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Effect of pre-slaughter handling on body weight loss and carcass and meat quality in crossbred fatteners

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In three successive trials the effects were evaluated of different variants of pre-slaughter handling of pigs on their carcass and meat quality in relation to *RYR1* genotypes. Considered were 309 TORHYB crossbred fatteners [(Polish Large White × Polish Landrace) × Pietrain]. Pre-slaughter transport of fatteners was employed on a distance of 30 *vs*. 100 km during one or four hours, respectively. Then the animals were slaughtered without giving them any rest, *i.e.* within an hour from unloading, or after 24-h rest in lairage space with bedding and access to food and water. The body weight loss during pre-slaughter treatment of animals was recorded and carcass value and meat quality traits were assessed in details. No significant differences in body weight loss were identified among the analysed groups of pigs of *CC*, *CT* and *TT RYR1* genotypes transported over 30 km and slaughtered within an hour from unloading (1.67%, 1.27% and 1.82%, respectively).

Compared to 30 km distance, transport over 100 km caused the higher body weight loss (2.09% *vs.* 1.16%; P≤0.01) and higher carcass weight loss during chilling (2.04 *vs.* 0.88%; P≤0.01).

The diurnal lairage was found to be unfavourable as it led to the body weight loss two times higher than in pigs slaughtered without lairage (2.92 *vs.* 1.20%) and lowered meat quality in stress-susceptible animals (*RYR1 CT*).

KEY WORDS: body weight loss / carcass weight loss / meat quality / pig transport / pre-slaughter handling /

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Pre-slaughter handling of pigs during their delivery from farms to meat plants is inseparably related to disturbed animal welfare and exposes them to various stressful factors. Many new situations created by loading, unloading, lairage or contact with unfamiliar enviromnent or destruction of the group hierarchy are not neutral for animal organism. All that may promote the more intensive metabolism and physiological reactions and in consequence lead to carcass and meat quality changes detectable post-slaughter. Effects of pre-slaughter handling on lowering the pig carcass value are well known [Wajda and Kapelański 1978, Warris *et al*. 1998, Gispert *et al.* 2000], but in practice impossible to be avoided. The factor enhancing diverse results of pre-slaughter handling in pigs is that they are frequently burdened with *RYR1*^{T} gene and are more stress-prone.

The aim of this report is to present the results of evaluation of effects of different variants of pre-slaughter handling on body weight losses and carcass and meat quality traits in fatteners.

Material and methods

Within the years 2000-2003 three consecutive trials were conducted on 92, 102 and 115 crossbred pigs coming from the TORHYB programme of high-lean pig production [Kapelański 1996]. The TORHYB crossbreds [(Polish Large White × Landrace) × Pietrain] were reared and fed under the same standard conditions from 30 to about 105 kg live weight and then transported during about one hour or four hours to the slaughterhouse located 30 or 100 km from the farm. Then the pigs were slaughtered within one hour from unloading or after 24 h rest in bedded lairage space, with full access to food and water. All animals were weighed on the farm before loading and next in slaughterhouse before slaughter. Losses in body weight during pre-slaughter handling of animals were recorded and given in kilograms and per cent.

The deliveries were carried out in similar manner and under similar conditions according to meat industry obligatory standards [Dz.U. No. 86, 1998] using the same long and similar loading density. Animals were slaughtered following current standards. Blood for *RYR1* genotype identification was withdrawn and analysed according to Fuji *et al*. [1991] and Kurył and Korwin-Kossakowska [1993]. Cooled carcasses were divided into cuts and then dissected according to the European Union procedure given by Walstra and Merkus [1996], and meat content of carcass was calculated.

The pH_1 and electric conductivity (EC_1) values were recorded 45 min. *post mortem* in the *longissimus lumborum* muscle (LL). Determinations of pH_1 were made with a portable pH-meter (R. MATHAUS, Germany) with glass spearhead electrode. Electric conductivity was measured with LF_1-STRAR apparatus (R. MATHAUS, Germany).

