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Influence of season, distance and mixed loads on the physical and carcass integrity of pigs transported to slaughter

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Abstract

To determine the influences of season, distance and multiple-farm loads on pigs transported to slaughter under Spanish commercial conditions, 496 journeys, involving 90,366 pigs, were analysed. Mortality, liveweight loss, transport yield, killing out percentage, carcass yield after overnight chilling and percentage of condemned and trimmed carcasses were recorded. Season significantly affected killing out percentage and trimmed carcasses, with the lowest values found in autumn and summer, respectively. Distance significantly affected liveweight loss and transport yield. Loads composed of pigs from a number of farms had more deaths and carcass problems. It can be concluded that, under Spanish climatic conditions, if journey planning and handling at loading are adequately performed, season and distance do not impair the welfare of slaughter pigs. On the other hand, loading at a number of farms, alone, or interacting with distance, can compromise pig welfare.

Keywords: Transport; Pig; Season; Stress; Welfare

1. Introduction

Transport is a procedure in livestock production that has a stress component that may affect welfare (Grandin, 2000), as well as different carcass (Tarrant, Kenny, Garrington, & Murphy, 1992) and meat quality traits (Warriss, 1996).

Many factors can affect pigs transported to slaughter. It is generally accepted that the duration of a journey has a negative impact on pig welfare and meat quality (Pérez et al., 2002), although this effect cannot always be directly related to distance. The season in which pigs are transported may have negative effects on the comfort of animals, and an increase in mortality in hot humid conditions has been reported (Abbott et al., 1995). Mixing animals from different farms, as well as the number of farms in which animals are loaded, may also negatively affect pigs. Mixing animals during loading results in an increase in fights between them (Bradshaw et al., 1996), thus increasing skin blemishes (Guise & Penny, 1989) and leading to carcass downgrading, which has been calculated to cost 3.3% of their value (Guise, 1991).

Liveweight loss (Dantzer, 1982; Warriss, 1993) also caused a decrease in value. Prolonged fasting periods induced dehydration and mobilization of glycogen reserves (Tarrant, 1989; Warriss, Bevis, & Ekins, 1989). Lambooy, Garssen, Walstra, Mateman, and Merkus (1985) found that the reduction of intake associated to transport caused dehydration as well as a mobilization of fats to supply metabolic needs. Moreover, liveweight loss and carcass yield, the latter being considered a good indicator of losses of components of an animal's body (Warriss, 1998), were found to be strongly correlated to journey duration and available space per animal (Muller Haye, González, & Navas, 1973). Consequently, they might be appropriate variables when quantifying stress produced by journeys.

Mortality during transportation to slaughter also reflects high levels of stress suffered by pigs during the

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journey. A genetic pre-disposition, as well as some inadequate procedures when loading pigs onto the lorry (Warriss, 1998) may cause sufficient stress, in poor transport conditions, to result in deaths.

Carcass blemishes indicating poor handling and fights during transport, provide valuable additional information about a pigs welfare and result in economic loss (Broom, 2000).

The aim of this study was to analyse the influence of season, distance travelled and number of farms contributing to a load of pigs on some welfare related physical and carcass parameters of pigs transported to slaughter under Spanish commercial conditions.

2. Material and methods

Information on 90,366 crossbred fattening pigs with a live weight of approximately 100 kg was used. They were grouped in 680 different lots from 46 farms, and were transported to the same slaughterhouse in 496 different journeys. All transports were commercial and they were carried out with loading densities around 235 kg/m^2, as recommended by European and Spanish law (Council Directives 91/628/EEC and 95/29/EC; Real Decreto 1041/1997). Consequently, there where transports that loaded pigs at different farms until fully loaded. Three different, authorized, commercial vehicles were used, each provided with natural ventilation, drinking nipples and showers, so it was assumed that penning conditions during transport were similar for all animals. After arrival at the slaughterhouse, pigs were unloaded, housed in resting pens for between 2 and 10 h, with water ad libitum, until they were killed according to normal commercial practice.

