Livestock Science 124 (2009) 277–287

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Effect of magnesium sulphate and L-tryptophan and genotype on the feed intake, behaviour and meat quality of pigs

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ARTICLE INFO

Article history:
Received 24 July 2008
Received in revised form 11 February 2009
Accepted 13 February 2009

Keywords:
Animal behaviour
Feed intake
Halothane gene
Magnesium sulphate
Tryptophan
Meat quality

ABSTRACT

Sixty-nine entire male pigs with different halothane genotype (homozygous halothane positive — nn-, $n=36$; and homozygous halothane negative — NN-, $n=33$) were fed with a supplementation of magnesium sulphate (Mg) and/or L-tryptophan (Trp) in the diet for 5 days before slaughter. Animals were housed individually and were submitted to stressful *ante mortem* conditions (mixed in the lorry according to treatments and transported 1 h on rough roads). Individual feed intake was recorded during the 5-d treatment. At the abattoir, pig behaviour was assessed in the raceway to the stunning system and during the stunning period by exposure to CO_2. Muscle pH, colour, water holding capacity, texture and cathepsin activities were determined to assess meat quality. The number of pigs with an individual feed intake lower than 2 kg/day was significantly different among diets ($P<0.05$; Control: 8.7%; Mg&Trp: 43.5%; Trp: 17.4%) and they were considered to have inadequate supplement intake. During the *ante mortem* period, 15.2% of pigs included in the experiment died, and this percentage decreased to 8.7% in those pigs with a feed intake >2 kg/day, all of them from the stress-sensitive pigs (nn). In general, no differences were observed in the behaviour of pigs along the corridor leading to the stunning system and inside the CO_2 stunning system. During the stunning procedure, Trp diet showed shorter periods of muscular excitation than control and Mg&Trp diets. The combination of a stressful *ante mortem* treatment and Mg&Trp supplementation led to carcasses with high incidence of severe skin lesions. Different meat quality results were found when considering all pigs or considering only those with adequate supplement intake. In this later case, Trp increased pH_{45} (6.15) vs Control diet (5.96) in the Longissimus thoracis (LT) muscle ($P<0.05$) and pH at 24 h (Trp: 5.59 vs C: 5.47) led to a higher incidence of dark, firm and exudative (DFD) traits in SM muscle ($P<0.05$). Genotype affected negatively all the meat quality traits. Seventy-five percent of LT and 60.0% of the SM muscles from nn pigs were classified as pale, soft and exudative (PSE), while none of the NN pigs showed these traits ($P<0.0001$). No significant differences were found between genotypes on the incidence of DFD meat.

Due to the negative effects observed in the Mg&Trp group in feed intake and carcass quality, the utilization of a mixture of magnesium sulphate and tryptophan is not recommended.

1. Introduction

Carcass and meat quality of finishing pigs can be affected by genetics as well as by the pre-slaughter handling. During this period, pigs experience some of the most stressful situations in their life (Gispert et al., 1996; Guardia et al., 2004). The effect of the stress on the muscle metabolism is especially dramatic on the pigs carrying the halothane gene, *n*: nn pigs have a mutation in the RYR1 gene which codifies one of the calcium release channels of sarcoplasmic reticulum: the ryanodine receptor (Fujii et al.,

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doi:10.1016/j.livsci.2009.02.010

1991). This mutation makes pigs particularly sensitive to acute stress, which is the main cause of death before slaughter (Barton-Gade and Christensen, 1998) and of the development of pale, soft and exudative meat (PSE; Jensen and Barton-Gade, 1985; Oliver et al., 1993). Despite these negative effects, the halothane gene is still used in Spanish commercial herds (Oliver et al., 1993) because it enables producers to target carcass specifications of high value according to the price payment grids based on carcass weight and lean content (Gispert and Font i Furnols, 2007). Nevertheless, meat from halothane-free pigs (NN) submitted to pre-slaughter stressful stimuli can also become PSE (Honkavaara, 1988).

The stunning procedure may also modify the final carcass and pork quality (Channon et al., 2000; EFSA, 2004). The CO_2 stunning system is one of the approved methods of stunning pigs in Europe (EC, 1993). Despite its positive effects on meat quality in comparison to the electrical stunning (Velarde et al., 2001), it has been questioned on welfare grounds as CO_2 itself has been described as an aversive gas (Raj and Gregory, 1995).

