Human Milk vs. Cow's Milk

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THE beneficial effect of breast milk on infants has long been recognised. On the other hand, animal milk could serve as a nearly complete food for the adult. Milk substitute from soya bean (*Glycine hispida L*) or groundnut (*Arachis hypogœa*) may also occupy a place in the Indian dietary, especially since dairy milk supply is as yet inadequately small.

There exist many chemical and physical differences between human milk and unmodified cow's milk. They are both good sources of fat, protein and carbohydrate and are fairly good sources of vitamins and minerals.

Soya or groundnut milk being of vegetable origin is inferior to cow's milk and human milk, unless fortified.

Between human and cow's milk, there is a close similarity in composition. The sugar content of human milk is higher and the protein and mineral contents lower than that of cow's milk. What is more important, however, is the quality of the individual constituents of milk. And these seemingly small differences assume importance in the nutrition of the infant.

Fat: The fat particles in human breast milk are more finely dispersed than those in cow's milk. This fine dispersion of fat globules presents a greater surface to the action of lipases. Fat digestion is therefore easier, quicker and more complete.

Rigid exclusion of fat from an otherwise adequate diet of a variety of animals results in the delayed appearance of a deficiency syndrome. This deficiency has been shown to be caused by the lack of certain fatty acids which have come to be called the essential fatty acids. The fat in human breast milk contains at least 25% more of unsaturated fatty acids including these essential fatty acids : linoleic, linolenic, and arachidonic. The chief fats are esters of tripalmitin and triolein, of which the readily utilisable triolein comprises about 35%, a significantly larger amount than that found in cow's milk. The inclusion in the diet of fats rich in unsaturated fatty acids is of definite benefit in a majority of eczematous patients, even without other forms of therapy.

On the other hand, cow's milk is richer in volatile fatty acids namely, the caproic, caprylic and butyric acids. These acids have been found "somewhat irritating to the gastro-intestinal tract" resulting in gastro-intestinal disorders among infants.

The breast milk fat is retained 92.4% in the body whereas butter fat retention is 88.9%.

Protein: Human milk protein consists predominantly of lactalbumin whereas cow's milk protein is predominantly casein. The ratio of non-casein to casein protein in human milk is nearly four times that in cow's milk while the ratio of non-protein nitrogen to casein nitrogen in human milk is almost thirteen times that in cow's milk.

An examination of the essential amino acid make-up of the proteins of human and cow's milk reveals that the former suffers by composition, being especially low in tryptophan, lysine, methionine, phenylalanine, valine and

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histidine. It was formerly believed that mother's milk was superior to cow's milk in protein because of the higher biological value of lactalbumin as determined by studies on rats. This erroneous concept was based upon the deficiency of cystine in casein (major protein in cow's milk). However, it is now known that it is methionine, and not cystine, which is essential for growth; and that the casein and whey proteins of cow's milk contain all the amino acids necessary for growth. Human milk proteins are therefore not nutritionally superior to the proteins of cow's milk.

Whereas lactalbumin is in true solution in human milk, cow's milk protein is colloidally dispersed. By the action of acids in stomach and in intestine, human milk protein precipitates in the form of a fine, soft flaky curd which is easier to digest. Cow milk protein, on the other hand, forms relatively large and tough curds that hinder speedy digestion.

Nitrogen retention of cow's milk protein is of the same order as that of human milk protein.

Lactose: The milk sugar is exclusively lactose. The high lactose content of breast milk is beneficial to children. Lactose helps to foster normal intestinal function by encouraging the growth of, predominantly, specifically and beneficially, fermentative bacteria, such as *B. bifidus* and *B. acidophilus*. The lactic acid produced on fermentation creates an environment hostile to pathogenic bacteria and putrefactive products.

Lactose is known to exert a fat and protein sparing action. The lactose: protein ratio of human breast milk is normally as 4:1. In this proportion the lactose in human breast milk can exert an optimum protein sparing action. This ratio approximates to 1.25:1 in cow's milk.

Children receiving lactose derive other benefits. There is a greater retention of calcium and phosphorus in their body as also a lessened tendency to constipation or diarrhea among babies given breast milk or receiving lactose as basic carbohydrate of artificial feeding.

Vitamins: Both mother's milk and cow's milk are known to contain vitamin A and vitamins of the B complex. Milk is an excellent source of riboflavin. Other B vitamins present include thiamine, niacin, pyridoxine, pantothenic acid, inositol, choline, folic acid and B_{12}.

