DEVELOPING INDIGENOUS WEANING FOOD BASED ON BANANA FLOUR

By

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DECLARATION

I hereby declare that this thesis entitled "Developing indigenous weaning food based on Banana flour" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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Certified that this thesis entitled "**Developing indigenous weaning food based on Banana flour**" is a record of research work done independently by SHEELA PRASAD, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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INTRODUCTION

INTRODUCTION

Children are the wealth of a nation and therefore utmost care must be exercised to promote their health and to protect them from malnutrition. Good nutrition, in childhood and through out the life span, is of paramount importance in fostering the physical, mental, emotional and social growth of the individual (Kaul, 1977). No single factor determines the growth and development of children as decisively as proper nutrition (Goah, 1971). The infants and pre-school children are extremely vulnerable because they are growing and they need more nutritious food in proportion to their weight than adults (Gopalan, 1972). Swaminathan (1974) reports that the rate of growth and development of infants and pre-school children depend to a large measure on the adequacy of the diet consumed by them.

Protein-Caloric malnutrition is largely responsible for the high rate of mortality and morbidity among poor children (Shukla, 1982). Malnutrition in early life is reported to have lasting effects on the future growth performance of the child (Gopalan, 1972). The development of the child's nutritional status never occures in isolation. It is rather a combination of

various environmental factors that exists which produce a synergistic effect (Sen, 1976).

The fact that the best food for infant is breast milk, is established not only by general experience but also by scientific observations. After the age of 3 or 4 months, breast milk is not sufficient to satisfy the nutritional requirement of the child (Report of ministry of social welfare, (1981) National Institute of Nutrition (1981), Govindankutty (1984) and Kumarietal (1985). Studies done by Damodaran (1979) showed that breast milk alone can sustain proper growth till 4 to 5 months of age and beyond that age unless additional food is provided, growth slows down.

Weaning is the process in which an infant's diet pattern is gradually changed from liquid foods like breast milk and substitute milk preparations to cooked solid foods (Geervani, 1983). According to Daga (1984) this process can be started from the age of three months and carbohydrate foods can be given to the infant from this age onwards provided the food is cooked soft and mashed to a thin consistency. According to Devadas et al (1977) the most important aspect of weaning is the introduction of solid foods and not stoppage of breast milk. Since a majority of people in India live in rural areas, and since many of them are living under economic stress in which they

can hardly afford processed foods, these foods cannot be expected to make any impact on the solution of the problem of infant malnutrition (Jelliffee, 1971). The approach under these circumstances must, therefore lies in the effective use of the locally available and inexpensive foods and in educating the community especially the mothers in the proper use of such resources.

The present study has been conducted to develop a weaning food based on banana flour with the following objectives.

(1) To develop a weaning food which is nutritious, low cost and acceptable using banana flour as a basic ingredient.

(2) to assess the net protein utilisation and protein efficiency ratio of the weaning formula.

(3) to standardise recipes with the weaning food developed and

(4) to assess the acceptability of the recipes.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Nutrition is one of the factors most closely associated with growth in infancy and childhood (Gopalan, 1972). The short adult stature of people in many developing countries may be the result of malnutrition in early childhood. The high rates of infant and maternal mortality in our country stem chiefly from under-nutrition (Gopalan, 1972). Malnutrition is more prevalent among the poorer sections of the society due to restriction of the diet imposed upon them by their poverty (Shukla, 1982). Devadas et al (1980) have reported that the health and welfare of the children is important not only to reduce the mortality rate but also to withstand the stress and strain of growth and development which are characteristic of this period.

Swaminathan (1975) has reported that in developing countries infants are mostly fed with adult diets without considering their nutritive requirement and nutritive value of the diet. A dietary survey conducted in rural Kerala revealed that the majority of children studied were deficient in calories, protein, fat, calcium, Vitamin A and Vitamin C (Mukundan 1970). Yuskel et al (1975) pointed out that socio-economic level and the type of supplementary foods are some of the contributing factors which have an

important role in the etiology of Protein-calorie malnutrition. From the point of view of custom, practice, feasibility and cost, it would be most convenient for the mother to feed the infant, older than 6 months on an easily modified family diet (Cowan, 1983). In a study of the children of vellore, Pereira (1971) found that the diets of children from the low income families were low in calories and Vitamin A while Basricha (1973) has reported that a young Indian toddler could satisfy his energy needs if fed with a normal Indian cereal-pulse bulky diet.

Infant food can be defined as a complementary food, breast milk supplement or weaning food represented as a partial or total replacement for breast milk (Ministry of Social Welfare, 1981). Infant foods include infant milk food and any manufactured or locally prepared food, suitable as a complement to breast milk after 4 months of age to meet the nutritional needs of the infant. (Ministry of Social Welfare, Government of India, 1981). According to Ghosh etal (1973) liquid and solid foods were introduced in the infant's diet mostly before the age of six months and one year respectively. Woodruff (1978) has pointed out some guidelines for feeding infants based on the recommendation of the American academy of paediatrics. Food recommended by them were mainly breast milk, evaporated milk, fresh cow's milk and skimmed milk, stained foods

and cereals. Jelliffee (1967) was one of the first to popularise the concept of "Multimixes", namely, double (cereal + pulse), triple (cereal + legume + dark leafy vegetables) and quadruple (adding animal protein to the triple mix).

According to Jelliffee (1971) the simplest recipe for weaning food is one which has only two ingredients. This is the basic mix. Recipes which are more suitable for the weaning period and for feeding later are the multimixes. According to Cameron etal (1983) the food square is a useful concept to choose ingredients for weaning recipe consisting of breast milk and a mixture of a staple, protein, Vitamin and mineral foods with energy supplements.

At the community and industrial level many attempts have been made to develop low cost weaning foods for infants. Pasricha etal (1973) had developed ready-to-mix powder and the main ingredients were cereal (wheat, Bajra or Ragi) pulse (roasted bengal gram), oilseed and sugar. The supplement is based exclusively on local resources. Devadas etal (1974) had developed a weaning mix. The major ingredients of this weaning food were cereal (Cholam, Ragi or Maize), pulse (roasted greengram or bengalgram dal) oilseed (roasted ground nut) and jaggery. Gopaldas etal (1975) have developed Poshak. The main ingredients were cereal (wheat, maize,

rice or jowar) pulse (Channa dal or mung dal), an oilseed (ground nut) and jaggery in the proportion of 4:2:1:2. Rau *etal* (1975) had developed extruded RTE which contained corn soya milk (CSM) and Salad oil. Chandrasekhara *etal* (1976) had developed KIF (Kerala Indigenous Food) which include tapioca rava, Soya fortified bulgar wheat (SFB) rava and ground nut flour. ICMR (1977) has developed ready-to-consume mixture which included roasted cereal (Cholam, maize, ragi or bajra) pulse (roasted or sprouted bengalgram or greengram) and oilseed (ground nut, ground nut or sesame cake flour). The Gandhigram Institute of Rural Health and family planning in 1970 had developed (win food) using greengram dal flour (roasted) ground nut cake flour (roasted) and jaggery. Sri Avinashilingam Home Science College for women, Coimbatore (1971) had developed Kuzhandai Amudhu and the formulations were with jowar, Bengalgram, ground nut, jaggery, ragi, maize and greengram. The institute conducted trials and found this infant food to be suitable for supplementary feeding programme. The project on manufacture of Balahar started under the guidance of Food Corporation of India (1964). The raw materials used were bulgar wheat, Soya flour, Ground nut flour, Bengalgram flour, maize and Vitamin mineral mix. Central Food Technological Research Institute, Mysore (1974) had developed energy food and the raw materials used were wheat flour,

bengalgram flour, ground nut flour and jaggery powder. Another supplementary food developed by CFTRI, Mysore was Miltone (1970). The raw materials included were ground nut protein isolate, cow's milk, water, sugar syrup and vitamin-mineral mix. Child in Need Institute (CINI) have started the project on CINI-NUTRIMIX since 1976. The major ingredients included were rice, moongdal, and skim milk powder (UNICEF, 1977).

Ahmed etal (1981) had standardised cereal-pulse based weaning foods which were of high protein quality and which met approximately 1/3rd of the energy requirements of a one year old child. A Soy-whey weaning food constituted by grinding the Soy-whey mixture, oil and oil soluble vitamins was standardised by Kapoor and Gupta (1981). This product was reported to be free from trypsin inhibitor activity and was acceptable with or without added flavor. Morcos and Gabrial (1983) had made chemical and biological evaluation of protein and rich food mixtures for feeding the young in Egypt. The results depicted that these weaning foods were of high biological value and that they could be safely given to children. Swaminathan and Parpia (1968) based on the investigations, carried out at Central Food Technological Research Institute, Mysore, had shown that infant foods prepared from blends of groundnut and Soybean or ground nut protein isolate and non-fat milk solids possessed high nutritive value. Markh etal (1982)

evaluated the nutritional value of meat-cereal canned food with added vegetables, herbs and vitamins included for infant nutrition and the result, indicated that this gave optimal combinations of protein-carbohydrates and vitamin, salt substances and had increased nutritional value.

Sharma (1983) had reported that in view of shortage of production of milk, egg, meat and fish, the deficiencies in the diet will have to be made up by the inclusion of locally availeble low cost foods of Vegetable origin. Mudambi _otal_ (1986) had also stated that there is an urgent need to conserve food to derive maximum benefit from available foods by utilising edible parts of all available plants and animal foods.

According to Jelliffee (1966) since the animal proteins are inadequate and more costly, it is of great importance to make the best possible use of all locally available plant protein foods. Vegetable protein foods are viable economic alternative to animal protein foods and nutritional according to Rotruck and Seligaon (1978). Practical observations had shown that some plant foods appeared to be less commonly associated with the development of Kwashiorkar (Jelliffee, 1966)

Kerala grows multitudes of varities of banana

under an area of 49.3 thousand hectares with a production potential of 293.8 thousand tonnes. (Ministry of Agriculture, 1982-83). Banana (Musa species) is considered to be one of the most easily assimilated of all fruits suitable for dessert and culinary purposes. (Von Loeseck, 1965). This fruit has also been used as a palliative food for people suffering from various intestinal disorders. Banana fruit is a rich source of energy, minerals like magnesium, sodium, potassium, phosphorous and vitamins C and A. Ripe bananas are excellent supplementary foods for babies in the age group of 4 to 6 months (Von Loesecke, 1965). For infants, persons of delicate digestion, dyspeptics and those suffering from temporary derangement of the stomach, banana flour would be of universal demand (Von Loesecke, 1965). Pleasant tasting meals prepared from unripe bananas were reported as early as 1893 by Reichelt. Kindt (1893) had also reported of a preparation made from green banana flour. Purseglove (1975) had reported that bananas given to children suffering from Coeliac diseases who had an intolerance to carbohydrates. According to Jelliffee (1975) banana is the only food of calorific significance which can be given to the infant uncooked and straight from the tree in an originally bacterologically uncontaminated condition. Swaminathan (1973) had stated that banana flour is a boon to the

mother when the cost, nutritional composition, availability, mode of preparation and shelf life are considered. Bogert (1942) had reported that a slightly unripe banana contains 12.8% of undigestible starch and 11.6% of sugar, while a fully ripe banana contained 1.2% starch and 19.5% sugar which is easily digested and absorbed by the infant. According to Lulla etal (1955) Chromatographic analysis of sugars in banana in ripened stages contained different sugars like maltose, sucrose, glucose, fructose, rhamnose while for unripened fruit the sugars present were sucrose, glucose and fructose. Patil etal (1976) has analysed banana powders prepared from three varities (Basrai, Rajeli, safed volchi) and found considerable variations in moisture content, starch, sugars and protein. Banana powder contained important minerals viz. sodium, potassium, phosphorous, magnesium and vitamins like thiamine, niacin and ascorbic acid. According to Padmaja (1977) Robusta and red bananas are superior in their protein and mineral contents. Siddappa (1961) reported that the Nendran variety of banana contained carotene and is also rich in thiamine unlike the other varities. Analysis of banana flours prepared from different varieties such as monthan, palayankodan, Kunnan, Padathi Nendran, Pooven showed that there was not much variation in the quantity of nutrients available in these varieties (Kerala Agricultural University Research Report, 1982-83). Quaglia etal (1983) had stated that banana flour were

suitable for bread making when mixed with soy or wheat flour in the proportion of 10%. Rheological characteristics of baby foods based on banana was studied by Irazabal (1981) and the results indicated that consistency coefficient tended to decrease with increasing temperature whereas flow behaviour index did not vary significantly with temperature. The nutritive value of a cow's milk-banana formula for infant feeding was studied by oliveria (1970). The results suggested that the proposed mixture could be given as a well balanced complete food for infants in developing countries and it was locally cheaper than foods supplemented with oilseed proteins. Soy-babana food bar fabrication has been carried out by Ralda etal (1980) and the soy-banana food bars were pressed from soybean-banana flakes developed as infant weaning food. In another study conducted by Kerala Agricultural University (1983) a weaning food based on locally available and traditionally accepted materials such as banana flour, Ragi flour and fortified them by mixing soyabean and greengram flours. The feeding trials on babies between the age group of six months to one year showed that the weight gain ranged from 400 grams to 1 kilogram in one month and the gain was much higher than the weight gain recorded on babies fed with banana flour and milk alone.

