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Mette S. Herskin, Isa Kernberger-Fischer and Lysanne van Bijnen-Hendrikx

info.pigs@eurcaw.eu

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Animal welfare and pre-transport fasting of pigs - Short review

Mette S. Herskin[1], Isa Kernberger-Fischer[2] and Lysanne van Bijnen-Hendrikx[3]

[1] *Aarhus University, Denmark*
[2] *Friedrich-Loeffler-Institute, Germany*
[3] *Wageningen Livestock Research, The Netherlands*

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This short review provides a detailed background on the issue of 'pre-transport fasting', including current knowledge on effects of pre-transport fasting, that may be relevant to animal welfare, such as aggression, ease of handling, mortality, susceptibility to heat stress, motion sickness and hunger.

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1 Background and aim

Typically, pigs sent to slaughter are fasted prior to transport so that the gastrointestinal tract is easier to remove at slaughter. Another consequence of the fasted pigs is that transport vehicles are less contaminated with faeces and urine (EFSA AHAW Panel, 2020). In addition, avoiding that pigs have full stomachs during transport may also have welfare benefits (EFSA AHAW Panel, 2022a), although these are not well documented by scientific studies. At the same time, pre-transport fasting may also have negative welfare consequences including hunger, depending on the inter-feeding interval (EFSA AHAW Panel, 2022a).

The EURCAW-Pigs team did not identify any requirements or regulations on national or EU level regarding pre-transport fasting periods, for example from Competent Authorities in EU Member States (MSs), quality assurance companies or animal welfare labels. However, industry requirements for pre-slaughter fasting were identified (e.g., in Denmark). For pigs transported for reasons other than slaughter (e.g., for further breeding or finishing) no guidelines were identified at all. Irrespectively of the reason for transport of pigs, farmers may load their pigs fasted to save feed and to reduce the need for post-transport cleaning of transport vehicles. If pigs are transported in the early hours of the morning, one typical approach might be to turn off the feeding system the night before. Conversely, lack of appropriate pick-up facilities (sometimes called shipping rooms), or concern about body weight loss, may be arguments for farmers not to fast their pigs before transport. To the best of our knowledge, no quantitative data are available on the practice of European pig farmers and/or European pig transporters with respect to fasting incidence, duration or the reasons for choosing a certain practice.

In some MSs animal welfare labels are widely used, and may have stricter requirements than national or international regulations. These often have some requirements for the transport of pigs, such as shorter maximum transport duration, the use of climate controlled air-conditioned vehicles and a ban on sloping loading ramps. Despite the possible welfare consequences of pre-transport fasting, no requirements regarding fasting are included.

Table 1 provides an overview of the categories of pigs that are typically transported in the EU as well as the purpose of the transport.

Table 1. Overview of the typical categories of pigs including their body weight and the purpose of their transport.

Pig category	Purpose of transport
Newly weaned (<10 kg)	Transported between production sites for further growth
'Spanferkel' (approx. 10 to 30 kg)	Transported to slaughter, for special meat products
Weaners (around 30 kg)	Transported between production sites for further growth
Finishers (110-120 kg)	Transported to slaughter
Heavy finishers (160-170 kg)	Transported to slaughter
Sows (180-220 kg or more)	Transported to slaughter
Boars (220-250 kg or more)	Transported to slaughter

Aim

The aim of this EURCAW-Pigs review is to provide a detailed background on the issue of 'pre-transport fasting', including current knowledge on effects of pre-transport fasting, that may be relevant to animal welfare, such as aggression, ease of handling, mortality, susceptibility to heat stress, motion sickness and hunger.

Almost all of the available knowledge is based on finisher pigs. In the final part of this review, specific knowledge will be presented for young pigs that are sent to slaughter, while typically weighing from 10-30 kg. These animals may potentially be more vulnerable to transport and to pre-transport fasting than older pigs, but have been the subjects of very limited scientific focus.

2 Carcass and body weight changes in fasted pigs

After a meal, it takes 4-8 hours for the feed content to be absorbed in the pig's small intestine, and the majority of the nutrients do not enter the circulation until about 9 hours after a meal (Kephart and Mills, 2005). This means that the feed intake of pigs during the last approximately 10 hours before slaughter does not end up as carcass gain (Faucitano et al., 2006).

