

**NUTRITIONAL EVALUATION OF COW  
AND BUFFALO MILK BASED  
INFANT FOOD FORMULAE**

**BY  
HARINDER BINDRA**

**1979**

**DIVISION OF HUMAN NUTRITION AND DIETETICS  
NATIONAL DAIRY RESEARCH INSTITUTE  
(I. C. A. R.)  
KARNAL (HARYANA)**

**NUTRITIONAL EVALUATION OF COW  
AND BUFFALO MILK BASED  
INFANT FOOD FORMULAE**

*BY*  
**HARINDER BINDRA**

**A DISSERTATION  
SUBMITTED IN PARTIAL FULFILMENT OF  
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**1979**

**Division of Human Nutrition and Dietetics  
NATIONAL DAIRY RESEARCH INSTITUTE  
( I. C. A. R. )  
KARNAL (HARYANA)**



**DEDICATED TO MY MUMMY AND PAPA**


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I, hereby, certify that the thesis entitled "Nutritional Evaluation of Cow and Buffalo Milk based Infant Food Formulae" submitted in partial fulfilment of the requirement for the Degree of M.Sc.(Dairying) in Human Nutrition and Dietetics to the University of Kurukshetra, embodies the result of a bonafide research carried out by Miss Harinder Bindra under my guidance and supervision and that no part of this has been submitted for any other degree or diploma.

I further certify that such help or source of information as has been availed of in this connection, is duly acknowledged by her.

  
(A.D.DEODHAR)

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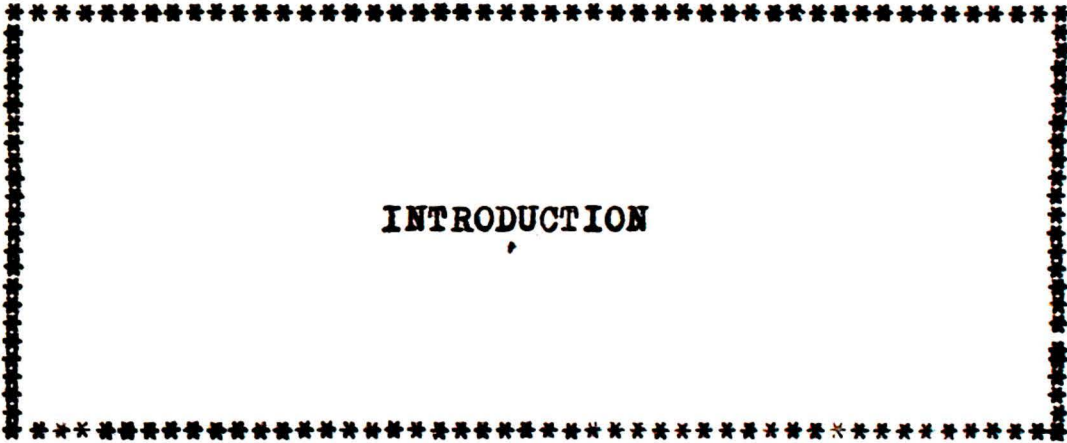
Finally the author wishes to thank all her friends and colleagues who have been very kind and tolerant to the inadequacies of this author.

*Harinder*

(HARINDER BINDRA)

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**INTRODUCTION**

## INTRODUCTION

Milk has been well recognized as an ideal food for the mammalian new born. Man has adopted milk of domesticated animals from other species in his dietary habits, since the dawn of civilization. Compositional differences in milk existent among various species, as pointed out by Kon (1959), however, assume a unique significance especially in the nutrition of an infant in the early stage of life. Merits of human milk in the infant nutrition are apparent in its characteristic chemical composition and nutritional value apart from its availability in most conducive form. Human milk is endowed with additional virtues, like presence of wide

spectrum of antimicrobial resistance factors, immunoglobulins, lactoferrin, leukocytes, macrophages, lymphocytes and comprising of physicochemical properties (Chandra, 1978; Bullin, 1976 and Mafa, 1978).

In view of the aforesaid the desirability of breast feeding practices has been critically evaluated by various nutritionists and it has now been advocated to breast feed the baby in her early stage of life, particularly by women in population from developing and underdeveloped countries (Aitken et al. 1960 and Jelliffe, 1971). Breast feeding practice is also highlighted in the light of its contraceptive value and economic significance.

• However, because of several factors such as physical or physiological inability of the mother to successfully nurse the baby, effect of urbanization, onset of pregnancy etc, it often becomes necessary to artificially feed the child." While the use of milk from domesticated animals such as cow, buffalo, and sheep are often employed with slight modification by population in many developing countries, mothers from affluent countries often resort to infant food formulae, based on dried milk powders and tailored to meet the requirements of the growing infant, in respect of macro and micro nutrients. Though majority of such preparations prevalent in the western countries

are based on cow milk, the situation is markedly different in a country like India, where milk from other species such as buffalo, forms a significant portion of the total milk production. Several attempts have been made in the recent past towards humanization of buffalo milk (Swaminathan et al. 1968 and Ganguli, 1976). Conspicuous differences in the major constituents of buffalo and cow milk as evident in differences in the pattern of milk proteins and also in the quality and quantity of milk fat, raise an important question whether the infant food preparations based on milk from these species would behave differently when fed to an infant. Studies conducted so far, have been observed to be focussed chiefly on cow milk-based preparations.

Keeping in view the differences between cow and buffalo milk composition, further reflecting in the formulation based on them, the present study has been undertaken to have the comparative evaluation of certain nutritional aspects of infant food formulations based on cow and buffalo milk.



**REVIEW OF LITERATURE**

## REVIEW OF LITERATURE

Methods of infant feeding are primarily comprised of blend of biological constants modified by cultural factors, ancient and modern alike and are profoundly influenced by local dietary habits. Scientific medical revolution undergone during past two decades, coupled with the influence of urbanization in the recent past, have led to the consideration that infant feeding is a sort of technique by which a child is nurtured with mathematically calculated quantum of known nutrients and delivered mechanically from a feeding bottle.

Breast feeding practice upto first six months of infancy, has been unequivocally recommended by pediatricians all over the world. However, as a result of various factors ranging from physical and physiological to socio-economic, mother often fails to successfully feed a baby on her breasts.

Surveys carried out by Ross and co-workers (1951) on British subjects during 1930 - 1950 showed that the breast feeding practices even during early stage of lactation, markedly declined from about 77 percent in the year 1929 - 1930, to 36 percent in the year 1949. Similar observations were made later by Spence and co-workers (1954). It was observed that urbanization, social inconvenience, and lactation failure were the prime factors responsible for this condition. The influence of the sophistication of the community on the tendency of the mother to breast feed her child could be evident from almost total breast feeding practices at 6 months in a rural Indian community, in contrast to meagre 12 percent by second month of lactation among certain American communities (Hytten et al. 1960). Physiological inability of the mother to secrete adequate amount of milk was observed to be another important factor among Mexican women, by Vega Franco and co-workers (1977). Other medical reasons for lactation failure and also the

necessity of the mother to work, were equally important factors. Apart from these considerations, other reasons such as beliefs about superiority of bottle feeding over breast feeding, emotional interference with a critical let down reflex related to anxiety and uncertainty were found to be equally responsible (Jelliffe et al. 1978 and Carballo et al. 1977).

In addition to factors mentioned above responsible for decline in breast feeding practices Ghosh et al. (1978) in their studies on Indian mothers reported that the decline in breast feeding is as well due to illness of mothers or babies, occurrence of next pregnancy, misconceptions about the adequacy of milk in meeting the requirements of the baby and claims made in the commercial advertisements, about artificial infant foods. Adverse effect of the educational status on the lactation performance has been reported among African population in Uganda by Welbourn (1958).