Studies on nutritional adequacy of commercial baby

foods conducted by Young (1982) revealed that except for calcium and iron at one month and iron at 18 months, the intakes of nutrients exceeded the recommended dietary intake. The survey also revealed that without fortification with iron, calcium and B-Vitamins, a large number of infants would have insufficient intakes of these nutrients. The nutritional composition of white and black varieties of sesame seeds (whole and dehusked) and their meals were determined by Krishnamurthy etal (1960) and according to them, sesame proteins were found to be rich in methionine and tryptophan and no appreciable difference was observed in the amino acid composition. Among different varieties of oilseed like ground nut, mustard, coconut, sesame and safflower sesame was found to be the richest source of most of the inorganic elements by Deosthale (1981). Brito (1981) had evaluated the usage of sesame for human consumption and revealed that sesame was found to have a high protein content and to be rich in sulfur containing amino acid. Some functional and utilization characteristics of sesame flour and protein was estimated by Pauda (1983) and the results indicate that Phenolic acids in oil seed flour was studied by Kozlowska etal (1983) and noticeable quantitative differences were found in the content of free and bound phenolic acids, in flours of the oilseeds. Akobundku (1976) developed and evaluated corn-cowpea mixtures as protein

sources for Nigerian infants. The results indicated that the cystine content of corn-cowpea mixture was significantly reduced in yeast-fermented samples and fermentation increased the content of all essential amino acids except tryptophan. Hemanalini et al (1980) reported that the growth promoting value of sprouted ragi was much higher than that of whole ragi. The phytic acid content of cereals is decreased by 40% upon sprouting. Morch et al (1981) had indicated that iron - deficient infants would absorb 1.7 to 4.1 percent of the iron contained in the infant foods. Changes in soluble esterases during germination of ragi were studied by Veerabhadrappa and Aravinda Upadhya (1979). According to Bender et al (1969) the most widely used method for the measurement of growth of rats in relation to the amount of protein in protein efficiency ratio (PER) Venkata Rao et al (1976) in the development of processed weaning foods prepared by roller drying of blends of cereals, legumes and ground nut flour had emphasised protein quality interms of PER determination using rats. In a study conducted by solberg et al (1979) comparing relative slope ratio and protein efficiency ratio values for fifteen foods representing a wide variety of protein sources indicated that the relative slope ratio method cannot be substituted for the protein efficiency ratio. Dako and Hill (1977) had made a chemical and biological

evaluation of beans and results indicated that rats fed raw beans did not grow but autoclaving the beans at 15 lbs. pressure for 30 minutes greatly improved the nutritive value as measured by the protein efficiency ratio, net protein utilisation, net protein ratio and biological value. In another study made by Fahmay et al (1981) the vitamin content and net protein ~~ca~~ utilisation of baby food prepared with germinated seeds were analysed and the highest NPU value was for germinated seeds. Chandrasekhar et al (1982) assessed the protein quality of legume based weaning foods through rat growth studies and the results of the study indicated that in general autoclaving improved the protein quality of legumes.

Efficacy of blends of groundnut protein isolate, casein and skim milk powder fortified with essential amino-acids in meeting the protein requirements of protein depleted rats was studied by Tasker et al (1962). The results have shown that ground nut protein isolate by itself was slightly less effective while a 2:1 blend of ground nut protein isolate and skim milk powder was almost as effective as skim milk powder in meeting the protein requirements of protein depleted rats. Evaluation of the protein quality of corn soya meal, Balahar and leaf proteins concentrate on albino rats was studied by Devadas et al (1974). In the descending order the four protein blends

assessed for nutritive value were ranked as corn soya meal, skim milk, leaf protein concentrate, and Balahar.

Hemanalini et al (1980) have made nutritional evaluation of ragi based infant food. Three rat feeding trials were performed to evaluate the flour as growth promoters to find their protein efficiency ratios (PER) and to establish their calcium availability levels. Sprouted ragi was a better growth promoter than the others and so was suitable for inclusion in the diets of infants. Because of the highest calcium availability the weaning food could be recommended as a supplement for infant foods. Lina and Reddy (1983) had evaluated the protein quality of food mixes in albino rats. Measurement used for evaluation based on growth were food intake and weight gain, protein efficiency ratio (PER), Net Protein ratio (NPR), Hepatic weight and nitrogen, Liver protein utilisation (LPU) and protein value cost index. Klopfenstein (1985) had evaluated the nutritional quality of pearl millet and sorghum grain diets and a pearlmillet weaning food through rat experiments. Mitchell and Jenkins (1985) had made the assessment of protein quality methodology for infant foods and data indicated that protein quality evaluation of infant formulas using rat-bio assay warranted the use of matched casein reference diets for each type of formula. Almouri et al (1980) had made a biological evaluation of protein supplementation of broad beans with

sesame and feeding experiments with weaning rats indicated that the proteins of broad beans and sesame were mutually supplementary. Vaidehi and Annapurna (1981) had made an evaluation of the protein quality extrusion of cooked cereal based weaning foods in albino rats and no significant difference was observed between the mixed cereal extrusion cooked weaning food and a proprietary popular weaning food, in protein quality and growth promoting value in rats. Desai et al (1969) have made studies on supplementary value of low cost balanced foods based on cereals, cotton seed or peanut flour and bengalgram flour to poor Indian diets. The results have shown that replacement of 50 per cent of cereals in poor Indian diets by low cost balanced foods made up all the deficiencies in the diet. A study conducted by Mankernika et al (1964) revealed that a blend of sesame and Bengalgram and Soyabean were ideal mixture, for weaning infants. Changari et al (1983) have developed a weaning food with wheat flour and peanut flour. Weaning food developed by Kaur and Guota (1982) contained potato, soyabean and skim milk in the ratio 65:20:15 with requisite quantity of protein, fat, moisture, ash and crude fibre and with a PER of 1.9. Bushra et al (1983) had developed a protein rich vegetable mix with rice, wheat, Chickpea, milk and drumstick leaves. Devadas et al (1984) had developed several low cost indigenous diet combination using rice and ragi as the staple and low cost indigenous

foods such as sweet potato, horsegram, sesame, groundnut, and amaranthus. Popowa (1985) had formulated infant food using cereals such as rice, oats, maize flour using particular proportion of the flours.

Several researchers have carried out numerous studies on supplementary feeding at field level. Kaur and Bhatt (1979) studied the effect of supplementary feeding on the nutritional status of pre-school children. The results of the study indicated that the experimental group had an improved clinical picture at the end of the feeding trial showing an increase in heights and weights, over circumference and haemoglobin level of the experimental group were significantly higher than those of the control group. King et al (1967) have evaluated the response of pre-school children to high intakes of cereal-bean mixtures and the results indicated that all mixtures significantly increased weight over the standard, skin-fold thickness, muscular development, serum protein and serum albumin. An evaluation of the supplementary feeding programme sponsored by Indian Council for Child Welfare was made by Puri et al (1983). The children were given a light midday snack and reconstituted skimmed milk on 6 day a week. Total intake of food was found to be greater with supplementary food than for controls and boys had higher intake than girls. Swaminathan (1975) had made an evaluation on supplementary

foods based on oilseeds for infants and children. The results indicated that supplementary foods based on oilseeds and nuts are effective in improving the nutritional value of poor diet consumed by children in the developing countries. Devadas et al (1974) had made the nutritional evaluation of maize based indigenous infant food, 'Kuzhandai Amudhu' of the six ready indigenous infant food developed with maize, greengram blend. Significant improvement in nutritive status was shown as increments in anthropometric measurements, haemoglobin levels and clinical picture of children. Effect of low cost supplementary foods on nutritional status of pre-school children was studied by Ninave and Shashtri (1987) and the results indicated that there was a clear-cut change in physical activity, mental alertness and biochemical parameters. Haemoglobin level improved significantly from 8.7 to 9.5 g%. Dumn et al (1967) had compared Indian multipurpose food and supplemented ground nut protein isolate as supplements. Feeding trial was continued in pre-school children for more than six months and it was found that the average growth in both height and weight was greater in the experimental groups than in the control group. Kielman (1982) had stated that nutritional supplementation to pre-school children can significantly reduce the mortality especially those of the weaning age and overall growth of the children can be improved by nutrition supplementation.

Effect of processing, sweetening agent, type of container and storage period of some strained baby food was studied by Ashwah et al (1984) and results indicated that changes in physical properties and chemical constituents of the baby food was associated with the temperature of storage. Fahmay et al (1981) had stated that pre-cooking of samples reduced the amino acid content while germination increased their amino acids. Inamdar (1981) had developed, malted and roasted, powdered multimixes of staple, wheat, bengalgram, ground nut were formulated in ratios of 4:1:1, 8:1:1 and 8:1:o. The four steps in formulation of multimixes were steeping, germination, roasting and milling. Potedar et al (1981) had established the superior growth promoting and protein quality of malted ready-to-eat mixes over roasted ready-to-eat mixes. Desikachar (1983) had reported that malting of ragi helps in partial pre-digestion of the starch and proteins, reduce the viscosity, the phytase hydrolyses the phytin to available phosphate. According to Desikachar (1980) techniques such as malting, puffing, Flaking, chapathi making and extrusion through the house hold vermicelli press were found to be adaptable to the making of weaning foods. According to Desikachar (1980) malting or germination hyrolyses the phytin, predigests the starch partially and produces a good aroma. Malting reduces the viscosity

caused by the elaboration of amylases during the germination process, which helps in increasing the caloric density of the food. Jayaram (1980) had made studies on the commercial aspects of the production of nutrition supplements for children and indicated that the two factors which influenced the cost of processing of a food were the shelf life of the product and the type of packaging. The increase in shelf life of the product can be achieved by packaging in high or low density polythene bags.

Mc colmson and Mc Daniel (1980) had studied the taste and texture of infant cereals and all cereals prepared were found to be in varying degrees of viscosity mouth coating, astringency and had a slight flavor. Nayak (1983) had made an attempt to see whether a combination of malted and roasted RTFS could be developed with an acceptable overall lowered viscosity. Acceptability trials in children indicated a significant increase in intake of the gruel and biscuit forms. Biscuits with malted cereals has better melting-on-tongue properties and had a better acceptability in banwadi-age children. Jayaram (1980) had found that the acceptability of the nutritional supplements for infants improved when supplied in the forms of porridge. Lowenberg (1968) reported that infant foods which are stringy and sticky are disliked because the child is not familiar with

the texture. Devadas et al (1974) had evaluated the acceptability of a weaning mixture based on local foods namely sorghum, Bengalgram dal, ground nuts and jaggery. The food was easily acceptable and did not create any problem as a result of its digestion. Prasannappa and Jagannath (1985) had studied the acceptability of a food supplement based on wheat, maize, ground nut meal, chickpea dal and unrefined sugar. The taste panel found the preparation to be acceptable. Ashwah et al (1984) have evaluated the acceptability of the sweetening agent in some strained baby foods. The use of sucrose-corn syrup blend (3:1 w/w) as a sweetner increased the reducing sugar content, retarded corosion, improved colour and enhanced the flavor of the product.

Chandrasekhara et al (1960) had studied the shelf life of infant food and found that thiobarbituric acid value of the infant foods increased steadily during storage. Ranganna and Siddappa (1961) had found that the shelf life of strained baby food packed in tins under nitrogen and stored at 5°C for over a year remained perfect without any marked loss of colour, flavor and reconstitution properties.

Shelf life studies on spray dried infant food based on ground nut protein isolate and skim milk powder was determined by Subrahmanyan et al 1962) and Shurpalekar et al (1962). Kantharaj et al (1962) had made studies on factors

affecting the shelf life of edible pea nut cake, grits and flour and it is found that the pre-requisite for such a storage is the need to restrict the initial moisture content to about 7 per cent. Shelf life of the protein food based on blend of Soyabean, groundnut, and coconut flour has been studied by Tasker et al (1963). The prepared protein food kept well at 37°C in hermatically sealed containers for a period of 9 months.

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation was conducted in the Department of Home Science, College of Agriculture, Vellayani during the period from September, 1985 to February, 1986.

A. Plan of Action

1. Formulation of different combinations of nutritious low cost and acceptable weaning foods using banana flour as a base.
2. Analysing the nutritional quality of the weaning formulae developed.
3. Assessing the nutritional quality of the weaning formulae developed through suitable animal experiments.
4. Standardising the recipes in the laboratory using weaning formulae developed.
5. Assessing the acceptability of the recipes.

