SUITABILITY OF FOOD MIXES DEVELOPED BY KAU AS FOOD SUPPLEMENT UNDER ICDS

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DECLARATION

I hereby declare that the thesis entitled "*Suitability of food mixes developed by KAU as food supplement under ICDS*" 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 of any degree, diploma, associateship, fellowship or other similar title of any other university or society.

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CERTIFICATE

Certified that this thesis entitled "Suitability of food mixes developed KAU as food supplement under ICDS" is a record of research work done independently by Ms. Jyothe Elezabeth Thomas under my guidance and Supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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INTRODUCTION

"Every man, woman and child has the in alienable right to be free from hunger and malnutrition, inorder to develop fully and maintain their physical and mental facilities". Children are the vulnerable assets of a nation who are to be the potential parents of tomorrow. The quality of life they enjoy today would ultimately determine the quality of future population. Therefore, prime importance should be given to their health and nutritional, recreational and educational facilities. (Pathak and Saxena, 1979).

Dayal (1983) is of the opinion that early childhood constitutes the foundation of adult productivity, and nutrition is a major determinant of the quality of strength of this foundation. UNICEF (1998) - the only United Nation's agency dedicated exclusively to children - spells out a simple but most piercing truth, that sound nutrition can change children's lives, improve their physical and mental development, protect their health and lay a fine foundation for future productivity. As reported by Annan (1998) over 200 million children in developing countries under the age of five are malnourished. Malnutrition contributes to more than half of the nearly 12 million under five deaths in developing countries. Sen. *et al.* (1995) had reported that children under five years of age accounts for 13 percent of our population. Mathew (1994) has observed that eight percent of the children in Kerala are either mildly or moderately malnourished.

Devi *et. al.* (2000) are of the opinion that in developing countries preschool children are particularly vulnerable to malnutrition. Therefore ensuring proper nutrition to the preschool children is of paramount importance to overcome the severe effects of malnutrition and they must be provided with nutritious supplementary foods. The government of India has also placed high priority in improving the health and nutrition of children and nutrition programmes are being constantly implemented to improve the nutritional status of the vulnerable groups of population and to combat malnutrition.

One such intervention programme is the Integrated Child Development Services (ICDS). An important objective of this service is supplementary feeding programme aimed at increasing the energy consumption of vulnerable individuals through non-commercial, free or subsidised food distribution. The major food items of these feeding programmes were supplied by external donor agencies. As the donors of the supplementary foods have already withdrawn their support, it has become a necessity to find out suitable substitutes which are indigenous, low cost, acceptable and suitable for mass feeding to the needy beneficiaries.

Several such supplementary foods have been developed by scientific institutions and research workers. As opined by Devadas (1983), in the interest of the well-being of millions and millions of nutritionally affected children from economically backward and culturally bound societies, it is the duty of the nutritionists and home scientists to spread the message about such locally available supplementary foods.

This study entitled "Suitability of food mixes developed by Kerala Agricultural University (KAU) as food supplement under ICDS" is an attempt in this direction to find suitable supplements for large scale feeding. The Department of Home Science, College of Agriculture, Vellayani has already developed five Weaning/Supplementary foods from locally available food materials through extensive laboratory and small scale field based feeding trails. Now through this study the technology developed in the laboratory is being tested in the field to find out whether any of the five supplements developed by KAU can be used as an indigenous supplement to feed the preschool children under ICDS.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The literature related to study are reviewed in this chapter under the following headings.

1. Status of children and need for supplementation.
2. Need for supplementary feeding programmes
4. Suplementary food developed by institution and researchers
5. Nature of supplementary foods and their essential qualities
6. Effect of supplementation

Status of children and need for supplementation

Khan (1989) had opined that children occupy a prominent place in the demography of any country. They are the ctitizens of tomorrow. Their present conditions shape the future of their adulthood. The development of any nation depends on the attention and care bestowed upon the development of children.

As reported by Chowdhary (1992) the foundation of personality of a man is laid in his formative years of life. Early childhood is a period of rapid growth and development and is dependent on the interaction of hereditary as well as environment factors. Hence he stated that any deficiency during this period may cause irrepairable change in the future development of children. Therefore according to the above author an investment in child development is an investment for the future.

Annan(1998) is of the opinion that to look into some aspects of the future we do not need projections by super computers. Much of the next millenium can be seen in how we care for our children today. Tomorrow's world may be influenced by science and technology; but more than anything it is already taking shape in the bodies and minds of our children.

As reported by Sharma and Kalia (1990) from the nutritional stand point children below the age of five years are the most vulnerable group. The foundation for good health and sound mind are laid during the preschool age, and nutrition is one of the most important factors responsible for growth in infancy and childhood.

Devadas *et. al.* (1984) had reported that the period between 0-6 years is crucial in every child's life for laying the foundation for lifetime. Since nutrition is a pre requisite for optimal growth and development of children and if these needs are not adequately met both qualitatively and quantitatively, signs of malnutrition will manifest and would result in long term deficiencies in physical, mental and all round development.

UNICEF (1998) had reported that of the nearly 12 million children under five who die each year in developing countries mainly from preventable causes, the death of over six million or 55 per cent is either directly or indirectly attributable to malnutrition. However Goel and Kumar (1998) have observed that around 63 per cent of under fives in India are malnourished which accounts for 75 million malnourished children.

Malnutrition " the man made disaster" is an avoidable tragedy with enormous social and economic costs in wasted human potential (FAO, 1992). It affects growth and reproduction and undermines health, learning and working capacity and overall quality of life and well being.

The International Conference on nutrition (1992) reported that malnutrition among children is more likely to result from ignorance about hygiene and dietary needs of children.

Grant (1998) reported that malnutrition is the contributing cause in one third of the million child deaths in the world and malnutrition continues to undermine the development of vulnerable groups in the developing countries including India (Yadav and Sehgal, 1995).

United Nations Administrative Committtee on Co-ordination - Subcommitte on Nutrition (UNACC/SCN) (2000) in its fourth report on the World Nutrition situation estimated that 32.5 per cent of the children under five in developing countries are stunted. They had also reported that the global prevalence of wasting among preschool children is 9.4 per cent whereas 26.7 per cent of preschool children in developing countries were estimated to be underweight. United Nations Sub Committe on Nutrition (UN SCN) (1993) had also remarked that malnutrition in pre-school years leads to stunting and other ill effects of malnutrition, and these have been widely observed to be associated with reduced school performance.

Annan (1998) had reported that in 1995, 27 per cent (168 million) of all children under five were under weight. Mortality rates are five times higher among severely under weight children than those of normal weight and about 50 per cent of deaths among children under five are associated with malnutrition.

UN ACC/SCN (1996) reported that the prevalence of underweight in south Asia is around 50 per cent. The progress of Nation's reports (1996) released jointly by government of India and UNICEF indicated that as many as 53 per cent of all under five children are underweight, indicating malnutrition.

Charanjit *et. al* (1997) had reported that major nutritional deficiencies found in India include PEM, vitamin A deficiency, anaemia, Iodine Deficiency Disorder and B complex deficiency. Among them protein energy malnutrition is found to affect 45 per cent of preschool children.

Gopalan *et.al.* (1996) observed that 44 per cent of preschool children in India are suffering from Protein Energy Malnutrition.

Dayal (1983) had reported that protein energy malnutrition, anaemia and vitamin A deficiency are the major problems confronting the children of the developing countries and childhood morbidity still remains a problem in the state of Kerala. Sreeja (1999) had observed that Kerala is adulated as the most progressive state in India in the domain of health, though the morbidity level is becoming highly prominent.This can be considered as a natural consequence of overall development as observed in the developed western countries. But the morbidity pattern seen in Kerala is quite different from that of developed countries. There are both the "lifestyle diseases" (non-communicable diseases) and communicable diseases co-existing in considerable proportions.

Moreover, Soman (1998) had observed that Kerala has the attention of the world for its unique achievements in health. He had opined that Kerala has the highest proportion of normally nourished and the lowest proportion of severly undernourished children under five yearsof age. A recent estimate of undernutrition in Kerala was provided by the National Family Health Survey (NFHS, 1995), which proclaimed that mild to moderate malnutrition is widely prevalent in Kerala, among children under four years. Hence Soman (1998) noted that any adverse impact on food intake may result in an increase in the prevalence of malnutrition.

Mathew (1994) had reported that in Kerala the percentage of severly malnourished children (less than four years of age) has shown a declining trend over the years. Over the decade the percentage of children with normal nutritional status has gone up- from 7.6 to 17.9 percent. But at the same time she had also observed that a large proportion of children in Kerala ie, 80 per cent are midly or moderately malnourished.

The nutritional status of the under five in Kerala is comparable to or even better than that of affluent sections of the populations of other parts of India. If the nutritional status of the underfive in urban Kerala is better and the nutritional status among rural areas is inferior, the 'villians' must be some of the factors operating in between such as poverty, poor socio economic status, inadequate food intake, ignorance, false food believes, tradition and faulty feeding practices as reported by WHO (1997)

Gupta (1995) had reported that mothers have very little idea about how much food a child needs for adequate growth and nutrition; hence inadequate feeding practices lead to malnutrition. There is now a growing realisation that malnutrition is not only a problem of food supply but also the behavioural determinants affecting child feeding and rearing (Devi, 1998). This fact is endorsed by Rao (1996) who has opined that wide spread malnutrition prevalent in the world is largely attributed to social , cultural and economic factors.

Tandon (1996) had opined that nutrition is the focal point for health and well being. The problems of poverty, safe drinking water, environmental hygiene and poor literacy contributes to problems of nutrition and public health. Malnutrition is an ecological problem that does not occur alone.

Swaminathan (1985) had stated that the rate of growth and development of infants and preschool children depend to a large measure on the adequacy of the diet consumed by them.

Rohini *et. al.* (1990) had opined that pre-school cildren are the most vulnerable group of the community to the vagaries of malnutrition. Therefore adquate intake of nutrients and maintanence of good health must be ensured during childhood.

According to Thakar and Patil (1990) nutrition of the pre-school child is of paramount importance because the foundation for lifetime, health, strength and intellectual validity is laid during that period.

WHO (1993) stated that the causes of growth retardation are deeply rooted in poverty and lack of education. To continue to allow the under previlaged environments to affect children's developments not only perpetuates the vicious cycle of poverty but leads to an enormous waste of human potential.

According to Michaelsen and Firiis (1993) the growth of children in developing countries often declines with the introduction of supplementary foods which are nutritionally inadequate. These growth deficits are accompanied by delayed development and increased morbidity and mortality.

Need for supplementary feeding

Soman (1998) had pointed out that food consumption of the people particularly the vulnerable segments like young children and pregnant and lactating mothers is much below the recommended levels. Any decline in intake particularly of protective foods may lead to a deterioration of the nutritional situation.

Sri Kantia (1983) had reported that to tackle the problem of malnutrition among children, many a co-ordinated nutrition intervention strategy have been developed. In many developing countries supplementary feeding has been a major type of intervention and the use of low cost locally available foods patterned around the dietaries of the children has been suggested as a viable remedial measure.

Udani (1990) has stated that the quantity and quality of supplements provided at the weaning age determine the nutritional status of the children. Hence he opined that the incidence of malnutrition can be prevented by food supplements indtroduced to the diet of the children at different stages of development.

According to Tontisirin and Lamborisut (1995) two factors playing major role in the pathogenesis of protein energy malnutrition and low birth weight are inadequate dietary intake and the combined effect of stress and infections which may interfere with the intake, absorption and assimilation of nutrients. However, protein and energy malnutrition can be overcome with protein and energy supplements as reported by Annie *et. al.* (1993).

Obatolu *et.al.* (2000) has opined that the high cost of animal proteins in most developing countries have resulted in inadequate protein intake for normal body growth and development. Hence children in developing countries are often weaned on to cereal gruel that is inadequate in protein and energy.

After four months of birth, mother's milk alone cannot meet the growth requirement of infants as their weight and activity increases. Therefore the infant needs more energy than that it could get from mother's milk. The availability of mother's milk decreases gradually. Hence the child needs more food to meet his growth needs. So it is necessary to give supplementary foods along with milk.

Mitzner *et. al.* (1984) had remarked that any solid, semisolid or liquid nutrient fed to a child in addition to human milk can be called as "supplementary food". The term 'complementary food' can also be used instead of 'supplementary food' for conveying the idea that the food is a complement to, rather than a partial replacement of breast milk. Malleshi (1995) had stated that the foods that are given to the child at the later stages of the weaning period and upto school going age (5years) are generally adult foods but are so prepared as to make them nutritious, easily digestible and attractive and these are termed as 'supplementary foods' for. According toSri lakshmi (1993) foods that are given in addition to breastmilk are called as supplementary foods.

Begum (1991) had stated that a child who has failed to grow during the preschool period may not make up the loss in growth even with an excellent diet in later years. Thus supplementary foods should be given to improve physical, mental and social development.

Supplementation has been found to modify the negative effect of diarrhoea on growth; the more severe the diarrhoea, the more is the positive protective effect of feeding as observed by Lutter *et.al.*(1989) in his studies conducted in Colombia and Gautimala.

Suriakanti (1991) had observed that the supplementary foods given by the rural mothers are found to be mainly cooked cereal foods, biscuits, bananas, etc. and these foods do not supply all the nutrients needed by children. As a result children suffer from either malnutrition or undernutrition. Hence this problem can be solved by providing simple nutritious supplementary foods from locally available food materials which are also cheap.

Jasen and Harper (1980) are of the opinion that supplementary foods can be used as a direct means for providing malnourished groups with additional foods they require.

Ahmed *et. al.* (1993) stress that to combat protein energy malnutrition supplementation of cereals and legumes in the daily diets of children is advisable. Desikachar (1982) had opined that by introducing supplementary food of good quality and quantity at the right time in the right proportions, the incidence of protein calorie malnutrition can be prevented to a large extend.

Solanki (1986) feels that there is an urgent need to develop low cost Ready-to-eat mixes to improve the nutritional status of people. According to Annie *et. al.* (1993) protein energy malnutrition can be prevented with protein and energy rich ready-to-cook and ready-to-eat mixes need to be developed for supplementary feeding. According to Tirumaran (1993) the introduction of locally processed and preserved nutritious ready to use foods will reduce the time spent in drudgery by the women along with income generation and improved nutritional standards. Ashlesha and Vali (1997) have observed that the commercial ready-to eat infant foods are very expensive and mothers belonging to low income groups cannot afford to buy them. Hence there is a need to develop low cost, ready to eat weaning/supplementary foods which can be easily prepared at home.

Supplementary feeding programmes

Mathur (1984) had remarked that supplementary feeding forms an important target oriented nutrition action programme and is also one of the largest in terms of financial outlay and coverage.

According to Gillespie and Mc Niel (1992) the most common type of conventional nutrition intervention is supplementary feeding programmes aimed at increasing the energy consumption of vulnerable individuals through non-commercial, free or subsidised food distribution which may be 'on-site', 'take home' or with nutrition rehabilitation for the severely malnourished.

Neelakantan (1991) had reported that the Government of India has placed high priority on improving the health and nutrition of children and national programmes are being constantly improved. To improve the nutritional status of the vulnerable groups of population and to combat malnutrition several intervention programmes have been launched. Swaminathan (1985) had opined that supplementary feeding programmes has been instituted by the government to overcome malnutrition and to improve the nutritional status of the malnourished children. Rivera (1993) had noted that supplementary feeding has been shown to have positive effects on the growth of young children who are mildly or moderately malnourished.

Chirumulay (1997) had opined that malnutrition in preschool children remains a significant problem in India despite special effort over twenty years such as the implementation of the Integrated Child Development Services (ICDS).

Mahadevan (1992) has stated that supplementary feeding programmes traditionally have been the most popular form of intervention for correcting malnutrition. He stated that several programmes of nutritional supplementation of vulnerable groups of population have been implemented in our country in the last two decades.

According to Kennedy and Knudsen (1988) supplementary feeding programmes are the most common form of nutrition intervention in developing countries.

UNICEF (1983) had remarked that the purpose of supplementary feeding is to improve the nutritional status of vulnerable population groups.

Lutter (2000) had opined that supplementary feeding programmes are required to correct moderate wasting and to prevent moderately undernourished children from becoming severely undernourished.

Katona (1993) observed that supplementary feeding of pregnant or nursing mothers and young children promotes the child's growth and development, reduces morbidity and mortality and often provides a vehicle for micro nutrients.

Mahadevan (1992) had also reported that supplementary feeding programmes should be viewed as short term means for achieving specific nutrition and health objectives.

The intervention programmes in India as reported by Elizabeth (1998) are Integrated Child Development Services (ICDS), Mid-day meal programme, Balvadi Nutrition Programme, Specific Nutrient Supplementation, The Universal Immunization Programme, The Child Survival and Safe Motherhood (CSSM) programme and Special Nutrition Programme, Applied Nutrition Programme and Tamil Nadu Integrated Nutrition Programme.

UN ACC/SCN (1996) had remarked that the two main integrated nutrition interventions in India are the national level Integrated Child Development Services (ICDS) and the Tamil Nadu Integrated Nutrition project (TINP).

Reddy *et. al.* (1992) had opined that ICDS delivers a package of services comprising supplementary nutrition, immunization, health check ups, referral services, health and nutrition education to children under six years of age, pregnant and nursing women and preschool education to children between 3 and 6 years of age. Thus it adopts a holistic approach to improve child development by reducing incidence of mortality, morbidity, malnutrition and school drop-outs. Gillespie and McNiel (1992) had remarked that ICDS is mainly a health inervention which adopts a holistic approach aimed at improving both the prenatal and post natal environment. It is a centrally sponsored, state administered scheme which consists of maternal health care in pregnency and growth monitoring and nutritional supplementation for children.

Balachander (1991) had stated that TINP is a world bank assisted health and nutrition intervention Programme of Tamil Nadu aimed to reduce malnutrition and consequent high mortality among children under three.

Srilakshmi (1993) had reported that the mid-day meal programme for school children was started on the recommendation of National School Health Committee by the Government of India for providing mid-day meals to school children. Nutrition evaluation studies have shown that the growth rate of children receiving mid-day meals were greater and the incidence of nutritional deficiency were lesser than those observed in children not receiving mid day meals.

According to Elizabeth (1998) Balwadi nutrition programme is for preschool children and pregnant and nursing mothers which is assisted by the Ministry of Social Welfare. The supplemenatry feeding supplies 300 Kilo Calories of energy and 10-12g protein.

According to Swaminathan (1985) the special nutrition programme is a crash nutrition programme providing supplementary foods to the children below the age of six years living in tribal areas and urban slums. This programme was started in 1970-71 under the department of social welfare, Government of India and implemented through the state governments.

The special nutrition supplementation programmes as reported by Park and Park (1997) includes iodine deficiency control programme, vitamin A prophylaxis programme and national anaemia control programme. The supply of iodized salt in endemic areas, supply of five mega dozes of vitamin A concentrate to children at an interval of six months and supply and iron folic acid tablets to expectant and nursing mothers as well as children are undertaken under this scheme.

World Health Organization (WHO), United Nations International Children's (Emergency) Fund (UNICEF), World Bank, World Food Programme (WFP), Food and Agricultural Organization (FAO), United States Agency for International Development (USAID), The Co-operative for American Relief Everywhere (CARE) are some of the international agencies that had initiated and supported the child welfare programmes especially in the developing countries including India as observed by Elizabeth (1998). These agencies provide financial and technical support to implement various educational and nutritional programmes that help in child survival and child development.

Similar nutrition intervention programmes are in operation in many of the underdeveloped and developing countries all over the world.

Tagwireyi (1996) had stated that "Supplementary Food Production Programme" (SFPP) at Zimbabwe aimed to encourage communities to work together in order to meet the demand for nutritious food particularly for young children.

Maribe (1991) had reported that the "Drought Relief Programme in Botswana" was implemented by the government of Botswana with external support from World Food Programme, USAID and Government of Australia and Canada with the objective of supplementation of food supplies to reduce the incidence of forestall increase in malnutrition among those concerned at risk and rehabilitation of severely and moderately malnourished children through direct on site feeding and providing health facilities.

"The National Family Nutrition Improvement Programme" of Indonesia, as reported by United Nations Administrative Committtee on Co-ordination - Subcommitte on Nutrition (UN ACC/SCN) (1996) was implemented with the objectives of improving the nutritional status of infants, children and pregnant women; improving the nutritional status of the population by reducing the prevalence of nutritional diseases such as protein and energy deficiencies, Vitamin A deficiency, nutritional anaemia and goitre; improving nutritional status of the population through increased diversification of food consumption and sustaining food self sufficiency through increased food production.

Florencio (1991) had pointed out that the Alternative School Nutrition Programme of Philipines aimed to develop local capability to undertake a self sustaining national nutrition programme, with emphasis on supplementary feeding supported by income generating activities of the schools and families and was implemented by the department of education among 1047 public elementary schools in eleven regions of Philipines with external support from CARE.

Kennedy (1991) had reported that the Women, Infants and Children (WIC) Programme of USA was implemented by a number of local agencies' health centres and community action agencies with external support from the US Department of Agriculture with the objective to improve the health and nutritional status of vulnerable pregnant and lactating women, infants and children upto the age of five.

UN ACC/SCN (1996) had reported that the Food and Nutrition Programme of Brazil was implemented with the objective of food supplementation for preschool children for improving their nutritional status.

UN ACC/SCN (1996) had reported the implementation of Poverty alleviation and Rural Employment Project in Bengladesh, which was designed to complement efforts of the World Food Programme of feeding vulnerable groups. Another programme implemented in Argentina with the objective of nutrition rehabilitation of the malnourished, food supplementation for those at risk, improved targeting of school feeding programmes and development of nutrition information system, had also been quoted in the above report.

Schelp (1991) had observed that the community based nutrition intervention in North-East Thailand aimed at improving the nutritional status of the children from birth to five years of age.

According to Mata (1991), "National Nutrition and Holistic Care Programme" (NNHCP) of Costa Rica was implemented with the objective of feeding the preschool and school children along with nutrition education as a means of erradicating third degree malnutrition.

Taal (1991) had reported that "The Institutional Support for Health and Nutrition programme" of Gambia was implemented by the Gambian Food and Nutrition Association, the medical and health depertment of the ministry of health and community management committees with the objectives of growth monitoring, food supplementation and nutrition and health education.

"Improving child nutrition, weaning food project" of Ghana as reported by Orraca (1991) was implementated by the nutrition division, ministry of health, in collaboration with the department of Community development with the objectives of providing facilities for the preparation of community based weaning food; improving the nutrition of the weaned infants and training community members in order to maintain the project.

As reported by Mtalo (1991) "Joint WHO/UNICEF Nutrition Supplement Support Programme" (JNSP) of Iringa region, Tanzania was implemented by the government of Tanzania. Its objectives were reduction of infant and young child mortality and morbidity, better child growth and developement, improvement of maternal health and nutrition and improvement in the capabilities at all levels of society to assess and to analyse nutrition problems and to design appropriate actions.

Suntikitrurgruang (1991) had observed that "Nutrition and Primary Health Care" of Thailand was a national nutrition programme with the objective to improve nutritional status of the mothers, infants, preschool and school children.

Though several projects have been implemented Shekhar *et. al.* (1992) are of the opinion that future efforts directed at nutritional improvement must strike a balance between nutrition intervention and poverty alleviation schemes. However, both strategies must concentrate on targeting ie., improving a, community/family with targeting based on both poverty and nutritional criteria.

UN ACC/SCN (1996) had observed that direct interventions in nutrition seems to be effective and worthwhile when they are genuinely community-based. Many countries could meet internationally accepted goals for nutrition improvement. Enough countries have succeeded to show that success is a reasonable amibition and that the means to achieve it are broadly known. The committee has a highly positive attitude towards the benefits of supplementary feeding programme which is subjected in their remark "the end of malnutrition is coming into sight or the horizon and mankind could get there in the forseeable future".

Supplementary foods developed by Institutions and Researchers

After much experimentation and field trials, a variety of processed weaning foods and supplementary foods based on cereals and legumes, oilseeds and oil seed meals have been developed in India in the past few decades as pointed out by Jacob (1996).

Most of the nutrition programmes have been carried out using supplementary foods developed by several research workers. An account of such mixes and recipes are detailed below.

Wheat flour, green gram dhal and soya bean were the ingredients used for the preparation of protein rich multipurpose food by CFTRI (Malleshi 1995).

Inamder (1981) had developed malted and roasted powdered multimixes of staples viz. wheat, bengal gram and groundnut in the ratios of 4:1:2, 8:1:1 and 8:1:0 respectively.

Four weaning/supplementary foods based on ray keera, green gram, bengal gram dhal, bajra, rice flakes, jowar and soya bean were developed by Ashturkar *et. al.* (1992). The developed weaning/supplementary foods were reported to supply 349-362 kcal of energy and 12.6-17.2 g of protein /100g.

Roman *et. al.* (1987) developed a weaning/supplementary food based on rice, cowpea and milk powder. Their experiments revealed that the protein quality of developed food was comparable to animal proteins.

The supplementary food mixtures containing rice, soya beans and ground nuts or rice, mung beans and sesame providing 13.2-16.5 g of protein per 100g was reported to be distributed in Thailand (Dharmitta *et.al.* 1983).

Madruga and Camara (2000) have reported that " Multimistura" is a low cost food supplement used in institutional nutrition programmes for prevention of undernutrition in low income populations of Brazil. This mixture of Cornbran (30 per cent), wheat bran (30 per cent) Wheat flour (30 percent) powdered cassava leaves (3 per cent) powdered pumpkin seeds (3 per cent) and powdered egg shell (3 per cent)was found to be rich in carbohydrates (71.8 per cent), protein (13.6 per cent) and lipids (3.9 per cent) and was reported to provide 377 kcal of energy/100g.

Devi *et. al.* (2000) had developed four types of supplementary biscuits using green gram dhal, wheat flour,and soya bean and they were found to be nutritious as well as acceptable.

Bhaskaran *et. al.* (1999) had developed eight types of supplementary foods based on popped cereals blended with legumes and fortified with essential vitamins and minerals. Four of the supplements were prepared with cereals, soya flour and bengal gram dhal and the other four were prepared by combining cereals with soya flour. One hundred gram each of these supplements provided 370±20 kcal and 11±1g protein and could satisfactorily meet one third of the RDA of these nutrients per day for preschool children.

Ashlesha and Vali (1997) had a developed supplementary food based on wheat germ with ragi and green gram and they found it to be nutritious with a protein content of 16.8-21.7g per cent and 378 -400 kcal of energy.

Bhatnagar and Goyal (2000) had developed supplementary foods based on bajra, moth beans and groundnuts employing simple and inexpensive processing technology like malting and roasting, and these methods employed were proven to enhance the acceptability, digestibility and nutritional quality of cereals and pulses.

Rivera *et. al.* (2000) had developed supplements for children based on whole drymilk, sugar, malto dextrin, vitamins and minerals and adding banana, vanilla and chocolate flavours. forty four g of the dry powder was sufficient to supply 194 kcal of energy and 5.8g of protein.

Rozo (2000) had reported that complementary food named "Bienestarina" developed in Colombia to increase the availability of high quality protein at low cost for the beneficiaries of applied nutrition programme, had defatted soya flour, corn flour, wheat flour, rice flour, non-fat dry milk and vitamins and mineral premix as its ingredeints and was found to have a PER of 2.5.

