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A novel transport system (*TRANSUS*) for slaughter pigs

Key external stakeholders:

Animal hauliers/transport companies, slaughter plants, pigmeat processors, pig producers, consumers, policy makers

Practical implications for stakeholders:

- This project has shown that there is potential in the pig industry for developing alternative methods for transporting slaughter pigs
- Alternatives to conventional transportation methods such as TRANSUS have the potential to streamline the pre-slaughter handling of pigs thereby offering potential improvements to pig welfare and meat quality
- Under current conditions alternatives such as TRANSUS are more likely to be of interest to processors rather than pig producers or hauliers because of the initially higher costs associated with such a system

Main results:

- In TRANSUS pigs can be kept in small, familiar social groups without the need for re-mixing and thereby avoiding the associated aggression and social stress which has negative implications for pig welfare and for meat quality
- There was no detrimental impact on pig behaviour, welfare or meat quality of transporting in TRANSUS compared to conventional methods
- Using the TRANSUS prototype, loading and unloading pigs took longer than with conventional methods
- Nevertheless, refinements to the design and in the methods used to load/unload the containers could help to realise the potential for use of containers such as TRANSUS in the transportation of pigs to slaughter

Opportunity / Benefit:

This project tested a prototype container TRANSUS which proved satisfactory when compared to conventional transport. Improvements to the design of the container and to the method of loading/unloading are required. There are opportunities for companies to further the development of this concept for transportation of slaughter pigs. This method of transporting pigs offers an opportunity to improve pig welfare prior to slaughter and consequently to improve meat quality. This offers benefits to the producer who could use the concept to brand his pig meat and to the processor in terms of securing markets. Individual producers selling high value breeding stock may wish to adopt this concept to reduce stresses associated with handling during transport.

Collaborating Institutions:

Research partners

Danish Meat Research Institute (DMRI), Roskilde, Denmark
The Mechanical Engineering Group of the University of Cantabria (UC), Santander, Spain
Lightweight Structures, The Netherlands
Re/gent, The Netherlands

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1. Project background:

There is considerable concern about the effects of transport and associated handling on the welfare of animals. Consumers are now demanding better treatment of animals in the whole production chain including transport. The transport distance of pigs by road from a farm to the slaughterhouse is expanding because of the economic opportunities for long distance and international trade, improved infrastructure and increased demand for live animals for fattening and slaughtering. Within the EU, free movement of animals from one Member State to another and more uniformity in slaughter weight and quality requirements has resulted in more long distance travel to slaughter. Regulations to protect animals during transport are laid down in Council Regulation 1/2005[1] and in national legislation. A large variety of factors have been found to increase the stress levels experienced by the pig during the journey to slaughter, in particular: (a) rough treatment by staff during loading and unloading; (b) changing the pig's known and secure environment; (c) weather conditions (temperature, air velocity, humidity) during the journey; (d) the fitness of the pig; (e) unexpected truck movements during the journey; (f) mixing of pigs from different groups; (g) duration of the trip and (h) overloading of pigs on the trailer.

Using containerised transportation methods, the following advantages should be achievable:

1. Loading and unloading of individual pigs can be done offline.
2. The pigs can be brought into the transport container in sufficient time *prior to* transport so they can get used to the new environment, thus reducing stress levels in the animal.
3. Hygiene in the sector will improve because cleaning of empty containers can be done offline, and the standardisation makes it possible to develop dedicated cleaning tools and equipment.
4. The containers can be designed in a modular way, allowing optimised designs for expected group sizes, logistic handling at the farm and at the slaughterhouse, and cleaning/disinfection.

Hence, the proposed idea of this project was to develop a revolutionary new concept for the transport of a group of pigs, i.e. to use the concept of standardised container transport. To visualise the proposed concept, the container was to be developed for a small group of pigs (c. 10) of 100kg and to be of a size and weight that it could be handled by a standard forklift truck, and loaded onto a trailer from the side. Where a larger group of pigs is to be transported, a number of these containers can be stacked onto the trailer.

2. Questions addressed by the project:

The overarching goal of TRANSUS was to develop an easy-to-handle transport container that enabled the efficient transport of slaughter pigs from farm to slaughterhouse, taking into account animal welfare and hygiene requirements. The main scientific and technological objectives of TRANSUS were the following:

- To establish a set of parameters, enabling the engineering design of the transport container.
- To develop and manufacture a functional prototype.
- To validate the prototype functionality in terms of mechanics and animal behaviour, welfare and meat quality under real-world transport conditions.