1. Formulation of different combinations of nutritious, low cost and acceptable weaning food using Nendran banana flour as a base.

Recipes which are suitable for the weaning period and for later feeding are called "multimix". To make an adequate infant multimix, four components are essentially

needed, a basic staple, an energy rich supplement, a protein rich supplement and a mineral and Vitamin supplement (Mitzner et al (1984).

1.1 Justification for the selected ingredients in the multimix.

The ingredients selected for the weaning food formulated in the study were based on the local availability nutritional value, economic significance, shelf life qualities, acceptability, easiness for processing and digestability (Mitzner et al 1984). Accordingly banana flour, sesame, horsegram and skim milk powder were chosen as materials for the multimix.

Nendran banana was chosen as the basic staple because it is considered as the most easily assimilated of all fruits and the fruit has been used as a palliative food for people suffering from various intestinal disorders. Kerala grows multitudes of varieties of banana suitable for dessert and culinary purposes. Area under Banana cultivation in Kerala is 49.3 thousand hectares with a production potential of 293.8 thousand tonnes. (Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, (1982-83). From time immemorial banana flour has been used as a weaning food in the childrens' diet in Kerala. Further it is available in the markets in Kerala. It is a rich source of energy in the form of

sugars and starch and is the cheapest. It is also rich in minerals like magnesium, sodium, potassium and phosphorous and a fair source of calcium and iron which help to make strong bones and teeth and help to keep body healthy. (South Pacific Commission Community Education Training Centre, South Pacific Foods, Leaflet, 1983). Purseglove (1975) have reported that bananas are given to children suffering from Coeliac diseases in which there is an intolerance to carbohydrates. These are good attributes for a basic staple in a weaning diet.

According to the Kerala Agricultural University Research Report (1982-83) a study was undertaken with the object of testing the suitability of common banana varieties viz. Nendran, Kunnan, Monthan for the preparation of banana flour. The banana varieties were processed, dried and powdered. The flours were then made into a porridge by the addition of milk and sugar. The acceptability was tested by organoleptic evaluation. The data obtained from nutrient analysis showed that there was not much variation in the quantity of nutrients available in these varieties. The variety Kunnan scored highest with 105 in organoleptic test for taste while the variety Nendran scored highest for texture and appearance (117). So Nendran variety is selected for this study.

Protein rich complement should form a part of the

weaning formulae and Christobal et al (1968) suggested that a mixture of plant proteins is the most economical complement and can be nutritionally quite satisfactory. According to Desikachar (1983) Cereals and Pulses in the right proportion can ensure an adequate supply of good quality proteins. Deosthale (1982) reported that pulses are rich in protein, minerals and vitamins, hence they are important in the diets based on cereals. This justifies the inclusion of horsegram.

Accordingly to Rice (1971) effective use of oilseed proteins can go a long way towards correction of dietary protein deficiencies. Among oilseeds sesame is very commonly cultivated in the country. The annual production of sesame in India during 1985-86 is 520.7 thousand tonnes and in Kerala it is 3.6 thousand tonnes (Food Digest, 1986). Girija Devi (1984) reported that the principal protein in sesame seeds are globulin and the limiting amino acid is lysine. She also reported that it is rich in tryptophan and sulphur aminoacids particularly methionine. Therefore sesame proteins constitute a valuable supplement to pulse protein justifying its inclusion along with horsegram in the multimix formulae.

According to Desikachar (1983) supplementation with skim milk solids could increase the nutritive value of

weaning foods and make them nutritionally complete. Therefore in this study skim milk was used as the protein, vitamin and mineral supplement.

1.2 Formulation of the multimix.

On the basis of the nutritive value and the chemical score of the ingredients, the proportion of the ingredients in the multimix were worked out. The chemical score gives an indication on the protein quality of the product. Jansan and Harper (1985) have reported that aminoacid scores provide an useful estimate of the protein quality of the blended foods and are an acceptable substitute for the biological assays. Therefore, several formulations and combinations of the ingredients selected were worked out.

The aminoacid scores were worked out using the food consumption tables of ICMR (1981). Using these values chemical scores were worked out following the procedure of Block and Mitchell (1946) and the combinations which had chemical scores below 60 per cent were discarded. Six combinations were selected by this method.

1.3 Preparation of the multimix

For the preparation of multimix Banana (Variety; Nendran) was purchased from the local market (Fig. 1) and the unripe banana fruit was peeled and then sliced and

FIG. 1

FIG. 2

Table I

Percentage composition of the food ingredients in the weaning formulae

Ingredients (g)	1	2	3	4	5	6
Banana flour	30	35	40	45	50	40
Sesame	20	20	15	15	20	20
Horsegram	30	30	25	20	20	25
Skim milk powder	20	15	20	20	10	15
Chemical score	62.59	62.4.	61.203	61.85	63.98	61

dried at an oven temperature of 60°C (Fig. 2). When the fruit was completely dried, it was powdered and sieved following the procedure recommended by Snehalatha (1985).

Horsegram obtained from the local market was cleaned off impurities, washed in water and soaked for 18 hours. It was then sprouted following the procedure recommended by Rajalakshmi (1974). The soaked grains were tied in a moist muslin cloth (Fig. 3), kept on a plate and covered with a large inverted pan so as to keep the temperature uniform. The germinated grain was then dried in the sun, roasted, milled and sieved. Sprouting of horsegram was adopted because they in turn help partial pre-digestion of the starch and proteins reduce the viscosity and the phytase hydrolyses the phytin to available phosphate (Desikachar, 1983). Deosthale (1982) reported that during soaking and germination several enzyme systems become active and bring about profound changes in the nutritive value of the pulses. Several studies have shown that Vitamin C which is practically absent in the dry seeds of legumes increase in significant amounts (Prabhavathi and Rao, 1979, De and Barai, 1949) even after 24 hours of germination. Similarly 2 to 3 fold increase in the concentration of folic acid and B-group Vitamins takes place in germinated grains than in raw pulses (Babu, 1976). On the other hand anti nutritional factors such as phytate (Reddy et al 1978)

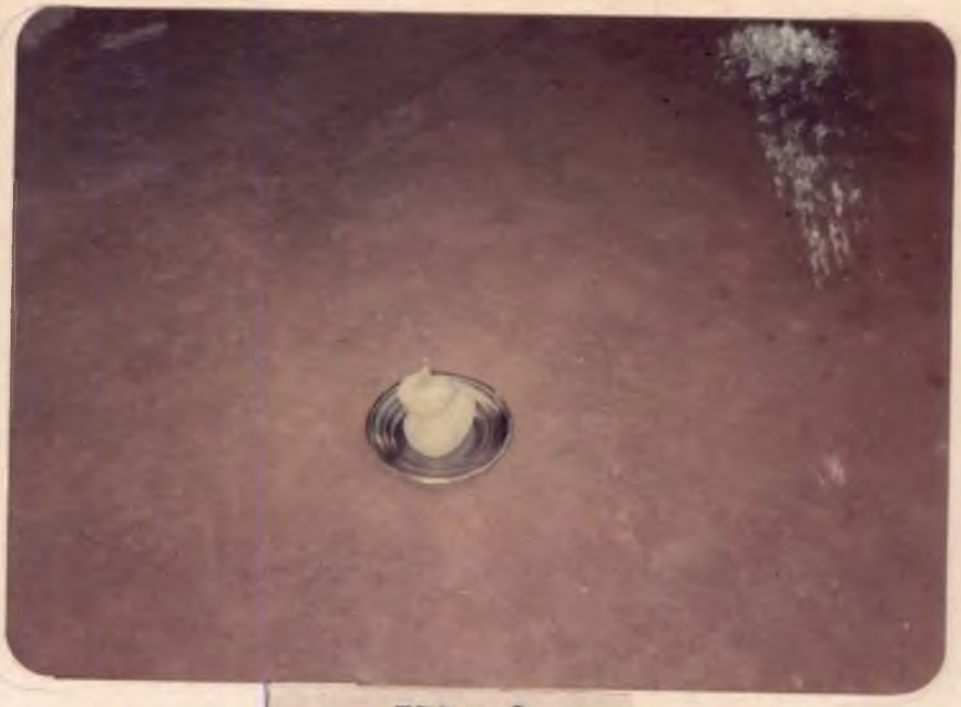

FIG. 3

and inhibitors of trypsin are inactivated (Subhalaxmi et al (1976). Rao and Deosthale (1982) have shown that by soaking in water for 24 hours about 24 per cent of tannin and by germinating for 24-48 hours, 20-25 per cent of tannin is lost from green gram. The beneficial effect of these changes is seen in the two-fold improvement in the bio-availability of iron from pulses after germination. Studies of flatulence factors of the legumes have shown that during 24 hours germination, the concentration of Oligosaccharides gets reduced to 50 percent of the initial value (Rao and Balavady, 1978). Germinated legumes therefore appear to be less flatus producing than raw grains. Good quality sesame was purchased from the local market and was cleared to remove all the impurities. It was then dried, roasted and powdered.

The above three powdered ingredients and skim milk powder were mixed in weighed quantities as per the six combinations selected (Fig.4).

2. Analysing the nutritional quality of the weaning formulae developed through calculation and suitable laboratory techniques.

2.1 Assessing through calculation

The nutrients present in the six combinations were calculated using the food composition table of ICMR (1981).

2.2 Analysing through laboratory techniques

The six selected combinations were subjected to chemical analysis. The protein content was analysed using the micro kjeldahl method (Hawk and Oser, 1965) given in Appendix 1.

3. Assessing the nutritional quality of the weaning formulae developed through suitable animal experiments.

Ritchey and Taper (1981) reported that the most realistic way to assess the nutritional quality of protein is feeding trials on animals usually rats and chicks. According to them several biological measurements have been proposed as indicators of protein quality and the simplest among them is the Protein Efficiency Ratio (PER). Other methods involve nitrogen balance studies from which several indices of protein quality namely true digestability, biological value and net protein utilisation (NPU) are calculated.

Diets were formulated using the six combinations of the weaning formulae standardised earlier. These six experimental diets were formulated so as to supply 10 per cent protein. The details are presented in Table 2. A control diet was also formulated with skimmed milk powder which would supply 10 per cent protein. The composition of the salt mixture and vitamin mixture used in the

diets are given in Table 3 and 4. The intake of minerals and vitamins were kept the same in the seven groups.

The animals were maintained on the respective diets to evaluate the protein quality of the weaning formulae.

Table 2.

Diets formulated for the animal Experiments

		Percentage of the various ingredients	Percentage of the multimix in the diet
Diet I			
	Banana flour	16.11	
	Horsegram	16.11	
	Sesame	10.74	
	Skim milk powder	10.74	53.7
	Starch	31.3	
	Ground nut oil	9	
	Mineral mix	4	
	Vitamin mix	2	
Diet II			
	Banana flour	20.77	
	Horsegram	17.81	
	Sesame	11.87	59.35
	Skim milk powder	8.9	
	Starch	25.65	
	Ground nut oil	9	
	Mineral mix	4	
	Vitamin mix	2	

Diet III			
	Banana flour	23.72	
	Horsegram	14.83	
	Sesame	8.90	
	Skim milk powder	11.86	
	Starch	25.69	59.31
	Ground nut oil	9	
	Mineral mix	4	
	Vitamin mix	2	
Diet IV			
	Banana flour	28.33	
	Horsegram	12.6	
	sesame	9.44	
	Skim milk powder	12.6	62.97
	Starch	22.03	
	Ground nut oil	9	
	Mineral mix	4	
	Vitamin mix	2	

Diet V

Banana flour	38.08	
Horsegram	15.232	
Sesame	15.232	
Skim milk powder	7.616	
Starch	8.84	76.16
Ground nut oil	9	
Mineral mix	4	
Vitamin mix	2	

Diet VI

Banana flour	25.2	
Horsegram	15.75	
Sesame	12.6	
Skim milk powder	9.45	
Starch	22	63
Ground nut oil	9	
Mineral mix	4	
Vitamin mix	2	

36

Table 3

Composition of mineral mixture

	Weight in g.
Calcium carbonate	38.1400
Cobalt chloride	0.0023
Cupric sulphate	0.0477
Ferrous sulphate	2.7000
Magresium sulphate	5.7300
Magnese sulphate	0.4010
Potassium Iodide	0.0790
Sodium Chloride	13.9300
Potassium phosphate monobasic	38.9000
Zinc sulphate	0.0548

Table 4

Composition of Vitamin mixture

Vitamin A	2000 IU
Vitamin D	200 I.U.
Vitamin E	10 I.U.
Vitamin K	0.5 mg.
Thiamine	0.5 mg.
Riboflavin	0.8 mg.
Pyridoxine	0.5 mg.
Calcium pantothenate	4 mg.
Niacin	4 mg.
Inositol	10 mg.
Para amino Benzoic acid	10 mg.
Biotin	40 mg.
Folic Acid	0.2 mg.
Choline chloride 200 mg. Vitamin B.2	3 mg.