The smallest lot analysed was a group of animals that were loaded at the same farm for one journey, consequently each journey was performed transporting one or more lots to the abattoir. Each transport was defined by: distance to the slaughterhouse (<50 km; 50–100 km; >100 km), season in which transport was performed (spring, summer, autumn and winter), and number of farms where animals were loaded (one and more than one).

The variables quantified for each lot were deaths during transport (%); mean liveweight loss (kg/pig); mean transport yield (live weight at unloading as percentage of live weight at loading); mean killing out percentage (hot carcass weight as percentage of live weight at loading); mean carcass yield during overnight chilling (24 h post-slaughtering carcass weight as percentage of hot carcass weight); condemned carcasses (%) and trimmed carcasses (%).

Collected data were analysed using S.A.S. (for Windows; v. 8.1, 1999–2000). Analysis of variance was performed, and main factors, as well as their significant interactions, were studied by means of the least squares method, using the GLM procedure, and accepting differences between variables if $p < 0.05$. In the case of significant differences, means were compared using the Fisher's LSD method. Relationships between variables were calculated by means of the Pearson's correlation coefficients.

3. Results and discussion

The effects of season on the studied variables are shown in Table 1. A summary of the climatological conditions in the area where pigs were transported is shown in Table 2. Mortality was not affected by the season in which pigs were transported. Although it is generally accepted that deaths during transport increase in hot climatic conditions (Smith & Allen, 1976; van Logtestijn, Romme, & Eikelenboom, 1982), our results differ from those of these authors. Moreover, Guardia, Gispert, and Diestre (1996) found that, under Spanish commercial conditions, months with the highest mortalities were October and November. This was associated with the fact that, in the hottest seasons, Spanish pig hauliers take precautions to protect animals from extreme conditions, such as undertaking journeys at night, reducing loading densities and showering animals. Our results agreed with these authors.

In Table 1 the low percentages of condemned (0.08%) and trimmed carcasses (0.29%; $p < 0.05$) observed in summer were also remarkable. This may have been due to the particular stress-reducing handling procedures carried out during this season. We also agree with Guàrdia et al.

Table 1
Effect of season on the physical and carcass integrity of pigs transported to slaughter (mean ± s.e.)

	Winter	Autumn	Spring	Summer	Signification
Mortality (%)	0.31 ± 0.06 (180)	0.42 ± 0.07 (118)	0.31 ± 0.04 (224)	0.29 ± 0.05 (158)	ns
Liveweight loss (kg/pig)	1.14 ± 0.04 (180)	1.29 ± 0.06 (118)	1.16 ± 0.03 (224)	1.22 ± 0.05 (158)	ns
Transport yield (%)	98.83 ± 0.04 (180)	98.69 ± 0.07 (118)	98.83 ± 0.03 (224)	98.77 ± 0.05 (158)	ns
Killing out percentage (%)	81.06 ± 0.11a (179)	80.37 ± 0.17c (115)	80.95 ± 0.14ab (224)	80.62 ± 0.18bc (157)	**
Carcass yield during overnight chilling (%)	97.96 ± 0.03 (179)	97.96 ± 0.04 (114)	97.99 ± 0.02 (224)	98.00 ± 0.01 (157)	ns
Condemned carcasses (%)	0.11 ± 0.03 (180)	0.10 ± 0.03 (118)	0.11 ± 0.04 (224)	0.08 ± 0.03 (158)	ns
Trimmed carcasses (%)	0.68 ± 0.08a (179)	0.71 ± 0.12a (116)	0.59 ± 0.11a (224)	0.29 ± 0.07b (157)	*

Between brackets, sample size.
ns, non-significant.
a–c: different letters indicate statistically significant differences.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 2
Climatological variables for the four seasons in the transport area

	T_M (°C)	T_m (°C)	RH (%)
Spring	22.3	9.9	58.7
Summer	28.9	15.4	56.9
Autumn	14.7	5.6	75.3
Winter	12.8	2.8	70.3

T_M, mean maximum temperature.
T_m, mean minimum temperature.
RH, mean relative humidity.

