chronic heat stress (HS) during pig growing compromises pork production efficiency due to lower growth performance resulting from reduced feed intake, as adaptive response to limit metabolic heat production [1]. The lower feed intake associated to the disturbed endocrine homeostasis induced by HS can also affect carcass composition, depending on intensity and duration of HS and pig's physiological stage [1, 2]. Effects of HS on muscle properties and pork quality are also controversial [2] and may depend on muscle metabolic type [3]. Moreover, animal physiological responses to HS during growing (GHS) can be affected by a previous HS experienced during prenatal period (PHS), as recently shown by Serviento *et al*. [4]. A better understanding of HS consequences on pork production and quality is of high importance for actors of the pork sector as more frequent and intense heat waves are highly likely to occur in the future due to global warming. Thus, this study aimed to evaluate the effects of PHS and/or GHS on muscle metabolism and pork quality in various muscle metabolic types.

II. MATERIALS AND METHODS

A total of 48 female pigs from 24 litters were used in the present study. From 6 to 109 d of gestation, 12 sows were kept under thermoneutral (TN) conditions (cyclic 18 to 24°C; PTN) and 12 sows under chronic HS (cyclic 28 to 34°C; PHS). Two female offspring per sow were randomly selected and housed from 82 to 140 d of age under cyclic GTN (18 to 24°C; n = 24) or GHS (28 to 34°C; n = 24) environments. There were four experimental treatments based on G and P thermal environments: GTN-PTN, GTN-PHS, GHS-PTN, and GHS-PHS. Pigs were fed *ad libitum* with a growing-finishing diet and were slaughtered at 140 d of age [4]. Pig growth and carcass traits were recorded. Quality traits were measured on *Longissimus thoracis* (LT) and *Semimembranosus* (SM) glycolytic and on *Semispinalis* (SS, neck) oxidative muscles. Metabolic properties of LT and SS muscles were determined as described previously [5]. Data were analysed using a mixed model (SAS software v9.4) with P, G and their interaction (P x G) as fixed effects, and sire and slaughter day as random effects. Final body weight was included as covariate for backfat thickness and carcass lean meat content.

III. RESULTS AND DISCUSSION

Compared with GTN, GHS pigs had lower growth rate and final body weight (Table 1) due to lower feed intake (not shown). GHS pigs had thicker backfat, especially for GHS-PHS pigs whereas carcass lean meat content did not differ according to P or G environments. Increased carcass fatness of pigs under PHS [6] or GHS [1] were already found and present data show that combining P and G heat stress promoted carcass fatness. GHS pigs had higher ultimate pH than GTN pigs in LT and SM, but not in the oxidative SS (Table 1). GHS pigs had lower LT drip loss, especially for GHS-PTN vs GTN-PTN pigs, and lower LT chroma but similar lightness values to GTN pigs (not shown). GHS pigs had lower glycolytic potential and activities of energy metabolism in LT compared with GTN pigs, but similar lipid content. In contrast, SS glycolytic potential and metabolic enzyme activities (not shown) were not modified by GHS. Thus, growing HS induced muscle-specific metabolic responses, with reduced energy metabolism in the glycolytic LT but not in the oxidative SS, leading to improved technological quality and appearance (lower drip) of pork loin. The altered LT energy metabolism of GHS pigs, which could result from their altered thyroid function [4], is in line with other findings [2, 7]. In contrast, prenatal HS had scarce effects on muscle metabolism and pork quality.

Table 1. Growth and carcass, muscle and meat quality traits according to thermal environment

Thermal treatment[1]	GTN-PTN	GTN-PHS	GHS-PTN	GHS-PHS	RMSE	Significance[2]		
						P	G	P x G
Final body weight, kg	104.4	105.8	98.8	95.6	7.0	0.667	<0.001	0.268
Average daily gain, g/d	1110	1129	984	966	93	0.990	<0.001	0.492
Hot carcass weight, kg	80.8	81.7	77.0	74.2	5.5	0.548	0.001	0.254
Backfat thickness, mm	10.2^{a}	10.0^{a}	10.5^{a}	12.5^{b}	1.8	0.094	0.038	0.043
Lean meat content, %	63.5	63.4	63.2	61.8	1.4	0.077	0.074	0.013
Longissimus thoracis muscle								
pH 24 h	5.51	5.50	5.59	5.54	0.07	0.143	0.006	0.355
Drip loss 1-3 d p.m., %	4.03^{b}	3.15^{ab}	2.62^{a}	3.16^{ab}	1.19	0.611	0.048	0.046
Intramuscular fat, %	1.45	1.47	1.48	1.65	0.42	0.430	0.395	0.552
Glycolytic potential, µmol/g	174	168	144	152	18	0.817	<0.001	0.186
Lactate dehydrogenase, µmol/min/g	2307	2271	2148	2141	162	0.653	0.004	0.752
Citrate synthase, µmol/min/g	7.54	7.77	6.80	6.92	1.08	0.582	0.014	0.860
Semimembranosus: pH 24 h	5.54	5.56	5.67	5.65	0.12	0.972	0.004	0.538
Semispinalis: pH 24 h	6.07	5.99	6.14	6.01	0.29	0.214	0.596	0.779

[1] GTN: growing thermoneutral, PTN: prenatal thermoneutral, GHS: growing heat stress, PHS: prenatal heat stress.
[2] P values of the fixed effects of prenatal (P), growing temperature (G), their interaction (PxG) and Root Meat Square Error obtained from the mixed model. a, b : differences between thermal treatments (P < 0.05).

IV. CONCLUSION

The present study confirms that chronic HS during growing impairs growth and carcass composition especially for pigs previously subjected to prenatal HS. Growing HS induces specific metabolic responses according to muscle type, leading to improved technological quality of pork loin and ham.

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