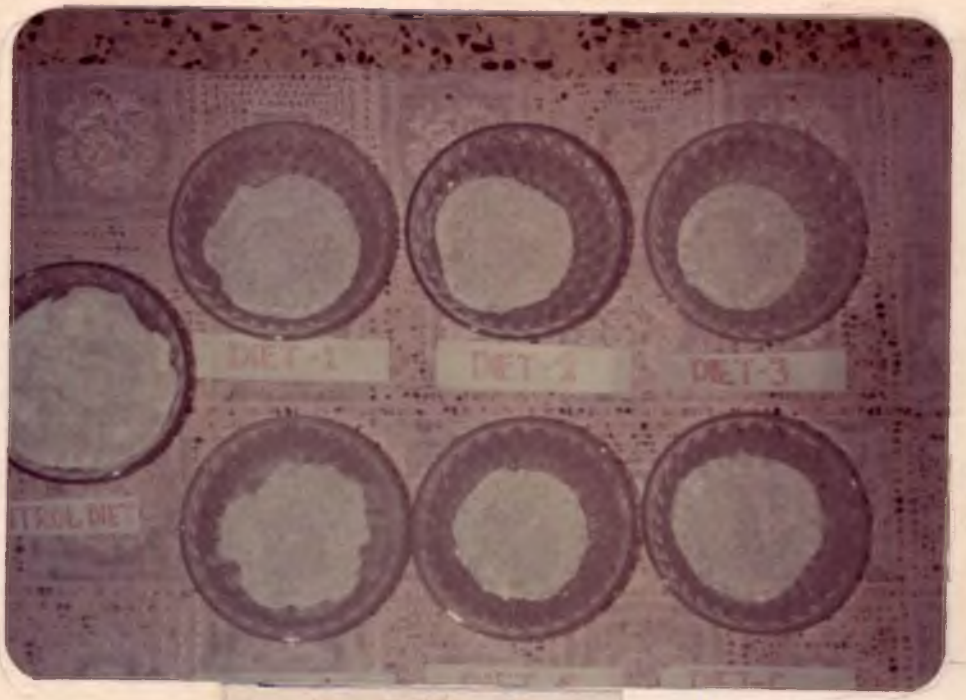

FIG. 4

FIG. 5

3.1 Protein Efficiency Ratio (PER)

The protein efficiency ratio (PER) which measures the weight gain per gram of protein eaten was determined according to the rat growth method of Osborne, Mendel and Ferry (Osborne *et al.* 1919).

Weaning male albino rats (Sprague Dawley strain) 28 days of age were used for the experiment. Animals of more or less identical weights (29 g ± 4 g.) were selected and divided into 7 groups of 6 rats each and fed the respective diets as detailed in Table 2.

The rats were housed in individual cages with wire mesh floor (Fig. 5). 15 g. of the diet (Fig. 6) was mixed with water, cooked in steam for 15 minutes, cooled and fed to the animals. Water was provided *ad libitum*. The left over food was collected daily and were dried and weighed. The food consumption was calculated by substracting the left over from the quantity served. The body weights of the animals were recorded once in three days during the experimental period (Fig. 7). During the experimental period conditions were maintained as uniform as possible. The rats were maintained on the respective diets for 28 days.

The PER was calculated using the formulae;

$$\text{Protein Efficiency Ratio (PER)} = \frac{\text{Gain in body weight in g.}}{\text{Protein intake in g.}}$$

FIG. 6

FIG. 7

From the PER values, the combination that gave the highest value was adjudged as the most suitable for its growth promoting effect.

The rats used for the PER study were deprived of food overnight stunned by a blow at the back of the neck and killed by decapitation. Blood was collected and the liver was removed to ice cold containers whole weight of the liver was recorded and liver and serum samples were taken for protein estimation by microkjeldahl method (Hawk and Oser, 1965).

3.2 Nitrogen balance study

To find out the extent of utilisation of proteins of the different combinations nitrogen balance study was conducted. The net protein utilisation values were found out by standard experimental procedures suggested by Mitchell (1923-24).

Male albino rats weighing 110-120 g. were divided into 7 groups of 6 each. The animals were housed in individual metabolic cages (Fig.8). The whole experiment was divided into 3 periods. During the first period of 4 days all the rats were fed with a non-protein diet to measure the endogenous nitrogen. The composition of the non-protein diet is given in Table 5. During the second period of 2 days the rats were fed with the stock diet

FIG. 8

FIG. 9

(Table 5). During the third period of 4 days the different groups were fed with the 6 different experimental diets and one standard diet. The diets used for the study are given in Table 2. The animals were given 15 g. of diet mixed with water, steamed for 15 minutes and cooled (Fig.9). The amount of food given, the quantity of left over food and actual consumption were recorded every day.

During the 1st and 3rd periods of the experiment stools and urine samples were collected. Two drops of toluene were added to the urine sample as a preservative. Stools collected were dried in the oven. The stools of each group collected for 3 days were pooled together for nitrogen estimation. Urinary and faecal nitrogen were estimated by the micro kjeldahl method (Hawk and Oser, 1965). The nitrogen content of the food mixtures were also estimated using the same procedure. Using the above values biological value, digestability coefficient and net protein utilisation were calculated using the following formulae.

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

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

$$NPU = \frac{Dc \times Bv}{100}$$

Dc = Digestability Coefficient

Bv = Biological value

NPU = Net Protein Utilisation

In = Nitrogen Intake

Fn = Nitrogen in Faeces

Fe = Endogenous faecal nitrogen

Un = Nitrogen in urine on protein diet

Ue = Nitrogen in urine on protein free diet

Table 5

Percentage Composition of the stock diet and Non-protein diet

Ingredients (g)	Non-protein diet	Stock diet
Starch	85	---
Ground nut oil	9	9
Mineral mix	4	4
Vitamin mix	2	2
Wheat flour	-	15
Roasted Bengal gramahal	-	58
Ground nut	-	10
Casein	-	4

Standardising recipes in the laboratory using weaning formulae developed.

Prior to the standardisation of recipes with the selected formulae, the following tests were conducted.

4.1 Tests on the selected weaning formulae

a. Quantity and cost of food ingredient included in the formulae

b. Acceptability and cost of the final product

(a) Quantity and cost of food ingredients included in the formulae

Quantity and cost of food ingredients included in the formulae is assessed by estimating.

Percentage preparation loss, cost of food ingredients as purchased and percentage yield.

i. The weight of the food ingredients as purchased (AP wt) minus the edible portion of the ingredients included in the formulae (Ep wt) gives the preparation loss and percentage preparation loss was calculated using the following formula.

$$\% \text{ preparation loss} = \frac{\text{AP wt} - \text{EP wt}}{\text{AP wt}}$$

ii. Cost of the edible portion of the ingredients used was calculated using the formula;

$$\frac{\text{Total Cost}}{\text{EP wt.}}$$

iii. The percentage yield of the recipe will be influenced by the cooking time and temperature used for cooking. Here the percentage yield of the recipe was worked out using the formula;

$$\frac{\text{Cooked weight}}{\text{weight before cooking}}$$

4.3 Recipes evolved

Recipes listed below were evolved and standardised.

A - Bland Porridge

B - Porridge with Chekkurmanis

C - Porridge with mango

Recipes were standardised for consistent quality production. In this the nutritional quality, availability and cost of various ingredients included in the recipe were considered. Suitability for clientele was considered in selecting and preparing the recipe. Each recipe selected was planned in such a way to meet the 1/3rd requirement of pre-school children. The amount of the weaning formulae selected was finalised on the basis of the quantity of the protein. Fruits, green leafy vegetables and jaggery which were very commonly available in the state were selected as ingredients in the recipes to meet the requirement of the nutrients like calorie, minerals and Vitamins.

Details regarding the recipes are given in Tables 6, 7 & 8.

Table 6

Bland Porridge

Ingredients	Weight (g)	Measure tea spoon	Direction
Banana flour	10.2	2	1. Mixed the ingredients from 1-5.
Sesame	6.8	1 3/4	2. Boiled the water
horsegram	9.2	1 ½	3. Added the mixed ingredients to the boiling water.
Skim milk powder	6.8	1 ¾	Stirred continously under simmering temperature to prevent lump formation till the mixture was cooked.
Water	110 ml.		

Table 7

Porridge with Chekkurmanis

Ingredients	Weight (g)	Measure tea spoon	Direction
1. Banana flour	10.2	2	1. Roast the ingredients from 1 to 5 in oil and keep away from fire.
2. Sesame	6.8	1 ¾	
3. Horsegram	9.2	1 ½	2. Boiled the water.
4. Skim milk powder	6.2	1 ¾	3. Added shredded chekkurmanis to water and boil until it is cooked.
5. Ground nut	25		
6. Chekkurmanis	14	½ cup	4. Ground nut was roasted and powdered. Added the roasted ingredients to the chekkurmanis, stirred continuously under simmering temperature to prevent lump formation till the mixture is cooked.
7. Cooking oil	15		
8. Water	114		
9. Salt	to taste		

The quantity of weaning formulae used was decided so as to meet 1/3rd requirement of protein of pre-school children. Chekkurmanis, the low cost and locally available green leafy vegetable was added to meet the requirement of vitamins and minerals. Ground nut and cooking oil were added to meet the calorie requirement.

Table 8

Porridge with Mango

Ingredients	Weight (g)	Measure tea spoon	Direction
Banana flour	10.2	2	1. Roast the ingredients from 1 to 5 in ghee and keep it away from fire.
Sesame	6.8	1 ¾	
Horsegram	9.2	1 ¼	2. Prepare jaggery syrup in water
Skim milk powder	6.8	1 ¾	3. Add the roasted ingredients to the jaggery syrup, stirred continuously under simmering temperature to prevent lump formation till the mixture is cooked.
Mango	30		
Jaggery	30		
Ghee	20		4. Prepare mango juice and add it to the cooked porridge.
Water	114 ml.		

The recipe was formulated so as to meet 1/3rd requirement of pre-school children. The nutritious low cost and locally available fruit mango and jaggery were added to meet the iron and calorie requirement. Ghee was added to meet the calorie requirement.

4.3 Cost of the recipes

Cost of the recipes was worked out by assessing the cost of the ingredients used for developing the recipe. Cost of the fuel was also worked out by recording the time needed for preparing the recipe. Gas stoves were used for cooking the recipes. The weight of a gas cylinder is 14.2 kgs. The life span of the cylinder is 120 hrs. The total time required for cooking each recipe was calculated. From this the fuel expenditure was worked out.

5. Assessing the acceptability of the recipes.

Acceptability trials of the selected weaning formulae were planned at the laboratory level and at the field level. The weaning formulae which gave the highest value for indices such as protein efficiency ratio, hepatic weight, hepatic nitrogen, serum protein, biological value, digestability coefficient and net protein utilization as well as the various tests and criteria developed for standardising recipes was selected for the acceptability trials.

A series of acceptability trials were carried out at the laboratory with a selected panel of judges. At the field level these trials were conducted among children who are the real clientele and among mothers who are responsible

for formulating specific desires and attitudes in children. (Fig. 10 - 13).

The panel members for acceptability trials at the laboratory level were selected from a group of 30 healthy women in the age group of 19 to 23. Triangle test (Jellinek, 1964) was employed to select the panel members. In the triangle test three sets of sugar solutions of different concentrations were used, of the three sets, two solutions were of identical concentrations and the women were asked to identify the third sample which is of different concentration. The evaluation card used for the triangle test is presented in Appendix IV. Small highly sensitive panels would usually give more reliable results than large less sensitive groups. Thus from the thirty women who participated in the triangle test, ten women were selected as judges for the present acceptability trial. The triangle test was not applied among children or mothers, even though they were treated as panel members at the field level.

The acceptability trials on panel members were done using the scoring method. A score card developed for the study is presented in Appendix III.

The major quality attributes included in the score card were appearance, flavour, texture, taste and overall acceptability on a five point hedonic scale. Each of the

FIG. 10

FIG. 11

FIG. 12

FIG. 13

above mentioned quality is assessed by a five point rating scale. The judges were requested to taste one sample and score it. They were requested to taste the second sample after washing their mouths. Each quality was assessed by the panel members after tasting the same sample several times if needed.

The panel members were permitted to take their own time and to judge the samples leisurely. The testing was conducted in the afternoons between 3 p.m. and 4 p.m. Since this time is considered as the ideal time for conducting the acceptability studies (Swaminaden, 1974). The panel members were requested to give scoring based on two sets of responses, the first giving preference rank and the second an assessment of sensory qualities.

For the conduct of acceptability trial among children, a nursery school adjacent to the University Campus was selected. There were 25 pre-school children attending the nursery regularly. The children were in the age group of 3 - 5 years. Responses of the young children could not be accurately recorded using a score card and hence it was left to the discretion of the investigator to decide if a child 'liked' or 'disliked'. For this each child was brought near the table where the food was kept. He was fed a tea spoon ful first and his reactions to the food was

observed and recorded as pleasant or as unpleasant expression. The pleasant expression may denote acceptance while the unpleasant expression a refusal. His acceptance was further checked by noting whether he voluntarily opened his mouth for a second mouthful of the food. This was also recorded.