Human milk has more thiamine and particularly choline. Choline is a preventive factor for infantile cirrhosis. Cow's milk is a poor source of choline and causes a fertile ground for the infection of the liver by *B. coli*. Infantile cirrhosis is one of the very common cases observed throughout this country, especially in the South, among the orthodox Hindus who are strictly vegetarians. It is especially noticeable in children between six and twenty four months of age, a period when a child is gradually weaned and takes to rice diet i.e. changes over from a diet rich in protein to one poor in protein.

Human milk has more vitamin C than cow's milk. Both mother's and cow's milk are deficient in vitamin D. However, mother's milk provides some corrective within itself to offset this deficiency. Its high ratio of calcium to phosphorus and the greater solubility of the calcium are among these.

The vitamins in breast milk (together with those other nutritive elements closely interrelated with them) are normally sufficient to guard against subclinical deficiencies (such as those resulting in night blindness, anorexia, poor gastro-intestinal functioning, retarded growth, skin lesions, poor bone formation and capillary fragility) as well as against frank

cases of xerophthalmia, beriberi, scurvy and rickets. Cow's milk (as commercially available), on the other hand, is markedly deficient in ascorbic acid, contains less vitamin D than mother's milk and has a lower and more variable vitamin A content.

Minerals: Human milk is poorer in most minerals than milk from other species. It is strikingly low in chlorides and sodium. In its high proportion of organic phosphorus, human milk recalls the chemical peculiarities of plant embryos or the yolk of egg.

Of the trace elements present in milk are iron, copper and iodine. The first two are essential for hæmoglobin formation and the last for the proper development of the thyroid gland and therefore, for general growth. The lowest figure for iron quoted for human milk is higher than the highest in cow's milk. Its deficiency in cow's milk has long been regarded as one of its chief drawbacks from nutritional stand-point.

Digestibility: When one remembers that albumin is a more easily digestible form of protein than caseinogen, it is evident that there is here an important practical difference between the two milks.

When milk is treated with rennin or acid, its casein coagulates into a fairly firm mass in the case of cow's milk and into a soft, almost fluid coagulum in the case of human milk. The resistance of the coagulated material to a cutting edge is called curd tension. Curd tension (more accurately, curd particle size) serves as an index to the digestibility of a milk and its suitability for infant feeding. Cow's milk has an average curd tension value of 50 to 60 grams ; this may be as high as 100 with individual samples. In contrast, human milk has a curd tension value of zero. A curd of low tension as that formed with human milk is readily digested and there is less likelihood of its shielding such bacteria as may be present from the antiseptic action of gastric juice.

Comparing the nutritive value of a given amount of human milk with that of an equal quantity of cow's milk, one may say that both yield practically the same amount of solid nutrients ; but the fuel value of cow's milk is rather more than that of human milk, owing to the larger amount of fat which it contains. The difference, however, is not great, for 100 grams of cow's milk yield 66 calories and a similar quantity of human milk 62½ calories.

However, the superiority of human milk over cow's milk for infant feeding is indisputed. Attempts have been made to modify cow's milk in such a way that it shall be identical with human milk. Some of the methods aim at modifying the character of cow milk protein, caseinogen. In one of these, the change is brought about by simple heat treatment, and in others, by peptonising, citrating or by pre-coagulating the milk with lactic acid. The heat treatment destroys vitamin C in the milk ; the other treatments affect its flavour.

Attempt has been made to *humanise* cow's milk by diluting it with an equal amount of water, centrifuging and separating the fat rich fraction which contains all the fat of the original milk but only half the other ingredients. Sugar may be added. This method has its drawback in that the relative proportion of caseinogen and lactalbumin remains unaltered. This can be remedied by diluting the milk with whey, but is troublesome.

A powdered completely modified cow's milk approaching that of human milk is claimed to have been formulated by (i) replacement of the butter fat with a special blend of vegetable oil, (ii) adjust-

ment of Ca-P ratio and essential amino acids and (iii) addition of K, Fe, vitamin A, D, C and B complex to levels especially suitable for children.

In light of the facts regarding the profound qualitative differences in chemical composition between human and cow's milk, one must conclude that it is impossible to modify the latter so that it shall be identical with the former. In other words, a truly *humanised* cow's milk is a chemical impossibility.

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