04-08-2021

Slutrapport af projektet

Velfærdskonsekvenser af fravænningsalder

Background

Under natural conditions weaning is a gradual process during which the piglets go from drinking milk from their mother to eating alternative food. Under commercial conditions however the weaning process is typically a stressful event in the life of a pig, often accompanied by both disease as well as a reduction in growth rate. According to EU directive 2008/120/EEC “No piglets shall be weaned from the sow at less than 28 days of age unless the welfare or health of the dam or the piglet would otherwise be adversely affected. However, piglets may be weaned up to seven days earlier if they are moved into specialised housings which are emptied and thoroughly cleaned and disinfected before the introduction of a new group and which are separated from housings where sows are kept, in order to minimise the transmission of diseases to the piglets.”. A higher weaning age has some positive consequences (for a discussion of these see later in the text), but it also entails a cost in the number of litters that can be produced (Chantziaras et al., 2018; Postma et al., 2016). In most cases the piglets are therefore weaned from 21 to 28 days or shortly thereafter. In contrast with the natural weaning process the weaning is typically abrupt with the piglets being removed from the sow, given solid food, and put into a new environment, in most instances also mixed with new individuals. All of these circumstances are important stressors for the piglet.

Definition of weaning age

The definition of weaning age is in Denmark when the piglets are removed from their sow, or a nursing sow. In other countries e.g., the Netherlands, weaning age is when the piglets are no longer given milk to drink (Baxter et al., 2013). This is also the way in which weaning age is defined for e.g. calves.

“Natural” behaviour around weaning

Much of what is known about the behaviour of domesticated pigs comes from two studies, one in Scotland, planned and managed by David Wood-Gush and one in Sweden, planned and managed by Per Jensen. In both cases a number of domesticated pigs were let out into a large fenced-in area and their undisturbed behaviour observed.

Under these conditions sows will live in sow groups (similar to wild boars). They leave the group a short time before farrowing, build a nest and then farrow in isolation (Csermely, 1994; Jensen, 1986). The sow and the piglets stay away from the group during the first two weeks after which they return to the group. When the sow returns to the group the piglets encounter unknown piglets for the first time. The meeting of the different litters typically happens with much snout to snout interactions, but very little aggression (Petersen et al., 1989). Under natural conditions the weaning process is a long-lasting gradual process which in pigs start around 3-4 weeks of age when the sow starts to terminate the sucklings (Jensen & Recén, 1989). At 10 weeks of age the sow decreases the number of sucklings it initiates. The sow increases the proportion of sucklings during which she is standing while the suckling occurs, at around 6 weeks 25% of the sucklings occur with the sow standing. Piglets are completely weaned at around 13-17 weeks after farrowing (Jensen & Stangel, 1992; Newberry & Wood-Gush, 1985).

Stressors:

Disentangling the stressors:

Weaning under commercial conditions often involves a number of stressors with the most important ones being removal from the sow, the change of diet from milk to solid food, a new environment and in many cases the mixing of litters (Wensley et al., 2021). Hötzel et al. (2011) presents one of the very few studies that compare the relative effect of the different stressors. In their experimental setup one group remained undisturbed but the sow was removed, another group was removed to a new environment, and the third group was removed to a new environment and mixed with another litter. Their results show a very strong effect on both feed

intake and growth rate of being able to remain in the same environment as before weaning. The level of aggression, activity and vocalisations was highest for the mixed litter group (Hötzel et al., 2011). Overall the results indicate that it is possible to minimize weaning stress, and the undesirable production consequences of it, by removing the sow rather than the piglets, and by not mixing the litters. In this context it may seem unfortunate that the EU directive only allows this method for piglets weaned at 28 days and not at 21 days, when they are probably more affected by the weaning process.

Effect of weaning age on stressors

As stated in the beginning according to the EU directive only weaning ages above 28 days (or under special conditions 21 days) are allowed. In the following text only articles dealing with effects of 21 days, or more are therefore included.