Under such circumstances mother has to rely on milk from other species i.e. cow, buffalo or goat. But employment of milk from domesticated animals in feeding infants in the event of inability of the mother to feed her child, is often confronted with several limitations, mainly the compositional differences and unhygienic <sup>n</sup>environment. Further, despite of attempts to narrow the gap between the

chemical composition of breast milk and that of other milks, the level of milk nutrients is often awfully inadequate to meet the growing nutritional needs of an infant. Thus, human as well as cow milk are inadequate in supplying adequate quantity of iron, vitamin D, and vitamin C. Although human milk fat provides fair amounts of essential fatty acids, cow milk fat proves unequal to meet this task, when solely fed to the child. The levels of B-group vitamins often prove to be too low to meet the growing requirements of an infant. Keeping in view these crucial points about infant nutrition among less fortunate infants deprived of mothers milk, several attempts have been made in the past few decades to formulate artificial infant foods, based on milk from different species.

By and large commercially available infant food formulations are based on skimmed or whole milk powders appropriately supplemented with limiting nutrients, to make it nutritionally compatible to meet the infant needs.

Data on the proximate composition of large variety of infant food formulae, based on either cow or buffalo milk appear to be identical. It was reported that the protein content in such preparations ranged between 22 - 27 percent, fat, between 14 - 18 percent and total carbohydrate between 45 - 55 percent (Chandrasekhara et al. 1960 ;

Seiffert, 1968; Udani et al. 1970; Ivanov et al. 1971; Jayasuriya and Soysa, 1974 and El-Ella et al. 1976). In most of these preparations the ratio of proteins to total calories was fairly identical. The total mineral contents ranged between 0.4 - 0.5 percent. It was further observed that supplementation with substantial degree of fat soluble and water soluble vitamins was practised to counter the inadequacies of dried milk base to provide adequate amounts of these nutrients. The content for these vitamins compared fairly well for different formulations.

#### Carbohydrates -

The major carbohydrate component in most of infant food preparations is milk sugar, lactose. However, to make it economically more feasible, various other disaccharides like dextri-maltose and sucrose, have also been employed in certain infant food preparations, yielding total carbohydrate contents about 6 percent after reconstitution (Olivi et al. 1967; Ivanov et al. 1967 and Andreevskaya et al. 1972).

#### Protein -

The high level of protein maintained in the formulae are in conformity with the higher requirements of essential amino acids in the diet of an infant in the state of rapid growth. The amount of protein available from artificial

infant formulae is somewhat higher than that attained when the child is breast fed. These are adjusted in such manner, since proteins from milk of other species, from cow in particular, are not as effectively utilized as human milk proteins. A striking difference between human and cow milk is the ratio of casein to whey proteins, which determines the digestibility of milk proteins in the stomach. The ratio of casein : lactoalbumin ranges between 1 : 1 in the case of human milk as against 6 : 1 in cow milk (Ewerbeck, 1953; Giordano, 1960; Deb and Cama, 1962 and Ganguli, 1976).

The essential amino acid composition of the protein of different milks are more or less similar and sufficient to meet the requirements of the growing infant (Holt and Snyderman, 1961). Some of these amino acids are provided in greater concentration as compared to what is required by the body. Selma et al. (1956) conducted a feeding trial on normal male infants of 1 - 5 months age and reported that the lysine requirement was less than 90mg/kg/day. Further it was observed that infant fed according to normal cow milk formulae receive at least three times this amount of lysine, as compared to breast fed infants.

#### Fat -

Human milk fat contains more unsaturated fatty acids as compared to fat from other species, that is cow and buffalo milk. Keeping in view this fact the cow milk fat

is replaced by vegetable fats. In some proprietary milk foods for infants the milk fat was replaced by olive oil or mixture of coconut, maize and olive oils (Spata, 1967 and Berio et al. 1970).

In the recent years sunflower oil and maize oil are being used to replace butter fat in order to increase the content of unsaturated fatty acid (Kozin et al. 1971; Sina, 1974 and Widdowson et al. 1974). In some preparations combination of coconut and maize oil has also been used (Rodini et al. 1974 and Fomon et al. 1976).

Various workers have reported that the fat content of infant food formulae ranges between 14 - 18 percent (Chandrasekhara, 1960; Udani et al. 1970 and Ivanov et al. 1971).

In a study on infants fed on cow milk based formulae for a period of 14 weeks in comparison with those breast fed, the same period, Naismith et al. (1976) reported that the proportion of linoleic and arachidonic acid in the plasma lipids were significantly lower in artificially fed infants as compared to breast fed ones. Thus infants fed solely on cow milk formulae over a realistic period of time before weaning are in no risk of linoleic acid deficiency.

Iron -

Despite of low levels of iron in human and cow milk, infants have sufficient body reserves during first few months of life (Hansen et al. 1971). Even the recommended allowances (National Research Council Washington, 1958) recommends an intake of 0.8 mg/kg/day during the first year of life using labelled iron. Schulz and Smith (1958) observed that the intake of 4 to 5 mg iron at three months of age is adequate to meet the body requirements upto 1½ years. Though the iron absorption is around ten percent, stress conditions like anaemia have been observed to enhance the absorption of iron. Egg, meat, cereals and vegetables are good sources of iron, however in modern feeding practices a special baby food fortified with ferrous salts is usually the most important single source of iron in the infant's diet (Del Mundo et al. 1964).

Vitamin C -

According to British Medical Association (1950) the dietary intake of 10 mg/day during first two years of life is sufficient to establish and maintain a good nutritional status with respect to this nutrient in representative subjects. Somewhat higher levels of 30 mg has been suggested by National Research Council Washington (1958).



Breast milk usually provides enough vitamin C to protect infants against scurvy. However, supplements of vitamin C have been recommended for breast fed infants after the third month as also for infants fed artificially (Khalil and Waly, 1949).

#### Vitamin D -

Precise requirement of vitamin D is not known. However, on the basis of calcium retention, a daily intake of 400 I.U is recommended for infants (National Research Council Washington, 1953, 1958).

The amounts supplied by human, cow and buffalo milk are very small and dietary supplements are desirable to be included if the intake at recommended allowances is to be ensured (Sturrock and Marian, 1952). This increased intake of vitamin D is achieved by irradiating cow's milk or adding vitamin D to it, or by providing cod liver oil or vitamin D supplements (Hytten et al. 1960).

#### Anti-infective Factors -

In an attempt to make cow's milk resemble human milk as closely as possible attention has been paid to what is called the *Lactobacillus bifidus* factor. It has long been known that the faeces of breast fed babies are slightly more acid<sup>ic</sup> than those of babies fed on cow's milk and contain a higher proportion of one type of organism *Lactobacillus*

bifidus. The factor present in human milk was termed as L.bifidus factor and has been shown to be a disaccharide called lactulose.

Some highly humanized milk contain added lactulose and dried milk mucin to increase intestinal bifidus flora and lysozyme activity (Lax, 1968 and Japanese Patent, 1970). Other manufacturers suggest the source of bifidus factor could be commercial pig's gastric mucin added at a level of one percent, or a mixture of N-acetyl-D-glucosamine, blood group substances A, B, or O, mucin or pancreas (Gyorgy et al. 1955 and Tomarelli et al. 1974).

#### Nutritional Evaluation -

Nutritional assessment of various commercially available infant food preparations using infants as subjects, have been reported by various workers. Shapiro et al. (1933) conducted long term feeding trials on infants of age between 4 - 25 weeks, and observed that a cow milk based preparation "Lactogen" when fed for periods upto ten months, was adequate to maintain normal body weight gains. Feeding such preparation was further reported to correct underweight conditions in certain infants. Similar observations on a cow milk based preparation, "Similac" were made by Chiossi et al. (1967) who included infants of six months age in their study and these were fed for periods ranging between 7 to 160 days.