When fasted, finisher pigs can lose up to 5% of their body weight during the first 24 hours of fasting, which corresponds to a weight loss rate of approximately 0.2% per hour (Warriss et al., 1998), but probably not in a linear fashion (Panella-Riera et al., 2012). However, the majority of this loss has been described as gut and bladder emptying and is therefore not carcass loss as such (Faucitano et al., 2006). Nevertheless, as

mentioned by Faucitano and Nannoni (2023), the timing of gastric emptying depends on the digestibility of the feed.

According to Warriss et al. (1998), carcass and liver weight loss, reflecting the loss of body reserves, begins 9-18 hours after the last meal. Liver weight loss is associated with a reduction in liver glycogen content. This follows a logarithmic pattern (Warriss and Bevis, 1987), so that very little remains after 24 h, with more than 66% lost in the first 12 hours. According to Warriss et al. (1998), it is likely that pigs are feeling very hungry at this time.

In line with the above, Fernandez et al. (1995) subjected pigs of approximately 100 kg body weight to either 0 or 24 hours of fasting, after which the animals were introduced to a novel pig in a novel environment for 30 minutes. The fasted pigs responded with an increased incidence of submissive behaviours and changes in their plasma glucose concentration, meaning that they were more dependent on their endogenous energy reserves (muscle glycogen). The authors interpreted the behavioural and physiological findings in the fasted pigs as signs of fatigue.

In their meta-analysis, Salmi et al. (2012) examined effects of duration of fasting before slaughter and duration of transport and lairage on measures of pork quality in papers published between 1985 and 2010. The authors reported a positive relation between the duration of fasting and the post-mortem pH in pig muscles. In a study comparing pigs fasted for either 0 or 12 hours prior to transport, Panella-Riera et al. (2012) highlighted that if the pre-transport fasting period is too long, pigs may lack the energy required to successfully withstand transport and lairage.

Based on studies of carcass yield, pork quality and safety, Faucitano et al. (2010) suggested that an interval of approximately 24 hours between the last meal and slaughter is beneficial. Observations of polydipsia in pigs in lairage (Brown et al., 1999; Saucier et al., 2007), even after 12 hours of pre-transport fasting, however, have been interpreted as a sign of hunger-induced excessive drinking leading to water-filled intestines at the slaughter line and associated problems. Based on these findings, Faucitano et al. (2010) concluded that fasting involves a conflict between animal welfare and food safety objectives.

Since pigs with *ad libitum* access to feed will eat limited amounts during the night (Bus et al., 2023) (Figure 2.1), departure early in the morning combined with a journey of at least 4 hours (including lairage) means that the stomachs will still be quite empty at the time of slaughter, even though no fasting as such has been applied.

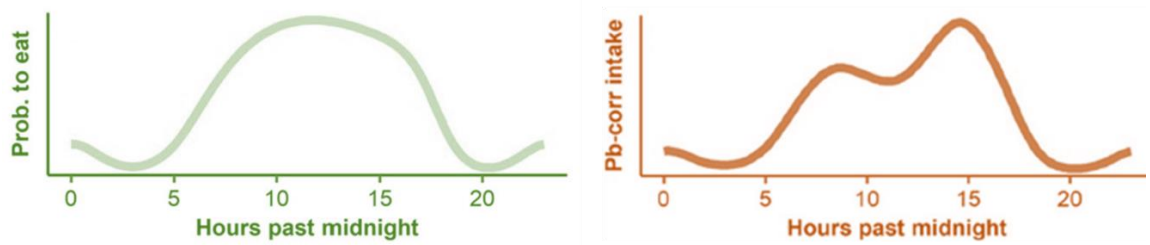

Figure 2.1. Estimates of the probability for growing pigs (average for 30 kg to > 100 kg) to eat during 24 h as well as their feed intake. Modified from Bus et al. (2023)