Growth rate and diarrhea

Under commercial conditions there is typically a growth check immediately after the weaning. This growth check may be larger or smaller and is known to be affected by a large number of factors, with weaning age being one of them (Dong & Pluske, 2007). A factor that correlates to weaning age is gut maturation (Pluske et al., 1997). There may e.g. be a marked difference between piglets weaned at six weeks compared to those weaned at four weeks (Miller et al., 2007). The size of the small intestine in this study was not affected, but the weight of the intestine (g/cm3) was higher for the higher weaning age. Villus heights was identical for the two weaning ages, but piglets weaned at six weeks had wider villi and deeper crypts.

Gut maturation is however not only affected by the weaning age but also of the feed intake, poor feed intake has been show to be a major risk factor for poor gut structure, and hence poor growth performance (Jayaraman & Nyachoti, 2017). When piglets are weaned, they are expected to start eating solid food as soon as possible. Most animals will however be cautious

of eating novel food types and neophobia may be an issue (Figueroa et al., 2013). With increasing weaning age piglets will have more time to get familiar with the creep feed.

While creep feed is routinely given to piglet pre-weaning there is a large variation in how much creep feed is eaten by the individual piglets (E. Bruininx et al., 2004). A problem in the scientific literature is that the creep feed consumption is typically measured on litter level but there is a huge individual difference in the consumption of the creep feed as well as the benefit for the piglets depending on e.g. their body weight (Huting et al., 2017).

There are a number of studies indicating that the growth check and diarrhea is less for piglets weaned at a higher age (Table 1). The ages used in the different studies differ however and, in most cases, the actual mechanism for the reduction in growth check is not clear. Possible mechanisms include heavier body weight, more mature/developed gut, more experience with the creep feed and of course a combination of these.

Table 1. Effect of weaning at different ages on growth and health of the piglets.

Weaning ages (days)	**Response**	**Result**	**Reference**
21, 28, no weaning	Growth check	More for earlier weaning age	Colson et al., 2006
19, 22, 25, 28	Growth check	More for earlier weaning age	Faccin et al., 2020
21, 42	Growth check	More for earlier weaning age	Devillers & Farmer, 2009
32, 36	Growth rate	Weaning age effect on light piglets	Huting et al., 2019
28, 49	Growth rate	Better growth rate at higher weaning age	van der Meulen et al., 2010
28, 42	Health	Better health (E. coli) at higher weaning age	Wellock et al., 2007a
21, 28, 35	Health	More E. coli 21 than 28, more lactic acid bact. 28 than 35	Leliveld et al., 2013
27, 33	Health	More E. coli at earlier weaning	Callesen et al., 2007

Belly nosing

Belly nosing is an abnormal behaviour that is primarily shown in weaned piglets from two to three days until two weeks after weaning, after which it declines (Widowski et al., 2008). There have however been observations of belly nosing in older, non-weaned piglets, even in the presence of the sow (Jarvis et al., 2008). The morphology of the behaviour is similar to a rooting motion directed towards the stomach of another pig, but most scientists agree that it is probably more related to pre- or post-massage in normal suckling bouts (Widowski et al., 2008). As for other abnormal behaviours the existence of belly nosing shows that there is lack in the current environment of the animal (Straw & Bartlett, 2001).

Piglets that are recipients of belly nosing may have an increased risk of umbilical lesions (Main et al., 2005) and it may disturb resting and sleeping in these animals. In most cases it seems that the effect is not very strong of being exposed to belly nosing however, and growth does not seem to be affected (Straw & Bartlett, 2001). The piglets that perform the behaviour spend less time at the feeder and show a poor growth rate (Bøe, 1993; Straw & Bartlett, 2001; Torrey & Widowski, 2006).

Much of the work on belly nosing has been done on animals that are weaned very early (typically at around 14 days), a high proportion of these animals, up to 80%, show belly nosing behaviour (Li & Gonyou, 2002).