Acceptability trial at the field level were conducted among ten women who were the mothers of pre-school children attending the nursery. Mothers were not selected by triangle test or any other test but they were selected for the test being mothers. Mothers generally tended to attribute their preference to their children and preferences and convictions of mothers largely determine what the child would receive and what the child would be taught to like. As mothers, they were responsible for preparing foods for their children and hence they were the better judges for deciding the acceptability of the weaning formulae evolved. The score card devised for the laboratory trials were used for the field trial among the mothers.

The weaning formulae was prepared as porridge and offered in four different forms as (i) bland (no addition of flavor and sugar) (ii) sweetened but no flavor (iii) bland with flavor but no sugar (iv) sweetened and flavored. For the acceptability trial, one part of the weaning formulae was mixed with three parts of hot water to make a bland

porridge. These four combinations were used for the trials at the laboratory and at the field levels. At the field level independent acceptability test were conducted among the children as well as their mothers.

The bland porridge was sweetened at two levels by adding:

(i) 14 per cent sugar

(ii) 28 per cent sugar.

In order to determine the taste preference, porridge prepared with the weaning formulae was mixed with the above two levels of sugar and tested. Through the acceptability trials, the acceptable concentration was identified. These trials were conducted with the panel members at the laboratory level.

The bland porridge was flavoured with different flavor in differert concentrations as indicated below:-

(a) Vanilla	(i) 0.025 percent
	(ii) 0.05 percent
(b) Rose	(i) 0.025 percent
	(ii) 0.05 percent
(c) Pineapple	(i) 0.025 percent
	(ii) 0.05 percent

To determine the flavor preference three most popular flavor viz. Vanilla, Rose and Pineapple were added to the

porridge prepared with the weaning formulae developed. To find out the best concentration of these flavors, the flavor were added at two concentrations (0.025 percent and 0.05 percent). The bland porridge with different flavor were tested to select the most accepted flavor by the panel members at the laboratory level. After identifying the most acceptable concentrations of flavor and sugar among panel members, these two qualities mainly sweetness and flavor were combined and were tested. With the variations in sweetness and flavor acceptable to the panel members, combinations of the porridge were worked out as detailed below:-

(i) Bland porridge

(ii) 0.05 percent pineapple without sugar

(iii) 28 percent sugar without flavor

(iv) 28 percent sugar and 0.05 percent pineapple.

The tests were conducted among panel members at the laboratory level and among mothers and children at the field level. Acceptability of the weaning formulae was based on preference ranking on the points scored by each panel member mothers and children on like/dislike rating scale. Regarding children, besides preference ranking quantity of plate waste was also a criterian.

The acceptability tests among the panel members, mothers and children were conducted on different days.

Statistical Analysis

Statistical signiricance of all the experiments were calculated using studence t-test (Bennet and Franklin 1967).

RESULT AND DISCUSSION

RESULT AND DISCUSSION

A study was conducted to develop a weaning food based on banana flour. The results of the study are presented and discussed under the following heads.

1. Formulation of different combinations of nutritious low cost and acceptable weaning foods using banana flour as a base.
2. Assessing the nutritional quality of the formulations through animal experiments supported by laboratory studies.
3. Standardising recipes using weaning formulae developed
4. Assessing their acceptability.

1. FORMULATION OF DIFFERENT COMBINATIONS OF NUTRITIOUS, LOW COST AND ACCEPTABLE WEANING FOODS USING BANANA FLOUR AS A BASE

Composition of the six combinations of the weaning formulae selected are presented in Table 9.

Chemical score of these mixtures were determined as major criteria for selecting few combinations from the weaning formulae. As indicated in table 9, food components in the weaning formulae, in the order of their priority, were banana flour, sesame, horse gram and skim

Table 9

Percentage composition of the food ingredients in the Weaning Formulae

	1	2	3	4	5	6
Banana flour	30	35	40	45	50	40
Sesame	20	20	15	15	20	20
Horsegram	30	30	25	20	20	25
Skim milk powder	20	15	20	20	10	15
Chemical score	62.59	62.41	61.20	61.85	63.98	61

milk powder. Banana flour was added in the proportion of 30 to 50 percent in the different combinations of weaning formulae while horsegram was added in the proportion of 20 to 30 percent. Skim milk powder were added in the proportion of 10 to 20 percent and sesame in the proportion of 15 to 20 percent. Weaning formulae group I was a mixture of banana flour, horsegram, sesame and skim milk powder in the proportion of 3:2:3:2. In weaning formulae (Group 2) compared to group 1, 5 part of skim milk powder was substituted with equal quantity of banana flour. In the weaning formulae group 3, 5 part each of sesame and horse gram were substituted by banana flour when compared to group 1. The quantity of skim milk powder was same for both groups. The weaning formula (group 4) has 5 percent decrease in the quantity of sesame and 10% decrease in the quantity of horse gram when compared to the group 1. In group 4 the amount of banana flour was increased by 15 percent and the quantity of skim milk powder remains the same as that of group 1. When compared with other groups the quantity of banana flour was highest for weaning formula identified as group 5. The quantity of sesame was same as that of group 1 while there was 10 percent decrease in the quantity of horse gram and skim milk powder when compared to group 1. In the weaning formulae (group 6) the amount of sesame was same as that

of group 1. There was 5 percent decrease in the quantity of horse gram and skim milk powder and 10% increase in the quantity of banana flour when compared to group 1.

2. ASSESSING THE NUTRITIONAL QUALITY OF THE WEANING FORMULAE DEVELOPED

The nutritional quality of the weaning formulae developed were assessed using food composition tables of ICMR (1982) and through suitable laboratory estimations.

2.1 ASSESSING THE NUTRITIONAL QUALITY OF THE WEANING FORMULAE DEVELOPED USING FOOD COMPOSITION TABLES

The protein, mineral and vitamin content of the six combinations as worked out from the food composition tables are given in Table 10.

As revealed in Table 10, the protein content of the six combinations of weaning formulae were found to have 13.13 g. to 18.62 g. percent and the calorific value of the weaning formulae was in the range of 244.5 to 299.5 calories per 100 g. of the sample. All the weaning formulae were found to contain adequate amounts of protein, calorie, fat, calcium and Thiamine so as to meet the requirements of infants.

Table 10

Nutrient composition of weaning formulae developed using food composition tables, weaning formulae (100 g)

Nutrients	1	2	3	4	5	6
Protein (g)	18.62	16.85	16.86	15.89	13.13	15.87
Fat (g)	10.33	10.34	7.92	7.67	9.83	10.08
Calorie (K.cal)	299.50	284.85	261.70	248.85	244.50	272.00
Niacin (mg)	1.22	1.18	1.36	1.29	1.43	1.54
Riboflavin (mg)	0.46	0.38	0.44	0.43	0.28	0.37
Thiamine (mg)	0.35	0.41	0.37	0.35	0.36	0.39
Vitamin A (mg)	42.30	43.80	38.75	36.70	41.20	41.75
Vitamin C (mg)	8.50	9.45	10.85	12.00	12.70	10.60
Calcium (mg)	0.65	0.31	0.56	0.55	0.48	0.57
Iron (mg)	5.08	5.04	4.19	3.81	4.22	4.65

2.2 ASSESSING THE NUTRITIONAL QUALITY OF THE WEANING FORMULAE DEVELOPED USING LABORATORY ESTIMATIONS

The protein quality of the six combinations were determined through suitable laboratory techniques and the results are presented in Table 11.

Table 11

Nutrient composition of the weaning formulae developed.

Nutrient	1	2	3	4	5	6
Protein	10.29	15.44	15.44	15.44	15.44	15.44
Calcium	0.01	0.01	0.01	0.01	0.01	0.01
Phosphorous	0.01	0.01	0.01	0.01	0.01	0.01

3. ASSESSING THE NUTRITIONAL QUALITY OF THE WEANING FORMULAE DEVELOPED THROUGH ANIMAL EXPERIMENTS

1. Gain in body weight.

Effect of selected six combinations of the weaning formulae with the various ingredients like banana flour, horse gram, sesame and skim milk powder in different proportions were assessed through animal experiments of 28 days duration. Gain in weight of the experimental animals in this experiment is presented in Table 12.

As revealed in Table 12, animals fed in group 1 gave the highest gain in weight followed by the animals included in group 3. Group 6 was ranked as third in the order. The results of the statistical analysis are given in Table 13.

Table 12

Effect of selected six combinations of the weaning formulae and standard diet on the growth of the Experimental animals

Diets	1	2	3	4	5	6	7
Mean initial Body weight (g)	27.07 ± 0.672	26.93 ± 0.84	23.70 ± 0.83	25.93 ± 1.01	34.30 ± 1.44	35.73 ± 1.61	31.00 ± 1.52
Mean final Body weight (g)	111.50 ± 2.09	92.17 ± 2.67	95.67 ± 3.06	84.10 ± 2.27	100.53 ± 3.62	103.43 ± 4.45	92.33 ± 3.79
Mean gain in Wt. (g)	84.43	65.24	71.97	58.17	66.23	67.70	61.33
Mean gain in weight in %	311.90 ± 8.42	242.26 ± 7.51	303.67 ± 10.32	224.33 ± 6.51	193.10 ± 7.14	189.48 ± 7.77	197.84 ± 8.90

Table 13

Statistical analysis of Table 12.

Groups	1 vs. 7	2 vs. 7	3 vs. 7	4 vs. 7	5 vs. 7	6 vs. 7
% weight t - value	2.86*	0.4333	3.208*	0.339	0.5385	0.2229
Groups	4 vs. 1	4 vs. 2	4 vs. 3	4 vs. 5	4 vs. 6	
% weight t - value	3.855*	1.932	3.624*	2.102	1.875	
Groups	1 vs. 2	1 vs. 6	1 vs. 5	1 vs. 3	2 vs. 7	2 vs. 5
% weight t - value	3.003*	2.292	2.804*	1.924	0.5462	0.3274
Groups	2 vs. 4	6 vs. 5	6 vs. 3	5 vs. 3		
% weight t - value	2.251	0.316	2.06	1.794		

* Significant at 5 percent level.

** Significant at 1 percent level.

Statistical analysis showed that the growth gained by the animals in group I and 3 were significantly higher when compared to the animals who were fed skim milk diet (group 7). Whereas group 2, 5 and 6 were equally efficient in promoting growth when compared with group 7, group 4 was least effective in promoting growth. When the different banana based diets were compared among themselves, the growth promoting value of group 3 and 6 were comparable with that of group 1 where the differences were not significant, while the values were significantly lower in group 2, 4 and 5.

2. Protein Efficiency Ratio.

Weight gain and protein intake of rats fed on different diets along with the PER of the diets are given in table 14.

The rats in group 1 showed the highest PER (4.91) followed by group 3, (4.06), group 7 (3.51), group 5 (3.21) group 6 (2.97), group 2 (2.7) and group 4 (2.65). The PEP values of the experimental groups are compared with the control group (group 7). The experimental groups are also compared among themselves. The results of the statistical analysis are given in Table 15.

Table 14

Protein Efficiency Ratio (PER) of different experimental diets.

Diets	1	2	3	4	5	6	7
Weight gain (g)	84.43	65.24	71.97	58.17	66.23	67.70	61.33
Protein intake (g)	17.21	24.20	17.72	21.94	20.64	22.82	17.46
PER	4.91 ± 0.124	2.70 ± 0.126	4.06 ± 0.068	2.65 ± 0.103	3.21 ± 0.135	2.97 ± 0.134	3.51 ± 0.098

Table 15

Statistical analysis of Table 14.

Groups	1 vs. 7	2 vs. 7	3 vs. 7	4 vs. 7	5 vs. 7	
t - value	10.84**	2.14	3.721**	8.80**	1.79	
Groups	5 vs. 7	4 vs. 1	4 vs. 2	4 vs. 6	4 vs. 5	4 vs. 3
t-value	1.87	19.58**	5.65**	1.13	3.55**	0.23
Groups	1 vs. 2	1 vs. 6	1 vs. 5	1 vs. 3	2 vs. 6	
t-value	3.23*	6.57**	9.514**	9.77**	1.71	
Groups	2 vs. 5	2 vs. 3	6 vs. 5	6 vs. 3	5 vs. 3	
t-value	2.99*	4.30*	0.76	0.79	2.04	

* Significant at 5% level.

