INTRODUCTION

In group housing systems for dry sows, it is preferable to have a feeding system that allows individual rationing to facilitate maintenance of optimal sow body condition. Although individual rationing is more easily achieved when dry sows are individually housed in stalls compared to grouped in pens (Johnston and Li, 2013; Young et al., 2004), there is impetus for the industry to change from individual stalls to group housing. In advance of the change, research is occurring on group housing of dry sows, including sow feeding strategies (e.g., Schneider et al., 2007; DeDecker et al., 2014) and the potential impacts of group housing on sow welfare and production (e.g., Salak-Johnson et al., 2007, 2012; Gonyou et al., 2013; Hemsworth et al., 2013). Whereas Gonyou et al. (2013) emphasized the importance of establishing sow groups based on nutritional requirements, the delivery of feed to the animal and

Individual variation in eating speed of dry sows

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ABSTRACT: We investigated the variation in eating speed by individual pregnant sows and the influence of feeding dry compared to wet feed. A total of 39 Norwegian Landrace × Yorkshire dry sows, 13 primiparous and 26 multiparous, were included in the experiment. In experimental period 1, each sow was offered 2.2 kg of a standard concentrate feed without added water. In experimental period 2, the sows were offered the same weight of concentrate feed but after mixing with water at a ratio of 1:4, based on weight. The sows were kept in groups of 4 or 5 in pens with individual feeding stalls. The weighed allocations of feed were poured into the troughs before the sows were given access to the food. On d 1, the sows were allowed to eat for 15 min, on d 2 for 10 min, on d 3 for 5 min, on d 4 for 2 min 30 s, and on d 5 for 1 min 15 s. At the designated time, feed troughs were covered, blocking sow access, and residual feed was carefully removed and weighed. Mean consumption rate of dry feed was 183.2 g/min for the first 5 min and 169.7 g/min for the first 10 min. For wet feed, the mean consumption rate was 1,859.8 g/min for the first 5 min and 1,060.7 g/min for the first 10 min. After 5 min, the sows had consumed 41.6% of the dry feed (range 19.5 to 79.1%, CV = 31.0%) and 84.5% of the wet feed (range 54.3 to 99.1%, CV = 14.9%). After 10 min, the sows had consumed 77.1% of the dry feed (range 33.9 to 100.0%, CV = 24.9%) and 5 of the 39 sows had completely ingested their allotted feed. When feed was wet, sows finished 96.4% of the ration (range 72.7 to 99.1%, CV = 6.4%) after 10 min. The speed of eating dry feed was positively correlated with sow weight, both at 5 ($R = 0.72, P < 0.001$) and 10 min ($R = 0.75, P < 0.001$), but for wet feed, the correlation was weak at 5 min ($R = 0.36, P < 0.05$) and there was no correlation at 10 min ($R = 0.20, P > 0.10$). We conclude that dry feed resulted in larger individual variation in feed consumption rate than wet feed. Furthermore, whereas feed consumption rate was correlated with liveweight of the sow when eating dry feed, the relationship was not significant when sows ate wet feed.

Key words: concentrated feed rations, dry sows, feed consumption rate, wet feed


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its feeding behavior are likely to be important factors influencing the efficient and sustainable management of restricted-fed sows (Johnston and Li, 2013). Simple feeding systems that dump or spread feed on the floor or in a trough without partitions, termed competitive feeding systems (Gonyou et al., 2013), increase variation in sow feed intake (Andersen et al., 1999) and increase risks to sow welfare from aggression and bullying (Petherick et al., 1987; Barnett et al., 1992; Salak-Johnson et al., 2007). Individual feed intake by sows in groups depends mainly on 3 factors: 1) eating capacity of the sow (eating speed or ingestion rate), 2) social status, and 3) spatial distribution of food within the pen. The long-term effects of unequal feed distribution in group housed sows are reduced weight gain and body condition (e.g., Edwards et al., 1993).

The physical form of the diet or ration will influence eating speed, with faster ingestion of feed reported for pelleted than meal (mash) diets in growing–finishing pigs (Hsia and Lu, 1985) and dry sows (Edwards et al., 1988). Furthermore, the addition of water to the concentrated ration also increases the eating speed in pigs (Hsia and Lu, 1985; Edwards et al., 1988; Gonyou and Lou, 2000) as does increased age/liveweight (Gonyou and Lou, 2000).

