EVALUATING THE NUTRITIONAL QUALITY OF SOYABASED SUPPLEMENTARY FOODS

BY

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THESIS
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Dedicated to
My Parents

DECLARATION

I hereby declare that this thesis entitled '**Evaluating the nutritional quality of soyabased supplementary foods**' 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 of any degree, diploma, associateship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled 'Evaluating the nutritional quality of soyabsed supplementary foods' is a record of research done by S. SAILAXMI under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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EXTERNAL EXAMINER

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INTRODUCTION

INTRODUCTION

Good nutrition and good health is a fundamental human right and should be the priority of all developmental schemes. Any investment, as Devadas (1987) points out towards improving the nutritional status of an individual is an investment for the wealth of the nation.

Certain segments of our population such as infants, young children, pregnant women and nursing mothers are vulnerable from the nutritional standpoint than are others (Grijalva *et al*, 1986). Childhood is perhaps the most critical and vulnerable period and it is during this period that we witness a high incidence of mortality and morbidity due to many factors and one of the most important contributing factor is faulty weaning or supplementation (Bhat, 1985).

Childhood is the period of rapid growth and children below the age of 5 years are considered to be the most vulnerable from the nutrition stand point and malnutrition is one of the major public health nutritional problem of rural preschool children in India (Bhat and Umapathy, 1986). Severe protein energy malnutrition causes stunted physical growth, mental retardation, gastrointestinal tract atrophic changes and also reduces life expectancy.

Supplementary foods are generally introduced between 5 to 9 months. The need for providing supplementary food is that, by the time a child reaches the age of about 6 months or even earlier, the development of the child retards due to decrease in milk yield and increase in the requirement of the child. A protein supplement has to be provided for making good, the deficient nutrients. There is thus an urgent need to develop satisfactory cheap infant foods which can be prepared from locally available resources in the community for use among the poor socio economic classes.

In India, the food that is intended as a supplement to the diet of weaned child should be fairly high in protein content and at the same time should provide enough vitamins and minerals for the proper growth of the child (Jelliffie, 1975). In developing countries, an application of a mixture of vegetable proteins may be suitable in the preparation of supplementary foods (Fashakin, 1986).

Cereals and pulses are the major sources of protein in India because animal protein is expensive and a large part of the population is vegetarian (Naik *et al*, 1988). The higher availability and lower cost of vegetable proteins compared with animal protein make the former more suitable as new sources or to increase the protein content or nutritional value of existing foods (Con Con, 1976). This can be achieved through mixture of vegetables with complementary aminoacid pattern or through vegetable proteins with a good aminoacid score, such as soyabean protein. Hence, the nutritional potential of soyabean in this context is considerable (Sulbeli, 1988).

The soyabean being rich in protein and energy is considered to be a "Wonder Bean", to solve the protein energy gap in developing countries. Among different vegetable proteins, soyabean is the cheapest source with its 40 per cent protein and 20 per cent oil, characteristic of a good product having high protein energy ratio (Gandhi *et al*, 1986). More over, this protein when processed properly is of high nutritional quality. Soyabean proteins supply all the essential amino acids except methionine, the limiting amino acid, but they are good sources of lysine and threonine and supplement effectively cereal proteins (Swaminathan, 1986). Now this prodigious bean is seen by some as a weapon aganist malnutrition in the third world countries owing to its very high content of quality protein (Aswathi *et al*, 1991).

It has the additional advantage in being comparatively less expensive than other oil seeds and is generally recommended for fortifying purposes (Arvind *et al*, 1994). Addition of 15 per cent soya flour to degermed corn meal and sorghum meal not only improved the nutritional quality of the sorghum flour but also improved its keeping quality (Jayalekshmi *et al*, 1987). Blends of soya flour with cereals such as corn, wheat, sorghum and oats are widely used in the world feeding programmes (Book Walter, 1978).

Considering all these possibilities, a study on "Evaluating the nutritional quality of soya based supplementary foods" was selected with the following objectives.

(1) To develop supplementary food mixes based on defatted soyaflour, roasted parboiled rice flour and groundnut flour;

(2) To ascertain the quality of the supplementary food mix through suitable laboratory experiments; and

(3) To ascertain the quality of the developed supplementary food mix through suitable field studies.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Literature pertaining to the study entitled 'Evaluating the nutritional quality of soya based supplementary foods' is reviewed under the following headings.

1. Prevalence and causes of malnutrition among preschool children.
2. Age and trend in weaning or supplementation.
3. Supplementary food - A strategy to overcome malnutrition.
4. Importance of soyabean as a supplementary food.

1. Prevalence and causes of malnutrition among preschool children

Children lay the foundation for future healthy status of the nation (Geetha and Devadas, 1986). Nutritional status of children is a crucial indicator in determining the quality of life of people and is linked with the health status. (Mugula, 1992).

Malnutrition is a condition when one or more nutrients are less or are in excess in the body. Malnutrition is the major health problem of our country and it is acute and wide spread (Alexander, 1985.) Malnutrition at the social level is a consequence of the relation of people with food (UNICEF, 1984).

According to Gosh (1986) malnutrition results from the interaction of several factors. They are poor socio economic conditions, parental ignorance and illiteracy, repeated infections, large families, closely spaced families and low birth weight. Protein calorie malnutrition amongst children is prevalent in some parts of the country (Subramanian, 1983).

Shukla (1982) has stated that the main causes for malnutrition in India include nonavailability of food, poverty, population growth, customs, conditioning which influences socio economic status, education, influence of industrialisation, urbanisation and modernisation. Srikantia (1983) indicated that one of the most important contributing factors for the development of infant malnutrition is the poor infant feeding practices.

Omotola and Akinyele (1986) conducted a study on the infant feeding practices of urban low income group in Ibdan. The survey indicated that the nutritional status of children is influenced by the socio economic status of the family and is directly related to the level of maternal education, whereas cultural practices have no significant influence on infant feeding behaviour. Vobecky *et al.* (1986) concluded that there is an important relationship among early eating behaviour, eating patterns later in life and health status. The study showed that nutritional patterns at age three, are affected by time at which solid foods are introduced to the infant and this is reflected in several familial and environmental factors.

According Vijayalakshmi *et al.* (1975), the causes for malnutrition in preschool children are low intake of nutrients, low income, lack of knowledge, infections, improper selection and preparation of foods, poor weaning practices and faulty food beleifs. Taylor and Taylor (1976) has listed the causes for malnutrition as lack of employment, agricultural factors, economic factors, cultural factors, inadequate health and nutritional services, physiological factors, levels of activity and infections. Gosh (1976) reported that prolonged breast feeding and late introduction of semisolids to the childs results in malnutrition. A study conducted by Caliendo *et al.* (1977) among preschool children of New york city revealed that the quality of diet of young children are influenced by sex, ordinal position of the family, mothers employment status, education and nutritional knowledge.

Ravindran (1984) has listed the main determinants which influence the nutritional status of the community. In addition to poverty, land tenure and land fertility, low family income, large family size, high cost and scarcity of protein rich foods, inadequate distribution and marketing system, intra familial food distribution which is unfavourable to children, food customs and taboos, poor education and literacy level of the parents were found to be important. Sharma (1979) has reported that the socio economic factors play an important role in the occurence of malnutrition and included poor health of the mother, poverty, scarcity of nutritious foods at the critical stages of growth and development, ignorance, socio cultural factors such as weaning taboos and prejudices, discrimination against girls and faulty cooking practices.

Shah (1979) concluded that the main factors play an important role in the occurance of malnutrition and the poor health of the mother are poverty, scarcity of nutritious food at the critical stages of growth and development, ignorance, socio-cultural factors such as weaning taboos and prejudices, discrimination against girls and faulty cooking practices.

Shah (1979) concluded that the main factors which leads to malnutrition among young children include late introduction of semisolid foods during infancy, diluted supplementary feeding, daily wages of mother, nuclear and large families, shorter intervals between two pregnencies, jobless period of parents, preferencial care of boys and poor antinatal care.

The results of the study conducted by Luwang (1980) among 500 preschool children of seven villages in Manipur indicate that the occurance of protein energy malnutrition was not due to birth order but age, sex and religion of the children. According to an International conference Report on Nutrition (1992), malnutrition among children is more likely to result from ignorance about hygiene and the dietry needs of children than from shortage of food.

By introducing supplementary food of good quality and quantity at right time and in right proportions, the incidence of protein calorie malnutrition can be prevented to a large extent (Desikachar, 1982). To combat protein energy malnutrition, supplementation of Cereals with legumes in the daily diets of the people has been emphasised by Ahmed *et al.* (1993).

Despande and Despande (1991) revealed that the children from relatively higher socio economic status were heavier and taller from birth upto five years. According to Salunkhe and Despande (1991) most of the children in developing countries had moderate to severe malnutrition during transition from breast feeding to adult diet, owing to the combined effect of inadequate diet and infection. Vast majority of the common diseases and malnutrition syndromes like marasmus, Kwashiorkor and under nutrition were observed to occur predominantly in preschool children (Bressani, 1991).

According to Hancock *et al.* (1990), a family greater than seven children result in higher incidence of protein energy malnutrition. A study by Ahmed *et al.* (1993) showed that 57 per cent of the children who died under the age of five years had immaturity or nutritional deficiency as a primary associated cause of death. According to Reddy (1992) severe protein energy malnutrition is associated with infection, especially of the lower respiratory tract and with marked fluid and electrolyte disturbances as a result of diarrhoea.

Infant morality is defined as the number of deaths under 1 year of age per 1,000 live - born babies. Stuart and Geraldine (1992) reported that the incidence of infectious diseases are high in infants and young children. According to the provisional estimates of Sample Registration System (1989), the Infant Mortality Rate, an index to measure the physical quality of life in any given population, was as low as 22 in Kerala. This is the lowest in the country and has been brought down from the level of 28 in 1988. The Infant Morality Rate (IMR) in urban areas in Kerala is comparatively lower than that in rural areas and the female IMR is found to be less than that of male (Directorarte of Health Services Report, 1991). Demographic and Evaluation cell reports (1991) revealed that the child morality rate both in the age group of 0-4 and 5-9 were the lowest in Kerala with very little rural - urban differences. The National Family Welfare Programme in Kerala (1994) reported that the Infant Morality Rate in Kerala was 17 during the year 1992 and it was reduced to 13 in the year 1993.

The adults, infants and older children are all adequately nourished, but the 1-5 year old children show evidence of current growth retardation and increased morality rates, possibility due to their no longer being protected by breast feeding (Stuart and Geraldine, 1992). Under nutrition is the contributing cause in one third of the million child deaths in the world (Grant, 1988). Beevi (1989) reported that chief killers of this age group were severe forms of protein energy malnutrition such as Kwarshiorkor and Marasmus and other non-nutritional diseases.

UNICEF (1988) has pointed out that 33 per cent of children under five in India were suffering from mild to severe forms of malnutrition. UNICEF (1990) has reported that in terms of age groups, the incidence of severe malnutrition and death rates appeared to be higher among children of 0-3 years than in other groups in almost all states.

Srikantia (1989) have reported that two immediate causes for child death are insufficient food intake and infective morbidity. Signs of malnutrition begins to manifest during weaning period and ultimately results in long term defeciencies in physical, mental and total development of our children (Srikantia 1983). Deaths during the period of weaning in developing countries are fifteen times higher than that in industrialised countries (Haxton, 1984). Semwal *et al.* (1986) found that in Delhi urban slums 45 to 47 per cent of children below 2 years were under nourished.

UNICEF (1991) revealed a substantial decline in the Infant Mortality Rate in India over the years and this achievement showed pronounced disparities between the states from 28 in Kerala to 123 in Utterpradesh. Parez Gil and Ufnenker (1987) studied the nutritional status of 89 preschool children from rural region in the Siena Narke de Pretha, Mexico and found that 21 were normal, 29 showed slight malnutrition, 31 showed moderate malnutrition and 8 showed severe malnutrition According to Sata Pathy *et al.* (1984) in lower socio economic groups in Brahampus in South Orissa, 42 per cent of the children were under nourished due to poor quality food and delayed weaning.

Geetha and Devadas (1986) conducted a survey in Coimbatore and reported that protein energy malnutrition was present in 44 per cent of the children. she also found that iron deficiency anaemia and Vitamin A deficiency were widely prevalent. In a report of International conference on nutrition (1992) it was shown that nearly 13 million children under 5 die every year from infections and as a direct or indirect result of hunger and malnutrition. It also indicated that lack of proteins, vitamins and minerals leads to malnutrition which has its greatest impact on the young, especially between 12 - 24 months. Devadas and Jaya (1986) conducted a study on preschool children in Coimbatore. The results indicated that 49 per cent had protein energy malnutrition, 7.50 per cent had vitamin A deficiency, 15.90 per cent had respiratory infections and 15.60 per cent had gastroenteritis. UNICEF (1985) reported that children under six is the most vulnerable group of population for they lay the foundation for future health status of the nation. They also carried out a study to assess the quantum of under nutrition, malnutrition and infectious diseases among preschool children of Coimbatore. The results showed that, the severe form of malnutrition was found to be more in the age group of 2 - 3 years. Morbidity pattern showed greater prevalance of respiratory tract infections, protein energy malnutrition, anaemia and Vitamin A deficiency.

More than 10 million babies in India are reported to suffer from malnutrition every year. It has been further stated that 15 per cent of our children admitted to any hospital show frank nutritional deficiencies and about 90 per cent preschool children suffer from growth retardation. The most important characteristic of malnutrition is inadequate intake of energy and protein over a period of time (Alexander, 1985).