Anon (2000) reported that "Amirtham" a low cost food which is a mixture of wheat flour, bengal gram, soya and groundnut is rich in proteins and calories. 100g of the flour can provide a child with one third of its daily requirement for energy and protein.

Apart from such ready-to-cook mixes, ICMR (1996) has reported several recipes suitable for weaning children as summarised below.

Weaning/Supplementary food recipes

Item	Ingredients	Nutritive Significance
Ragi kali	Ragiflour, roasted, bengal gram dhal flour, jaggery, salt	70g provides 252 kcal and 7.5g protein
Cholam kesari	Cholam flour, roasted, bengal gram dhal flour, jaggery	91g provides 324 kcal and 9.4g proteibn
Rice Uppuma	Parboiled rice, greengram dhal, onion, drumstick leaves, greenchillies	91g provides 332 kcal and 8.5g protein
Thenai iddli	Thenai bengalgram dhal	150g provides 517 kcal and 22.7 protein
Samai balls	Samai flour blackgram dhal flour	90g provides 308 kcal and 12.8g protein
Cholam-green gram mix	Roasted cholam flour, roasted bengalgram dhal roasted groundnut, jaggery	80g provides 304 kcal and 9.9g protein
Maize-green gram mix	Maize, roasted greengram dhal, roasted ground nut, jaggery jaggery	80 g provides 305 kcal and 11.5g protein
Ragi leaf cake	Ragi flour, greengram dhal jaggery, coconut scrapings caradamon powder	80g provides 290 kcal and 8.4 protein
Kicheri	Parbiled rice, lentils, spinach, oil	235g provides 549 kcal and 19.3g protein
Vegetable Kheer	Wheat flour, roasted bengal gram dal, amaranth oil	170g provides 480 Kcal and 21g protein
Khaman dhokla	Parboiled rice, bengal gramdal, amaranth oil	170g provides 531 kcal and 16.1g protein
Potato pudding	Horsegram dhal powder, Potato chips powder baking powder	115g provides 254 kcal and 21.5g protein
Groundnut cake/ Jackfruit seed powder	Roasted jackfruit seed flour, roasted groundnut cake flour, palm jaggery	100g provides 318 kcal and 22g protein
Ragi malted porridge	Malted ragi flour, roasted	105 g provides
Groundnut cake toffee	Roasted groundnut cake powder, bengalgram dal powder, palm jaggery	180g provides 661 kcal and 48.7g protein

Swaminathan (1985) has listed the following weaning/supplementary foods developed by different organization located at Coimbatore, Hyderabad, Madurai, New Delhi and Pune.

Supplementary foods developed by Institutions

Name of Food and Instituion	Ingredients	Nutritive value
1. Indian Multipurpose Food **CFTRI, Mysore**	Low fat Groundnut flour, Bengal gram flour- vitamin A and thiamine, riboflavin and $CaCo_3$	25/g day- Protein - 10g and ½ the daily requirements Vitamin A, Calcium
2. Malt Food **CFTRI, Mysore**	Cereal malt, low fat groundnut flour, roasted, bengal gram flour- calcium salts and vitamins	40g/ day Protein - 10g ½ daily requirements of Vitamin A, Ca and Riboflavin
3. Bal - Ahar **CFTRI, Mysore**	Whole wheat flour Groundnut flour roasted Bengal gram flour - Calcium salts and vitamins	50g/day Protein - 10g Substantial amounts of Vitamin A, Calcium and Riboflavin
4. Miltone **CFTRI, Mysore**	Buffalow milk, liquid glucose, ground nut protein isolate, wheat flour	
5. Supplementary food **NIN, Hyderabad**	Green gram flour, groundnut sugar or jaggery	80g/day 300 Kcal 10g/Protein
6. Kuzhandai Amudhu **Avinashilingam Home Science College for Women, Coimbatore**	Roasted maize flour, green gram flour, roasted groundnut, jaggery.	80g/day 305 Kcal 11.5 protein

From the above recipes it may be noted that all the above supplements are prepared with locally available materials. As opined by Devadas (1983) in the interest of well-being of millions and millions of nutritionally affected children from economically backward and culturally bound societies, it is the duty of the home scientistis to spread the message about such locally available supplementary foods. She had further stated that this must be communicated to the public in a language which they understand, and at the grass root level, so that it is well within their economic capacity.

Nature of supplementary foods and their essential qualities.

Malleshi (1995) had noted that considering the socio-economic conditions of the population, while formulating supplementary or weaning foods the methodology used for the preparation should be simple so that it can be made in homes or at community level. He has also pointed out that the foods should be prepared using locally available raw materials which are low in cost, and that the supplements should be rich in calories, good quality proteins with high biological value and should be high in vitamins and minerals.

Devadas (1983) had opined that development of complementary foods should be governed by certain principles: she reported that supplements should have high nutritional value and good supplementary value, high acceptablility, easiness to prepare, low in cost, and should be made from locally available materials and that it should have a shelf life of at least 4-6 months in a tropical environment.

Gopaldas *et.al* (1982), Desikachar (1983) and Chandrashekhara (1999) have listed the desirable characteristics of a supplementary food as high nutrient density and low bulk property. They have stressed the need for utilization of low cost and locally available cereals and pulses and traditional processing methods for developing indigenous supplementary foods at home and village level.

Malleshi and Amla (1988) have reiterated that supplementary foods developed should be easily digestible, nutritionally balanced, low in dietary bulk, high in calorie density and that these foods are to be sold at a price affordable to low income groups or even be produced at the house hold or at community level.

Gahlawat and Sehgal (1994) have advocated that the supplementary foods formulated from locally available cereals and pulses should be economical and simple to prepare. They have also stated that foods should be developed in forms which make their preparation easy at the time of feeding and that they should remain free from any toxic compounds and be resistant to any other changes for a sufficient length of time.

Thirumaran (1993) has stressed the need for the supplementary foods that are low in dietary bulk. She has stated that large volume /high viscoity makes it difficult for small children to fulfill their energy requirements.

Lutter and Huffmann (2000) have opined that complementary foods should be developed using traditional foods to ensure smooth transition to the family diet.

Rosado *et.al.* (2000) have stressed that the supplementary foods should include all of the nutrients that are essential for the target population, and that it should be well tolerated and accepted by the population in terms of flavour and appearance. Moreover it should be easy to use; it should be stable and have a shelf life long enough to allow for adequate distribution and utilization; should be of low cost and should be produced locally.

Huffman *et.al* (2000) have remarked that promotion of ideal complementary feeding should provide foods containing adequate energy, protein, fats and micronutrients to meet the needs of the children and should need only a short cooking period and is to be low in cost.

Rozo (2000) had observed that complementary foods for feeding young children should be formulated from locally available ingredients, low in cost, highly nutritions, should have a good shelf life and should be easy to prepare.

Marchione (2000) had reported that 100g of supplementary food should provide a child with one third of energy needs and two thirds of the protein, vitamin and mineral allowances and should be low in cost and that it should be locally available and already known to the low-income mothers.

Bhatnagar and Goyal (2000) have reported that to meet the RDA of infants and preschool children, low cost supplementary foods should be processed domestically by employing simple and in expensive processing technology.

Effect of supplementation

Several studies have been conducted to prove the effect of ideal supplements scientifically developed by research workers, on the nutritional status of children.

Anon (1999) had reported that low cost foods namely Rice Soya Wheatsoy, Suji-soy, Sorghum-soy foods have been formulated using cereal and defatted soy flour in 70:25 ratio which contained 370-380 kcal and 13-14 per cent protein and were highly accepted by preschool children. The effect of supplementation of the above mixes on children showed that the body weights and arm circumference of children increased significantly after supplementation and the difference was significant between the experimental and conrol group.

Bijlsma and McClean (1997) had made an assessment of a "take home" child supplementary feeding programme in a high dense suburb of Mutare city, Zimbabwe. The supplementary feeding programme was a health service to underweight children who attended the clinics. The study was done for ten months and it was found that eight per cent of the children attending the feeding regularly had improved in terms of anthropometric indices.

Anon (1999) had stated that a high density, low cost, supplementary food named PUSHTI was formulated with popped wheat, roasted defatted soy flour and sugar and further fortified with vitamins and minerals which provided 377 kcal and 13g protein per 100g of the mix.

Supplementation resulted in a significant decrease in the incidence of grade III malnutrition among children from 9.1 per cent to 2.6 per cent. There was also a significant decrease in the incidence of wasting and a less pronounced effect was observed in the prevalence of stunting.

Tagwiriyi (1996) had observed that providing a daily supplementary meal to children living in villages throughout Zimbabwe had significantly reduced the number of hospital admissions for clinical malnutrition and it also improved the nutritional status of the children receiving the supplementary meal.

Beaton (1982) had reviewed the impact of 43 supplementary feeding programmes on nutritional status and indicated that supplementary feeding programmes had a major impact on the nutrional status of children participating in the programmes where an improvement was noted in the anthropometric indices.

Corazon *et. al.* (1983) assessed the impact of one year dietary intervention on the nutritrional status and growth of preschool children of the Phillipines and found that experimental groups had significantly higher height, weight for age, weight for length and arm circumference for age. Evaluation of the Tamil Nadu Chief Minister's free meal programme by Sundararajula and Padmanabhan (1985) had revealed that the programme had a significant postive impact in terms of physical and anthropometric parameters in children.

Chandrasekhar et.al (1988) had 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.

Dharmitta *et.al* (1983) have reported that in Thailand the distribution of supplementary food mixtures containing rice, soybeans and groundnuts or rice, mung beans and sesame providing 13.2-16.5g/100g protein and 337-451 kcal was extremely successful in ameliorating the nutritional deficiency disorders among children, which was indicated by a decrease in the prevalence of PEM from 55 per cent to 21 per cent within eighteen months.

A feeding trial was conducted to assess the nutritronal quality of rice-soya supplementary food by Sailakshmi (1995). The trial was conducted for a period of six months and a comparision between initial and final antaropometric measurements of the preshool children revealed significant improvement in height, weight and upper arm circumferece.

As reported by Rozo (2000) in Colombia a complementary food namely "Colombiharina" was developed based on Rice, defatted soya flour, cotton seed and sesame and 12g of this product was found to provide 142 kcal of energy. The developed food was fed to children between two and five years of age and it was found that this supplement helped to stop diarrhoea and improved the levels of haemoglobin and serum proteins among the recipients.

UN ACC/SCN(1996) had opined that nutritional status, especially of children, is crucial for health and survival in the short run-through the interaction of nutrition and infection-and in the long term, affecting individual human capital and hence the well being of society. Good nutrition can be part of self-reinforcing cycles leading to more rapid development.

Thus an attempt is made in the present study to test the feasibility of utilizing supplementary food mixed developed by Kerala Agricultural University as a supplement under ICDS, the methodology of which is detailed in the next chapter.

MATERIALS AND METHODS

MATERIALS AND METHODS

The study under focus was undertaken to test the feasibility of using supplementary food mixes developed by KAU as supplements under Integrated Child Development Services (ICDS)

The plan of the study

3.1 Selection of the area of study

3.2 Selection of the subjects.

3.3 Suitability of the supplements.

3.3.1 Selection of the supplements.

3.3.1.1 Local availability of raw ingredients

3.3.1.2 Cost

3.3.1.3 Nutritive adequacy

3.3.1.4 Ease of preparation

3.3.1.5 Shelf life of the Supplements.

3.4 Bulk production of the supplements.

3.5 Feeding trial

3.5.1 Selection of a recipe

3.5.2 Organoleptic evaluation and overall acceptability.

3.5.3 Effects of feeding trial

3.6 Statistical analysis of the data

3.1. Selection of the area of the study:

Six Anganwadi Centres of the Kalliyoor Panchayat of the Nemom ICDS block were selected with the help of ICDS officials for the conduct of the study after obtaining official sanction from Director of social welfare. Access to the centres from the institution from where the study was conducted, and the co-operation of the anganwadi workers were the criteria for selection of the centres.

3.2 Selection of subjects

All preschool children from the selected five Anganwadi Centres were coopted for the study as experimental subjects. Thus there were 123 subjects in the experimental group as shown in Table 1.

Table 1. Distribution of children in the selected Anganwadi Centres.

	Serial number of the Anganwadi Centres	Number of children
Experimental group		
	90	26
	92	21
	94	28
	96	28
	97	20
	Total	123
Control group	91	21
	Grand Total	**144**

Since the study envisages to measure the impact of food mixes given as supplement, which is expected to influence the nutritional status of the beneficiaries of the Anganwadi Centres, a design for measuring the impact was scheduled. WHO (1983) has stated that any study designed to measure such an impact should have a control group from a population, living under identical conditions but not receiving supplementary food; a comparison of changes in the programme population with those in control group would indicate whether an observed improvement in nutritional status is a result of the programme or due to changes unrelated to the programme. Hence all preschool children from a nearby Anganwadi Centre (AWC. 91) were selected as control subjects for comparison.

3.3 Suitability of supplements

Five different weaning foods developed by the Department of HomeScience, Kerala Agricultural University were selected for the study to be used as supplements under ICDS. The five supplements selected were rice based mix, ragi based mix, rice soya based mix, cassava based mix and banana based mix as shown in Table 2. These supplements were produced in bulk. Each of the supplementary food mixes were apportioned to supply about 300 calories and 10-12 g of protein. The five supplements were fed to children from five selected anganwadies so that each anganwadi would get one particular supplement. The supplement was fed to the children for five months in the form of a recipe. The effect of the supplement on the nutritional status of the beneficiaries were monitored over a period of five months.

The nutritional status of subjects of the control group were assessed without feeding the KAU developed supplements but they were receiving the existing supplement (rice with greengram in the form of kanjee) given in the Anganwadi Centres.

3.3.1 Selection of the supplements

Five different supplementary/ weaning foods developed by KAU through detailed chemical and biological experiments,were selected as supplements for the study as shown in Table 2 and the detailed composition of the supplementsis presented I.

Table 2 Details of food mixes developed by KAU

Supplements	References	Ingredients
1. Banana based supplement	Prasad 1988	Banana, Horsegram, Sesame,Skim milk powder
2. Ragi based supplement	Philip 1987	Ragi, Green gram, Sesame, Tapioca, Skim milk powder
3. Cassava based supplement	Chellammal 1995	Cassava,Defatted Soya, Skim milk powder
4. Rice based supplement	Sailakshmi 1995	Parboiled Rice, Defatted soya, Groundnut,
5. Rice soya based supplement	Jacob 1996	Raw Rice, Defatted Soya, Amaranth leaves, Skimmilk powder

Various steps involved in the assessment of the suitability of the mixes are detailed below.

3.3.1.1 Local availability of raw ingredients.

The ingredients which are to be used as the supplementary foods should be locally available and also familiar to the mother. The local availability and familiarity of each of the supplements were assessed by scoring.

3.3.1.2 Cost

Cost of the supplements for 1kg mix and per capita cost of feeding were computed according to the existing market price for each ingredient used in the preparation of the respective supplement. Actual cost of one kilogram of the mix and also the amount needed to serve one portion and the cost of one kg of the mix after adding 20 percentage overhead charges were worked out to estimate the sale cost of the different supplements.

3.3.1.3 Nutritive adequacy

The five supplements were compared with the components in a food square to find whether these foods can function as effective supplements. Data already available on NPU was also used to evaluate the protein quality and growth promoting efficiency of the supplements. The nutritive value of the different supplements were also worked out using the food composition tables given in Nutritive value of Indian Foods. (Gopalan *et.al.*,1996).

3.3.1.4 Ease of preparation

Any supplement should be easy to prepare and should take only minimum time for cooking and also it should have simple technology for processing. The complexities involved in processing and the time taken for processing and preparation were hence assessed taking it as a measure that decides the ease of preparation

3.3.1.5 Shelf life of supplements

Since the supplementary foods are designed to be a ready to cook formula requiring minimum time for preparation and it has to be processed and stored before feeding, it is necessary to test the shelf life of the supplements. It has been suggested by Gahlawat and Sehgal (1994) that such foods should have a shelf life of six months. Hence the shelf life of the five supplements were ascertained by quality attributes like change in odour, colour, texture, and appearance by periodical physical examination for nine months. The products were also examined for insect infestation which were recorded at monthly intervals and the mean count was calcualted.

3.3.1.5.1 Microbial Evaluation

The food samples stored were assessed for their total bacterial count at the end of six months as per standard procedure suggested by Association of Agricultural Chemists (AOAC) (1976). The population of bacteria in the stored supplement was ascertained following the serial dilution plate technique recommended by Mehrotra, (1980).

The supplements were also assessed for the presence of E.coli using the presumptive test used for testing of coliforms as explained by Collins and Patricia (1976). The total microbial count as well as the coliform count were done to assess the sanitary quality as well as the shelf stability of the supplements.

3.4 Bulk production of supplements

Each of the five mixes were prepared in bulk following the procedures standardised by the designers of the supplements (Prasad, (1988) Philip (1987), Chellammal (1995) Sailakshmi (1995) and Jacob (1996).

One of the primary criterion for any food item to be used as a supplement under ICDS is that it should provide about 300 kcal of energy and 10-12g of protein (DISHA, 1989). Therefore each of the five food mixes to be given to the subjects daily were apportioned to supply 300 kcal and 10g of protein per serving. The quantity of the mixes (raw) needed to serve one portion which would supply 300 kcal and 10g protein are given in Table 3.

Table 3 Quantity per serving of the five supplements

Anganwadi centres	Supplements	Quantity per serving Raw weight
94	Banana based food mix	90g
92	Ragi based food mix	90g
97	Rice soya based mix	90g
90	Rice based food mix	100g
96	Cassava based mix	75g

Based on this each of the supplements were processed in bulk once in a month. The quantity of supplement required to feed all children in one anganwadi for a month was worked out using the following formula.

X = WxCxD where

X = the total amount needed for a month

W = Quantity of supplement needed to feed one child

C = No. of children

D = No. of days of feeding in a month

The five supplements were processed separately in the institution and were packed in polyethylene bags and stored in large stainless steel containers with air tight lids. The food mixes for each anganawadi for a period of one week were taken from the institution to the respective Anganwadi Centres in polyethylene bags where it was stored in closed metalic containers.

3.4.1 Processing Loss and Yield ratio

A product after processing and after preparation should have maximum yield and minimum processing loss. Therefore the processing loss and yield ratio were calculated using the formulae as detailed below.

$$\text{Processing Loss} = \frac{\text{AP wt - EP wt}}{\text{AP wt}}$$

Where

AP wt is weight of the ingredients "As Purchased"

EP wt is Weight of the "Edible portion" of the ingredients

$$\text{Yield Ratio} = \frac{\text{Cooked weight}}{\text{Raw weight}}$$

3.5 Feeding trial

3.5.1 Selection of a recipe

In order to conduct the feeding trial, so as to find out the 'suitability of the five different mixes as supplements under ICDS, the raw supplements (mixes) were to be converted into recipes. The criteria considered for selection of the recipes were familiarity; ease of preparation in bulk; time and fuel required for preparation and easiness of apportioning and serving. Two recipes namely puttu and balls were selected purposively. The method of preparation suggested by Mathew (1997) was adopted to prepare balls and puttu using the five different supplements. More over variation in the preparation of balls was introduced by varying the quantity of jaggery used and by varying the method of preparation. Variation was introduced in puttu, by varying the taste by adding either salt or jaggery and varying the quantity of jaggery used The preparations were evaluated for their acceptability, and the recipe that was most acceptable was selected for the feeding trial.

3.5.2 Organoleptic evaluation and overall acceptability

Beyond satisfying the nutritional needs the foods chosen by people and the quantity consumed depends upon its acceptability. Thirumaran (1993) opines that product development and acceptance by the people depend on the overall acceptability Organoleptic evaluation is considered as one of the methods of evaluating the acceptability of the newly developed products. Hence the two recipes made with each of the supplements were subjected to sensory evaluation by a panel of twenty judges. Scoring test was used for quality evaluation as suggested by Swaminathan (1975). The score card used is presented in Appendix II. Out of the two recipes (balls and puttu) the one which got the highest score was used for the feeding trial. The balls and puttu made with the five supplements were also field tested among 560 mothers of the local area, and they were asked to select one recipe based on their preference. The recipe which secured the highest preferential rating was finally selected for the feeding trial. The scores obtained were also used to compare to acceptability of all five different supplements.

3.5.3 Effects of Feeding trial

The efficiency of the supplements for nutritional intervention among preschool children was tested by conducting a feeding trial.

The feeding trial was conducted in five different Anganwadi Centres for a period of five months. One each of the selected five supplements were fed to the experimental group of preschool children. The supplement was prepared in the anganwadi itself in the form of a recipe (puttu) just before feeding. The recipe was served to the children at 3 pm each day on all working days.

A group of children from a near by anganwadi selected from the same locality functioned as control. These children were receiving the regular supplement of ICDS viz (cooked rice and greengram)

3.5.3.1 Recording of Attendance

The attendance of the beneficiaries who consumed the five supplements were recorded every day. Children who were irregular were eliminated while evaluating the impact of feeding trial.

3.5.3.2 Quantity of food supplements consumed and plate waste

To know the quantity of the supplement consumed, the children of the experimental group were closely observed everyday. The quantity served and the left over food if any, was weighed and recorded and the actual quantity of the supplement consumed by each child was calculated and recorded daily over a period of five months.

3.5.3.3 Clinical evaluation

According to Swaminathan (1985) clinical examination is the most essential part of all nutritional surveys as it gives direct information on the signs and symptoms of dietary deficiencies prevalent among children. The various clinical deficiency signs were recorded using a structured schedule suggested by the ICMR with the help of a qualified physician before the feeding trial and also after five months of feeding. Clinical examination was done for both the experimental as well as control subjects. Scoring was done by giving a score for each of the symptoms and then the total scores and average percentage scores were worked out.

3.5.3.4 Recording of morbidity

During the feeding trial the beneficiaries were closely observed and enquiries were made with respect to the presence of any health disorder. Special care was taken to find out the cause of absence of the child for the feeding, (when any child failed to attend the anganwadi;) and the details of type of health disorder suffered, if any, duration of illness etc. were found out and recorded as and when necessary.

3.5.3.5 Recording of anthropometric measurements

Anthropometry has been accepted as an important tool for the assessment of nutritional status. It has been recognised as a reliable tool in identification of nutritionally vulnerable groups, monitoring changes and the extent of malnutrition, selection of beneficiaries for intervention programmes and evaluating the impact of interventions (Rao and Vijaya Raghavan, 1996). Hence in this study the height, weight, arm circumference, chest circumference and head circumference of all the subjects were measured (both of the experimental as well as the control group) every month and also before starting the feeding trial and at the termination of the feeding trial following the procedures suggested by Jelliffe (1966). The values were then compared with NCHS standards.

Using the anthropometric data the following indices were also worked out.

Chest/Head circumference ratio:

The Chest/Head circumference was calculated using formula.

$$\text{Chest/Head Circumference ratio} = \frac{\text{Chest circumference (cm)}}{\text{Head Circumference (cm)}}$$

Body Mass Index

The BMI of the subjects were calculated using the Quetlet's index which is independent of age in preschool children (Rao and Vijaya Raghavan, 1996) using the formula,

$$\text{BMI} = \frac{\text{Weight (Kg)}}{\text{Height}^2\text{(Cm)}}$$

3.6. Statistical Analysis

The data collected were processed and analysed using Anova, Chisquare and Kruskal - Walis one-way analysis methods to find out the most suitable supplement to feed the preschool children under 1CDS in the selected area of study.

The data pertaining to beneficiaries who were irregular were eliminated, while analysing the data.

RESULTS

RESULTS

The results of the investigation entitled "Suitability of food mixes developed by KAU as food supplement under ICDS" are presented and discussed in this chapter, under three main heads namely, (1) Selection of Beneficiaries (2) Suitability of supplements and (3) Effects of feeding trial and these are discussed under the following heads.

4.1. Selection of beneficiaries

4.2. Suitability of supplements

4.2.1 Selection of the supplements

4.2.1.1 Local availability and familiarity of raw ingredients

4.2.1.2 Cost

4.2.1.3 Nutritive adequacy

4.2.1.4 Ease of preparation

4.2.1.5 Shelf life of the supplements

4.2.2 Bulk production of supplements

4.2.2.1 Yield of the mixes

4.2.2.1.1 Processing loss

4.2.2.1.2 Yield Ratio

4.3 Feeding Trial

4.3.1 Selection of a receipe

4.3.2 Organoleptic evaluation and overall acceptability

4.3.3 Effects of feeding trial

4.1 Selection of beneficiaries

All the preschool children from the selected five anganwadi centres were coopted for the study as experimental subjects and all the children from a nearby anganwadi centre were selected as control subjects for comparison.

4.2. Suitability of Supplements

Devadas (1983) has stated that development of complementary food should be governed by six major principles namely local availability of ingredients, low cost, high nutritive value, good supplementary value (ie high energy value and NPU of 60 to 65), ease of preparation and shelf life of 4-6 months. Based on this recommendation suitability of the selected food mixes were evaluated and the results are detailed below.

4.2.1. Selection of supplements

4.2.1.1. Availability of raw ingredients

Devadas (1983) had opined that the ingredients of the supplementary foods should be available from local area so that the product will be familiar to people. The nature of the raw ingredients used in the five supplements are given in Table 4.

Table 4 Scores for availability and familiarity of ingredients used in different supplements

Supplements	Ingredients	Availability				Familiarity				
		Easily Available	Moderately Available	Not Available	Total Score	Very Familiar	Moderately Familiar	Not Familiar	Total Score	Grand Total score
Banana based										
	Banana	2	-	-	2	2	-	-	2	
	Horsegram	2	-	-	2	-	1	-	1	13
	Sesame	2	-	-	2	2	-	-	2	(24)
	Skimmed Milk	-	1	-	1	-	1	-	1	
					7				**6**	
Ragi based										
	Ragi	2	-	-	2	2	-	-	2	
	Greengram	2	-	-	2	2	-	-	2	
	Sesame	2	-	-	2	-	1	-	1	17
	Cassava	2	-	-	2	2	-	-	2	
	Skimmed Milk	-	1	-	1	-	1	-	1	(30)
					9				**8**	
Rice Soya based	Raw Rice	2	-	-	2	2	-	-	2	
	Amaranth	2	-	-	2	2	-	-	2	12
	Soya flour	-	1	-	1	-	1	-	1	(24)
	Skimmed Milk	-	1	-	1	-	1	-	1	
					6				**6**	
Rice based	Rice	2	-	-	2	2	-	-	2	
	Ground Nut	2	-	-	2	2	-	-	2	10
	Soya flour	-	1	-	1	-	1	-	1	(18)
					5				**5**	
Cassava based	Cassava	2	-	-	2	2	-	-	2	
	Soya flour	-	1	-	1	-	1	-	1	8
	Skimmed Milk	-	1	-	1	-	1	-	1	(18)
					4				**4**	

Figures in parenthesis denotes maximum score

Availability and familiarity of ingredients used in different supplements were scored to find out which of the supplements in terms of its ingredients were readily and locally available and also is familiar to the people of Kerala. The availability of the ingredients of each of the supplements were scored on a 3- point continuum as easily available, moderately available and not available (with scores of 2,1, and 0) and familiarity of the ingredients were scored as very familiar, moderately familiar and not familiar and given scores of 2,1, and 0. The total scores obtained for each of the supplements based on their availability and familiarity are presented in Table 4.