** Significant at 1% level.

Statistical analysis showed that PER value obtained for group 1 (4.91) was significantly higher when compared to that of group 7 (3.51) in which skim milk was the major component. The PER value obtained for group 4 was 2.65 and it was significantly lower than group 7. There was significant difference in PER values of group 2, 3, 5 and 6 when compared with group 7. The PER values of the different groups were compared among themselves and statistical analysis showed that when compared with group 1, which has the highest PER value, PER values of all the other diets were significantly lower except that of group 3 (4.06). The PER value obtained for group 3 was comparable with group 1 where the difference was not statistically significant. When the PER valuesof the different groups were compared with group 3, the values obtained for groups 2, 4, 5 and 6 were significantly lower. The PER value obtained for group 5 was 3.21 and it was comparable to the PER values of groups 6 and 2 where as the difference was significantly low in the case of group 4. The PER value of group 6 was 2.97 and was comparable to that of group 2 (2.70) and group 4 (2.65) in this context the differences were insignificant. The PER value obtained for group 7 was 3.51 and it was comparable to group 5 and PER value of which was 3.21.

3. Hepatic weight and hepatic nitrogen of rats fed on different diets.

Weight of liver and its nitrogen content obtained from rats fed different combinations of weaning formulae were evaluated. The mean weight and nitrogen of rats fed different diets are given in Table 16.

Maximum liver weight and the highest hepatic nitrogen were recorded by rats fed on group 1 (5.123 and 466.5). Next ranked group 3 (3.32 and 411.6) followed by group 2 (3.201 and 404.4), group 7 (3.158 and 384.16), group 6 (2.937 and 329.28), group 4 (2.883 and 259.93) and group 5 (2.79 and 232.87).

The results or the data were statistically analysed and the values are given in Table 17.

Table 16

Hepatic Weight and Hepatic Nitrogen of Experimental rats fed on different diets

Groups	1	2	3	4	5	6	7
Hepatic Weight (g)	5.123 ± 0.128	3.201 ± 0.099	3.32 ± 0.116	2.883 ± 0.112	2.79 ± 0.117	2.937 ± 0.132	3.158 ± 0.155
Hepatic Nitrogen (mg)	466.5 ± 11.663	404.4 ± 6.34	411.6 ± 14.41	259.93 ± 10.14	232.87 ± 9.78	329.28 ± 14.82	384.16 ± 18.82

Table 17

Statistical Analysis of Table 16

Groups	1 vs. 7	2 vs. 7	3 vs. 7	4 vs. 7	5 vs. 7	6 vs. 7
Liver weight (t - value)	4.984**	0.218	0.28635	0.5656	1.08	0.50
Liver Nitrogen (t - value)	1.34	0.85	0.28	3.47*	0.64	1

Groups	4 vs. 1	4 vs. 2	4 vs. 6	4 vs. 5	4 vs. 3
Liver weight (t - value)	4.38*	1.91	0.14	0.36	1.29
Liver Nitrogen (t - value)	3.48*	0.26	1.31	0.12	3.90*

Groups	1 vs. 2	1 vs. 6	1 vs. 5	1 vs. 3	2 vs. 6	2 vs. 5
Liver weight (t - value)	3.84*	3.61*	4.33*	3.10*	0.72	1.73
Liver Nitrogen (t - value)	0.38	1.89	0.97	0.50	0.58	0.09

Groups	2 vs. 3	6 vs. 5	6 vs. 3	5 vs. 3
Liver weight (t value)	0.37	0.35	0.82	1.40
Liver nitrogen (t - value)	0.90	0.40	0.77	0.71

* Significant at 5 percent level. ** Significant at 1 percent level

Statistical analysis showed that when compared to control diet (group 7) the difference in hepatic weight was significantly higher for Groups 1 (5.123) Group 3 (3.32) and Group 2 (3.201) and for the remaining groups when compared to skim milk diet, the difference were not significant. The combinations of weaning formulae were compared among themselves, and when the values were compared with group 1, group 3 and 2 were comparable and there was significant difference when compared with group 4 (2.883) 5 (2.79) and 6 (2.937). Hepatic weight of rats in group 3 (3.32) and group 2 (3.201) were comparable and in this context the difference was insignificant. The values obtained for group 4 and 5 were significantly low. The hepatic weight of group 2 was statistically compared with group 4 and 5 and the difference was significantly low, while it is comparable with group 6. The values between group 5, 4 and 6 were comparable.

Statistical analysis for differences in total hepatic nitrogen of group 1, 3 and 2 were significantly high when compared with skim milk diet (group 7), while the values were insignificant for the rest of the groups. The difference in hepatic nitrogen of all the groups were significantly lower when compared with group 1. Group 3 was significantly high in hepatic nitrogen next to group 1.

Group 2 was comparable with group 7 in its hepatic nitrogen content while it was significantly high when compared with group 4, 5 and 6.

4. Serum Protein content

Serum protein content of rats fed on different diets are given in Table 18.

As indicated in Table 18 the highest serum protein content (15.007) was recorded in group 1. All the combinations of weaning formulae except group 5 and 6 showed higher serum protein content when compared with control diet. The different groups were compared statistically and the results are given in Table 19.

Statistical analysis showed that the differences in serum protein content were significantly higher for all groups except group 5 and group 6 when compared with control diet group 7. When group 1 was compared statistically with other groups, group 2, 6 and 3 were comparable and the differences were significant with group 5 and 6. The serum protein content of rats in group 1 was comparable to other groups except group 5 where the difference was significantly low. The difference in serum protein content of group 2 was zero when compared with group 3 and there was significant difference when compared with group 5 and 6 and it was significantly low when compared with group 1. The

Table 18

Mean Serum Protein of the Rats fed on different diets

Groups	1	2	3	4	5	6	7
Serum Protein g. %	15.007± 0.375	12.863 ± 0.398	12.863± 0.45	10.719± 0.418	5.469± 0.230	4.08± 0.184	7.438± 0.364

Table 19

Statistical Analysis of Table 18

Groups	1 vs. 7	2 vs. 7	3 vs. 7	4 vs. 7	5 vs. 7	6 vs. 7
t - value	3.38*	8.15**	1.93	1.46	1.54	3.46
Groups	4 vs. 1	4 vs. 2	4 vs. 6	4 vs. 5	4 vs. 3	
t - value	1.41	1.0	3.09*	2.18	0.50	
Groups	1 vs. 2	1 vs. 6	1 vs. 5	1 vs. 3	2 vs. 6	2 vs. 5
t - value	1.001	1.42	3.97*	0.50	12.45**	6.75**
Groups	2 vs. 6	6 vs. 5	6 vs. 3	5 vs. 3		
t - value	0	1.09	2.32	1.91		

* Significant at 5 percent level

** Significant at 1 percent level.

lowest serum protein values were shown by Group 6 which was significantly low when compared with all other groups.

5. Digestability Coefficient

Digestability coefficient was determined by nitrogen balance study and the results are presented in Table 20.

As indicated in Table 20 rats in group 1 showed the highest digestability followed by group 3 and group 7. The least value for digestability coefficient was found in group 5.

The results of the statistical analysis given in Table 20 revealed that even though group 1 and 3 registered high values, the difference was not significant and all the experimental diets were comparable to the control diet in their digestability coefficient. Among the experimental diets, when compared to Group 1 all groups are comparable except group 4 where the difference was significant.

Table 20

Digestability coefficient of the rats fed on different diets

Groups	1	2	3	4	5	6	7
Digestability Coefficient	92.38± 2.31	89.72± 2.78	90.32± 3.16	87.12± 3.40	85.13± 3.58	88.31± 3.97	90.12± 4.42

Table 21

Statistical Analysis of Table 20.

Groups	1 vs. 7	2 vs. 7	3 vs. 7	4 vs. 7	5 vs. 7	6 vs. 7
t - value	1.52	0.21	0.23	4.22*	6.74**	1.20
Groups	4 vs. 1	4 vs. 2	4 vs. 6	4 vs. 5	4 vs. 3	
t - value	3.60*	1.41	0.80	2.97*	4*	
Groups	1 vs. 2	1 vs. 6	1 vs. 3	2 vs. 6	2 vs. 5	
t - value	1.17	2.05	1.34	0.62	2.47	
Groups	2 vs. 3	6 vs. 5	6 vs. 3	5 vs. 3		
t - value	0.32	2.13	1.29	6.25**		

*Significant at 5 percent level

**Significant at 1 percent level.

6. Biological Value

Biological value (Bv) of the different weaning formulae was determined by nitrogen balance study and the results are presented in Table 22.

As indicated in Table 22, all the experimental diets were comparable with control diet in their biological value. The results of the statistical analysis of the above data is given in Table 23.

As revealed in Table 23, the difference was significant when group 1 was compared with other groups, groups 4, 6, 5 and 7. Group 2 was comparable to group 1, 3, 4, 6 and 7 and the difference was significant for group 5. Statistical difference was significant in the case of group 3 when compared with group 5. There was significant difference with group 4 and 1 when compared to group 5.

Table 22

Biological value of the different experimental diets.

Groups	1	2	3	4	5	6	7
Bv	85.32± 2.1333	81.02± 2.51	83.41± 2.92	78.51± 3.06	75.32± 3.16	78.69± 3.54	80.31± 3.94

Table 23

Statistical Analysis of Table 22.

Groups	1 vs. 7	2 vs. 7	3 vs. 7	4 vs. 7	5 vs. 7	6 vs. 7
t - value	3.36*	0.53	3.6*	2.53	6.74**	1.37
Groups	4 vs. 1	4 vs. 6	4 vs. 2	4 vs. 5		
t - value	4.66**	0.16	1.93	4.76**		
Groups	5 vs. 3	1 vs. 6	1 vs. 2	1 vs. 5	1 vs. 3	6 vs. 2
t - value	9.75**	3.81*	2.32	6.8**	1.24	1.46
Groups	6 vs. 5	6 vs. 3	2 vs. 5	2 vs. 3	5 vs. 3	
t - value	2.91*	3.84*	4.32*	1.72	9.75**	

* Significant at 5 percent level

** Significant at 1 percent level

7. Net Protein Utilisation.

Net Protein Utilisation (NPU) of different groups are determined from biological value and digestability coefficient and the results are presented in table 24.

As indicated in Table 24, group 1 showed the highest NPU (78.82) followed by groups 3, 2, 7, 6, 4 and 5.

The results of the statistical analysis of the above diets are presented in table 25.

Statistical analysis of the data given in the table 25 revealed that the difference in NPU values were significantly higher in group 1 and significantly low in group 5 when compared with control group. All the other groups were comparable to control group in their NPU values.

Table 24

Net Protein Utilisation of rats fed on different diets

Groups	1	2	3	4	5	6	7
NPU	78.82± 1.97	72.69± 2.25	75.34± 2.64	68.40± 2.67	64.12± 2.69	69.49± 3.13	72.38± 3.55

Table 25

Statistical Analysis of Table 24.

Groups	1 vs. 7	2 vs. 7	3 vs. 7	4 vs. 7	5 vs. 7	6 vs. 7
t - v a lue	4.67*	0.24	2.87*	4.10*	8.34**	2.7
Groups	4 vs. 1	4 vs. 6	4 vs. 2	4 vs. 5	4 vs. 3	
t - value	8.91**	1.40	3.97*	6.39**	9.5**	
Groups	1 vs. 6	1 vs. 2	1 vs. 5	1 vs. 3	6 vs. 2	6 vs. 5
t - value	7.43**	4.2*	12.35**	2.85*	2.74	6.63**
Groups	6 vs. 3	2 vs. 5	2 vs. 3	5 vs. 3		
t - value	6.8**	7.79**	2.32	2.32		

* Significant at 5 percent level

** Significant at 1 percent level.

4. STANDARDISING RECIPES IN THE LABORATORY USING WEANING FORMULAE DEVELOPED

Weaning formulae was standardised at the laboratory through following experiments.

1. Percentage Preparation Loss.

Percentage preparation loss assessed for the six combinations of weaning formulae are given in Table 26.

Table 26

Percentage preparation loss for different combinations of weaning formulae

Combination of Weaning formulae	A.P.weight (g)	B.P.weight (g)	% preparation loss
1	63.22	33	0.47
2	60.11	37	0.38
3	62.56	34	0.46
4	69.38	38	0.45
5	67.32	34	0.49
6	60.62	33	0.46

As indicated in the table the percentage preparation loss was highest for the weaning formulae (group 5).

2. Cost per serving.

Cost per serving of the different combinations were worked out and the details are given in table 27.

Table 27

Cost per serving for different combinations of weaning formulae

Combination of weaning formulae	Cost per serving (Ps.)
1	43
2	38
3	41
4	42
5	33
6	38

As revealed in Table 27, the cost per serving was lowest for weaning formulae (group 5, 2 and 6). The highest cost per serving was for weaning formulae (group 1) followed by group 4.

3. Percentage yield

The percentage yield were worked out for different weaning formulae and the results are given in Table 28.