Out of 568 studies conducted among under 5 children in Tamil Nadu, according to Gomez classification of malnutrition, have shown that 19 per cent were normal, 49.10 per cent showed mild malnutrition, moderate and severe malnutrition was found to be 26.60 per cent and 5.30 per cent respectively (Kakker *et al*, 1987). UNICEF (1988) has reported that 11.50 million infants in the world is currently dying each year due to malnutrition. According to Grant (1988) of about 34 million children born in South Asia each year around 4 million did not survive their first birthday. Kakker *et al*. (1987) has observed that in India, young children remained the most vulnerable group in the population with 40 per cent of all deaths occuring in 0-4 year groups. UNICEF (1990) in an analysis on children and women in India has reported that mortality rates of infants and children under 5 years still remained at levels which are unacceptably high. Passmore *et al.* (1986) pointed out that nutrient deficiencies, whether dietary or metabolic in origin, have long been known to cause learning disabilities and coginitive disorders. After conducting a comparative study between 2 different socially developed states like Kerala and Uttar Pradesh, Gosh (1986) has found that mortality among the 0-4 year female children was consistently higher in both Kerala and Uttar Pradesh.

According to UNICEF (1990), the causes of infant mortality were community environment, availability of social amenities, household environment, lack of physical, social and economic support, inadequate infant care at birth as well as at the prenatal and postnatal stages. Other factors influencing infant mortality were reported to be nutrition of mother, age at marriage and birth spacing (UNICEF, 1990). Elsie (1985) has stated the reason for low infant mortality in Kerala was mainly due to expanded medical facilities, availability of immunization programme, utilization of health services, high literacy rate particularly among female and improvement in the socio economic condition of the poorer section of the people.

2 Age and trend in weaning or supplementation

Infant feeding practices are strongly associated with the culture of the society. Weaning is a crucial event in the life of an infant.

One of the major issue concerning weaning is the age at which supplementary foods should be introduced (Srikantya, 1983). According to WHO report (1981) infants are given supplementary foods from an early age and there may be a prolonged period of mixed breast and supplementary feeding until the infant is weaned completely from the breast.

Devadas *et al.* (1983) have pointed out that suitable supplementary foods should be introduced to complement breast milk during first year of life. Srikantia (1983) has reported that supplementation is to be initiated after the third month to prevent malnutrition and related complication due to infection and infestation. From the point of view of custom, practice, feasibility and cost, it is obvious that it would be convenient for the mother to feed the infant on an early modified diet (Devadas *et al*, 1983).

According to Mitzer *et al.* (1984), complementation may be advisable as early as 2 - 4 months after birth depending upon the quantity of mothers milk, babies ability to suck, mothers health and activities or her availability to breast feed. Govindan kutty (1984) has reported that after the age of 3 or 4 months, breast milk is not sufficient to satisfy the nutritional requirement of an infant.

Devadas *et al.* (1984) stated that from the fourth month of infancy along with breast milk the infants should be gradually introduced to liquid and supplementary food. Rao (1989) reported that low cost weaning foods is to be introduced to the infants from 4 - 6 months onwards based on the concept of multimixes.

In Ethiopia, Nigeria, Zaire and Philipines, roughly 1/3 rd of rural infants were reported to be receiving regular supplements by the age of 2 - 3 months, with a higher rate of 56 per cent of infants in chillie (WHO, 1981).

According to a study conducted by Brown *et al.* (1982) in a predominantly rural area of Northern Thailand, nutritional quality of the supplementary diet was high, providing a wide variety of foods in the second half of the first year of life. The study also reveals that all infants received proteins of animal origin from the age of 9 months onwards.

Ramachandran (1984) has conducted studies among the more traditional urban poor in Hyderabad and found that the introduction of semi solid supplement begins by about 6 months after birth. In many rural communities in India, weaning does not start until 2 years and in some cases up to 4 years. Whereas in urban communities weaning starts much earlier and additional foods are sometimes given when the infant is only a few months old (Dube, 1986).

An investigation done by Omotola *et al.* (1986) showed that in north, east and south Ibdan the age at which solid foods given varied, but the type of solid food supplement used in each area was similar and consisted primarily of legumes. A survey conducted by Devadas and Geetha (1986) in Coimbatore revealed that only 9 per cent of the infants were breast fed beyond one year. It was also found that no special weaning foods were given and supplementary feeding started beyond 7 months with cereals. Semval *et al.* (1986) studied the feeding and weaning practices in Delhi urban slums. It was found that for 43.30 per cent of children, supplements were introduced at 4 months, while in 23.30 per cent, prolonged breast feeding and delayed weaning at one year were practised.

A study conducted by Thomas (1989) on the effect of birth order and spacing and the nutritional status of mothers and preschool children in Vellayani, Thiruvanthapuram District showed that majority of the mothers had introduced supplementary foods from 3 months of age. A study done by Brown *et al.* (1989) about infant feeding practices in Malaysia, Kenya and Mexico concluded that, only 11 per cent of infants under 4 months of age were exclusively breast fed. In Peru, 12 per cent of infants were exclusively breast fed at 1 month of age and in East Java 22 per cent. A survey conducted by Kaur (1989) has revealed that most mothers in Ludhiana introduced milk supplement from 6 months of age.

According to Underwood *et al.* (1982), International guide lines on infant feeding practices discourage supplementary feeding before the age of about 4 months due to the hazards of microbial contamination, the potentially inferior nutritional composition of supplementary foods compared with breast milk and the possibility that early supplementary feeding may lead to early termination of breast feeding. Food intake according to 24 hour recall of the mothers showed that more than 80 per cent of energy come from breast milk or milk formula at 4 months. Breast fed infants had lower intakes of energy and iron than those having supplements (Hoffmans *et al*, 1987).

With the increase in bottle feeding in India, as influenced by changes in socio economic conditions, compositional standards for infant formula have been updated and research has been directed at developing nutritionally improved formulae (Thompkinson *et al*, 1989).

Garfield (1990) had stated that in the low income population children were fed by a small quantity of adult diet. According to Irvin (1994) in rural India introduction of food supplements is usually delayed and in more than 90 per cent of the children complete weaning takes place only towards the end of the third year. Custom, practice, taboos, feasibility and cost, influence infant feeding practices (Shizuko, 1994).

3 Supplementary food-A strategy to overcome malnutrition.

Protein and energy malnutrition can be overcome with protein and energy rich supplements (Annie *et al*, 1985). The child needs a higher concentration of protein and calories in food than adult (UNICEF, 1986). The quality and quantity of supplements provided at the weaning age determines the nutritional status of children (Udani, 1990).

To save time and energy, ready to cook or ready to eat mixes need to be developed for supplementary feeding (Udani, 1990). ICMR (1984) realised the urgent need to develop satisfactory, cheap infant weaning foods and making them available for children as an important measure in the control and prevention of Protein Energy Malnutrition.

A simple process involving optimal roasting of the ingredients like cereals, legumes and oilseed flours, grinding and blending in suitable proportions was developed by Chandrasekharan *et al.* (1988). Low cost weaning foods using cereal and pulse proteins have been developed by various workers. (Khedar and Rao, 1987 and Gupta and Sehgal, 1991).

It is well known that the nutritive value of legume proteins can be significantly enhanced by complementation with cereal proteins due to mutual supplementary effect (Yadav and Leiner 1978). The high lysine content of pulse protein has a beneficial complementary effect on cereal proteins and the methionine and cysteine content of cereal proteins complements the pulse proteins (Ashraf *et al*, 1988).

According to UNICEF (1983) in the formulation of supplementary foods many factors have to be considered such as nutritive value, easy availability, suitable consistency, cultural acceptability, culinary feasibility, or digestability, frequency, quantity and volume.

Chandrasekhar *et al.* (1988) conducted feeding trials over a period of six months using malted weaning foods based on low cost locally available foods on infants and found them to be taller and heavier than their counter parts in the control group.

Popularizing soyabean in the diet will help in combating Protein Calorie Malnutrition in children to a certain extent (Kanchana and Neelakantan, 1994). Increased use of soyabean in human diet is of importance in view of the prevalent Protein Calorie Malnutrition (Krishna, 1993).

Soyabean has great potential in overcoming Protein Calorie Malnutrition on account of its higher protein (38 - 42 per cent) contents (Chauhan and Bains, 1985). Soyabean has a great promise to combat malnutrition in the third world countries owing to its very high content of quality protein (Aswathi *et al*, 1991). Nutritional studies conducted by various departments and Industries have proved that soyamilk is an economical and nutritious food for severely malnourished children (Manjhi, 1985).

4 Importance of soyabean as a supplementary food

Since 1961, considerable amount of work has been carried out by various workers in developing protein supplements based on oilseed meals and legumes suitable for supplementing the diets of children in developing countries (Scrimshaw *et al*, 1961). Graham *et al.* (1977) reported that growth of young children on soy protein of lysine fortified white flour is quite good, even when fed at a relatively low percentage of protein and calories. In the United States in 1975, it was estimated that approximately 10 per cent of formula fed infants were being fed formulae with protein from soyprotein isolates. For some infants, a formula based on soy protein isolate served as the sole source of protein for at least 6 months (Fomon, 1975). According to Jelliffee (1966) since the animal protein are inadequate and more costly, it is of great importance to make the best possible use of all locally available plant protein foods. Practical observations had shown that some plant foods appeared to be less commonly associated with the development of Kwashiorkar. Vegetable protein foods are viable economic alternative to animal protein foods and nutritional according to Rotruck and Seligon (1978).

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 available low cost foods of vegetable origin. Mudambi *et al.* (1986) had stated that there is urgent need to conserve food to device maximum benefit from available foods by utilising edible parts of all available plants and animal food. Soyabeans were introduced in India during mid sixties

(Sandeep *et al*, 1993). The soyabean has long been recognized not only as a valuable source of an edible oil but also as an excellent source of protein for feeding both animal and man. (Irvin, 1994).

The American farmers considered soyabean "The cindrella crop because of its high yields with little investment and minimal care (Iswarmurthi, 1988). Soyabean grows nearly in all types of soils but the best results are obtained in sandy and clay loam soils containing a fair amount of potash lime and phosphoric acids (Mitchel, 1983). It is a plant most suited to warm temperature or temperate regions. Very severe winter and excessive heat are detrimental to its growth (Kale, 1985).

Soyabean is a native of East Asia in which several species are generally recognised, namely *Glycine soja*, including the wild forms *Glycine gracils*, covering the intermediate semicultivated forms and *Glycine hispida* which includes the typical cultivated forms and *Glycine max*. The soyabean seed varies in size, shape, colour, from pale or straw yellow to jet black covering about 1500 varieties and is grown mainly as a food crop in China, Japan, Manchuria East and South and South Asia (Cowan *et al*, 1977).

Tamil Nadu was found to provide potential for continued crop sowings almost throughout the year except in the months of October and November wherein yield was low. Among the varities Co. 1 released by the Tamil Nadu Agricultural University was

Of the total meal produced, only about 3 per cent is being directly used as human food (Singh, 1989).

According to Sinha and Nawab (1993), use of wheat or rice and medium fat soyflour blend for making traditional food items can offer an unique opportunity for combating protein calorie malnutrition prevailing among our masses. There are an unlimited number of wholesome snacks for children that can be prepared from soyabean (Das, 1992). Soyabean, which is available at a low price and in plenty, would be a potential substitute for snack foods (Subba Rao, 1989). Soyabean has about 20 per cent oil and 40 per cent protein, which is twice the protein content of common pulses and a very little starch (CFTRI, 1992).

Fashakin *et al.* (1986) concluded that in developing countries an application of a maximum of vegetable proteins may be suitable in the preparation of weaning foods. Inorder to produce an acceptable product, the soyabean flour level in the mixture should not exceed 40 per cent (Keregero *et al*, 1988). Experiments have shown tnat Caseino phosphopeptide, supplementation of soyabean diet enhanced intestinal calcium solubility and absorption (Yuan and Kitts, 1991).

Swaminathan (1977) based on the investigations carried out at Central Food Technological Research Institute, Mysore, had shown that infant foods prepared from blends of groundnut and soyabean possessed high nutritive value.

found to be the best not only for high yield, but also for its high quality oil and protein flour (Palaniyappan, 1987).

According to Balyan and Mohtha (1985) seed yield of soyabean increased from 2.31 to 2.45 t/ha and 2.5 t/ha with increased plant density from 2.4 and 6 lakh plant/ha.

The production of legume in India is estimated as 55g per caput per day. The production of pulses in 1981 - 88 was 56.83g percaput per day. In world, India produces about 24.5 per cent of the total pulse production while in acreage India stands first accounting for about 33.8 per cent of the world pulse area. But the yield levels is 529 kg/ha (Mundinamani *et al*, 1989).

Considerable interest has been shown in India since the late 30's on the cultivation of soyabean as a food crop in view of its high protein and oil content (Subramanian, 1980). Soyabean is one of the cheapest sources of protein available today (Jayalakshmi *et al*, 1987).

Soyabean (*Glycine max*) is an important crop in Madhya Pradesh and a few other states in India, the annual production being about 2-2.4 million tonnes (Anon, 1992).

The total production of defatted meal, a protein rich by product has increased in recent years (Singh and Singh, 1993).

A soy-whey weaning food constituted by grinding the soywhey mixture, oil and oil soluble vitamins was standardised by Kapoor and Gupta (1981). It has been demonstrated repeatedly that properly processed soyabean products, provide a nutritious source of protein, essentially equivalent to milk protein, particularly if supplemented with sulphur containing amino acid (Irvin, 1994). Most commercially available soybean products intended for human consumption such as soy milk, soy based infant formulae, soy protein isolates and concentrates, and textured meat analogs, have received sufficient heat treatment to cause inactivation of atleast 80 per cent of the trypsin inhibitor activity present in raw soyabeans (Di Pierto *et al*, 1989).

