Short communication

Individual variation in concentrate consumption rate of pregnant ewes

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ABSTRACT

The aim of this study was to examine the variation within and between individuals in concentrate consumption rate and the effect of social facilitation. Eight pregnant ewes (four primiparous and four multiparous), were fed a low amount, 250 grams, of concentrate twice a day with *ad libitum* access to forage hay. The ewes ate their ration of concentrate individually to examine the variation in consumption rate (Experiment 1) and in pairs to look at the effect of social facilitation (Experiment 2); both experiments had eating bouts limited to 60 seconds. On average, the eight ewes had a concentrate consumption rate 172.0 ± 10.5 g/min (mean ± SD) when fed individually and 183.0 ± 8.9 g/min (mean ± SD) when fed pairwise. The coefficient of variation (CV) of consumption rate within and between ewes fed singly averaged 6.0% and 5.6%, respectively. When fed in pairs, the CV within individual ewes decreased to 4.9% and the CV between ewes increased to 9.4%. In conclusion, the overall CV for consumption rate was small, and when ewes are kept in groups under commercial conditions and fed concentrates in a long trough each ewe will consume approximately the targeted amount of concentrates.

Key words: Pregnant ewes, concentrate, feed consumption rate, social facilitation

1. Introduction

On commercial farms in Norway, sheep are normally housed during the winter season (Simensen et al., 2010) and are fed roughage supplemented with a limited ration of concentrate. Concentrate are usually fed once or twice daily in a feeding trough where all the ewes eat simultaneously. Ewes in late pregnancy have an increased requirement of nutrients due to high fetus growth (Robinson et al., 2002). The energy requirements increase with body weight and the number of fetuses. Both later parameters are measured at mid pregnancy. For ewes carrying twins, the energy requirements increases by about 20% in the last 6 weeks prior to lambing and by about 85% the last 2 weeks prior to lambing (INRA, 1989). Thus, ewes are usually divided into groups according to their nutritional requirements (Robinson et al., 2002) and receive an increasing proportion of feed as pelleted concentrate throughout gestation (Foot et al., 1973). The daily amount of concentrate for each group is calculated by multiplying the recommended ration per ewe with number of ewes in the group. It is then assumed that each individual eats the targeted amount of concentrate and individual variation in feed intake is not considered. If individual intake of concentrate is less than required, some ewes may become undernourished (Foot et al., 1973), with an increased lipid mobilization and risk of pregnancy toxaemia and reduced lamb birth weight (INRA, 1989). Late pregnancy undernutrition can also result in poor colostrum production and low milk yield (McGovern et al., 2015). In addition, Bowman and Sowell (1997) state in their review that there can be potential negative impacts on forage intake and digestibility, together with increased supplementation costs, if individual intake is higher than estimated.

Individual variation in intake of concentrate may arise from differences in feed consumption rate per se, social competition or social facilitation. Ewes that might have a high feed consumption rate will potentially consume a higher amount of feed (a higher proportion of the provided group ration)

than the targeted amount per individual. Bøe and Cronin (2015) reported that the variation in consumption rate of dry sows was large even if they were penned individually and that consumption rate of dry concentrate was positively correlated with body weight. Differences in concentrate consumption rate between individuals was also detected among cows fed individually in an electronic feeding station (Hyde et al., 1976). Gonzáles et al. (2008) found that in groups of heifers the eating rate for concentrate increased when the number of animals per feeder was increased to eight. Foot et al. (1973) demonstrated, using faecal collection, that individual intake of concentrates varied between ewes, and the variation was found to decrease when the amount of concentrate was increased. There seem, however, to be no studies on sheep that have focused on feed consumption rate per se.

Observations on commercial farms when sheep are housed during winter indicate that when all the ewes in the group are standing side-by-side at the feed barrier during feeding of concentrates, and that no individuals are displaced. This is in accordance with Arnold and Maller (1974) who observed that, when trough space was sufficient, all the ewes in the group fed undisturbed. Further, Bøe and Andersen (2010) found that frequencies of displacements and queuing were very low when feeding space was sufficient, allowing all ewes to eat simultaneously. Hence, competition is not present when there is sufficient feeding space. Correspondingly Gonzáles et al. (2008) found that number of displacements among pen mates at the concentrate feeders increased linearly as the number of heifers per feeder increased.

Studies show that calves reared in groups begin consuming food at an earlier age and consume more food (e.g. Hepola et al., 2006), which could be explained by social facilitation. Social facilitation has been defined by Clayton (1978) as an increase in the frequency or intensity of responses when shown in the presence of others engaged in the same behavior. Hsia and Wood-

Gush (1984) found that social facilitation occurred in the feeding behavior of pigs, where satiated pigs commenced feeding on the return of a hungry pen-mate. As sheep do react to social isolation (e.g. Villeneuve et al., 2009), it is possible that social facilitation, when keeping ewes in groups of two or more, could potentially increase the feed consumption rate.

