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THE STRESS SYNDROME AND MEAT QUALITY

A STANDARDIZED PROCEDURE FOR THE PRE-SLAUGHTER TREATMENT OF PIGS TO BE TESTED FOR MEAT QUALITY

by

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This paper describes the work leading up to a standardized procedure for the pre-slaughter treatment of pigs to be tested for meat quality. The procedure consists of:

1. moderate feeding but no weighing on the day of slaughter
2. loading using a hydraulic pig lift
3. transport for approximately 40 minutes in a special lorry equipped with a non-skid floor, partitions and a mechanical ventilation system
4. driving directly from the lorry to the stunning pen without using an electric goad or other means of force
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This system is now used for all pigs from Danish progeny testing stations.

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1. Affouragement modéré, mais aucun pesage au jour d'abattage
2. Chargement par appareil élévatoire hydraulique pour cochons
3. Transport pendant 40 minutes à peu près dans un camion spécial, muni d'un plancher antiglissant, de parois et d'un système d'aération automatique
4. Conduisant les cochons du camion directement à l'endroit où se fait l'anésthésie en utilisant ni de gourdin électrique ni d'autres moyens de force
5. Anésthésie électrique à terre.

Ce systeme est utilisé à présent pour tous les porcs des stations expérimentales danoises pour le contrôle de progéniture.

EIN STANDARDISIERTES VERFAHREN FÜR DIE VORSCHLACHTBEHANDLUNG VON SCHWEINEN, DIE MIT BEZUG AUF DIE FLEISCHQUALITÄT GETESTET WERDEN SOLLEN

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Diese Abhandlung beschreibt die Arbeit, die auf ein standardisiertes Verfahren für die Vorschlachtbehandlung von Schweinen, die mit Bezug auf die Fleischqualität getestet werden sollen, führt.

Das Verfahren ist wie folgt:

1. Mässige Futterung, doch kein Wiegen am Schlachttag
2. Ladung mittels einer hydraulischen Schweinehebevorrichtung
3. Transport ungefahr 40 Minuten in einem speziellen LKW, mit gleitsicherem Boden, Scheidewänden und einer mechanischen Lüftungsanlage versehen
4. Treiben direkt von dem LKW zu dem Betäubungsraum ohne Verwendung von elektrischem Stab oder anderen Gewaltmitteln
5. Elektrische Betäubung am Boden

Dieses System kommt jetzt zur Anwendung für alle Schweine von dänischen Brutprobe-stationen

СТАНДАРТИЗОВАННЫЙ СПОСОБ ОБРАЩЕНИЯ ДО УБОЯ СО СВИНЬЯМИ, МЯСО КОТОРЫХ ДОЛЖНО ПОДВЕРГАТЬСЯ ОЦЕНКЕ КАЧЕСТВА.

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1. Умеренное кормление но без взвешивания в день убоя
2. Погрузка с помощью гидравлического подъёмника
3. Транспорт, приблизительно 40 минут, в специально оборудованных грузовиках с настилом, который предохраняет от скольжения, с перегородками и механической вентиляционной системой
4. Свиней из грузовика непосредственно перегоняют в помещение для оглушения, не применяя при этом электроподгонятель или другие меры принуждения
5. Электрооглушение на полу

Этот способ применяют для всех свиней из датских контрольных племенных станций.

THE STRESS SYNDROME AND MEAT QUALITY

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Introduction

In pig progeny testing work it is very important that any increase in meatiness is not accompanied by a poorer meat quality. As pre-slaughter treatment is known to affect the meat quality pattern shown in stress-prone pigs (Barton, (1971), Scheper, (1971)), it is essential that any breeding programme containing a meat quality estimation also has a standardized pre-slaughter treatment. This paper describes the work leading up to the standardized pre-slaughter treatment now used for all pigs from Danish progeny testing stations.

In all experiments the material consisted of approximately 90 kg live weight Danish Landrace pigs from two of the permanent progeny testing stations, and meat quality was determined the day after slaughter using the longissimus dorsi (lumbar region) and biceps femoris muscles, partly as pH_2 and partly as colour, as described by Barton, (1971). In addition, the pH_2 of the rectus femoris was determined on the whole minced muscle.

