1. Introduction

Animal Sciences Group

The Animal Sciences Group of Wageningen University & Research Centre offers research, education and expertise on livestock, fish and companion animals. Our work is concerned with sustainable methods for food production, sound ecological management of landscape, nature and sea and the social functions that animals fulfil. With a workforce of 1100 and the potential to carry out high quality technological research in our well-equipped facilities, we develop the knowledge of today for the solutions of tomorrow.

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A study at the Faculty of Veterinary Medicine of the University of Utrecht was finished in 1976. The veterinary practice and meat inspection was performed. From 1979 on, research in animal science was done at the DLO - Institute for Animal Production in Zeist and, at present, at the Animal Sciences Group of the Wageningen University and Research Centres, Division Nutrition and Food in Lelystad.

The PhD was received in 1981. The thesis was entitled “Some neural and physiological aspects of electrical and mechanical stunning in ruminants”. Afterwards research in the fields of euthanasia, stunning, transport, electronic identification, muscle physiology and meat quality in ruminants, pigs, fur animals, poultry and fish was performed. The main research interests are handling and animal welfare of animals before slaughter and effects on product quality. Moreover the group “Meat quality aspects” is leading.

Road transport

Nowadays transport distance of farm animals by road to another farm or 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 has resulted in more long distance travel to slaughter. Regulations to protect animals during transport are laid down in an EC-Council directive (1991) and in governmental legislation. Consumers are now demanding better treatment of animals in the whole production chain including transport. The conditions during transport and the welfare of transported animals are more and more the subject of discussion.

2. Behaviour and physiology

Welfare

Transport and associated handling always have some adverse affects on the welfare of pigs. Adverse effects are related to psychological, physical, environmental, metabolic and treatment factors (Figure 1). Indicators of poor welfare include behavioural responses indicative of coping ability. Where control systems are overtaxed the term stress is used. A well known disease related to transport is the Porcine Stress Syndrome (PSS). This syndrome is the acute reaction to stress, mediated by the sympathetic nervous system, which can cause severe distress and even death. More over pigs have a relative small heart, weak bones and heavy musculature. The affected animal show severe signs of dispnoea, cyanosis and hyperthermia and may develop rigor in the muscles before death occurs. The death rate is between 0.1% and 1.0% equally in piglets, slaughter pigs and sows, where the highest values occur during short transports. There is no reason to make a difference between breeding and slaughter animals, because welfare and health need to be at the same level for both groups of animals. Both groups represent a special economic worth, which cannot determine the level of welfare. The regulations and directives do not distinguish between breeding and slaughter animals.

During road transport weather conditions (temperature, air velocity, humidity) loading density and duration of the trip are important factors, which influence the condition of the animals.
Figure 1: Factors that affect stress, meat quality and contamination

Individual pigs respond in different ways to stress factors. The response is dependent on the genotype, coping ability, treatment and experience of the animal. Coping style may correlate with response to transport and associated conditions. Transport conditions involve exposure to social stress (e.g. mixing with unfamiliar pigs) and non-social stress (rough handling).

Thermo regulation
The variation in temperatures encountered by the pigs during transport may increase up to approximately 20°C. This variation in temperature within the vehicle is related to variation in temperature outside. Therefore ventilation rate during transport should be adapted to the inside temperature which is the resultant of heat flowing from outside to inside and heat produced by the animals. Data of heat production at climatic conditions that occur during transports of slaughter pigs are not known. Little quantitative information is available on thermal thresholds during transport.

Meat Quality
During loading and unloading transport injuries and bruising occur in all animal species. These defects occur by forceful contacts in passageways, in compartments and in containers, by fighting between animals and mounting. Skin blemish is a serious commercial problem. The skin blemish score reflects the amount of fighting which pigs have indulged in preslaughter. It is observed that 63% of 5484 carcasses from pigs in the EU had some damage and in about 10% of carcasses was this moderate to severe after a short transport (< 4 hrs). Loss of live and carcass weight are the result of excretion, evaporation and respiratory exchange, which is a normal physiological reaction. On long trips of 2 or 3 days pigs are exposed to wide variations in weather conditions. In general, live weight losses during transport of 1 or 2 days are 40 to 60 g/kg. It is assumed that stress before slaughter leads to a greater decrease in the energy store. In pigs this results in pale, soft and exudative (PSE) meat after a short stress period and in dark, firm and dry (DFD) meat after exhaustion at slaughter.

Contamination
It is thought that after high physical and psychological labour in clinically healthy animals carrying Salmonella and other pathogenic micro-organisms, the excretion pattern from the intestinal tract may be changed from intermittent to constant shedding. This disturbance may also lower the immunological response and facilitate the spreading of intestinal bacteria. Feeding, environmental conditions during transport and lairage, including the total time involved and mixing animals from several herds, have been shown to be the main factors.
The mechanism of spreading micro-organisms by stressed carrier animals is not clear. However, it is known that preslaughter conditions affect the contamination rate of the product after slaughter.

3. Treatment during transport

Loading and unloading
Transport causes physical and behavioural problems, because the animals are not accustomed to transport conditions and procedures. The loading procedures, the design of the facilities and the other animals are unfamiliar to the animals and will frighten them. The drivers may not treat the animals in a proper way to minimise stress and sometimes animals are mixed or regrouped thus increasing stress and resulting in fighting amongst the animals to determine social order (Figure 1).

