



EFFECT OF SUPPLEMENTATION WITH MAGNESIUM AND TRYPTOPHAN ON THE WELFARE AND MEAT QUALITY OF PIGS

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Background

Handling of animals during transport, lairage and slaughter is one of the most important causes of stress in pigs and that, together with genotype, most influence the final carcass and meat quality. A supplementation of magnesium (Mg) in the diet of pigs may reduce the response of the animals to stressful stimuli by reducing the levels of cortisol and catecholamines in plasma (Kietzman & Jablonski, 1985). An increase of tryptophan (Trp) concentration in the diet enhances the synthesis of brain serotonin and may have sedative effects (Leathwood, 1987). Some authors report an improvement of pork meat quality as a result of the supplementation of Mg (Schaefer et al., 1993; D'Souza et al., 1998, 1999, 2000; Apple et al., 2000; Hamilton et al., 2003; Swigert et al., 2004) or Trp (Adeola & Ball, 1992; Henry et al, 1996). However, other studies contradict these findings or obtain inconsistent results (Caine et al., 2000; O'Quinn et al., 2000; Apple et al., 2002; Hamilton et al., 2002). The effects of the supplement of Mg on meat quality seem to be related to the stress-susceptibility of the pigs, that is to their halothane genotype (Apple et al., 2000; Caine et al., 2000). On the other hand, Souza et al. (2000) found that under a negative antemortem handling treatment, a dietary Mg supplementation improves significantly pork quality and reduces the incidence of PSE carcasses. Accordingly, Geesink et al. (2004) report that a short-term supplementation of the diet with magnesium acetate or with a combination of this salt with Trp and vitamins does not improve pork quality when pigs are not stressed beyond levels associated with routine slaughter procedures.

Objectives

The aim of this study was to evaluate the effect of the supplementation of the diet with Mg and Trp on the response to stressful factors and on meat quality of pigs. Animals homozygous with respect to the halothane gene (positive, nn, and negative, NN) were used to achieve this objective.

Materials and methods

Animals, diets and pre-slaughter treatment: Seventy-one entire male pigs (36 NN and 35 nn) from Pietrain, Landrace and Large White lines, with an average live weight of 108.51 ± 8.32 kg, were used in this study. All animals were housed individually in pens with a space allowance of 4 m², permitting visual and olfactory contact between each other. They were fed the same diet until 5 days before slaughtering, when three diet groups were established for each genotype: diet 1 group, same diet supplemented with 1.2 g elemental magnesium (Mg) and 8 g L-tryptophan (Trp) per kg; diet 2 group, same diet supplemented with 8 g Trp per kg, and control group, with no supplement. Two batches of 35 and 36 animals were slaughtered in 2 different days. The animals of each batch were mixed in 6 different groups according to diet and genotype and transported from the farm to the experimental abattoir for one hour on rougher secondary roads. Lairage time for the first pigs slaughtered was about 30 min and for the last ones was of 7 h. They were all stunned with 90 % CO₂ and slaughtered. In each batch, the animals from the 6 groups were slaughtered alternatively. Hot carcass weight was measured at 45 min. *postmortem* (pm), and used to calculate the killing-out (%).

Skin lesions: After sticking, and when the carcasses were hoisted on the bleeding rail, fresh scratches on the skin were inspected and subjectively scored according to their location (head/neck, flanks/back and hindquarter) and occurrence (0= No occurrence, 1=1 occurrence, 2=2 to 5 occurrence, and 3=more than 5).

Meat quality measurements: The left side of the carcass was used to perform meat quality measurements on the *Longissimus thoracis* (LT) and *Semimembranosus* (SM) muscles. Muscle pH at 45 min (pH₄₅) and at 24 h (pH₂₄) pm were measured using a portable pH meter equipped with a Xerolyt electrode. Electrical conductivity at 24 h pm (EC₂₄) was measured at the last rib level using a Pork Quality Meater. The muscle water holding capacity (WHC) was determined in the LT muscle as drip losses following the reference method supported by OECD (Honikel, 1997).



Colour measurements: Colour measurements were carried out with a Minolta Chroma Meter CR-200 using the white tile provided by the manufacturer as the internal standard and set to illuminant C. Triplicate measurements were taken on LT muscle. The measurements were expressed as CIE L*a*b* (CIE, 1976).

Statistical analysis: The GLM procedure of SAS software (SAS, 1999) was used. Genotype and diet were considered as fixed effects (the interaction was not significant in any of the variables studied) and when the slaughter day effect was significant ($P < 0.20$) it was included in the model as a blocking variable.

