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## Changes in rumination behaviour after abrupt or diluted-milk weaning methods in goat kids

HBR Freeman, JR Webster and G Zobel\*

*AgResearch Ltd., Ruakura Research Centre, 10 Bisley Road, Private Bag 3123, Hamilton 3214, New Zealand.*

\*Corresponding author. Email: gosia.zobel@agresearch.co.nz

### Abstract

Rumination development is vital during weaning, when kids are transitioning from a reliance on milk to hard feeds. This study analysed rumination behaviour prior to, and following, two weaning methods: abrupt milk removal, and dilution of milk with water; both are common weaning practices on farm. We hypothesised that the dilution weaning method would better prepare kids to cope with the transition to full rumination. Thirty, 13-week-old Saanen cross goat kids were housed in pens of five. Two kids were nominated, for observation, from six pens (n=6/treatment). Kids had free choice access to hay, straw, water and a pelleted ration. Rumination behaviour was continuously recorded for two 24 h periods, before weaning and after weaning. Weaning treatment had no effect on rumination behaviour, though, both daily rumination time and number of boli regurgitated increased following weaning (3.6 vs. 5±0.4 h/d, and 289 vs. 403±29 boli/day). Rumination may be unaffected by using either weaning method, provided the kids have had access to forages and are not weaned too early. Early development of rumination allows kids to cope with milk removal and the switch to solid food, and quantifying its development is important to create best practice guidelines for the weaning period.

**Keywords:** dairy goat; milk removal; behaviour

### Introduction

Rumination, the regular regurgitation and remastication of ingested food from the rumen, is a vital behaviour for goat welfare that has been associated with healthy development in ruminants (Khan et al. 2016) as well as reduced stereotypic (abnormal) behaviour (Lindström & Redbo 2000); stereotypies are repetitive, maladaptive behaviours, associated with poor welfare and behavioural frustration. The onset of rumination occurs with the intake of solid food and becomes increasingly important following weaning. Without human intervention, weaning occurs gradually, with the mother reducing milk feedings, in both frequency and volume, whilst the young increase their forage intake (Khan et al. 2011). A successful transition to full rumination after weaning is essential to ruminant welfare and has ongoing affects throughout their life.

In a commercial dairy setting, two commonly reported ways of weaning are to either abruptly stop supplying milk, or to dilute the milk incrementally with increasing amounts of water (with no change in volume). An abrupt switch to a solid food diet may have negative consequences for rumination behaviour after weaning, and thus, goat welfare may be compromised. The aims of the paper are to establish the effects on rumination behaviour of two different weaning methods, abrupt milk removal and dilution of milk with water. It is hypothesised that more gradual weaning, through increasing, incremental dilution of the kids' milk replacer, will increase their rumination behaviour leading up to complete weaning, relative to abruptly weaned kids. We believe the more gradual weaning method will better prepare the young goats to cope with the transition to full rumination.

### Materials and methods

This study was approved by AgResearch Ltd, Ruakura Animal Ethics Committee (13685), and was undertaken in October of 2015.

Thirty, 13-week-old Saanen cross kids were housed indoors, in six pens of five goats. Pens were 2.65 x 3 m, bedded with wood shavings, and with solid plywood sides to prevent interaction with neighbouring pens. Pens were built inside a larger goat housing facility, which has slatted walls and skylights, to allow natural light into the building. Artificial lights were switched on at 07.15 and off at 17.30.

Three pens were assigned to the abrupt treatment, and three to the dilution treatment. Both treatment groups received milk replacer powder (Anlamb™) diluted in water. The kids in the abrupt treatment were given milk for the first 8 days of the experimental period and none was offered after day 8. Kids in the dilution treatment received the normal allocation during days 1 and 2 (same as abrupt treatment), and then the milk was diluted to 75% of the usual milk powder concentration (same volume) on days 3 and 4, 50% on days 5 and 6, and 25% on days 7 and 8, after which milk was discontinued (Table 1).

Two focal goats were nominated from each pen (six per treatment) for observation. Due to near infrared lighting being used for night-time vision, only white or beige goats were nominated. Kids were weighed on day 2, and the focal goats weighed 20±4 kg (mean±SD).

Before weaning, goats were given milk *ad libitum* twice daily for 30 min at 08.40 and 16.30. Throughout the trial goats had *ad libitum*-access to water, pasture hay (DM: 91%, CP: 14.5% DM, NDF: 51.8% DM, ME: 8.5 MJ/kgDM), straw (DM: 95%, CP: 4.7% DM, NDF: 74.3% DM, ME: 5.3 MJ/kgDM) and Dunstan Keg Fibre Plus pellets (Dunstan Nutritional Limited).

