A POSSIBLE FACTOR INFLUENCING THE ASSIMILATION OF CALCIUM.*

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Hart and associates (1) have shown that milking goats, when fed a green feed, have been able to utilize the calcium to a higher degree than when fed dry feed. They state that “apparently there is something having its source in fresh green materials, which controls or assists calcium assimilation.” Hart and associates (2) have also reported evidence secured with milking cows that it is possible to maintain calcium and phosphorus equilibrium on a ration of grain and dry alfalfa hay—the hay having been cured under caps. These results are contrary to those of Forbes and his coworkers (3) and even to their own later findings (4), when they obtained a negative calcium balance with milking cows on a similar ration. The alfalfa hay in the latter case was cured in windrows for 4 days. They state “these differences in effect of the two alfalfa hays may be attributed to a difference in the degree of destruction during the curing process of the vitamine assisting calcium assimilation.”

Working on the hypothesis that most of the calcium, in whatever combination it may be, in the cells of green plants is in a highly dispersed form and hence better assimilated than the calcium in the dry plant, the drying of which no doubt causes a change in the physical properties of the cell and its content, we set about to imitate, in a rough way, the cell content as far as it represents our idea of the highly dispersed form in which the calcium exists in green plants. A starch paste was made up with a known solution of CaCl₂ (4 normal). Then an equal volume

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Assimilation of Ca

of Na₃PO₄ of the same strength as the CaCl₂ was added. The starch acted in a slight degree as a protective colloid for the calcium ion and the final product, Ca₃(PO₄)₂, was left in a highly dispersed form. This starch paste was added to the ration of grain and dry timothy hay, which in turn was fed to two milking goats. The grain mixture used consisted of 100 parts ground corn, 100 parts ground oats, 50 parts wheat bran, and 30 parts linseed oil meal. The proportion of hay to the grain mixture as fed was about as 1 is to 1 ½. No salt was given as such since it was formed in the reaction between the calcium chloride and the sodium phosphate.

The goats were mature animals in the beginning of their 4th (No. 5) and 5th (No. 2) months of lactation, respectively, and gave a milk yield of from 700 to 850 gm. per day. None of the

TABLE I.
Balance of Calcium and Magnesium.

<table>
<thead>
<tr>
<th>Date</th>
<th>Yield of milk per period</th>
<th>Calcium.</th>
<th>Magnesium.</th>
<th>Calcium.</th>
<th>Magnesium.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1921</td>
<td></td>
<td>gm.</td>
<td>gm.</td>
<td>gm.</td>
<td>gm.</td>
</tr>
<tr>
<td>Oct. 13 to 20</td>
<td>6,026</td>
<td>39.46</td>
<td>15.38</td>
<td>5.35</td>
<td>1.08</td>
</tr>
<tr>
<td>Oct. 27 to Nov. 8</td>
<td>10,585</td>
<td>62.31</td>
<td>24.60</td>
<td>9,093</td>
<td>55.31</td>
</tr>
</tbody>
</table>

parts ground oats, 50 parts wheat bran, and 30 parts linseed oil meal. The proportion of hay to the grain mixture as fed was about as 1 is to 1 ½. No salt was given as such since it was formed in the reaction between the calcium chloride and the sodium phosphate.

The goats were mature animals in the beginning of their 4th (No. 5) and 5th (No. 2) months of lactation, respectively, and gave a milk yield of from 700 to 850 gm. per day. None of the
goats was bred. They were confined in the metabolism crates designed by Dr. Forbes for hogs. The test was carried on for a period of 26 days, preceded by a preliminary period of 10 days. The 26 day period was divided into three periods of 7, 7, and 12 days, respectively. The goats were milked and fed twice daily. The excreta were collected quantitatively. The methods used for the determination of calcium and magnesium were the same as those given in Ohio Agricultural Experiment Station Bulletin 363. All determinations were made in triplicate. The results are recorded in Table I.

DISCUSSION.

Our results show (Table I) that five of the six complete accountings of the calcium were positive or in equilibrium, while one was negative. This negative balance may be due to the fact that the animal, No. 5, refused to eat the last 288 gm. of mixed feed. Part of this had been accumulating for a day or two and, no doubt, had lost some moisture. When this was analyzed and subtracted from the apparent positive balance, a negative balance was the result. The magnesium balances were all negative. This may be due to the physiological antagonism between calcium and magnesium or it may be due to an insufficient intake. The results as far as the calcium balances go were a little surprising to us, especially after we had failed in a previous trial which will be reported later, to obtain a positive calcium balance on a dry ration and a mineral supplement. We realize that the animals were in a later stage of lactation in this trial than in the one 2 months previous when a negative calcium balance was obtained, with practically the same intake, and this may be the factor affecting our results, but the data presented here raise a question that we believe is worth some consideration.

The cow may be a more highly specialized animal than the milking goat, and whether similar or identical results can be obtained with milking cows remains to be seen.

A vitamine, or the vitamines, resident in green plants and properly cured alfalfa hay, as reported by Hart, may play an important part in the assimilation of calcium, yet we believe the difference can be partly attributed to the difference in the physical properties of the cell wall and cell content of green and dry hay and, there-
fore, a difference in the digestibility. It is true that drying causes a reversible or irreversible change in an artificial colloidal system, depending upon the presence of a protective colloid, and we have reasons to believe that a similar change takes place in the plant when it dries, and if such is the case then the highly dispersed materials coalesce and form larger aggregates and these large aggregates may be less permeable to the digestive juices than the highly dispersed material and, therefore, not so readily digested and assimilated. It is not our intention to leave the impression that this is the only difference in the green and dry plant or that this is the only factor in causing the difference in the assimilation of calcium. If our results are only the effect of adding a calcium supplement then they are contrary to those of Forbes and co-workers (3), Hart and associates (4), and our unpublished data.

SUMMARY AND CONCLUSIONS.

1. The calcium balance in two milking goats was favorably influenced by feeding tricalcium phosphate, which was precipitated in a starch paste. This influence may be due to the fineness of division of the tricalcium phosphate.

2. The results of this experiment seem to indicate that possibly the difference between green and dry hay in causing a difference in the assimilation of calcium is partly due to the difference in the physical properties (fineness of division) of the cell content of the two hays and, therefore, a difference in the digestibility.

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