The results of the pH_2 and colour measurements are given partly as average values and partly as the percentage of pigs with values deviating from normal. For Danish Landrace, pH_2 values are considered to be higher than normal if they are higher than 5.70 for longissimus dorsi, and 5.90 for biceps femoris and rectus femoris, and colour is considered as deviating from normal if the samples are pale, soft and exudative or if they have higher than normal pH_2 values (generally "beefy" in appearance).

Experiment 1. Influence of transport time on meat quality

In this experiment 403 pigs slaughtered over a 9 week period in April - June were used. The pigs were not fed on the day of slaughter, but they were weighed shortly before loading. After weighing halters were placed on each pig to prevent biting during transport (Wichmann Jørgensen, (1963)). The pigs were then loaded using a hydraulic pig lift onto a special lorry equipped with a non-skid floor and 3 partitions. As far as possible gilts and castrates as well as litter mates were divided evenly between the 4 compartments.

3 transport times were investigated, 1/4 hour, 1 hour and 3 hours, corresponding to an average distance of 10, 37 and 116 km respectively. Each week 2 of the 3 transport times were investigated and 12 pigs were unloaded at the abattoir after each transport time.

The pigs were always driven directly from the lorry to electrical stunning on the floor without using an electric goad or other means of force.

Results

The average results are shown in Table 1 and the percentage of pigs with a meat quality deviating from normal are shown in Table 2.

Table 1. Average results for meat quality

Results showing significant differences with transport time (≥ 99.0% confidence level) are framed.

Transport time	No. of pigs	Longissimus dorsi		Biceps femoris		Rectus femoris
		pH_2	Cured colour	pH_2	Uncured colour	pH_2
1/4 hour	123	5.41	14.8	5.52	17.4	5.70
1 hour	138	5.40	14.0	5.53	16.9	5.72
3 hours	142	5.42	12.9	5.55	15.2	5.79

Table 2. Percentage of pigs with a meat quality deviating from normal

Transport time	No. of pigs	Longissimus dorsi		Biceps femoris		Rectus femoris
		% PSE (subjective)	% DFD $pH_2 \geq 5.7$	% PSE $R_{535} \geq 16.5$	% DFD $pH_2 \geq 5.9$	% DFD $pH_2 \geq 5.9$
1/4 hour	123	44.7	0.8	55.3	0	8.1
1 hour	138	26.8	0	51.3	0	11.1
3 hours	142	11.3	0.7	22.5	1.4	23.8

The colour of the cured longissimus dorsi and uncured biceps femoris muscles became darker as the transport time increased, whereas the pH_2-values remained relatively constant (Table 1). Only the rectus femoris muscle showed any significant increase in pH_2, in that the pH_2 was higher after 3 hours transport than after 1/4 or 1 hour.

The percentage of pigs with pale, soft and exudative (PSE) meat in longissimus dorsi and biceps femoris decreased with longer transport times, whereas the percentage of pigs with dark, firm and dry (DFD) meat in the rectus femoris muscle increased with increasing transport (Table 2). These results were further supported by determinations of the PSE and DFD condition using, respectively, the solubility of the sarcoplasmic and myofibrillar proteins and liver glycogen levels. Protein solubility increased with increasing transport time (the meat became less exudative), whereas liver glycogen levels fell with increasing transport (Buchter, 1971a).

The poor meat quality obtained after the shortest transport time is undoubtedly due to the fact that the pigs were excited by the many different changes over a short time interval. Over the longest transport a large number of the pigs had apparently calmed down and the gentle unloading and driving to the stunning has apparently not been sufficiently demanding to excite them again. However, the results of the pH_2-measurements in the rectus femoris muscle show that a number of the pigs were beginning to show signs of exhaustion after 3 hours transport.

Experiment 2. Influence of treatment on the station, use of halters and transport time on meat quality

In this experiment 185 pigs slaughtered over a 4 week period in October - November were used. The pigs received 1/3 of their ration about 1 hour before loading and they were not weighed on the day of slaughter. They were loaded as before onto the same lorry described in experiment 1. Pigs destined for the 2 centre compartments received halters in the pen before loading.

2 transport times were used, 1/4 hour and 3 hours, so that one compartment of pigs without halters and one with halters were unloaded after each transport time. The pigs were driven as before directly from the lorry to electrical stunning on the floor.

Results

As no significant difference in average values was observed for pigs transported with or without halters, Table 3 shows only the average values for the 2 transport times. Table 4, however, shows the percentage of pigs deviating from normal for all experimental groups.