The data presented in Table 4 revealed that the ingredients of ragi based supplement had the highest score (9) in terms of availability followed by banana based (7) rice soya based (6) rice based (5) and cassava based supplements (4) in the descending order The ingredients in ragi based supplement was also found to have the highest score of 8 with regard to familiarity, followed by rice soya based (6), banana based (6), rice based (5) and cassava based (4) supplement in the descending order.

When the availability and familiarity of the ingredients were scored together it was found that highest score was obtained for ragi based supplement (17) followed by, banana based (13), rice soya based (12), rice based supplement (10) and the lowest score was recorded against cassava based supplement (8).

Thus based on the scores obtained for availability and familiarity of ingredients used in the supplements ragi based supplement can be used as an effective supplement under ICDS, though banana based and rice based, can be used since they also have higher scores compared to other supplements.

4.2.1.2 Cost

The cost of one kilogram of the different supplements inclusive of 20% overhead charges (comprising the cost of fuel, labour, transportation etc) were computed to ascertain the cost of the supplementary mixes and are presented in Table 5.

Table - 5 Unit cost of the supplements (Rupees per kilogram and percapita cost)

Supplement	Cost of raw material		Over Head Charges	Total cost	
	Percapita Cost	For 1Kg mix.		Percapita /day Rs.	For 1 Kg mix Rs.
1) Banana based	5.65	62. 82	20%	6.75	75.00
2) Ragi based	3.06	34.75	20%	3.78	42.00
3) Rice soya, based	2.52	28.20	20%	3.06	34.00
4) Rice based	1.72	17.17	20%	2.00	20.00
5) Cassava based	2.79	37.20	20%	3.40	45.00

The data presented in Table 5 revealed that rice based mix is the cheapest (Rs. 20/Kg) followed by rice soya based mix (Rs. 34.00/Kg) ragi based mix (Rs. 42.00/Kg) and cassava based mix (Rs. 45/Kg) The banana based mix was found to be the costliest, (Rs. 75/Kg)But when compared to a commercial supplementary foods these are found to be very cheap. Therefore from the point of view of cost, rice based supplement food will be the cheapest and it can be adopted for supplementation under ICDS.

The data depicted in Table 5 also revealed that percapita cost (cost of feeding one child per day) of feeding, rice based mix was found to be the cheapest (Rs. 2.00) followed by rice, soya based mix (Rs. 3.06), cassava based (Rs. 3.40), ragi based (Rs. 3.78) and banana based mix (Rs. 6.75). Thus it can be noted that rice based supplement was the cheapest when compared to other four mixes in term of percapita cost of feeding.

4.2.1.3. Nutritional Adequacy

The Nutritional adequacy of the supplements were analysed based on

1. Presence of components specified under 'Food Square' in the development of multimix.
2. Nutritive value of the mix
3. Protein quality (NPU)

4.2.1.3.1 Presence of Components specified under 'Food Square' in the multimix

Mitzner *et.al.* (1984) had stated that recipes containing more than two items which are suitable for the weaning period and for later months are called "multimix"

To formulate a multimix, four components are essentially needed viz: a basic staple, an energy rich supplement, a protein supplement and a mineral and vitamin supplement which has been illustrated by a "Food Square".

The five supplements developed by KAU were fitted into the "food square" to find out whether these foods can function as effective supplements, being 'multimixes' as shown in Table 6.

Table-6 Composition of supplements based on 'food square' concept

Supplements	A Staple	B Protein Supplement	C Vitamin and Mineral Supplement	D Energy Supplement
1. Banana based Mix	Banana	Horsegram Skim Milk Powder	Sesame Skim Milk Powder	Sesame Jaggery
2. Ragi based Mix	Ragi Tapioca	Greengram Skim Milk	Ragi, Greengram Skim Milk Powder	Sesame Jaggery
3. Rice soya based Mix	Rice	Soya flour Skim Milk Powder	Amaranth Skim Milk Powder	Jaggery
4. Rice based Mix	Rice	Soya flour Groundnut	- -	Jaggery
5. Cassava based Mix	Cassava	Soya flour Skim Milk Powder		Jaggery

As can be observed from Table 6, in banana based mix horsegram and skim milk powder supplies necessary protein. In the ragi based mix there are two staples which are ragi and cassava. The rice, soya based mix has all the components that can be fitted into the food square so that it can function as an effective multimix, where rice is the staple, soya flour and skim milk are the protein supplements, amaranth and skim milk are the vitamin and mineral supplements and jaggery is the energy supplement. Cassava based mix and rice based mix do not have a specific vitamin and mineral supplement.

The above analysis revealed the fact that as an effective multimix, rice soya mix is the most acceptable one. The banana, as well as ragi based supplements are also adequate when viewed in the light of nutritional adequacy based on their composition, while cassava and rice based mixes, lack specific vitamin and mineral components. Hence the former three mixes can be proclaimed as more suitable than the latter two mixes to be used as supplements under ICDS.

4.2.1.3.2 Nutritive Value

The Nutritive value viz., energy, protein, fat, calcium, iron and carotene content of the five supplements were worked out and the details are presented in Table 7.

Table 7 Nutritive Value of the different supplements

Supplements	Nutrients/100g					
	Energy (Kcal)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Carotene (mcg)
1.Banana based	300	18.6	10.3	522	3.4	41.2
2. Ragi based	320	20.4	7.2	578	5.3	40.4
3.Rice Soya based	358	16.94	3.3	403	4.2	381.2
4. Rice based	369	11.20	2.5	322	1.9	42.6
5. Cassava based	403	18.2	5.2	344	4.5	456

As shown in Table 7the cassava based mix has the highest energy value of 403 followed by rice based mix, rice, soya based mix (358); ragi based mix (320); and banana based mix (300) in the descending order of energy density. As far as the protein content is concerned ragi based mix had the highest protein level of 20.40 g and rice based mix had the lowest value of 11.20g.

While comparing the level of fat, banana based mix had the highest fat (10.3 g) content while rice based mix had the lowest value of 2.5 g. per 100 of the mixture.

A comparison between the mixes for the levels of calcium showed that ragi based mix had the highest calcium level of 578 mg and rice based mix with 322 mg was found to be the lowest.

Ragi based mix was found to have the highest iron content of 5.3 mg and rice based mix had the lowest value of 1.9 mg.

While comparing the carotene content of the supplementary mixes rice soya based mix had the highest level of 381.2 microgram and the lowest value was found in ragi based mix with 40.4 microgram

4.2.1.3.3 Supplementary Value

ICDS and similar intervention programmes stipulates that the supplement should be capable of giving atleast 300 kcal of energy and 10-12 gm of protein. When viewed with this background all the five mixes can be utlilised as supplement for children under ICDS. However ragi based mix has an added advantage that it supplies iron and calcium also.

According to Devadas (1983) while developing a complementary food it should have high nutritive value and good supplementary value (ie high energy value and a NPU of 60 to 65). The energy value of the five supplements given in Table 7 showed that and all the supplements are found to be good sources of energy since the values ranged from 300 to 403 Kcals. As far as the protein content is concerned except rice based supplement all had a protein content above 16g but below 20g/100gm.

As the protein content of the mixes were found to be adequate (more than 10g) the quality in terms of NPU as reported by the designers of the supplements were also taken into consideration and it was found that rice based mix had the lowest NPU of 67 followed by rice soya based (71), cassava based (78) banana based (79) and ragi based (83) mixes in the ascending order.

It may be noted that all the mixes were discovered to have an NPU above 65, which is the recommended level of protein quality parameter for supplementary food for children in general. Hence all the supplements are found to be adequate from the nutritional point of view.

4.2.1.4 Ease of preparation

If the supplement is to be advocated for large scale feeding , it becomes essential that the food should involve simple technology and should be less time and energy consuming.

Ease of preparation was assessed through

(a) Simplicity and familiarity of technology used

(b) the time taken for processing

(c) ease of convertion of processed mix into a recipe.

4.2.1.4.1 Simplicity of technology used

Table 8 shows the techniques involved in the processing of the different mixes which indicates the simplicity or the intricacies involved in the processing of the raw ingredients into a multimix which is ready to use.

Table 8. Steps involved in the processing of the supplements

Supplements	Steps (Processess) involved									
	Peeling/ (Skin) plucking (leaves)	Soaking	Germi-nating	Cutting/ Slicing	Washing/ (Cleaning)	Drying	Powdering	Roasting	Seiving	Total No. of steps
Banana based										
Banana	✓	✓	✓	-	✓	✓	✓	✓	✓	7
Horse gram	-	✓	✓	-	✓	✓	✓	✓	✓	7
Sesame	-	-	-	-	✓	✓	✓	-	-	3
Skimmilk powder	-	-	-		-	-	-	-	-	0
							Total Number of Steps			**17**
Ragi based										
Ragi	-	✓	✓	-	✓	✓	✓	✓	✓	7
Green gram	-	✓	✓	-	✓	✓	✓	✓	✓	7
Cassava	✓	-	-	✓	✓	✓	✓	✓	✓	7
Sesame	-	-	-	-	✓	✓	✓	-	0	3
Skimmilk Powder	-	-	-	-	-	-	-	-	-	
							Total Number of steps			**24**
Rice Soya based										
Rice	-	-	-	-	✓	✓	✓	✓	✓	5
Soya flour	-	-	-	-	-	-	-	✓	✓	2
Amaranth	✓	-	-	-	✓	✓	✓	✓	✓	6
Skim milk Powder	-	-	-	-	-	-	-	-	0	
							Total Number of Steps			**13**
Rice based										
Rice	-	-	-	-	✓	✓	✓	✓	✓	5
Ground nut	-	-	-	-	-	✓	✓	✓	-	3
Soya flour	-	-	-	-	-	-	-	✓	✓	2
							Total Number of Steps			**10**
Cassava based										
Cassava	✓	-	-	✓	✓	✓	✓	✓	✓	7
Soya flour	-	-	-	-	-	-	-	✓	✓	2
Skim milk powder	-	-	-	-	-	-	-	-	0	
							Total Number of Steps			**9**

LEGEND:
✓ processing steps involved
- processing steps not involved

As shown in Table 8 out of the five supplements ragi based mix required elaborate processing where there are 21 steps involved like germination and malting which also takes time and much care. This is followed by banana based mix which has 15 steps involved like germinating and malting and also peeling of banana skin and cutting them into slices which takes time. In the case of rice soya based mix there were 10 steps involved, which are simple, but the separating of amaranth leaves and drying them takes time. Rice based mix has only 8 steps in processing which involves simple technologies like roasting and powdering. Preparation of cassava mix involves nine simple steps.

Hence based on the steps involved in processing and the complexity of the process of preparing the supplement, rice based mix and cassava based mix were found to be simple when compared to other three supplements. In case of cassava based mix if raw cassava was used instead of drychips, the process may become more complex. This then would negatively influence the ease of preparation. Hence rice based supplement is found to be the easiest to process when compared to other supplments.

In the processing of five different mixes technologies such as germination, malting, sundrying, roasting and seiving are involved. All these processes (technologies) are familiar to the rural mothers of Kerala and hence can be used by them to prepare supplementary foods in their own households.

4.2.1.4.2. Time taken for proccessing

The time needed to process each of the supplements (10 Kg) were assessed and it was observed that rice based mix required minimum time (14 hours) while banana and ragi based mixes took maximum time (90 hours) and rice soya based and cassava based mix took 50 hours for processing its ingredients. On the basis of processing time, rice based mix is the easiest one to prepare compared to other mixes .

4.2.1.4.3 Ease of convertion of processed mix into a recipe.

The time taken for converting the multimix into a recipe ie puttu/balls is another factor which decides the ease of preparation. The time taken for this convertion for different mixes are given in Table 9 and Table 10.

Table 9 Time required for preparation of puttu from different multimixes

Supplements (100 g)	Mixing by sprinkling water (without lumps) (min)	Cooking time (min)	Mixing with jaggery (min)	Total time (min)	Rounded to (min)
Banana based	2.59	6.18	2.12	10.89	11.0
Ragi based	3.14	5.52	1.53	10.19	10.0
Rice Soya based	2.49	5.47	2.04	10.00	10.0
Rice based	2.32	5.03	1.28	8.63	9.0
Cassava based	2.56	5.58	1.49	9.63	10.0

As shown in Table 9 banana based supplement took the maximum time to make 100g of puttu which was 11 min.and rice based supplement took the minimum time of 9 min.

Table 10. Time required for the preparation of balls from different multi mixes

Supplement (100 g)	Scraping Jaggery (min)	Mixing the Supplement with jaggery (min)	Rolling into balls (min)	Steaming (min)	Total time (min)	Rounded to (min)
Banana based	0.59	1.38	1.57	4.12	7.66	8.0
Ragi based	0.58	1.26	1.59	3.53	6.96	7.0
Rice Soya based	0.58	1.44	1.46	4.16	7.64	8.0
Rice based	0.56	1.19	1.52	3.32	6.59	7.0
Cassava based	0.57	1.22	1.51	3.59	6.89	7.0

For making balls, ragi based, cassava based, rice based supplements required only 7 minutes. The rice soya based and banana based supplements took the maximum time of 8 min. This in general indicates that the time required varies with in a small range of 7 to 8 minutes as shown in Table 10.

In the case of the five supplements under focus the method adopted for processing is simple and the preparation time would not exceed 8 minutes. Hence it can be concluded that the time taken for the preparation of recipes from the five supplements is acceptable as per the recommendations of ICMR (1970). While comparing puttu and balls, ball takes lesser time (7 to 8 minutes) than puttu (9to 11).

While looking into the time taken for processing the mix and then converting it into a recipe (for each supplement) the rice based supplement was found to take minimum time. This shows that rice based supplement is the easiest to prepare with respect to time as well as the technique involved.

4.2.1.4.5. Shelf life of the mixes

The storage stability of the supplements were assessed by;

1. Physical Examination
2. Count of storage pest
3. Total microbial count
4. E.Coli Count

4.2.1.4.5.1 Physical Examination

In the process of ascertaining the shelf life, the multimixes packed in polyethylene covers were kept in air tight containers for a period of nine months. They were subjected to physical examination at the end of each month.

It was observed that there was absence of visible signs of spoilage till the sixth month for all the five supplements pertaining to the various quality attributes like odour, colour, taste, texture, and apperance. Out of the five supplements changes in odour, texture and appearance were observed in all the five supplements from the seventh month onwards except for cassava based supplement where the change was seen only from the ninenth month. Rice based supplement had a colour change from the seventh month onwards where as banana based mix should a change from eighth month and the other three mixes had a change in colour from ninth month. Hence based on the quality attributes cassava based mix exihibited minimum changes during the storage period. This also indicates that all the mixes can be stored for a period of six months without alteration in physical quality attributes.

4.2.1.4.5.2Count of Storage pests

The supplements were also examined for the presence of storage pests, which will affect the quality of the product. Visual examination showed that all the mixes were free from insect attack upto the sixth month. From the seventh month of storage there was pest attack in the mix. The storage pest namely *Tribolium castaneum* was the only pest found in all the mixes. The mean value for insect count from 7-9 months and mean total microbial count are shown in Table 11.

Table 11. Mean insect count and total microbial count of different multi mixes

Supplements	Mean Count / 100 g	Mean total bacterial count /gm
1. Banana based Mix	53.6	30,000
2. Ragi based Mix	30.3	30,000
3. Rice Soya based Mix	39.2	30,000
4. Rice based mix	58.0	10,000
5. Cassava based mix	28.6	20,000

The data presented in table 11 reveals that cassava based mix had the lowest insect count (28.6) followed by ragi based mix (30.3). Rice based mix was found to have the highest count of 58.0 per 100g of the sample.

Processed foods which are stored and consumed after a period are to satisfy certain microbiological standards to ensure their quality and safety. Hence the total bacterial count of the five supplements were assessed and the mean values are given in Table 11 which indicated that the total bacterial count after sixth months of storage varied from 10,000 - 30,000/g. The rice based supplement had the lowest count of 10,000 / g while banana based, ragi based and rice soya based mixes had a count of 30,000/g. Data reveals that all the five mixes could be stored for a period of six months. Though the mixes showed a bacterial count of 10,000 - 30,000/ g after a period of six months, these values are within the limit specified as per ISI Standards. (IS:1656-1969) ie 50,000/g.

4.2.1.4.5.4 E.Coli Count

The supplements were also assessed for the presence of E.Coli using the presumptive test and E.coli was found to be absent in all the five supplements. This indicated that the items have been prepared in a hygienic manner and can be given to children safely.

4.2.2. Bulk production of the supplements

The quantity of supplement needed per child and the amount of food needed in each anganwadi for a period of one month for feeding was calculated and the data is presented in Table 12.

Table 12 Quantity of food needed in each anganwadi for a period of one month

Anganwadi Centre No.	Supplementary food given	No of Working days (March 1998)	Total No. of Children in each Anganwadi	Quantity/ Child	Total amount of Supplements needed for one month
94	Banana based	22	28	90g	55.0 kg
92	Ragi based	22	21	90g	41.6 kg
97	Rice soya based	22	20	90g	40.0 kg
90	Rice based	22	26	100g	57.2 kg
96	Cassava based	22	28	75g	46.0 kg

4.2.2.1. Yield of the multimixes

The yield of the supplements both after processing and after preparation is a major factor that determines the cost of the mixes and also the suitability of the mix for mass feeding. The ingredients of a product should give maximum yield both after processing and after preparation if the cost has to be kept low. In other words the weight loss during the processing should be minimum inorder to facilitate maximum out put or yield. The higher the yield more is the returns for the amount spent. Hence supplement should have minimum processing loss and high yield.

Keeping this in view the processing loss and the yield ratio of the multimixes during processing and cooking were worked out.

4.2.2.1.1 Processing Loss

The processing loss of the different supplements were assessed using the formula (APwt -EPwt)/(APwt) ; and are given in Table 13. This was assessed by calculating the total amount needed for preparing 1 kg of multi mix.

Table13 Processing Loss (For 1 kg)

Supplements	APWeight	EPWeight	Processing Loss
Banana based	2.420	1Kg	0.58
Ragi based	1.424	1Kg	0.29
Rice soya based	2.857	1Kg	0.65
Rice based	1.1625	1 Kg	0.14
Cassava based	1.150	1 Kg	0.13

As indicated in the Table13, the processing loss of rice soya based mix was found to be the highest (0.65) when compared to the remaining four mixes. The low yield of amaranth powder during processing accounts for the major share of processing loss in rice soya based mix.

The processing loss of banana based mix (0.58) was found to be the next highest in comparison with the other mixes. In this case the low yield of banana powder during processing accounts for the major share of processing loss. The processing loss of ragi based mix was found to be 0.29.

The processing loss of cassava based mix is found to be the lowest (0.13). This is because majority of the cassava powder used for the feeding trial was made from dried chips. Hence the loss was low. But when cassava flour was prepared from fresh tuber the yield was found to be very low. There was also no processing loss for skim milk powder and soya flour which are the other components of this mix.

The processing loss of rice based mix was found to be comparatively low. During processing, rice, groundnut and soya flour suffered minimum loss.

The above mentioned factors account for the processing loss in the five mixes and the mix made from cassava had the lowest processing loss of 0.13 hence, has the highest yield followed by rice based mix (0.14).Rice soya based mix with a value of 0.65 was found to have the highest loss. This indicated that with respect to yield, rice based mix is most suitable for large scale feeding; though cassava based mix has the lowest processing loss here it is mostly due to the use of powdered dried chips in the place of raw cassava tuber.

4.2.2.1.2 Yield Ratio (Recipe)

The yield ratio of the five different supplements while converting the multi mix into a recipe were worked out. The yield ratio will influence the time needed for the preparation of the recipe in bulk. The yield of one portion (Serving) of the food mixes (as puttu) were assessed and the ratio is given in Table 14.

Table 14 Yield ratio for one portion of the recipe

Supplements	Wt before Cooking (g)	Cooked weight (g)	Yield Ratio
1. Banana based	90	160	1.77
2. Ragi based	90	162	1.80
3. Rice Soya based	90	167	1.85
4. Rice based	100	185	1.85
5. Cassava based	75	146	1.94

As indicated in Table 14 the highest yield ratio was found for cassava mix (1.94) followed by rice, soya based mix and rice based mix (1.85), ragi based mix (1.80) and banana based mix (1.77) in the descending order.

This incidates that maximum cooked product can be obtained from cassava mix and the product yield will be minimum when banana based mix is used.

4.3 FEEDING TRIAL

4.3.1 Selection of a recipe

After examining the suitability of the mixes for using them as a supplement under ICDS based on on their availability, cost, nuritional adequacy, ease of preparation, shelf life and yield, attempts were made to test the acceptability of the products. As the food mixes are in the form of powders/ flours and as they are meant to be consumed by the preschool children attending the local anganwadi centres, the next step in the study was to develop suitable and acceptable recipes with the five different mixes and to select one recipe for the feeding trial.

Based on the general food consumption ability of preschool children and ease of bulk preparation, serving and apportioning, two familiar and simple basic recipes were selected purposively for the feeding trial. The basic recipes selected were puttu and balls. Puttu and balls were prepared with the five different KAU mixes. Inorder to prepare most acceptable recipes with the different mixes variations in the basic recipe were made by varying the taste and the method of preparation. The taste was varied by adding jaggery in different quantites for balls as well as for puttu. For balls variation in method of preparation was also introduced as explained in chapter 3.

4.3.1.1 Overall mean acceptability scores for puttu and balls given by experts

The preparation of the above recipes and their variations were initially standardised in the laboratory by the investigator. The standard recipes made with the five different mixes were presented before a panel of twenty experts and they were asked to score the preparation with the help of a score card (Appendix II). The maximum score a recipe could get was 25 and the minimum was 5. The scores assigned by each expert for each recipe was pooled to arrive at the overall score. From the overall score assigned by the 20 experts for each recipe the mean overall acceptability score was worked out.

The overall mean acceptability score for balls [6 variations viz 3 varying the taste by addition of jaggery 25/30/35g respectively (3 variations) and (2) by varying the method of cooking by (steaming or not steaming) (2 variation) - Total =3 x 2 = 6] and puttu [4 variations viz. varying the taste by adding salt or jaggery (varying quantities of jaggery -25g, 30g and 35g) Total - 1+3 = 4] made from five different KAU mixes are presented in Table 15

Table 15 Overall mean acceptability scores for puttu and balls

Supplements	Puttu*				Balls**					
	1	2	3	4	1		2		3	
					a	b	a	b	a	b
Banana based	16	18	17	17	15	16	15	14	13	12
Ragi based	14	16	15	13	14	15	13	13	13	12
Rice soya based	17	19	16	15	18	17	15	15	14	14
Rice based	21	24	23	22	22	22	18	19	20	21
Cassava based	12	13	11	12	13	16	12	15	14	14
Total	80	90	82	79	83	86	73	76	74	73

Legend:

***Puttu** - variations

1- with salt
2 - with 25g jaggery
3 - with 30g jaggery
4 - with 35g jaggery

****Balls** - Variations

1a - with 25g jaggery and steamed
1b - with 25g jaggery (not steamed)
2a - with 30g jaggery and steamed
2b - with 30g jaggery (not steamed)
3a - with 35g jaggery and steamed
3b - with 35g jaggery (not steamed)

As depicted in Table 15 as far as puttu is concerned, out of the four variations the one made with 25g of jaggery was found to be most acceptable when compared to other three variations irrespective of the type of mix used followed by puttu prepared with 30g jaggery and salt and the least acceptable one was the puttu prepared with 35g jaggery.

When the balls were compared, out of the six variations when the quantity of jaggery was varied balls prepared with 25g jaggery was found to be the best irrespective of the type of mix used. But when the method of cooking was varied, the one prepared with 25g of jaggery and served without steaming was the most acceptable one for all the mixes except the one made with rice soya based supplements.

Hence puttu (with 25g jaggery and steamed) was taken as the suitable recipe for the feeding trial irrespective of the mixes.

4.3.1.2 Preference of mothers

Selection of a food supplement to be given to children will be influenced by the likes and dislikes of their parents, especially the mothers. Hence a field test was conducted to know the preference of the mothers of children and the results are presented in Table 16.

Table 16. Preference of mothers

Supplements	Total Number of mothers	Number of respondents who have expressed postive response			
		Puttu		Balls	
		No.	%	No.	%
Rice soya based	85	62	72.9	23	27.1
Banana based	109	48	44.1	61	55.9
Rice based	137	94	68.6	43	31.4
Ragi based	98	60	61.3	38	38.7
Cassava based	131	79	60.4	52	39.6
Total	560	343		217	
Average		68.6	61.3	43.5	38.7

The data in Table 16 revealed that puttu made from rice soya based mix was preferred by maximum number of mothers (72.9%) followed by rice based (68.6%), ragi based (61.2%), cassava based (60.3%) and banana based mix (44.1%) in the descending order.

As for balls those made from banana based mix was the most preferred one by mothers (55.9%) followed by cassava based (39.6%) ragi based (38.7%), rice based (31.3%) and rice soya based (27.1%) supplement in the descending order.

While comparing puttu and balls made from the five different mixes, the maximum number of mothers preferred puttu (61.3%) than balls (38.7%). Hence puttu was selected as the recipe for feeding trial.

4.3.2 Organoleptic evaluation and overall acceptability of five mixes

The most acceptable variation in puttu and balls (puttu - with 25g jaggery and steaming and balls with 25g jaggery and prepared without steaming) made from five KAU mixes were evaluated for organoleptic quality and over all acceptability. The most acceptable variation of puttu and balls made with the five different supplements were presented before a panel of twenty judges for organoleptic evaluation using a score card with quality attributes like appearance, colour, taste texture and flavour. The maximum score that can be assigned to a product was 25 and the minimum was five. The mean scores, for the different quality attributes of the recipes made with five supplements are presented in Table 17.

Table 17 Mean acceptability scores for puttu and balls made with five mixes given by experts.

Quality Attributes	Supplements	Mean Scores	
		Puttu	Balls
Appearance			
	Banana based	4	4
	Ragi based	4	4
	Rice Soya based	4	4
	Rice based	5	5
	Cassava based	3	4
Colour			
	Banana based	4	3
	Ragi based	3	3
	Rice soya based	4	4
	Rice based	5	4
	Cassava based	3	3
Taste			
	Banana based	3	2
	Ragi based	2	2
	Rice soya based	3	4
	Rice based	5	5
	Cassava based	2	3
Texture			
	Banana based	4	4
	Ragi based	4	3
	Rice soya based	4	4
	Rice based	4	4
	Cassava based	3	4
Flavour			
	Banana based	3	3
	Ragi based	3	3
	Rice soya based	3	3
	Rice based	5	4
	Cassava based	2	2
Overall acceptability	**Banana based**	**18**	**16**
	Ragi based	**16**	**15**
	Rice soya based	**19**	**17**
	Rice based	**24**	**22**
	Cassava based	**13**	**16**
Total		**90**	**86**

The data presented in Table 17 revealed that when the appearance of five supplements were compared rice based supplement received the highest score for both puttu and balls (5) followed by banana, ragi and rice soya based (4), and cassava based (3 for puttu and 4 for balls) mixes in the descending order.