Both Olsson (1977) in growing–finishing pigs and Edwards et al. (1988) in dry sows found considerable variation in eating speed when dry concentrate feed was provided. Olsson (1977) also stated that variation in eating speed among growing–finishing pigs was reduced when wet feed was given. Hence, if a reduction in variability of feed consumption rate can be achieved by providing wet feed, this method of presenting feed could contribute to a more equal distribution of food among group housed sows. The aim of this experiment was to investigate the variation between individual pregnant sows in eating speed and the influence of dry and wet feed.

MATERIALS AND METHODS

Experimental Design

In experimental period 1, the sows were offered a standard ration of concentrate feed (2.2 kg) without added water. In experimental period 2, the sows were offered the same weight of concentrate feed but now mixed with water at a ratio of 1:4 (2.2 kg of dry feed plus 8.8 kg of water). The sows were allowed 1 wk to become accustomed to the experimental procedures before recordings started and 1 wk for the transition from dry to wet feed. This experiment was approved by the National Research Authority (http://www.fdu.no/)

Animals and Feeding

Two batches of 19 and 20 healthy, nonlactating Norwegian Landrace × Yorkshire crossbreed sows from the Norwegian University of Life Sciences (Ås, Norway) herd, in mid gestation, were used in the experiment. Of the total of 39 sows, 13 were primiparous and 26 were multiparous. The sows were weighed before entering the experiment (primiparous, mean ± SE: 131.8 ± 4.1 kg; multiparous, mean ± SE: 208.5 ± 5.2 kg) and were scored for body condition using the scale developed by Norsvin and Animalia (Thingnes et al., 2012). All sows were categorized as being in normal body condition range. Sows in the norwegian University of Life Sciences herd were fed 2.2 kg of a standard, pelleted concentrate ration (8.4 MJ NE/kg, 121 g CP/kg, 88.3% DM, and 10.7% crude fiber) in the morning (0800 h).

Housing and Pens

The sows were kept in an environment-controlled building in groups of 4 or 5 individuals in pens with feeding stalls (0.70 × 2.00 m) with a trough across the front and a 2.00-m wide activity area behind the stalls. Nipple drinkers were located over the troughs, allowing the sows to drink while feeding. During feeding, the sows were closed in the stalls for 20 to 30 min to ensure that the sows did not leave the stalls and all sows could finish their allocated ration without being displaced by another sow. The pens were cleaned after feeding in the morning and new litter provided (sawdust).

Experimental Procedure

The experimental procedure was developed on the basis of pilot studies with sows other than those used in this experiment. In the morning of each observation day, the food and water (only in the treatment with wet feed) for each sow were weighed into large buckets on an electronic balance (Mettler Toledo International Inc., Greifensee, Switzerland). For the wet feed treatment, the feed and water were thoroughly mixed when combined in the buckets and again just before feeding, to ensure equal consistency. Before feeding, the water supply to the nipple drinkers over the troughs was closed, the troughs were emptied and cleaned, and the sows’ access to the troughs blocked by solid boards. The sows were then allowed to enter the feeding stalls and the gates were shut behind them.

The weighed allocations of feed were then poured into the troughs and the sows were given access to
the food by removing the solid boards. On d 1, the sows were allowed to eat for 15 min before access to the troughs was blocked by again putting the solid boards between the sows and the troughs. The residual feed was then carefully removed from the trough and weighed on the electronic balance. Intake of feed was calculated as the difference between feed provided minus the residual. The proportion of feed consumed (%) was then calculated. On d 2, the sows were allowed to eat for 10 min, on d 3 for 5 min, on d 4 for 2 min 30 s, and on d 5 for 1 min 15 s.

After weighing the residual feed, an amount of concentrates equal to the feed residuals was immediately provided in the trough to ensure the sows got their normal daily allowance.

Dry Matter Content in Residuals

The DM content of the feed residuals in the wet feeding period for the 20 sows in batch 2 was analyzed using simple standard methods, in which the residual wet feed was poured into metal trays and placed in a drying oven at 80°C for 24 h. The dried feed residue was then weighed and recorded.

Statistical Analysis

Regression analysis was used to explore the relationship between sow weight and feed consumption rate for dry and wet feed and the relationship between feed consumption rates for dry and wet feed. Furthermore, regression analysis was used to explore the relationship between residual DM and proportion of wet ration (i.e., feed plus water) consumed.

RESULTS

Feed Consumption Rate and Individual Variation

The mean feed consumption rate for dry feed was 183.2 g/min (range 86.0 to 348 g/min) for the first 5 min and 169.7 g/min (range 74.5 to 220.0 g/min) for the first 10 min. For wet feed, the mean feed consumption rate was 1,859.8 g/min (range 1,194.0 to 2,180.0 g/min) for the first 5 min and 1,060.7 g/min (range 799.5 to 1,100.0 g/min) for the first 10 min.