3 Effects of fasting on aggression and ease of handling

In a study where finishers were fasted for either 0 or 12 hours prior to transport, Panella-Riera et al. (2012) observed an increased tendency for the latter group to have an increased occurrence of skin lesions at slaughter, presumably as a result of an increased level of aggression (as reviewed by Faucitano, 2018). Similarly, Sterten et al. (2009) examined aggression-induced skin lesions in finishing pigs fasted for different durations and observed an increased occurrence of lesions in pigs fasted for 18 or 26 hours compared to pigs fasted for 4 hours. Brown et al. (1999) compared the level of aggression and skin lesions in finishers fasted for 1, 12 or 18 hours prior to transport and observed the lowest level of skin damage in the pigs fasted for 1 hour. In addition, the highest level of aggression was observed in the pigs fasted for 18 hours, while pigs fasted for 12 hours were intermediate. In a Canadian study, Murray et al. (2001) observed an increased level of skin lesions after transport in finishers fasted for 15 hours compared to non-fasted animals.

Above, we mentioned the results from Fernandez et al. (1995), reporting that fasted pigs responded with an increased incidence of submissive behaviour, which, together with changes in their concentration of plasma glucose, were interpreted as signs of fatigue. This may seem contradictory to the above findings on aggression. There are several possible explanations for this. One possible explanation might be that the physical condition of the fasted pigs leads to changes in motivational priorities. This has been suggested recently by Kobek-Kjeldager et al. (2023) in a study on transport of cull sows, where the sows prioritized resting on a cold floor over drinking after long journeys. Further studies are, however, needed to clarify relations between aggressive motivation, aggressive behaviour and fasting in pigs during transport.

Fasting not only affects the level of aggression and the consequent occurrence of skin lesions, but may also reduce the ease of handling of pigs (Acevedo-Giraldo et al., 2020; Dalla Costa et al., 2016). However, there are also data suggesting that pigs fasted for 18 hours were less aggressive than non-fasted pigs during post-transport lairage (Dalla Costa et al., 2016), as well as studies reporting no physiological stress responses after handling of pigs with full stomachs compared to fasted pigs (Faucitano et al., 2006). Importantly, the available data on the effects of pre-transport fasting on pig behaviour and welfare are all from studies of finishers. Whether there are effects of fasting on, for example, aggression in weaners or in cull sows – the latter often lactating at the time of transport and therefore accustomed to a high feeding level (Thodberg et al., 2019) – is not known.

4 Effects of pre-transport fasting on the risk of heat stress and mortality during transport

Survey studies have reported an increased risk of in-transit mortality in pigs that were not fasted prior to transport e.g., Averós et al. (2008) reviewed data from 739 European journeys of weaner pigs and suggested that the mortality rate of unfasted pigs increased with journeys of up to 8 hours. It is thought that death in unfasted pigs results from the pressure of a full stomach on the vena cava (the main vein that carries deoxygenated blood back to the heart), reducing its diameter and the efficiency of blood flow (Warriss, 1994). However, as reviewed by Zurbrigg et al. (2017), the use of survey type studies means that the fasting per se may not be the causal factor in mortality as this management tool is most likely confounded by other pre-

slaughter management, such as the method of pig sorting. The physiological mechanism of why fasting can reduce transport mortality is not well understood (as discussed by Zurbrigg et al. (2017)).

In another study, Peterson et al. (2017) described an increased risk of hyperthermia in non-fasted pigs compared to fasted animals, which the authors explained by ongoing digestion. Whether increased risk of heat stress as a consequence of transporting pigs with full stomachs may contribute to the reported increased mortality risk is not clear.

Taken together, the available information on relationships between risk of death during transport, hyperthermia and lack of fasting is limited and often based more on correlations rather than studies of causality. Further studies are needed to clarify this.

5 Effect of pre-transport fasting on the development of hunger in pigs during transport

Within the scientific literature, no agreed definition of hunger exists. Recently, the EFSA AHAW Panel (2022b) defined hunger as 'the animal experiences craving or urgent need for food or a specific nutrient, accompanied by a negative affective state, and eventually leading to a weakened condition as metabolic requirements are not met'. Thus, with definitions such as this one, hunger is considered a negative welfare consequence.