With respect to colour, the highest score was observed for rice based mix (5 for puttu and 4 for balls) followed by rice soya based (4)(for both puttu and balls) and for ragi and cassava based mixes, the score of 3 was observed for both balls and puttu.

While comparing the five supplements with regard to taste the highest score was observed for rice based mix for both puttu and balls (5), followed by rice soya based mix (3 for puttu and 4 for balls), banana based (3 for puttu and 2 for balls), and cassava based mix (2 for puttu and 3 for balls) in the descending order.

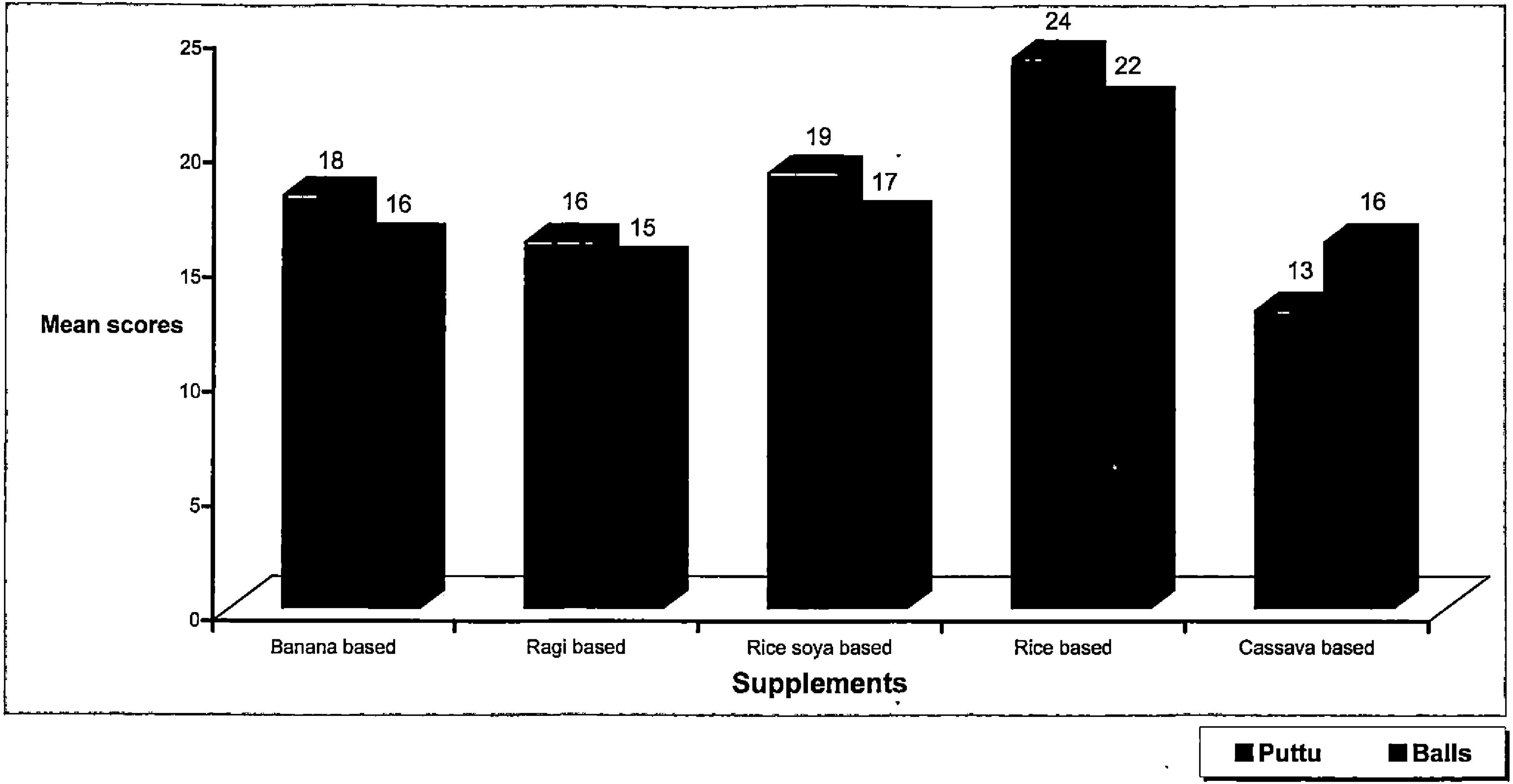
With respect to texture the lowest score was alloted to cassava based (3 for puttu and 4 for balls) follwed by ragi based (4 for puttu and 3 for balls), and rice based, banana based and rice soyed (with score of 4 for both puttu and balls) in the ascending order.

The highest score for flavour was allotted to rice based mix (for puttu 5 and flavour 4) followed by banana, ragi and rice soya based (with mean score of 3 for both puttu and balls) and cassava based mix (2) in the descending order.

When the mean overall acceptability score was worked out rice based mix had the highest score for both puttu and balls (24 and 22 respectively) followed by rice soya based (19 for puttu and 17 for balls), banana based (18 for balls and 16 for puttu) ragi based (16 for puttu and 15 for balls) and cassava based (13 for puttu and 16 for balls) in the descending order out of a total score of 25 as given in Figure 1.

Here again the puttu ranked higher than the balls and hence the selection of puttu for feeding trial is further justified.

Fig.1. Mean Overall Acceptability Scores for recipe given by experts



4.3.3. EFFECTS OF FEEDING TRIAL

The suitability of the five mixes to be used as supplements under ICDS were assessed by conducting a feeding trial. Subjects of the feeding experiment were preschool children attending selected five anganawadi centres of Kalliyoor Panchayat. The children were given the selected supplementary foods (one mix per centre) for six days in a week and the trial was carried out for a period of five consecutive months. All preschool children from a nearby anganawadi centre functioned as control subjects for comparison.

The results of the feeding trial are detailed below.

4.3.3.1 Number of days of feeding in the feeding trial.

Under the ICDS Scheme all the beneficiaries are expected to be given supplementary feeding on all working days except government holidays (six days in a week). Accordingly during the five months of feeding (from January 7th to June 6th 1998) on an average there were twenty three working days in a month. However due to local events the actual days of feeding on an average was found to be twenty two in three centres and twenty one in two centres as given Appendix III.

The rate of attendance is a factor that would influence the effect of the supplement; higher the participation better may be the impact of the supplement on health profile of children. Hence the attendance of the beneficiaries were recorded on a daily basis which indicated their rate of participation.

The rate of participation (mean attendance) of the children from the six Anganawadi Centres including the control group is presented in Table 18.

Table 18. Rate of participation of the subjects in the feeding

Supplements	Mean attendance
Experiemental group	
Banana based	67.28^{d}
Ragi based	63.8^{def}
Rice soya based	64.82^{de}
Rice based	81.74^{abc}
Cassava based	82.35^{a}
Control group	82.29^{ab}
	$F_{5,126}$-11.92**

Note: The treatments for which the same superscript letters appears are on par

As shown in Table 18 the highest mean attendance was seen for children who were fed with cassava based mix (82.35 days) followed by the control group and children who received rice based mix (with 82.29 days and 82.74 days respectively). The minimum mean attendance was seen among children who received ragi based supplement with 63.8 days followed by rice soya based supplement with 64.8 days. Hence the rate of participation in the feeding trial indicates that the maximum participation was with children who were fed with cassava based supplement followed closely by rice based supplement.

The data when subjected to anova revealed that there is a significant variation in the rate of participation (No. of days of attendance) ($F_{5,126}$ - 11.92) significant at 1% level) among the subjects. The children who were fed with cassava based supplement were found to be having significantly higher rate of participation than others.

4.3.3.2. Quantity of supplement consumed and plate waste

The quantity of the different supplements consumed per day and the plate waste during the entire feeding period is given in Tables 19 and 20.

For the feeding trial the quantity of supplement given was fixed based on the ability to supply 300 calories and 10g of protein. Hence the quantity of different supplements to be served per day was worked out and is given in Table 19.

Table 19 Quantity per serving

Anganwadi Centres	Supplements	Quantity per serving Raw Wt. (g)	Cooked Wt. (g)	Volume
94	Banana based	90	160	1 standard cup of 200 ml capacity
92	Ragi based	90	160	1 standard cup of 200 ml capacity
97	Rice soya based	90	167	1 standard cup of 200 ml capacity
90	Rice based	100	185	3 standard cups of 100 ml capaicty
96	Cassava based	75	146	3/4th standard cup of 200 ml capacity

Thus children in each anganwadi received one of the five supplement in varying quantities (75 g to 100 g of raw mixes per day). The cooked quantity served per day varied from 146g to 185g, depending on the supplement. All the children in one anganwadi were served one supplement in equal quantities.

As indicated in Table 19 children were fed with standardized quntities of supplements in the form of recipe. The children were all given the specified amount of supplements at the time of feeding, and the children were requested to take the supplement. The plate waste, if any was weighed, and the actual amount of the supplement consumed was derived by substracting the weight of the plate waste from the actual quantity served.

Table 20 Mean plate waste during the feeding period.

Supplement	n	Mean Plate Waste/month (g)						Mean waste (%)
		Jan	Feb	Mar	Apr	May	June	
Banana based	25	31.5	21.2	23.6	23.3	22.1	24.5	24.21
Ragi based	20	24.5	25.3	24.7	25.4	26.2	26.4	25.42
Rice Soya based	17	1.0	3.3	4.0	3.4	2.0	1.0	2.29
Rice based	23.	0.5	0.4	1.1	2.2	0.4	0.1	0.8
Cassava based	26	0.5	0.4	1.1	2.2	0.47	0.07	0.63

As depicted in Table 20 the minimum mean platewaste was noted for cassava based mix (0.63%) followed by rice based mix (0. 8%) and rice soya based supplement (2.29%). The maximum plate waste was noted for ragi based mix (25.4%) and banana based mix (24.2%).

It was found that as cassava based mix had the minimum plate waste hence it can be considered as an acceptable supplement in terms followed by rice based supplement mix.

Table 21. Average quantity of different supplements consumed by subjects during the feeding period.

Supplement	No. of subjects	Average quantity Consumed (g)/month						Mean Consumption(%)
	n	Jan	Feb	Mar	Apr	May	June	
Banana based	25	68.5	78.8	76.4	76.7	77.9	75.5	75.79
Ragi based	20	75.5	74.7	75.3	74.6	73.8	73.6	74.58
Rice, Soya based	17	99.0	96.7	96.0	96.6	98.0	99.0	97.71
Rice based	23	99.5	99.6	98.9	97.8	99.6	99.9	99.20
Cassava based	26	99.5	99.64	98.92	97.81	99.59	99.93	99.37

$F_{4, 29}$- 23934**

** significant at 1% level

SE - Treatments - 0.8469308 CD - Treatments - 2.467346

As shown in Table 21 the maximum mean consumption was noted among children who consumed cassava based mix (99.37%) followed closely by rice based mix (99.20%) and rice soya based mix (97.71%) The consumption was minimum among children who had ragi based mix (74.58%) and banana based mix (75.79%). The data reveals that statistically there was a significant difference between the quantity of supplements consumed.($F_{4,29}$-239.34 significant at 1% level), over the entire feeding period.

4.3.3.3. Morbidity pattern of the subjects

Data were collected on episodes of illness suffered by the subjects as recalled by mothers and also by the anganawadi workers. The mean percentage morbidity incidence among children from the six anganawadi centres during the five month period was consolidated and is presented in Table 22.

Table 22. Mean percentage morbidity incidence among subjects during the feeding trial

Supplements	No. of subjects	Incidence of common minor ailments								
		Cough	Cold	Vomitting	Diarrhoea	Conjunctivitis	Boils & ulcers	Fever	Average disease incidence (%)	F value
Experimental group										
Banana based	25	19.68	23.15	7.39	6.58	9.51	9.25	10.77	12.34	0.998
Ragi based	20	6.46	6.46	2.15	11.17	6.04	0.00	14.68	6.71	1.279
Rice Soya based	17	8.02	19.23	7.02	8.02	16.59	7.48	16.24	11.80	2.122
Rice based	23	15.20	6.01	6.87	2.86	2.86	2.86	7.53	6.31	1.346
Cassava based	26	8.90	11.18	0.00	0.00	5.61	7.61	13.09	6.63	1.435
Control Group	21	3.69	13.75	0.00	0.00	9.08	9.96	9.36	6.65	1.467
									$F_{5,210}$- 2.9**	$F_{41,210}$- 1.6**

** Significant at 1% level.

CD - Treatments - 12.24268, 4.6273.

The observations made during the feeding trial period of five months revealed the incidence of common ailments among the subjects such as cough, cold, vomitting, diarrhoea, boils, ulcers and fever. Apart from these conjunctivitis was also observed among few of the subjects. The incidence of such minor ailments varied from anganawadi to anganawadi as shown in Table 22.

The highest average disease incidence was noted among children who were fed with banana based supplement (12.3%) followed by rice soya based supplement (11.8%) and the minimum disease incidence was noted among children fed with rice based mix (6.31%)

Statistical analysis of the data showed a significant difference ($F_{41,210}$ - 1.623 - Significant at 1% level) in the incidence of minor ailments between the children who received the different supplements.

4.3.3.4. Clinical profile of the subjects:

The clinical profile of the children before and after the feeding trial and the mean recovery incidence with special reference to nutritional deficiency disorders was assessed.

The data revealed that before the feeding trial the children in Anganwadi Centre no: 94 had symptoms of deficiency disorders such as anaemia (11 number), caries (3) mottled enamel (1), photophobia (1), angular stomatitis (1) and atrophic tongue papillae. When they were fed with banana based supplement for five months, after the feeding trial symptoms like photophobia and angular stomatitis were completely eliminated. The number of children with anaemia and caries were reduced to 5 and 1 respectively and the cases with mottled enamel remained the same.

The children from Anganwadi Centre No. 92 had symptoms like anaemia (7), caries (4), and mottled enamel (2) before the feeding trial while after the feeding trial with ragi based supplement the the prevalence reduced to 3 and 1 respectively for anaemia and cariesbut for mottled enamel it remained the same.

Children from Anganwadi Centre No. 97 who received rice soya based supplement had symptoms like anaemia (11), mottled enamel(1), glossitis (1), thyroid enlargement (1), naso-labial dyssebacea (1), angular stomatitis (1) and scabies (1) before the feeding trial. The number of children who had anaemia was reduced from 11 to 8 after the feeding trial.

Angular stomatitis and caries were eliminated after the trial period. However children who had thyroid enlargement, mottled enamel, naso-labial dyssebacea, glossitis and scabies remained with the above symptoms even though they received rice soya based supplement for five months. Children who received rice based mix had symptoms like anaemia (9), caries (2), beading of ribs and mottled enamel (2) before the feeding trial and after the trial period beading of ribs and mottled enamel remained the same while the incidence of anaemia and caries were reduced to 5 and 1 respectively.

The number of children who were fed with cassava based supplement had symptoms like anaemia (11), mottled enamel (2) and photophobia (1) before the study. Number of children with anaemia were reduced to 6 after the feeding trial, photophobia were not found in those children who had it after the feeding trial of five months, but mottled enamel remained the same.

As for the control group, these children had symptoms of anaemia (15), caries (1) and mottled enamel (4) before the study period. After the study period the number of children who had anaemia were reduced to 13,and carries was eliminated but there was no change in mottling of teeth.

Statistically there was a significant difference ($F_{10,65}$ 3.076 significant at 1% level) between the subjects when the recovery rate for different symptoms (percentage of children who showed change in the symptoms after the feeding trail). Maximum recovery was observed among subjects who had angular stomatistis (45%) followed by caries (39%) and anaemia (38%) and minimum recovery was noted among those who had scabies (15%) and tongue papillae atrophy (15%). Before the feeding trial the highest diesease incidence was noted among children who received banana based and rice soya based supplement.

When the overall status of the nutritional profile of the children were evaluated based on the clinical profile, children who were fed with banana based and rice based supplement had initially 7 and 6 "normal" children which after the feeding trial became 12 and 11 respectively.

4.3.3.5. Growth rate of children:

The impact of the feeding on growth rate of the subjects was assessed by taking the anthropometric measurements. Body measurements such as height, weight, arm circumference, chest circumference and head circumference of all the subjects were recorded both of the experimental as well as the control subjects once every month (including once before starting the feeding trial and at the termination of the feeding trial) following the procedures suggested by Jelliffe (1966). The values were then compared with NCHS standards and the results are presented below.

4.3.3.5.1. Mean Height:

The variation[(growth rate (range)] in height of children receiving the supplements over a period of five months and the mean height and mean gain in height of the subjects including the control group before and after the experimental period are presented in Table 23.The initial and final height of children is presented in Appendix IV.

Table 23: Variation in the growth rate and mean gain in height of the subjects.

Supplements Experimental Group	No. of subjects n	Range in height (cm) Initial Range	Initial Mean	Final Range	Final Mean	Mean gain %
Banana based	25	78.8 - 105.2	95.29^{b}	83.1 - 106.7	98.62^{abc}	3.604^{abcd}
Ragi based	20	78.1 - 102.1	89.84^{cb}	80.1 - 105.9	93.21^{ef}	3.800^{ab}
Rice soya based	17	83.4 - 110.5	99.38^{a}	87.6 - 112.9	102.25^{a}	2.925^{bcde}
Rice based	23	88.0 - 102.7	95.20^{bcd}	92.9 - 103.4	98.68^{ab}	3.689^{abc}
Cassava based	26	87.3 - 108.0	95.29^{bc}	89.3 - 109.3	97.71^{bcde}	2.569^{bcdef}
Control Group	21	81.0 - 107.0	93.72^{de}	82.7 - 113.0	98.00^{bcd}	4.663^{a}
						$F_{5,126}$ 1.799

Note: The treatments for which the same superscript letters appear, are on par.

The data presented in Table 23 shows that before the trial period the highest mean height was observed among children who received rice soya based mix which was 99.38 cm followed by those who were to receive banana based (95.29cm), cassava based (95.29 cm), rice based (95.20 cm) and ragi based supplement (89.84cm) After the feeding trial it became102.25 cm for rice soya based supplemented group which was the highest mean height followed by those who received rice based, banana based, cassava based and ragi based mixes with mean height of 98.68, 98.62, 97.71 and 93.21 cm respectively. As for the control group the intial mean height was 93.72cm which became 98.00 cm after the feeding trial.

The data also indicated that there was an increase in the mean gain in height in all subjects who received the supplements. The gain was maximum among children who received ragi based supplement (3.8 %) followed by rice based supplement (3.7 %) , while the gain was minimum for those who received cassava based supplement (2.5%).

The data when subjected to statistical analysis, the results showed no significant variation between the children who received the different supplements and they were on par. Hence all the supplements were found to be equally effective in increasing the height of the subjects.

4.3.3.5.2. Height for age

To find out the influence of the different supplements on the nutritional status of the children the subjects were classified based on their height for age as recommended by Waterlow *et.al.*(1972). The shift in the nutritional status of children based on height for age due to supplementation is presented in Table 24.

Table 24 Nutritional status of subjects based on height for age, before and after supplementation

Supplements		Normal >95 %	Marginal malnutrition 90-95 %	Moderate malnutrition 85-90 %	Severe malnutrition < 85%	Number of subjects
Experimental group						
	Initial	10	14	0	1	25
Banana based	Final	19	5	1	0	25
	Shift	+9	9	1	1	
	Initial	3	8	8	1	20
Ragi based	Final	5	11	4	0	20
	Shift	+2	3	4	1	
	Initial	12	4	1	0	17
Rice soya based	Final	13	4	0	0	17
	Shift	+1	0	1	0	
	Initial	12	4	4	3	23
Rice based	Final	16	4	1	2	23
	Shift	+4	0	3	1	
	Initial	15	6	4	1	26
Cassava based	Final	19	4	2	1	26
	Shift	+4	2	2	0	
	Initial	1	10	7	3	21
Control group	Final	8	6	6	1	21
	Shift	+8	4	1	2	

Fig. 3 Measurement of Height of Subject

Fig. 4 Measurement of Weight of Subject

As shown in Table 24 there was an increase in the number of 'normal' children after the feeding trial which showed that the feeding programme had a favourable impact on the subjects. The maximum increase in the normal category was seen among children fed with banana based supplement where 9 children who were marginally malnourished became normal after the trial period and one child who was severely malnourished became moderately malnourished. The minimum difference was noted in children who received rice soya based supplement where only one child came into the normal category. Children fed with rice based and cassava based supplement showed that four children each became normal after the feeding trial. Thus it can be noted that based on the classification of height for age, children fed with banana based supplement showed a most favourable effect compared to the other supplements.

4.3.3.5.3. Mean Weight:

The growth rate (range) of the subjects receving the different supplements in terms of weight gain over a period of five months in comparison with the control group is presented in Table 25.

The initial weight of the subjects of the study and the final weight of the subjects after the feeding trial are presented in Appendix IV.

Table 25 Mean weight and mean weight gain among the subjects

Supplements	No. of subjects n	Initial Range	Initial Mean	Final Range	Final Mean	Mean gain weight %
Experimental Group						
Banana based	25	9.5 - 16.5	13.16^{bcd}	10.5 - 18.0	14.08^{bcde}	7.23^{bcd}
Ragi based	20	9.0 - 15.0	11.93^{f}	10.0 - 15.5	13.12^{ef}	10.43^{ab}
Rice, soya based	17	11.0 - 16.5	14.5^{a}	12.5 - 18.5	15.53^{a}	7.20^{bcde}
Rice based	23	10.5 - 15.0	13.13^{bcde}	11.5 - 15.5	14.608^{abc}	11.87^{a}
Cassava based	26	11.0 - 19.0	13.92^{ab}	11.5 - 20.0	14.96^{ab}	7.62^{bcde}
Control group	21	11.0-18.5	13.55^{abc}	11.5 - 18.0	14.23^{bcd}	5.57^{cdef}
			$F_{5,126}$-4.634**		$F_{5,126}$-4.51**	$F_{5,126}$-4.15**

Note: The treatments for which the same superscript letters appear are on par

As presented in Table 25, initially the highest mean weight was seen for children who received rice soya based supplement (14.5kg) followed by those who recived cassava based (13.92 kg), banana based (13.16 kg), rice based (13.13 kg) and ragi based supplement (11.93 kg). After the feeding trial the highest mean weight was obaserved among those who were fed with rice soya based (15.53 kg) followed by cassava based (14.93 kg) rice based (14.60 kg) banana based (14.08 kg) and ragi based supplements (13.12 kg) in the decending order. As for the control group, the initial mean weight was 13.55 kg which became 14.23 kg after the feeding trial period.

The data shown in Table 25 also revealed that when the mean weight of the subjects, before and after the feeding (both of experimental group and the control group) were compared, there was a general increase in the mean weight of the entire population. However the gain was maximum among children who received rice based supplement which was 11.87% while the gain was minimum for children who received rice soya based supplement (7.20%) and it was lowest for the control group (5.57%).

When the data were subjected to anova it showed that a significant variation ($F_{5,126}$ -4.15 significant at 1%) in gain in weight was observed in beneficiaries who were fed with the five different supplements. (There was an average increase of 11.87 % in the children who received, rice based supplement which was maximum when compared tothe other four supplements.)

Thus while comparing the weight gain due to supplementation rice based supplement was found to be the most effective, compared to the other four supplements under focus.

4.3.3.5.4. Weight for age:

Using Gomez classification the children were categorised into different groups based on their nutritional status and the shift in nutritional status after feeding the different supplements for a period of five months are presented in Table 26. The weight for age was compared with the 50th percentile of NCHS reference standard for each child before and after the feeding trial.

Table 26. Effect of different supplements on the nutritional status of subjects based on weight for age

Supplements		Normal >90%	Grade I malnutrition 76-90%	Grade II malnutrition 61-75%	Grade III malnutrition < 60%	Number of subjects
		Nutritional Status				
Experimental group						
Banana based	Initial	6 (24.0)	13 (52.0)	6 (24.0)	0	25
	Final	10 (40.0)	14 (56.0)	1 (4.0)	0	25
	Shift	4 (16.0)	1 (4.0)	5 (20.0)	0	
Ragi based	Initial	0	11 (55.0)	9 (45.0)	0	20
	Final	5 (25.0)	12 (60.0)	3 (15.0)	0	20
	Shift	5 (25.0)	1 (5.0)	6 (30.0)	0	
Rice soya based	Initial	7 (41.2)	9 (52.9)	1 (5.9)	0	17
	Final	10 (58.8)	5 (29.4)	2 (11.8)	0	17
	Shift	3 (17.6)	4 (23.5)	1 (5.0)	0	
Rice based	Initial	5 (21.7)	12 (52.1)	3 (13.0)	3 (13.0)	23
	Final	11 (47.8)	9 (39.1)	2 (8.7)	1 (4.3)	23
	Shift	6 (26.1)	3 (13.0)	1 (4.3)	2 (8.7)	
Cassava based	Initial	11 (42.3)	13 (50.0)	2 (7.7)	0	26
	Final	16 (61.5)	9 (34.6)	1 (3.9)	0	26
	Shift	5 (19.2)	4 (15.4)	1 (3.8)	0	
Control group	Initial	1 (4.8)	13 (61.9)	6 (28.5)	1 (4.8)	21
	Final	3 (14.3)	14 (66.7)	4 (19.0)	0	21
	Shift	2 (9.5)	1 (4.8)	2 (9.5)	0	

Figures in paranthesis denotes percentage

Data presented in Table 26 indicated that initially there were 3(13%) subjects with Grade III malnutrition who received rice based mix which became 1 (4.4%) after the feeding trial. This indicates that two of these children had shifted to Grade II malnutrition. There was an increase in the number of normal children from six to ten, zero to five, seven to ten, five to eleven and eleven to sixteen among children who were fed with banana based, ragi based mix, rice, soya based mix rice based mix and cassava based mix respectively. In the control group also there was an increase in the number of children who became normal. (1 to 3)

This indicated that all the mixes had favourably influenced the weight gain among the beneficiaries. But the highest increase in the normal category was noted among children who received rice based supplement ie an increase of 26%; (before the study there were only 21.7% children who were normal which became 47.8% after the period) followed by ragi based supplement where the increase in normal children was from 0 to 25%.

4.3.3.5.5. Mid upper arm circumference

The actual arm circumference of children over the period of five months is presented in Appendix IV.

The growth rate (range) of the subjects receiving the five supplements with respect to MUAC and mean gain in MUAC is presented in Table 27.

Table 27: Variation and meangain in the MUAC of the subjects.

Supplements	n	MUAC (cm) Initial Range	Initial Mean	Final Range	Final Mean	Mean gain (percentage)
Experimental Group						
Banana based	25	12.8 - 16.8	14.71^{d}	13.3 - 17.1	15.16^{d}	3.12^{abcde}
Ragi based	20	13.5 - 15.5	14.29^{def}	13.7 - 15.7	14.8^{def}	3.61^{abcd}
Rice soya based	17	14.4 - 16.2	15.25^{a}	14.8 - 16.4	15.63^{abc}	2.47^{cdef}
Rice based	23	14.1 - 17.1	15.13^{abc}	14.6 - 17.6	15.76^{a}	4.20^{a}
Cassava based	26	13.8 - 16.5	15.19^{ab}	13.9 - 16.9	15.75^{ab}	3.67^{abc}
Control group	21	13.1 - 16.6	14.46^{de}	13.7 - 16.7	14.98^{de}	3.74^{ab}
						$F_{5,126}$ 1.089

Note: The treatments for which the same superscript letter appear are on par.