Experiments with another kind of humanized cow milk formulae "Nan", simulated in respect of ratios of casein : albumin and saturated : unsaturated fatty acids, by way of addition of demineralized whey and milk and vegetable fats, when fed to healthy newborn infants as well as premature ones, was found to be well tolerated by them without any gastro-intestinal upsets (Rodriguez, 1967). Distinct advantage of a preparation based on dried acidified milk product "Pelargon" in comparison with a preparation based on evaporated milk supplemented with dextri-maltose, was reported in respect of growth rate and disease resistance in infants. A group of infants receiving 'Pelargon' showed higher growth rates during first two months of life, with relatively lower incidences of vomiting, diarrhoea as compared to a group fed on other preparations (Beland et al. 1960). Earlier Tremblay (1957) reported better digestibility of 'Pelargon' in comparison with pasteurized cow milk, when these preparations were fed for the period of two months to healthy infants. Beneficial effects of feeding in respect of consistency of stools and microflora in stools, were reported when a humanized milk preparation "Humana" were given to full term as well as premature infants and a comparison made with groups receiving human or butter milk. Daily gains in body weight were observed to be comparable among premature and full term infants (Berger et al. (1956).

Studies have been reported on the effect of feeding modified buffalo milk formulae "Amul" in infants upto two years of age and varying in nutritional status (normal and calorie deficient). When a comparison was made with group fed breast milk, diluted cow's milk and other commercial preparation based on cow milk (Glaxo and lactogen), a group receiving modified buffalo milk compared favourably with other groups. Subjects chosen in this investigation, however, appeared to be of higher age than permissible for evaluating infant food preparation (Misra, 1959).

In addition to the measurement parameters for growth, attempts have also been made to determine the influence of feeding infant food formulae on the hematological picture. Crosse and co-workers (1954) reported the effect of feeding different humanized cow milk preparations based on evaporated milk or half skimmed dried milk, providing low and high levels of protein, on the level of haemoglobin, and serum proteins in infants with lower birth weights. All the preparations employed in feeding trials, were isocaloric to that of human milk. It was observed that human milk was distinctly superior to other preparations in preventing the tendency of the development of rickitic conditions. High protein yielding cow milk mixture based on half skimmed milk ranked next only to

human milk. Similar observations were made by Bucci et al. (1963) in respect of haemoglobin and hematocrit levels when premature infants were administered different formulae of humanized milk, in comparison with human milk.

Modified cow milk formulae "Humana" when fed to premature as well as full term infants in the age group between 1 - 3 months compared well in respect of their response on total serum protein haemoglobin, red blood cells and reticulocyte count with other groups receiving human milk and soya milk. Gains in body weight as well as length, in addition to levels of amino nitrogen, calcium, phosphorus, iron, lipid content and alkaline phosphatase activity were comparable with other groups (Vest et al. (1966)). In an another study on premature infants, feeding trials were conducted for period of 17 - 45 days in which "Humana" supplemented with one percent protein hydrolysate was compared with human milk. It was observed that the weight gains were considerably high for the group receiving "Humana" supplemented with protein hydrolysate as compared to human milk. Nitrogen retention was, however, only 50 percent in all these preparations (Vest et al. (1971)). Similar observations were made on infants of age ranging between 2 - 6 months when another humanized milk preparation "Babilon" was fed (Blaim et al. 1972).

## Nitrogen Balance Studies -

Attempts have been made to study the utilization of proteins and calcium from infant food preparations in comparison with protein and calcium available from human milk. Studies conducted by Barnes and co-workers (1957) on healthy infants showed that nitrogen retention was somewhat better when infants were given human milk as compared to those receiving cow milk, when both preparations were isocaloric and isonitrogenous. It was further observed that there was major preponderance of *Lactobacillus bifidus* var. penn. in the stools of infants fed human milk. Similar observations were made by Fomon (1959) during the nitrogen retention studies among infants.

Short term nitrogen balance studies for the period of 4 - 8 days among premature babies were conducted by Senterre et al. (1972), in which half skimmed cow's milk and the formula acidified with lactic or citric acid were fed to premature infants. It was observed that nitrogen retention was similar in both the cases. A comparative study on various humanized milk preparations available from certain European countries was made by Zoula et al. (1967), in which premature infants of 3 - 9 weeks age were chosen for 4 days balance trials. It was observed that gains in body weight were within normal limits, and distinctly higher on humanized milk than on human milk.

Further no significant differences were observed in nitrogen retention.

Excretion of urinary urea nitrogen and  $\alpha$ -amino nitrogen have been reported to be similar on Japanese healthy infants 2 weeks - 4 months of age when fed with humanized milk formula SMA 'S-26' and human milk. Serum protein and serum urea nitrogen levels were also found to be within normal range (Morita et al. 1970).

It would appear from nitrogen retention studies reported so far either with premature or full term infants, or conducted for short or long term that, by and large the nitrogen retention by the body from most of the humanized cow milk preparations with or without acidification, was comparable to that observed for human milk despite of high level of protein intake in bottle fed infants.

#### Calcium Balance Studies -

Studies carried out by Southgate et al. (1969) among infants ( 5 - 8 days old) suggested that there was highest calcium retention (66%) in breast fed infants compared with other milk preparations i.e. oster milk and SMA - 'S-26' based on cow milk. Different milk formulae varying in calcium content between 90 - 165 mg/100g and also in calcium to phosphorus ratio between 1.2 - 1.97 mg/100g

were compared. Wysokinska et al. (1972), observed that formulae supplemented with whey supported better calcium retention than formulae rich in fat content. The extent and composition of fatty acids of the fat present in infant food formulae was also observed to have influence on the absorption of calcium. Hanna et al. (1970) observed that cow milk based infant food formulae containing different levels of different types of vegetable oils and varied amount of calcium, when fed to infants showed positive correlation between faecal fat and calcium. It was concluded that appropriate fatty acid composition is essential to ensure proper mineral retention.

A short term calcium/phosphorus balance study was conducted among premature babies fed either half skimmed cow milk or the formulae acidified with lactic or citric acid. It was observed that the retention of calcium was same in all the preparations whether plain or acidified, but the absorption and excretion of phosphorus was increased by inclusion of lactic or citric acid (Senterre et al. 1972).

#### Biological Evaluation -

Studies have been reported on biological value, net protein utilization, digestibility and protein efficiency ratio of various infant food formulae in experiments with albino rats.

In view of the deficiency of S-amino acids in milk proteins Henry et al. (1953) studied the effect of cysteine and methionine supplementation separately or together on the biological value of dried skimmed milk. A feeding trial was conducted on albino rats at an 8% level of protein intake. It was observed that the biological value was significantly increased by the addition of 0.2% DL-methionine or 0.4% cysteine but when 0.4% DL-methionine or these two were given together no further improvements was seen. On the other hand, the true digestibility of the milk proteins was not affected by the addition of methionine or cysteine. Further, nutritive value of infant food prepared from buffalo milk and fortified with DL-methionine was assessed in an experiment with albino rats. It was observed that the protein efficiency ratio of the milk food fortified with DL-methionine was significantly higher PER (4.0) than that of the unfortified milk food at 10 percent level of protein PER (3.3) Daniel et al. (1968).