Backfat thickness was determined in five carcass points (over the shoulder, on the back, on sacrum I, II, III) and loin cross-section area measured behind the last thoracic vertebra.

The following meat quality traits of LL muscle were determined 48 h post-slaughter: ultimate pH (pH_u), drip loss (%) after Honikel [1987], water-holding capacity (WHC) according to Grau and Hamm method modified by Pohja and Niinivaara [1957], meat colour using Spekol 11 spectrophotometer with a reflectance attachment. Colour parameters were calculated from the regression equation derived by Różyczka *et al*. [1968].

Arithmetic means and their standard deviations (SD) were computed. One-way analysis of variance was used and Student's t-test applied for evaluation the differences between animal groups transported over 30 and 100 km before slaughter (first and second trials). Two-way analysis of variance was applied when tested factors were stress-susceptible genotypes (*CC*, *CT* and *TT*) and different pre-slaughter handling versions (third trial). Significance of differences was tested with Duncan test. Statistical calculations were made using STATISTICA 8 PL Software [2008].

Results and discussion

In the first trial the effect of *RYR1* genotype was evaluated on carcass characteristics and transport losses over the distance of 30 km and slaughter within 1 hour from unloading (Tab. 1). No significant differences in body weight losses during that pre-slaughter handling were found among pigs of *CC*, *CT* and *TT* genotypes. The mean pre-slaughter handling loss ranged from 1.27% in *Nn* to 1.82% in *nn* pigs.

Extending of the transport distance to 100 km was studied in the second trial (Tab. 2 and 3). Pigs transported over 100 km showed greater body weight losses than those transported over 30 km (2.09% *vs*. 1.16%; $P \leq 0.01$). Moreover, they showed greater carcass weight loss during 24 h cooling (2.04% *vs*. 0.88 %; $P \leq 0.01$). This emphasizes the profound effect of long-distance transport on final carcass properties.

The influence of longer transport distance upon some meat quality traits is shown in Table 3. Taking into account the well known significant relations between animal *RYR1* genotype and meat quality traits, the comparison was based on pigs of one (*CT*) genotype. Pigs transported over 100 km had lower pH_1 ($P \leq 0.01$) and lighter colour ($P \leq 0.01$), while LF_1, pH_u, WHC and drip loss were within the range similar to that found in pigs transported over 30 km. These observations show the longer travel distance to be more stressful to pigs, the results being in accordance with Bradshaw *et al*. [1996], Perez *et al*. [2002], and Wajda and Denaburski [2003].

Warris *et al*. [1990] compared the effect of pre-slaughter transport time (1 or 4 hours) and lairage time (2 or 21 hours) on carcass and meat quality and showed that longer transport time of pigs increased live weight loss while longer lairage time resulted in reduced dressing percentage and some meat traits. An excellent survey of preslaughter conditions, halothane gene frequency, and carcass and meat quality in five Spanish pig commercial abbatoirs was done by Gispert *et al*. [2000] on 15,695 pigs. The overall incidence of serious PSE and DFD carcasses was 6.5% and 12.5%, respectively. According to Perez *et al*. [2002], pigs transported for 15 min showed a

Table 1. Means and their standard deviations (SD) for slaughter traits in fatteners of three *RYR1* genotypes transported over 30 km and slaughtered within an hour from unloading