The data presented in Table 27 revealed that intially the highest mean MUAC was seen among children who received rice soya based supplement (15.25 cm) followed by those who had cassava based (15.19 cm), rice based (15.13 cm), banana based (14.71cm) and ragi based supplement (14.29 cm). After the feeding trial the highest mean MUAC was noted among those who received rice based supplement (15.76cm) followed by cassava based (15.75 cm), rice soya based (15.63 cm), banana based (15.16 cm) and ragi based supplement (14.8 cm) respectively. The mean MUAC of the control group was 14.46 cm initially which became 14.98 cm after the feeding trial.

The data shown in Table 27 also revealed that when the mean MUAC of both the experimental group and control group were compared there was a general increase in the mean MUAC of the entire population during the experimental period, irrespective of the supplement received.

The pooled data presented in Table 27 reaffirms the fact that the highest mean percentage increase in MUAC was seen among children who received rice based supplement (4.20%) followed by cassava based mix (3.67%) and rice soya based supplement which had the lowest gain of 2.47%.

Though there is a general increase in the mean MUAC, when the data was subjected to anova, the effects of supplements were not satistically significant and they were on par. Hence all the supplements are found to be effective in improving the arm circumference of the subjects.

4.3.3.5.6 Nutritional status of subjects based on Mid Upper Arm Circumference

The shift in the nutritional status due to supplementation among the subjects who participated in the feeding trial along with the control children is presented in Table 28.

Table 28. Shift in nutritional status of subjects based on Mid Upper Arm Circumference

Supplements		Normal >13.5cm	Moderate malnutrition 12.5-13.5cm	Severe malnutrition <12.5cm	Number of subjects
Experimental group					
Banana based	Initial	23	2	0	25
	Final	25	1	0	25
	Shift	2	0	0	
Ragi based	Initial	18	2	0	20
	Final	20	0	0	20
	Shift	2	0	0	
Rice soya based	Initial	17	0	0	17
	Final	17	0	0	17
	Shift	0	0	0	
Rice based	Initial	23	0	0	23
	Final	23	0	0	23
	Shift	0	0	0	
Cassava based	Initial	26	0	0	26
	Final	26	0	0	26
	Shift	0	0	0	
Control group	Initial	19	2	0	21
	Final	21	0	0	21
	Shift	2	0	0	

. As shown in Table 28 all the children became normal irrespective of the type of supplement after the feeding trial.

It may be also noted that there were two children (each who were fed with banana based and ragi based supplement) who were moderately malnourished initially and after the feeding trial the two children who received ragi based supplement and one child who received banana based supplement became normal as shown in Table 28. As for the control group two children who were moderately malnourished remained the same after the lapse of a period of five months.

4.3.3.5.7 Chest/Head circumference ratio.

The variation [growth rate - (range)] in the chest circumference and head circumference of the subjects before and after the feeding trial is presented in Tables 29 and 30. The actual chest and head circumference of the subjects over the period is presented in Appendix IV.

Table29. Mean Chest circumference of subjects before and after the feeding trial.

Supplements	Chest circumference (cm)			
	Initial		Final	
	Range	Mean	Range	Mean
Experimental group				
Banana based	45.5 - 54.0	47.7	48. 5 - 55.0	51.4
Ragi based	47.0 - 52.0	49.3	48.0 - 53.0	50.7
Rice soya based	47.0 - 53.0	51.5	49.5 - 54.5	53.6
Rice based	45.5 - 53.5	50.1	48.0 - 55.5	52.2
Cassava based	48.0 - 56.5	50.5	50.5 - 58.0	53.0
Control group	46.5 - 56.0	50.2	49.0 - 57.0	54.4

The data presented in Table 29 revealed that before the feeding trial children who were fed with rice soya based supplement had the highest mean for chest circumference (51.5) cm followed by those who received cassava based (50.5 cm), rice based (50.1 cm), ragi based (49.3 cm) and banana based mix (47.7 cm) in the descending order. After the trial period the mean chest circumference was seen highest among children who were fed with rice soya based mix (53.6). followed by cassava based (53 cm), rice based (52.2 cm), banana based (51.4 cm) and ragi based in descending order.

Fig. 5. Measurement of Head Circumference of Subject

For the control group the mean chest circumference was initially 50.2cm which after the feeding trial became 54.4cm.

Table 30. Mean head circumference of subjects before and after the feeding trial

Supplements	Head circumference (cm)			
	Initial		Final	
	Range	Mean	Range	Mean
Experimental group				
Banana based	46.0 - 52.0	46.4	47.0 - 52.5	49.3
Ragi based	45.0 - 49.5	47.5	46.0 - 50.5	48.5
Rice soya based	46.0 - 51.0	48.7	47.0 - 51.5	49.6
Rice based	46.0 - 49.5	47.9	47.0 - 51.5	49.2
Cassava based	46.0 - 51.0	48.5	47.5 - 52.5	49.7
Control group	45.5 - 51.0	48.0	46.5 - 51.5	49.3

The data presented in Table 30 showed that the head circumference of the children before the feeding trial was highest among children who received rice soya based mix (48.7 cm) followed by cassava based (48.5 cm), rice based (47.9cm), ragi based (47.5 cm) and banana based (46.4 cm) in the descending order. After the feeding trial the highest mean was observed in children fed with cassava based mix (49.7cm) followed by those fed with rice soya based (49.6 cm), banana based (49.3 cm), rice based (49.2 cm) and ragi based mix (48.5cm).

As far the control group initially the subjects had a mean head circumference of 48.0 cm which became 49.3 after the study period.

4.3.3.5.8. Mean chest/head circumference ratio and mean percentage gain in Chest/Head circumference ratio.

The mean Chest/Head circumference ratio and mean gain over the initial Chest/head circumference ratio of the children who were fed with the five supplements and also of the control group is presented in Table 31.

Table 31. Mean Chest/Head circumference ratio and mean percentage gain of circumference ratio of the subjects

Supplements	No. of subjects n	Mean chest/head circumgerence ratio (cm) Initial	Final	Mean gain in CHR (percentage)
Experimental group				
Banana based	25	1.030^{bcdef}	1.042^{cdef}	1.27^{abcd}
Ragi based	20	1.039^{abcde}	1.045^{bcde}	0.59^{bcdef}
Rice soya based	17	1.059^{a}	1.079^{a}	1.99^{abc}
Rice based	23	1.042^{abc}	1.0663^{abc}	2.05^{ab}
Cassava based	26	1.041^{abcd}	1.067^{ab}	2.55^{a}
Control group	21	1.047^{ab}	1.053^{bcd}	0.63^{bcde}
		$F_{5,126}$ - 1.02	$F_{5,126}$ - 2.743**	$F_{5,126}$-2.184

Note: The treatments for which the same superscript letters appear are on par

When the mean Chest/Head circumference ratio(CHR) of the subjects both of the five experimental groups and of control group were compared, there was a general increase in the mean ratio of the entire population.

The data presented in Table 31 revealed the fact that before the feeding trial children who were to received rice soya based supplement had the highest mean Chest / Head Circumference ratio (1.059%) followed by those who were to receive rice based (1.04%), cassava based (1.042%), ragi based (1.039%) and banana based supplement (1.030cm) After the feeding trial the highest mean ratio was noted for children supplemented with rice soya based supplement (1.079%) followed by cassava based (1.670%), rice based (1.066%), ragi based (1.045%) and banana based supplements (1.042%) respectively. As far as the control group of children were concerned the initial mean value was 1.047% which became 1.053% after the study period.

The data shown in Table 31 indicated that the maximum gain in the mean Chest/Head circumference ratio is for those who received cassava based supplement (2.55%) followed by rice based supplement (2.05%). The minimum increase was found for those subjects who consumed ragi based supplement (0.59%) followed by the control group (0.63%).

Though there is a general increase in the Chest/Head circumference ratio for all groups, when the data were subjected to anova it revealed that there was no significant difference between the children who received different supplements and also the control group as the values were on par.

Hence all the supplements were found to be effective in improving the Chest/Head circumference ratio of the benificiaries.

4.3.3.5.9. Nutritional classification of subjects based on Chest /Head circumference Ratio:

Based on the Chest/Head circumference ratio, the children were catagorised into normal (if the value is morethan 1) and malnourished (if the value is less than 1). Data presented in Table 32 shows the effect of supplementation on the nutritional status of children based on their Chest/head ratio.

Table 32 : Effect of different supplements on the nutritional status based on Chest Head circumference ratio of subjects

Supplements		Normal (>1)	Malnurished (<1)	Number of subjects
Experimental group				
Banana based	Initial	19(76.0)	6(24.0)	25
	Final	22(88.0)	3(12.0)	25
	Shift	3 (12.0)	3 (12.0)	
Ragi based	Initial	18(90.0)	2(10.0)	20
	Final	19(95.0)	1(5.0)	20
	Shift	1 (5.0)	1 (5.0)	
Rice soya based	Initial	16(94.1)	1(5.9)	17
	Final	16(94.1)	1(5.9)	17
	Shift	0 (0)	0 (0)	
Rice based	Initial	21(91.3)	2(8.7)	23
	Final	23(100.0)	0	23
	Shift	2 (8.70)	0	
Cassava based	Initial	24(92.3)	2(7.7)	26
	Final	26(100)	0	26
	Shift	2 (7.7)	0	
Control group	Initial	19(90.5)	2(9.5)	21
	Final	20(95.2)	1(4.8)	21
	Shift	1 (4.7)	1 (4.7)	

Figures in parenthesis denotes percentage

As depicted in Table 32 the maximum increase in the number of children belonging to normal category was seen among subjects who were fed on banana based mix (76 became 88%) followed by rice based mix and cassava based mix (91.3 to 100% and 92.3 to 100% respectively). In the case of malnourished children, 8.7 and 7.7% of the subjects who consumed rice based mix and cassava based mix respectively had shifted to normal range after the feeding trial.

In the control group also there was a slight increase in the number of normal children (90.5 was increased to 95.2%). Thus based on the nutritional status of children with respect to Chest/ Head circumference ratio showed that rice based supplement and cassava based supplement proved to be most effective in improving their nutritional status, when compared to other supplements.

4.3.3.5.10 Mean BMI and Mean percentage gain in BMI

The data on weight and height of children was used to calculate the BMI of subjects.

The mean BMI and mean percentage gain over the initial BMI of the children due to supplementary feeding along with that of control is presented in Table 33 and Figure 2.

Table 33. Mean BMI and Mean Percentage gain in BMI of the subjects

Supplements	No. of subjects n	Mean BMI Initial	Final	Mean gain in BMI (percentage)
Experimental Group				
Banana based	25	13.5	14.5	1.10^{bcde}
Ragi based	20	14.7	15.2	2.78^{ab}
Rice, soya based	17	14.7	14.9	1.18^{abcd}
Rice based	23	14.5	15.1	4.10^{a}
Cassava based	26	15.3	15.7	2.33^{abc}
Control Group	21	15.4	14.8	-3.55^{f}
		$F_{5,126}$ 2.645**	$F_{5,126}$ 2.742**	$F_{5,126}$ 4.361**

Note : The treatments for which the same superscript letter appear are on par

The data presented in Table 33 revealed that the highest mean BMI before the trial period was found among children who received cassava based supplement (15.3) followed by ragi based (14.7) and rice soya based (14.7) rice based and banana supplement (13.5) in the descending order. After

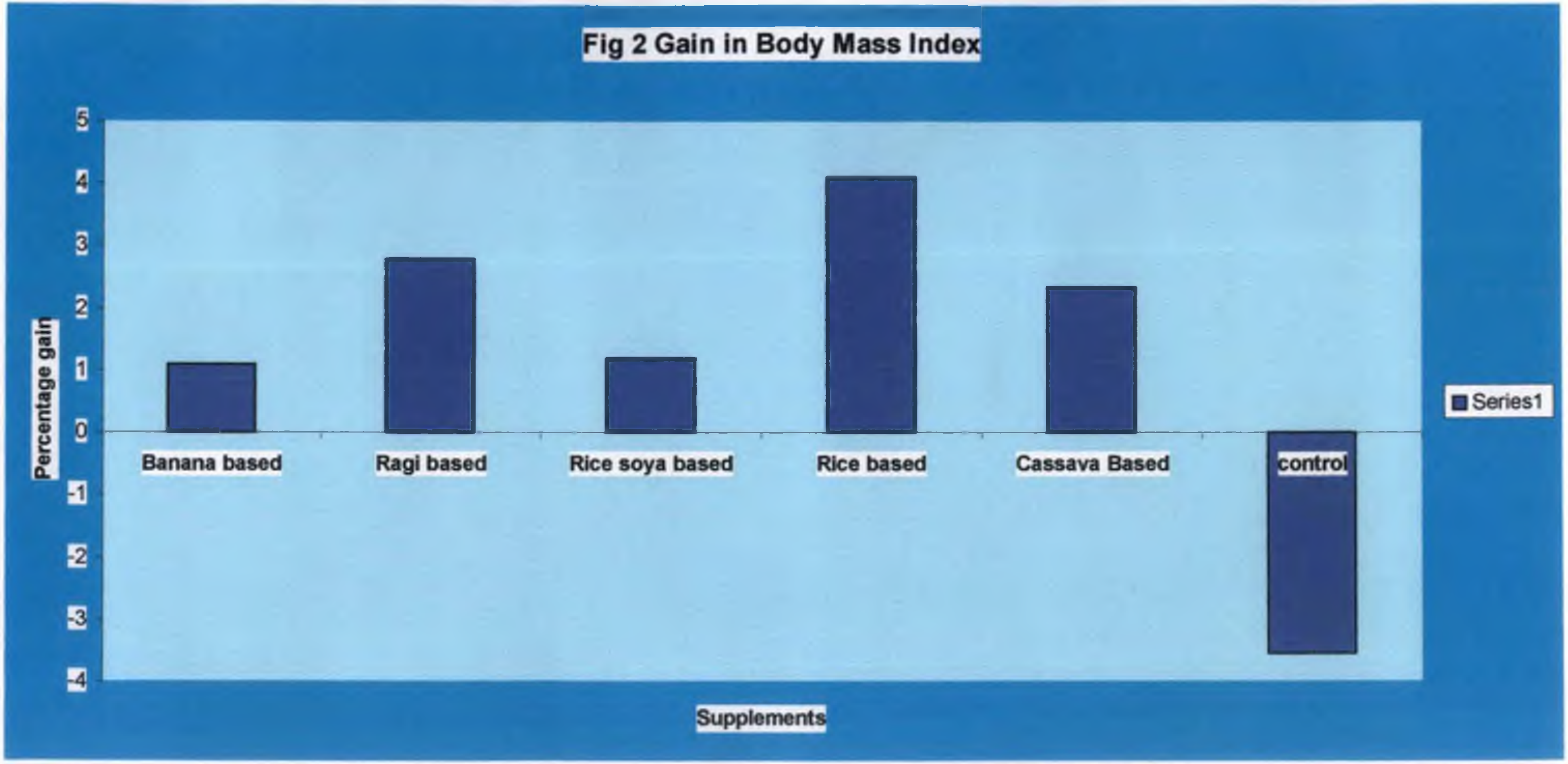


Fig 2 Gain in Body Mass Index
Percentage gain
5
4
3
2
1
0
-1
-2
-3
-4
Banana based
Ragi based
Rice soya based
Rice based
Cassava Based
control
Supplements
Series1

the trial period the highest mean BMI was found among those who received cassava based supplement (15.7) followed by ragi based (15.2), rice based (15.1), rice soya based (14.9) and banana based supplements (14.5). As for the control, group the initial mean BMI of 15.4 was decreased to 14.8 after the experimental period. The data when subjected to anova showed a significant variation ($F_{5,126}$ –2.742 - Significant at 1level) between the children who received the different supplements.

The data shown in Figure 2 indicates that the maximum gain in the mean BMI is for those who received rice based mix (4.1%) followed by ragi based supplement (2.78%). A minimum increase was found for those who consumed banana based supplement (1.10%).

The mean gain in BMI as presented in Table 33 showed a significant variation ($F_{5,126}$-4.361 - significant at 1% level) among children who received the different supplements. It also revealed that the experimental group of children had significantly higher percentage gain in BMI than those of the control group. The highest variation in gain in BMI was noted among those who received rice based supplement and lowest was noted for those who had banana based supplement. Thus based on the BMI all the supplements are found to be effective though the most effective one was found to be rice based mix. The control diet had negatively influenced the BMI of the subjects.

4.3.3.5.11 Classification of subjects based on Body Mass Index before and after the feeding trial

The shift in nutritional status of children based on Body Mass Index, due to supplementation through the five supplements are given in Table 34.

Table 34. Shift in Nutritional status of subjects based on Body Mass Index due to supplementation

Supplements		Normal >0.0015	Moderate malnutrition 0.0013-0.0015	Under nourished <0.0013	Number of Subject
Experimental group					
Banana based	Initial	11 (44.0)	14 (56.0)	1 (4.0)	25
	Final	8 (32.0)	15 (60.0)	1 (4.0)	25
	Shift	3 (12.0)	1 (4.0)	0	
Ragi based	Initial	8 (40.0)	11 (55.0)	1 (5.0)	20
	Final	9 (45.0)	10 (50.0)	1 (5.0)	20
	Shift	1 (5.0)	1 (5.0)	0	
Rice soya based	Initial	7 (41.2)	10 (58.8)	0	17
	Final	7 (41.2)	10(58.8)	0	17
	Shift	0	1 (5.9)	0	
Rice based	Initial	6 (26.1)	16 (69.6)	1 (4.3)	23
	Final	11 (47.8)	12 (52.2)	0	23
	Shift	5 (21.7)	4 (17.3)	1 (4.3)	
Cassava based	Initial	11 (42.3)	14 (53.9)	1 (3.8)	26
	Final	17 (65.4)	9 (34.6)	0	26
	Shift	6 (23.0)	5 (19.2)	1 (3.8)	
Control group	Initial	15 (71.4)	6 (28.6)	0	21
	Final	8 (38.0)	13 (62.0)	0	21
	Shift	-7 (33.4)	7 (33.4)	0	

The data presented in Table 34 proved that the children who were fed with cassava based mix showed the maximum change after the feeding trial. Though there were only 42 per cent of subjects who were initially normal, after feeding the cassava based mix for five months 65 per cent became normal which indicates that there was a substantial improvement. In the case of children who consumed rice based supplement the percentage of normal subjects increased from 26 per cent to 48 percent after the study period. A decrease in the normal category of children, ie. from 44 per cent to 32 per cent was seen in children fed with banana based supplement. Children who received rice soya based supplement did not show any change in the normal category even after the study period.

As for the control group 71 per cent of the subjects were normal before the study period which was reduced to 38 per cent after the five months trial period.

Contd.......

While summing up the anthropometric data the following significant results were obtained. When the gain in weight was computed as a positive impact of supplementation there was a universal increase in the body weight of subjects . However the rate of gain varied significantly ($F_{5,126}$-4.15 significant at 1% level) between the groups (between supplements). The gain in weight was highest among those who received rice based supplement (11.8%) followed by ragi based supplement (10.43%) and the gain in weight of the children receiving the other three supplements were on par.

Though there was a general increase in the mean height, arm circumference and Chest/ Head circumference ratio the variation due to supplementation,they were not satistically significant and hence all five supplements are found to be equally effective.

The gain in BMI also varied significantly ($F_{5,126}$-4.36 significant at 1% level) between the groups of children who were fed with the five supplements and when compared with the control group and the highest gain was noted for rice based mix (4.103) followed by ragi based supplement (2.78).

When the overall nutritional status of the subjects were analysed based on their weight for age there was a variation among the subjects receiving the five supplements. However the maximum shift of the children from the "malnourished" category to normal category was seen among those fed with rice based mix followed by cassava based and rice soya based mixes.

The nutritional status of subjects based on BMI showed that the maximum shift of children from 'malnourished' to 'normal' category was seen in childreen fed on cassava based mix followed by rice based mix and ragi based mix.

However the shift in nutritional status of the subjects based on mid arm circumference and chest head circumference ratio the maximum shift to normal category was seen in those fed on rice based mix followed by cassava based mix. Based on height for age the shift was seen maximum among those who received banana based supplement followed by rice based and cassava based supplement.

Thus when the effect of supplementation on anthropometric parameters of the subjects when observed together there was positively significant difference between the supplements.When BMI and gain in weight were taken into account, and the maximum variation was seen among children who were fed with rice based mix followed by cassava based supplement. Based on MUAC, and the Chest/Head Ratio, all the five supplements were found to be equally effective in facilitating growth of the subjects.

Overall evaluation of the five supplements

To find out the most effective supplement among the five mixes, all the characteristics used to assess the suitability of the supplements were grouped into two categories (1) Quality of the products viz. availability of ingredients, nutrient composition, protein quality, time required for processing, ease of preparation, cost, yield and shelf life and (2) Response to the feeding trial viz. rate of participation, quantity consumed, clinical profile, morbidity pattern and variation in anthropometric parameters like height, weight, arm circumference, Chest/Head circumference ratio and BMI. The above attributes were scored on a five point continuum and the total scores were summed up to find out the most suitable supplement. The supplements were further ranked based on the total score obtained. The scores and ranks assigned to the supplements are presented Tables 35.

Table 35. Overall ranking for the five supplements

Components	Banana based	Ragi based	Rice Soya based	Rice based	Cassava based	Control
I. Quality attributes						
1. Availability & familiarity	4	5	3	1	2	
2. Cost	1	3	4	5	2	
3. NPU	4	5	2	1	3	
4. Nutritive value	4	5	3	1	2	
5. Composition based						

Food square	3	4	5	2	1
6. Overall accepatability					
Experts	3	2	4	5	1
Mothers	3	2	1	5	4
7. Ease of preparation					
a) No. of steps in processing	2	1	3	4	5
b) Time taken for processing	3	3	4	5	4
c) Time taken for preparation of receipe	1	2	3	5	4
8. Yield Ratio	2	3	4	4	5
9. Processsing Loss	2	3	1	4	5
10. Shelf Life					
Visual sign	2	3	4	1	5
Insect infestation	2	4	3	1	5
Bacterial count	3	3	3	5	4
Total score	39	48	47	49	52
Ranking order	V	III	IV	II	I
II. Response to feeding trial					
11. Rate of participation	3	1	2	4	5
12. Quantity consumed	2	1	3	4	5
13. Clinical Profile	2	4	1	3	5
14. Morbidity	1	3	2	5	4
15. Height					
% gain	3	5	2	4	
Ht. for age	5	2	1	4	3
16. Weight					
% gain	2	4	1	5	3
Wt. for age	1	4	2	5	3
17. Mid Arm Circumference					
% gain	2	3	1	5	4
Classification in Nutrition status	4	4	5	5	5
18. CH Ratio					
% gain	2	1	3	4	5
Classification in					

Nutritional status	2	4	5	3	3
19. BMI					
% gain	1	4	2	5	3
classification in					
Nutritional status	1	3	2	4	5
Total score	31	43	32	60	54
Ranking Order	V	III	IV	I	II
Overall Score(1+2)	70	91	79	109	106
Overall Rank	V	III	IV	I	II

As shown in Table35, while comparing the quality of the products based on availability, nutrient composition, time for processing, yield and shelf life, the quality attributes of cassava based mix scored the highest (52) followed by rice based (49), ragi based (48) and rice soya based supplement (47)and the minimum score was seen for banana based supplement (39).

The data when subjected to Kruskal-Walis one way analysis of vairance the results revealed that based on the above quality attributes (I) there is no significant variation between the five supplements and they were on par. Hence all the five supplements can be used as food supplements under ICDS.

When the response of the feeding trial (II)was evaluated by scoring the various characters like rate of participation, quantity consumed, clinical profile, morbidity pattern and change in anthropometric measurements rice based supplement scored the highest value of 60 followed by cassava based (54), ragi based supplement (43) and rice soya based supplement (32) as shown in Table 35. It may also be noted that banana based supplement had the lowest value (31).

When the data was subjected to Kruskal-Walis one way analysis of variance, the results showed that the response to the feeding trial of the beneficiaries who received the five different supplements and also between the experimental and the control group there were significant variation between supplements (X^2_5 - 14.18 significant at 1% level). The maximum response (score of 60) was noted among children who received rice based supplement. When children receiving the supplements were compared, a difference in response was seen only in children who received rice based supplement and other four were on par.

As presented in Table 35 when the scores for quality attributes (I) and response of feeding trial (II) were combined and ranked the first rank was for in rice based supplement with total score of 109, followed by cassava based (106), ragi based (91), rice soya based (79) and banana based (70)in the descending order.

Thus it can be noted that as rice based supplement secured the first rank when the scores of all the characteristics were to summed up. Therefore it can be used as an effective supplement under ICDS since the ingredients in the mix are easily available and suitable to the people of Kerala; it is cheap; takes minimum time for processing and preparation; had high acceptability in terms of organoleptic quality; children had less morbidity; showed a positive change in the anthrometric indices like weight, mid arm circumference, Chest/Head circumference ratio and BMI when it was fed to children. Hence rice based supplement could be recommended as a desirable supplement that satisfies the needs of the local children and their mothers and could be popularised as a supplement, for homelevel or community level, production and feeding under ICDS and for sale or free distribution on a large scale.

DISCUSSION

DISCUSSION

Quantitatively though Kerala has achieved remarkable progress in the reduction of infant mortality which has been identified as an indicator of positive health status, the incidence of mild to moderate levels of malnutrition among two third of infant population cannot be treated as trivial, but it is to be dealt with utmost care and insight.

Hence for combating malnutrition among the vulnerable groups a study was conducted to test the feasibility of utilising food mixes developed by KAU as food supplement under ICDS. Five different such food mixes developed by the Department of Homescience, Kerala Agricultural University were selected for the study and these supplements were fed to the children from five selected Anganwadi Centres for a period of five months. Preschool children from a nearby Anganwadi Centre functioned as control subjects for comparison. The characteristics of the supplements on various parameters like suitability and availability, yield, time for processing and preparation, cost, shelf life and acceptability were initially assessed. Variation in anthropometric measurements of children like height, weight, arm circumference, head circumference and chest circumference after supplementation for five months were also monitored. The results obtained from the above trial are discussed below.

Availability and suitability of raw ingredients

According to Marero *et.al.* (1998) supplementatry foods needs to be developed from locally available resources which are economical, easily digestible and acceptable to children.Gopaldas *et.al* (1982) and Desikachar (1983) have also pointed out that low cost and locally available cereals and pulses should be utilised for preparing supplementary foods. Rosado *et.al* (2000) had opined that the ingredients needed for production of supplementary foods should be available in the country in sufficient quantities and at a relatively low cost and should be produced locally. Details pertaining to availability and suitability of ingredients used in the five supplementary food mixes were examined in the light of the above recommendations.

Banana based mix has banana flour, sesame, horsegram and skimmilk powder as its raw indgredients. Nendran banana is the basic staple used in this mix. It is considered as the most easily assimilated of all fruits and the fruit has been used as palliative food for people suffering from various intestinal disorders. Kerala grows multitudes of varieties of banana suitable for dessert and culinary purposes and the state produces 415156 tonnes of banana which is cultivated in a considerably large area of 29120 ha of land (Government of Kerala, 2001). Because of this fact it is an item used frequently in the daily diet of Keralites and it is one of the most familiar item used by young and old. Banana has always found a place in the preparation of weaning foods in Kerala from time immemorial.The afore said statements reveals that the major staple included in banana based mix is locally available and is readily acceptable to the common man.