(2005), who found a higher probability of finding dark, firm and dry (DFD) meat in winter than in summer, reflecting the tendency of pigs to group in order to create a warmer microclimate that protects them from cold. Our results would confirm this, suggesting that cold might cause some pigs to shiver, accelerating depletion of muscle glycogen reserves. Cold would cause the animals to group as well, what would increase fights and, consequently, carcass bruises, what would cause carcass trimming. Furthermore, the percentage of trimmed carcasses was negatively correlated with killing out percentage (-0.55; $p < 0.001$).

Killing out percentage was significantly affected by season ($p < 0.01$), with maximum values being obtained in winter and spring, and minimum values appearing in summer and autumn, although spring and summer values did not differ statistically. Killing out percentage was negatively correlated with liveweight losses (-0.13; $p < 0.001$).

Distance (Table 3) significantly affected mortality ($p < 0.01$), liveweight losses and transport yield ($p < 0.001$) and killing out percentage ($p < 0.05$). Mortality and liveweight losses increased as distance increased, so that the lowest values corresponded to less than 50 km journeys (0.21% and 1.06 kg/pig, respectively) and the highest to more than 100 km journeys (0.46% and 1.36 kg/pig, respectively). Our results agreed with those of Warriss, Dudley, and Brown (1983) Warriss, Brown, Bevis, and Kestin (1990), suggesting that, in short journeys, liveweight losses are mainly caused by urine and faeces excretion. Transport yield diminished when distance increased, but killing out percentage showed no clear tendency, with the lowest values being in distances between 50 and 100 km, in disagreement with Warriss et al. (1983), who found that killing out percentage decreased when distance increased.

Distance did not affect condemned and trimmed carcasses, which might be explained by the transport company's way of working, being more selective with those farms more distant from the abattoir. It is generally accepted that loading may cause high stress to pigs (Warriss, 1998), so if initial stress is reduced, subsequent stress during transport would be reduced as well, resulting in less carcass problems.

Table 3
Effect of distance on the physical and carcass integrity of pigs transported to slaughter (mean ± s.e.)

	<50 km	50–100 km	>100 km	Signification
Mortality (%)	0.21 ± 0.03b (267)	0.32 ± 0.05ab (219)	0.46 ± 0.06a (194)	**
Liveweight loss (kg/pig)	1.06 ± 0.03c (267)	1.20 ± 0.04b (219)	1.36 ± 0.04a (194)	***
Transport yield (%)	98.96 ± 0.03a (267)	98.81 ± 0.04b (219)	98.58 ± 0.05c (194)	***
Killing out percentage (%)	80.81 ± 0.08a (265)	80.42 ± 0.13b (217)	81.03 ± 0.18a (193)	*
Carcass yield during overnight chilling (%)	97.99 ± 0.01 (265)	98.00 ± 0.01 (216)	97.95 ± 0.04 (193)	ns
Condemned carcasses (%)	0.12 ± 0.03 (267)	0.10 ± 0.02 (219)	0.07 ± 0.03 (194)	ns
Trimmed carcasses (%)	0.63 ± 0.07 (265)	0.60 ± 0.11 (218)	0.48 ± 0.07 (193)	ns

Between brackets, sample size.
ns, non-significant.
a–c: different letters indicate statistically significant differences.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 4
Effect of number of farms loading on the physical and carcass integrity of pigs transported to slaughter (mean ± s.e.)

	One	More than one	Signification
Mortality (%)	0.25 ± 0.03 (347)	0.41 ± 0.05 (333)	**
Liveweight loss (kg/pig)	1.23 ± 0.03 (347)	1.17 ± 0.03 (333)	ns
Transport yield (%)	98.77 ± 0.03 (347)	98.79 ± 0.03 (333)	ns
Killing out percentage (%)	80.84 ± 0.10 (346)	80.66 ± 0.11 (329)	ns
Carcass yield during overnight chilling (%)	97.97 ± 0.02 (345)	97.99 ± 0.01 (329)	ns
Condemned carcasses (%)	0.12 ± 0.02 (347)	0.08 ± 0.03 (333)	ns
Trimmed carcasses (%)	0.46 ± 0.04 (346)	0.68 ± 0.09 (330)	*

Between brackets, sample size.
ns, non-significant.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 5
Effect of the interaction between season and distance on the physical and carcass integrity of pigs transported to slaughter (mean ± s.e.)