3. The experimental study:

The main objective of Teagasc's role in this project was to evaluate the containerised transportation method (TRANSUS) from the point of view of pig behaviour and welfare and the main objective of DMRI's role in the project was to evaluate TRANSUS from the point of view of pig meat quality. In collaboration with researchers from DMRI we compared the behaviour, welfare and meat quality of pigs transported by two methods, 1) in a conventional two tier lorry and 2) in a modularised container (TRANSUS prototype) carried on the back of a flat deck truck. The study was conducted between Teagasc, Moorepark Research Centre,

1 COUNCIL REGULATION (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97

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Fermoy, Co. Cork and Dawn Pork and Bacon Factory, Grannagh, Co. Waterford in Ireland during March 11th to 16th inclusive and March 19th to 23rd inclusive 2013. The evaluation of pig welfare during transport in the TRANSUS prototype employed a multidisciplinary approach incorporating a wide range of welfare behaviour, physiology, injury and meat quality indicators. These reflected not only the handling associated with TRANSUS (i.e. loading and unloading) but also stress levels in the pigs during transportation in the prototype.

Prior to each transport test day a number of pens of finisher pigs containing between 10 and 14 of either entire male, female or mixed gender pigs were selected. All pigs in these pens were weighed individually and the lightest and heaviest pigs available were removed from the dataset until 48 pigs (24 males and 24 females) remained. These were blocked within gender on the basis of weight and pen of origin and randomly assigned to one of four experimental groups of 12 pigs. Each experimental group was composed of 6 male and 6 female pigs coming from not more than five original home pens. The groups were randomly assigned to one of two transportation treatments: 1) TRANSUS [T, n=2/day] or 2) Conventional [C, n=2/day]. The same procedure was repeated for each of the five test days such that 20 groups of 12 slaughter pigs (240 pigs in total: 120 males and 120 females, mean live weight 97.5 ± 7.09kg) were tested. Four focal pigs were also identified in each test group (80 pigs in total; mean weight: 97.5 ± 9.12kg) based on their relationship to the mean weight of the group. At 0630h on each test day, experimental pigs were removed from their home pen and weighed individually. Skin lesions of focal pigs were scored. The non-focal test pigs were then divided into one of four pre-transport pens labeled T1 (TRANSUS 1), T2 (TRANSUS 2), C1 (Conventional 1) and C2 (Conventional 2) depending on the experimental group to which they'd been assigned. Focal pigs were fitted with heart rate monitors. Once these were fitted, their skin temperature was recorded. Once all the groups were assembled, pigs were left undisturbed in the pre-transport pens for 25 ± 10 minutes prior to loading. Five minutes before the start of loading the skin temperature of the 16 focal pigs was measured again. Thereafter the first group of 12 pigs was moved the short distance to the loading area, where they were loaded either directly into the first TRANSUS box (T1) at ground level or into the upper deck of the conventional lorry by the ramp (C1) depending on the schedule shown below. A protocol for moving the pigs was strictly adhered to so that differences between systems could not be attributed to handling. The same handler was used throughout the experiment, and pig boards were used to herd the animals as rapidly as possible but with the minimum of coercion. Goads were not used. Once the first group was loaded, the second group from the same treatment was loaded. Thereafter, groups 1 and 2 of the 2nd treatment were loaded. During loading and unloading, one person recorded pig behaviour and a second recorded the loading times. During transport pig behaviour and environmental conditions were recorded. Pigs were unloaded at the factory and once HR monitors were removed and skin lesions scored, they were slaughtered immediately. Blood samples were collected at exsanguination for later determination of haematological parameters and during blood collection the blood temperature was measured. Meat quality measures were taken by DMRI personnel in the chill room 45 mins post slaughter and 22 hours later.

4. Main results:

Loading and unloading of TRANSUS pigs took significantly longer than loading/unloading of Conventional pigs (Figure 1). This was because of the necessity to lift the TRANSUS boxes onto the back of the flat deck truck. However, when the time taken to lift the TRANSUS box onto the truck was removed from the data, loading times between TRANSUS and Conventional were similar (Figure 1). It took significantly longer to position the TRANSUS box on the truck than it did to remove the TRANSUS box from the truck.

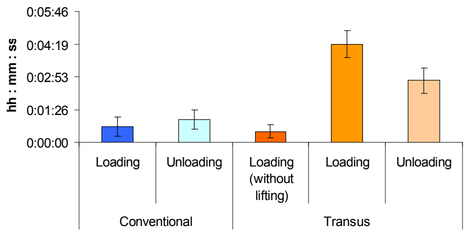

Figure 1 *Loading and unloading times for pigs transported by TRANSUS or Conventional means*

In TRANSUS a maximum of two pigs were observed in a dog sitting position at any one time during transport in four of 10 test groups. In the Conventional treatment six pigs were observed in a dog sitting position simultaneously in one test group and 4 pigs were observed in this position simultaneously in another two test groups during transportation. There was never more than one pig seen lying down in either treatment (in 5 Conventional groups and in three TRANSUS groups).
In the conventional truck more incidences of aggression were seen compared to TRANSUS, however, in