The EFSA AHAW Panel (2022c) evaluated the interval from initiation of fasting to the onset of hunger in pigs. Based on the available literature, it was concluded that after 12 hours, it is likely that pigs experience hunger and that severity of hunger increases with time, potentially leading to weakness and exhaustion. This estimate was made for pigs in general and did not take into account, for example, the high metabolism of cull sows sent to slaughter shortly after weaning of their piglets, or the age or body weight of pigs slaughtered either younger or older than the traditional finisher (typically weighing 110-120 kg with some variation between EU MSs).

Recently, Bus et al. (2023) studied the rhythmicity of eating in grower pigs from approximately 10 weeks of age (average body weight: 27.5) and until close to slaughter weight. As illustrated in Figure 1, the results showed that pigs with *ad libitum* access to feed consumed the majority of their feed intake during daytime. However, the authors reported a large individual variability between pigs, and also that this rhythmicity became more pronounced as the pigs approached slaughter weight.

The experience of gastric emptying does not only affect feeding motivation or hunger. In a study of pigs weaned at 28 days of age and examined approximately 10 days later, Lalles and David (2011) subjected the pigs to three consecutive skipped meals (equivalent to 1.5 day without access to feed), after which the pigs were killed and the gastrointestinal tracts examined. The authors described atrophy of the intestinal mucosa and of villous crypts, as well as altered enzyme activity in the small intestine of the pigs, combined with modulated heat shock proteins, known to be involved in the maintaining of cell integrity and cytoprotection. Thus, for pigs transported for further growth or as breeding animals, fasting may have consequences not only on feeding motivation and hunger but also on the ability to restore intestinal health and production upon arrival.

Furthermore, feed withdrawal prior to transport and slaughter may influence the prevalence of gastric ulcers in pigs (Eisemann et al., 2002, Swaby and Gregory, 2012). However, neither of these studies provided a precise assessment of the effect of feed withdrawal over time, either because the exact fasting times were not known, or because the feed withdrawal time was not significantly associated with the ulcer score found at the time of slaughter, as ulcer score and the prevalence of chronic damage did not depend on the feed withdrawal time.

In summary, over time, fasting in pigs becomes a welfare problem, the severity of which increase with time. Based on various animal-based measures, the interval from last feeding to hunger has been estimated to be around 8-12 hours, but the exact threshold is difficult to characterise, as many factors are likely to be involved (Driessen et al., 2020).

6 Motion sickness in pigs during transport and potential effects of fasting

In some animal species, including humans, transport may lead to motion sickness caused by motion stress (Santurtun and Phillips, 2015). The EFSA AHAW Panel (2022b) defined motion stress as 'an animal experiencing motion sickness, stress and/or fatigue due to the forces exerted as a result of acceleration, braking, stopping, cornering, gear changing, vibrations and uneven road surfaces during transport'.

As reviewed by Valadez Noriega and Miranda de la Lama (2020), animals are exposed to vertical, lateral and horizontal vibrations during transport. Unpaved roads or roads with strong wind currents transmit a greater amount of vibration.

The degree to which motion sickness is a problem during commercial pig transport – in any category of pig – is not known. Bradshaw et al. (1996a) transported finisher pigs at 0.49 m^2/animal for 1.5 hours after a 2.5 h fasting period. The authors travelled with the pigs inside the main body of a vehicle (called a commercial livestock vehicle, but not further described), and observed retching/gagging behaviour and vomiting pigs during transport. The authors suggested that symptoms of motion sickness were sniffing, foaming, chomping, retching and vomiting which seemed to occur sequentially. Interestingly, half of the pigs were mixed on the vehicle and the other half were not, and the signs of motion sickness were only observed among the non-mixed pigs. The authors speculated that mixing may have delayed the onset of motion sickness because the pigs were preoccupied with aggressive interactions. Importantly, the authors had access to accelerometer data from the involved journeys and classified the trips as rough.

In another study, Bradshaw et al. (1996b) investigated effects of road transport on plasma concentrations of lysine vasopressin (LVP) and cortisol in pigs. The results showed that pigs responded more strongly on their first journey and on rougher terrain compared with later journeys and smoother terrain. The experiments involved loading pigs onto a stationary vehicle and taking blood samples every 30 minutes for eight hours. Two days later, the procedure was repeated with a moving vehicle for eight hours. The results showed an increased plasma concentration of LVP between 2 and 4.5 hours of driving, combined with behavioural observations indicating that the pigs experienced motion sickness.