Even at the weaning age more relevant for European and Danish conditions there is a relationship between the prevalence of belly nosing and weaning age however. Faccin et al. (2020) compared the level of belly nosing of piglets weaned at 19, 22, 25 and 28 days. The prevalence of of belly nosing show was 28%, 15%, 6% and 1%. In an older study Bøe (1993) likewise found a difference between piglets weaned at 4 weeks compared to 6 weeks. However a study by (Colson et al., 2006), found no difference between groups of piglets weaned at 21 or 28 days.

There may be many explanations for the discrepancy in the results between Colson et al (2006 and the other studies one factor that has been shown to be of importance is the level of stress experienced by the piglets. The response to early weaning, in this case 21 days, seems to be affected by the level of stress experienced by the animals (O'Connell et al., 2005). Offspring of dams raised in a barren environment reacted with heightened adrenocortical activity and more belly nosing to a weaning age of 21 days compared to a weaning age of 28 days. Offspring of

dams raised in an enriched environment were not affected by the difference in weaning age in this way. While there thus is some evidence that belly nosing is related to stress levels, other studies show that not all stress affects the level of belly nosing (Gardner et al., 2001).

In conclusion, while belly nosing may sometimes cause welfare problems for the recipient, it is mostly as a signal that something is lacking that the behaviour is important.

Other indications of weaning stress

Vocalisations are often considered as honest signals, and as such true indications of the inner state of an animal (Weary et al., 1997, 1998). The reason for this is the cost of vocalising, both the energetic cost and the possibility that it under natural conditions may attract predators. Piglets that are weaned earlier will call more: 21 vs 28 vs 35 days (Weary & Fraser, 1997).

The effect of weaning stress on physiological parameters is more complex. On the one hand lower ACTH levels have been found in piglets weaned at 35 vs 21 days (L. A. Li et al., 2016). However, when comparing the cortisone and noradrenaline level between a control and weaned piglets especially piglets weaned at 21 days, but also those weaned at 28 days, have lower levels of cortisone and noradrenaline (Colson et al 2006). The authors of the study explain it as being a result of a food intake deficit. Similar results, with a decrease in cortisol after weaning was obtained by Jarvis et al. (2008) for weaning ages 12, 21 and 42 days, with stronger declines for 12 and 21 days weaning. However, at 90 days all groups had the same cortisol level, and so no long/term effects of weaning age could be detected.

Weaning age and alternative weaning strategies

The sows of today are hyperprolific and produce many more piglets than they can rear successfully (Danmarks statistik 2021). Denmark has traditionally used cross fostering together with nursing sows to increase survival of the piglets either alone or together with giving piglets access to milk cups (Sorensen et al., 2016).

An alternative strategy is being employed in the Netherlands, Germany and Switzerland in Europe, and is relatively common in Canada as well as the US (Baxter et al., 2013). In this

approach the piglets are removed from the sow very early, after colostrum intake, typically already after 2-3 days and placed in a separate container/pen with access to milk cups. The location may be in the immediate vicinity of the sow, or further away (Baxter et al., 2013).

The development of the immune response in artificially reared piglets is affected but not drastically so (Prims et al., 2016, 2017), and the level of disease has been reported as being comparable to conventionally nursed piglets (Schmitt et al., 2019b). There are differences in intestinal development between the artificial and conventional reared piglets but once again these are reported as not being of major importance (De Vos et al., 2014; Vergauwen et al., 2017). There is no consensus on the difference in body weight gain for the two systems, with Vergauwen et al. (2017) reporting that the artificially reared piglets were 33-40% heavier than the conventionally reared piglets at weaning (19 days), whereas Schmitt et al. (2019b) on the other hand reported that the artificially reared piglets were approximately 20% lighter than the conventionally reared piglets at weaning (27 days).

The studies that include welfare consequences of artificial rearing tend to agree that welfare is impaired. As already mentioned belly nosing is associated with early weaning, so it is understandable that piglets that are artificially reared, and are removed from the sow at two to three days, show more belly nosing than piglets that are kept with their sow for longer (Frei et al., 2018; Rzezniczek et al., 2015; Schmitt et al., 2019b).