The aim of this study was to investigate the variation in individual consumption rate of concentrates in pregnant ewes and the effect of social facilitation.

2. Materials and methods

Two experiments were conducted using eight ewes in mid pregnancy of the Norwegian Nor-X breed from the herd at The Norwegian University of Life Sciences. Before the experiments began, ewes were kept in groups of 20 – 25 animals in an uninsulated barn with pens with slatted flooring. The ewes were fed 100 g pelleted concentrate/ewe (6.3 MJ net energy lactation per kg, 16.5% crude protein, 21.7% neutral detergent fiber, 4.1% fat and 26.4% starch; Formel sau, Felleskjøpet, Norway) twice daily (approximately 08:00 and 15:00) in a long trough, with sufficient space for all animals to eat simultaneously (45 cm/ewe). The ewes had free access to water, minerals and good quality haylage of late cut (63% dry matter).

Five days before the experiment started (adaption period), four primiparous ewes (2 years of age) and four multiparous ewes (3 – 4 years of age) were randomly selected, and their body weight was collected on an electronic balance (79.8 ± 6.0 kg and 97.1 ± 15.0 kg, respectively). The ewes were moved to pens in an insulated barn with slatted flooring and a feeding table allowing all ewes to eat simultaneously. As before, the ewes had free access to good quality haylage, water and minerals.

In order to become accustomed to the test situation, each ewe was separated from the group, put in a separate test pen (2.1 m x 3.6 m), six times during the adaptation period. In the test pen, the ewe was fed 250 g of standard concentrate in a small feed container (82 cm long, 30 cm wide and 16 cm deep) located behind a feeding barrier. A ration of 250 g was chosen based on initial observations ensuring that no ewes were able to consume the whole ration within the duration of the test (60 seconds). The individual concentrate rations were weighed on an electronic balance (Mettler PE3000).

2.1 Experiment 1

After the adaption period, all ewes were housed together in a group pen (2.1 m x 7.2 m) and each ewe was tested twice daily (09:00 and 14:00) for 3 days. During the test, each ewe was moved to an introduction pen (2.1 m x 3.6 m) for 60 seconds and then moved further to a test pen (2.1 m x 3.6 m) where it had access to the feed container. The feed container was located behind a standard feeding barrier for sheep and contained 250 g of concentrate, as in the adaption period. After 60 seconds, starting when the ewe's mouth was in contact with the concentrate, a person removed the feed container from the ewe by pulling a rope attached to the container. The ewe was returned to the group pen and the leftovers were weighed on the electronic balance.

2.2 Experiment 2

The same eight ewes and the same test method as in Experiment 1 were used in Experiment 2 with the exception that the ewes were now tested in pairs. In order to achieve all combinations of pairs,

each ewe was tested seven times during the 5 test days (a maximum of twice daily) resulting in a total of 28 pairings. The feed container was located the same place as in Experiment 1; behind a standard feeding barrier for sheep, with separate openings with centers 40 cm apart (Figure 1). A Plexiglas divider was used to split the feed container into two equal parts, allowing ewes to see but not to interact physically with each other while eating. The ewes were provided 250 g concentrate each. After 60 seconds, starting when the first ewe touched the concentrate with its mouth, the feed container was removed and the leftovers were weighed as in Experiment 1.

Figure 1 here

2.3 Behavioral observations

In both Experiment 1 and 2, the ewes were video recorded during the tests. In order to identify the ewes, they had colored collars around their necks. The position of the head, either mouth in contact with feed or head in a raised position, was scored using continuous sampling. Following Frid (1997), we considered head in raised position to reflect vigilance behavior. All events of vocalizations and instances of displacements, defined as physical impact from one animal resulting complete withdrawal of the other animal's head from the feeding barrier (Experiment 2), were also scored.

2.4 Statistical analysis

Individual variation was analyzed with the coefficient of variation (CV) for each animal in both experiments. In order to test the effect of social facilitation on mean concentrate consumption rate,

145 we used a Welch's t-test for paired samples. A Welch's t-test for unpaired samples was used to
146 look at differences in mean concentrate consumption rate between primiparous and multiparous
147 ewes. To investigate the relationship between mean concentrate consumption rate and the time
148 (seconds) ewes spent with head in raised position and body weight, respectively, we used
149 Spearman rank correlation coefficients. A paired sample t-test was used to look for differences in
150 concentrate consumption rate between feeding times at 09:00 and 14:00 in Experiment 1.
151