The area under sesame cultivation in Kerala is 2771hectares with a production potential of 284 tonnes (Government of Kerala 2001). According to Rice (1971) effective use of oilseed proteins can go a long way towards correction of dietary protein deficiencies. Hence the use of sesame in the mix is justified, being a familiar and locally available protein source incorporated into banana based mix.

According to Desikacher (1983) addition of milk solids could increase the nutritive value of supplementary foods and make them nutritionally complete. But the addition of skimmilk however increases the cost of the final product. Dijkhuizen (2000) has also supported this view that the addition of dried skim milk powder increases the cost but greatly improves the flavour. Thus it is seen that the banana based supplement has banana, horse gram, sesame and skim milk powder all of which are familiar ingredients that are easily available from the local market.

Ragi based supplementary food consists of ragi, greengram, cassava, sesame and skim milk powder. Ragi is the basic item in this mix. It is known as a poor man's millet popular in central and southern parts of India and the average annual production of ragi in Kerala is 1273 tonnes in the year 1998-99 (Government of Kerala, 2001). This millet has been used as a traditional item for weaning infants in Kerala. According to Rao(1986) it is the best millet suited for weaning food, being rich in calcium, iron, B vitamins and protein. Further it is easily available in the markets of Kerala.

A protein rich complement should form a part of any supplementary food formulae and Christobal *et.al* (1968) had suggested that a mixture of plant proteins and animal proteins the most economical complement which is nutritionally adequate. Hence green gram and skim milk powder finds their place in this multimix. Green gram is very familiar to the Keralities as it is used everyday in the households and is locally available. Greengram is also familiar to the children attending the Anganwadi Centres and primary schools, since their mid-day meal consists of rice and greengram. As explained earlier skim milk powder though less familiar it is easily available from the markets in Kerala. Hence all the items in the ragi based mix are familiar and easily available to the people of Kerala.

Cassava is the energy complement used in the mix and it functions as a concentrated source of energy. Gopalan (1979) has stated that people of Kerala have adopted tapioca as their basic food. He has reported that eventhough the protein content is very low it is easily digestible and is a fair source of phosphorous and calcium and has traces of iron and vitamins. It is a poor man's crop and is used as a partial substitute for cereals, (Ghosh, 1984) as it is the cheapest source of calories (Ramanathan *et.al.* 1990)

Rice based mix contains parboiled rice, soya and groundnut as its ingredients. Sailakshmi (1995) has reported that rice or wheat is usually used as the cereal base for supplementary foods. Rice as the staple food of Keralites from ancient times, has many diverse uses and is consumed in many forms (Munday et.al 1989). It is the most important food crop of Kerala and is easily available being cultivated locally in an area of 35263 ha. with an annual production of 82.12 million tonnes (Goverment of Kerala, 2001). Rice has been recognised as a food material of more than half the world's population as pointed out by Pillaiyar (1988) and Stephanie (1990). Among cereals it has a comparatively high content of essential amino acids as reported by Bandyopadhyay and Roy (1992). Again, parboiled rice is the preferred staple cereal of majority of Keralites and is easily available and also is processed indigenously in Kerala. Gopalan *et.al.*(1996) had reported that parbolied rice is more nutritious when compared to raw rice. Danur(1985) had pointed out that the mineral content of rice is found to increase as a result of parboiling. Hence its use in two of the KAU supplement is justified.

Groundnut and soya flour are the protein sources of rice based mix. The annual production of groundnut is 29.29 million tonnes. (Government of India, 1999). Oil seeds like groundnut are inexpensive, familiar to people, easily available in local market and at the same time are rich source of energy and protein. Groundnut is readily available in the local markets of Kerala and so is familiar to Keralites.

Here the pulse component used is soya flour. Singh (1997) had reported that soyabean production in India is 4.89 million tonnes and it is cultivated in an area of 5 million hectares with an yield of 1020 Kg/ha. He has also stated that soya bean has great potential to provide good quality protein and calorie at low price and helps in combtaing protein calorie malnutrition in the country. Moreover it is found to contain 40 percent protein which is twice the protein content of common pulses (CFTRI, 1992). Patil (1997) has pointed out that properly prepared soya flour is high in protein content and is very similar to inclusion of an egg in the diet.

Although not cultivated as a regular food crop in Kerala, it has been shown by Pushpakumari (1981) that soya bean can be effectively cultivated in the rice fallows of Kerala.

Though soya is not cultivated in Kerala it is not unfamiliar to the children in Kerala who are the beneficiaries of the nutrition intervention programmes impemented in the state. Supplements like Corn Soya Blend (CSB), Corn Soya Meal (CSM) which were distributed through balwadies and anganwadies contains soya as a major component. Moreover soya bean is now available in the market. Though the high income groups are using this in Kerala it is less familiar to those in the low income groups. Hence all the above mentioned items of rice based mix except soya are familiar to people of Kerala. However all the three ingredients can be purchased from local markets.

Rice soya based supplementary food contains raw rice, soya, amaranth and skim milk powder. Rice which the primary ingredient in this mix is capable of imparting desirable characteristics like smoothness, flavour, colour and taste in reconstituted products. The pulse component used along with rice is defatted soya flour, which is a rich source of plant protein.

Amaranth leaves which is another component of the mix is locally available, inexpensive, easy to cultivate and cook and is rich in several nutrients essential for human health. Yadav and Sehgal (1995) have opined that vegetables occupy an important place specially in vegetarian diets of India supplying essential nutrients apart from adding variety to the diet; while Gopalan *et.al* (1996) have emphasized that green leafy vegetables in general are rich sources of β-carotene, ascorbic acid, calcium, iron, riboflavin, folic acid and provides protein as well as appreciable amounts of other minerals. Amaranth is familiar to Keralites and is also available locally at a cheap rate. Another ingredient in the mix is skim milk powder is a source of protein and is easily available from the local markets. The ingredient in the rice soya based mix are easily available and familiar to the people of Kerala.

Cassava based supplement contains cassava, soya and skimmilk powder. As discussed earlier in this chapter cassava, soya and skim milk powder are familiar to the people of Kerala and are also easily available from local markets.

When the availability and familiarity of the ingredients of the five different supplements were scored ragi based supplement had the highest score (17) followed by banana based (13), rice soya based (12), rice based (10) and cassava based (8) mixes in the descending order. As also discussed earlier the ingredients in the ragi based mix viz ragi, greengram, cassava, sesame and skimmed milk powder are easily available and cultivated in Kerala and also are very familiar to the people of Kerala. Therefore ragi based mix may be adopted as a supplement for distribution under ICDS from the point of view of availability and familiarity.

Cost

With a goal to improve the nutritional status of the people several nutrition intervention programmes have been implemented in Kerala. One of such nutrition intervention programme implemented in the state is ICDS. The supplements given under ICDS were all supplied by external donor agencies and hence the actual cost of the supplements were not known. Moreover since they have been supplied free of cost, neither the recipients nor the government seemed to be concerned about the cost of supplements. Sukin and Sykes(1984) had opined that complementary feeding programme that use donated imported foods have been vigorously criticised in recent years as dole programmes that create dependency and it is extremely important that communities be integrally involved in the planning, design and implementation of complementary feeding programmes. Hence it is better to discard dole foods and to produce and distribute indigenous foods.

Moreover the supplementary nutrition through ICDS utitlising foods donated by WFP was however terminated in 1997. Hence substitutes had to be made using locally available, low cost nutritious ingredients to the needy beneficiaries. They should not be of prohibitive prices as these supplements are to be given free of cost to a large segment of populaltion over several years, inorder to make much programmes cost effective.

Devadas (1983) had suggested that the supplementary foods for the young children in the low income strata of the society must necessarily be low in cost. Ashlesha and Vali (1997) have observed that the commercial ready-to-eat foods are very expensive. Hence there is a need to develop low cost ready-to-eat foods which are easy to prepare.

Mehta and Shah (2000) had also stressed the need for developing supplementary foods with technologies that are accessible but are also cost effective and those that would use locally available ingredients.

With the above concept when the unit cost of the five KAU supplements were evaluated, rice based mix was found to be the cheapest (Rs.20/kg) and banana based mix (Rs 75/Kg) was found to be the costliest . When the percapita cost of feeding was assessed it was seen that banana based mix was the costliest (Rs. 6.75/90g) and rice based mix was the cheapest (Rs. 2.00/100g) in order to supply atleast 300 calories of energy and 10-12g of protein per day as required under ICDS.

In rice based mix, rice constituted the major portion (850g/kg) which costs Rs. 13 per kilogram. Though groundnut is considered as a costly item (Rs. 36/Kg) only 50g is used and hence it does not influence the cost of the mix to a great extent.The same fact also applies to soya flour. The flour was found to be low cost (only Rs 14 per Kilogram) and only 100 grams are used to make a kilogram of the mix.. Hence the rice based mix is found to be the cheapest when compared with the other supplements. But the cost of this supplement can further be reduced if rice distributed through ration shops is made available to prepare the mix in large quantities for feeding under ICDS.

Banana based supplement was found to be the costliest among the five mixes since it contains sesame and skim milk powder. Among the different items used to produce to banana mix, the basic material banana seems to be less costly compared to other items. To prepare every kilogram of banana based mix 300g of banana flour is required. For the production of 300g of banana flour 1.6kg of raw banana was needed when household technology was used for its production. This low yield of the flour as well as wastage encountered through the removal of skin also contributed indirectly to higher net cost of the supplement. The cost of sesame was Rs. 60/Kg while skim milk powder was the costliest item being Rs. 112/ Kg. Though the amount used is less in the mix, the cost of sesame and skim milk had also helped in accelerating the cost of this mix, though it contained horse gram which is a cheap source of protein..

The cost of cassava based supplement was Rs. 45 per kilogram. Here the major part of the cost can be attributed to skim milk powder. Though cassava costs only Rs. 5 per kilogram the processing loss of cassava seems to be very high, hence a large quantity of raw cassava is needed to prepare the flour. However the soya flour was cheap but was highly nutritious. Neelakantan and Jayalakshmi (1987) have reported that soya bean is one of the cheapest source of protein available today.

Ragi based supplement costs Rs 42 per kilogram. The greater part of the cost in this supplement is borne by sesame and skim milk. Ragi and greengram are relatively cheaper (Ragi Rs.12/Kg and greengram Rs. 22/Kg), when compared to sesame and skimmed milk (Rs. 112/ Kg).

Rice soya based supplement costs Rs. 34 per Kilogram. Here also the major part of the cost is due to the presence of skim milk powder. Dijkhuizen (2000) had reported that the addition of dried skim milk powder increases the cost but greatly improves the flavour. Though amaranth is cheap (Rs. 5/Kg) its processing loss is very high and hence a large quanitity of raw amaranth is needed to prepare the mix in a powdered form.This would also ultimately increase the cost.

Ashlesha and Vali (1997) have developed wheat germ based supplementary food formulations with wheat germ, greengram and ragi as its ingredients and found that the developed mix had relatively low cost which ranged from Rs. 3.92 - Rs. 4.43 per 100 g when compared to other marketed samples.

For supplements to be provided under ICDS, the material needs to be produced on a large scale so as to cover the entire preschool beneficiaries of a larger area viz a panchayat / block /taluk/district or state at length. This large scale production is liable to reduce the cost. Another aspect is that for large scale feeding, generally the supplements will be processed at a central point and would be transported to various centres which may enhance the cost.These too might influence the cost of production.

Thus based on the cost, rice based supplement is found to be the cheapest as rice,soya and groundnut are low in cost and as the mix has high yield with less processing loss. Hence this can be popularised as a supplement under ICDS. The next preferred mix on the basis of its cost would be rice soya based supplement.

Nutritional adequacy

According to Pederson *et.al* (1989) and Young and Pellet (1987) the supplementary foods given to a child should be nutritionally adequate. Thus a food material to be used as a supplement in a mass feeding programme like that of ICDS should also be nutritionally adequate.

The nutritional adequacy with respect to composition of the five supplements were compared with components of "Food Square". The concept of multimixes and the 'Food Square' system has been adopted for formulation of nutritionally acceptable supplementary foods by several workers including Livingstone *et. al.* (1993) and Dahiya and Kapoor(1994). The five KAU mixes when fitted into the "Food Square" to ensure that they are ideal supplements, it was found that rice soya based mix is the most acceptable one as its ingredients can be fitted into the 'Food Square', so that it can fuction as an effective 'multimix'. In this supplement the basic mix comprises of rice and defatted soya flour where in rice is the staple and soya is the protein supplement. It also containes amaranth leaves and skim milk powder, which are good sources of minerals and vitamins. Another advantage of this mix is that it contains two good protein sources; Skim milk and Soya - one of animal and other of plant origin. Cameron and Hofvander (1983) have remarked that two protein foods, one from an animal source and another from a plant source when used together is effective in improving the protein quality of a supplementary formulae. The mix also has a specific vitamin, mineral component which increases the nutritive value of the mix further.

It could be observed that banana and ragi based supplements are also adequate when viewed in the light of nutritional adequacy based on their composition. The ragi based mix has two staples, ragi and cassava which provides energy. Greengram and skim milk provides necessary protein which forms a combination of animal and plant proteins which renders the material to be of high biological value. In the banana based mix horsegram and skim milk constitutes the protein source.

It can be noted that cassava based mix and rice based mix does not have a specific vitamin - mineral compliment hence they can not be treated as effective supplements when its components are fitted into be the food square. Thus based on the 'Food Square'concept rice soya , banana and ragi based supplements are found to be nutritionally adequate.

Apart from the composition, in order to find out the nutritional adequacy, the quantity of nutrients supplied by the supplements was also to be taken into consideration. Moreover as per the norms stipulated by the Ministry of Social Welfare the supplement used under ICDS should supply 300 kcal of energy and 10-12g of protein. (Neelakantan, 1991).

In order to find out the suitability of the supplement initially the mixes should be capable of providing the above two nutrients in required amounts.

The calorific value of the five multimixes ranged from 300-403 kcal.Cassava based food provided the highest amount of energy (403 kcal 100 g) while the lowest energy content was observed for banana based supplement (300 kcal / 100g). The high energy content of cassava based food could be the presence of soyaflour along with cassava in it. One hundred gram of soya flour supplies 432 Kcal of energy (Nandi, 1997). The above facts indicates that all the five mixes satisfies the calorie requirement, as stipulated under ICDS.

While comparing the nutrients, it was noted that the protein content of the five supplements ranged from 11.2g to 20.4g. The ragi based supplement had the highest protein value of 20.40g per 100 g and rice based supplement had the lowest protein content. Three of the supplements have soya as a component which supplies protein. Neeraja *et.al* (1991) had observed that the amount of nutrients would increase due to roasting, which may be attributed to lowered moisture content, causing a concentration effect. That may explain the high content of protein in the supplements especially of ragi based (20.4g), banana based (18.6g) and cassava based supplements (18.2g). All these four supplements also have skim milk powder as an ingredient which is rich in protein while rice based mix does not have this ingredient in it and therefore has a low protein content. This indicates that all the five mixes can be used as supplements under ICDS since all of them satisfies the protein requirement of 10-12/g per serving.

The nutritional adequacy cannot be adjudged only by the quantity of protein. If the supplements are to be effective, their quality is to be taken into account. As reported by Young and Pellet (1987) a supplementary food should be nutritionally adequate. One of the methods to assess the nutritional adequacy of a food is to find out its protein quality.

Mitchell (1924) had introduced the term "Net Protein Utilisation of Dietary Protein" which is a product of Digestibility coefficient (DC) and biological value (BV) divided by 100. Since the NPU of the five supplements were already available they were used to assess the protein quality.

While comparing the NPU of the five supplements it was noted that the NPU of ragi based supplement was 83 which was the highest followed by banana based, cassava based and rice soya based supplements with NPU of 79, 78 and 71 respectively and the lowest value of 67 was noted for rice based supplement. The reason for high NPU value of ragi based supplement may be the presence of skim milk powder. The other three mixes viz. banana based, rice soya based and cassava based mix also have relatively high NPU values. This could be attributed to the presence of skim milk powder and soya which are found to be the ingredients that supplies good quality proteins. Malleshi *et.al* (1986) have reported that an increase in NPU from 51.60 to 63.40 was possible by the addition of 10 per cent skim milk powder to any supplement. Absence of skim milk powder may be one of the reasons for the low NPU of the rice based supplement.

In a study conducted by Gahlawat and Sehgal (1994) a weaning food consisting of rice, greengram and jaggery (70:30:25), the NPU was found to be 53.56 ± 2.48, while in a study conducted by Sailakshmi (1995) the NPU of a mix containing par boiled rice, defatted soya flour and groundnut flour (85:10:5) was 67.

In this study the NPU of the five supplements ranged between 67 and 83 (Prasad, 1988, Philip, 1987, Chellammal, 1995, Sailakshmi, 1995 and Jacob, 1996). As reported by Devadas (1983) supplementary foods should have an NPU of 60 to 65. It was observed that all the five different supplements had an NPU above 65. Thus in conclusion since all the five supplements under the study had an NPU above 67 all can be used as supplements under ICDS.

A supplement if it has to be nutritionally effective, it should supply other nutrients other than protein and energy. In order to understand the nutritional supremacy of the five mixes, their nutrient content with respect to fat, essential minerals and vitamins were examined, since according to Potty (1993) the nutritive value of a food is an important parameter for the development of any new food.

The fat content of banana based mix (10.3g) was observed to be the highest followed by ragi based mix (7.3g) while the rice based supplement had only 2.5g / 100g of fat. The high fat content in banana based mix may be attributed to the presence of sesame. The low fat content in rice based supplement may be the low fat content of rice, which forms 85 percent of the above multimix, whereas the amount of soya and groundnut, the other two components in this mix is very low; ie, 10 and 5 per cent respectively which if present in larger quantities might have increased the fat content and hence also the caloriedensity.The low fat content of rice based and cassava based supplements could also be attributed to addition of defatted soyaflour. The low fat content can be considered as one fact which might have helped to extend the shelf life of all the supplements.

Ragi based supplement had the highest calcium content which was 578mg/100g and the lowest content was observed in rice based supplement (322 mg / 100g). The high content of calcium in ragi based mix is due to the presence of ragi, sesame and skim milk powder which are rich sources of calcium where as in rice based supplement, rice, which is the major ingredient of the mix is low in calcium. Chellammal (1995) had observed that addition of skimmed milk powder in to a food increased its calcium content.

As far as the iron content was concerned the ragi based supplement had highest amount of iron and the lowest concentration was noted in rice based supplement. The higher iron content may be attributed to presence of ragi, sesame and greengram in the ragi based multimix where as for rice based mix, rice is reported to be a poor source of iron.

The highest carotene content was observed in rice, soya based supplement which was 381.2 μg followed by cassava based, rice based, banana based supplements with 106.5, 42.6 and 41.2 μg respectively and the lowest value was seen for ragi based supplement (40.4 μg).

The high carotene content of rice soya mix is due to the presence of amaranth leaves and soya in the mix. Gopalan *et.al.* (1996) have emphasised that green leafy vegetables in general are rich sources of β- carotene, ascorbic acid, calcium, iron, riboflavin, folic acid and that it provides proteins as well as appreciable amounts of other minerals. Soya has a carotene content of 426µg/100g (Gopalan *et. al.* 1996 and Nandi 1997). The high carotene content of cassava based supplement and rice based supplement may be due to the incorporation of skim milkpowder and soyaflour in it (Chellammal, 1995). The carotene content of ragi based mix could be attributed to the presence of ragi, greengram and sesame which have a carotene content of 42µg/100g, 94µg/100g and 60µg/100g respectively (Gopalan *et.al.* 1996) in them, where as in cassava mix cassava is reported to be a poor source of carotene.

In conclusion it can be observed that all the five mixes are effective in supplying energy and protein as per the requirement of a supplement under ICDS (300 kcal and 10-12g protein). However ragi based mix has the advantages of having high, calcium and iron content in the multimix and rice soya mix has a higher content of carotene. Therefore, based on the nutrients ragi based mix and rice soya based mixes can be used as an effective supplement under ICDS.

Hence based on the Nutritional adequacy ragi based supplement was found have the highest NPU and was also rich in calcium and iron when compared to the other four mixes while rice soya based supplement was found to be the effective supplement based on "Food Square" followed by ragi based and banana based supplements. Based on protein and calorie content the all the supplements are effective. When protein quality was taken into account all the five mixes had an NPU above 65. When nutrient content was evaluated ragi, banana and rice soya based mixes also were found to be effective supplements which can all be popularised under ICDS.

Ease of preparation

As observed by Geerwani, (1983) Women's employment has solved the economic problems of the family to some extent, but has created some nutritional problems. Educated and uneducated working women are dependent on others for feeding their infants while at work they are willing to buy weaning / supplementary foods at a higher cost if they are time saving. But not many weaning / supplementary foods are available at hand for the people belonging to the low income groups.

According to Tirumaran (1993) the introduction of locally processed and preserved nutritious ready-to-use foods will reduce the time spent in drudgery by the farm women along with income generation and improved nutritional standards.

Hence if the supplement is to be advocated for large scale feeding, it should be made from locally available cereals and pulses and the preparation and processing of the raw materials should involve simple technology so that it is less time and energy consuming and is also cheap.

While comparing the simplicity of the technology used in processing the five supplements minimum steps involved in processing was for cassava based supplement (7 steps like powdering of cassava chips, roasting of soya flour and cassava flour) followed by rice based supplement (8 steps such as cleaning, drying, powdering and roasting of rice, roasting and powdering of groundnut and roasting of soya flour) which is followed by rice soya based supplement (10 steps where amaranth leaves has to be plucked, dried and powdered, rice has to be cleaned, dried and powdered and soya flour roasted). Elaborate processing is needed for ragi based supplement which involves twenty one-steps followed by banana based supplement which involves fifteen steps. Here steps include soaking and malting of grams and ragi, peeling, cutting, drying and powdering of banana, roasting and powdering of sesame which are labour intensive activities, that takes much time and careful handling. Hence these cannot be advocated to working women who are pressed for time with "double days work".

In cassava based supplement only cassava needs processing; like peeling the skin of cassava, cutting them, washing, powdering and roasting. But majority of the cassava used for the feeding trial was produced from dried parboiled chips which was readily available in the market. The other ingredients in the supplement are soya flour and skim milk powder, where soya flour needs only roasting as the processing method, were as skim milk powder can be used as such without any processing. Rice based mix and rice soya based mix also does not require elaborate processing like germination or malting which takes time and is laborious. Simple technology of washing, drying, powdering of rice, groundnut and amaranth are involved in it.

The complexity of the process can be understood from the process chart given in Table 8. Hence based on the simplicity of the technology cassava based supplement ranks first followed by rice based, rice soya based, banana and ragi based supplement.

Though some of the multimix require several elaborative steps, all the methods of processing involved are well known and familiar to mothers of Kerala. Moreover none of the steps call for expensive and elaborate equipment.On the other hand the utensils and simple household devices available at hand could be made use of for processing and even for roasting and drying the ingredients. The roasted ingredients could be powdered at ordinary flour mills if necessary. Such mills are available even in rural areas of Kerala. The cost of pounding is also low. Hence all the processing and preparation procedures are simple, less time consuming and well known to the rural housewife.

According to Gahlawat and Sehgal (1994) supplementary foods should be developed in forms which make their preparation easy.

The time taken for processing can also be taken as an indicator of simplicity with respect to processing. Rosado *et.al.* (2000) had opined that the production process for the supplements should be as simple and cheap as possible so that this allows the supplements to be produced in different regions of the country therefore facilitating their distribution.

The time taken for processing unit quantities of different supplements varied between the five mixes where banana based mix and ragi based mix took 90 hours as the total processing time followed by rice, soya based and cassava based supplement, (50 hours), Rice based mix took the minimum time of 14 hours for processing. Banana and ragi based supplements took the maximum time for processing as the steps involved in processing were complex. Though the processing of rice soya based supplement was simple, the inlcusion of amaranth in it, where the plucking and drying of amaranth leaves are involved, the time required for processing also increases.

Rice based mix consumes least time as it does not involve germination or drying. It involves only roasting and powdering. Thus after comparing the five supplements rice based supplement can be recommended as a supplement under ICDS when time and ease of processing are taken into consideration.

According to Huffman *et.al.* (2000) pre cooked cereals reduce the amount of fuel and cooking time needed. They also save time in peparation because few ingredients needed to be processed.

Hence not only the time taken for processing but the time taken for converting the powdered supplements into recipes (puttu or balls) needs to be reduced to make the product acceptable. The time required for preparation of puttu varied within a range of 8-11 min while for balls it was 6.5 - 8 min indicating that balls takes minimum time for preparation than puttu. However for feeding trial, puttu was selected because it was more acceptable and familiar to the clientale.

One of the major criterion recommended by ICMR (1970) for judging the acceptability of developed supplements is that the method of preparing the supplement should be simple and it should not take more than 15 minutes. Huffman *et.al.* (2000) had remarked that an ideal supplementary food would only need a short cooking period, which would save mothers' time and enable the food to be cooked each time just before it is served.

In the case of the supplements under focus the preparation time in all the cases did not exceed 11 minutes and hence it can be concluded that based on the time taken for the preparation, all the five mixes can be considered as acceptable as per the recommendation of ICMR (1970). However based on the ease of preparation of the multimixes on the whole rice based supplement was found to be the simplest one.

Yield of the multximix

The yield of the supplement (mix) both during processing and preparation (recipe) is one of the major factors affecting the cost of the mixes. The weight loss during the processing should be minimum in order to facilitate maximum output or yield. The higher the yield more will be the returns for the amount spent. Hence any supplementary food prepared should have minimum processing loss with high yield. Hence the processing loss and the yield ratio of the supplements were worked out.

A higher yield ratio may be pronounced as a favourable phenomenon in the case of ready - to - cook mixes that are to be prepared in bulk and stored for feeding large number of beneficiaries. Moreover when the yield ratio is high, only small quantities of the nutrient dense multimix needs to be taken to obtain the desired quantity for feeding individual children.

The processing loss was also assessed and highest loss was seen in rice soya based supplement (0.65). This was because of the low yield of amaranth powder during processing. The quantity of amaranth powder obtained from the fresh vegetable was found to be very low.

The processing loss of banana based mix was found to be the next highest in comparison with the other mixes. In this case the low yield of banana powder during processing accounts for processing loss. The processing loss of cassava based supplement is found to be the lowest. This is because majority of the cassava used for the feeding trial was produced from dried parboiled chips which was readily available in market. Hence the loss was low. But if the powder was prepared from the fresh tuber the loss would be very high. There was also no processing loss for, skim milk powder and soya flour which were the other ingredients of the multimix.

The processing loss of rice based mix was found to be comparatively low. During processing, rice, groundnut and soya suffered minimum loss. Thus it can be noted that cassava based mix has the lowest processing loss of 0.13 hence the highest yield followed by rice based mix (0.14). While rice soya based supplement had the highest loss. Hence based on the processing loss of the supplements, cassava based supplement is the most suitable followed by rice based supplement and hence they may be popularised as supplements under ICDS. The processing loss in cassava based mix is low because dried chips was used instead of the raw tuber.