Results and discussion

Five animals died before being slaughtered (during transport or while unloading the lorry), all of them from halothane positive pigs (nn): three corresponded to the control and the other two to the diet 1 group (Mg + Trp). The sedative effect of the diet with Trp (diet 2) seemed to facilitate the coping of the animals to stressful factors, such as new environments. The presence and severity of skin lesions indicative of aggressive behaviour are presented in Table 1. Skin lesions in the head/neck, flanks/back and hindquarters were significantly higher in the group of animals fed diet 1 compared with the animals of the control group. This was in agreement with the results of Caine et al. (2000), who found a higher frequency of pre-transport aggression in pigs fed on a supplement of 40 mg Mg (in the magnesium aspartate hydrochloride form)/kg of live weight during the 7 days prior to slaughter, with respect to the controls. No differences were found in the occurrence of skin lesions between diet 1 and diet 2, except in the flanks. That increase in skin lesions of the animals of diet 1 and 2 would suggest an increase of activity due to fighting and a depletion of the glycogen resource before slaughter. That was reflected in the ultimate pH and other meat quality variables. Table 2 shows the effect of the diet on several meat quality variables: pH_u SM tended to be higher ($P = 0.080$) in the animals fed diet 1 and diet 2 than in the control. The incidence of DFD carcasses (dark, firm and dry), established as $pH_u SM \geq 6.0$, was 12.5% in the diet 1 group and 16.7% in the diet 2 group, and 0% in the control. The ECuLT tended to be slightly lower ($P = 0.088$) when animals were fed diet 2. The most important differences among groups were found for the L* (lightness) and the drip loss variables. L* values were lower ($P < 0.05$), indicating darker muscle colour, in the LT of pigs fed the supplemented diets than in the LT of controls, whereas drip losses were lower ($P < 0.05$) in the LT of animals fed with diets 1 and 2 than the control. Thus, the supplementation with Mg+Trp or with Trp improved the muscle colour and the WHC. These results are in accordance with the ones reported by Hamilton et al. (2002), with a supplement of 3.2 g Mg per day and 2 days of treatment, and by D'Souza et al. (1998) who studied the effect of a supplement of 3.2 g Mg per day using magnesium aspartate for 5 days. Hamilton et al. (2002, 2003) and Frederick et al. (2004) evaluate the effect of different times of feeding the Mg supplement prior to slaughter and report that the shortest time studied (1-2 days) may be effective in improving pork colour and muscle WHC. From the present preliminary results and in the conditions of this experiment, it would seem that the darker colour and the decrease in drip losses of the muscle were a consequence of the inclusion of a supplement of (Mg+Trp) and Trp in the diet.

Conclusions

The mixture of Mg and Trp increased the frequency of skin lesions due to fighting during transport and lairage. The aggressive behaviour due to mixing contribute to an increase in pH_u in the meat from the animals fed diet 1 and diet 2 and, as a consequence, some meat quality characteristics (colour and water holding capacity) improved. However, to ascertain if these supplements are adequate to be used in animal production in order to improve meat quality, other factors such as food intake and daily growth should be considered.



Table 1. Least squares means and standard errors of skin lesions mean values in pigs from three groups of diets

	CONTROL (n= 19)		DIET 1* (n= 22)		DIET 2* (n= 23)	
	LSM	S.E.	LSM	S.E.	LSM	S.E.
Head/neck	0.93 ^b	0.195	1.58 ^a	0.180	1.17 ^{ab}	0.176
Flanks/back	0.82 ^b	0.205	1.80 ^a	0.190	1.17 ^b	0.186
hindquarters	0.34 ^b	0.161	1.06 ^a	0.149	0.83 ^a	0.146

^{a,b}: Different superscripts within a row indicated significant differences (P<0.05).

*DIET 1: Magnesium and Tryptophan; DIET 2: Tryptophan.

(0= No occurrence, 1=1 occurrence, 2=2 to 5 occurrence, and 3=more than 5).

Table 2. Least squares means and standard errors of meat quality variables in the LT and SM muscles of pigs from the two genotypes fed the three groups of diets

	CONTROL (n=20)		DIET 1* (n= 22)		DIET 2* (n= 24)	
	LSM	S.E.	LSM	S.E.	LSM	S.E.
Killing out (%)	77.67	0.391	78.22	0.371	77.47	0.355
Carcass weight at 24 h (Kg)	43.18	0.580	41.95	0.536	42.04	0.5151
pH45LT	6.01	0.059	6.04	0.055	6.10	0.053
pH45SM	6.12	0.071	6.18	0.066	6.10	0.063
pHuLT	5.47	0.043	5.53	0.041	5.58	0.039
pHuSM	5.59	0.065	5.79	0.062	5.67	0.059
ECuLT	6.82	0.409	6.84	0.388	5.79	0.371
ECuSM	8.16	0.513	7.49	0.487	7.18	0.466
L* (lightness)	54.06 ^a	0.999	50.82 ^b	0.948	51.04 ^b	0.907
a (redness)	0.79	0.231	1.22	0.214	1.22	0.206
b (yellowness)	5.10	0.394	4.45	0.374	4.41	0.357
Drip loss (%)	8.72 ^a	0.460	7.34 ^b	0.436	7.35 ^b	0.417

^{a,b}: Different superscripts within a row indicated significant differences (P<0.05).

*DIET 1: Magnesium and Tryptophan; DIET 2: Tryptophan.

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