In a follow-up study, Bradshaw et al. (1999) used a commercial livestock lorry (mentioned that it was 17 tons, but type of suspension or the number of decks were not described) and transported 50 finisher pigs for 4.5 hours at a density of 0.49 m^2/pig and an average speed of 49 km/h. The pigs were loaded at 08:00 h in the

morning, after removal of feed from 17:00 h the previous day. Again, an observer was present in the vehicle with the pigs to observe for signs of motion sickness. The results showed that 26% of the pigs vomited or retched during the journey and 50% foamed or chomped. The authors found no relationship between the occurrence of these behavioural signs of motion sickness and the plasma concentrations of cortisol, beta-endorphin or LVP measured at exsanguination.

From the publications mentioned above, no photos were available, and in general very few pictures or videos of pigs showing behavioural signs of motion sickness can be found. The photo in Figure 6.1 was taken from video monitoring of the behaviour of weaners during long distance journeys in a vehicle approved for long distance pig transport in the EU, with air suspension and 4 or 5 decks. The study took place in 2021, and signs of motion sickness were not recorded systematically, but on this occasion foam-like vomit seems to be dripping from the mouth of one of the pigs.

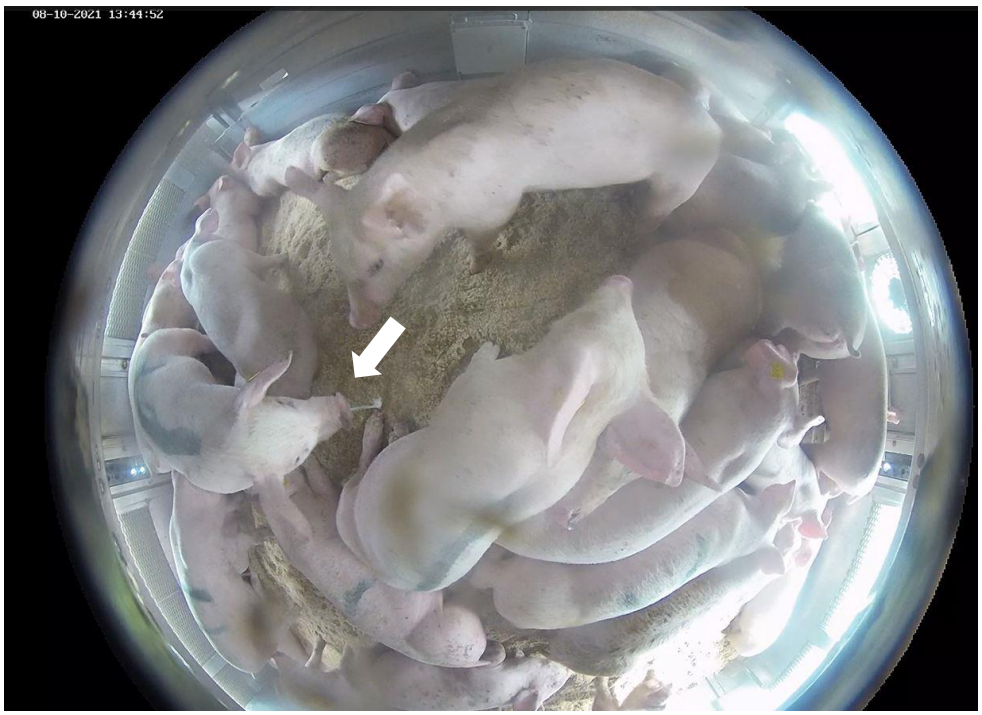

Figure 6.1. Picture of a weaner pig (20-25 kg) that seems to be vomiting during transport. The reason for the vomiting is unknown. The picture was taken in 2021. Photo: Cecilie Kobek-Kjeldager, Aarhus University.