The yield ratio of the five supplements in the present study ranged from 1.77 - 1.94. The maximum yield ratio was found for cassava based mix (1.94) followed by rice based and rice soya based (1.85), ragi based supplement(1.8) and the minimum yield ratio was found in banana based mix which was 1.77. The high yield ratio of cassava based supplement is due to the precence of cassava itself which forms a major portion (50 per cent) of the basic mix. The high yield of rice soya based mix and rice based mix could be mainly due to the presence of rice which forms the major part of the basic mix. Rice swells and increases in bulk due to gelatinization when mixed with water. The minimum yield was found in banana based supplement as the swelling of banana, horsegram, sesame or skim milk is minimum when compared to rice or cassava. Hence based on the yield ratio cassava based supplement can be popularised as a supplement under ICDS when compared with the other four supplements as it gives the highest yield ratio,while converting the multimix into a recipe.

Shelf life of the supplements

As reported by Livingstone *et.al.* (1993) shelf life qualities are essential parameters to be assessed since they determine the suitability of a particular product. This should be a matter of great concern in the case of supplementary foods. Children are extremely sensitive and vulnerable to various diseases and Mathur and Reddy (1983) have reported that incidence of diarrhoeal disease is high in children which could be due to microbial contamination of food and water.

Varsanyi (1993) had observed that storage of foods has become so complex that an entire industry has been developed to satisfy the needs of the consumer. The mechanism and the kinetics of food deterioration can be controlled by the storage techniques applied.

The multimixes that were packed in polyethylene covers, kept in air tight containers and stored for a period of nine months were subjected to visual examination at the end of each month.There was absence of visible signs of spoilage till the sixth month. Out of the five food supplements cassava based supplement had exihibited minimum visual changes during the storage period.

Food in excess of immediate consumption is stored for future use. As reported by Mathen (1997) one disadvantage of storing is the deterioration it undergoes during storage. This deterioration is caused by damage due to bacterial and fungal infections and insect infestation. Foodgrains, flours, dry fruits, oilseeds, tubers, spices and condiments are subjected to insect damage. Nevertheless the damage caused by insects may be considerable since they not only consume stored food but also contaminate them with insect ferments, faeces, webbing, and ill smelling metabolic products. As reported by Mathen(1997) and Chellammal (1995) insect attack depends on atmospheric conditions at the place of storage, length of storage and method and conditions of storage.

The assessment of incidence of insect pest contamination of the stored supplements revealed that insect infestation could be observed in the supplements only from the seventh month onwards. Upto the end of ninth month the insect count was carried out. The storage pest namely *Tribolium Castaneum* was the only pest found in all the mixes. The mean value for insect count from 7-9 month showed that the maximum count was seen in rice based mix (58.0) and the minimum count was for cassava based supplement (28.6). A study conducted by Chellammal (1995) on complementary food products based on cassava and sweet potato showed that in the stored products *Tribolium Castaneum* was seen after nine months with a count between 0.40 - 15.00. In the present study also with respect to the signs of spoilage and insect infestation cassava based supplement was found to have the minimum spoilage and insect count and hence could be popularised as a supplement under ICDS. The study also indicates that all the supplements have good shelf life since they all were free of deterioration up to a period of six months.

Processed foods which are stored and consumed after a period of storage require certain microbiological criteria to be employed to ensure their quality and safety. Many organisms causing food borne illness may grow in processed foods. As observed by Sankaran (1993) several factors such as raw material quality, storage temperature, storage containers, process employed, the environment in which it is processed etc will have an effect on the microbiological quality of the processed foods. Leela et.al (1993) had also stated that processed foods and ready to eat foods provide ample scope for contamination and spoilage with pathogenic micro organisms, thus necessitating microbiological quality assessment as an integral part of food processing.

In order to ascertain that the multimixes are safe for feeding children, the total microbial count and the microbes present in the feed if any were acertained by serial dilution technique. The samples were observed for the presence of fungus, bacteria and yeast colonies. The total bacterial count revealed that banana based, ragi based and rice soya based mix had a bacterial count of 30,000 per g. The lowest bacterial count was seen in rice based mix (10,000/100 g) followed by cassava based mix (20,000/g). However the count was within the limit specified by ISI ie (50,000) IS : 1656 - 1969 indicating that all the supplements are safe to be fed to children . It also reveals that superior quality raw materials and hygienic handling practices were invloved in the preparation of all the supplements.

In a storage study of rice and cowpea based weaning food a bacterial count of 20,000 was reported by, Roman *et.al.* (1987) while Gopaldas *et al* (1982) had reported a bacterial count upto 50,000 during the storage of malted weaning food prepared by them.

The supplements were also assessed for the presence of E.Coli It was found to be absent in all the five supplements which indicated that the supplements have been prepared in a hygienic manner and can be given to children safely.

Preference of mothers for the supplementary foods developed

Watts *et.al* (1989) have reported that during the development of new food products or the reformulation of existing products like identification of changes caused by processing method, by storage or by the use of new ingredients, their acceptability should be assessed by conducting preference test on a large number of consumers. They have also stated that preference studies are designed to determine consumer's subjective reactions to external phenomena and their reasons for having them.

Hence the five supplements were given to 560 mothers of the local area to know their preference for the two recipes viz puttu and balls made from the KAU mixes. While comparing the five supplements except for banana based supplement mothers preferred puttu and 61.2 per cent of the mothers preferred puttu than balls. Moreover puttu is easy to prepare, especially for mass feeding. It is less time and fuel consuming and can be served easily. Therefore supplements were given in the form of puttu. This may be due to the fact that the appearance, taste and flavour of mixes increase while steaming whereas for balls as it is not steamed there is a decrease in aroma and flavour. It may also be due to the fact that puttu is a trdaditional food and so is very familiar to the people of Kerala.However Indian Food Industry (1995) had reported that quality is the main criterion on which the acceptability of any product depends.

Hence organoleptic quality of the recipes made from the KAU mixes were evaluatedby experts who also ascertained the high acceptability of puttu.The reason for preferring puttu than balls by majority of the judges was due to the fact that the appearance, colour, texture and flavour of puttu were scored higher than balls.

Therefore based on the opinion given by the experts and mothers "puttu" was used as recipe in the feeding programme.

Organoleptic evaluation

Setty (1989) has defined the quality of a food as a combination of the attributes that determine the degree of acceptability of the product. These include nutritional value, microbiological safety, cost, convenience and organoleptic qualities. For an average consumer the concept of food quality relates to the sensory characteristics which may be classified in accordance with the human senses of perception as appearance, kinesthetics (texture), odour and taste.

Assessment of organoleptic qualities was carried out mainly to draw conclusion about a particular food from a large population through selection by limited number of panel members.

According to Mahony (1985) the organoleptically assessed samples form a true representative of the products developed and organoleptic assessment stands essential for the further development of products.He has further opined that through sensory evaluation tests, the judge will provide clues about physical characteristics of the developed product.

The most acceptable variation of puttu (25g jaggery with steaming) and balls (25g jaggery without steaming) made with the five different KAU mixes were presented before experts to find out the most acceptable supplement.

Birch et. al. (1988) have opined that the first impression of food is usually visual and a major part of our willingness to accept a food depends on its appearance. It is a composite of all information about the product and its environment, which reaches the eye. Colour, one of the important visual attributes has been used to judge the overall quality of foods for a very long time. According to Fergus (1993) colour influences the sensory characteristics and in turn influences the food acceptability, choice and preference.When the appearance of the five supplements were compared rice based supplement received the highest score for both puttu and balls (5).

The better appearance and colour of rice based mix may be due to the good colour combination created by all the ingredients used in the mix. Rice, groundnut and soya when mixed together gives a pleasing appearance than the other mixes where sesame and horse gram in banana based mix, sesame and ragi in ragi based mix and amaranth in rice soya based mix may induce a dull appearance to the above mixes marring its acceptability.

Odour difference is generated by stimulation of sensory cells by specific compounds present in the food. According to Birch et. al. (1988) flavour is the mingled but unique experience of sensation produced by a material taken in the mouth perceived principally by the senses of basic smell and by other cutaneous smell in the mouth. While comparing the five supplements for flavour the puttu and balls made of rice based mix had the highest acceptability, while cassava mix had the lowest profile.

The high score for rice based mix may be due to the fact that the process of roasting of parboiled rice and groundnut is involved in the preparation of this mix. This enhances the flavour of the product. The flavour of rice soya based may be due to the presence of skim milk powder in it. Dijkhuizen (2000) had supported that the addition of dried skim milk powder improves the flavour of supplements. Where as for cassava based mix cassava and soya together gives an off flavour to the product and also sesame and ragi gives an odd flavour to banana and ragi based mix. Moreover steaming might have enhanced these off flavours already hidden in the raw mix.

Texture constitutes a physical property of food stuffs apprehended by the eyes, the skin and muscle senses located in the mouth. When the texture of the recipe using the five supplements were compared rice based, banana based and rice soya based mix had the same score of 4 (for both puttu and balls) followed by ragi based and cassava based mix in the descending order. This might bedue to the effect of processing involved. When all the ingredients in the mixes are powdered, roasted and sieved and then mixed, they might all exhibit similar texture.

Taste is a primary attribute which determines the acceptability of a food material. When the supplements were compared the highest score for taste was observed for rice based mix (5) for both puttu and balls followed by rice soya based, banana based, ragi based and cassava based mix. The highest score for rice based mix might be due to the presence of groundnut in it. As for rice soya based the taste is enhanced by the addition of skim milk powder also roasting of rice and groundnut apart from enhancing the flavour might have also gone a long way to improve the taste as well.

Addition of sesame, ragi and cassava might have decreased the taste of ragi based mix and for cassava based mix the addition of cassava and soya flour might have induced a slight bitter taste which might have lowered its overall acceptability.Moreover the lump formation in puttu made with cassava might have reduced the acceptability of cassavabased mix.

Thus when puttu and balls made with the five supplements where compared with regard to the organoleptic quality attributes rice based mix secured the highest score and cassava had the lowest score.

Therefore rice based mix made into sweet puttu may be used as a supplement under ICDS, based on its acceptability. However cassava based supplement, though it had several other plus points is found to be organoleptically least acceptable, which could be attributed to the sticky nature of cassava when made in to puttu.

Effects of the feeding trial

The effects of the feeding trial was acertained through rate of participation, rate of consumption, morbidity pattern and clinical profile of the subjects and changes in various anthropometric parameters before and after the feeding trial.

Rate of participation

The rate of participation of children in a supplementary feeding programme will influence the effect of the supplement; as higher the participation higher may be the impact of the supplement on the nuritional status of the subjects. Bijlsma and McClean (1997) had reported that the child supplementary feeding programme does make an impact if the children attend the programme regularly. Tjon and Kusin (1990) had observed that if a supplementary feeding prograamme has a positive effect on attendance rates, it contributes to a higher coverage of various activities like immunization, health and nutrition education and growth monitoring which are associated with the developmental programme

Hence based on the rate of participation in the feeding trial, children fed with cassava based supplement had a higher rate compared with those who were fed with the other four supplements which might also endorse the acceptability of the supplement.

The rate of participation of children in the supplementary feeding programme in this study also might have depended on the motivation given to the children by the anganwadi workers and also by the mothers of children. It might also depend on the health and nutrition education given to the mothers. Further it may be influenced by the morbidity status of the beneficiery children also. It can be noted that children fed on rice and cassava based mix had lower morbidity rate (6.3 and 6.6 per cent). The higher attendance will also might be due to higher acceptability.

Higher rate of participation is also likely to influence the beneficial effects of supplementation. Only when the children attend the feeding programme regularly, there will be a positive response due to feeding . Sarojini *et.al.* (1999) have observed that children attending the anganwadi centres in Hyderabad were fed with ready to eat food containing 2g of red palmoil and it was seen that there was an increase in the attendance of the children and the quantity of supplements consumed and she also observed that the nutritional grades of children improved which resulted in the removal of vitamin A deficiency among the beneficieries.

Quantity of Supplement consumed and plate waste

Jasen and Harper (1980) opined that supplementary foods can be used as a direct means for providing malnourished population groups with the additional food they required. These foods may supply not only much needed food energy, but also substantial amounts of high quality protein, vitamins and minerals. But it is essential that the food eaten should be adequate in quantity. Devadas (1986) had observed that the major consequences of giving inadequate or wrong kinds of food, as increased susceptibility to infections and frequency and severity of diseases, decreased physical performance and increased mortality. UNICEF (1990) has reported that the nutritional status of an individual is directly influenced by food intake and by the occurrence of diseases. Gross *et. al.* (1996) have opined that a larger inadequate food intake and/or repeated episodes of infection that do not allow an adequate absorption of nutrients will result in growth resolution. Hence an adequate intake of food for that particular age group is to be ensured.Therefore the quantity of the five supplements consumed and the plate waste during the entire feeding period was recorded. It was noted that the maximum mean consumption was among children who received cassava based supplement (99.37 percent) followed closely by rice based supplement (99.20 per cent) and banana based mix (97.71 per cent). The maximum consumption of cassava based supplement and rice based supplements might be due to the taste of the supplements as well as the motivation provided by the anganwadi workers and helpers. This might also stimulate the children further to come to the anganwadies which will enhance the consumption rate and thus a positive response to the feeding trial.

When the rate of participation of the children in the feeding programme and the quantity consumed were compared it was seen that the children who had the highest attendance (average 82 days) had the maximum consumption (99.37 per cent). This shows the relationship between rate of participation and the quatity consumed. It was also noted that children fed with rice based supplement also had a mean consumption of 99.2 per cent. When the rate of participation of these children and their mean consumption were compared, it was seen that they too had a higher attendance (81 days) and hence the quantity consumedwas also high. The higher consumption rate of rice based supplement may also be due to the high overall acceptability of rice based mix

Clinical profile of the subjects

Jelliffe (1966) had reported that clinical examination is an important practical method of assessing the nutritional status of a community. The method for clinical examination is usually based on examination for changes believed to be related to inadequate nutrition that can be seen or felt in superficial epithelial tissues, especially the skin, eyes, hair and buccal mucosa, or in organs near the surface of the body, such as parotid and thyroid glands.

The clinical assessment done on children revealed that the most prevalent deficiency sign was anaemia followed by caries. But it can be noted that there was no clinical deficiency signs of protein energy malnutiriton like Kwashiorkar and marasmus.This is in line with observations made by NNMB (1996) that manifestation of pure clinical deficiency sings of malnutrition are lesser in Kerala when compared to other states of India. Asha (1990) had reported that in rural areas of Trivandrum clinically detectable nutritional deficiency signs were much less.

Prakash (1999) had observed that anaemia is the most widespread nutritional deficiency disorder in the country with high prevalence particularly among children. He also had stated that among children of 1 to 6 years in India 56.3 per cent boys and 57.5 per cent girls have moderate forms of anaemia and 10.9 per cent boys and 7.6 per cent girls have severe forms of anaemia. A similar picture of increased prevalence of anaemia is noticed among the children participating in the present study also.

While comparing the five supplements, among those children who were fed with rice soya based mix four deficiency symptoms remained even after the feeding trial. The reason may be that they are the symptoms of a more serious ailment and recovery is not based on diet alone as opined by Nair (1999). There was minimum recovery (10% children became normal) among the control group after the five months of trial period. The presence of iron (4.2mg) in rice soya based mix may attribute to the reduction of anaemia in children who consumed it. Children who received ragi based supplement also had a better recovery from the clinical signs. Here also the higher content of iron in ragi based mix (5.3mg/100) compared to other mixes might have reduced the number of cases of anaemia in this group of children. The maximum positive effect of shift of children from malnourished category to 'normal' category was seen among children fed on rice soya based mix (26.6%), followed by rice based mix (23.8%), banana based (21.7%), ragi based (10%) and cassava based mix (8.3%) in the descending order.

The higher shift of malnourished children to normal category among the subjects who received rice soya based mix may be because of the nutritional adequacy of the mix. This mix contains all the components (staple, protien, vitamin and mineral supplement and energy supplement) that has to be there in a multimix.Moreover the mix was found to supply good amounts of caroteneand iron due to the presence of leafy vegetables in it. It may also be attributed to the higher rate of consumption (97.7%) and lesser incidence of minor ailments (6.7%) among these subjects. The higher shift noted among the children receiving rice based mix may also be due to higher rate of participation (81 days), low morbidity (6.3%) and higher acceptability of the mix.All these factors would positively influence the nutritional status of the subjects.

Hence based on the clinical profile of children rice soya based mix was found to be the most effective followed by rice based mix.

Morbidity

Soman (1994) had opined that preschool children in the urban environment suffer on an average, more than 100 days of illness while the number of disease free weeks is less than 26 for the whole year. Fever, respiratory diseases, diarrhoea and skin disorders constitute the bulk of childhood disorders (UNICEF, 1991).

Indrayan and Satyanarayana (2000) have opined that morbidity is departure from health. This results or has potential to result in at least some restriction in performing the normal activities of life. They also observed that morbidity in children could be in terms of infectious diseases such as diarrhoea, pneumonia and tetanus, or chronic disorders such as congenital anomalies and thalassemia.

The minor ailments observed among children who received the supplements were cough, cold, vomiting, diarrhoea, boils, ulcer and conjuctivitis.

Cunha *et. al.* (2000) have assessed the profile of complaints and clinical syndromes of children under five in Rio de Janeiro in Brazil and found that the most frequent complaints were fever and respiratory signs (cough or difficult breathing and running nose).

Similar findings were observed by Awasthi and Pande (1997) who conducted a study on morbidity pattern of preschool slum children in Lucknow and found that the major community burden of disease was due to combined respiratory and diarrhoeal diseases. They also observed that diarrhoea was found highest in summer and skin diseases in the monsoon months and influenza in the months of January, April and May.

Incidence of infections ie morbidity is found to be more among children than adults. Such a state of affairs further increases the nutritional requirement of children because Rao (1999) has opined that infection brings about deterioration of nutritional status. Moreover dietary deficiencies and infective morbidity act synergistically (Prakash, 1999). Similar studies were reported by Latham (1999) and Ramalingaswamy (1999). Infection precipitates malnutrition either by reduced intake or by decreased utilization of food or through increased nutrient loss.

Hence to see whether the nutritional status of the subjects was influenced by morbidity, and to find out whether morbidity pattern was influenced by the nature of supplement the morbidity pattern during the feeding trial period was assessed.

In the present study the minimum disease incidence was noted among children who received rice based supplement (6.3%) followed by cassava based supplement (6.6%). This minimum incidence might have a relation with the rate of participation and rate of consumption as only a healthy child can come to the anganwadi and participate in the feeding trial and also can consume the quantity of supplement served which can directly influence their nutritional status.

Ramalingaswami (1999) had reported that recurrent infection and unhygienic practices adversely affects the nutritional status of children.

When children who received five supplements were compared with respect to the rate of participation it was seen that children who had cassava based supplement and rice based supplement had a higher rate of participation (82 and 81 days respectively) when compared with the other three mixes. Hence this can influence the morbidity pattern of the children in that higher the rate of participation, lower will be their morbidity(6.6% and 6.3% respectively).Hence when the rate of consumption is high and the incidence of minor ailments are low the absorption of nutrients among children might be high which might lead to better nutritional status.

Growth pattern of children

Easwaran (1994) had remarked that the commonly used criterion for assessing nutritional status in children and adolescents is their growth rate because physique is influenced by the nutriture received. Use of body dimensions for assessing nutritional status can be traced back to Baldwing in 1925, who while preparing the standards for heights and weights used the term nutritional anthropometry which is now employed for such studies.

Kalia and Sharma (1990) had reported that nutritional anthropometry is one of the important and simple methods of assessment of growth and development, especially in the rapidly growing children.

Saxena *et. al.* (1997) have observed that in developing countries, anthropometry, despite its inherent limitations, still remains the most practical tool for assessing the nutritional status of children.

Onins *et. al.* (1993) had reported that growth assessment is the single assessment that best defines the health and nutritional status of children, because disturbances in health and nutrition, regardless of their etiology, invariably affects child growth.Hence anthropometry was used to assess the impact of feeding the different supplements on the growth pattern and the nutritional status of the subjects.

Height

The higher increment in height that was seen to be brought about by ragi based mix over and above the other four supplements could be attributed to the higher mineral content especially calcium supplied by ragi and skim milk powder which are the major constituents of ragi based supplement. Moreover the availability of these nutrients might have been enhanced because of germination, malting and devegetation.The availability of calcium might have been enhanced by the protein supplied by the skimmilk powder.

When the gain in height was analysed on the basis of different supplements there was no statistically significant difference between the supplements. This shows that there was no difference induced by the nature of supplement on the gain in height.

Similar results were observed in feeding trials conducted by NIN (1969) and Nair (1999).This might also be due to the fact that heightis a parameterwhichdoes not reveal a significant difference in six months period as observed by Andrews (1997).

However when the nutritional status of the subjects when further evaluated through classification procedure suggested by Waterlow *et. al.* (1972) based on height for age it was found that 35 per cent of children fed with banana based supplement came to the normal category from the marginally malnourished category after the feeding trial. This indicates the nutritional supremacy of banana based supplement over other supplements

Thus it can be noted that based on the gain in height and on the basis of Waterlow's classification ragi based supplement and banana based supplement are found to be effective supplements which can be recommended for feeding under ICDS.

Weight

Gopaldas and Sheshadri (1987) had stated that weight is a measurement of body mass. Weight deficiency appears to be the best indicator of the prevalence of protein-energy malnutrition in children of all age groups.

A significant difference at one per cent level ($F_{5, 126}$ - 4.15) was noted in the mean weight gain in children belonging to different Anganwadi Centres. The maximum mean gain in weight was seen in children who received rice based supplement (11.87%). The minimum gain in weight was noted for control group children (5.57%) and children receiving rice, soya based supplement (7.20%). The lowest increment in weight was noted in the control group wherethe regularICDS supplement viz. rice with greengram was given as supplement.The difference in gain in weight between the control and experimental group indicates the efficacy of the different supplements developedby KAU.

A significant increase in body weight of the experimental group in feeding trials was also reported by Subrahmanyan *et.al.* (1961), Sindhu (1995), Sailakshmi (1995) and Andrews (1997).

The maximum increase in weight for children who received rice based supplement and ragi based supplement may be the sum total effect of the nutritional efficacy of the supplements *per se* motivation given by the anganwadi workers and mothers to children to eat the products, rate of participation in feeding, absence of illness during the trial period and also of the acceptability of the above products. Higher rate of consumption due to better acceptability of rice based mix over the other supplements might have also led to higher weight gain among children who received rice based supplement. But the lower increment in weight seen among children fed with rice soya based mix might be due to the lower attendance rate and higher incidence of minor ailments which might have negatively affected the quantity consumed as well as the utilization of nutrients from the supplements consumed.

Thus based on the percentage gain in weight of the children all the supplements had brought in significant gain in weight but as rice based mix had the maximum percentage gain, it can be recommended as a supplement under ICDS.

Onins *et. al.* (1993) have stated that weight for age represents a convenient synthesis of both linear growth and body proportions. Gomez *et al* (1956) had classified children into different grades based on their body weight. NNMB (1996) had reported that this classification would enable to identify most needy children in any field oriented programmes. In the present study the data collected on weight for age of subjects, was used to classify children into different grades of nutrition. It was found that the maximum change was seen among children who received rice based supplement where before the supplementation there were 13 per cent of subjects with Grade I malnutrition which was changed to 4.4 per cent after the feeding trial and also 26 per cent of the subjects came to the normal category after trial period. A change from Grade I malnourishment to normal category was also seen in children who received ragi based supplement, rice soya based supplement, banana based supplement and those in the control group also.

The highly positive change in children fed with rice based mix may be due to the motivation given by the anganwadi worker to the children to attend the feeding trial and lower incidence ofminor ailments among these subjects.The positive change in rice based mix may also be due to the higher consumption and higher rate of participation which could be attributed also to better acceptability of the mix when compared to other supplements.

Anon (1999) had reported that a low cost food made with cereal and defatted soya flour in the ratio of 70:25 had improved the body weights and arm circumference of children significantly after supplementation.

Thus based on the weight parameter viz weight gain and nutritional classification based on weight for age it was seen that all the five supplements had a positive impact. However when compared with other four supplements rice based supplement was found to be most effective hence could be recommended for mass feeding under ICDS.

Mid Arm Circumference

Mid arm circumference value was used as an indicator for screening malnourishment among children in this study and also to assess the impact of supplementation.Sharma and Bora (1998) had also supported this view that mid arm circumference is a simple, sensitive and cost effective measurement for community assessment of early childhood malnutrition. Mid arm circumference has been used for many years as an alternative index of nutritional status of children as opined by Mei *et. al.* (1997).

When the beneficiaries were classified into the different grades of malnutrition based on mid arm circumference it was noted that there were no severly malnourished children and all the children became normal irrespective of the type of supplement except for one child who receive the banana based supplement who remained moderately malnourished even after the feeding trial. This shows that the difference in the composition of these supplements does not seem to affect the arm circumference. This could be due to the fact that the supplement was served in such a way that it provides 300kcal and 10g of protein. However the marginal differences observed between the subjectsreceiving different supplements could be attributed to the quantity and quality of other nutrients present in individual supplements. Though there was an increment which varied between 3.12% - 4.20% in arm circumference of subjects who received the five supplements there was no significant variation between the supplements. As there was no significant difference between the gain in arm circumference in the subjects, all the five supplements are found to be effective in improving the arm circumference of the beneficiaries. Thecontrol group of children also had an incrementof 3.7percent in their MUAC.

Multilocational study conducted by NNMB during 1993-94 among rural population including Trivandrum showed that MUAC values of children were below standards.But in the present study only five percent of subjects were found to be malnourished on the basis of their MUAC.

Chest Head Circumference Ratio

Utilizing the measurements pertaining to head and chest circumferences the Chest Head circumference ratio was worked out as it would reveal irregularities in growth which can be taken as an indicater of nutritional and health status of the subjects (Sundaram, 1994).

All the five supplements were found to be effective when the mean percentage gain (which varied from 9.59%-2.55%)in Chest/Head circumference ratio was assessed before and after supplementation as there was no significant difference between the subjects.

When the children were classified based on the Chest/Head ratio there were malnourished children (ie those with Chest/head ratios less than one) in all the five groups of beneficiaries at the time of starting the feeding trial. But after the trial period there was a change in the malnourishment in all the children except for the children who received rice soya based supplement. The maximum change was seen among the children who received rice and cassava based supplement where all the children shifted into the normal category after the feeding trial and for banana based supplement 88 per cent of the beneficiaries came to the normal category from 76 per cent after the feeding trial.

This indicates the positive influence of the supplements. The shift from 'mild' or 'moderate' malnourishment to the 'normal' category indicates the quality and efficacy of the supplements for promoting growth.

The maximum shift was seen among children who received rice and cassava based supplement might be due to higher rate of participation (81 and 82 days respectively) higher rate of consumption (99.2% and 99.4% respectively), low incidence of minor ailments (6.6% and 6.7% respectively) and the higher acceptability of the above mixes.

This general effect shows that the all supplements have favourably influenced the Chest/Head ratio of the beneficiaries especially that of thosewho received the rice based and cassava based supplements and hence these two can be popularised under ICDS.

