STUDIES ON PROTEINS FROM BOVINE COLOSTRUM

III. THE HOMOLOGOUS AND HETEROLOGOUS TRANSFER OF INGESTED PROTEIN TO THE BLOOD STREAM OF THE YOUNG ANIMAL*

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It has been adequately demonstrated that the new-born calf and kid acquire antibody proteins from ingested colostrum (1). These immune proteins appear in the blood stream of the young animal in a form immunologically indistinguishable from that in the colostrum (1). This apparent passage of intact protein through the gastrointestinal tract of the calf and kid is characteristic of the first few days of life (1, 2).

The proteins of colostrum whey of the cow, goat, and pig are similar in that the principal fraction is globulin in nature (arbitrarily called "immune" globulin) with a low electric mobility (3, 4). The "immune" globulins of cow colostrum have been reported (4) to migrate in an electric field at a faster rate than the corresponding proteins of goat and pig colostrum. This difference in mobility has been used to study, by electrophoresis, the apparent gastrointestinal absorption of these colostrum proteins by the young kid. Further, immunological tests have been employed to study the possible transfer of normal milk "immune" protein from the gastrointestinal tract to the blood of the new-born calf. The results of both the electrophoretic and the immunological studies are reported here.

Methods

Colostrum samples were taken from the goat, cow, and pig immediately following parturition. Each sample was divided into two portions. One portion was fed ad libitum to a newly dropped kid. Electrophoretic analyses were performed in duplicate on the second portion of each colostrum whey after dialysis at 0°, first against several changes of saline, then finally against two changes of the barbiturate-citrate buffer used previously (2). Blood serum samples were taken from the jugular vein of each kid at birth and 24 hours after feeding and analyzed electrophoretically. The results were computed as in earlier studies (2).

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Three groups of new-born calves were separated from their dams before nursing and treated as follows: One group (control) was fasted 24 hours, the second group was fed milk from cows in mid-lactation, while the third was fed cow colostrum. The calves were bled from the jugular vein at birth, then again at 24 hours, and the serum was separated for the immunological studies.

Rabbits were immunized to the purified cow colostrum pseudoglobulin described previously (5). Serum from the immune rabbits (two to three per group) was collected and pooled. The possible presence of specific antigen proteins in the sera of the calf was studied by conventional precipitin tests. Various dilutions of the sera under test were placed in layers above the immune serum and turbidity was estimated visually after a 2 hour incubation period. In check determinations, turbidity was also estimated in the Beckman spectrophotometer at 660 mμ.

Results

Colostrum Feeding—The various colostrum whey electrophoretic patterns were observed to be similar to those described by Deutsch (4), and are therefore not presented in detail; however, the percentage and mobility of the “immune” component of each whey studied is given in Table I. The principal component of cow colostrum exhibited decidedly greater mobility (−2.7 × 10⁻⁸ sq. cm. per volt per second) than either of the corresponding components from goat and pig colostrum. It was not possible to distinguish between the “immune” components of goat and pig colostrum electrophoretically.

The serum of the kid at birth contains very little, if any, protein corresponding to the adult γ-globulin fraction (Fig. 1). This may perhaps be inferred from an analogy to results of the studies with the calf (6). Following ingestion of each of the three colostrum milks studied, there was a striking increase in the “immune” proteins of the goat serum. In the case of the animal receiving the cow colostrum, half (49.8 per cent) of the serum proteins was acquired from the ingested milk, while in the animals fed goat and pig colostrum, this newly acquired protein amounted to 40.2 and 26.7 per cent, respectively, of the serum proteins. As ad libitum feeding was permitted, it is not possible to compare the magnitude of the serum changes between the various animals, following the ingestion of colostrum from the different sources.

The electrophoretic mobility of the newly acquired protein in the kid serum in all cases was identical to the mobility of the principal whey component of the ingested colostrum (Table I). From an electrophoretic standpoint, no alteration in the protein appears to have occurred in the change from colostrum to the blood of the kid. The similarity of the colos-
trum "immune" proteins from the various sources studied is emphasized by the striking change in the serum of the new-born goat following their ingestion; this similarity is evident in spite of the mobility differences. The young animal demonstrates considerable selectivity in this reaction to ingested proteins as evidenced by the failure of other colostrum and milk

**Table I**

*Absorption of Colostrum Proteins by New-Born Goat As Measured by Electrophoresis*

The electrophoretic analyses were performed at 1° in a barbiturate-citrate buffer at pH 8.6 and ionic strength 0.088. Mobilities are negative in sign and are expressed as sq. cm. per volt per second $\times 10^{-4}$ and were calculated with reference to the salt boundary.

<table>
<thead>
<tr>
<th>Source of colostrum</th>
<th>% of whey proteins</th>
<th>Mobility</th>
<th>% of serum proteins</th>
<th>Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goat</td>
<td>50.2</td>
<td>2.0</td>
<td>40.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Cow</td>
<td>71.0</td>
<td>2.7</td>
<td>49.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Pig</td>
<td>63.0</td>
<td>2.0</td>
<td>26.7</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Fig. 1.** Electrophoresis patterns of new-born goat serum (A) prior to and (B) 24 hours after the ingestion of goat (1), cow (2), or pig (3) colostrum. The experiments were conducted for 120 minutes in a barbiturate-citrate buffer at pH 8.6.
proteins to appear in the bloodstream as shown by the electrophoretic studies.

**Immunological Studies**—Even before the ingestion of milk, the serum of the new-born calf gave decided evidence for the presence of protein immunologically similar to cow colostrum pseudoglobulin (Table II). This finding is unusual inasmuch as numerous workers (1) have clearly shown that specific antibodies are not present in calf serum until after colostrum feeding. The relation of this protein to the "immune" proteins and its position in the serum electrophoretic pattern is therefore of considerable interest; however, until isolation of this protein can be accomplished, the electrophoretic serum fraction with which it is associated remains a matter of speculation.

**Table II**

**Absorption of Proteins by New-Born Calf As Measured by Immunological Assay**

<table>
<thead>
<tr>
<th>No. of calves</th>
<th>Material fed</th>
<th>Time</th>
<th>Serum dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Serum 1 2 3 4 5</td>
</tr>
<tr>
<td>3</td>
<td>Control</td>
<td>Birth</td>
<td>+ + ± - - -</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 hrs.</td>
<td>+ + - - - -</td>
</tr>
<tr>
<td>3</td>
<td>Normal milk</td>
<td>Birth</td>
<td>+ + ± - - -</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 hrs.</td>
<td>+ + + ± - -</td>
</tr>
<tr>
<td>1</td>
<td>Colostrum</td>
<td>Birth</td>
<td>+ + + + + ±</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 hrs.</td>
<td>+ + + + + ±</td>
</tr>
</tbody>
</table>

Immunological tests indicated that the serum of the young calf acquires "immune" protein from the ingestion of normal milk (Table II). The suggested (7) similarity of globulins of colostrum and normal milk is thus further indicated. The magnitude of this increase is small, however, as evidenced by the failure of electrophoretic procedures to detect any change in calf serum following the ingestion of normal milk (2).

**SUMMARY**

New proteins appear in the bloodstream of young kids following the ingestion of goat, cow, and pig colostrum. No change in these proteins, measurable by electrophoresis, appears to have occurred during their passage from the colostrum to the bloodstream of the kid.

The serum of the new-born calf contains small amounts of proteins immunologically similar to colostrum "immune" proteins.

An increase in serum "immune" proteins of the young calf resulted from the ingestion of normal milk.
BIBLIOGRAPHY

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