Although soyabean has some undesirable constituents like trypsin inhibitors, the information available on processing of soyabean for food use could be judicioulsy adopted to get rid of these factors and to have delicious food items (Kanchana and Neelakantan, 1994). Nelson *et al*. (1986) have suggested the subjection of soyabean to a temperature of 135°C for 30 seconds for reducing the antinutritional factors.

According to Manorama and Sarojini (1982) puffing, roasting, soaking, boiling, in water steaming under 15/lb are the various methods used for inhibitor inactivation. Pressure cooking was effective in trypsin inhibitor inactivation, but soaking and steaming under pressure was best followed by soaking and boiling, puffing and roasting. According to Charanjeet *et al*, (1993) among all treatments, roasting is the best in lowering the phytate content of foods.

Raw full fat soyabean contains numerous antinutritional factors, the most important of which are the trypsin inhibitors. Careful application of heat repeatedly destroys the trypsin inhibitors and improves the feeding quality of full fat soyabean. The defined heat treatment conditions were sufficient to have reduced the activities of the antinutritional factors to safe level (Herkelman, 1991). There has been general agreement that heat treatment inactivates trypsin inhibitor, haemagglutinin, saponin and other growth inhibitors and greatly enhances the nutritive value of soyabeans (Friedman *et al*, 1984). The typical 'beany' flavour of soyabeans can be completely prevented by water blanching whole soyabeans (Legume seeds Symposium, 1975). Heat treatment improved the protein bioavailability of soyabeans. The protein quality of soyabeans was further improved by sulphur amino acid supplementation (Lowgren, 1988). All legumes are consumed only after they have been subjected to some form of processing such as heating, roasting, soaking, sprouting, and autoclaving. All these methods are known to improve their palatability, digestability, reduce antinutritional factors and convert vital constituents of pulse into simpler compounds which are beneficial nutritionally (Chandrasekhar *et al*, 1981). Ologhobo and Fetuga (1984) indicated that cooking, autoclaving and soaking were effective in lowering the phytate content of soyabean and thus improving its nutritional value.

Sheikh *et al*. (1986) developed a weaning food 'soylac' based on blend of rice, wheat and soyabean. Biological evaluation showed that it was of high nutritional value and conformed to FAO/WHO Protein Advisory group specification for weaning foods. The study also indicated that it had a better nutritive value than that of other weaning foods based on cereals, skimmed milk powder and legumes.

Although live steam treatment (toasting) of soyabeans is the most commonly employed method for inactivating the trypsin inhibitor, other modes of heat treatment have proven equally effective. These include boiling soyabeans in water, dry wasting (Faldet *et al*, 1992), dielectric heating, microwave irradiation (Hafez *et al*, 1983), gamma irraditation and infrared radiation (Konzeh *et al*, 1993). Germination has been reported to improve the nutritional quality of legumes by increasing vitamin content and reducing the antinutritional factors (Marero *et al*, 1991).

Soyabean and its protein products contain higher amounts of quality protein and are abundantly rich in lysine (Synder, 1987). Incorporation of defatted soyaflour in diets will not only enhance tne protein content of the diet but also raise its nutritive value, thereby helping in combating malnutrition (Anita *et al*, 1994).

According to Desikachar (1983), as the importance of energy in preventing malnutrition is now well recognised, there is a need for nutritionally balanced, energy dense and easily digestible weaning foods. He also added that legumes could be used to produce energy dense weaning foods.

Soyabean is being widely used in various food preparations in China, Japan, Indonesia, Sri Lanka and Western countries. Attempts are also being made to popularise soyabean in India (Singh, 1987).

Soyabean contains hardly any starch but it contains carbohydrates in small molecules, that is about 30 - 32 per cent carbohydrate (Kale, 1985). It is an established fact that soyabeans contain more protein when compared to meat, egg, dhals and gram. It is the best source of protein from vegetable kingdom (Bhat, 1985). Soyabean protein is found to be rich in 'Lysine' an essential amino acid that is 6.1 per cent of total protein, which is generally deficient in most cereal and millet protein and it can easily be overcome by the inclusion of cereal protein in the diet (Singh, 1987).

Cereals and pulses are the major sources of protein in India because animal protein is expensive and a large part of the population is vegetarian (Naik and Gleason, 1988). Among different vegetable proteins soyabean is the cheapest source and it assumes the most predominant position in solving the food shortage created by the ever expanding population in India (Gandhi and Ali, 1986).

Soyabean protiens supply all the essential amino acid except methionine, the limiting amino acid, but they are good sources of Lysine and Theronine and supplement efficiently cereal protein (Swaminathan, 1990).

Vitamin A is present in the form of precursor 'carotene' which is converted into vitamin A in the intestine. The quantity present is very low. Vitamin E is present to a level of 1.4 mg\g and prevent the oxidation of fatty acids. Germination of soyabean brings a sufficient increase in concentration of B group vitamins and ascorbic acid (Singh, 1987).

Soyabean is rich not only in protein and fat but also in iron. Iron in soyabean is concentrated in the seed coats. As much as 20 per cent of the iron of the whole seed is in the hull where as its mass is less than 10 per cent of the whole seed mass (Shizuko, 1994).

Schroder *et al*. (1973) has concluded that soyabean protein is unique among plant proteins by virtue of their relatively high biological value and essential amino acid pattern. Burnett (1981) pointed out that properly prepared soyabean product is equal or superior to egg albumin. Functional properties of soyabean constitute to structural properties such as foaming, emulcification, binding, thickening, dispersibility and gelling in food (Circle, 1972).

A study conducted by Eka (1978) indicated that the nutrient status of paps and porridges supplemented with soyabean milk or flour was comparable with that of cerelac, a commercial weaning food. It was estimated that 100g of an infant weaning food from soyabean and cheese whey supply the minimum daily requirements of all nutrients, except calories for children upto 4 years old (Kapoor *et al*, 1988).

The Digestibility Co-efficient, Protein Efficiency Ratio and Net Protein Ratio of fermented soyabeans is comparable with skimmed milk. Moreover, dietry fibre increased on fermentation of soyabeans, phytate content decreased and iron absorption increased (Igbedioh, 1991). Bressani (1978) attempted to treat Kwashiorkor in children in Uganda by feeding them a mixture of cooked soyabeans and banana. The majority of the children were relieved of the signs of Kwashiorkor and gained weight.

Defatted soyaflour is a common form in which soyabean can be incorporated in various food preparations (Chauhan *et al*, 1985). 'Soyaven' is a nutritious low cost infant formula based on oats and soyabean. It was used in Mexico to alleviate malnutrition. The processing and production of soyabean has won the 1983 IFT Food Technology Industrial Achievement Award (Mermelstein, 1983).

Studies have shown that addition of 15 per cent soyaflour to degermed corn meal and sorghum meal seperately increased the Protein Efficiency Ratio. The study also showed that incorporation of the soyaflour not only improved the nutritional quality of the sorghum flour but also improved its keeping quality (Jayalakshmi *et al*, 1987).

Protein quality of weaning foods can be optimized by adding legumes (beans, pulses) on the basis of their lysine content (Nout, 1993). Studies carried out by several workers have shown that the growth and nutritional status of children subsisting on poor cereal diets could be considerably improved by supplementation with oil seeds and legumes (Swaminathan, 1973). Soyaflour is most attractive in price, quality and quantity and has been extensively studied and generally recommended for fortifying pupose (Gupta *et al*, 1991). Blends of soyaflour with cereals such as corn, wheat, sorghum and oats are widely used in world feeding programmes (Book Walter, 1978).

Soyabean fits all who eats it, from baby in arms to the aged and infirm (World Health Organization, 1984). Soyabean in the form of soyaflour, soy concentrate and soy isolate is currently used in infant formulae and food enternal formulae, beverages, cereal simulated milk, textured meat analogs and meat extenders (Duke, 1987). A soya ragi multimix formulated by Vijayalakshmi *et al.* (1985) was recommended, as a low cost, nutritious multimix, used as a preschool childs snack and also a remedial and preventive measure against protein energy malnutrition.

Soyabean can double the nutritional content of bread at no extra cost (Manjhi, 1985). The bean is very useful in the preparation of bread, biscuits, cakes, pastries, soups, omlettes, sprouts and some Indian, Chinese, European and Japanese dishes (Kale, 1985).

Studies have been initiated to utilise soyabean flour as a protein rich ingredient in balahar, protein beverage and so on. The soyabean cake which remain after oil extraction is also very rich in protein and mineral salts and is very valuable as fertilisers for soil and as a feed livestock for animal (Sharma, 1983). For the preparation of roti, soyaflour could be blended with sorghum flour only upto 30 per cent level. Soyabean enriched wheat flour for use in chappathi is acceptable (Rathod *et al*, 1983).

According to Jayalakshmi *et al.* (1987) because of the extra ordinary beany flour of soyabean, it is not accepted by people. This can be overcome by blending soyaflour to a certain extent with cereals or millet flours. Soyabean oil resembles butter in its properties and are used for cooking purposes (Kale, 1985).

Various other fermented and coagulated products are available in the world market. Among them soya paneer is one of the most promising item. Soyapaneer which is known as tofu can even replace milk paneer (Swaminathan, 1987).

The effect of fortifying two snack items with dessicated coconut and soyaflour was investigated. The level of fortification was 30 per cent. The products were highly accepted and lends itself to cottage level processing, thus it was suggested as an ideal vehicle for nutrition fortification (Gonzales, 1983).

Numerous soy products have been developed in India and abroad. These include ful- fat soya flour (Mishra, 1992), soy milk (Reddy and Mital 1992), soy paneer or tofu, soy spaghetti, soy chunks and soyabean oil (Patil and Ali, 1990). Soyabean proteins have been utilised in many kinds of traditional oriental foods, including soya sauce, soyabean paste and others over the countries (Yukako *et al*, 1994).

The consumption of soyabean food products is being promoted the world over, since soyabean proteins are not only an economic resource, but also have high nutritional qualities (Ananthanarayanan *et al*, 1992).

Among oilseeds, soyabean is considered as a major source of edible oil (Om Kumar *et al*. 1992). Soyaflour is widely used for making soy idli (Akolkar and Parekh, 1983), chapathi (Bhat and Vivian, 1980), bread and also for extended soy rice products (Chauhan and Bains, 1985). The fortified soyflour is also used for making a number of soy fortified food items such as biscuits, bread and cookies (Patil and Ali, 1990).

Soyabeans, being rich source of lysine are used for developing products, such as high protein beverages, baby food formulations and breakfast foods (Singh and Chauhan, 1989). Defatted soyaflour is widely used for preparing various extended rice products (Chauhan and Bains, 1989). In recent years soyabean has been recognised and exploited as a rich source of food and feed (Gandhi *et al*, 1985).

Valle and Visconti (1983) tabulated the nutrient content of fortified bread, peanut butter, soy extended with soft cheese and soya analogue chiriza (dry sausage) used in Mexican school breakfast programme. Milk powder in vanilla and chocolate ice cream were partially substituted by soyaflour at 10, 20 and 30 per cent and stored at 100°F for three hours. It was concluded from the study that the ice cream was acceptable at 10 percentage level of incorporation (El Deeb and Salam, 1984).

Soyaflour is of great importance in diabetic dietary. Its starch content being quite negligible and its saccharides low, it is most suited to diabetic patients. Soyabean contains abundance of phosphates so that it can be used with advantage, for the one of nervous system. Some medical authorities have used them for the one of rickets, pulmonary diseases, anaemia with great success. (Kale, 1985).

A study was conducted during 1985 by 50 children admitted with acute diarrhoea. One group was fed with cows milk and other group with soy based formula - soyal. The study showed that infants fed with soy based formula have a shorter period of illness and a shorter stay in hospital (Singh, 1987).

The role of soy polysaccharide in lowering post prandial plasma glucose in diabetics individual was observed. Soy protein causes decreased sterol concentration and this might be of importance since high faecal steroid concentration have been implicated as risk factor for cancer of the large intestine (Reddy *et al*, 1985). The conclusion is that the nutritional quality of isolated soyaproteins is high and this plant protein can serve as the sole source of essential amino acid and nitrogen for protein maintanance in adults (Young *et al*, 1984). For atopic diseases, soya milk can be given because it is similar in composition to human milk (Birch and Parker, 1980).

Soyabean has an important medicinal quality in the fact that unlike meat, fish, egg, cereals and pulses which produce acidity in blood tissues, soyabean is alkaline in its effect and therefore neutralise acidity in the blood. Protein from meat increases the amount of uric acid in the system and thus creates kidney troubles and gout, and that from soyabean neutralises uric acid and does not produce any disease (Sharma, 1983).

In a short term rat study by Hendrich *et al.* (1994) hepatic hydroperoxide activity was increased by feeding a soy isoflavone extract. These findings may be alternative mechanisms of inhibition of iron - hormone related tumorigenesis by soy isoflavone.

From the epidimological data, consumption of soyabeans contribute to the low incidence of breast cancer (Adlercrentz *et al*, 1991). A similar result was found in the investigation on dietary soyabean consuming people with lower breast cancer risk in Singapore (Lee and Lee, 1991).

Besides being nutritious, soyamilk is free from lactose, cholestrol and is low in fat and hence is recommended for people suffering from malnutrition, allergies and diseases associated with saturated fat - rich diets (Narayanan *et al*, 1992). The isoflavone compounds in soyabean seems to act as anticarcinogens by exciting a biological antioxidant (Messina and Barnes, 1991). The use of soyabeans has increased in the United States to decrease the risk of diseases (Messina and Messina, 1991). The soyabean and soyabean foods are consumed in significant amounts in Asian countries because of there inexpensive high quality protein and anticarcinogenic effects (Wang and Murphy, 1994).