Table 3. Average values for meat quality

Results showing significant differences with transport time (≥ 99.0% confidence level) are framed.

Transport time	No. of pigs	Longissimus dorsi		Biceps femoris		Rectus femoris
		pH_2	Cured colour	pH_2	Uncured colour	pH_2
1/4 hour	91	5.41	13.0	5.51	16.9	5.68
3 hours	94	5.44	12.7	5.52	15.1	5.73

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Transport time	Halter	No. of pigs	Longissimus dorsi		Biceps femoris		Rectus femoris
			% PSE (subjective)	% DFD $pH_2 \geq 5.7$	% PSE $R_{535} \geq 16.5$	% DFD $pH_2 \geq 5.9$	% DFD $pH_2 \geq 5.9$
1/4 hour	without	45	35.5	0	44.4	0	4.4
	with	46	47.8	0	45.7	0	6.5
Average		91	41.7	0	45.1	0	5.5
3 hours	without	47	2.1	0	17.0	0	10.6
	with	47	8.5	0	21.3	0	8.5
Average		94	5.3	0	19.2	0	9.6

As in experiment 1, the colour of the cured longissimus dorsi and uncured biceps femoris muscles became darker without any large change in pH_2, and the pH_2 in the rectus femoris muscle increased with longer transport (Table 3).

While the percentage of pigs with PSE-meat decreased with longer transport as before, the percentage of pigs with DFD-meat in the rectus femoris muscle did not increase to the same extent as in experiment 1 (Table 4). Results of liver glycogen levels confirmed that even after 3 hours transport the pigs in this experiment still had sufficient liver glycogen to maintain energy reserves in the muscles (Buchter, 1971b). The moderate feeding the pigs received on the day of slaughter is undoubtedly the cause of the lower level of exhaustion of the pigs after 3 hours transport.

Although not statistically significant Table 4 shows that with 3 hours transport especially, the use of halters during transport gave a higher percentage of pigs with PSE-meat, although it did not appear to affect the number of pigs with DFD-meat in the rectus femoris muscle. In general the pigs in this experiment had a slightly better meat quality than in experiment 1, which is probably due to the fact that they were not weighed on the day of slaughter and that only half of them wore halters during transport.

Experiment 3. Influence of driving/stunning on meat quality

In this experiment 275 pigs slaughtered over a 6 week period in January - March were used. The pigs received 1/3 of their ration about 1 hour before loading and they were not weighed on the day of slaughter. The pigs were loaded in the same way onto the same lorry as in the previous experiments and halters were not used during transport.

A transport time of 3 hours was used for the first 3 weeks of the experiment. Each week half the pigs from each load were driven directly from the lorry to electrical

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In this experiment 185 pigs slaughtered over a 4 week period in October - November were used. The pigs received 1/3 of their ration about 1 hour before loading and they were not weighed on the day of slaughter. They were loaded as before onto the same lorry described in experiment 1. Pigs destined for the 2 centre compartments received halters in the pen before loading.

2 transport times were used, 1/4 hour and 3 hours, so that one compartment of pigs without halters and one with halters were unloaded after each transport time. The pigs were driven as before directly from the lorry to electrical stunning on the floor.

Results

As no significant difference in average values was observed for pigs transported with or without halters, Table 3 shows only the average values for the 2 transport times. Table 4, however, shows the percentage of pigs deviating from normal for all experimental groups.

Table 3. Average values for meat quality

Results showing significant differences with transport time (≥ 99.0% confidence level) are framed.

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1/4 hour	without	45	35.5	0	44.4	0	4.4
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3 hours	without	47	2.1	0	17.0	0	10.6
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As in experiment 1, the colour of the cured longissimus dorsi and uncured biceps femoris muscles became darker without any large change in pH_2, and the pH_2 in the rectus femoris muscle increased with longer transport (Table 3).

While the percentage of pigs with PSE-meat decreased with longer transport as before, the percentage of pigs with DFD-meat in the rectus femoris muscle did not increase to the same extent as in experiment 1 (Table 4). Results of liver glycogen levels confirmed that even after 3 hours transport the pigs in this experiment still had sufficient liver glycogen to maintain energy reserves in the muscles (Buchter, 1971b). The moderate feeding the pigs received on the day of slaughter is undoubtedly the cause of the lower level of exhaustion of the pigs after 3 hours transport.