Therefore, an adequate strategy is needed to avoid the negative effect of the *ante mortem* handling of pigs, especially those with the halothane gene. Some studies suggest that magnesium (Mg) or L-tryptophan (Trp) supplementation of the diet of pigs can help to alleviate it and improve meat quality (D'Souza et al., 1998; Kietzmann and Jablonski, 1985; Peeters et al., 2005). Mg is a cofactor essential in many metabolic pathways (Stryer, 1988), it depresses the muscular activity due to its antagonism towards calcium and counteracts catecholamine effects in stressful situations by reducing levels of catecholamine in plasma (D'Souza et al., 1998; Kietzmann and Jablonski, 1985). Some authors reported a positive effect of Mg supplementation on pig behaviour (Peeters et al., 2005), water holding capacity of meat (WHC), pork colour and pork texture (D'Souza et al., 1998; Caine et al., 2000; Frederick et al., 2006). Nevertheless, non conclusive results have been obtained when comparing the effect of Mg supplementation within carriers (Nn) and non-carriers (NN) of the Halothane gene (Apple et al., 2000; Caine et al., 2000; Panella-Riera et al., 2008).

Trp, as a precursor of serotonin (Fernstrom and Wurtman, 1971), has a potential sedative effect by promoting its synthesis in the brain (Leathwood, 1987). Contradictory results have been found with Trp supplementation with respect to meat quality: some authors claimed an increase of *post mortem* muscle pH (Henry et al., 1996) or a reduction of incidence of PSE meat (Adeola and Ball, 1992; Henry et al., 1996), while others reported no significant effect or even poorer meat quality (Guzik et al., 2006; Li et al., 2006).

A previous study reported the effect of magnesium carbonate ($MgCO_3$) and Trp on the welfare and on the carcass and meat quality of two halothane pig genotypes (NN and nn) under non-stressful conditions (Panella-Riera et al., 2008). The aim of the present work was to evaluate the effect of dietary supplementation with magnesium and Trp on feed intake, mortality, animal behaviour and carcass and meat quality characteristics of NN and nn pigs under stressful *ante mortem* conditions.

2. Materials and methods

2.1. Animals and diets

Sixty-nine pure-breed entire male pigs were used in this study: 36 NN (24 Landrace and 12 Large White) and 33 nn (Pietrain), with an average live weight at slaughter of 108.5 ± 8.3 kg. They were housed individually from the age of 90 to 150 days in pens with a space allowance of 4 m^2, with visual and olfactory contact between each other. All were fed the same commercial diet (30.0% barley, 25.0% soy, 15.0% maize, 11.9% wheat and a vitamin/mineral source) until 5 days before slaughter. The diet contained 87.9% of dry matter and 14.10 MJ/kg of digestible energy on fresh matter.

Five days before slaughter three diet groups were established for each genotype: Control group, with no supplement; Mg&Trp group, control diet supplemented with 1.2 g elemental Mg and 8 g L-tryptophan per kg; and Trp group, control diet supplemented with 8 g L-tryptophan per kg (Table 1). Diets were designed considering a minimum of feed intake of 2 kg/day during the monitoring period (initial pig weight: 105.6 ± 7.0 kg). Individual feed intake was monitored for each pig during the 5 days prior to slaughter.

2.2. Ante mortem treatment and slaughter procedure

Two batches of 36 and 33 animals were slaughtered on two different days. The animals from each treatment were mixed in 6 different groups according to diet and genotype. The day before slaughter, pigs were fasted on-farm during 9 h and then transported from the IRTA pig experimental station to the IRTA experimental abattoir for 1 h on rough secondary roads. Lairage time for the first pig slaughtered was about 30 min and for the last one was 7 h as they were slaughtered individually by exsanguination, after stunning with 90% CO_2. In each batch, the animals from the 6 groups were slaughtered alternatively (3 diets × 2 genotypes).

2.3. Animal behaviour measurements

Behaviour measurements were recorded along the corridor leading to the stunning system and in the CO_2 stunning unit following the procedure described by Panella-Riera et al. (2008). The raceway was 412 cm long and 60 cm wide, and it was lined with steel panels of 90 cm height to prevent the pig from seeing out of the raceway. It was divided into three different sections: raceway, ramp and entrance. Pigs were

Table 1
Feed composition of experimental and control diets (%).

	Diets		
	C	Mg&Trp	Trp
Humidity (%)	11.8	11.47	11.80
Ash (%)	6.79	6.78	6.87
Crude fiber (%)	3.12	3.40	3.24
Crude protein (%)	16.8	18.54	18.4
Ether extract (%)	6.84	6.30	6.19
Magnesium (%)	0.21	**0.40**	0.20
Tryptophan (%)	0.21	**0.70**	**0.77**

C: Control Diet; Mg&Trp: Control diet with Mg and Trp supplementation; Trp: Control diet with Trp supplementation.