As indicated in the table, there was no significant variation in the percentage yield of various weaning formulae tried. Since there was no significant variation among the various weaning formulae tried, the weaning

Table 28

Percentage yield for different combinations of weaning formule

Combinations	Weight before cooking (g)	Cooked weight (g)	Percentage yield
1	35	97	2.77
2	34	100	2.94
3	35	105	3.00
4	33	94	2.86
5	35	106	3.03
6	34	92	2.71

formula which gave the highest values for protein efficiency ratio, hepatic weight, hepatic nitrogen, serum protein and net protein utilisation was selected for further trials on standardisation.

4. The Nutritional Quality.

The nutritional quality was calculated on the basis of the fact that the supplementary food included in the diet of pre-school children should meet 1/3rd of his nutritional requirement. In this case the quantity of weaning formulae to be taken for standardisation of recipe selection is on the basis of 1/3rd protein requirement of the pre-school children. 33 g. of weaning formula was required to supply

6 g. of protein which is the 1/3rd protein requirement and the details of other nutrients supplied by 33 g. of the weaning formula was worked out and the details are given in Table 29.

Table 29

Nutrient composition of recipe
(a) Bland Porridge.

		1/3rd R.D.A.
Caloric K.cal	99	400
Protein g	6	6
Vitamin A mg	20	333
Vitamin B, (mg.)	0.24	0.2
Vitamin C, (mg.)	2.805	13
Calcium g	0.359	0.15
Iron mg	2.72	6

As revealed in Table 29, the weaning formula was found to be deficient in calorie and nutrients such as Vitamin A, Vitamin C and Iron.

The cost of 33 g or weaning formula was worked out by estimating the cost of various food ingredients and cost of fuel needed for preparing the formula. The cost per serving of the formula is given in Table 30.

Table 30

Cost of serving of Bland Porridge.

	Cost (Ps.)
Cost of various food ingredients	40
Cost of fuel needed	5
Total	45

As revealed in Table 30, the cost of the formulae comes around ps. 45.

Three recipes were standardised with weaning formula as the base natural. Porridge was one of the receipes developed while standardising the other two recipes, care was taken to make up the nutritional deficiencies in the bland porridge. The nutrient composition of the two recipes were calculated and compared with 1/3rd requirement of pre-school children. The weight of various ingredients used in the recipe (b) porridge with Chekkurmanis its nutritive value and cost are given in Table 31.

Table 31

Nutrient composition and cost of recipe

(b) Porridge with Chekkurmanis

	Weight (g)	Cost (ps.)	Calorie	Protein	Vitamin A
Bland porridge	33	40	99	6.145	19.899
Chekkurmanis	14	..	14.42	0.952	798.84
Cooking Oil	15	39	135	..	..
Fuel	..	12	..	..	..
Total		111	403.255	14.027	828.879
1/3rd R.D.A.	..	..	400	6	333

	Vitamin B	Vitamin C	Calcium	Iron
Bland porridge	0.243	2.805	0.359	2.716
Chekkurmanis	0.0672	34.58	0.0798	3.92
Cooking Oil	..	..	..	..
Ground nut	0.246	..	0.0246	0.767
Total	0.5562	37.385	0.4634	7.403
1/3rd R.D.A.	0.2	13	0.15	6

Cost per serving; 111 ps.

As revealed in Table 31 the bland porridge was defficient in calorie and nutrients such as Vitamin A, Vitamin C and Iron. To make up the calorie deficiency, Vegetable Oil and Ground Nut were added. Similarly deficiency of Vitamin A, Vitamin C and iron were made up by adding Chekkurmanis. The cost per serving of the recipe is worked by estimating the cost of food ingredients and the cost of fuel needed for preparing the recipe. As revealed in Table 31 the cost of the recipe comes around 111 Ps.

The nutritious value and cost of recipe (b) is given in Table 32.

As revealed in Table 32 the bland porridge was defficient in Calorie, Vitamin A and Vitamin C. To make up the Calorie defficiency Ghee and Jaggery were added. The defficiency of Vitamin A and Vitamin C were made up by adding mango. As revealed in Table 32 the cost of the recipe comes around 174 Ps.

Table 32

Nutrient composition and cost of recipe

(c) Porridge with Mango

	Weight (g)	Cost Ps.	Calorie K-Cal	Protien	Vitamin A(mg)	Vitamin B(mg)
Weaning food	33	40	98.335	6.145	19.899	0.243
Mango	30	9	30	0.124	1112	0.032
Ghee	20	100	180	..	400	..
Jaggery	30	13	114.9	0.12	..	0.006
Fuel	..	12	..	..	..	..
Total	..	174	423.735	6.505	1531.899	0.281
1/3rd R.D.A		..	400	6	333	0.2

	Vitamin C	Calcium	Iron
Bland Porridge	2.805	0.359	2.716
Chekkurmanis	6.49	0.0057	0.53
Ghee	..	..	..
Jaggery	..	0.024	3.42
Total	9.295	0.3847	6.666
1/3rd R.D.A.	13	0.15	6

5. ASSESSING THE ACCEPTABILITY OF THE RECIPES

Among the various recipes standardised porridge was selected for the conduct of the acceptability because this recipe was very easy to prepare without addition of any other food material which may influence the acceptability of a recipe.

The porridge was prepared with the combination of weaning formula which gave the highest value for protein efficiency ratio, hepatic nitrogen, serum protein and net protein utilisation and for the tests conducted while standardising recipes. Acceptability of the porridge was conducted in the laboratory with the help of ten panel members and at the field among the ten mothers and children.

1. Preference for the porridge at different sugar concentration.

Preference of the panel members for the porridge at different sugar concentration was tested and the results are given in Table 33.

As revealed in Table 33 all the panel members liked the porridge when the sugar concentration was 28 percent. While 10 percent of the panel members had graded 14 percent sugar concentration as neither acceptable nor unacceptable. Thus the porridge with 28 percent sugar concentration was taken as the best level of sweetness for the porridge

Table 33

Preference of panel members for porridge at two levels of sugar

*N = 10

	Highly acceptable	Acceptable	Slightly acceptable	Neither acceptable nor unacceptable	Slightly unacceptable	Unacceptable	Highly unacceptable
Blend	..	..	60	20	20	..	..
14 percent Sugar	..	40	50	10	..	..	..
28 percent Sugar	..	40	60	..	..	..	..

* Number of panel members.

developed. This concentration was used for further testing of sweetened porridge with flavour.

Test was conducted to assess the relative importance of added sugar at two different concentrations on the quality attributes such as overall acceptability, appearance, flavour, taste and texture. The mean scores on a 5 point hedonic scale obtained for bland and sweetened porridge are given in table 34.

Table 34

Acceptability profile for different levels of sugar

	Over all acceptability	Appearance	Flavour	Texture	Taste
Bland	4.4	3	3.2	3.7	2.5
14 percent sugar	5.3	3	3.5	3.7	3.5
28 percent sugar	5.4	3	3.3	3.7	3.9

As indicated in Table 34 the sweetened porridge was more acceptable when compared with the bland, in qualities such as over all acceptability, flavour and taste. Among the sweetened porridge doubling the concentration of sugar considerably improved the rank and score. As revealed in the table the scores obtained for appearance and texture were same for all the three samples.

The over all acceptability and taste were highest for the porridge which contained 28 per cent sugar.

2. Preference for the porridge with different flavours

The preference ranking given for different flavours at two different concentrations are given in Table 35.

As indicated in Table 35, the porridge prepared with different flavour were not highly unacceptable. However 10 percent of the panel members had graded bland porridge as unacceptable and Vanila at 0.05 percent level as slightly unacceptable. But pineapple flavour was not treated as unacceptable at any level. Hence pineapple flavour was selected.

On the basis of the mean scores obtained, pineapple was considered as the most acceptable flavour. Among various qualities tested there was no variation for scores obtained for qualities such as appearance and texture while variations among different levels of flavours are found in the quality attribute namely 'flavour'. As revealed from the table 0.05 percent pineapple was most acceptable flavour.

The acceptability profile of the flavours among the panel members were calculated by summing up the scores given for individual quality attributes such as overall

Table 35

Preference ranking for different flavors

by panel members

$N^{x} = 10$

	Highly acceptable	Acceptable	Slightly acceptable	Neither acceptable nor unacceptable	Slightly unacceptable	Unacceptable	Highly unacceptable
Bland	..	40	20	30	..	10	..
0.025 percent Vanila	..	50	40	10	..	..	..
0.05 percent Vanila	..	60	20	10	10	..	..
0.025 percent Orange	10	10	30	50	..	..	..
0.05 percent Organge	10	20	40	30	..	..	..
0.025 percent Pineapple	20	60	20	..	..	..	..
0.05 percent Pineapple	20	70	10	..	..	..	..

Table 36

Acceptability profile of the flavors by the panel members

N^{X} = 10

	Mean Scores on 5 point hedonic scales				
	Over all acceptability	Appearance	Flavor	Texture	Taste
0.025 percent Vanila	5.2	3.6	3.4	3.5	3.7
0.05 percent Vanila	5.4	3.7	4.0	3.4	3.7
0.025 percent Orange	4.8	3.8	3.2	3.4	3.8
0.05 percent Orange	5.5	3.8	3.4	3.5	3.8
0.025 percent Pineapple	5.4	3.8	4.0	3.5	3.7
0.05 percent Pineapple	5.8	3.7	4.8	3.5	3.8

N^{X} = No. of panel members

acceptability, appearance, flavour, texture and taste. The percentage was worked out from the total scores and the detailes are given in Table 36.

3. Acceptability of the porridge

Acceptability test of the porridge was conducted at the laboratory level with the help of ten panel members and at the field level among ten mothers and children. The sugar concentration for the porridge tested at the field level was 28 percent and pineapple flavour (0.05 percent) being the most acceptable one was used for field trials. The results are presented in Table 37.

From the table 37, it was revealed that among the four forms of the porridge tested, samples which were sweetened with flavour and without flavour were found to be acceptable for all the panel members and mothers. In the case of sample to which flavour alone was added acceptability was not uniform among different panel members. Preference for this recipe was higher among mothers and children compared to panel members who participated in the laboratory trials.

Table 37

Acceptability trial of porridge at the field/laboratory level

Different forms of porridge	Laboratory Level		Field Level			
	Panel members N = 10		Mothers N = 10		Children	
	Liked %	Disliked %	Liked %	Disliked %	Liked %	Disliked %
1. Bland ..	40	60	70	30	98 (2)	18
2. Flavored ..	40	60	50	50	92 (8)	20
3. Sweetened ..	100	..	100	..	95 (5)	17
4. Sweetened & flavored ..	100	..	100	..	94 (6)	18

But when sugar was added to the flavored porridge the acceptability become 100 percent. The table also indicate that the responses of the members at the field as well as laboratory level are strongly based in favour sweetened samples with sweetened and flavored ranking the highest. However, in the case of children they seem to be not influenced either by sweetness or by flavor since all the four forms including the bland was well acceptable to 90 - 92 percent of the children. The responses and reactions of the children indicated that they accepted all samples equally well without discrimination among sweetened, flavored and bland samples.

4. Quality responsible for the acceptability of the porridge

The general acceptability of the product was calculated by summing up the scores given for individual quality attributes such as over all acceptability, appearance, flavor, texture and taste by the panel members at the laboratory as well as at the field level. The percentage was worked out from the total scores. The data obtained for each of the weaning formulae is given in the table 38.

As revealed from Table 38 the sweetened as well as flavored porridge obtained the highest score followed by

Table 38

General acceptability of the porridge among panel members and mothers

Different forms of porridge	Panel Members		Mothers	
	Mean score	Percentage	Mean score	Percentage
1. Bland	15.4 ± 0.39	57.04 ± 1.42	16.1 ± 0.40	59.63 ± 1.49
2. Flavored	21.9 ± 0.74	81.11 ± 2.76	17.2 ± 0.58	63.70 ± 2.23
3. Sweetened	22.3 ± 0.88	82.59 ± 3.22	21.6 ± 0 84	80.0 ± 3.12
4. Sweetened & Flavored	23.1 ± 1.02	85.56 ± 3.85	22.3 ± 1.003	82.59 ± 3.79

the sweetened porridge without addition of flavor. Results of the statistical analysis of the data are presented in Table 39.

Table 39

Statistical analysis of Table 38.

	1 vs. 2	1 vs. 3	1 vs. 4	4 vs.2	4 vs.3	2 vs.3
Panel members	3x3*	1.9	6.91*	3.44*	5.16*	2.56
Mothers	3.56*	1.3	5.48*	2.95	4.93*	3.01

* Significant at 1 percent level.

Statistical analysis showed that the difference between the two were significant in the case of panel members at the laboratory level whereas the difference was not significant for the mothers. The least score was obtained for the bland porridge.When compared with the bland porridge the difference was significantly higher for the sweetened porridge. This indicates that sweetness is responsible for the variations in acceptability

5. Preference ranking

Preference ranking for the porridge by the panel members and the laboratory level as well as the field level are given in Table 40.