MATERIALS & METHODS

3 MATERIALS AND METHODS

The study on "Evaluating the nutritional quality of soyabased supplementary foods" was conducted in the Department of Home Science, College of Agriculture, Vellayani during the period from August 1992 to August 1994.

Plan of action

Plan of action of the study comprised of

3.1 Formulation of different combinations of nutritious, low cost and acceptable supplementary food.

3.2 Computation of aminoacid scores and chemical scores of different combinations of supplementary food mixes.

3.3 Ascertaining the acceptability of the supplementary foods developed through:

estimation of nutritional composition

working out cost analysis and

assessment of the organoleptic qualities

Based on the above parameters, the best combination of the supplementary food mix was selected for further study.

3.4 Assessment of the nutritional quality of the selected combination by estimating the major nutrients through chemical analysis.

3.5 Ascertaining the physiological utilisation of the selected supplementary food through suitable animal experiments.

3.6 Testing the impact of the selected supplementary food by conducting six months feeding trial among selected preschool children.

3.7 Ascertaining the shelflife qualities of the supplementary food developed.

3.1 Formulation of different combinations of nutritious low cost and acceptable supplementary food

The basic ingredients selected for developing supplementary foods were defatted soyaflour, parboiled rice and groundnut.

3.1.1 Justification for the selected ingredients

Defatted Soyaflour as protein supplement:

Since animal proteins are in short supply and costly, plant proteins have received considerable attention by virtue of their availability, low cost as well as nutritional and functional attributes. Among different vegetable proteins, soyabean is the cheapest source of protein, supplying 40-50g/100g. Soyabean has a great promise to combat malnutrition owing to its very high content of protein, except sulfur containing ones (Gandhi *et al*, 1991). It is well known that nutritive value of legume proteins can be significantly enhanced by complementation with cereal proteins due to mutual amino acid supplementation. Defatted soyaflour has the additional advantage in being comparatively less expensive than other pulses; the cost being Rs.12 per kilogram.

Parboiled rice as a staple cereal ingredient:

Rice is a vital food material for more than half the world's population and parboiled rice is nutritionally better compared to raw rice. Again, parboiled rice is the preferred staple cereal among majority of Keralites. Danur (1985) had pointed out that the mineral content of rice were found to have increased as a result of parboiling.

Usually rice or wheat is used as the cereal base for supplementary foods. The purpose is to dilute the protein and provide the calories. At the same time they provide desirable characteristics like smoothness of the reconstituted product, desirable flavour, colour and taste.

Groundnut flour:

Oil seeds are produced in large quantities in many of the developing countries. Oil seeds like groundnut is inexpensive and at the same time is a concentrated source of energy and protein and also good source of minerals and vitamins.

3.1.2 Formulation of supplementary foods (Multimix)

For the preparation of multimix, good quality parboiled rice was purchased from the local market and was cleaned to remove all the impurities. It was then fully dried in shade. Dried rice was roasted, powdered, sieved and kept in clean air tight containers. Defatted soyaflour was purchased and roasted just before preparation of the food mix. Groundnut was purchased from local market, skin removed, roasted and powdered. The above three powdered ingredients were weighed and mixed together. With these three ingredients, ten combinations of multimix were formulated.

3.2 Computation of amino acid scores and chemical scores of different combinations of supplementary food mixes

Jansen and Harper (1985) have reported that amino acid scores provide a useful estimate of the protein quality of blended foods and is an acceptable substitute for biological assays.

The amino acid scores were worked out using the Food Composition Tables of ICMR, 1991. Using these values chemical scores were worked out from the ratio between the content of the most limiting amino acid in the test protein to the content of the same amino acid in egg protein expressed as percentage. Five combinations were selected which had chemical scores above 75 per cent for further investigation.

3.3 Ascertaining the acceptability of the supplementary food developed

3.3.1 Estimation of nutritional composition

The nutrients present in the five combinations were calculated using the Food Composition Table of ICMR (1991).

3.3.2 Cost analysis of the Supplementary food

The cost of ingredients of the selected five combinations were calculated. The total cost of 1kg of supplementary food was found out by adding the cost of different ingredients and ten per cent of total cost was added as processing charges.

3.3.3 Assessment of the organoleptic qualities of the supplementary food

Through a triangle test 25 panel members were selected for the evaluation of organoleptic qualities.

The acceptability trials were done by using a score card. (Details pertaining to score card are presented in Appendix I). The major quality attributes included in the score card were appearance, flavour, taste and texture. The testing was conducted in the afternoon between 3 to 4 pm, since this time was considered as the ideal time for conducting the acceptability studies (Swaminathan, 1975).

3.3.4 Selection of the most acceptable formula of supplementary food:

On the basis of amino acid scores, chemical score, cost and organoleptic evaluation, the most acceptable formulation with parboiled rice flour (85g), soyaflour (10g) and groundnut flour (5g) was selected for detailed investigations.

3.4 Assessment of the nutritional quality of the selected combination of supplementary food

The nutritional quality of the selected combination of supplementary food was ascertained by estimating major nutrients by the following standard methods.

Sl.No.	Estimations	References
I	Calories	(Swaminathan, 1984)
II	Proteins	(Hawk and Oser, 1965)
III	Minerals (Calcium, Iron and phosphorus)	(Jackson, 1973)

3.5 Ascertaining the physiological utilisation of the selected formulation of supplementary food

3.5.1 Protein Efficiency Ratio (PER):

The Protein Efficiency Ratio (PER) which measures the weight gain per gram of protein consumed was determined according to the rat growth method of Osborne (1919).

Weanling male albino rats (Sprague Dawley Strain) of 28 days age were used for the experiment. Animals of more or less uniform weights (29g ± 4g) were selected and divided into three groups of two rats each and fed the respective diets as detailed in Tables 1 and 2. Composition of vitamin mixture and mineral mixture used for the experiment are detailed in Tables 3 and 4.

Table 1

Composition of Control Diet

Ingredients	Quantity
Skimmed milk powder	26.30g
Groundnut Oil	9.00ml
Starch	58.70g
Mineral mixture	4.00ml
Vitamin mixture	2.00ml

Table 2

Composition of Experimental Diet

Ingredients	Quantity
Supplementary food	50.00g
Groundnut oil	9.00ml
Starch	35.00g
Mineral mixture	4.00ml
Vitamin mixture	2.00ml

Table 3

Composition of vitamin mixture

Ingredients	Quantity
Vitamin A	2000 I.U
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	4.0 mg
Niacin	4.0 mg
Inositol	10.0 mg
Para amino benzoic acid	10.0 mg
Biotin	40.0 mg
Folic acid	0.2 mg
Vitamin B12	3.0 mg
Choline chloride	200.0 mg

(NIN, 1983)

. Weighing of rats in the Triple Beam Balance

Table 4

Composition of mineral mixture

Ingredients	Quantity (g)
Calcium carbonate	38.1400
Cobalt chloride	0.0023
Cupric sulphate	0.0477
Ferrous sulphate	0.7000
Magnesium sulphate	5.7300
Manganese sulphate	0.4010
Potassium iodide	0.0790
Potassium phosphate monobasic	38.9000
Sodium chloride	13.9300
Zinc sulphate	0.0548

(NIN, 1983)

The rats were housed in individual cages with wire mesh floor ~~(Plate 1)~~. Fifteen grams of the selected mixture was fed to the animals. Water was also provided. 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 3 days during the experimental period (Plate 1). During the experimental period conditions were maintained as uniform as possible. The rats were maintained on the respective diets for 28 days.

Rats housed in a metabolic cage for Nitrogen balance study.

The PER was Calculated using the formula (Swaminathan, 1975)

$$\text{PER} = \frac{\text{Gain in body weight}}{\text{Protein intake}}$$

3.5.2 Biological Value (BV)

Male albino rats (Sprague Dawley strain) were divided into two groups of two each. The animals were housed in individual metabolic cages (Plate 2). The whole experiment was divided into 3 periods. During the first period of four days, all the rats were fed with non-protein diet to measure the endogenous nitrogen. The composition of non-protein diet is given Table 5.

Table 5

Composition of non-protein diet

Ingredients	Non-protein diet	Stock diet
Starch (g)	85	85
Groundnut oil (ml)	9	9
Mineral mixture (ml)	4	4
Vitamin mixture (ml)	2	2
Parboiled rice (g)	-	-
Soya flour (g)	-	-
Groundnut (g)	-	-
Casein (g)	-	26.3

During the second period of two days, the rats were fed with stock diet. During the third period of four days, the rats in one group was fed with the experimental diet and the other one with control diet. The animals were given 15g of the experimental diet. The amount of food given, the quantity of left over food and actual consumption were recorded everyday.

During the first and third periods of the experiment, stools and urine samples were collected. Two drops of toluene was added to urine sample as a preservative. Stools of each group collected for three days were pooled together for nitrogen estimation. Urinary and faecal nitrogen was estimated by the microkjeldhal method (Hawk and Oser, 1965). The nitrogen content of the food mixtures was also estimated using the same procedure.

Biological value was calculated using the formula (Swaminathan, 1975)

$$Bv = \frac{In - (Fn - Fe) - (Un - Ue) \times 100}{In - (fn - Fe)}$$ where,

In = Nitrogen intake

Fn = Nitrogen in faeces

Fe = Endogenous faecal nitrogen

Un = Nitrogen in urine of protein diet

Ue = Nitrogen in urine of protein free diet.

3.5.3 Digestibility Co-efficient (DC)

Digestibility co-efficient (DC) was calculated using the formula (Swaminathan, 1975)

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

3.5.4 Net Protein Utilisation (NPU)

The extent of utilisation of protein of the combination selected was estimated by standard experimental procedures suggested by Mitchell (1924).

Net protein utilisation was calculated using the formula

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

Bv = Biological value

Dc = Digestibility co-efficient

3.5.5 Food Efficiency Ratio (FER)

Food Efficiency Ratio (FER) of the rats was calculated using the formula (Swaminathan, 1975)

$$FER = \frac{\text{Gain in body weight}}{\text{Food intake}} \times 100$$

3.6 Assessment of the impact of the selected supplementary food

The impact of the selected supplementary food was tested by conducting a feeding trial for six months among preschool

Shelflife study of the supplementary food children. The feeding trial for six months was conducted among 15 preschool children who were selected from creche, College of Agriculture, Vellayani. Everyday the supplementary food was made at the laboratory and was fed to the preschool children under the direct supervision of the investigator.(~~Plate 3~~). Records of the daily attendance and food intake was mainatained. Before starting the feeding trials anthropometric measurements were taken since anthropometry has been accepted as an important tool for assessment of nutritional quality of foods, particularly among growing children. According to Chen *et al*, (1978) anthropometric measurements are the internationally accepted system for classifying Protein Energy Malnutrition which accurately portray the nature, severity and prevalence of the problem. In this study body weight, height, arm circumference, head and chest circumference were measured. Anthropometric measurements of all preschool children were carried out every month for a period of six months. ~~(Plate 5-7)~~.

3.7 Ascertaining the shelflife qualities

The shelflife qualities of selected combination of the supplementery mixture was ascertained by monitoring the quality attributes like change in odour, colour, texture and appearance (Plate 3&4). During storage microbial contamination of the different combinations were assessed by serial dilution method detailed below (Mehrotra, 1980).

The medium used for microbial examination was potato dextrose agar medium and nutrient agar medium. A sample of two grams was first washed with mercuric chloride solution and then in sterile water. The sample was then placed on the solidified media in the petridish. It was kept at room temperature and observed after 48 hours. After the formation of visible microbial growth, the growths were transferred to agar slants and identified under a microscope.

3.8 Statistical analysis

Data generated in the study was documented and analysed applying suitable statistical techniques (Pannse and Sukhalme, 1967).

RESULTS & DISCUSSION

4 RESULTS AND DISCUSSION

Results of the present investigation entitled "Evaluating the nutritional quality of **soya based supplementary food**" are presented under the following headings.

4.1 Formulations of different combinations of nutritious, low cost and acceptable supplementary food.

4.2 Computation of amino acid scores and chemical scores of different combinations of supplementary food mixes.

4.3 Asertaining the acceptability of the supplementry foods developed through:

4.3.1 analysis of nutritional composition.

4.3.2 estimation of cost.

4.3.3 test for organoleptic qualities.

4.4 Nutritional quality of selected combination of supplementary food.

4.5 Physiological utilisation of the selected supplementry food.

4.6 Impact of selected supplementary food on the growth of preschool children.

4.7 Shelflife qualities of the selected supplementary food.

4.1 Formulation of different combinations of nutritious, low cost and acceptable supplementary food

The basic ingredients selected for the present study were defatted soyaflour, parboiled rice and groundnut. Ten combinations of the food supplement were formulated. The proportion of the ten combinations of the food supplement are presented in Table 6.

Table 6

Composition of the food ingredient in the different combinations of supplementary food

Ingredients(g)	Combinations									
	1	2	3	4	5	6	7	8	9	10
Parboiled rice	90	85	80	75	70	65	60	55	50	50
Soyaflour	5	10	15	20	25	30	35	40	45	50
Groundnut flour	5	5	5	5	5	5	5	5	5	0

As indicated in Table 6 parboiled rice was added in the proportion ranging from 50 to 90 per cent in different combinations of food supplement. Rice, the staple cereal of Keralites was the major ingredient in the supplementary food mix in the form of roasted parboiled rice powder. Parboiled rice is more nutritious compared to raw rice (National Institute of Nutrition, 1993). According to Rajalekshmi (1984) the Iron content increased as a result of parboiling when compared to raw rice. The storage quality of parboiled rice is also high when compared to raw rice (Saikia and Bains, 1993).