TRANSUS more incidences of mounting and hitting the ceiling were seen compared to the conventional truck. A key difference between both transportation methods was that the ceiling was much lower in TRANSUS (90cm) and this probably influenced these findings for pig behaviour during transportation.
There was no significant effect of treatment on skin temperatures of the focal pigs in the home pens, prior to or post loading ($P>0.05$). The total and front body skin lesion scores of all pigs increased significantly between the pre and post transport measurements ($P<0.05$). This reflected the fighting which occurred at mixing. However, there was no significant effect of treatment on the skin lesion scores ($P>0.05$).
There was a considerable amount of technical difficulties associated with use of the heart rate monitors. There were problems with lost belts and belts loosening and therefore losing the signal. Hence, missing data points meant that statistical analysis could only be conducted during the transport and loading periods. There was no statistical difference between TRANSUS and the conventional transportation treatment in the mean heart rate of focal pigs at these two stages ($P>0.05$). There was no effect of treatment on any of the blood parameters ($P>0.05$) although there tended to be an effect of treatment on glucose with Conventional pigs being slightly higher than TRANSUS pigs (7.29mM *vs.* 6.97mM, s.e.=0.133; $P=0.088$). There was a significant effect of day on albumin, glucose and lactate ($P<0.001$). There was no effect of treatment on blood temperature but there were significant differences between test days ($P<0.001$). There was no treatment effect on carcass weight (overall mean: 74.3 ± 5.87kg [SD]; $P>0.05$) but there was an effect of test day ($P<0.001$). There was no interaction between treatment and test day ($P>0.05$). There was a weak tendency for an effect of treatment on lean meat percentage (overall mean: 58.7 ± 1.77 [SD] %; $P=0.096$) as well as a significant test day effect ($P<0.05$). There was no effect of treatment or day on kill out % (overall mean: 49.2 ± 4.06 [SD] %; $P>0.05$). There was a significant effect of treatment on fat percentage (overall mean: 10.4 ± 1.94 [SD] %; $P<0.05$) and a tendency for an effect of test day ($P=0.068$).
In the cold storage room, the temperature at the region of the loin centre ranged from 6.0 to 6.3^{o}C while the temperature at the region of the centre of the hams ranged from 5.3 to 5.6^{o}C.
There was no effect of treatment on the temperature of the longissimuss dorsi 40 minutes after exsanguination ($P>0.05$). However, there was a significant effect of test day and an interaction (not shown) between treatment and test day ($P<0.001$). There was a significant effect of test day on the pH of the longissimuss dorsi 40 minutes post slaughter ($P<0.05$) but no effect of treatment ($P>0.05$).

pH 22 hours post slaughter

There was a significant effect of test day on the pH of the longissimuss dorsi 22 hours post slaughter and an interactive effect ($P<0.01$, data not shown) but no effect of treatment ($P>0.05$). There was a significant effect of treatment, day and an interaction between treatment and day ($P<0.05$, data not shown) on the pH of the semimembranosus 22 hours post slaughter. Conventionally transported pigs had higher values for this measure compared to TRANSUS pigs. However, in the absence of any other differences in physiological/meat quality measurements, it is difficult to suggest a biologically plausible explanation for this difference.
There was no effect of treatment on drip loss (C: 2.41 *vs.* T: 2.24 s.e. 0.259; $P>0.05$). However, there was a significant effect of position on the truck ($P<0.01$) and sex (Male: 2.75 *vs.* Female: 1.82, s.e. 0.283; $P<0.001$).

5. Opportunity/Benefit:

Butina is a moderate to large company which was given special dispensation by the EC to be involved in the project as an SME. Butina manufactures equipment/machinery for use in pig slaughter plants and they may be interested in carrying the concept forwards to develop it commercially. This research was for the benefit of SMEs and so the information is readily available to all the SMEs which were involved, to use as they see fit to develop the concept.

6. Dissemination:

Main publications:

Reports produced as per deliverable requirements for **TRANSUS – 262312 (Research for SMEs): A Novel Transport System for Slaughter Pigs.**

Boyle, L.A., Lykke, L. and Blaabjerg, L. 2011. Deliverable No: D2.1: Pig and Technology Research - Literature review. 61 pgs.
Boyle, L.A., D., Lykke, L. and Blaabjerg, L. 2013. Deliverable No: D2.1: Pig and Technology Research - Welfare requirements. 14pgs.
Boyle, L.A., Lemos Teixeira, D., Lykke, L. and Blaabjerg, L. 2013. Deliverable No: D4.3 Pig welfare, behaviour and meat quality test report. 51 pgs.

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