As revealed in the Table 40, the over all acceptability of the porridge at the laboratory level as well as at

Table 40

Preference ranking for the weaning formulae by the panel members

Different forms of porridge	Highly acceptable	Acceptable	Slightly acceptable	Neither acceptable nor unacceptable	Slightly unacceptable	Unacceptable	Highly unacceptable
Bland							
Laboratory trials	..	40	20	30	..	10	..
Field trials	..	60	30	10	..	..	..
Flavored							
Laboratory trials	..	40	30	40	..	..	..
Field trials	..	50	30	20	..	..	..
Sweetened							
Laboratory trials	..	70	20	10	..	..	..
Field trials	60	20	10	10	..	..	..
Sweetened & Flavored							
Laboratory trials	80	20	..	..	..	..	..
Field trials	80	20	..	..	..	..	...

the field level were found to be influenced by the addition of sugar. However the acceptance of the porridge at the field level was also influenced by the flavor to an extent and the porridge with sugar and flavor was also found to be acceptable. The porridge in which flavor and sugar were added was found to be the most acceptable. Preference ranking further stressed that sweetness was the quality responsible for the variation in the acceptability of the porridge.

6. Over all acceptability of the Porridge

The overall acceptability was ranked according to laboratory trials and the results are presented in Table 41.

From the table it is revealed that the appearance and texture of the different formulae were the same. But the mean scores obtained for overall acceptability, flavor and taste were highest for sweetened and flavored porridge. The results were statistically analysed and the data is given in Table 42.

Table 41

Overall acceptability of porridge on a 7-point hedonic scale (Lab/field trial)

	Bland	Flavored	Sweetened	Sweetened & Flavored
Overall acceptability:				
Laboratory Trials	4.8 ± 0.12	5.4 ± 0.14	5.6 ± 0.14	5.8 ± 0.15
Field Trials	5.2 ± 0.13	5.3 ± 0.13	5.4 ± 0.14	5.6 ± 0.15
Appearance:				
Laboratory Trials	3.4 ± 0.12	4.0 ± 0.14	4.0 ± 0.14	4.2 ± 0.14
Field Trials	3.1 ± 0.11	3.8 ± 0.13	3.7 ± 0.13	3.8 ± 0.13
Flavor:				
Laboratory trial	2.8 ± 0.07	4.8 ± 0.16	3.0 ± 0.10	4.9 ± 0.17
Field Trials	3.0 ± 0.08	4.5 ± 0.15	3.1 ± 0.10	4.7 ± 0.16
Texture:				
Laboratory trial	3.3 ± 0.08	3.9 ± 0.15	3.7 ± 0.14	3.5 ± 0.14
Field trial	3.3 ± 0.08	3.4 ± 0.12	3.3 ± 0.13	3.6 ± 0.14
Taste:				
Laboratory Trials	2.9 ± 0.07	3.8 ± 0.17	4.3 ± 0.19	4.6 ± 0.21
Field Trials	3.1 ± 0.08	3.5 ± 0.16	4.6 ± 0.21	4.7 ± 0.21

Table 42

Statistical analysis or Table 41

	1 vs. 2	1 vs. 3	1 vs. 4	4 vs. 2	4 vs. 3	3 vs. 2
				Y		
Overall acceptability:						
Panel members	..	5.6*	10.7*	10.4*	4.9*	5.4*
Mother	0.32	5.7	7.2	8.55	2.8	17.3
Flavor:						
Panel members	4.6*	0.78	6.7*	1.7	6*	4*
Mother	7.0*	2.7	6.6*	..	4.4*	4.7*
Taste:						
Panel members	1.9	11.5*	14.4*	12.5*	3.8*	9.4*
Mother	1.9	7.6*	11.1*	12.8*	3.4*	9.3*

* Significant at 1 percent level.

7. Acceptability of the Recipes

Acceptability study of various recipes, bland porridge, porridge with Chekkurmanis and porridge with Mango were conducted among the panel members and the results are given in Table 43.

Table 43

Acceptability of the recipes standardised among the panel members

Recipes	Liked %	Disliked %
Bland porridge	50	50
Porridge with Chekkurmanies	60	40
Porridge with Mango	100	..

As revealed in Table 43 all the panel members accepted the porridge with mango while porridge with chekkurmanis was accepted by 60 percent. Among the three bland porridge was least acceptable.

Mean scores obtained for different recipes are worked out and the results are given in Table 44.

Acceptability trials conducted among adults revealed that the highest score was obtained for the porridge with mango and the least acceptable was bland porridge

Table 44

Mean Scores obtained for different recipes

Recipes	Mean score	Percentage
Bland Porridge	15.4 ± 0.39	57.04 ± 1.42
Porridge with Chekkurmanis	17.3 ± 0.59	64.07 ± 2.18
Porridge with Manoo	20.6 ± 0.93	76.3 ± 3.43

Field trials are conducted separately among children to assess the acceptability of different recipes as a major constituent of their mid-day meal and the results collected are presented in Table 45.

Table 45

Acceptability of the recipes among children

	Food given; cooked weight	Children who consumed fully		Children who wasted		Average quantity wasted
		Number	Percentage	Number	Percentage	
Bland	160	10	71	4	29	11
Porridge with Chekkurmanis	185	12	70	5	30	20
Porridge with Mango	190	10	83	2	17	15

As revealed in Table 45, porridge with Mango was the most acceptable recipe. 83 percent of the children consumed the porridge fully while 17 percent wasted. In ranking porridge with mango was followed by porridge with Chekkurmanis as well as bland porridge. Average plate waste was found to be lowest for porridge with mango compared to the bland porridge and porridge with Chekkurmanis is salt medium. Acceptability studies conducted among panel members and children indicated that the response of the panel members were based in favour of sweetened porridge. However in the case of children, they seem to be not influenced by sweetness.

SUMMARY

SUMMARY

Use of processed infant foods is being suggested as a solution to the problem of supplementary feeding to children. Processed foods cannot be expected to make any impact on the majority of the rural population subsisting below poverty line. The approach under these circumstances must therefore, lie in the effective use of locally available and inexpensive foods as infant food (educating the community). In this context the present study was undertaken to develop a weaning food based on banana flour which is nutritious, low cost and acceptable.

Six combinations of weaning formulae were developed under the study. In this the banana flour was supplemented with different proportions of food articles such as horsegram, sesame and skim milk powder to enhance the nutritive value and protein quality of weaning formulae. The protein quality of the six combinations of banana based weaning formulae developed, were evaluated through animal experiment weight gain, protein efficiency ratio biological value, digestability, coefficient net protein utilisation, liver weight, liver nitrogen and serum protein were the important criteria selected for evaluating the proteins of the weaning formulae. The weaning formulae in which the food articles namely banana, horsegram,

sesame and skim milk powder were in the proportion of 3:2:3:2 gave significantly better values for all the above criteria than the skim milk diet which was kept as standard.

The organoleptic qualities of the weaning formulae were assessed by the panel members at the laboratory level and by the mothers and children at the field level. The results of the study indicated that addition of sugar and flavour increased the acceptability of the bland porridge.

As the bland porridge was deficient in nutrients such as calories, Iron and Vitamin A, other food ingredients were added to make up those deficiencies while standardising recipes. Thus two recipes were standardised such as porridge with chekkurmanis in salt medium and porridge with mango in sweet medium. The acceptability trials of these two recipes were conducted at the field level and laboratory level. Among the three recipes, porridge with mango was most acceptable to the children as well as for the panel members.

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APPENDICES

APPENDIX I

Micro-kjeldahl method

Principle

The nitrogen present in combined organic form is converted to ammoniackal form by digestion with concentrated H_2SO_4 in the presence of catalyst mixture. The digest is made alkaline and ammonia liberated is distilled off into an acid solution. Quantity of ammonia liberated is determined by titration against standard acid.

Reagents

1. Conc. H_2SO_4.
2. Digestion mixture
3. Standard acid
4. Mixed indicator
5. 4 percent boric acid
6. 40 percent NaOH

Preparation of Reagents

1. 4% Boric acid - Dissolve 4 g. boric acid in 100 ml. water.
2. 40% NaOH - Dissolve 40 g. NaOH in 100 ml. water.
3. Mixed indicator- Dissolve 3 g. of bromocresol green and 2 g. of methyl red in 400 ml. of 90% ethenol. The indicator colour change from red in acid to blue in alkaline solution.
4. Digestion mixture- 10:5:1 of K_2SO_4 and selenium powder.

5. Conc. H_2SO_4 for digestion.

6. 0.1 NH_2SO_4

7. 0.1 N Na_2CO_3 - 5.3 g of AR Na_2CO_3 to 1 litre and standardised with N_2SO_4.

Standardization of acid

Reagents required;

1. Methyl orange indicator 0.1% in water.
2. Reference solution 80 ml. CO_2 free water with 3 drops of methyl orange indicator.
3. Na_2CO_3 solution 0.02 N dry Na_2CO_3 at 120°C kept for 2 hours. Cool in a desicator and weigh 1.008 into 100 ml. volumetric flask and made upto mark with distilled water. This gives 0.2 N solution 20 ml. of the solution diluted to 200 ml. to get 0.02 N solution.

Procedure for Standardisation

40 ml. 0.02 N Na_2CO_3 solution was taken in a 250 ml. conical flask. Three drops of methyl orange indicator was added and this was filtrated against Hcl to be standardised until the colour begins to deviate from water tint. Boiled the solution gently for 2 minutes to expel CO_2. Cooled and titrated against the acid until the colour was water tint of indicator.

Procedure

One gram sample was placed in a digestion flask. About 1 g. digestion mixture and 10 ml. H_2SO_4 were added to the sample and digestion was effected in a kjeldahl digestion track with low flame for the first 10-30 minutes until the frothing stopped. Then the flame was gradually increased until the sample was completely chared. The flask rotated at intervals and heating was continued intil organic matter was destroyed and their end point was judged by taming the digestion for 15 minutes after the solution has cleaned. At the end of the digestion the flask was kept for cooling and then made upto 100 ml.

Distillation

10 ml. of the digest (made upto 100 ml.) was transferred in to the vacuum mental of the steam distillation arsembly. 10 ml. of 40 percent NaOH was added and washed in with distilled water. The ammonia was distilled out for about 5 minutes and collected in a 100 ml. conical flask containing 10 ml. 4% boric acid. 30 ml. of the distillation was thus collected.

Calculations

Weight of sample	1 g.
Volume of acid used	X
Blank value	Y
Normality of acid	0.02 N
1 ml. IN acid	0.014 g of N_2

$$\% \text{ of total } N_2 = \frac{(X-Y)\ 0.014 \times N \text{ of acid}}{1 \times 10}$$

$$\% \text{ of total } N_2 = \frac{(X-Y)0.014 \times 0.02 \times 100 \times 100}{1 \times 10}$$

APPENDIX II

Score card for acceptability test of food products

Quality attributes	Sub-division of attributes	Score for each sub-division attribute	Score for samples Code No. 1	2	3	4
Appearance	Very poor	1				
	Poor	2				
	Fair	3				
	Good	4				
	Very Good	5				
Flavour (aroma)	Not at all pleasant	1				
	Not pleasant	2				
	Neither pleasant Nonupleasant	3				
	Pleasant	4				
	Very pleasant	5				
Texture	Very sticky	1				
	Moderately sticky	2				
	Slightly sticky	3				
	Not sticky	4				
	Others	5				
Taste	Not at all tasty	1				
	Not tasty	2				
	Slightly tasty	3				
	Moderately tasty	4				
	Very tasty	5				
Overall acceptability	Highly unacceptable	1				
	Unacceptable	2				
	Slightly unacceptable	3				
	Neither acceptable- Nor unacceptable	4				
	Slightly acceptable	5				
	Acceptable	6				
	Highly acceptable	7				

APPENDIX III

Evaluation card for Triangle Test

Name of the product : Sugar solution

Note: Two of the three samples are identical.
Identify the odd sample.

Sl. No.	Code No. of sample	Code No. of identical sample	Code No. of odd sample.

DEVELOPING INDIGENOUS WEANING FOOD BASED ON BANANA FLOUR

By

SHEELA PRASAD

ABSTRACT OF A THESIS

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ABSTRACT

A study was conducted to develop a weaning food based on banana flour which is nutritious, low cost and acceptable.

The Banana flour was supplemented with horsegram, sesame and skim milk powder to improve the nutritive value. Based on the nutritive value and chemical score, six combinations of the weaning formulae were developed. Protein quality of the weaning formulae assessed through animal experiments revealed that the weaning food which contains banana flour, horsegram, sesame and skim milk powder in the ratio 3:2:3:2 gave significantly better values for all the criteria.

The acceptability of the weaning formulae was assessed by the panel members, mothers and children. The results of the study indicate that the bland porridge prepared with the weaning formulae was acceptable. The bland porridge was deficient in calories, Vitamin A and iron. Other food ingredients were added to make up these deficiencies and two recipes were standardised. The recipes were also found to be acceptable for the panel members and children.