The EFSA AHAW Panel (2022c) listed preventive measures for this welfare hazard, such as planning journeys on motorways, with vehicles equipped with good suspension and driven by experienced and skilled drivers. Vehicle vibration can be reduced by the suspension system, which in the case of lorries, can be either leaf spring or air suspension. Both suspension systems improve vehicle contact with the road surface and indirectly reduce vehicle vibration (Dalla Costa et al., 2017). Randall et al. (1996b) recommended a good air suspension on all axles of the vehicle to reduce vibration. Driessen et al. (2008) examined the effect of vibration on cardiac activity and lying behaviour in 90 finisher pigs that were vertically vibrated in a transport simulator at a frequency of 8 Hz and an acceleration of 3 m/s^2. The effect of vibration increased heart rate. More recently, Morris et al. (2021) collected and interpreted three-dimensional acceleration, temperature and relative humidity data from six locations within commercial transport trailers transporting finisher pigs.

Based on the data collected, the greatest vibration (both horizontal and vertical) occurred in the lower rear compartment, potentially exposing pigs to an uncomfortable transport experience that could lead to discomfort or fatigue.

Previously, pre-transport fasting has been suggested to reduce the likelihood of motion sickness (Bradshaw et al., 1996a; Randall, 1992). However, the scientific evidence for an optimal fasting time in relation to motion sickness is sparse. Warriss et al. (1998) reviewed the available literature, and concluded that the optimal pre-transport fasting interval is unclear, but suggested that, at least for vehicles with poor vibration characteristics or when transported on rough roads, an on-farm fasting period of about 12 hours may be preferable for finishers in terms of in-transit mortality.

Based on the available literature it seems likely that pigs may experience motion sickness during transport. Whether the risk of or the severity of this condition is related to the fact that pigs are fasted (or not) is a gap in knowledge.

7 Specific knowledge on pigs weighing approximately 10-30 kg and transported directly to slaughter

The transport to slaughter of piglets under approximately 30 kg (according to the categorisation of pigs in Germany in accordance with Article 26(3)(1) ViehVerkV) plays a smaller role compared to the transport of finishers to slaughter or the transport of weaners for further growth (Dahl-Pedersen and Herskin, 2023). In the present review, this group of pigs are given special attention for two reasons: a) the number of slaughterhouses accepting this pig category is low which means that they may be transported quite far for slaughter; and b) this category of pigs have received almost no scientific attention in terms of potential welfare consequences related to transport to slaughter.

The market for pigs weighing approximately 10-30 kg and transported directly to slaughter is not well-described. The trade of this category of pigs from farm to slaughter may include animals that are lacking behind in growth compared to age-matched conspecifics, and pigs with a higher than normal risk of becoming unmarketable fattening pigs (e.g., pigs with small umbilical outpouchings). Such pigs may be sold to slaughterhouses before the fattening stage. For this reason, smaller batches of piglets may be collected from farms and sent to slaughter at smaller abattoirs, or pigs may be collected from several farms to fill up larger vehicles to be sent to slaughter at specialised slaughter facilities in the countries where this speciality is produced. Although the transport of this category of pigs is not as standardized as that of finishers, data from TRACES-NT show that there are organized consignments from at least the Netherlands, Denmark, Switzerland and Germany to specialized piglet slaughterhouses. According to data from TRACES-NT, in 2022, 11,078,213 10-week-old piglets were transported from the above countries to Germany for slaughter, with planned journey times of 8 hours or less for all but one journey from Denmark (17.5 h). Similarly, in 2022, 2000 7-week-old piglets were transported from Denmark to Germany for slaughter with a planned journey time of 13.75 hours. In addition, in 2022, 4,776 piglets of 15 kg body weight were exported from Hungary, Germany and Denmark to Spain for slaughter with a planned journey time between 59 and 64 hours, where the animals had to be unloaded at a control post to rest, feed and drink. Although the data in TRACES-NT often does not contain information on in-transit mortality or animals unfit for transport, it can be seen that for one

consignment from Germany to Spain, 88 piglets did not arrive alive and 24 animals were classified as unfit for transport upon arrival (own analysis TRACES-NT, 2023).

To the best of our knowledge, Valkova et al. (2021), are the only authors who scientifically have evaluated the prevalence of traumatic injuries in carcasses of piglets sent to slaughter based on post-mortem slaughterhouse data from 2010 to 2019 (in the Czech Republic). The authors reported a higher prevalence of limb injuries in piglets than in finishers (0.15 vs. 0.10%). They concluded that this finding could be related to the fact that piglets are not a category of pigs normally slaughtered in the Czech Republic and therefore the piglets sent to slaughter were selected for slaughter due to health problems and slower than normal growth performance. However, these animals should have been fit for transport throughout the journey.

