SHORT COMMUNICATION

EFFECT OF THE HALOTHANE GENE ON PRE-SLAUGHTER MORTALITY IN TWO SPANISH COMMERCIAL PIG ABATTOIRS

E Fàbrega*, A Diestre*, D Carrión[†], J Font[‡] and X Manteca[§]

* Institut de Recerca i Tecnologia Agroalimentàries, Centre de Tecnologia de la Carn, Monells, Spain

[†] Pig Improvement Company Europe, Sant Cugat del Vallès, Spain

[‡] Pinsos Baucells, Tona, Spain

[§] Unitat de Fisiologia Animal, Facultat de Veterinària, Universitat Autonòma de Barcelona, 08193-Bellaterra, Barcelona, Spain

[§] Contact for correspondence and requests for reprints: xavier.manteca@uab.es

Abstract *Animal Welfare 2002, **11***: 449-452

A total of 107 ear samples from all the pigs that died during transport or lairage at two commercial abattoirs were collected during two months (February and July), in order to determine their halothane genotype (NN, Nn or nn). The frequencies of the three halothane genotypes among dead pigs were significantly different (P < 0.001), being 4.7%, 24.3% and 71.0% for NN, Nn and nn individuals, respectively. The frequencies of pre-slaughter deaths within each genotype were estimated to be 0.02%, 0.09% and 2.29% for NN, Nn and nn genotypes, respectively. According to these results, the removal of both nn and Nn genotypes would give rise to an eleven-fold reduction in the pre-slaughter mortality rate (from 0.22% to 0.02%). It is therefore suggested that, from an animal welfare point of view, the elimination of the halothane gene in existing breeding schemes would have a major beneficial impact.

Keywords: *animal welfare, halothane gene, lairage, mortality rate, pig, transport*

Introduction

Mortality during transport is a major welfare concern. Mortality rates in slaughter pigs during transport or lairage are very different among EU countries, varying from 0.03% to 0.5% (Christensen *et al* 1994). Although transport and environmental conditions, which also affect mortality, are not the same in those countries (Warriss & Brown 1994), there is no doubt that halothane gene frequencies within the pig population play a major role in such regional variation (Gratz 1981; Christensen *et al* 1994; Guàrdia *et al* 1996).

The halothane gene (*Hal*) is now considered to be equivalent to the *ryr-1* (ryanodine receptor 1) gene (Fujii *et al* 1991). Pigs homozygous for a mutation in this locus (nn) are thought to be genetically susceptible to stress, because they are likely to develop a potentially lethal condition known as porcine stress syndrome (PSS). However, the position of heterozygous pigs (Nn) with respect to the other genotypes in terms of meat quality, mortality rate and welfare is still controversial. Recent studies have suggested that any stressful situation, such as transport, can trigger the onset of PSS, increasing mortality rates in both nn and Nn genotypes (Murray & Johnson 1998). Murray and Johnson (1998) found that frequencies of death during lairage and transport were 0.05%, 0.27% and 9.2% for the

NN, Nn and nn genotypes, respectively. These data are in agreement with other authors' findings obtained under different environmental conditions (Webb *et al* 1982; McPhee *et al* 1994). Moreover, if nn or Nn pigs are slaughtered under stressful conditions, they are both likely to produce pale, soft and exudative meat (PSE) (Gispert *et al* 2000). Therefore, selection against the halothane gene would have positive implications for both welfare and meat-quality.

The aim of this survey was to determine the frequency of pre-slaughter deaths within each of the halothane genotypes under commercial conditions, and to evaluate the impact that the removal of this mutation from the Spanish pig population would have on the mortality rate. We were particularly interested to assess pigs of the genotype Nn with respect to the other genotypes, as one of the present breeding programs aims to reduce the frequency of nn slaughter pigs but to increase the frequency of Nn (which have higher carcass quality) up to 50%.