Although not statistically significant Table 4 shows that with 3 hours transport especially, the use of halters during transport gave a higher percentage of pigs with PSE-meat, although it did not appear to affect the number of pigs with DFD-meat in the rectus femoris muscle. In general the pigs in this experiment had a slightly better meat quality than in experiment 1, which is probably due to the fact that they were not weighed on the day of slaughter and that only half of them wore halters during transport.

Experiment 3. Influence of driving/stunning on meat quality

In this experiment 275 pigs slaughtered over a 6 week period in January - March were used. The pigs received 1/3 of their ration about 1 hour before loading and they were not weighed on the day of slaughter. The pigs were loaded in the same way onto the same lorry as in the previous experiments and halters were not used during transport.

A transport time of 3 hours was used for the first 3 weeks of the experiment. Each week half the pigs from each load were driven directly from the lorry to electrical

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stunning on the floor, whereas the other half were driven through a pen, race and restrainer to electrical stunning (station 1) or a pen and race to CO_2-stunning in a tunnel (station 2). No electric goad or other means of force was used for pigs electrically stunned on the floor, while pigs stunned using the other methods all received one shock from the goad immediately before the entrance to the restrainer/CO_2-tunnel.

During the last 3 weeks of the experiment the transport time was reduced to 2 hours and the pigs stunned in the restrainer/CO_2-tunnel were allowed to stand 5-10 minutes in the race before stunning commenced.

Results

The average results are shown in Table 5 and the percentage of pigs with a meat quality deviating from normal are shown in Table 6.

Table 5. Average values for meat quality

Results showing significant differences between stunning/driving forms (>95% confidence level) are framed.

Transport time	Station	Stunning	No. of pigs	Longissimus dorsi		Biceps femoris		Rectus femoris
				pH_2	Cured colour	pH_2	Uncured colour	pH_2
2 hours	1	El-floor	40	5.45	12.2	5.63	14.6	5.92
		El-restrainer	38	5.48	11.8	5.64	15.1	5.99
	2	El-floor	32	5.47	12.2	5.64	13.8	5.80
		CO_2	34	5.46	12.6	5.68	14.1	5.91
3 hours	1	El-floor	32	5.46	12.8	5.64	14.4	5.91
		El-restrainer	33	5.45	12.5	5.63	14.9	5.93
	2	El-floor	33	5.50	12.6	5.71	13.3	5.89
		CO_2	33	5.49	12.1	5.81	12.9	6.01

Table 6. Percentage of pigs with a meat quality deviating from normal

Transport time	Station	Stunning	No. of pigs	Longissimus dorsi		Biceps femoris		Rectus femoris
				% PSE (subjective)	% DFD $pH_2 \geq 5.7$	% PSE $R_{535} \geq 16.5$	% DFD $pH_2 \geq 5.9$	% DFD $pH_2 \geq 5.9$
2 hours	1	El-floor	40	2.5	0	17.5	0	40.0
		El-restrainer	38	13.2	0	18.4	5.3	55.3
	2	El-floor	32	9.4	0	3.1	0	25.0
		CO_2	34	5.9	0	11.8	2.9	41.2
3 hours	1	El-floor	32	6.3	0	12.5	3.1	46.9
		El-restrainer	33	9.1	0	15.2	0	45.5
	2	El-floor	33	3.0	3.0	0	12.1	39.4
		CO_2	33	6.1	0	3.0	15.2	66.7

For pigs with 2 hours transport only the pH_2 in the rectus femoris muscle showed any significant difference with type of stunning/driving, in that pigs driven through a pen, race and restrainer/CO_2-tunnel had a higher pH_2 compared to pigs driven directly to electrical stunning on the floor (Table 5). The same effect was also present in pigs transported 3 hours, but in addition, the colour of the cured longissimus dorsi muscle was darker. In pigs stunned via the CO_2-tunnel (but not the restrainer) the pH_2 in the biceps femoris muscle was higher than in pigs driven directly to electrical stunning on the floor.

The percentage of pigs with PSE-meat in the longissimus dorsi and biceps femoris muscles was slightly higher for driving to stunning in a restrainer/CO_2-tunnel, whereas the percentage of pigs with DFD-meat in the rectus femoris muscle was considerably higher, especially for pigs stunned in a CO_2-tunnel (Table 6). These results show that driving pigs through pens, races and restrainers/CO_2-tunnels causes a greater degree of exhaustion and exitation than driving directly to electrical stunning on the floor.