		Mortality (%)	Lw. loss (kg/pig)[a]	Transport yield (%)	K. Percent. (%)[b]	Car. yield (%)[c]	Condemned c. (%)[d]	Trimmed c. (%)[e]
Winter	<50 km	0.23 ± 0.06 (70)	0.98 ± 0.06 (70)	99.00 ± 0.05a (70)	80.96 ± 0.15 (70)	97.99 ± 0.02 (70)	0.07 ± 0.02 (70)	0.82 ± 0.13 (70)
	50–100 km	0.30 ± 0.08 (59)	1.17 ± 0.08 (59)	98.81 ± 0.08abcd (59)	80.77 ± 0.19 (58)	98.02 ± 0.01 (58)	0.14 ±0.05 (59)	0.46 ± 0.12 (58)
	>100 km	0.40 ± 0.16 (51)	1.29 ± 0.08 (51)	98.69 ± 0.08cd (51)	81.45 ± 0.26 (51)	97.88 ± 0.11 (51)	0.11 ± 0.06 (51)	0.76 ± 0.19 (51)
Autumn	<50 km	0.22 ± 0.06 (44)	1.10 ± 0.10 (44)	99.00 ± 0.08ab (44)	80.64 ± 0.17 (43)	97.99 ± 0.03 (43)	0.16 ± 0.06 (44)	0.71 ± 0.17 (43)
	50–100 km	0.51 ± 0.17 (39)	1.19 ± 0.10 (39)	98.84 ± 0.09abcd (39)	80.08 ± 0.29 (38)	97.98 ± 0.03 (37)	0.11 ± 0.04 (39)	0.88 ± 0.29 (39)
	>100 km	0.54 ± 0.13 (35)	1.57 ± 0.10 (35)	98.24 ± 0.17e (35)	80.39 ± 0.41 (34)	97.90 ± 0.11 (34)	0.03 ± 0.03 (35)	0.55 ± 0.13 (34)
Spring	<50 km	0.23 ± 0.06 (82)	1.13 ± 0.05 (82)	98.87 ± 0.05abc (82)	80.68 ± 0.19 (82)	97.96 ± 0.04 (82)	0.15 ± 0.08 (82)	0.63 ± 0.16 (82)
	50–100 km	0.36 ± 0.09 (75)	1.17 ± 0.06 (75)	98.83 ± 0.06abc (75)	80.58 ± 0.28 (75)	98.01 ± 0.01 (75)	0.12 ± 0.05 (75)	0.77 ± 0.27 (75)
	>100 km	0.34 ± 0.05 (67)	1.19 ± 0.06 (67)	98.79 ± 0.06bcd (67)	81.61 ± 0.22 (67)	97.99 ± 0.04 (67)	0.07 ± 0.05 (67)	0.37 ± 0.12 (67)
Summer	<50 km	0.17 ± 0.05 (71)	1.04 ± 0.07 (71)	98.96 ± 0.07abc (71)	80.94 ± 0.13 (70)	97.99 ± 0.01 (70)	0.10 ± 0.05 (71)	0.35 ± 0.11 (70)
	50–100 km	0.13 ± 0.05 (46)	1.25 ± 0.11 (46)	98.75 ± 0.11cd (46)	80.26 ± 0.24 (46)	97.98 ± 0.01 (46)	0.05 ± 0.04 (46)	0.30 ± 0.12 (46)
	>100 km	0.57 ± 0.18 (41)	1.37 ± 0.10 (41)	98.59 ± 0.10d (41)	80.66 ± 0.61 (41)	98.01 ± 0.01 (41)	0.08 ± 0.06 (41)	0.22 ± 0.10 (41)
	Signification	ns	ns	**	ns	ns	ns	ns

Between brackets, sample size.
ns, non-significant.
a–e: different letters indicate statistically significant differences.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.
[a] Liveweight loss (kg/pig).
[b] Killing out percentage (%).
[c] Carcass yield during overnight chilling (%).
[d] Condemned carcasses (%).
[e] Trimmed carcasses (%).

Table 6
Effect of the interaction between distance and number of farms loading on the physical and carcass integrity of pigs transported to slaughter (mean ± s.e.)

