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学位論文題目	The factors and control of wool-biting behaviour in housed sheep (舎飼いのヒツジにおける羊毛食い行動の発現要因およびその制御)
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論 文 内 容 の 要 旨

Wool-biting behaviour is a serious animal welfare problem within the sheep industry, and the driving factors and the actual conditions still remain unknown. The aim of this study attempted to clarify the factors resulting in wool-biting and review potential solutions for this animal welfare problem.

1. The influence of diurnal variation and individual exclusion on wool-biting behaviour

The diurnal variation of wool-biting behaviour under a high density of 45 sheep (1 sheep/m²) and a low density of 24 sheep (0.4 sheep/m²) were investigated. Behavioural observations were conducted from 07:00 to 19:00, and the number of biting bouts, the number of bites within a bout and the number of sheep engaged in wool-biting were recorded. The wool-biting frequency and the proportion of sheep engaged in wool-biting behaviour increased significantly during the post-feeding period under both density conditions ($P < 0.05$), but the number of bites per bout during that period was significantly lower than that seen during the other periods ($P < 0.05$). These results suggested that wool-biting behaviour in sheep occurred mainly after feeding time and probably resulted from a lack of oral stimulations.

2. The influence of social order on wool-biting behaviour in housed sheep

Twelve sheep were used in the study. Behavioural observations were conducted 2 hours before (06:30–08:30 and 13:00–15:00) and after (09:30–11:30 and 16:00–18:00) feeding 2 two days a week continuously for 4 weeks. The individual number, number of biting bouts and number of bites within a bout of both the performer and receiver were recorded. The social hierarchy of this flock was investigated by the feed scrambling method after behavioural observation. There was no significant correlation between social rank and wool-biting behaviour in either the performers or receivers. However, a remarkable individual difference of wool-biting behaviour was detected in performers ($P < 0.05$) but not in receivers ($P = 0.967$). These results indicate that wool-biting was not influenced by social ranking in the flock, and some

active wool-biter performed more wool-biting than other individuals.

3. The influence of flocking density on wool biting in housed sheep

Twelve sheep divided into three groups (1, 2 and 4 sheep / m²) were used. All sheep were fed on baled hay. Behavioural observations were conducted 2 hours before (13:00–15:00) and after (16:00–18:00) feeding in the afternoon for 2 days a week continuously for 4 weeks. The individual number, number of biting bouts and number of bites within a bout by both the performer and receiver were recorded. There was no significant difference between the three density treatments in wool-biting frequency, suggesting the density did not influence the wool-biting behaviour in housed sheep.

4. The influence of food types and their effect on repressing wool-biting behaviour in housed sheep

Ten sheep and three forms of roughage (hay bales, rolls and cubes) were used. The wool-biting frequency associated with hay bales was significantly higher than that associated with rolls ($P < 0.05$) and cubes ($P < 0.05$); however, there was no significant difference between rolls and cubes. Wool-biting significantly decreased after feeding with hay rolls ($P < 0.05$). The results suggested that rolled hay provide sheep with appropriate oral stimulation, thus decreasing their post-feeding wool-biting behaviour.

5. The proportion of rolled hay in the feed and its effect on repressing wool-biting behaviour among housed sheep

Sixteen sheep divided into four groups, and 4 treatments differed in the proportion of rolled hay and baled hay were used in this study. Behavioural observations were made once a day 2 h after feeding (16:00–18:00) for 2 days a week continuously for 4 weeks. The individual number, number of biting bouts and number of bites within a bout by both the performer and receiver were recorded. The wool-biting frequency was highest in the 100% baled hay treatment, and was no significant difference between the other three treatments. The result suggests that the rolled hay provides sufficient oral stimulation, even in a quantity, and has the effect of restraining wool-biting behaviour.

Here the wool-biting behaviour in housed sheep was associated with foraging frustration due to a lack of appropriate oral stimulation from the roughage in their daily food. This behaviour can be repressed by changing the type of roughage in their food to elicit normal foraging movements of sheep, and this effect is dependent on the quality not the quantity of the appropriate oral stimulation. The findings suggest that sheep fed with rolled-type roughage provided them with a more appropriate oral stimulation, and this repressed the wool-biting behaviour. In addition, the wool-biting behaviour was less related to social factors, such as dominance and density. However, a remarkable individual difference existed among sheep, where some individuals engaged in wool-biting much more than their pen-mates.

This finding indicates that the wool-biting behaviour can be controlled facilely, balancing animal welfare and the cost incurred by the mainly indoor sheep industry.