Soyabean protein is known to be rich in 'lysine' an essential aminoacid (that is 6.1 per cent of total protein), which is generally deficient in cereal and millet proteins

(Singh, 1987). Defatted soyaflour, which is the protein supplement was added (5 to 45 per cent) in different proportions of supplementary food. Addition of even small quantity improves the protein content of the food supplement. In the combination containing 5 per cent soyaflour, the quantity of parboiled rice added was 90 per cent. In the 9th combination, 45 per cent defatted soyaflour was included as the amount of parboiled rice was only 50 per cent. The amount of parboiled rice in combinations 9 and 10 are the same (50 per cent) but the quantity of soyaflour was 45 and 50 percent respectively.

Groundnut, the third ingredient in the food supplement formulated was added in 5 per cent level since it is a concentrated source of energy and protein. It is also a good source of minerals and vitamins. In combination 10, parboiled rice and soyaflour was in the equal proportion of 50 per cent. In this combination, groundnut flour was not added.

4.2 Computation of amino acid scores and chemical scores of the supplementry food

The amino acid scores was worked out are presented in Table 7. Chemical scores of the ten combinations of the supplementary formulae are presented in Table 8.

As indicated in Table 7, the lowest amino acid score (31.0) was obtained for combination 10. The highest amino acid score

Table 7

Amino acid score of different combinations of supplementary food

Ingredients (g)	Combinations									
	1	2	3	4	5	6	7	8	9	10
Parboiled rice	90	85	80	75	70	65	60	55	50	50
Soyaflour	5	10	15	20	25	30	35	40	45	50
Groundnut flour	5	5	5	5	5	5	5	5	5	0
Amino acid score	36.8	36.2	35.5	34.9	34.2	33.5	32.8	32.2	31.6	31.0

Table 8

Chemical Score of different combinations of supplementary food

Ingredients (g)	Combinations									
	1	2	3	4	5	6	7	8	9	10
Parboiled rice	90	85	80	75	70	65	60	55	50	50
Soyaflour	5	10	15	20	25	30	35	40	45	50
Groundnut flour	5	5	5	5	5	5	5	5	5	0
Chemical score	98.2	97.5	94.4	92.6	90.8	88.8	74.8	72.8	70.8	68.4

(36.8) was obtained for combination 1, which contain maximum amount of parboiled rice (90 per cent).

Major criterion for selecting a combination from the ten formulations was the chemical score of these mixtures. As indicated in Table 8, the lowest chemical score 68.40 was obtained for combination 10, containing equal amount of parboiled rice and defatted soyaflour. The highest chemical score (98.20) was obtained for combination 1. Only six combinations (combinations 1 - 6) showed chemical scores above 75 per cent. The first five combinations with highest chemical score were selected for further study.

4.3 Acceptability of the supplementary foods developed

The acceptability of the soyabean supplementary food was ascertained with the help of determinants viz., nutritional quality, cost and organoleptic qualities.

4.3.1 Nutritional quality

In the selected five combinations the nutrients, viz. protein, calaries, minerals and B-complex vitamins were worked out and the data are presented in Table 9.

As revealed in the table, the protein content of the five combinations of supplementary food ranged between 9.3 to 16.60g per cent. Table 9 also showed that combination 5 had the highest protein content of 16.60g. This is explained by the addition of

Table 8

Nutritional quality of five selected combinations of supplementary food mix (100g)

Nutrients	Combinations				
	1	2	3	4	5
	90:5:5	85:10:5	80:15:5	75:20:5	70:25:5
Protein (g)	9.30	11.00	12.90	14.70	16.60
Energy (kcals)	361.50	365.80	370.10	374.40	378.70
Calcium (mg)	24.00	35.60	47.10	58.70	70.20
Phosphorus (mg)	181.70	209.00	236.40	263.70	291.10
Iron (mg)	1.60	2.10	2.60	3.10	3.50
Thiamine (mg)	0.20	0.30	0.30	0.30	0.40
Riboflavin (mg)	0.10	0.10	0.10	0.10	0.20
Niacin (mg)	4.60	4.60	4.60	4.60	4.70

25 per cent soyaflour to the supplementary food mix. Combination 1 had the lowest protein content of 9.30g/100g. From the table it is very clear that as the quantity of soyaflour increased, the protein content of the food also increased correspondingly. Table 9 indicated that the addition of soyaflour at 5 per cent level can increase the nutritional quality of the food.

The calorific value of the food supplements were in the range of 361.50 Kcals to 378.70 Kcals per 100g. As indicated in the table, the first combination provided the lowest amount of energy 361.50 Kcals. Combination 5 had the maximum calorific value (378.70 Kcals) which contains the highest amount of soyaflour (25 per cent) among the different combinations tried. This showed that defatted soyaflour is a good source of energy.

The amount of calcium, phosphorus and iron were also found to be the highest in combination 5. It provided 70.20mg of calcium, 291.10mg of phosphorus and 3.50mg of iron. Combination 1 had the lowest mineral content (24.00mg calcium. 181.70mg phosphorus and 1.60mg iron per 100g respectively). The vitamin content of different combinations of supplementry food mix was found to be the highest in combination 5 (thiamine 0.50mg, riboflavin 0.20mg and niacin 4.70mg).

All the five combinations of supplementary foods were found to contain adequate amounts of protein, energy, minerals and

B-complex vitamin to meet the requirements for a cereal based supplementary food.

4.3.2 Cost analysis of the supplementary food

The cost of ingredients in selected combinations of supplementary foods are presented in Table 10.

Table 10

Cost analysis of the supplementary food

Sl. No	PR	DSF	GNF	Cost (Rs.)
1	90	5	5	1.09
2	85	10	5	1.10
3	80	15	5	1.12
4	75	20	5	1.13
5	70	25	5	1.14

PR - Parboiled rice
DSF - Defatted soyaflour
GNF - Groundnut flour

The cost of supplementary food mix in different combinations were worked out by adding the cost of ingredients and overhead charges. The cost of 1kg of supplementary food in different proportions were almost the same. The cost is very low as it is only Rs. 10.00 per kilogram of the food mix and it is very economical especially for low income groups. Sinha *et al.* (1993) has recomended soya flour as an ideal substitute for

Organoleptic evaluation of the supplementary food.

expensive ingredients like non-fat dry milk there by offering nutritionally better food at lower cost.

4.3.3 Organoleptic qualities of the selected supplementary food

Organoleptic investigation was carried out by a group of judges selected by triangle test. In the triangle test three sets of sugar solutions of different concentrations were used. Of the three samples, two were of identical concentrations and the subjects were asked to identify the third sample which is of different concentration. On the basis of the test 25 judges were selected for conducting organoleptic evaluation of the supplementary food (Plate 4).

Recipes viz., porridge sweetened with jaggery, porridge with sugar and laddu with sugar in different proportions were standardised using 5 combination of food mix.

Acceptability of porridge sweetened with jaggery

Powders of porridge was prepared with roasted parboiled rice, defatted soyaflour and groundnut. Jaggery was added as sweetening agent. The results of the organoleptic evaluation of porridge sweetened with jaggery are given in Table 11 and the scores given by the judges were subjected to statistical analysis. Simple (ANOVA) method analysed on CRD was done.

Organoleptic evaluation of the selected combinations of supplementary food prepared in the form of porridge with jaggery

Table 11

Organoleptic evaluation of porridge sweetened with jaggery

Sl. No.	Ingredients PR:DSF:GNF	Mean Scores					Total Mean score
		Appearance	Flavour	Taste	Texture	colour	
1	85:10:5	3.40 ± 1.80	3.40 ± 1.20	3.30 ± 1.40	3.40 ± 1.90	2.80 ± 1.10	16.30
2	80:15:5	3.50 ± 1.30	3.40 ± 1.20	3.20 ± 1.50	3.40 ± 0.80	3.00 ± 1.10	16.50
3	75:20:5	3.40 ± 1.70	3.10 ± 1.00	3.20 ± 1.10	3.40 ± 1.60	3.00 ± 1.00	16.10
4	70:25:5	3.20 ± 1.70	2.80 ± 1.30	3.30 ± 1.00	3.50 ± 1.10	3.20 ± 1.30	16.00
5	65:30:5	3.30 ± 1.50	3.20 ± 1.20	3.20 ± 1.10	3.40 ± 0.70	3.10 ± 2.00	16.20
CD (0.01)		0.165	0.204	0.193	0.196	0.218	

PR - Parboiled Rice
DSF - Defatted Soya Flour
GNF - Groundnut Flour

showed the highest mean score for combination 2 (16.50) followed by combinations 1,5,3 and 4. The total mean scores were 16.30, 16.20, 16.10 and 16.00 respectively. The total mean score was lowest for proportion 4 (16.00). But the mean score obtained for taste was highest for this proportion (3.30). In the case of appearance, the mean score was maximum for proportion 2. The proportions 1 and 2 obtained a maximum score of 3.40 for the quality attribute, flavour. The scores obtained for texture ranged from 3.40 - 3.50. The mean score obtained for colour was highest for proportion 4 (3.20) and lowest for proportion 1 (2.80).

Statistical analysis of the data revealed that a significant difference existed between combination 2 and 4 and between combination 2 and 5 whereas the difference was not significant between combination 2 and 1. In the case of quality flavour, a significant difference existed between combination 1 and 3 and between combination 1 and 4. But the difference was not significant between combination 1 and 2. For the qualities taste and texture, the difference was found not to be significant among the different combinations. Significant difference existed between combination 1 and 4, and between combination 1 and 5 for the quality, colour (Details pertaining to this are presented in Appendix II).

3.3.1.2 Acceptability study of porridge sweetened with sugar

Roasted powder of parboiled rice, defatted soyaflour and groundnut was mixed with sugar syrup and steamed. The result of acceptability test obtained is presented in Table 12. The results showed that the combination 1 was more acceptable compared to other combinations and the total mean score obtained for the same was 17.40. The total mean score for combination 2 and 3 were 17.20 and 17.10 respectively and for the combinations 4 and 5 were 16.90 and 16.80 respectively. The mean scores for the quality attributes of the combination 85:10:5 was 3.40, 3.40, 3.70, 3.50 and 3.40.

The less acceptable combination was 65:30:5 with a total mean score of 16.70. This combination obtained a mean score of 3.30 for appearance, 3.20 for flavour, 3.20 for taste, 3.40 for texture and 3.60 for colour. According to Ranganna (1984) in the various quality attribute tests, the first evaluation goes to the taste followed by flavour, appearance, texture and colour.

Statistical analysis of the data related to the appearance and flavour revealed that the difference was not significant among the different combinations. For the quality taste, the difference between combinations 1 and 3 was found to be not significant whereas a significant difference existed between the combinations 1 and 2; between combinations 1 and 4; and between combination 1 and 5. The differences among combinations 2, 3, 4

Table 12

Organoleptic evaluation of porridge sweetened with sugar

Sl. No.	Proportion of ingredients PR:DSF:GNF	Mean Scores					Total Mean Score
		Appearance	Flavour	Taste	Texture	Colour	
1	85:10:5	3.40 ± 1.40	3.40 ± 1.30	3.70 ± 1.40	3.50 ± 1.00	3.40 ± 1.70	17.40
2	80:15:5	3.20 ± 1.70	3.40 ± 1.40	3.40 ± 1.90	3.60 ± 1.50	3.40 ± 1.20	17.00
3	75:20:5	3.40 ± 1.20	3.30 ± 1.80	3.50 ± 0.80	3.40 ± 1.00	3.50 ± 1.20	17.10
4	70:25:5	3.40 ± 1.10	3.20 ± 1.00	3.30 ± 1.10	3.40 ± 1.20	3.60 ± 1.00	16.90
5	65:30:5	3.30 ± 1.30	3.20 ± 0.40	3.20 ± 1.70	3.40 ± 1.10	3.60 ± 1.10	16.70
CD (0.01)		0.213	0.263	0.250	0.253	0.281	

PR - Parboiled Rice
DSF - Defatted Soya Flour
GNF - Groundnut Flour

and 5 were not significant. There was no significant difference among different combinations for the qualities texture and colour (Details pertaining to this are presented in Appendix III).

The results of acceptability tests of porridge sweetened with jaggery and sugar showed that the supplementary food made with sugar was of more acceptable quality while the supplementary food made of jaggery was of undesirable colour. Chalky mouthfeel was prominent in samples made with jaggery. The recipes made with sugar, in general, were found to be devoid of beany flavour. The overall acceptability was the highest for the supplementary food sweetened with sugar. According to Fergus (1993) colour influences other sensory characteristics and, in turn food acceptability, choice and preference. Its role has an effect on the total contribution to food quality. Studies reviewed by Clydesclale (1984) found that colour affected the perception of other sensory characteristics such as sweetness, salt and flavour.

On the basis of the above observations, sugar was selected as acceptable sweetener in the supplementary food. A study conducted by Gupta *et al* in 1982 showing that addition of sugar improved the sensory score and is in agreement with the results of the current experiment.

3.3.1.3 Acceptability of laddu sweetened with sugar

The roasted powdered ingredients were mixed with sugar syrup and made into balls. Table 13 shows the mean scores obtained in the sensory evaluation of laddu. From the data, it is clear that combination 1 obtained the maximum total mean score of 20.10, followed by combination 3 (17.80), combination 2 (17.50), combination 4 (17.10) and combination 5 (17.00). The data thus showed that the supplementary food prepared in the combination 85:10:5 was superior in all quality attributes except flavour when compared to other combinations selected.