Shurpalekar et al. (1964) estimated the nutritive value of skim milk powder from cow, buffalo and goat's milk and observed that goat's milk was slightly higher in calcium, niacin, and protein levels. However, the protein contained lower amounts of total sulphur amino acids than cow and buffalo milk proteins. Feeding trials

on albino male rats for a period of 4 and 8 weeks to determine the PER of the protein, showed higher PER in case of buffalo milk followed by cow's milk and least in case of goat's milk, possibly because of lesser amount of sulphur containing amino acids. Relatively fewer studies were also carried out on infants. A study on cow milk-banana formulae was made by Dutra et al. (1970) in Brazil in which weanling rats as well as infants of 1 - 3 months age, were chosen. It was observed that the PER of the formula assessed on rat was greater 2.88 as compared to 2.65 for casein. Further no significant differences were observed in weight gain by infants fed this formula compared with human milk.

#### Fat Absorption Experiment -

Fat absorption from various infant food formulae depends upon the positional distribution of palmitic acid in a triglyceride and to lesser extent on myristic and oleic, but not on stearic acid. It was observed that high proportion of palmitic acid in 2-position of triglyceride could be related to superior absorption of human milk (Tomarelli et al. 1968).

A fat absorption study conducted by Tomarelli et al. (1968) in rats showed that the high absorption of human milk fat (94.6 percent) was equaled by a fat blend of a

similar fatty acid composition with a high content of 2-palmitoyl-triglyceride, (96.3 percent) in contrast to one with low content (89.9 percent). It was further, observed that absorption of butter fat was 89.5, lard 92.4 and oleo 79.9 percent.

Short term balance studies conducted by Vignetti et al. (1958) on premature infants with birth weights ranging between 1 to 2 kg, showed that maximum absorption of fat (92.7 percent) was observed for a preparation in which equal amounts of human milk and 'Medium Pentolac', a humanized cow milk preparation were added, followed by 92.0 percent from 'Pentolac' alone and minimum absorption was from human milk when all preparations were isocaloric. Further it was observed that mean daily weight increase was highest from a formula from which there was maximum absorption of fat. Similar observations on fat absorption (79 - 97 percent) for various cow milk based preparations were made by Huber et al. (1961) on healthy infants of 2 - 7 months old in their study and these were fed for 3 days period.

In comparison with a formula consisting low levels of animal fat Davidson et al. (1960) observed that the absorption of fat was significantly higher among premature infants receiving food formulae consisting corn oil as

compared to other groups. The levels of faecal saturated fatty acids were similar in all the groups. In their study on different artificial milks using full term healthy infants of 7 - 10 days age Heinz et al. (1966) observed fairly similar extent of absorption of fatty acids. Absorption of certain saturated fats varied considerably between 60 - 75 percent for stearic acid to 71 - 85 percent for palmitic acid.

The excretion of fat by normal infants of age between 8 and 180 days, was studied by Fomon et al. (1970). The infants were fed (i) Human milk, (ii) homogenized cow's milk and (iii) evaporated cow's milk. It was observed that excretion of fat was less than 1 g/kg/day by infants fed (i) and greater than 2g/kg/day by infants fed (ii) whereas those fed (iii) or a formula with butter fat generally excreted between 1 and 2g/kg/day.

MATERIALS AND METHODS,

## MATERIALS AND METHODS

### Collection of Samples -

Samples from different batches of infant food formula "Indec" prepared from cow's milk, were obtained from the 'Indian Dairy Entrepreneurs Agricultural Co. Ltd' (IDEAL) Raniwara, Kallan, Rajasthan. Amulspray samples of Infant Food Formula based on buffalo milk were procured from the local market.

### Determination of Proximate Principles -

Following constituents namely protein, fat, lactose, moisture and ash were determined from infant food samples as below:

### Determination of Protein -

The protein content of the samples was determined by using conventional microkjeldhal digestion and distillation procedure described by Association of Official Analytical Chemist (1975).

### Procedure -

0.5g of sample was digested in duplicate with the aid of a pinch of digestion mixture and 5 ml of concentrated  $H_2SO_4$ . After complete digestion it was diluted to 50 ml and 5 ml of digested samples was transferred to vacuum jacketed flask of kjeldahl apparatus. Ammonia liberated on addition of 3 ml of sodium hydroxide (80%) was collected in 25 ml of boric acid (3 %) and determined by titrating against standard 0.02 N HCl with mixed indicator as an external indicator (methyl red and methylene blue).

### Determination of lactose -

Lactose content was determined according to Polin and Wu (1920).

Reagents -

- i) Alkaline Copper Solution - Forty g of the  $\text{Na}_2\text{CO}_3$  (anhydrous) were dissolved in 400 ml of water, to which 7.5g of tartaric acid and 9.5 g of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  were added and was further diluted to 1 litre with water.
- ii) Phosphomolybdic Acid Reagent - Thirty five g of molybdic acid and 5 g of Na - tungstate were dissolved with 200 ml of NaOH (10% w/v) and 200 ml water. On boiling for about 40 min. to eliminate dissolved residual ammonia it was further diluted to 350 ml. 125 ml of concentrated O-phosphoric acid (85%) were added and the content were diluted to 500 ml.
- iii) Sodium tungstate (10% w/v).
- iv)  $\text{H}_2\text{SO}_4$  2/3 N.

Procedure -

Three g of sample were suspended in 6 ml of water and the protein was precipitated by addition of 6 ml of Na - tungstate and 6 ml of 2/3 N  $\text{H}_2\text{SO}_4$ . The precipitate was removed by filtration through whatman filter paper No. I and 2 ml of filtrate were mixed with equal volume of reagent I in folin - Wu sugar tube and heated in boiling water bath for 8 minutes. On cooling, 4 ml of reagent (ii) were added. The volume was adjusted to 25 ml with reagent (ii) diluted (1 : 4 ) with water.

The intensity of the colour was measured at 420 m $\mu$  (Blue filter) using Klett Summerson Photoelectric Colorimeter.

#### Estimation of Fat -

Fat content was determined according to Rose Gottlieb ether extraction method described in the I.S.I. Bulletin (1968).

#### Procedure -

One g of sample was weighed in a beaker. To that 9 ml of sodium chloride solution (0.5% w/v) was added and contents were transferred to a fat extraction tube. To this 1 ml of concentrated ammonia, 10 ml of alcohol (95%) and 25 ml of diethyl ether were added and this was mixed vigorously for 1 minute. Cork was moistened with water before each insertion and rinsed with solvent before removal. Then 25 ml of petroleum ether was added and shaken vigorously again for 30 seconds.

On separation, the ethereal layer was transferred to a suitable flask with the help of siphon. In this way extraction was repeated thrice with 15 ml of diethyl ether and 15 ml of petroleum ether. Contents were dried on water bath and then in a electric oven maintained at 80°C.

### Determination of Moisture -

Moisture content was determined according to the method described in I.S.I. Bulletin (1968).

### Determination of Total Ash -

Total ash content of the sample was determined according to the procedure described in I.S.I. Bulletin (1968).

### Estimation of Phosphorus -

The procedure for the estimation of phosphorus has been described by Ames (1966).

### Reagents -

- i) Ascorbic acid (10%).
- ii) Ammonium molybdate (0.42%) - 28.6 ml concentrated  $H_2SO_4$  and 4.2 g ammonium molybdate were dissolved in distilled water and volume made to one litre.
- iii) Mix one part of (i) and 6 parts of (ii).
- iv) Preparation of standard solution - 13.609 of  $KH_2PO_4$  were dissolved in distilled water and volume made to 100 ml. This was suitably diluted to contain phosphorus in the range of 2 - 6  $\mu g$ .