After 5 min, the sows had consumed 41.6% of the dry feed allocation (range 19.5 to 79.1%, CV = 31.0%) and 84.5% of the wet feed allocation (range 54.3 to 99.1%, CV = 14.9%; Fig. 1). After 10 min, the sows had consumed 77.1% of the dry feed (range 33.9 to 100.0%, CV = 24.9%) and only 5 of the 39 sows had finished their allocated ration completely. When the sows were fed wet feed, they had finished 96.4% of the ration (range 72.7 to 99.1%, CV = 6.4%) after 10 min. Eighteen of the 39 sows had finished their ration completely and 29 of the 39 sows had finished more than 95% of the ration.

After 15 min, 28 of the 39 sows had finished at least 95% of the allocated feed and 25 of the sows had finished their ration completely when fed dry feed (Fig. 1). For wet feed the corresponding numbers were 37 and 30 sows, respectively.

The speed of eating dry feed was positively correlated to sow weight (see Fig. 2), both at 5 (R = 0.72, P < 0.001) and 10 min (R = 0.75, P < 0.001), but for wet feed, the correlation was weak at 5 min (R = 0.36, P < 0.05) and there was no correlation at 10 min (R = 0.20, P > 0.10). There was no correlation between speed of eating dry and wet feed at either 5 (R = 0.47, P > 0.10) or 10 min (R = 0.28, P > 0.10). It was anecdotally noted that different sows applied different methods to ingest the mixture of feed plus water. For example, some sows appeared to try chewing the wet feed whereas other sows were sucking the mixture from the surface and others immersed their snout under the surface, deep into the wet feed mixture. However, the methods applied by sows to ingest wet feed were neither systematically measured nor objectively analyzed.

DISCUSSION

The eating speed increased significantly when water was added to the dry concentrate feed ration, which is in accordance with reports for growing–finishing pigs (Olsson, 1977; Hsia and Lu, 1985) and dry sows (Edwards et al., 1988). Although the wet feed rations occupied a larger volume, the sows actually consumed the wet ration faster than the dry ration.

Figures in Olsson (1977) indicate a range in feed consumption rate for growing–finishing pigs at 90 kg liveweight from 80 to 160 g/min for dry feed. Nielsen (1980) presented data on individually housed fattening pigs given wet feed (the feed:water ratio was 1:2). For pigs weighing 61 kg, the mean consumption
rate was $424 \pm 179$ g/min with a range from 300 to 1,000 g/min. Edwards et al. (1988) reported a range in feed consumption rate for dry sows of 138 to 309 g/min. Even though the sows in the present experiment ate slower, on average, the extent of the variation is similar to other reported studies.

The CV showed that the individual variation was less on wet feed. The very low CV values at 10 and 15 min, however, reflected the fact that many sows had already finished their allocated weight of feed within the allotted time. Reduced variation when providing wet feed was also stated by Olsson (1977), even though no data were presented. It is interesting to note the significant positive correlation between sow weight and feed consumption rate for dry feed, whereas on wet feed, the consumption rate was not correlated with liveweight but, rather, appeared to depend more on the “method” of feed ingestion.

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**Figure 1.** Proportion (%) of dry and wet feed consumed at different time intervals after the start of feeding. Box plot shows median, first and third quartile, and maximum and minimum values.
Reduced variation in feed consumption rate is of special interest in group housing with simple feeding systems. However, it is questionable whether reduced variation in feed consumption rate when providing wet feed is enough to actually reduce the problem of intragroup liveweight variability revealed by Stewart (1993) and Edwards et al. (1993). When feeding concentrates to group-housed sows either on the floor or in troughs with no head or shoulder barriers, higher ranked individuals will be able to control parts of the feeding area and significantly reduce the access to feed for lower ranked individuals (Andersen et al., 1999). Even if aggression in dry sows was found to be lower when providing wet feed than dry feed in an open trough (Andersen et al., 1999), the lower variation in feed consumption rate for wet feed will presumably be of minor importance.

We conclude that the provision of dry concentrate feed results in larger individual variation in feed consumption rate by sows than wet feed. Feed consumption rate is higher when wet rather than dry feed is provided, but because of the increased volume

Figure 2. The relationship between sow liveweight and proportion of ration consumed after 5 and 10 min for dry and wet feed.
(i.e., feed plus water), the time for finishing the meal is only slightly shorter on wet feed. Feed consumption rate is correlated with liveweight of the sow when eating dry feed but not with wet feed.

**LITERATURE CITED**