Statistical analysis of the data revealed that combination 1 was significantly different from the rest of the combinations. The difference among combinations 2, 3 and 4 were not significant for the quality flavour. Combination 3 was found to be significantly different from rest of the combinations while the differences among combinations 1, 2, 4 and 5 were not siginificant. There existed a significant difference between combination 2 and 4 whereas the difference was not significant among the rest of the combinations for the quality colour (Details pertaining to this are presented in Appendix IV).

According to Shanti (1986) several South Indian dishes like baji, pakoda and boonthi were prepared partially substituting soyabean flour in the recipes and the acceptability of these dishes were found to be good. Neelakantan *et al.*(1987) conducted

Table 13

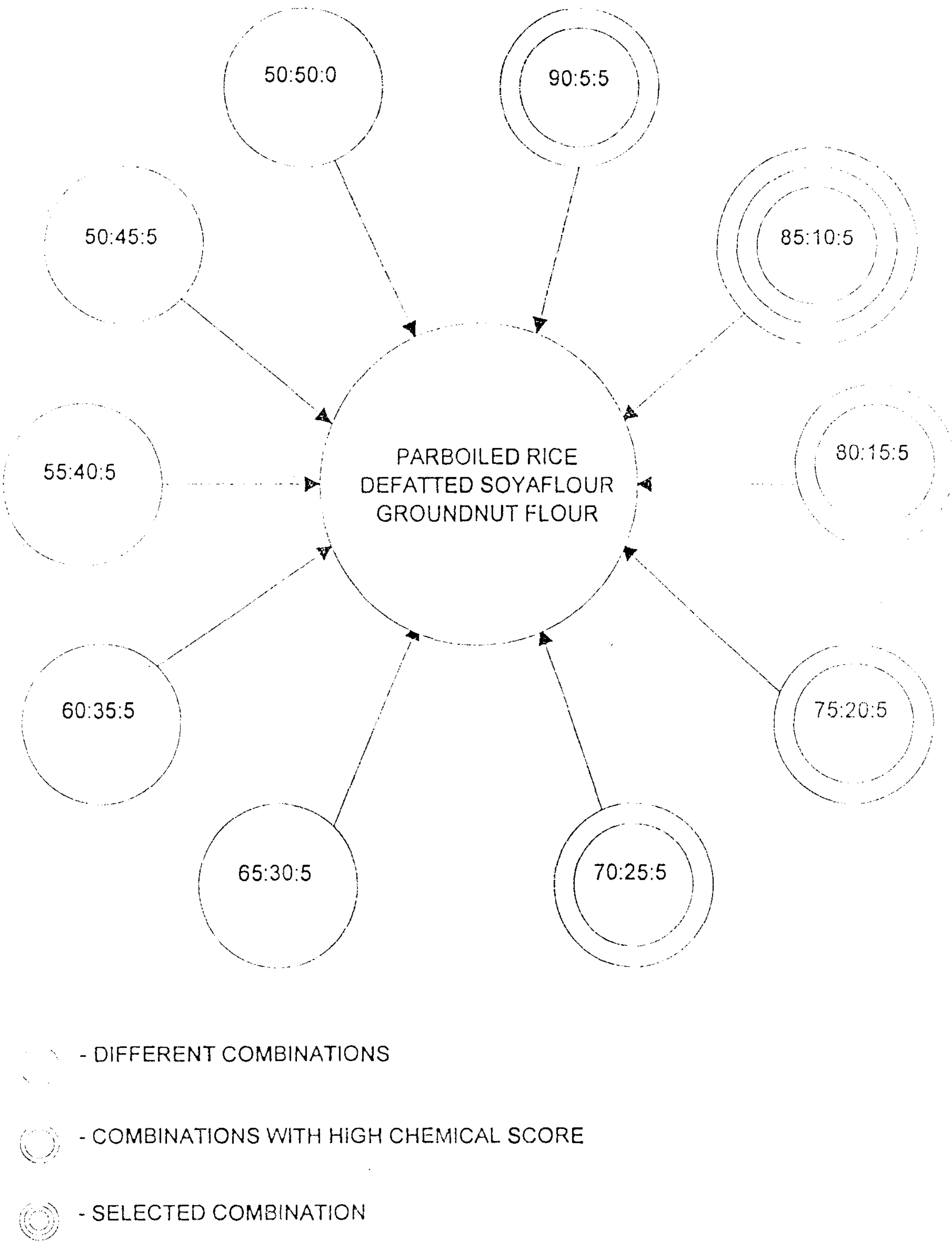
Organoleptic evaluation of laddu sweetened with sugar

Sl. No.	Proportion of ingredients PR:DSF:GNF	Mean Scores					Total Mean Score
		Appearance	Flavour	Taste	Texture	Colour	
1	85:10:5	4.50 ± 1.00	3.40 ± 1.10	4.10 ± 0.40	4.50 ± 1.20	3.60 ± 1.30	20.10
2	80:15:5	3.30 ± 0.80	3.40 ± 0.40	3.40 ± 1.40	3.70 ± 1.00	3.70 ± 1.10	17.50
3	75:20:5	3.30 ± 1.20	4.20 ± 1.00	3.40 ± 1.30	3.40 ± 1.40	3.50 ± 1.00	17.80
4	70:25:5	3.50 ± 1.40	3.20 ± 1.00	3.40 ± 0.90	3.70 ± 1.00	3.30 ± 1.00	17.10
5	65:30:5	3.40 ± 0.90	3.30 ± 1.50	3.40 ± 1.10	3.40 ± 1.00	3.50 ± 1.20	17.00
CD (0.01)		0.456	0.369	0.433	0.438	0.487	

PR - Parboiled Rice
DSF - Defatted Soya Flour
GNF - Groundnut Flour

FIG.I

DIAGRAMATIC REPRESENTATION OF DIFFERENT COMBINATIONS OF SUPPLEMENTARY FOOD



studies on the acceptability of soya-sorghum blends in a few South Indian dishes and found that the dishes were well accepted. Results of the studies in similar lines (Pallavi *et al*, 1991) showed that in the preparation of some traditional foods, defatted soyaflour can be incorporated to the extent of 100 per cent without significantly affecting their textural properties. Moreover, its addition increased the protein content to a great extent.

To identify the suitable supplementary food under the present investigation using soyabean, the mean scores of the five combinations in each recipe was worked out. The supplementary food with the highest mean score was identified as the suitable one. Sensory evaluation studies identified the 85:10:5 blend of supplementary food in the form of laddu sweetned with sugar as superior (20.10) for its quality attributes and this combination was selected for detailed investigation.

4.4 Assessment of the nutritional quality of the selected combination of supplementary food

The nutritional quality of the supplementary food with reference to calories, protein and mineral content were determined through suitable laboratory techniques and the data are presented in Table 14.

Table 14

Nutritional quality of the selected combination of supplementary food (100g)

Nutrients	Quantity
Energy	368.50 ± 1.54 Kcals
Protein	11.20 ± 1.60 g
Calcium	32.80 ± 1.30 mg
Iron	1.90 ± 0.80 mg
Phosphorus	200.00 ± 1.10 mg

As observed from Table 14, the calorific value of the selected supplementary food was found to be 368.50 kcals. The protein content of the food was found to be 11.20 g/100g and the calcium, iron and phosphorus contents were found to be 32.80 mg, 1.90 mg and 200.00 mg respectively. From the table it is clear that by inclusion of this supplementary food daily in the diet of young children, adequate amount of protein, energy and minerals could easily be provided for their proper development.

Kapoor and Gupta (1981) estimated that 100g of an infant food from soyabean and cheese whey supply the minimum daily requirement of all the nutrients for children upto 4 years age.

4.5 Physiological utilisation of the selected combination of supplementary food

Ritchey and Taper (1981) reported that the most reliable way to assess the nutritional quality of proteins is through feeding trials. Several biological measurements have been proposed as indicators viz, Protein Efficiency Ratio (PER), Food Efficiency Ratio (FER) and nitrogen balance studies. From these indices of protein quality, true digestability co-efficient and biological value were worked out.

Swaminathan (1989) has also reported that quantitative data regarding the relative digestability co efficient and nutritive value of proteins could be obtained only through experiments on animals or human beings. Three methods namely, Protein Efficiency Ratio (PER), Net Protein Utilization (NPU) and Net Protein Ratio (NPR) have been widely used as suitable methods for the evaluation of quality dietary proteins.

4.5.1 Protein Efficiency Ratio (PER)

The Protein Efficiency Ratio (PER) of the experimental and control diet were worked out. According to the studies of Fashakin *et al.* (1986), a mixture of vegetable protein diet including soyabean, melon and cowpea compared favourably with the milk powder based control diet in terms of growth rate, Protein Efficiency Ratio (PER) and Net Protein Ratio (NPR).

In this experiment, Protein Efficiency Ratio (PER) obtained for the experimental group was compared with the control group. Protein Efficiency Ratio of the experimental group was observed to be 2.50, which was significantly higher than the value of 2.10, the requirement specified for supplementary foods by the protein advisory group of FAO (1971). As per the results of the study conducted by Lee (1970), a supplementary food based on soyabean and sweet potato had a Protein Efficiency Ratio of 2.63 and was found nutritionaly comoparable to the starch and milk based diet. In another experiment Gupta *et al*, (1982) observed that a supplementary food based on Jowar and soyabean showed Protein Efficiency Ratio (PER) between 2.10 and 2.60. The soy-whey weaning food developed by the National Dairy Research Institute was evaluated for Protein Efficiency Ratio (PER) and it was found that the Protein Efficiency Ratio of blanched soyabean was 2.10 and soya-whey powder was 2.30 (Kapoor, 1981).

In this experiment, gain in body weight in 4 weeks were found to be higher in control group which was given the milk diet than the experimental group in which the rats were fed with soyabean as the protein source.

Statistical analysis using 't' test was employed to find out the association between experimental and control group. The Protein Efficiency Ratio (PER) of the experimental group was found to be 2.50 whereas the Protein Efficiency Ratio of the control group was higher than that of the experimental group

Table 15

Protein Efficiency Ratio (PER) of the supplementary food

Weeks	Experimental group			Control group			't' value
	Average protein intake (g)	Average weight (g)	Average weight gain/week (g)	Average protein intake (g)	Average weight (g)	Average weight gain/week (g)	
Initial weight	-	54.50 ± 1.60	-	-	68.50 ± 1.40	-	
End of 1st week	8.40 ± 1.30	56.70 ± 1.30	2.20 ± 0.30	9.30 ± 1.10	71.20 ± 0.60	2.70 ± 0.80	
End of 2nd week	8.70 ± 0.90	59.20 ± 1.00	2.50 ± 0.30	9.60 ± 0.70	77.20 ± 0.70	6.00 ± 0.10	7.07**
End of 3rd week	9.40 ± 0.60	66.50 ± 0.50	7.30 ± 0.50	9.90 ± 0.90	93.20 ± 1.30	16.00 ± 0.60	
End of 4th week	9.70 ± 0.90	77.30 ± 1.10	10.80 ± 0.60	10.00 ± 1.60	101.20 ± 0.40	8.00 ± 0.90	
Average weight gain in one month			22.80			32.70	
Protein Efficiency Ratio			2.50			3.30	

** Significant at 1 per cent level.

(3.30). The results showed that there is significant difference between the experimental and control groups at 1 per cent level Table 15).

4.5.2 Biological Value (BV)

Biological Value (BV) of a protein is the fraction of its nitrogen retained in the body for growth and maintenance of cell synthesis. The BV of proteins can be determined by Nitrogen balance experiments (Swaminthan, 1975).

Osborne (1964) developed a method for determining the biological value of proteins. The biological value of the developed rice soya supplementary food as well as milk powder was tested in groups of 28 days old male albino rats. In this experiment, the biological value of the control diet was higher when compared to the experimental diet (Table 16). The biological value of the supplementary food was 77.80 per cent, where as the biological value (BV) of control diet was 87.6 percent. In a study conducted by Ifon (1980), the biological value of soyabean millet porridge was found to be 78.93 $\pm$ 1.01 per cent. The percentage of nitrogen excreted through faeces was higher than those excreted through urine in both the groups. The percentage of protein in soyabean is very much higher than the protein content of almost all vegetables. (Margareta *et al*, 1989).

The biological value of the control group was 87.60 and that of the experimental group was 77.80. Statistical analysis of the data showed that the biological value of the control group was significantly higher than experimental group at 1 percent level.

Table 16

Biological Value (BV) of the selected combination of supplementary food

Sl.No.	Group	BV	't' Value
1	Experimental Group	77.80	
2	Control Group	87.60	47.20**

** Significant at 1 per cent level

4.5 Digestability co-efficient (DC)

Digestability co-efficient of a protein is defined as the ratio of food nitrogen intake to food nitrogen absorbed. The digestability co-efficient was calculated in rats which were given the soyabean supplementary food and milk based control diet. Experiment with rats have shown high digestability for soyabean and heated soyabean was found to be more digestable than the unheated soyabean meal (Caroll *et al*, 1952).

In the present study the digestability co-efficient was found higher in the control diet than the experimental diet. The digestability co-efficient of the supplementary food was observed to be 85.90 per cent and that of control diet was 92.80 per cent. The results showed that there is significant difference between experimental and control groups at 1 per cent level (Table 17).

Table 17

Digestability co-efficient (DC) of the selected combination of supplementary food

Sl. NO	Group	DC	't' Value
1	Experimental	85.90	
2	Control	92.80	57.69**

** Significant at 1 per cent level

4.5.4 Net Protein Utilisation (NPU)

Net Protein Utilisation (NPU) is the ratio of nitrogen retained to the total nitrogen intake and determined from Biological Value (BV) and Digestability Co-efficient (DC) and the data are presented in Table 18.