Piglets in artificial rearing are reported to show more oral manipulation of the ears and tails of their litter mates as well as higher levels of aggression (Rzezniczek et al., 2015; Schmitt et al., 2019). A qualitative behaviour assessment (Wemelsfelder et al., 2000) of the piglets indicates a lower emotional state in the artificially reared piglets (Schmitt et al., 2019b). There are no indications of negative long-term effect on fear responses in artificially reared piglets. Schmitt et al. (2019a) did a startle test, a novel object test, a human-animal relationship test and an open-door test one week after weaning. The only effect detected was a decrease of fear of humans in the artificially reared animals.

In summary, while the artificial rearing of piglets may help piglets to survive, and under some circumstances grow well, there can be no doubt that the practice also introduces serious welfare challenges.

Strategies to reduce weaning stress

Increasing the acceptance of creep feed

Access to solid feed before weaning, creep feed, is often given to prepare the piglets for the transition to solid food. The creep feed is eaten, but unless specifically studied by e.g. mixing it with dye it is unclear how many piglets that are actually eating it (Bruininx et al., 2002; Sommavilla et al., 2015).

There are indications that amount of creep feed eaten prior to weaning does affect the amount eaten immediately after weaning, and especially the speed with which the piglets start eating (Bruininx et al 2001 in Dong & Pluske 2007). Piglets that eat more creep feed are also those that gain most weight before weaning (Pajor et al., 1991). The heaviest piglets at weaning are also those that show most weight gain post weaning, no direct correlation between creep feed consumption and postweaning was found in this study however.

As noted previously the amount of creep feed eaten during lactation affects the gut so that more solid feed gives better gut development (Kuller, van Beers-Schreurs, et al., 2007). It is therefore not surprising that piglets that eat more creep feed will be less likely to develop diarrhea (Callesen et al., 2007b).

Attempts have been made to influence the piglets to reduce their neophobia towards the novel feed, by changing the way it is presented during preweaning, the diversity of flavours or texture (Middelkoop, Choudhury, et al., 2020; Middelkoop et al., 2018; Middelkoop, Kemp, et al., 2020). While there is some effect of these on the intake of the piglets, the effect is not dramatic, nor does it affect the consumption during the post weaning phase. The same holds true for attempts at giving the sow feed with specific flavours were thought to be transmitted to the piglet (Figueroa et al., 2019).

One possibility is that the piglets are not eat motivated to eat much of the creep feed because the quality and accessibility of milk is good (Middelkoop et al., 2019). In an attempt to decrease the milk quality and quantity sows were restrictively fed pre-weaning and food was also presented in “play-feeders” to the piglets (conventional feeders with ropes, cloths or pvc spirals

attached to them). The results of this study was more promising, although the piglets of the restricted sows had a lower growth rate (41g/day) the treatments resulted in better creep feed intake as well as better feed intake shortly after weaning, with less diarrhea and less body lesions and ear biting (Middelkoop et al., 2019). A separate study specifically looking at employing feeders that increased exploration found similar results on creep feed intake (Kuller, Tobias, et al., 2010).

The hypothesis that the good access to milk affects the tendency of piglets to eat creep feed has also been tested in a series experiments during which access to the sow has been restricted ((Berkeveld et al., 2007; de Ruyter et al., 2017; Kuller et al., 2004; Kuller, Soede, et al., 2007, 2010; van Nieuwamerongen et al., 2017). Although the growth of the piglets during the lactation phase may be affected the results are positive for the daily weight gain post-weaning.

In the studies above it was the experimenters that restricted the access to the sow. Under natural conditions it is the sow herself that gradually restricts the possibility of suckling, something that also happens in farrowing systems in which the sow can get away from the piglets (Bøe, 1991, 1993, 1994; Pajor et al., 1999), which in many cases lead to the same positive decrease in post-weaning growth check.