**Table 1** Weaning treatment plan showing milk concentration percentages across time. Goats were fully weaned from milk powder on day 9. Behavioural observations were made on days 1 and 10. Kid weights were recorded on day 2.

Treatment	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Abrupt (milk powder allowance, %)	100	100	100	100	100	100	100	100	-	-
Dilution (milk powder allowance, %)	100	100	75	75	50	50	25	25	-	-

All observations were made from video, recorded using HIKVISION Network cube cameras and a HIKVISION digital video recorder (Hangzhou Hikvision Digital Technology Co., Ltd). A single camera was able to record a single pen, and mounting enabled lateral observations of animals. Adobe Premiere Pro software was used to view the videos. Two sets of twenty-four hour observations were made for each focal goat, from 01.15 on day 1 to 01.15 on day 2, and 00.00 to 24.00 on day 10 of the trial (difference in period due to loss of video between 00.00 and 01.15 on day 1). The first observations (day 1) occurred eight days before complete weaning and two days before dilution treatment commenced; the second observations (day 10) occurred two days after complete milk removal (Table 1).

The number and duration of each boli regurgitated was recorded. Boli durations (time spent chewing boli) were taken from the start of each bolus regurgitation until swallowing. A rumination bout was defined as a period of successive boli regurgitations followed by a period of at least 120 seconds where no regurgitation occurred (Kaske et al. 2002). Total rumination time was taken as the sum of rumination bouts. If the focal individual was obstructed by an obstacle whilst regurgitating or swallowing a bolus, then that bolus was removed from calculations of bolus duration (56/8304 boli removed). Total time missing due to goats being obstructed by an obstacle was 1% of total observation time (obstacles include: other goats, pen walls, and water and milk feeders). Observations were completed by one person, and intra-observer reliability was high, with a weighted kappa value of 0.89 (95% confidence interval 0.83-0.95;  $P < 0.0001$ ).

The effect of each weaning treatment and time period relative to weaning (before and after) on daily rumination time (h/d), number of boli regurgitated (boli/d) and mean bolus duration (sec/boli) was determined PROC MIXED (SAS, 9.2). Data is presented as mean  $\pm$  SED. Weight was included in the initial mixed models as a covariate, but was removed from the final model as it had no effect.

## Results

Treatment had no effect on any measure of rumination in this study. However, after weaning there was an increase in daily rumination time (3.6 vs.  $5.0 \pm 0.4$  h/d), and number of boli regurgitated per day (289 vs.  $403 \pm 29$  boli/d), though no change in the average bolus duration was noted ( $32$  vs  $35 \pm 2$  s/boli).

## Discussion

This study hypothesised that diluting the concentration of milk replacer provided to kids, leading up to complete weaning, would encourage more rumination behaviour.

However, this was not supported; there was no difference in rumination behaviour between the treatment groups.

There may be several reasons why no difference between treatments was found. Ingestion of solid feed stimulates rumination, improves rumen motility and causes rumen development (Khan et al. 2016). These goats were provided solid feed (pellets) from four weeks of age onwards and during the trial were allowed *ad libitum* access to several sources of forage. Secondly, rumination also develops with age, and these goats were weaned 10 days later than on an average New Zealand farm (mean of  $87 \pm 13$  days; Deeming et al. 2016). Both of these factors may have allowed these goats to develop successful rumination regardless of weaning method. Finally, the dilution of milk may not stimulate rumination as there is no reduction in liquid volume ingested. Individual solid feed consumption was not available for the present study, however, Neilson et al. (2008) found that calves weaned by dilution, rather than by reducing volume, consumed less solid feed. Therefore, dilution weaning may not emulate natural weaning sufficiently to stimulate the transition to solid food more than abrupt weaning.

Regardless of treatment, kids increased daily rumination time after weaning, and did so by regurgitating more boli, rather than masticating each bolus for longer. This suggests that the temporal pattern of rumination behaviour (timing of regurgitation, remastication and swallowing) is well developed by 13 weeks of age before weaning, and simply increases in frequency after weaning. In this study, daily rumination time was calculated using 120 seconds as a threshold to distinguish separate rumination bouts (Kaske et al. 2002). However, further analysis is needed to determine if this is appropriate for kids as thresholds varying between 30 seconds (Schirmann et al. 2009) and six minutes (Gross et al. 1995) have been used in other studies, depending on the sampling method and ruminant species.

There may be no effect on welfare (in terms of rumination) by either abruptly stopping milk access, or diluting the milk with increasing amounts of water, as long as kids have had access to forages and are not being weaned too early. However, some New Zealand farmers wean their kids earlier than in this study (Deeming et al. 2016); therefore, it is pertinent that future work assess an age threshold that may negatively impact rumination development, as well as how this may be impacted by type and timing of access to solid feeds prior to weaning.

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