152 ## 3. Results

153 ### 3.1 Experiment 1

154 Mean consumption rate of concentrate when the ewes were fed individually (Experiment 1) was
155 172.0 ± 10.5 g/min (range 159.2 – 186.2 g/min, Table 1). The mean consumption rate remained
156 stable during the experimental period. It was no significant difference in consumption rate between
157 feeding times at 09:00 and 14:00 ($t = 1.51$, $P = 0.15$). The fastest ewe consumed 17.0% more
158 concentrate within 60 seconds than the slowest ewe and the calculated coefficient of variation
159 (CV) between ewes was 5.6%. There was no significant effect on concentrate consumption rate of
160 either parity (primiparous vs. multiparous, $t = 0.69$, $P = 0.51$) or the body weight of the ewes ($r =$
161 -0.19, $P = 0.66$).
162 There was low variation in concentrate consumption rate within individuals (CV = 6.0%, range
163 3.6 – 10.0%, Table 1). The ewes spent, on average, 5.1 seconds (range 0.8 – 11.8 seconds) of the
164 total 60 second test duration with the head in raised position, but it apparently had no significant
165 effect on the concentrate consumption rate ($r = 0.10$, $P = 0.84$).
166

3.2 Experiment 2

When the ewes were tested in pairs (Experiment 2), the mean concentrate consumption rate was 183.0 ± 8.9 g/min (range 167.9 – 200.2 g/min, Table 1). The means concentrate consumption rate was higher for all ewes when compared to Experiment 1 ($t = -7.38$, $P < 0.001$) and remained stable during the experimental period. The fastest ewe consumed 19.2% more concentrate within 60 seconds than the ewe with the slowest concentrate consumption rate, and the calculated CV between ewes was 9.4%. Parity ($t = 0.03$, $P = 0.98$) and body weight ($r = 0.07$, $P = 0.88$) had no significant effect on concentrate consumption rate. Ewes' rank-order differences in consumption rates were consistent across the two experiments (Table 1).

The variation in concentrate consumption rate within individuals was even lower than in Experiment 1 (CV = 4.9%, range 3.0 – 7.7%, Table 1). The mean time spent with their head in raised position (2.4 seconds, range 0.0 – 6.2 seconds), had no significant effect on concentrate consumption rate ($r = -0.26$, $P = 0.54$), nor was there any difference in time spent with head in raised position between the two experiments ($t = 1.88$, $P = 0.10$).

There were no instances of vocalizations and displacements.

Table 1 here

4. Discussion

The concentrate consumption rate was higher in all ewes when tested in pairs than when tested individually. The most likely explanation of why the presence of another ewe stimulated the ewes to eat faster seems to be social facilitation, possibly due to scramble competition. For example,

188 Estevez et al. (2002) observed that domestic fowl scrambled to get as much food as possible and
189 as fast as possible when large numbers of birds were present at a patch with a limited supply of
190 highly attractive food.

191 In our study, there were no displacements and/or vocalizations and hence no aggressive
192 competition, which could have disturbed the ewes and effected the distribution of concentrate.
193 This is in accordance with the study of Arnold and Maller (1974) showing that disturbance is low
194 when trough space is adequate, as in the present study. Because sheep are more comfortable in
195 social situations it is reasonable to believe that ewes would focus less on vigilance and more on
196 eating when fed in pairs. However, the time ewes spent with heads in raised position did not differ
197 significantly between the two experiments, and pairwise feeding seems to have minor effect on
198 their vigilance behavior.

199 Even though the individual variation among ewes increased when fed in pairs compared to
200 individual feeding, the variation is relatively small (CV < 10%). This variation is considerably less
201 than what has been reported in individually fed dairy cows (Hyde et al., 1976) and dry sows (Bøe
202 and Cronin, 2015). There seems to be no other comparable data on individually fed ewes; however,
203 previous studies on general feed intake in group-housed ewes showed large individual variation
204 over time (Ducker et al., 1981; Foot et al., 1973; Kahn, 1994; Kendall et al., 1980). Whereas
205 concentrate consumption rate in dry sows is positively correlated to body weight (Bøe and Cronin,
206 2015), no significant effect of either body weight or parity on consumption rate was found in our
207 experiments. Consumption rate appears a stable individual characteristic since there was
208 consistency between ewes across the experiments and was unaffected by weight or
209 parity. Because of stable mean consumption rate during each experimental period, we are assured

that the ewes did not eat faster with increasing test experience and anticipation of limited feeding time.

The low variation between and within ewes in concentrate consumption rate, show that when ewes are regrouped according to their energy requirements as recommended in commercial conditions, all ewes will receive their full ration of concentrate. Hence, feeding concentrate in a trough with all ewes eating simultaneously will not result in differences in feed intake between individuals.

5. Conclusion

Pregnant ewes, when fed low amounts of concentrate, have an overall small individual variation in consumption rate both within and between each other. When fed in pairs, they consumed concentrate faster, but the variation within and between ewes remained low. Hence, when ewes are kept in groups under commercial conditions and fed concentrates in a long trough, each ewe will consume approximately the targeted amount of concentrates.

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