Climbing a loading ramp is easy for horses, cattle and sheep when ramp design and handling procedures are good. For pigs climbing a loading ramp is difficult since the situation is often psychologically disturbing. The animals may simply refuse to try and even turn their sides towards the ramps. As a result the heart rate may increase to a level where the heart starts to loose synchronisation. The angle of the loading-ramp should not be greater than 15-20°. Descending a loading ramp steeper than 20° is difficult for all animals and should be avoided.

Feeding and watering
Animals should be fit for the intended journey irrespective of the purpose of the journey. Pigs are likely to suffer motion sickness during road transport, which may result in vomiting after eating 4 hours before transport. For this reason pigs require careful preparation before transport and comprehensive plans for the journey should be made. This means that pigs feed should be withheld for at least 12 hours before slaughter. Depending on the transport distance they can be fed with a thin porridge consisting of one part feed (high sugar content) and three parts water in the transit station or even better on the vehicle to reduce weight loss.

During stops in transport of long duration piglets were observed to drink from bite nipples. Observations of slaughter pigs during such journeys showed that pigs drank only 1.6 litres water per pig when available via bite nipples during motion or in a trough after unloading. When fed at the vehicle they will drink more than 5 l.

The stress of handling, transport and fasting lowered blood sugar level, however, additional energy was obtained from fat break down, which started 9 hours after feed withdrawal. It is recommended that pigs should be given feeding and watering freely throughout the transport or after 20 hrs during a 9 hr rest stop.

Loading density
Animals must be able to stand in their natural position and all must be able to lie down at the same time. For animals, which may stand during the journey, the roof must be well above the heads of all animals when they are standing with their heads up in a natural position. This height will ensure adequate freedom of movement and ventilation and will depend on the age and breed concerned. The activities of the pigs are influenced by the loading density. At a loading density of 235 kg/m² all slaughter pigs have just room to lie down and it takes 3 to 4 hours for all of them to lie down. When the loading density is higher than 235 kg/m² not all pigs are able to lie down, hence there is a continual changing of positions and the pigs cannot rest. The consequences are more skin blemishes, rectal prolapses and a bad meat quality. There is a risk of more skin blemishes at lower densities. A loading density for slaughter pigs of 235 kg/m² is suggested to be accepted as a compromise between animal welfare, meat quality and economics of transport. The loading densities for different weight groups and species are presented in Table 1.

Table 1: Loading densities recommended by the EC-working group (1992).

<table>
<thead>
<tr>
<th>Category</th>
<th>kg live weight</th>
<th>m²/animal</th>
<th>animals/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piglets</td>
<td>&lt;25</td>
<td>0.15</td>
<td>6.60</td>
</tr>
<tr>
<td>Feeder pigs</td>
<td>60</td>
<td>0.35</td>
<td>2.80</td>
</tr>
<tr>
<td>Slaughter pigs</td>
<td>100</td>
<td>0.42</td>
<td>2.35</td>
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<tr>
<td>Heavy pigs</td>
<td>120</td>
<td>0.51</td>
<td>1.96</td>
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Microclimate
The effect of climatic conditions is difficult to measure. The weather conditions are dependent of the location, the time of the day and the season. Experiments in climate controlled calorimeters showed that the lowest heat...
production ante mortem and best meat quality post mortem in pigs occurred at an environmental temperature of 16°C and an air velocity of 0.2 m/s.
The most common method of ventilating compartments and containers is via vents positioned at the upper part of the left and right sides. During the journey the correlation between the outside and inside temperature was positive and significant but for humidity this was not the case. The temperature during stops increased with 1 to 4°C in the compartments. Placing covers at the holes, which can be opened or closed, can vary the ventilation. In pigs this variable ventilation is used in many vehicles.
Artificial ventilation in compartments and containers may improve conditions during transport. At the moment different ventilation systems for pigs are in development.

4. What need to be done

Conclusion
Problems during transport of farm animals may be the result of low robustness of the animal, inexperience and unfamiliarity of the animal, mixing of animals of different origin and the treatment by the drivers during loading and unloading. A decrease of the present set limit (24 hours) for the maximum duration of transport will not solve these problems. Information of the farmer, education of drivers and the set up of an adequate and rigid control system both performed by the transport organisations as well by the government will help to improve the welfare of the animals during transport.

Authority
Inspectors and authorities appointed under the National act or of the EU can obtain possession of an animal where the inspector believes that an offence is being or has been committed in respect of that animal. A problem is that authorities are not well trained and the frequency of audits is very low.

Model code
A strategy that has been related to success in meat business is the delivery of high quality products. Animal welfare and hygiene belong to the total quality management of a production chain. The total quality management should be documented in a “Good Management Practise Code”. This code is intended as a guide for people who are involved in transporting pigs within the European Union. The code emphasises the responsibilities of the owner of the animals, drivers, attendants and authorities. Ignorance is no excuse for the inappropriate handling of animals. Employers have an obligation to train employees in proper handling of animals, use of equipment and care of livestock.
Quality should be the leading key in transport:
Equipment (model code)
Education (cause, including test)
Control (veteran and ethical audit)