Trait (n=92)	*RYR1* genotype					
	CC (n=35)		*CT* (n=35)		*TT* (n=22)	
	mean	SD	mean	SD	mean	SD
Body weight at loading (kg)	106.14	2.86	106.14	3.47	104.86	5.08
Body weight at slaughter (kg)	104.36	2.92	104.77	2.91	102.91	4.23
Transport loss (kg)	1.79	2.05	1.37	1.61	1.95	1.94
Transport loss (%)	1.67	1.89	1.27	1.43	1.82	1.78
Dressing percentage	79.69	1.95	81.12	1.40	80.33	1.91
Hot carcass weight (kg)	83.17	2.26	84.83	2.71	83.75	4.48
Cold carcass weight (kg)	82.56	2.35	84.05	2.82	83.16	4.34
Cooling loss (kg)	0.61	0.43	0.78	0.58	0.59	0.53
Cooling loss (%)	0.74	0.56	0.92	0.68	0.70	0.58
Backfat thickness (mean from 5 measurements, cm)	2.99^{a}	0.41	3.04^{a}	0.59	2.69^{b}	0.49
Loin eye area (cm^2)	41.53^{A}	4.54	45.39^{A}	6.02	47.58^{B}	5.64
Lean content of carcass (%)	50.59^{A}	3.67	52.07^{A}	3.60	55.34^{B}	3.10

n – number of animals.
$^{aA...}$Within rows means bearing different superscripts differ significantly at: small letters – P≤0.05; capitals – P≤0.01.

Table 2. Means and their standard deviations (SD) for slaughter traits as affected by transport distance in fatteners slaughtered within an hour from unloading

Trait (n=102)	Transport distance			
	30 km (n=63)		100 km (n=39)	
	mean	SD	mean	SD
Body weight at loading (kg)	105.27	4.13	100.00	4.61
Body weight at slaughter (kg)	104.02^{A}	3.66	97.92^{B}	4.79
Transport loss (kg)	1.25^{A}	1.44	2.08^{B}	0.53
Transport loss (%)	1.16^{A}	1.30	2.09^{B}	0.57
Dressing percentage	80.78^{a}	1.77	81.63^{b}	2.01
Hot carcass weight (kg)	84.03^{A}	3.40	79.96^{B}	4.78
Cold carcass weight (kg)	83.29^{A}	3.43	78.32^{B}	4.60
Cooling loss (kg)	0.74^{A}	0.60	1.64^{B}	0.62
Cooling loss (%)	0.88^{A}	0.71	2.04^{B}	0.74
Backfat thickness (mean from 5 measurements, cm)	2.96^{A}	0.56	2.43^{B}	0.52
Loin eye area (cm^2)	44.73	6.33	44.25	7.79
Lean content of carcass (%)	52.42	3.87	53.72	3.24

n – number of animals.
$^{aA...}$Within rows means bearing different superscripts differ significantly at: small letters – P≤0.05; capitals – P≤0.01.

Table 3. Means and their standard deviations (SD) for meat quality traits as affected by transport distance in *RYR1 CT* fatteners slaughtered within an hour from unloading

Trait (n=86)	Transport distance			
	30 km (n=58)		100 km (n=28)	
	mean	SD	mean	SD
pH_1	6.26^A	0.38	6.02^B	0.29
pH_u	5.50	0.12	5.51	0.17
LF_1 (mS/cm)	3.94	0.93	4.44	1.50
Dominant wavelength (nm)	584.4	1.27	584.0	1.15
Colour saturation (%)	21.02	2.71	21.83	2.58
Colour lightness (%)	23.80^A	3.75	26.76^B	4.89
WHC (% loose water)	20.39	2.71	21.53	3.69
Drip loss (%)	4.46	2.90	4.55	2.58

n– number of animals.
$^{aA...}$Within rows means bearing different superscripts differ significantly at: small letters – P≤0.05; capitals – P≤0.01.

more marked stress response and poorer meat quality than those subjected to transport lasting 3 hours, when immediately slaughtered after unloading. Transport lasting 3 hours might have allowed the animals to adopt to transport conditions.