### Preparation of Standard Curve -

The standard solution prepared above, was taken in a series of test tubes in different concentration and solution made to 3.0 ml in each with the help of distilled

water. 7 ml of reagent (iii) was added to each tube and incubated for 20 min. at 45°C. For blank 3.0 ml of distilled water was taken in a test tube. Rest is same as for standard. The tubes were then cooled to room temperature. The blue colour of phosphomolybdic acid formed as a reaction of phosphorus with molybdate was read in Klett Summerson Colorimeter using red filter (660 - 720 mμ ).

Procedure -

For estimation of phosphorus in sample, the sample was digested with the aid of a pinch of digestion mixture and concentrated H<sub>2</sub>SO<sub>4</sub>. An aliquot of digested material containing 2 - 6 μg phosphorus was taken in a test tube in duplicate and volume and to 3.0 ml. The phosphorus was then estimated as described above.

Phosphorus content of the sample -

$$\frac{X}{\text{Klett A}} \times \frac{\text{Klett B}}{C} \times D$$

X = ug phosphorus present in standard.

Klett A = Klett reading for standard.

Klett B = Klett reading for sample.

C = Amount of digested material taken for estimation.

D = Dilution factor.

Estimation of Calcium -

Calcium was estimated according to the procedure described in I.S.I. Bulletin (1964 - 68).

Procedure -

On ashing as described earlier 1 g of sample was dissolved in 40 ml of HCl (25% v/v) and a few drops of concentrated  $\text{HNO}_3$ . The volume was adjusted to 250 ml. A measured portion of the aliquot (100 ml) was employed for the precipitation of calcium as oxalate by adding 1 - 2 g of  $\text{NH}_4\text{Cl}$  and 10 ml of saturated solution of ammonium oxalate. The solution was brought to boil and ammonium hydroxide (50%, w/v) was added in a dropwise fashion till the precipitate began to appear. The solution was kept overnight to facilitate the complete precipitation of calcium oxalate.

The solution was filtered through whatman filter paper No.42 and the precipitate was washed with  $\text{NH}_4\text{OH}$  (50%) and was further collected in a beaker and dissolved in dilute  $\text{H}_2\text{SO}_4$  (1 : 25). On heating to 60 - 70°C this was titrated against 0.1 N  $\text{KMnO}_4$  till the pink colour persisted.

The calcium content was calculated as given below:

$$\text{Calcium Percent} = \frac{V \times 250 \times 20 \times 100}{100 \times 1000 \times W}$$

V = Volume of 0.1 N  $\text{KMnO}_4$

W = Weight of the sample taken

### Biological Evaluation -

The protein quality of infant food preparation depends mainly on the type of dried milk powder employed in their preparation. These are of two type - Spray dried and Roller dried.

In order to assess the same, growth promoting ability of different formulae as well as biological value were determined using albino rats as experimental animal models.

### Protein Efficiency Ratio -

The growth promoting ability of different formulae was determined according to the procedure developed by Osborne, ~~etal~~<sup>etal.</sup> (1919).

Weanling male albino rats weighing between 35 - 40 g from the Small Animal House, Stock Colony were used for the experiment. Animals with identical weight were divided into two group. Each group was consisted of ten animals. These were maintained on following diets for the period of 28 days.

- Group I - Fed Indec milk food based diet, protein content of which was adjusted to 10% level.
- Group II - Fed Amulspray milk food based diet, protein content of which was adjusted to 10% level.

### Preparation of Diet -

The composition of the diets for each group has been shown in table 'A'.



Table A. Percentage Composition of the Diet used in PER and B.V.

Ingredients	Casein diet (10% level)	Indec powder diet.	Amulspray powder diet (10% level)	Protein- free diet
Casein	11.2 g	-	-	-
Indec	-	45.4g	-	-
Amulspray	-	-	45.5 g	-
Sugar	-	-	-	.9 g
Salt Mixture	5 g	4 g	4 g	4 g
Cellulose	1 g	1 g	1 g	1 g
Vitamin Mixture	1 g	1 g	1 g	1 g
Fat added	9 g	0.81g	0.81 g	13 g
Starch	72.8 g	39.5 g	39.5 g	68 g
<b>Total</b>	<b>100 g</b>	<b>100 g</b>	<b>100 g</b>	<b>100 g</b>

Vitamin mixture = Prepared according to Eggum et al. (1975)

Mineral mixture = Prepared according to AOAC (1970)

Infant food samples contain 22% protein, 18% fat.

During the experimental period of 28 days animals were fed ad libitum. Food intake by the individual animals were recorded every day. Changes in the body wt. were recorded every third day. After 28 days the total wt. gain and total diet consumption, was calculated.

Protein Efficiency Ratio was calculated as given below:

$$\text{PER \%} = \frac{\text{Gain in body wt. in 28 days (g)}}{\text{g. of protein consumed by the animal}} \times 100$$

#### Biological Assays -

- 1) To find the digestibility co-efficient of the respective protein.
- 2) To find the biological value (B.V.) of the proteins. Biological value was determined according to the method described by Mitchell (1923).

Experiment was conducted on weanling female albino rats weighing between (40 - 50 g) and obtained from N.D.R.I. Small Animal House Stock Colony. The animals were weighed and fed with protein free diet (Table A) for the period of ten days. 24 hrs collection of urine and faeces were made during this period. After ten days they were grouped and were maintained on the dietary regime given below:

Group I - Fed Indec milk food based diet, protein content of which was adjusted to 10% level.

Group II - Fed Amalspray milk food based diets  
protein content of which was adjusted to  
10% level.

The urine and faecal collection were pooled for the period of ten days for individual animal and analysed for nitrogen content. The food intake during protein free and test protein diet regime were recorded.

Collection of Urine and Faeces -

For the collection of faeces and urine the rats were kept in special metabolic cages, specially designed for this purpose. 150/250 ml conical flask or plastic bottles were kept below the funnel of the cages in such a way that urine can not spill out. The urine excreted by animals could pass through the mesh fitted inside the cage and collected over a few drops of chloroform and hydrochloric acid, whereas the faeces were collected on the mesh fitted inside the cage. Urine and faeces were collected daily. Urine samples were stored in refrigerator whereas faeces samples were kept in oven for dryness. After 10 days of experiment the cages were washed with distilled water to collect the urine which dried in the cage. The volume of urine was made to 250 ml with distilled and filtered and 25 ml of this was taken for digestion in duplicate to estimate the urinary nitrogen.

Faeces were dried in oven until constant weight at 90 to 100°C, weighed accurately and ground to a fine powder and 1.0 g of the powder was digested in duplicate, and nitrogen in total faeces excreted was estimated.

From the data obtained digestibility coefficient and biological value were calculated using the following formula (Mitchell, 1923).

Digestibility Coefficient (D.C.) -

$$\frac{\text{N intake} - (\text{faecal N} - \text{endogenous faecal N})}{\text{N intake}} \times 100$$

$$= \frac{\text{In} - (\text{Fn} - \text{Fe})}{\text{In}} \times 100$$

$$= \frac{\text{Nitrogen Digested}}{\text{Nitrogen intake}} \times 100$$

Biological Value (B.V.) -

$$\frac{\text{In} - (\text{Fn} - \text{Fe}) - (\text{Un} - \text{Ue})}{\text{In} - (\text{Fn} - \text{Fe})} \times 100$$

$$= \frac{\text{Nitrogen Utilized}}{\text{Nitrogen digested}} \times 100$$

Where

In = Nitrogen intake

Fn = Faecal N on test protein diet.

Fe = Faecal N on protein free diet.

