Modifications of Human Milk Composition During the Early Stages of Lactation

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This chapter deals with the modifications of human milk composition during the early stages of lactation and the possible implications of these modifications as far as the needs of the newborn are concerned.

Figure 1 illustrates how difficult human milk is to work on, especially that from the first part of lactation (Fig. 1). This figure, based on results of a study carried out recently in Australia (3), shows the tremendous modifications that occur in milk composition during the prepartum period. The composition of prepartum colostrum remains quite constant, as far as lactose and total proteins are concerned (Fig. 1, top). Within a few hours after delivery, however, the composition of milk changes dramatically. Therefore, when one has to study the composition of milk during this period, it is very hard to present data representative of an average human milk composition.

Figure 2 compares the protein composition of human milk and of colostrum with that of cow's milk. This figure shows that there are major differences between human and bovine milks, and also important differences between human milk and human colostrum. Figure 2 top shows the differences in the proportion of casein and whey protein, and the fairly high proportion of low-molecular products containing nitrogen in human milk and colostrum. Among them is taurine, which might be important for the newborn.

Figure 2 bottom shows the differences in composition between human milk and cow's milk, human colostrum, and mature human milk as far as the individual whey proteins are concerned. It is well known that a given protein exists only in a single species; that is to say, when comparing two species, one generally finds similar sets of proteins with similar functions, but in most cases, the homologous proteins are different. The more different the species, the more different the proteins. In Figure 2 bottom, for example, both human and cow's milks contain lactoferrin, but this does not mean that these proteins are identical. Indeed they are different. The proportions of the individual proteins are very different in the two milks. Furthermore, β-lactoglobulin, the main whey protein in cow's milk, is absent in human milk. Figure 2 bottom also shows the relative importance of lactoferrin and lysozyme in human milk. In any
case, the concentration of proteins is higher in colostrum than in mature milk, and this is true for all animal species.

Following is a review of data that have been obtained in collaboration with Dr. Gamarra. The study, which was carried out a few years ago, was concerned with the changes in the composition of human milk during the early days after
delivery. Two sets of data have been included in Fig. 3. Closed circles and triangles represent data obtained in collaboration with Dr. Gamarra, while open circles and triangles correspond to data obtained in another study by Atkinson et al. (2). The figure represents the variations in nitrogen content of samples of human milk collected from 76 women (49 women from our study and 27 from Atkinson's study). The scattering of points at any time after delivery is striking, thus clarifying the difficulties in deciding what a newborn needs in terms of protein during the early days. Only a range of concentrations, perhaps an average concentration, can be deduced from such a study. In fact, the purpose of our study was to compare milk from preterm and full-term mothers. Our results are quite similar to those of Atkinson et al. A statistical analysis was carried out on both sets of data. It indicates that there is no significant difference between the two types of milk as far as the nitrogen content is concerned, which is at variance with the conclusions drawn by Atkinson et al. (2) in 1978 and more recently by the same authors (1).

I would like to add that milk proteins have several functions. The first one
is obviously to provide the young child with nitrogen, essential amino acids, and calories. This may not be the only role of these proteins. Specific milk proteins such as IgA, lactoferrin, and lysozyme are supposed to have a physiological role; whether they play it or not is difficult to know. We have carried out several studies to discover if lactoferrin has any bacteriostatic activity in the gut of newborns, and for the moment we have not been able to show any such action, but this does not mean that it does not exist! There is an increasing number of components that are believed to play a role in the newborn gut, but apart from IgAs, in no case has this action been proved in vivo. For example, lysozyme has never been shown to interact in vivo with the bacterial flora of the gut. I believe that the only good data that have been obtained so far are those dealing with IgAs. The proportions and concentrations of IgAs of different classes in colostrum are quite different from one species to another. In human colostrum there is a fairly high amount of IgA and a low proportion of IgG. It is the opposite in ruminants. It now seems well established that IgAs directed against the microorganisms of the mother’s environment are present in her milk and protect the baby’s gut against them. The role, if any, of IgMs and IgGs in human milk is still unknown.

Human milk is certainly the best food for the human baby. But, apart from the hygienic aspect, this assertion is based mainly on the fact that human milk has been the only food for the human infant for more than 1 million years. More research is needed to establish its value on a sound scientific basis.
REFERENCES


DISCUSSION

*Dr. Semenza:* Milk, of course, contains a lot of hormones, and I imagine that they may well be of great importance for premature infants. I wonder if there are any data as to how much of a given hormone is present in milk at the beginning of lactation and how much it changes during lactation.

*Dr. Ribadeau Dumas:* Several investigators have studied the level of hormones in milk and especially of prolactin. It has been shown that prolactin is indeed present, but nobody knows whether it plays a real role in the gastrointestinal tract of the newborn.

*Dr. Shwachman:* Would you please comment on the accuracy or inaccuracy of the measurement of electrolytes in milk? I am specifically referring to the milk of women with cystic fibrosis. There was one report years ago that it is dangerous for a baby born from a mother with cystic fibrosis to be fed her milk. We have not been able to verify this information and the reason for this is the inaccuracy of the measurement of electrolytes in milk.

*Dr. Ribadeau Dumas:* I would like to say first that I am not a specialist of electrolytes, but I know something about the determination of electrolytes in milk. When one looks at results dealing with electrolytes one should verify when the figures were obtained. Nowadays, with appropriate techniques, the measurements usually give good-quality data. Atomic absorption and emission spectrometry are very accurate techniques.

*Dr. Ferguson:* You mentioned that the importance of IgA's in milk is well established. Your talk made me realize that I don't know of any study on the composition of milk in women who are IgA-deficient. Approximately one in 700 individuals is IgA-deficient, and most of these individuals have normal gastrointestinal function and no evidence of a predisposition to gastrointestinal infection. You may know of some work on the nature of the milk in IgA-deficient women. For example, is there a great deal more IgM under these circumstances?

*Dr. Ribadeau Dumas:* It is true that IgA may play a role, but something which has not been much emphasized in this meeting is important and this is the bacterial population of the intestine of the newborn. It is not only the population by itself that is important but also the pattern of establishment of this flora. Dominant bacterial species in the gut change with time after birth, and this occurs following a rather strict pattern. It may well be possible that in the children of IgA-deficient women, as it is the case in many normal children, the "good" flora establishes itself rapidly and remains in the gut, preventing the occurrence of pathogenic bacteria.