It has not been possible for the EURCAW-Pigs team to identify requirements for fasting or other pre-transport preparation specifically for this pig category, even though they may be more vulnerable to transport than most other categories due to their young age and potential clinical condition. If the destination is a slaughterhouse, there is a European requirement that the animals must be fed within the slaughterhouse from 12 hours of stabling (Annex III No. 1.2 of Regulation (EC) No. 1099/2009) and if the pigs pass a staging point on the way, Regulation 1255/97 Art. 4 No 1 states that they must be fed and watered there. In total, without prior fasting times of the animals on farm, this would result in a possible period without feed of 36 hours.

8 Conclusion

In this review, pre-transport fasting of different categories of pigs was considered. Despite the lack of scientific data, this management procedure appears to be quite common, especially when pigs are destined for slaughter. Reasons for fasting include improved hygiene during transport and at slaughterhouses, and reduced costs for feed during the last day(s) while pigs are kept on farm. There may also be welfare benefits from this practice in terms of reduced risk of in-transit mortality, hyperthermia and motion sickness. However, the evidence underlying these welfare benefits is weak. The evidence for welfare problems caused by pre-transport fasting, such as increased aggression during transport and in lairage, is stronger. Thus, the use of pre-transport fasting appears to be a trade-off between several concerns, with slaughter hygiene and food safety often being prioritized. However, there seems to be a lack of guidelines or regulations on this practice, apart from a few industry guidelines from only a few EU MSs.

For pigs transported for further fattening or for breeding, hygiene concerns at slaughter are not relevant. For these categories of pigs, no studies have identified advantages and/or disadvantages of fasting prior to transport. Similarly, no studies have examined effects of fasting duration or established guidelines, for example taking into account different types of feed (wet feed vs. dry feed fed from feeding stations), or potential post-transport consequences of the fasting in terms of health impairments (e.g., the development of gastric ulcers). This is a knowledge gap.

The Animal Transport Guides Project recommended that the time of withdrawal of feed should be adapted to the planned journey, such that finishers/sows and boars should be fasted for 10-12 hours prior to transport for journeys of 8 hours or less. For journeys exceeding 8 hours or for the transport of pigs for further fattening, an on-farm fasting period of 5 hours was recommended (Consortium on the Animal Transport

Guidelines Project, 2017). More recently, the EFSA AHAW Panel (2022c) recommended that pre-transport fasting periods should be adapted to the category of pigs and be appropriate for the planned journey duration, and also take into account whether pigs are being transported for slaughter or for further fattening. Pending the establishment of evidence-based thresholds, the EFSA AHAW Panel (2022c) recommended that finishing pigs should be subjected to a pre-transport fasting period of less than 10 hours. The time taken to load should be included within this 10 hour period. For other categories of pigs, the pre-transit fasting period should probably be shorter.

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EU Reference Centre for Animal Welfare *Pigs*

About EURCAW-Pigs

EURCAW-Pigs is the first European Union Reference Centre for Animal Welfare. It focuses on pig welfare and legislation, and covers the entire life cycle of pigs from birth to the end of life. EURCAW-Pigs' main objective is a harmonised compliance with EU legislation regarding welfare in EU Member States. This includes:

- for pig husbandry: Directives 98/58/EC and 2008/120/EC;
- for pig transport: Regulation (EC) No 1/2005;
- for slaughter and killing of pigs: Regulation (EC) No 1099/2009.

EURCAW-Pigs supports:

- inspectors of Competent Authorities (CA's);
- pig welfare policy workers;
- bodies supporting CA's with science, training, and communication.

Website and contact

EURCAW-Pigs' website www.eurcaw-pigs.eu offers relevant and actual information to support enforcement of pig welfare legislation.
Are you an inspector or pig welfare policy worker, or otherwise dealing with advice or support for official controls of pig welfare? Your question is our challenge! Please, send us an email with your question and details and we'll get you in touch with the right expert.

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