In conclusion it thus seems that there are good possibilities for increasing the feed intake of creep feed by somewhat decreasing the access to and/or quality of the milk from the sow. This, despite the small decrease in growth during the lactation phase, will result in better post-weaning growth.

Early socialisation

As mentioned in the introduction one of the stressors often associated with the weaning process is the mixing of litters with the resulting aggression. Under natural conditions the mixing of litters occurs at ten to fourteen days when the sow and the litter go back to the sow group. There is very little aggression in this situation, and mostly just snout to snout contact (Petersen et al., 1989). This has inspired number of researchers to try something similar under commercial conditions (D'Eath, 2005; Salazar et al., 2018; Verdon et al., 2019, 2019). In these studies, the litters are given access to one or more unfamiliar litters, typically at around the age of two

weeks. The general finding is that there is some aggression when the litters first come into contact, but that it is not very serious. After weaning the socialised piglets seem to have better social skills so that even when they fight at mixing, their fights are shorter, and a dominance hierarchy is established faster. A general finding is also that the piglets from the socialised litters are somewhat lighter/grow slower during lactation, but that the average daily weight gain after weaning is as good as or better than the non-socialised litters, further emphasising the interaction between stressors.

Early socialisation is not the only strategy for decreasing aggression at mixing. If fighting is seen as a way of gathering information about an opponent and deciding on whether to continue to attempt to gain access to a resource, whether present or future, then an animal's learning speed should affect the length, but not necessarily the initial frequency of fights. While some studies have found the expected results (O'Connell & Beattie, 1999; Olsson et al., 1999), others have found the opposite result, with piglets from the enriched conditions fighting for longer and more frequently at mixing (Melotti et al., 2011). Observations on outdoor piglets suggest that they fight less at mixing than piglets from an indoor more barren environment (Cox & Cooper, 2001). Since there are many more differences between the outdoor and indoor environments it is however hard to know what causes this difference.

In conclusion, if the obvious practical difficulties inherent in the mixing of litters can be overcome then this may be a way forward for reducing aggression at mixing, not only at weaning but possibly also if mixing occurs later in the life of the pig.

Weaning – an international perspective

Overall countries in the EU are following the directive 2008/120/EEC, Sweden has a higher minimum weaning age however – 28 days.

Table 2. Weaning ages reported during interviews and from the UK-agricultural board (Postma et al. 2016, UK agricultural board 2019). Unfortunately, the number given for the average weaning age is sometimes given as the lactation period for farms or countries that have a high proportion of nursing sows this may skew the results (for a discussion see the report Arbejdsgruppen for hold af svin 2010). Whether this is the case for the numbers below is unknown.

Country	Average	Min	Max
UK (2018)	26.4	--	--
Belgium (2013)	23.5	19	28
France (2013)	24	19.5	34.5
Germany (2013)	24.4	19.3	32.6
Sweden (2013)	35.1	28	49

Discussion and conclusion

Under natural conditions there is little or no weaning stress. Under standard commercial conditions the piglets are exposed to a series of stressors e.g. transition to solid feed, absence of sow, mixing, new environment. In most cases studies have focused on one of these stressors, but as has become apparent in the text above, they often interact. When pigs are

socialised during the lactation phase, the drop in weight gain is reduced (Salazar et al., 2018), gradual weaning results in lower aggression (van Nieuwamerongen et al., 2017) and so forth. When evaluating strategies for reducing weaning stress it is therefore important that more than one effect is taken into consideration.

In the literature the time for total weaning under natural conditioned is often cited: 17-19 weeks. As can be seen in Table 1, not least the work during the last 10-15 years has shown that it is possible to decrease the weaning stress by prolonging the lactation phase with much less, in some instances with only one or two weeks.

The use of intermittent suckling and early socialisation both hold good promise for decreasing weaning stress. It is however obvious that there are severe practical difficulties with both approaches.

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