Table 18

Net Protein Utilisation of rats fed on experimental and control diet

Groups	NPU	t value
Experimental	66.83	
Control	81.29	94.87**

** Significant at 1 per cent level

From Table 18 it is seen that Net Protein Utilisation (NPU) of rats in the control group was high (81.29) when compared to the experimental group (66.83). Statistical analysis of the data revealed that the Net Protein Utilisation (NPU) of the experimental and the control groups was significantly different. In a study conducted by Ifon (1980) on rats fed with millet soyabean porridge, the Net Protein Utilisation of rats were found to be 67.56 ± 1.20.

4.5.5 Food Efficiency Ratio (FER)

In the present investigation animal feeding experiments were conducted to evaluate the quality of the developed supplementary food. The results of Food Efficiency Ratio (FER) study are given in Table 19.

The gain in body weight of the experimental group in four weeks was 22.80 g and the gain in body weight of the control

Table 19

Food Efficiency Ratio (FER) of the supplementary food

Weeks	Experimental group			Control group			
	Average food intake (g)	Average weight (g)	Average weight gain/week (g)	Average food intake (g)	Average weight (g)	Average weight gain/week (g)	't' value
Initial weight	-	54.50 ± 0.70	-	-	68.50 ± 0.70	-	
End of 1st week	63.60 ± 1.60	56.70 ± 1.50	2.20 ± 0.80	70.00 ± 2.10	71.20 ± 1.20	2.70 ± 0.50	
End of 2nd week	65.70 ± 0.90	59.20 ± 1.30	2.50 ± 0.20	71.70 ± 0.70	77.20 ± 2.10	6.00 ± 0.90	** 95.40
End of 3rd week	70.80 ± 1.30	66.50 ± 1.60	7.30 ± 0.30	74.20 ± 1.90	93.20 ± 1.80	16.00 ± 0.30	
End of 4th week	72.80 ± 1.20	77.30 ± 0.90	10.80 ± 0.70	75.00 ± 1.80	101.20 ± 1.90	8.00 ± 0.10	
Average weight gain in one month			22.80			32.70	
Food Efficiency Ratio			33.40			44.90	

** Significant at 1 per cent level.

group was 32.70 g. The food intake of the experimental group in the first week was higher when compared with the control group, but in the rest of the week the food intake was found higher in the control group. From the data obtained (Table 19) the Food Efficiency Ratio (FER) of both the experimental and control group were calculated. The Food Efficiency Ratio of the rats which were given soyaflour as the protein source was 33.40 and that of control group was 44.90. The food intake of the rats which were given the experimental diet were less when compared with the rats which were given control diet with milk powder.

The data was subjected to 't' test so as to test its significance. The Food Efficiency Ration of the experimental group was 33.40 and the Food Efficiency Ratio of the control group was 44.90. The results showed significant difference in FER between the experimental and control groups at 1 per cent level.

4.6 Impact of the selected supplementary food on the growth of preschool children

The suitability of the selected combination of the supplementary food was assessed by conducting a 6 months feeding trial and beneficaries of the feeding experiment were preschool children attending the creche run by the department of Home science. The selected preschool children were given the developed supplementry food for six days in a week and the trial was carried out for a period of six months, without break.

A preliminary clinical examination of 30 preschool children was done by a qualified physician to eliminate the pre-school children with clinical signs of nutritional defeciencies. Out of 30 preschool children, 15 pre-school children with similar socioeconomic and health background within the age group of 3 - 5 years were selected for the feeding trial.

Table 20

Age wise distribution of the preschool children

Age(years)	Number of preschool children	Per cent
3 - 4	5	33.33
4 - 5	10	66.67
Total	15	100.00

During ten day pre-testing peroid, the selected preschool children were given the supplementary food to test its acceptability by the children. The selected combination of supplementary mix was sweetened with sugar, made into balls and were given to the children. 130g of food mix was made into sweet balls and was given to each child so as to meet the protein requirement (14g) as specified under ICDS norms. In the pilot study conducted, it was observed that within two days the preschoolers were adjusted to the new food mix.

4.6.1 Growth pattern of the selected preschool children

The impact of the feeding trial upon preschool children were assessed by taking anthropometric measurements. (Details of anthropometric measurements are presented in Appendix V). Body measurements are often used as indicators of body composition (Robert, 1993). As indicated by Scrimshaw (1967), ICMR (1972), National Institute of Nutrition (1973) and Gopaldas (1975), a well accepted procedure for evaluating the impact of supplementary feeding is to measure absolute weight gains and significant growth differences.

The selected preschool children were weighed and their crown heel length (Height) were recorded at the intial and final stages of the experiment. After removing the shoes each child was allowed to stand on the platform of a weighing balance with equal weight on both the legs. The subject was not allowed to touch anything else and the accurate weight was recorded.

Each child was allowed to stand erect on to a wall with heels together after removing the shoes. He was allowed to look straight with head comfortably erect and arms hanging at the side. The buttocks, shoulders and back of the head was kept on the same line. After keeping the hair pressed the actual height was marked on the wall and the height of the child was measured with a tape.

The head, chest and upper arm circumference were also measured during the experimental period. The maximum circumference of the forehead was recorded by using a measuring tape. The chest circumference was measured at the level of the nipples mid way between inspiration and expiration with a measuring tape. The midarm circumference gives an assessment of muscle mass, subcutaneous tissue and hence indirectly the nutritional status (Beegum, 1991). Upper arm circumference was measured at the mid point of the upper arm keeping the arm flexed at the elbow. The circumference was measured by passing a tape around the mid upper arm without disturbing the contours of the arm. Measurement of chest and upper arm circumference reveal the protein calorie defeciency state of the preschool children reflecting indirectly on body constitution with reference to the fat content in soft tissues.

Anthropometric measurements in the beginning and completion of feeding trial are furnished in Table 21.

Table 21 revealed that the mean height and weight of the selected preschool children increased after the feeding trial. (Details pertaining to anthropometric measurements are presented in Appendix V). Morotell *et al*, (1980) had reported that greater supplement intake was clearly associated with better growth in height and weight. Vaidehi (1990) found that a soyabean product produced satisfactory rates of growth in young children and recommended its widespread use as a supplementary food.

Table 21

Anthropometric measurements of preschool children

during the feeding trial

Sl. No.	Parameters	Mean values Initial	Final	't' value
1	Height(cms)	102.10 ± 2.90	104.60 ± 2.71	** 2.41
2	Weight (kg)	14.20 ± 1.30	17.10 ± 1.10	** 2.93
3	Head Circumference (cms)	50.20 ± 1.30	50.70 ± 1.30	0.781 NS
4	Chest circumference (cms)	53.40 ± 1.60	54.40 ± 0.30	1.149 NS
5	Upper arm circumference (cms)	16.30 ± 0.50	17.20 ± 0.70	** 3.18

** - Significant at 1 per cent level
NS - Not significant

The data on the mean values of height, weight, head, chest and upper arm circumference were statistically tested to find out the significance of increase in anthropometric measurements by using paired 't' test.

Statistical analysis of the data revealed that there was a significant improvement in height, weight and upper arm circumference. The difference was not significant in the case of head and chest circumference. According to Bhatia (1994) child gains about two kg every year between the ages of 3 and 7 years and 5 cm increase in height every year, until the age of ten years. The present supplementary food formula was able to achieve improvement in the height and weight of preschool children.

A comparision of final height and weight data of the selected preschool children with standards are presented in Table 22.

Table 22

Comparison of the mean height and weight of the preschool children with ICMR standards

Anthropometic measurements	Final	ICMR Standard	't' Value
Height	104.38	104.10	0.16 NS
Weight	17.11	17.08	0.06 NS

NS - Not significant.

As revealed in Table 22, the mean weight and height of children were slightly higher than the standard recommended however the two measurements were statically not significant.

4.6.2 Weight for age profile of the preschool children

The most recognised indicator of protein energy malnutrition is weight for age (Jellifee, 1966). A comparison of the final weight of the preschool children with standards recommended at the corresponding ages will help to determine the degree of underweight. According to Gopaldas and Seshadri (1987) this index is effectively used to determine the current state of nutritional status of children.

Details of the final body weight of the preschool children were analysed and compared with the standards. Anthorpometric measurements developed by Gosh (1986) was used in the present study for comparison. Weight for age profile of the preschool children according to different age classes in comparison with standards are presented in Table 23.

Table 23

Weight for age profile of the preschool children in comparison with standards

Age (Years)	Final mean weight (kg)	Standard(kg) (Shanti Gosh, 1986)	't' value
3 - 4	16.00	14.70	1.24 NS
4 - 5	18.70	16.50	314.83**

** Significant at 1 per cent level.

As indicated in Table 23, mean weight (final) for age of children belonging to different age groups were found to range between 16.7 kg to 17.5 kg. The final mean weight for children in the age group 3 - 4 was found to be higher than the standard. But the mean weight of the children belonging to the age group 4 - 5 was found to be slightly lower than the standard.

When the data was tested stastically it was found that the mean weight for age of the preschool children belonging to the age group 4 - 5 was significantly higher than the standards. However, it was found to be not significant with the standard in the second age class (3 - 4).

4.6.3 Height for age profile of the children

Height for age profile shows the state of chronic malnutrition or stunting in children (Gopaldas and Sesadri,1987). The extent of height deficit in relation to age, as compared to standards, can be regarded as a measure of the past nutritional history of a subject.

Mean 'height for age' of the selected children in comparison with the standards are presented in Table 24.

Table 24

Comparison of mean height for age profile of the pre school children with standard

Age (years)	Final mean height (cm)	Standard(cm) (Shanti Gosh, 1986)	't' value
3 - 4	102.86	96.90	1.69 NS
4 - 5	106.67	104.90	1.74 NS

NS - Not significant

Final mean height for age of the children ranged between 100.40 cms to 108.50 cms. The final mean height for age of the preschool children selected for the study was found to be higher than the standards for all groups. Chandha (1980) stated that a soyabean fortified diet to a set of malnourished preschool children caused an increase in weight and majority of the children were relieved of the sign of Kwashiorkor.

When the data was tested statistically it was found that the height for age was non significant when compared to the standard for the children of the age group 3 - 4 and 4 - 5.

4.8.4 Body Mass Index of the selected preschool children

Body Mass Index of the preschool children were worked out and the details are presented in Table 25. According to Visweswara Rao and Singh (1970), weight in kilogram divided by height in centimetre square ratio is normally about 0.0015 or 0.0001 for preschool children. The ratio is reduced if the weight of the child decreases to a greater extent in proportion to his height. If the ratio falls below 0.0013, it indicates the presence of low weight or under nutrition.

Table 25

Weight/Height^2 ratio of the preschool children

Grade of malnutrition	Preschool children			
	Initial		Final	
	Number	Per cent	Number	Per cent
Normal (>0.0015)	3	20	13	86.67
Moderate malnutrition (0.00.13 - 0.0014)	12	80	2	13.33
Total	15	100	15	100.00

As revealed by the Table 25, 80 per cent of the selected preschool children were depicting symptoms of mild malnutrition during the initial stage of the experiment. On completion of the study, 87 per cent were found to become normal when the ratio of Weight/Height^2 was applied.

Weight/Height^2 is an index used to detect the malnourished children. In the present experiment, it was seen that majority of the preschool children had attained better health status after the feeding trail.

4.7 Assessment of the shelflife quality of the supplementary food

Shelflife qualities are essential parameters to be assessed since they determine the suitability of the particular product. Hence, the selected proportion of supplementary food mix

(85:10:5 - Parboiled rice:Soyaflour:Groundnut flour) was assessed for its storage qualities. Indicators selected for assessing shelflife were appearance, flavour, taste, texture and colour. The microbes of the sample were identified applying serial dilution techniques.

The developed supplementary food mix (100g each) was packed in sterile glass bottles and kept in a chamber of a cupboard at room temperature. Monthly observations were made for changes in appearance, flavour, taste, texture and colour by using a suitable score card. Details pertaining to score card are presented in Appendix VI. Scoring was done by selected judges. The scores given by the judges were subjected to statistical analysis using simple ANOVA method.

During the first month, the sample scored highest for all the quality attributes such as appearance, flavour, taste, texture, and colour. The mean scores were 4.50, 3.90, 4.00, 4.30 and 4.50 respectively. The maximum score was obtained for appearance (4.50) and colour (4.50) in the first month. Other attributes such as taste, flavour and texture were also good. Studies on the storage stability of supplementary foods based on pulses have shown that these foods would be stored up to 2 to 5 months depending on the moisture content of the food and the type of container (Malleshi *et al*, 1989).

Table 26

Mean Scores obtained for the supplementary food at different storage periods

Storage period	Mean scores				
	Appearance	Flavour	Taste	Texture	Colour
End of 1st month	4.50 ± 1.20	3.90 ± 1.30	4.00 ± 1.70	4.30 ± 3.20	4.50 ± 1.40
End of 2nd month	4.20 ± 1.30	3.50 ± 1.60	3.90 ± 1.00	3.90 ± 2.10	3.80 ± 1.90
End of 3rd month	3.70 ± 1.80	3.20 ± 1.40	2.80 ± 1.30	3.80 ± 1.40	3.30 ± 0.80
End of 4th month	2.40 ± 1.70	1.60 ± 1.00	1.40 ± 1.40	3.20 ± 3.00	2.90 ± 1.10
CD (0.01)	0.146	0.150	0.159	0.263	0.243

In comparison with the first month, the quality attributes of the sample slightly decreased during the second month. The mean scores obtained for appearance, flavour, taste, texture and colour was 4.20, 3.50, 3.90, 3.90 and 3.80 respectively. There was no considerable change in appearance, taste and texture on the second month of analysis. Sinha and Ali (1993) found that medium fat soyaflour can be stored in metallic containers and polythene bags for a period of 4 months under room conditions.