Only the colour of the uncured biceps femoris muscle showed any difference with transport time, in that the colour was darkest after 3 hours transport (99% confidence level) (Table 5). However, the percentage of pigs with PSE-meat in longissimus dorsi and biceps femoris was highest after 2 hours transport, while the percentage of pigs with DFD-meat in the rectus femoris muscle was highest after 3 hours transport, confirming the trends seen in the previous experiments.

It is surprising that a waiting period in the race before stunning in a restrainer/CO_2-tunnel did not cause a greater increase in the number of pigs with PSE-meat with 2 hours transport, as this treatment was undoubtedly more stressful. However, the generally higher pH_2-values and darker colour in pigs transported 3 hours with electrical stunning on the floor in this experiment compared to pigs with the corresponding treatment in experiment 2 point to a higher level of exhaustion in this experiment 3 (confirmed incidentally by lower liver glycogen levels (Buchter, 1972)). This higher level of exhaustion was most likely due to the weather conditions during transport. The weather varied from freezing fog at just above 0°C to blizzard conditions at -10°C, whereas in experiment 2 it was considerably milder, varying from 3°C, sunny to 13°C, rain. Even pigs transported 2 hours were thus comparatively exhausted on arrival at the abattoir, so that even after a stressful treatment they were unable to show PSE-meat.

Discussion

These experiments show the overwhelming importance of transport time, i.e., time from leaving the station to stunning, on the meat quality pattern in stress-prone pigs. Over the shortest time the pigs showing a meat quality deviating from normal were mainly PSE with normal pH_2-values, whereas with increasing transport times, i.e., increasing exhaustion, the pigs were unable to manifest the PSE-condition but instead showed DFD-meat, especially in the rectus femoris muscle. That the PSE-condition and DFD-condition are related has been shown previously by among others (Sybesma (1968)).

It is always possible to exhaust a pig even when it is not stress-prone by choosing an appropriate (prolonged) pre-slaughter treatment, so that it is necessary when measuring a pig's heritable disposition for poor meat quality to choose a pre-slaughter treatment, which ensures that the pig arrives at the stunning pen as little exhausted as possible. In this way stress-prone pigs will generally show PSE-meat and normal or low pH_2-values after slaughter, while stress-resistant pigs will show good meat quality.

The present work shows that longer transport times, lack of feeding on the day of slaughter, driving through pens and mechanical systems to stunning in a restrainer/CO_2-tunnel as well as very cold weather during transport all lead to increasing exhaustion in the pig.

Taking the above factors into account as well as the fact that the chosen treatment must be able to be carried out for all Danish progeny testing stations, the following pre-slaughter treatment was chosen for pigs to be tested for meat quality:

Station: moderate feeding but no weighing on the day of slaughter.

Loading: using a hydraulic pig lift.

Transport: transport for approximately 40 minutes (the minimum time which can be used for all stations) in a lorry equipped as described in these experiments. In cold weather the open vents at the front of the trailer are closed; in warm weather the mechanical ventilation system is used.

Unloading: driving directly from the lorry to the stunning pen without using an electric goad or other means of force.

Stunning: electrical stunning on the floor.

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References

1. BARTON, P.A., (1971): Some experience on the effect of pre-slaughter treatment on meat quality of pigs with low stress-resistance. 2nd International Symposium on Condition and Meat Quality in Pigs, 22-24 March, Zeist, The Netherlands.
2. BUCHTER, L., (1971a, 1971b and 1972): Internal reports of the Danish Meat Research Institute.
3. SCHEPER, J., (1971): Research to determine the limits of normal and aberrant meat quality (PSE and DFD) in pork. 2nd International Symposium on Condition and Meat Quality in Pigs, 22-24 March, Zeist, The Netherlands.
4. SYBESMA, W., (1968): Some remarks on the relation between 2 different meat quality types. International Symposium on Meat Quality 6-10 May, Zeist, The Netherlands.
5. WICHMANN-JØRGENSEN, T., (1963): Some Observations of Pig Behaviour with Special Reference to Pre-slaughter Treatment. 9th Conference of Meat Research Workers, Budapest.

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