The aim of third trial was to study the effect of diurnal pig rest before slaughter when animals were transported over 30 km on body weight loss, lairage loss, dressing percentage, lean content of carcass and meat quality traits as related to different *RYR1* genotypes. The results are presented in Tables 4 and 5. Differences between the values for non-lairaged and lairaged pigs occurred highly significant. Mean body weight losses (genotypes pooled) were 1.16% and 2.81% (P≤0.01), while dressing percentage reached 80.78% and 79.63% (P≤0.01), respectively. These results suggest that diurnal lairage time affected animal welfare as prolonged rough stress condition. Also meat traits, such as colour lightness, WHC and drip loss were less advantageous in lairaged pigs (especially of *RYR1 TT* genotype) than in those slaughtered immediately on arrival (P≤0.01).

The results presented here show serious body weight losses to occur in pigs during transport, especially on distance longer than 30 km. The diurnal lairage time effect occurred similar to prolonged rough stress condition. Also meat quality parametres indicated the more marked trend to meat exudation. The all above reduce dressing percentage and decrease the pig production profits.

Table 4. Means and their standard deviations (SD) for slaughter traits in fatteners of different *RYR1* genotypes transported over 30 km and then slaughtered immediately (*i.e.* within an hour from unloading), or after 24-hour lairage rest

Trait	Pre-slaughter handling	*RYR1* genotype						*RYR1* genotypes pooled	
		CC (n=35)		*CT* (n=35)		*TT* (n=22)			
		mean	SD	mean	SD	mean	SD	mean[1]	SD
Number of animals = 115	without rest	n=15		n=35		n=13		n=63	
	lairage rest	n=20		n=23		n=19		n=52	
Transport loss (kg)	without rest	0.90	1.23	1.37	1.61	1.31	1.18	1.25^{C}	1.44
	lairage rest	2.45	2.31	3.61	2.76	2.89	2.47	3.04^{D}	2.55
Transport loss (%)	without rest	0.85	1.15	1.27	1.43	1.23	1.11	1.16^{C}	1.30
	lairage rest	2.28	2.12	3.34	2.51	2.66	2.26	2.81^{D}	2.33
Dressing percentage	without rest	80.33	2.09	81.12	1.40	80.37	2.19	80.78^{C}	1.77
	lairage rest	79.22	1.74	79.75	2.39	80.27	1.56	79.63^{D}	2.03
Backfat thickness (mean from 5 measurements, cm)	without rest	3.08^{b}	0.49	3.04^{b}	0.60	2.61^{a}	0.41	2.96	0.56
	lairage rest	2.93	0.34	2.88	0.44	2.80	0.60	2.88	0.43
Loin eye area (cm^2)	without rest	40.44^{Bb}	4.92	45.39^{a}	6.03	47.89^{A}	6.37	44.73	6.33
	lairage rest	42.35^{B}	4.18	41.48^{B}	4.76	47.13^{A}	4.71	42.79	4.89
Lean content of carcass (%)	without rest	50.49^{B}	3.61	52.07^{B}	3.60	55.58^{A}	3.10	52.42	3.87
	lairage rest	50.60^{B}	3.81	51.75^{b}	2.91	54.99^{Aa}	3.26	51.90	3.61

$^{aA...}$Within rows means for individual genotypes bearing different superscripts differ significantly at: small letters – P≤0.05; capitals– P≤0.01.

[1]Within this column and individual traits means bearing different superscripts differ significantly at P≤0.01.

Table 5. Means and their standard deviations (SD) for meat quality traits in fatteners of different *RYR1* genotypes transported over 30 km and then slaughtered immediately (*i.e.* within an hour from unloading), or after 24-hour lairage rest