	<50 km		50–100 km		>100 km		Signification
	One	More than one	One	More than one	One	More than one	
Mortality (%)	0.19 ± 0.03b (132)	0.23 ± 0.05b (135)	0.31 ± 0.08b (62)	0.33 ± 0.06b (157)	0.25 ± 0.04b (153)	0.68 ± 0.25a (41)	*
Liveweight loss (kg/pig)	1.16 ± 0.05 (132)	0.96 ± 0.04 (135)	1.20 ± 0.07 (62)	1.19 ± 0.05 (157)	1.34 ± 0.05 (153)	1.38 ± 0.09 (41)	ns
Transport yield (%)	98.87 ± 0.05 (132)	99.05 ± 0.04 (135)	98.80 ± 0.07 (62)	98.81 ± 0.05 (157)	98.64 ± 0.05 (153)	98.52 ± 0.15 (41)	ns
Killing out percentage (%)	80.77 ± 0.08 (131)	80.84 ± 0.14 (134)	80.62 ± 0.15 (62)	80.22 ± 0.17 (155)	81.14 ± 0.21 (153)	80.91 ± 0.35 (40)	ns
Car. yield (%)[a]	97.98 ± 0.03 (131)	97.99 ± 0.01 (134)	98.00 ± 0.02 (61)	97.99 ± 0.01 (155)	97.92 ± 0.05 (153)	97.97 ± 0.04 (40)	ns
Condemned carcasses (%)	0.13 ± 0.03 (132)	0.10 ± 0.06 (135)	0.10 ± 0.03 (62)	0.11 ± 0.03 (157)	0.12 ± 0.03 (153)	0.02 ± 0.03 (41)	ns
Trimmed carcasses (%)	0.61 ± 0.07 (131)	0.65 ± 0.13 (134)	0.38 ± 0.07 (62)	0.82 ± 0.15 (156)	0.38 ± 0.07 (153)	0.57 ± 0.22 (40)	ns

Between brackets, sample size.
ns, non-significant.
a and b: different letters indicate statistically significant differences.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.
[a] Carcass yield during overnight chilling (%).

The number of farms where pigs were loaded (Table 4) significantly affected mortality and percentage of trimmed carcasses, with less deaths (0.25% vs. 0.41%; $p < 0.01$) and lower percentage of trimmed carcasses (0.46% vs. 0.68%; $p < 0.05$) when loading at only one farm than when doing so at two or more farms. These results clearly support what is generally known, that is, mixing unfamiliar pigs when being transported to slaughter increases fighting, reduces welfare and meat quality, and causes increased carcass blemishes (Guise & Penny, 1989).

Interaction between season and distance (Table 5) affected transport yield ($p < 0.01$), it decreasing markedly when distance increased in autumn, and with no significant differences in spring. On the other hand, no differences between seasons were observed for less than 50 km distances, but these differences appeared when distance increased. These results suggest a strong season × distance influence on transport yield.

Interaction between distance and the number of farms where pigs were loaded (Table 6) significantly affected mortality ($p < 0.05$) so that, as journey's distance increased, the negative influence of loading pigs at more than one farm became more evident. Thus, when loading was made at only one farm, mortality varied between 0.19% and 0.31%, but when loading was made at more than one farm deaths in more than 100 km journeys almost tripled those found in less than 50 km journeys (0.23% vs. 0.68%). These results suggest that mixing animals from different farms can have a more marked effect on pig welfare than the distance they are transported.

4. Conclusions

From our results it can be concluded that, under Spanish climatic conditions, season influenced the welfare of pigs, although the worst results were found in autumn. On the other hand, good results obtained in summer indicated adequate journey planning, depending on meteorological conditions. Although a negative effect of distance was observed on liveweight losses, this was caused by excretion processes, moreover, there was a strong season × distance effect. Loading at different farms decreased pig welfare, increasing mortality and carcass problems, markedly aggravating the effect of distance. Thus it can be said that, under Spanish climatic conditions, if journey planning and handling of pigs are performed adequately, season and distance do not affect welfare. Nevertheless, loading at different farms, alone, or interacting with distance, decreased the welfare of transported pigs.

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