Un = Urinary N on test protein diet

Ue = Urinary N on protein free diet

### Net Protein Utilization (N.P.U.) -

The NPU values were calculated from biological value and digestibility coefficient according to Mitchell (1923).

$$\text{N.P.U.} = \frac{\text{B.V.} \times \text{D.C.}}{100}$$

B.V. = Biological Value

D.C. = Digestibility Coefficient

### Determination of fat Absorption -

Absorption of fat from infant food formula was determined according to the procedure described by Tomarelli *et al.* (1968).

Young male rats (80 - 100g) weight maintained on a fat free diet of the following composition - casein - 220g/kg of diet, glucose 738 g/kg, salt mixture - 40g/kg, vitamin mixture 1 g/kg and choline chloride 1 g/kg.

Rats were divided into groups having identical body weights. Each group consisting of 6 animals was fed ad libitum the test fat diet at 18% level, replacing an equal amount of glucose from the fat free basal diet, for the period of three days and later switched over to fat free diet for another three days. During the period of 6 days of feeding the dietary fat intake were recorded and also faeces collected for the determination of fat excretion level.

Group receiving fat free diet for the 6 days served as a control, for the estimation of endogenous faecal fat excretion, under identical conditions. The total fatty acid content of the food and faeces was determined by the procedure of Van de Kamer (1949).

Percent of fat absorption based on fat intake was calculated.

$$\text{Fat absorption} = 100 - \frac{\text{meq. faecal fatty acid} - \text{meq. endogenous fatty acid}}{\text{meq. food fatty acid}} \times 100$$

#### Determination of Total Fat in Faeces -

Total fat in faeces were determined according to Van de Kamer method (1949).

#### Reagents -

- i) Ethanol - 90% containing 0.4% amyl alcohol
- ii) Ethanol - 96% (neutral to thymol blue)
- iii) KOH (33% w/v)
- iv) HCl (25%) specific gravity 1.13
- v) Petroleum ether (60 - 80°C)
- vi) Sodium hydroxide (0.1 N)
- vii) Thymol blue (2% w/v) in 50% ethanol

#### Procedure -

Five g of powdered sample of faeces were refluxed with 10 ml of reagent (iii) and 40 ml of reagent (i) for 30 minutes. On cooling, 10 ml of reagent (iv) were added. The saponified samples was further extracted twice with 50 ml of reagent (v).

A measured aliquot (25ml) was taken and evaporated on water bath. The residue was taken in 10 ml of reagent (ii) and titrated against 0.1 N NaOH with thymol blue as external indicator.

Statistical Analysis -

Data obtained were subjected to statistical analysis according to the method suggested by Sukhatma and Panse (1967).



## RESULTS AND DISCUSSION

### SECTION - A

In order to know about the nutritional value of a product it is essential at first to understand about its nutrient composition. To assess the nutritional quality of infant food formulae based on cow and buffalo milk, samples from different batches of preparations were analysed for proximate principles, and data are presented in Table 1 & 1a. It was observed that the contents of various nutrients like protein, fat, carbohydrates (total reducing sugars) ash, calcium and phosphorus in both kinds of preparations were

TABLE - 1

Chemical Composition of Infant Food based on  
Buffalo Milk

Batch No.	Protein	Fat	Moisture	Ash	Lactose	Calcium	Phosphorus
1.	25.06	17.94	3.99	1.87	44.92	0.85	0.67
2.	24.52	18.11	4.05	1.85	45.67	0.90	0.71
3.	25.06	18.37	3.85	1.90	44.23	0.92	0.65
4.	25.42	18.09	4.12	1.82	45.21	0.87	0.69
5.	25.06	17.99	3.95	1.89	43.94	0.89	0.62
6.	24.67	18.20	4.07	1.91	45.60	0.95	0.65
M.V.	24.96	18.12	4.00	1.87	44.93	0.89	0.66
S.E.	$\pm 0.040$	$\pm 0.057$	$\pm 0.031$	$\pm 0.018$	$\pm 0.289$	$\pm 0.011$	$\pm 0.010$

Values expressed as g/100g

No. of observations - Each value is the average of six independent observations conducted in duplicate.

M.V. = Mean Value

S.E. = Standard Error

TABLE - 1 a.

Chemical Composition of Infant Food based on  
Cow Milk

Batch No.	Protein	Fat	Moisture	Ash	Lactose	Calcium	Phosphorus
1.	24.70	18.60	4.15	1.72	45.52	0.75	0.52
2.	24.35	17.89	4.02	1.70	42.75	0.79	0.55
3.	24.15	18.12	4.21	1.75	45.50	0.80	0.49
4.	24.65	17.98	3.96	1.79	44.25	0.75	0.50
5.	24.52	18.04	4.10	1.69	42.59	0.81	0.57
6.	23.99	18.05	4.25	1.75	43.95	0.73	0.52
M.V.	24.39	18.09	4.12	1.73	44.09	0.77	0.52
S.E.	$\pm 0.115$	$\pm 0.104$	$\pm 0.044$	$\pm 0.018$	$\pm 0.520$	$\pm 0.011$	$\pm 0.010$

Values expressed as g/100g

No. of observations - Each value is the average of six independent observations conducted in duplicate.

M.V. = Mean Value

S.E. = Standard Error

highly comparable. This was evident from the average values of 24.39 - 24.96% for protein; 18.09 - 18.12% for fat; 4.00 - 4.12% for moisture; 1.73 - 1.87% for ash; 44.09 - 44.93% for lactose; 0.77 - 0.89% for calcium and 0.52 - 0.66% for phosphorus, for buffalo milk based 'Amul-spray' product and cow milk based preparation 'Indec'. It was observed that the differences between these average values were not statistically significant.

It would appear that infant food formulae under investigation provide adequate amounts of protein to the infant (6 months old) against their requirement of 12 g protein/day (2 g/kg/day).

Although the average fat content in both the preparations were very close, the amount of vegetable fat employed to adjust the total fat content in the preparation apparently varies. This could be inferred from the observation that 'Indec' preparation was based on whole cow milk whereas dried skimmed milk was employed in the other preparation. Though the nature of fat used for this purpose is not clearly evident, it could have profound influence on the utilization of this nutrient, which depends on the fatty acid composition of the diet and the positional distribution of palmitic acid, in a triglyceride molecule and to a lesser extent on myristic and oleic acid (Tomarelli et al. 1968). The amount of milk fat present in the total fat content for the infant food formulae,

would further reflect on the total essential fatty acids available from these preparations.

As regards total carbohydrate content both preparations have been reported to contain 50 percent of its total bulk as total carbohydrates. The content of total reducing sugars in these preparations ranged between 44.09 - 44.93 percent. It would appear that in both the preparations non-reducing disaccharide sugar has been possibly assimilated to make up the total carbohydrate content of 50 percent as displayed on the container. Taking into account the level of proteins in the dried whole milk and in dried skim milk, it is possible that the quantities of milk powders employed in these preparations varied considerably, thereby affecting the amount of lactose derived from powdered milk. On the basis of the amount of lactose present in different dried milk preparations (Gopalan et al. 1971), it would appear that the quantity of milk powder necessary to provide about 25 g protein in the formulae would provide lactose ranging between 32 - 35 g as against the level of 44 g of reducing sugars observed in the present investigation. This further indicates that substantial quantity of other reducing sugars were used in both these preparations. The nature of this sugar is far from clear.

Moisture levels in dried milk based infant food formulae is an important factor in view of its profound

influence on the availability of lysine, which was evident from the observation by Erbersdobler (1970) who showed that the losses of available lysine were maximum when the samples having about 8 percent moisture were stored at 30°C for 12 weeks. The moisture level during present investigation in both the preparations were observed to be about 4 percent.