Trait	Pre-slaughter handling	*RYR1* genotype						*RYR1* genotypes pooled	
		CC (n=35)		*CT* (n=35)		*TT* (n=22)			
		mean	SD	mean	SD	mean	SD	mean[1]	SD
Number of animals = 115	without rest	n=15		n=35		n=13		n=63	
	lairage rest	n=20		n=23		n=19		n=52	
pH_1	without rest	6.49^{A}	0.37	6.41^{a}	0.34	6.08^{Bb}	0.41	6.38^{c}	0.38
	lairage rest	6.46^{A}	0.38	6.26^{A}	0.38	5.71^{B}	0.46	6.19^{d}	0.47
pH_u	without rest	5.50^{A}	0.08	5.52^{A}	0.11	5.66^{B}	0.14	5.54^{c}	0.12
	lairage rest	5.48	0.07	5.50	0.12	5.49	0.19	5.49^{d}	0.13
LF_1 (mS/cm)	without rest	3.93^{A}	0.44	4.13^{A}	0.87	5.62B	2.07	4.31	1.20
	lairage rest	3.69^{A}	0.44	3.94^{A}	0.93	7.89B	3.45	4.70	2.35
Colour saturation (%)	without rest	18.23	1.15	18.65	1.47	17.74	2.28	18.33^{C}	1.53
	lairage rest	20.18^{A}	2.64	21.02	2.71	22.83^{B}	3.31	21.19^{D}	2.93
Colour lightness (%)	without rest	21.23	1.74	21.66	2.81	21.24	4.47	21.42^{C}	2.78
	lairage rest	23.28^{a}	3.10	23.80	3.75	26.06^{b}	4.23	24.14^{D}	3.79
WHC (% loose water)	without rest	18.91	1.83	19.34	2.28	18.85	3.16	19.09^{C}	2.26
	lairage rest	19.35^{A}	1.81	20.40^{A}	2.71	23.62^{B}	3.06	20.81^{D}	2.97
Drip loss (%)	without rest	2.89	2.05	3.58	1.94	3.58	2.14	3.31^{c}	2.00
	lairage rest	2.77^{A}	1.61	4.46^{A}	2.90	6.78^{B}	2.45	4.54^{d}	2.86

[aA...]Within rows means for individual genotypes bearing different superscripts differ significantly at: small letters – P≤0.05; capitals – P≤0.01.
[1]Within this column and for individual traits means bearing different superscripts differ significantly at: small letters – P≤0.05; capitals – P≤0.01.

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Wpływ postępowania przed ubojem na straty masy ciała, wartość rzeźną tusz i jakość mięsa towarowych mieszańców świń

S t r e s z c z e n i e

Dokonano trzech niezależnych od siebie i ułożonych kolejno w czasie oszacowań wpływu różnych wariantów postępowania przedubojowego na jakość tuszy i mięsa tuczników. Uwzględniono także związek między kształtowaniem się tych cech a genotypem *RYR1*. Badania przeprowadzono na 309 towarowych mieszańcach TORHYB – [(PLW × PL) × Pietrain]. Tuczniki transportowano na odległość 30 lub 100 km (odpowiednio w czasie 1 lub 4 godzin), a następnie ubijano bez wypoczynku, t.j. w ciągu godziny od rozładowania lub po całodobowym wypoczynku w magazynie żywca. Oceniano ubytki masy ciała podczas obrotu przedubojowego, wartość rzeźną tuszy i jakość mięsa.

Przy transporcie na dystansie 30 km i uboju w ciągu godziny od rozładunku analizowane grupy tuczników (35 osobników *RYR1 CC*, 35 *CT* i 22 *TT*) mimo istotnych różnic w mięsności nie odbiegały istotnie od siebie pod względem ubytku masy ciała (odpowiednio 1,67, 1,27 i 1,82%). Przedłużenie dystansu przewozu do 100 km wyraźnie zwiększyło ubytek masy ciała tuczników (2.09 wobec 1,16%; P≤0,01), a także spowodowało dalsze ubytki masy tuszy podczas wychładzania (2,04 wobec 0,88%; P≤0,01).

Przedłużenie obrotu przedubojowego o całodobowy wypoczynek przed ubojem okazało się niekorzystne, gdyż ponad dwukrotnie zwiększyło ubytek masy ciała świń odpoczywających (2,81 wobec 1,16%; P≤0,01) i znacznie obniżyło jakość mięsa osobników wrażliwych na stres.