However, during the third month, there was a considerable decrease in the score values on comparison with the first two months. The mean scores representing appearance, flavour, taste, texture and colour were 3.70, 3.20, 2.80, 3.80 and 3.30 respectively. The score for taste was decreased considerably due to rancidity of peanuts. Storage stability of roasted peanuts under atmospheric conditions was critically dependent upon moisture content and shelflife only doubled when storage temperature was reduced by 15°C (Ozgul, 1993). A sharp increase in peroxide value during storage of peanuts confirms the development of rancidity (Fourie, 1989).

The quality attributes markedly decreased in the fourth month when compared with the first, second and third months. The mean scores obtained during the fourth month were 2.40, 1.60, 1.40, 3.20 and 2.90 respectively. The reduced shelflife of the supplementary food was due to the rancidity of groundnut.

Shelflife of peanuts is influenced by the variety, maturity, market grade and quality of the raw stock (Mozingo *et al*, 1988).

The mean values obtained for the supplementary foods at different storage periods were statistically compared among themselves and the details are presented in Appendix VII.

The mean values for appearance, flavour, texture and colour was found significantly different from the first month onwards. The difference was not significant for the attribute taste during the first month. However, there existed a significant difference from the second month onwards. After 4 months of storage, the samples completely deteriorated showing changes in colour, appearance, flavour and taste and were subjected to examine microbial contamination. The result showed that there were only fungal attack. No yeast and bacteria were found. The fungal colony was transferred to a slide and identified under microscope. The fungus identified in the sample was Aspergillus niger. The storage stability test of the supplementary food developed by Alin *et al*, (1985) on rice, soyabean and sesame showed that the total plate count, coliform count and bacterial count of the ingredients was quite low. However, after 30 and 60 days storage, the counts for the supplementary food based on rice, fish, soyabean and sesame increased and were higher at room temperature than at refrigerated temperature. A study conducted by Kapoor *et al*, (1978) showed that the storage life of low cost soyabean weaning food packed in cans was 8 months at 5°C and 6 months at 30°C. Dried soyabean product could be stored in polythylene bags for more than 20 days at 37°C without deterioration (Gupta *et al*, 1991). Analysis at regualr intervals for physical and chemical properties indicated that the soy-whey weaning food can be stored for 4 months at a temperature of 30 ± 1°C in polyethylene bags and in tins without Nitrogen for 6 months (Kapoor *et al*, 1981).

From the above observations and findings the developed supplementary food is found to be low cost and nutritious. Moreover it is easy to prepare at home level and has got a good shelflife. Since the rice-soya supplementary food is highly accepted by the preschool children, it can be popularised as a food supplement to eradicate malnutrition in the community.

SUMMARY

SUMMARY

A study on "**Evaluating the nutritional quality of aoya based supplementary foods**" was conducted with the major objective to develop a nutritionally balanced soyabean supplementary food for preschool children. Ten formulations of supplementary food were developed with parboiled rice, defatted soyaflour and groundnut flour.

The aminoacid score and chemical score of these 10 combinations of supplementary food were worked out and the 5 combinations which had chemical scores above 75 per cent were selected for further study, the selected combinations with Rice, Defatted soyaflour and Groundnut flour were 90:5:5, 85:10:5, 80:15:5, 75:20:5, and 70:25:5. The chemical scores of these combinations of supplementary food were 98.20, 97.50, 94.40, 92.60 and 90.80 per cent respectively.

The nutritional composition of the 5 combinations of supplementary food were worked out and the results revealed that the calories, protein, calcium, phosphorus and iron in the fifth combination (70:25:5) was found higher as the percentage of soyaflour added was high (25 per cent).

Cost analysis of the supplementary food revealed that the cost of 1Kg of the developed supplementary food costs Rs 10 and it is found very cheap and economical for low income groups.

Organoleptic qualities of the developed formulae was assessed by selected panel members. Five combinations of supplementary food which has got high chemical scores were selected and prepared in the form of porridge and laddu sweetened with jaggery and sugar separately. The parameters tested under organoleptic studies were appearance, flavour, taste, texture and colour. Based on the above observation, sugar was found as the acceptable sweetner for the supplementary food. Among the recipes tested, the 85:10:5 blend in the form of laddu with sugar was scored highest as a most acceptable supplementary food.

The selected combination of supplementary food was analysed for its nutrient content and found that it contained 11.20g of protein and 368.50 kcals /100g. The amount of minerals such as calcium, iron and phosphorus was found to be 32.80mg, 1.90mg and 200mg respectively.

Animal experiment conducted revealed that PER, NPU and FER of the supplementary food was 2.50, 66.83 and 33.40 respectively. The Biological Value and Digestability Co-efficient were found to be 77.80 and 85.90 per cent respectively.

A feeding trial was conducted to assess the nutritional quality of the rice-soya supplementary food. The feeding trial was conducted for a period of 6 months among 15 preschool children selected through a preliminary clinical examination by a qualified physician to eliminate the preschool children with clinical signs of nutritional defeciencies. 130g of food mix in the form of laddu was given to each child. During the 6 months period, the health status of the preschool children were ascertained through anthropometric measurements viz; height, weight, chest circumference, upper arm circumference and head circumference. The anthropometric measurements were recorded before starting the experiment as well as after completion of the experiment.

A comparison between the initial and final anthropometric measurements of the preschool children revealed a significant improvement in height, weight and upperarm circumference. The difference was non significant in the case of head and chest circumference. A comparison of the final height for age revealed that this was found to be statistically non significant for children in the age group 3 - 4 and was found to be significant for those in the age class 4 - 5. A comparison of the final weight for age revealed that the difference was not significant for both the age groups. The final height and weight were compared with the standards and they revealed that the two measurements were statistically significant. An assesment of the Body Mass Index of the preschool children showed that during the beginning of the experiment 80 per cent were depicting symptoms of malnutrition. But after the completion of the feeding trial it was reduced to 13 per cent and 87 per cent of the children were found to become normal. A significant improvement in the anthropometric measurements revealed that it can be used as a food supplement for preschool children.

Shelflife qualities of the selected combination of supplementary food was assessed with reference to appearance, flavour, texture, taste, colour and microbial status. An assessment of shelflife revealed that the main changes of deterioration were changes in taste and off flavour developed due to rancidity. The product retained its quality upto 4 months. The microbial study revealed the presence of fungus Aspergillus niger which occured after 4 months. The supplementary food was found to be unaffected by bacteria and yeast.

From the above observations and findings the developed supplementary food is found to be low cost and nutritious. Moreover it is easy to prepare at home level and has got a good shelflife. Since the rice-soya supplementary food is found to be highly acceptable by the preschool children, it can be popularised as a food supplement to eradicate malnutrition in the community.

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APPENDICES

APPENDIX I

SCORE CARD FOR EVALUATING THE ACCEPTABILITY OF THE DIFFERENT COMBINATIONS OF SUPPLEMENTRY FOOD

Name of the panel member

Qualities	Different Combinations				
	1	2	3	4	5
Appearance					
Taste					
Flavour					
Texture					
Colour					

Basis of scoring

Appearance		Taste		Flavour		Texture		Colour	
Very good	5	Very good	5	Very good	5	Very fine	5	Veryacceptable	5
Good	4	Good	4	Good	4	Fine	4	Acceptable	4
Fair	3	Fair	3	Fair	3	Slightly coarse	3	Slightly acceptable	3
Poor	2	Poor	2	Poor	2	Coarse powder	2	Neither acceptable nor unacceptable	2
Very poor	1	Very poor	1	Very poor	1	Very coarse	1	Unacceptable	1

APPENDIX II

ABSTRACT OF ANOVA RELATED TO ORGANOLEPTIC QUALITIES OF PORRIDGE SWEETENED WITH JAGGERY

Organoleptic qualities	DF	MSS	F Value
Appearance	4	2.290	5.154**
Flavour	4	1.391	2.055**
Taste	4	1.423	2.330 NS
Texture	4	1.471	2.610 NS
Colour	4	3.803	6.077**

APPENDIX III

ABSTRACT OF ANOVA RELATED TO ORGANOLEPTIC QUALITIES OF PORRIDGE SWEETNED WITH SUGAR

Organoleptic qualities	DF	MSS	F Value
Appearance	4	1.943	2.373_{NS}
Flavour	4	0.531	0.784_{NS}
Taste	4	4.131	6.767^{**}
Texture	4	1.003	2.396_{NS}
Colour	4	1.591	2.239_{NS}

APPENDIX IV

ABSTRACT OF ANOVA RELATED TO ORGANOLEPTIC QUALITIES OF LADDU SWEETNED WITH SUGAR

Organoleptic qualities	DF	MSS	F Value
Appearance	4	2.338	5.261**
Flavour	4	0.936	1.384*
Taste	4	1.894	3.103**
Texture	4	4.471	7.145**
Colour	4	4.903	6.306**

APPENDIX V

INITIAL AND FINAL ANTHROPOMETRIC MEASUREMENT OF THE SELECTED PRESCHOOL CHILDREN

No. of Preschoolers	Age	Height (cm)		Weight (kg)		Head circumference (cm)		Chest circumference (cm)		Upper arm circumference (cm)	
		Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
1	3	97.5	102.0	11.5	15.5	50.5	51.0	51.0	53.0	17.0	18.0
2	3	97.0	99.1	13.0	15.5	49.0	49.5	51.0	53.0	16.0	16.5
3	3	96.0	97.5	14.0	15.5	49.0	49.5	52.0	53.0	16.0	17.0
4	3 1/2	102.5	104.5	13.5	17.0	48.0	48.0	53.0	54.0	16.0	16.0
5	3 1/2	106.5	109.0	15.5	19.0	49.0	50.0	55.0	56.5	18.0	19.0
6	4	103.0	105.0	12.5	15.0	49.5	50.0	52.0	53.0	16.5	17.5
7	4	98.5	101.1	13.5	16.0	51.0	51.5	52.0	53.0	16.0	16.5
8	4	103.0	105.5	13.0	17.0	50.5	50.0	52.0	53.5	16.0	17.0
9	4	99.5	102.0	13.5	16.5	49.0	49.5	52.5	53.5	16.5	18.0
10	4 1/2	102.0	104.5	16.0	19.0	55.0	55.5	54.0	54.5	16.5	17.5
11	4 1/2	108.0	110.5	16.0	18.5	49.0	50.0	57.0	57.0	16.0	17.5
12	4 1/2	105.5	107.5	15.0	18.0	51.5	52.0	54.0	54.5	15.0	16.0
13	4 1/2	105.0	107.5	15.0	19.0	52.0	52.5	54.5	55.0	15.5	16.5
14	4 1/2	103.0	104.0	15.5	17.5	51.0	52.0	53.0	53.5	16.5	17.0
15	5	104.5	106.0	16.5	17.5	50.5	50.5	58.0	59.0	17.0	18.0

APPENDIX VI

SCORE CARD FOR EVALUATING THE SHELFLIFE QUALITIES OF THE SELECTED SUPPLEMENTARY FOOD

Name of the panel member

Qualities	Months 1	2	3	4	5	6
Appearance						
Taste						
Flavour						
Texture						
Colour						

Basis of scoring

Appearance		Taste		Flavour		Texture		Colour	
Very good	5	Very good	5	Very good	5	Very fine	5	Veryacceptable	5
Good	4	Good	4	Good	4	Fine	4	Acceptable	4
Fair	3	Fair	3	Fair	3	Slightly coarse	3	Slightly acceptable	3
Poor	2	Poor	2	Poor	2	Coarse powder	2	Neither acceptable nor unacceptable	2
Very poor	1	Very poor	1	Very poor	1	Very coarse	1	Unacceptable	1

APPENDIX VII

ABSTRACT OF ANOVA RELATED TO SHELFLIFE QUALITIES OF THE SUPPLEMENTARY FOOD

Qualities	DF	MSS	F value
Appearance	3	12.578	90.203^{**}
Flavour	3	12.138	82.657^{**}
Taste	3	19.725	119.278^{**}
Texture	3	1.187	2.646_{NS}
Colour	3	2.014	2.415_{NS}

EVALUATING THE NUTRITIONAL QUALITY OF SOYABASED SUPPLEMENTARY FOODS

BY

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ABSTRACT

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A study on '**Evaluating the nutritional quality of soyabean supplementary foods**' was conducted by selecting different food ingredients like parboiled rice, soyaflour and groundnut to develop a nutritionally balanced supplementary food for preschool children.

The aminoacid score and chemical score of ten formulations of supplementary food were worked out and five combinations which had chemical scores above 75 per cent were selected for further study.

Nutritional composition and organoleptic qualities of the five combinations of supplementary food were ascertained and based on these aspects parboiled rice : defatted soyaflour : groundnut flour in the proportion 85:10:5 was selected.

The selected combination of supplementary food was analysed for its nutrient content and found that it contained 11.20g of protein and 368.50 kcals/100g. Reasonable amount of minerals such as iron and phosphorus was also present in the selected combination. The Protein Efficiency Ratio, Net Protein Utilisation and Food Efficiency Ratio was found to be 2.50, 66.83 and 33.40 respectively.

The feasibility of this combination as a food supplement was ascertained by conducting a feeding trial for a period of 6

months among 15 preschool children and the results revealed a significant improvement in anthropometric measurements. The developed supplementary food maintained its shelflife qualities upto 4 months. The microbial study revealed the presence of fungus Aspergillus niger which occured after four months. The supplementary food was found to be unaffected by bacteria and yeast.

From the above observations and findings the developed food supplement is found to be low cost and nutritious. Moreover it is easy to prepare at home and has got a good shelflife. Since the rice-soya supplementary food is accepted by the preschool children, it can be popularised as a food supplement to eradicate malnutrition in the community.