Materials and methods

Ear samples were collected from all the fattening pigs that died during transport or lairage at two commercial abattoirs, both of which were considered to have a high capacity of slaughter (> 500 000 pigs per year). The experiment was carried out during winter (February) and summer (July) of the year 2000. A total of 107 samples were collected. Samples were frozen pending analysis to determine the halothane genotype (homozygous nn and NN, or heterozygous Nn) using polymerase chain reaction (PCR) amplification and digestion with restriction enzymes, as described by Fujii *et al* (1991). We used the HAL-1843® genotyping test (registered trademark of Innovations Foundation, Toronto, Canada). The frequency of pre-slaughter deaths within each genotype (Z) was calculated by means of the formula previously used by Murray and Johnson (1998):

$$Z = (Y \times p) / X$$

where Y is the percentage of pre-slaughter deaths for a specific genotype in the sample or in a specific period or abattoir, p is the mean mortality rate during transport or lairage in Spain (0.22% according to Guàrdia *et al* 1996), and X is the percentage of a specific genotype in the commercial kill. These percentages were obtained from the mean frequencies observed at five commercial abattoirs surveyed by Gispert *et al* (2000) (42.2%, 51.7% and 6.2% for NN, Nn and nn pigs, respectively).

Differences between the mortality rates of each genotype were analysed using Chi-square tests with the SAS/STAT PROC FREQ technique (SAS Institute Inc 1988). Data from both sampling months (February and July) and both abattoirs have been pooled together in the analysis because of the small number of samples in some of the categories — for instance, the number of NN observations in each abattoir was less than five.

Results and discussion

The frequencies of the different halothane genotypes of pigs that died pre-slaughter during transit or lairage are presented in Table 1. The distribution of halothane genotype frequencies in the two abattoirs was slightly different, mainly between the Nn individuals (37.2% versus 15.6%). This may be attributable to differences in the genotype frequencies in slaughtered animals in both abattoirs, perhaps associated with preferences for certain breeds or types of animals. In support of this, Gispert *et al* (2000) surveyed five abattoirs and found that the frequency of the mutant halothane allele (n) varied from 54% to 8%. Despite this difference, the number of nn pigs that died during transport or lairage was higher in each abattoir and significantly higher in the combined data ($P < 0.001$).

Table 1 Frequencies of pigs of the three halothane genotypes that died during transport or lairage at two commercial abattoirs.

	Abattoir		
	A	B	Combined
Total number of dead pigs	43	64	107
% NN	2.3	6.3	4.7^a
% Nn	37.2	15.6	24.3^b
% nn	60.5	78.1	71.0^c

Percentages with different superscripts are significantly different ($P < 0.05$). Chi^2 was calculated for the combined data only.

Data for both abattoirs combined indicate that 4.7%, 24.3% and 71.0% of pigs that died were NN, Nn and nn genotypes, respectively. Therefore, more than two thirds of pre-slaughter deaths may be associated with the presence of the halothane gene. Estimating the frequencies of death within the NN, Nn and nn genotypes as described earlier, we obtained 0.02%, 0.09% and 2.29%, respectively. Other authors have found results with the same pattern (ie NN, low percentage of deaths; Nn, higher percentage; nn, highest percentage) but with different overall percentages. These differences may be related to different pre-slaughter practices and gene frequencies of the population in the surveyed countries (Webb *et al* 1982; McPhee *et al* 1994; Murray & Johnson 1998). However, there has been general agreement with the finding that pigs of the genotype nn are considerably more prone to death during transit or lairage than pigs of the NN genotype and that Nn pigs hold an intermediate position between the two homozygotes.

After removal of Nn and nn pigs from the population, an eleven-fold reduction in mortality rate would be expected (from the 0.22% estimated by Guàrdia *et al* [1996] to the level of the NN genotype, ie 0.02%). Taking into consideration that in Spain a total of 35.2 million pigs are slaughtered yearly (Anuario Cárnico 1999–2000), and based on the pre-slaughter death rate of 0.22%, there would be 77 440 pre-slaughter deaths, of which 70 400 could be avoided by the removal of the halothane gene. On the other hand, elimination of nn slaughter pigs together with an increase of Nn up to 50% would give rise to a smaller reduction in mortality compared to eliminating both Nn and nn pigs (from 0.22% to the mean mortality rate of NN and Nn pigs, ie 0.06%).

Animal welfare implications

Even though environmental conditions such as temperature and pre-slaughter practices such as duration of fasting influence mortality rates (Warriss & Brown 1994), this experiment suggests that the halothane gene has a major detrimental impact on mortality, for both nn and Nn pigs. New breeding possibilities have become available to the pig industry, such as the use of improved NN terminal boars. These new strategies, which could lead to the elimination of the n mutant genotype in slaughter pigs, are expected to decrease mortality rates and to have important concomitant benefits to welfare.

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