The calcium and phosphorus contents in infant food formulae based on buffalo milk were considerably higher than those observed in cow milk based preparations. Statistically the values are significant. The ratio of calcium to phosphorus has been known to influence the uptake of calcium in the body (Davidson et al. 1975). The ratios for these two preparations were fairly close, viz 1.34 for 'Amulspray' and 1.48 for 'Indec' but were markedly low in comparison with the ratio obtained for human milk i.e. 2.54.

Values obtained for various proximate principles mentioned earlier, compared fairly well with the reported values for infant food formulae based on cow milk preparation and buffalo milk preparation (Ivanov et al. 1970 and Chandrasekhara et al. 1960).

#### SECTION - B

#### Biological Evaluation of Infant Food Formulae -

Though the quantity of proteins present in both the preparations were fairly identical, the differences in the

profiles of constituent proteins vary among different species (Davies, 1939; Karmarkar, 1959; Kon and Cowie, 1961 and Ganguli, 1974) which could have influence on the utilisation of milk proteins. Further, the kind of heat treatment involved during the preparation of skim milk powders, either roller or spray dried, has been shown to have profound effect on the level of available lysine in these preparations (Freimuth et al. 1969) which in turn, affects their protein value. In order to get better picture on the protein quality from these preparations the growth promoting abilities of such preparations were measured and data are presented in Table 2 and 3.

#### Protein Efficiency Ratio -

Data presented in Table 2 and FIG 1. shows that the protein efficiency ratio for the preparation based on buffalo milk Amulspray (2.57) was slightly but significantly ( $P < 0.05$ ) higher than that observed for cow milk based powder (2.37). Similar observations were made by Shurpalekar and co-workers (1964) who observed the protein efficiency ratio for buffalo milk to be significantly higher (2.74) than PER for cow (2.49) and goat's (2.21) milks. These differences were <sup>attributed to relative deficiency of sulphur</sup> containing amino acids in the case of goat milk. Daniel et al. (1968) reported that supplementation of infant food

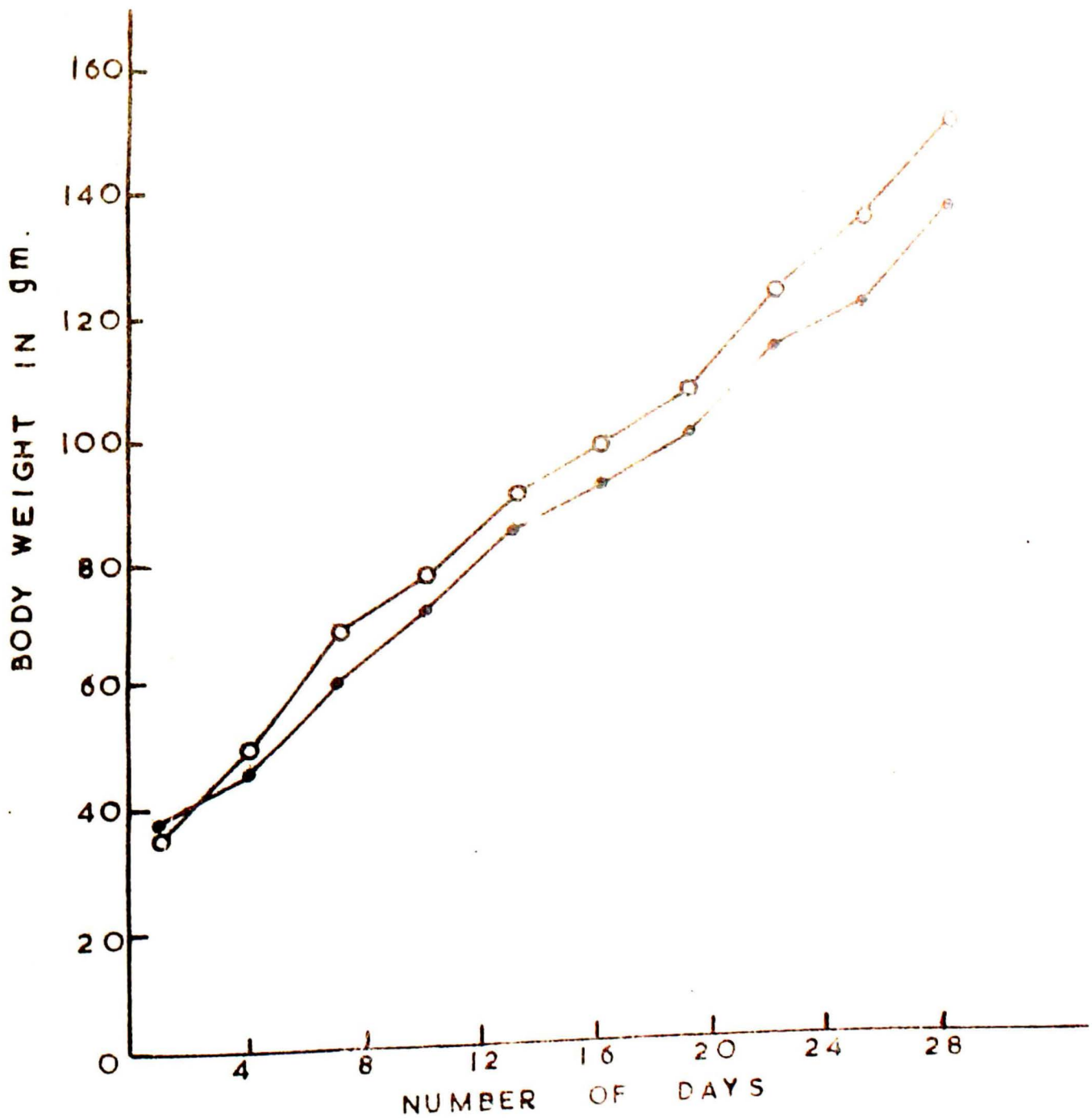
TABLE - 2

Protein Efficiency Ratio (PER) for Groups Receiving  
Experimental Diets Based on Different Infant Food  
Formulae

<u>Diets</u>	<u>No. of animals in each group</u>	<u>Initial weight (g)</u>	<u>Final weight (g)</u>	<u>Av. gain in body weight (g)</u>	<u>Av. Protein intake (g)</u>	<u>Av. PER</u>
Indec milk powder diet	10	37.0	138.0	101.0	42.6717	2.3713 ± 0.0485
Amulspray milk powder diet	10	36.7	152.0	115.3	44.8084	2.5732 ± 0.0636

<sup>t</sup> 0.05 ; 9 d.f = 2.262 (Significant)

FIG. 1. GRAPH SHOWING GROWTH RATE IN RATS FED WITH INDEC<sup>1</sup>—COW MILK PREPARATION AND "MULSPRAY"<sup>2</sup>—BUFFALO MILK PREPARATION.



formulae based on buffalo milk with DL-methionine was found to improve the protein efficiency ratio.

The content of methionine in buffalo milk is (0.17g/g of N) greater than that of cow's milk (0.16 g/g of N). This could be the reason for slightly <sup>higher</sup> PER for Amulspray ~~higher~~ as compared to cow milk preparation. On the other hand, human milk contains relatively smaller amount of methionine (0.10g/g of N) compared with cow and buffalo milk (Gopalan et al. 1971), however, the cystine content of human milk is much larger.

Values obtained for protein efficiency ratio were considerably lower than those reported for dried skim milk preparations. This could also be the result of difference in the amount of available lysine, between Infant food formulae under study and dried skim milk powder. Further it is interesting to note that the ratio of lysine to carbohydrate is highest in case of buffalo milk 0.066 and compared well with cow milk 0.057, though it is very low 0.032 in human milk. This may have effect on the growth promoting ability of the product.

