--- Research Note ---

Effect of Delayed Supply with Solid Feeds on Water-Balance of Unweaned Calves

Tsunenori IRIKI, Reiko MATSUI, Masayuki FUNABA and Matanobu ABÉ

School of Veterinary Medicine, Azabu University, Sagamihara-shi 229

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In the early-weaning of dairy male calves, solid feeds are usually *ad libitum* fed as early as the beginning of feeding milk replacer. However, the analysis of data for 196 calves that were purchased at about 1 wk of age from a livestock market suggested that the incidence of diarrhea would be lower when solid feeds were offered from the 3rd wk after introduction than when supplied from the 1st wk. The causes of the difference are not known in detail, although it is easily supposed that too much inflow of non-milk components into the lower gut would not be preferable to infant calves.

The present study was conducted to examine the water-balance of purchased calves that were given solid feeds either from the 1st wk or from the 3rd wk after introduction.

Materials and Methods

*Animals*: Six Holstein male calves weighing 44±4 kg were used in the experiment. They were selected out of 22 infant calves purchased at about 1 wk of age from a livestock market in the southern part of Ibaraki Prefecture by a physical checkup (hematocrit, total protein and γ-globulin in the serum, and salmonella and coccidium in feces). During the checkup-period for three days after introduction, all calves received daily 400 g commercial milk replacer in two equal quantities and vitamins A, D and E (Adeptosoluble®, Mitaka Seiyaku, Tokyo) and antibiotics (Amipenix Dry Syrup®, Toyo Jozo, Shizuoka).

*Milk replacer, solid feeds and water*: On the 4th d after introduction, the selected healthy calves were individually stalled in metabolic cages and divided into two groups. Three calves (Group A) were given free access to commercial calf starter (10.5% moisture) and rice straw chopped into about 3 cm (9.5% moisture) in addition to daily 500 g commercial milk replacer (3.7% moisture) throughout the experiment for 4 wk. The other three calves (Group B) received daily 500 g milk replacer without solid feeds for the first 2 wk, and then...
given free access to calf starter and chopped rice straw in addition to daily 500 g milk replacer for the next 2 wk.

The milk replacer used in the experiment was same one as that given during the check-up-period, and offered from buckets by suspending a half the daily amounts in 1.8 l warm water at 8:30 and 16:30 every day. Additional water was not given for the first 2 wk of experiment, but 1 and 1.5 l of warm tap water were given to all calves every day at 12:30 in wk 3 and in wk 4, respectively.

Water-balance trials: For 5 d each in wk 2 and in wk 4, urine and feces were entirely collected, and daily intakes of solid feeds and water were measured.

Total water intake was obtained as the sum of moisture originally contained in feeds, water used for suspending milk replacer and tap water additionally given. On the other hand, the sum of urine volume and fecal moisture was regarded as total water excretion. The difference between total water intake and total water excretion was defined as an apparent water retention (AWR). Although the AWR includes the evaporation of water from the body surface and the lung, the effect can be assumed to be similar in the two groups because of both being under the same environmental condition throughout the study.

Statistics: Data were subjected to one-way analysis of variance.

Results and Discussion

The water-balance, fecal moisture content and daily gain (DG) in wk 2 and in wk 4 are presented in Table 1.

In wk 2, urine volume was significantly less (P<0.05) in Group A which received solid feeds from the 1st wk after introduction than in Group B given solid feeds from the 3rd wk. On the other hand, significantly more water was excreted into feces (P<0.05) and the fecal moisture content was significantly higher (P<0.03) in Group A. The DG and AWR tended to be higher in Group A, though not significant. Much higher values of AWR compared to DG would probably be due to the inclusion of evaporated water in the former.

In wk 4, little differences were detected in water-balance, fecal moisture content and DG between the two groups. In addition, feces of

Table 1. Water-balance, moisture content of feces and daily gain of calves in the 2nd and the 4th wk of experiment, in which solid feeds were offered from the start (Group A) or from the 3rd wk (Group B) (Means±SD for 3 calves)

<table>
<thead>
<tr>
<th>Water intake (ml/d)</th>
<th>Water excretion (ml/d)</th>
<th>Apparent water retention (ml/d)</th>
<th>Moisture in feces (%)</th>
<th>Daily gain (kg/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk replacer*</td>
<td>Tap water</td>
<td>Calf starter</td>
<td>Rice straw</td>
<td>Total</td>
</tr>
<tr>
<td>A</td>
<td>3,619</td>
<td>±0</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>B</td>
<td>3,619</td>
<td>±0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

| 4th wk |
|-------------------|------------------------|---------------------------------|-----------------------|------------------|
| A | 3,619 | 1,500 | 80 | 5 | 5,204 | 1,766 | 863 | 2,629 | 2,575 | 79.1 | 0.67 | ±0.22 |
| B | 3,619 | 1,356 | 79 | 6 | 5,059 | 1,799 | 660 | 2,459 | 2,600 | 78.3 | 0.81 | ±0.68 |

1) 500 g milk replacer (3.7% moisture) were suspended in 3.6 l warm water. *P<0.05, **P<0.03
2) 10.5% moisture.
3) 9.5% moisture.
4) Difference between total water intake and total water excretion. Evaporation loss is included.
both groups contained almost the same level of moisture as those of Group A in wk 2. Daily intakes of calf starter and rice straw were 766±210 and 53±23 g, respectively, in Group A, and 746±269 and 66±15 g, respectively, in Group B, suggesting a rapid development of the rumen in calves given solid feeds from the 3rd wk after introduction.

The ingestion of solid feeds in wk 2 decreased urine volume on the one hand, but increased fecal excretion of water on the other hand. Assuming that the evaporation loss was almost similar in both groups, the tendency to a higher AWR in Group A might indicate a net increase in water influx into digestive organs. The net increase would probably be due to an increased secretion of water, because both groups were given the same daily amount of liquid milk replacer without additional water to quench thirst in wk 2. In ruminants, secretion of water usually occurs at the rumen and the large intestine where microbial fermentation takes place. The ingestion of solid feeds in infant calves would cause not only a rapid development of the rumen but also an increase in solids flowing out of the rumen. The resultant activation of fermentation in the rumen and the large intestine might cause an increase in water secreted into both organs, leading to the shift of water excretion as well as the higher moisture content of feces.

The higher moisture content of feces in Group A does not always mean an increased incidence of diarrhea. From our own experience, apparently diarrheic feces of unweaned calves receiving solid feeds contained more than 85% moisture\(^1\). Usually, feces that contain 80% moisture and plenty of large particles appear more "normal" rather than those containing 70% moisture without rough particles, as are excreted by calves receiving only milk replacer. However, infant calves purchased from livestock markets are liable to occur diarrhea for the first 2 wk after introduction, because many factors including stress surrounding the introduction, decrease of antibodies from colostrum and transitional and abnormal multiplication of intestinal flora, etc. are piled up in this stage\(^2-4\). Provided that the increase in fecal moisture content is an inevitable consequence of ingesting solid feeds, it would not be preferable at least in the early stage of suckling, even if it might be only an indirect factor as the cause of diarrhea.

Our previous work\(^2\) indicated that the incidence of diarrhea in bought-in calves would be lower when solid feeds were offered from the 3rd wk after introduction as compared with the case of giving solid feeds from the 1st wk, and that weaning would not be delayed by the delayed supply with solid feeds in spite of a possible depression of growth in the early stage. Present results are considered to support the previous work.

References