#### Biological Value -

Data on the biological value of these preparations are presented in Table 3. It was observed that the biological value for both the preparations were very close viz 91.85 for 'Indec' and 91.80 for 'Amulspray'. Values obtained in the present study were somewhat higher than the value reported for dried skim milk powder by Kon (1962).

TABLE - 3

Biological Value

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Treatment	No. of animals	Av. total N <sub>2</sub> intake (mg)	Av. Fn-Fe (mg)	Av. Un-Ue (mg)	Biological value
Indec milk (M.V.) powder diet (S.E.)	6	2014.25	274.16	140.10	91.85 ± 0.868
Amulspray (M.V.) milk powder diet (S.E.)	6	2092.77	230.92	150.66	91.80 ± 0.596

---

Fn = Faecal N<sub>2</sub> on test protein diet  
Fe = Faecal N<sub>2</sub> on nitrogen free diet  
Un = Urinary N<sub>2</sub> on test protein diet  
Ue = Urinary N<sub>2</sub> on nitrogen free diet

Raw milk 84, pasteurised milk 84, spray dried powder 84, roller dried powder 83, evaporated milk 82 and sterilised milk 79. Determinations on the milk powders employed in both the preparations reports, however could not be undertaken in the present study. The beneficial effect of the supplementation of dried skim milk powder with certain vitamins of B group and minerals does not appear possible in view of the observation by Kansal et al (1979) who failed to observe the beneficial effects of vitamin supplementation on the protein value. Henry et al. (1953) reported the salutary effect of supplementation of dried skim milk powder with cystine and methionine at 0.2% and 0.4% respectively.

It is interesting to note that the biological value of the product based on cow milk preparation 'Indec' was around 91.8 even after six months of storage of the product in a sealed container, at room temperature. It would appear that the biological value of the product did not alter much under these conditions of storage, probably because of low moisture content in these preparations which ranged between 4.00 - 4.12%. This was further supported by the observation of Erbersdobler (1970) who reported decreases in the biological values only when the moisture content was higher than 7 percent by way of

decrease in the availability of lysine. The high level of reducing sugar, about 44.09 - 44.93% apparently did not exert much influence on the biological value of the product.

#### Digestibility Coefficient -

From the data presented in Table 4 it would appear that the digestibility coefficient for buffalo milk based preparation was significantly higher (83.46) than the value observed for Indec, (85.87) cow milk based formula. It would be interesting to note that despite the statistically significant difference between the two values for digestibility, there was no resultant adverse effect on the biological value of these proteins, computed from the data obtained on these animals. It would appear to be likely that although the digestibility co-efficient for Amulspray preparation was better than that for Indec, the differences were not adequate to reflect further on the biological value of these proteins.

The computation of net protein utilisation value from the biological value and digestibility co-efficient indicated slightly but <sup>non</sup> significantly higher values for buffalo milk preparation.

#### SECTION - C

##### Fat Absorption -

Data for fat absorption are presented in Table 7. It was observed that absorption of fat from Amulspray was

TABLE - 4

Digestibility Coefficient (D.C.)

Treatment	No. of animals	Av. total N <sub>2</sub> intake	Av. total N <sub>2</sub> in faeces	Av. total endogenous faecal N <sub>2</sub>	Digestibility Coefficient
Indec milk powder diet (M.V.) (S.E.)	6	2014.25	349.87	75.70	85.87 ± 0.888
Amulspray milk powder diet (M.V.) (S.E.)	6	2092.77	307.95	77.02	88.96 ± 0.282

<sup>t</sup> 0.05 ; 5 d.f = 3.3812 (Significant)

TABLE - 5

Net Protein Utilization (NPU)

Treatments	No. of animals	Biological value	Digestibility coefficient	Net protein utilization
Indec milk (M.V.) powder diet (S.E.)	6	91.85	85.87	78.88 ± 1.114
Amlsray (M.V.) milk powder diet (S.E.)	6	91.80	88.96	81.67 ± 0.608

$t_{0.05 ; 5 \text{ d.f.}} = 2.5003$  (Non - Significant)

TABLE - 7

Fat Absorption

---

Treatments	g.of faecal fatty acid	g.of endo- genous fatty acid	g.of food fatty acid	Fat absorption
Indec milk (M.V.) powder diet (S.E.)	0.8190	0.1604	54.84	92.61 ± 2.245
Amulspray (M.V.) milk powder diet (S.E.)	0.9041	0.1604	57.94	92.27 ± 1.072

---

92.27% and that from 'Indec' was 92.61%, the difference being statistically non-significant.

The values observed in the present study compared well with the values reported by other workers (Heinz et al. 1966). Vignetti et al. (1956) conducted a short term, fat absorption study on infants, by feeding them (i) human milk (ii) humanized cow's milk preparation 'Medium Pentolac' and human milk in equal amounts and (iii) Pentolac alone. It was observed that the absorption was maximum from (ii) preparation (92.7%). This could be attributed to the positional distribution of fatty acids particularly palmitic acid in a triglyceride molecule. The presence of high proportion of palmitic acid in the 2 - position in a triglyceride molecule was responsible for the maximum absorption of fat from this preparation. Similar observation on fat absorption (79 - 97%) for various cow milk based preparations, were made by Huber and Scheibl (1961). Further Tomarelli et al. (1968) reported that maximum absorption of fat was from lard (92.4%), than from butter fat (89.5%) and was minimum from oleo (79.9%). It would appear from the present study that similar kind of fat was present in both the preparations.

SUMMARY AND CONCLUSION

### SUMMARY AND CONCLUSION

The present study was undertaken to assess the nutritive value of 'Amilspray' buffalo-milk preparation and 'Indec' cow's milk preparation and to see which of the formulae is utilized better. Samples of both the preparation, from six different batches were analysed for proximate principles.

The average protein content were 24.39 - 24.96%; fat 18.09 - 18.12%; moisture 4.00 - 4.12%; ash 1.73 - 1.87%; lactose 44.09 - 44.93%; calcium 0.77 - 0.89%; and phosphorus

for Buffalo and Cow milk preparations respectively.<sup>48</sup>  
0.52 - 0.66% } The values compared well with the value  
reported by various workers.

PER was determined for the diets based on cow-milk and buffalo-milk-infant-food-formulae. From this study it was seen that PER for Amulspray diet is slightly but significantly higher (2.57) than Indec (2.37). The possible reason for the lower PER value in the cow-milk based preparation has been discussed.

A nitrogen balance study was conducted to further assess the nutritive value of infant food formulae and <sup>their</sup> ~~its~~ digestibility. Biological value (B.V.), Digestibility Coefficient and Net Protein Utilization values of the diets were estimated. B.V. of the diets were 91.80 for Amulspray 91.85 for Indec.

Digestibility coefficient for Amulspray was 88.96 and for Indec 85.87. Net protein utilization values for Amulspray was 81.67 and that for Indec 78.88.

Fat absorption <sup>was</sup> studied according to Tomarelli et al. (1968) from these formulae. The values obtained were 90.61 percent for 'Indec' and 92.27 percent for 'Amulspray'.

From the comparative study made on the utilization of nutrients from infant food formulae prepared from buffalo and cow milk, it was observed that there was not much difference in their chemical composition. Proteins

from the buffalo milk preparation were utilized better than those from cow milk formulae as evident from growth study. There was no difference in the biological value for respective infant food formulae, whereas digestibility co-efficients and values for net protein utilization (calculated) were slightly but significantly higher in case of buffalo milk preparation. Although fat absorption was also found to be higher in buffalo milk preparation than cow milk formulae, but it was not found to be significant.

It could, thus be inferred from the present investigation that apparently there is not much difference in both the preparations, in the parameters which the author has studied.



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