Body Mass Index (BMI)

Rao and Vijayaraghavan (1996) had reported that the ratio of Weight/Height^2 is referred to as body mass index (BMI). The BMI has a good correlation with fatness. Body Mass Index is a good indicator of nutritional status (NIN, 1991). Rao and Singh (1970) found that Quetlet's index - (Weight/Height^2) is independent of age in preschool children. Malnourished children have lower values of weight/height^2.

A significant difference ($F_{5,126}$-4.36 significant at 1 per cent level) was noted in the mean percentage gain in BMI among the beneficiaries and maximum gain in BMI was seen among children who received rice based supplement (4%) followed by ragi based supplement (2.78%) and cassava based supplement (2.3%)after supplementation. The minimum gain was noted among the children who received banana based supplement(1.10%).However it was surprising to find a lowering in BMI(-3.5%) among the control group who received the regular ICDS supplement.

The lower gain in BMI noted in subjects who received banana based mix might be due to low attendance (average of 67 days), low rate of consumption (75 per cent),high incidence of minor ailments (12.3 per cent) and low acceptability, when compared to other mixes.

Devadas *et. al.* (1984) had reported that the Body Mass Index is a more sensitive index to assess the degree of malnutrition among all other indices for children and was found to be independent of age and sex in longitudinal studies. In the present study the children were classified into different grades based on their nutritional status.

The classification of children based on BMI in to different grades of malnutiriton proved that children who were fed with cassava based mix showed the maximum shift after the feeding trial where after the five months of the feeding trial 65 per cent of the children became normal from 42 per cent which indicates that there is an improvement in the nutritional status. In the case of rice based supplement the percentage of normal subjects increased from 26 to 48 per cent after the feeding trial. As for banana based supplement the percentage of normal category of children was decreased from 44 to 32 percent which shows that there was minimum improvement in the subjects. Children fed with rice soya based supplement had no change in the normal category before and after supplementation. This may be because of the lesser rate of participation of the children (average of 64.8 days) and higher incidence of minor ailments (11.8%) which might discrease the utilization of supplements. Thus cassava based mix and rice based mix were found to favourably enhance the BMI over the othersupplements,they may be recommended as supplements under ICDS.

Anon (1999) had stated that a high density, low cost supplementary food named PUSHTI formulated with popped wheat, roasted defatted soy flour and sugar and fortified with vitamins and minerals had significantly decreased the incidence of grade III malnutrition from 9.1 per cent to 2.6 per cent among children who received it as a supplement.

In a nut shell when the circumferences of arm, head and chest and height were measured to find out the influence of the supplements on the nutritional status of the beneficiaries there were advancements in the measurements of these parameters in all groups. When the gain in these measurements were compared between supplements, though there were variations the increments, they were not statistically significant indicating that all the five supplements are equally effective in improving the nutritional status of these children. The differences in the composition of these supplements do not seem to affect chest, head and arm measurements as well as height of these subjects as stated earlier.

This could be due to the fact that all the supplements were given in such a way that it would provide 300 kcal and 10g protein. However the marginal differences observed between the supplements could be attributed to the bio availability of the nutrients and the quantity and quality of other nutrients present in the individual supplements.

When the nutritional status of the beneficiaries were examined on the basis of gain in body weight as well as BMI the results indicated that though all the supplements are found effective that they positively improved the nutritional status, their efficiency was not on par. There was significant variation between supplements in bringing about an improvement in the nutritional status. This variation is not due to the composition of the supplements per se but due to several other factors involved in the feeding trial. One of the primary factors which might have brought about this change may be the protein quality of the supplements. This fact was found by analysing the value of NPU of the five supplements which ranged between 67 to 83. Though all the mixes were fed so as to provide 10 grams protein the ones with higher NPU might have influenced the overall benefit the children have received through the supplementation. The higher NPU of Ragi based mix (83) might have increased the gain in weight of subjects who received that supplement; higher the NPU higher will be its effectiveness as a supplement. Highly quality protein might inturn influence the absorption and utilisation of other nutrients especially minerals and vitamins.

The second factor which might have induced variation between supplements might be the acceptability. Higher the acceptability more might be the rate of consumption. Higher rate of consumption is normally expected to improve the nutritional status. The acceptability of the mixes inturn is influenced by the familiarity of the ingredient as well as the preparation (recipe). Most of the ingredients in the mixes are familiar except soya. The taste of soya which is influenced by its high fat and protien content is liable to reduce the acceptability of some of the supplements since it might impart a mild bitterness along with altered flavour. Acceptibility of cassava based mix among exports and rice soya based mix among mothers was the least which might be due to the presence of soya flour in it. Variation in acceptability therefore might have brought about differences between the supplements in improving their efficiency.

Acceptability has been recognised as an attribute which decides quantity consumed. The quantity consumed of each supplement by individual children might have introduced variations between supplements. Moreover the quantity consumed over the five months period of feeding time is also influenced by the rate of participation by the beneficiaries. This can be proven by the fact that rice based mix had higher acceptability, higher rate of participation, higher rate of consumption and higher nutritional status in terms of weight and BMI, where as rice soya based mix had lower acceptability by the opinion of mothers, lower rate of participation and hence lower nutritional status in terms of shift to the normal category from malnourished categories.

The influence of the supplements on nutrritional status of the children might also be varied depending on the initial nutritional status of the beneficiaries. It has been reported that anaemic children absorb more iron than non anaemics. Therefore presence of malnourished children at the initial stage prior to feeding might have also brought about a variation in the effectiveness of the supplements. Children from Anganwadi Centres 94, 97 and 96 who were to receive banana based, rice soya based and cassava based mix had 11 children each who were anaemic prior to feeding trial where as for ragi based and rice based there were only 7 and 9 children respectively who were anaemic.Therefore their initial state of malnourishment would have also influenced the rate of advancement in their health status by supplementation.

The insults suffered by the beneficiaries by the way of incidence of minor ailments during the feeding trial period as well as the morbidity status of the beneficiaries prior to their induction in to the study might have also brought in some variation on the impact of the different supplements on individual beneficiaries. In the study the children who had higher incidence of morbidity were those who received banana based (12.34%), rice soya based (11.8%) and their initial BMI was lower (14.5 and 14.7% respectively) when compared to those who received cassava based mix where the initial BMI was 15.3 and the incidence of the morbidity was only 6.6 per cent.

The positive influence of the supplement have further been emphasised by the fact that the supplements have been instrumental in bringing a positive shift in the nutritional status ofthe children; for eg: the number of children with 'normal' nutritional status have been increased due to supplementation. In another way this may be explained by the fact that the number of children who were victims of moderate and mild forms of malnutrition (malnutrition-Grade I and II) has been reduced which has resulted in an increase in the number of normal children. This trend was seen in the case of all the supplements.

This fact of reduced incidence of mild and moderate malnutrition itself indicates the positive impact of the supplements indicating their quality and efficiency. In Kerala mild and moderate forms of malnutiriton is found to be prevalent among 69 per cent of children as reported by Soman (1998) and Mathew (1994). As these supplements especially rice based, cassava based and ragi based supplements are found to be effective in reducing mild to moderate malnutrition, they may be used under ICDS.

Overall evaluation of the five supplements

To find out the most effective supplements all the characters used in the study were grouped into two as "quality of the supplements" and "response to the feeding trial".

While comparing the supplements based on the quality attributes viz availability, cost, nutrient composition, yield, shelf life, ease of preparation, time for processing and preparation, cassava based mix scored the highest (52 outof 75) followed by rice based (49) and the lowest was seen in banana based (39). However these differences were not statistically significant and hence all the five supplements can be used as effective supplements under ICDS in terms of quality attributes.

When the response to the feeding trial was evaluated by scoring the various characters like rate of participation, quantity consumed, clinical profile, morbidity pattern and changes in anthropometric measurements of children who received different supplements there was a significant difference ($x^2$5 - 14.18) - significant at 1% level) between the supplements which shows the efficiency of the supplements. The highest score was seen for rice based mix (60) followed by cassava based mix and the lowest score was noted for banana based mix (31).

But when all the characters included in the study were combined together and the scores were totalled and ranked together, rice based mix ranked first with a total score of 109 followed by cassava based (106), ragi based (91), rice soya (79) and banana based mix (71) in the descending order.

The rice based mix ranked first, which could be attributed to the fact that it scored highest in terms of low cost, overall acceptability, weight gain, BMI, rate of consumption and rate of attendance where as the lowest rank for banana based mix could be attributed to the fact that it was costly; its preparation involved complex procedures; its yield was low morbidity rate was high and nutritional status of subjects who received this mix was also lower when compared to other supplements.

To conclude, inspite of all the variations explained earlier, the study has categorically brought out the beneficial effect of the supplements. The study has proven that all the five supplements are effective in improving the nutritional status of the selected beneficiaries. Hence they all can be used as supplements under ICDS. But apart from their efficiency, the cost, yield, processing loss, shelf life, availability and familiarity, time and ease of preparation of the individual supplements are to be taken into consideration if they are to be recommended as a suitable supplement under ICDS.

While summing up though all thefive supplements were found to be effective rice based supplement was found to be the best followed by cassava, ragi, rice soya and banana based supplements.The rice based mix is recommended as the most suitable mix since it is highly acceptable, easy to process and prepare and also had a positive effect on all anthropometric parameters. The next choice could be cassava based, ragi based,rice soya based and banana based supplements from the nutritional point of view but the processing of these mixes are complex and time taking.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The study entitled "Suitability of food mixes developed by KAU as food supplement under ICDS" was under taken with an objective to test the feasibility of using five supplementary food mixes developed by KAU as supplements under ICDS.

The five supplements were fed to children from five selected anganwadies of Kalliyoor Panchayat, Thiruvananthapuram, so that each Anganwadi would get one particular supplement in the form of a recipe. All the preschool children enrolled in the above five Anganwadi Centres (123) were selected as subjects for the study. All preschool children from a nearby Anganwadi Centre (21) were selected as control subjects for comparison.

The recipes selected were puttu and balls and the preparation of these using the five mixes were standardised. Sweet puttu made using the five mixes by steaming with the addition of 25g of jaggery was found to be the most acceptable recipe and hence was used for the feeding trial of five months. Puttu made from five different mixes were served in such a way that one serving will supply 300 kcal and 10g of protein as per the stipulations made under ICDS. The control group received only the regular ICDS supplement (Rice kanji and greengram).

In order to find out the suitability of the five mixes as supplements under ICDS, several parameters were taken into consideration. These parameters were grouped into two catagories namely (1) Quality of the products (2) Response to the feeding trial. The factors taken into consideration under "Quality of the products" were availability and familiarity of the ingredients, cost, nutrient composition, protein quality, time required for processing, ease of preparation, overall acceptability, yield ratio, processing loss and shelf life. The response to the feeding trial was assessed from rate of participation, quantity consumed, clinical profile, morbidity pattern and variation in anthropometric parameters (height, weight, arm circumference, Chest/Head circumference ratio and BMI) of the subjects.

When the availability and familiarity of the ingredients of the five different mixes were scored together ragi based mix secured the highest (17) and the cassava based mix had the lowest value.

When the cost of one kilogram of different mixes were computed the cheapest was found to be rice based mix (Rs. 20.00) and the costliest was banana based mix (Rs. 75.00).

When the nutritional adequacy of the supplements were analysed based on "food square" principle rice soya based mix was found to be the most acceptable one, having all the four essential constituents of an ideal supplement.All the supplements were capable of supplying one third of energy and protein requirement per serving of pre schoolers and since they also had an NPU of 65 all were found to be adequate from the nutritional point of view.

However ragi based mix was found to have added advantage that it was able to provide additional amounts of calcium and iron when compared to other mixes.

Based on the steps involved in processing as well as the complexity of processess involved in preparing the supplements when examined, rice based mix and cassava based mix were found to be simple when compared to other three supplements. Ragi based mix was found to be the most complex one involving several steps including malting. When the time taken for processing was analysed rice based mix required the minimum time while banana and ragi based mix was recorded to take maximum time , giving another indication to the complexity of processing involved.

When the processing loss were analysed, the highest loss was seen for rice soya based mix (0.65) and the lowest was seen for cassava based mix (0.13) and hence the highest yield ratio (1.94).

The time taken for convertion of the multimix into a rceipe (puttu) for the different mixes showed that the time varied from 9 to 11 minutes and rice based mix took the minimum time (9 min) while banana based mix was found to take maximum time (11 min).

Extended shelf life is one of the essential features of a supplement that is to be used for mass feeding. The shelf life was assessed through physical examination and microbial evaluation of mixes which were stored over a period of time. There was no visible signs of spoilage, in all the five supplements over a period to six months. The cassava based mix exhibited minimum changes in different quality attributes such as colour, appearance, texture and odour and such changes were noticed in it only from the ninth month onwards indicating its stability over the other four supplements.

Thus when the quality parameters mentioned above were taken into account, so as to evaluate the suitability of KAU supplements to be used under ICDS, cassava based mix with a mean score of 52 was found to rank first followed by rice based (49), ragi based (48), rice soya based (47) and banana based mix (39) in the descending order out of 75.

In order to find out the dietary efficiency of the mixes the five KAU supplements were fed to preschool children of five different Anganwadi Centres for a period of five months in specified quantities. The response to the feeding trial was taken as another indicator to examine the suitability of the supplements. The response to the feeding trial was assessed with respect to quantity consumed, rate of participation, morbidity and clinical profile and changes in various anthropometric parameters like weight, circumferences of arm, chest and head and BMI.

When the quantity of supplements consumed were analysed the maximum mean consumption was noted among children who received cassava based mix (99.37%) and the quantity consumed was minimum among those who received ragi based mix (74.58%). The data revealed that there was a significant difference between the quantity of supplements consumed by the subjects ($F_{4,29}$ - 239.34 significant at 1% level) over the entire feeding period.

The variation in quantity consumed may also be due to variation in rate of participation. When the rate of participation (mean attendance) of the children were worked out, the highest mean attendance was seen for children who were fed with cassava based mix (average of 82 days) and the minimum attendance was recorded for those who received ragi based supplement (average of 63.4 days) indicating a significant variation ($F_{5,126}$ -11.92 - significant at 1% level) in the rate of participation among the subjects receiving different supplements.The control group of children had an average attendance of 82 days.

The observations made during the feeding trial period of five months revealed the incidence of common ailments among the subjects and the highest average disease incidence was noted among children fed with banana based supplement (12.3%) and the lowest was among those who received rice based mix (6.31%) and for the control group it was 6.65%. Statistical analysis of data showed a significant difference ($F_{41,210}$ - 1.62 significant at 1% level) in the incidence of minor ailments between the children who received the supplement.

The mean recovery incidence in the clinical profile of children before and after the feeding trial showed a signicant difference ($F_{10,65}$ - 3.076 significant at 1% level) between the subjects. Maximum recovery was observed among subjects who had angular stomatitis (45%) and minimum recovery was noted among those who had scabies and tongue papillae atrophic (15%).

The maximum positive effect of shift from 'malnourished' category to "normal" category (when the clinical profile of children was observed) was seen among children fed on rice soya based mix (26.6%) followed by rice based (23.8%), banana based (21.7%) ragi based (10%) and cassava based mix (8.3%) in the descending order.

There was a significant variation ($F_{5,126}$ - 4.15 significant at 1% level) in gain in weight between the subjects and the weight gain was highest among those who received rice based mix (11.8%) and the lowest was for those who received rice soya based mix (7.20%). However the children from the control group had the lowest weight gain(5.57%).

When the overall effect of supplementation on anthropometric parameters were considered there was a general increase in all the parameters taken into account irrespective of the supplements indicating the nutritional efficacy of the mixes. However when the gain in weight and BMI were taken into account there was a postively significant increase in these two parameters of thesubjects fed with different supplements. Maximum gain in weight and BMI was seen among children who were fed with rice based mix followed by cassava based mix. Though there was gain in height, and gain in circumference of arm, chest and head of all beneficiaries irrespective of the supplements there was no statistically significant variation between supplements. Hence they are found to be on par with respect to their growth promoting characters.

The gain in BMI also varied significantly ($F_{5,126}$ - 4.36 - significant at 1% level) between the groups of children who were fed with the five different supplements and when compared with the control group. The highest gain in BMI was noted for those who received rice based mix .

When the overall nutritional status of the subjects were analysed based on their weight for age there was a variation among the subjects receiving the five supplements. However the maximum shift of children from the malnourished cateogory to normal category based on weight for age was seen among those fed with rice based mix followed by cassava and rice soya based mixes.

The nutritional status of children based on BMI showed that the maximum shift of children from "malnourished" to "normal" category was seen among subjects who received cassava based mix followed by rice based and banana based mixes.

Thus when the response of feeding trial mentioned above were taken into account to evaluate the suitability of KAU supplements to be used under ICDS, rice based mix with a mean score of 60 was found to rank first followed by cassava based (54), ragi based (43), rice soya based (32) and banana based (31) in the descending order (out of 70).

In order to find out the suitability of five KAU supplements, the result of quality attributes and the response of feeding trial were combined together and ranked. The rice based supplement secured a mean score of 109 and was ranked as the best one followed by cassava based (106), ragi based (91), rice soya based (79) and banana based mixes (70 out of 145) in the descending order.

While summing up the results it can be stated that all the five supplements are found to be effective and suitable for feeding under ICDS. However rice based supplement was found to be the best followed by cassava, ragi, rice soya and banana based mixes. The rice based mix is recommended as the most suitable mix since it is cheap, highly, acceptable, easy to process and prepare and also had a postive effect on all anthropometric parameters. The next choice could be cassava based mix, ragi based, rice soya based and banana based mixes which can also be used as effective supplements from the nutritional point of view but the processing of these mixes are complex and time taking.

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*Originals not seen.

APPENDICES

APPENDIX I

COMPOSITION OF THE SUPPLEMENTS

Banana based Supplement

Banana	27g
Horsegram	18g
Sesame	27 g
Skimmed milk powder	18 g
Total	**90gm**

Ragi based Supplement

Ragi	27g
Green gram	18 g
Sesame	13.5g
Cassava	18g
Skimmed milk powder	13.5g
Total	**90g**

Rice soya based supplement

Raw rice	55.35 g
Defatted soya	13.86g
Amaranth	6.93g
Skimmed milk powder	13.86g
Total	**90 g**

Rice based supplement

Parboiled rice	85g
Defatted soya	10g
Ground nut	5g
Total	**100g**

Cassava based supplement

Cassava	37.5g
Defatted soya	18.75g
Skimmed milk powder	18.75g
Total	**75g**

APPENDIX II

SCORE CARD FOR SENSORY EVALUATION OF THE SUPPLEMENTS GIVEN TO EXPERTS

Characteristics	Experts
Appearance	Excellent
	Very good
	Good
	Fair
	Poor
Colour	Excellent
	Very good
	Good
	Fair
	Poor
Taste	Excellent
	Verygood
	Too Sweet
	Not Sweet
	Poor
Texture	Soft
	Hard
	Sticky
	Smooth
	Lathery
Flavour	Excellent
	Very good
	Good
	Fair
	Poor

APPENDIX III

NUMBER OF DAYS OF FEEDING

Anganwadi Centre Number	Supplements	No. of Subjects n	No of days of feeding							
			Jan	Feb	Mar	Apr	May	June	Total	Average
Experimental group										
94	Banana based	25	13	21	23	19	23	6	105	21
92	Ragi based	20	18	21	22	19	22	6	108	22
97	Rice soya based	17	18	21	23	21	22	6	111	22
90	Rice based	23	18	18	22	21	23	6	108	22
96	Cassava based	26	18	21	21	20	23	6	109	22
91	**Control group**	21	16	21	22	20	22	6	107	21
	Actual working days		19	22	25	22	23	6	117	23

APPENDIX IV

Age (Year)		Height (cm)		Weight (Kg)		Arm Circumference (cm)		Head Circumference (cm)		Chest Circumference (cm)	
Intiai	Final	Intial	Final	Intial	Final	Intial	Final	Initial	Final	Intial	Final
1 Anganwadi Centre 90								Total Subjects 23			
3.2	3.8	90.6	95.6	12.5	14.5	16.2	17.6	46.0	48.0	47.5	52.0
2.1	3.5	93.0	95.9	12.5	14.5	15.0	15.7	47.0	49.5	51.0	53.0
4.5	5.1	93.8	98.1	12.5	14.0	14.1	14.7	47.0	48.5	49.0	53.5
3.9	4.3	88.6	94.2	12.0	13.5	15.6	16.5	49.0	51.5	50.0	51.5
3.2	3.8	95.8	97.3	12.5	14.0	14.2	14.6	49.0	50.0	50.0	51.5
3.2	3.8	95.8	97.3	13.0	15.5	15.2	16.2	48.0	49.0	49.0	51.0
5.9	6.3	89.0	92.9	10.5	14.0	14.5	14.8	48.0	49.0	50.5	51.5
4.1	4.7	97.5	100.8	13.0	14.0	14.5	14.7	48.5	49.0	50.0	51.0
4.8	5.2	102.7	103.4	14.5	15.5	14.7	14.8	49.0	49.5	53.5	55.0
3.9	4.3	97.4	99.9	13.0	14.5	14.7	16.0	49.0	50.5	51.5	52.0
4.8	5.2	90.8	94.2	10.5	13.5	14.3	15.2	49.5	50.5	48.0	50.5
4.8	5.2	99.1	103.4	14.5	15.5	15.4	15.5	49.0	50.0	51.0	53.0
3.7	4.1	98.0	99.8	14.0	15.5	15.4	15.5	49.0	50.0	52.0	53.0
2.4	3.1	93.2	97.9	14.0	15.5	16.0	16.2	48.0	49.0	50.5	55.0
5.5	5.1	115.0	118.1	18.0	18.5	14.0	14.9	49.0	49.5	53.0	55.5
5.4	5.1	88.0	92.9	10.5	11.5	14.5	14.8	47.5	48.0	45.5	48.0
3.1	3.7	91.3	94.6	12.0	13.5	16.0	16.5	46.0	47.0	49.5	50.5
3.1	4.4	91.0	92.9	12.0	12.5	14.3	14.9	49.0	49.5	50.0	52.5
4.8	5.2	98.8	103.2	14.0	15.5	15.0	15.5	48.0	49.5	49.5	52.0
3.9	4.3	94.5	100.4	14.5	15.0	15.2	17.0	48.0	49.0	50.0	54.0
2.8	3.2	96.4	101.6	13.0	15.0	15.5	16.4	48.0	49.0	49.0	52.0
4.4	4.1	94.0	97.4	15.0	15.5	17.1	17.6	47.0	49.0	52.5	54.0
2.7	3.1	95.4	97.8	14.0	15.0	16.7	17.1	48.0	49.0	51.0	53.5
2 Anganwadi Centre 92								Total Subjects 20			
5.9	6.3	102.1	105.9	14.0	15.0	13.5	14.1	48.5	49.0	48.0	52.5
4.3	4.9	93.3	96.8	12.5	13.0	13.5	13.7	48.0	49.0	49.0	50.5
3.6	4.0	87.8	89.9	12.0	13.0	15.0	15.9	47.0	47.5	48.0	49.5
2.2	2.8	78.1	80.1	9.5	10.0	13.6	13.9	46.5	47.5	47.0	48.0
2.7	3.1	81.0	85.3	11.0	13.0	13.9	14.7	46.0	48.0	50.0	52.0
3.7	4.1	88.9	93.1	12.0	13.0	14.0	14.3	49.0	50.5	50.0	51.5
4.6	5.0	95.5	98.3	12.5	13.5	14.0	14.5	48.0	49.0	48.5	51.0
4.1	5.5	83.6	98.4	11.5	13.0	14.5	15.0	48.0	50.5	47.0	49.0
4.3	4.9	88.6	91.8	12.0	13.5	14.0	15.0	48.0	48.5	51.0	51.5
4.3	4.9	88.6	91.8	12.0	13.5	14.0	15.0	48.0	48.5	51.0	51.5
5.9	6.3	103.9	106.7	14.0	14.5	14.0	14.2	49.5	50.5	51.0	51.5
2.7	3.1	79.5	81.1	10.5	12.0	15.0	15.5	48.0	49.0	48.0	49.5
5.3	5.9	100.5	104.5	15.0	15.5	15.5	15.7	49.5	49.5	52.0	53.0
3.8	4.2	92.5	95.8	12.0	15.5	14.8	15.3	48.5	49.5	50.0	51.0
4.8	5.2	98.2	101.1	13.5	14.5	14.4	15.6	46.5	48.0	51.0	52.5
3.3	3.9	96.4	97.3	12.5	14.0	15.0	15.3	47.0	47.5	51.0	52.0
3.3	3.9	93.3	93.7	12.5	13.0	15.1	15.5	47.0	47.5	51.0	52.0
2.4	2.1	78.8	79.3	9.0	10.5	13.9	14.3	45.0	46.0	47.0	48.5
4.0	4.6	87.6	92.7	11.5	12.0	14.0	14.2	46.0	48.5	47.0	49.0

contd..........

1.4	1.1	78.5	80.6	9.0	10.5	14.0	14.3	45.0	47.5	48.5	49.0
2.4	2.1	93.6	94.2	13.5	14.0	14.9	15.2	48.5	49.0	49.5	50.5
3 Anganwadi Centre 94								Total Subjects 25			
4.8	5.2	100.2	102.8	14.0	15.0	14.3	14.5	48.0	51.0	50.5	52.5
4.0	4.6	97.0	100.3	13.0	13.5	14.2	14.9	49.5	51.0	49.5	51.5
5.2	5.8	104.0	106.5	14.0	14.5	14.2	14.4	49.0	49.5	51.0	51.5
2.3	2.9	79.8	83.1	11.5	12.5	15.6	15.8	46.0	47.5	49.0	50.5
5.6	6.0	103.1	105.5	16.5	18.0	15.0	15.4	48.0	49.0	53.5	54.4
3.8	4.2	96.2	97.7	14.0	14.5	15.5	15.7	50.0	50.5	52.0	53.0
5.8	6.2	105.0	106.9	13.5	14.5	13.7	13.9	46.0	47.0	50.0	52.5
4.0	4.6	93.8	96.6	13.5	14.0	14.8	15.5	47.0	48.5	50.0	52.0
3.8	4.2	93.6	97.2	12.0	13.0	14.5	14.7	49.5	50.0	47.5	49.0
4.4	4.1	99.5	103.6	15.0	16.5	16.8	17.1	48.5	49.0	51.0	54.0
3.1	4.4	93.8	98.7	15.5	16.5	16.0	16.4	50.5	51.5	54.0	55.0
5.2	5.8	98.8	100.6	12.0	13.0	15.1	15.3	45.5	47.0	48.0	49.0
5.1	6.5	96.0	100.1	13.0	13.5	14.7	15.1	47.5	48.5	45.5	49.5
3.7	4.1	91.0	95.2	11.0	12.0	13.2	14.1	50.5	51.5	46.0	47.5
3.8	4.2	95.6	99.4	13.5	14.0	15.0	15.4	47.0	47.5	50.0	51.5
3.2	3.8	95.5	100.3	14.0	14.5	14.4	15.5	49.0	51.0	51.0	52.5
4.8	5.2	100.2	100.7	14.0	14.5	14.0	14.2	48.0	49.0	49.5	50.5
3.4	3.1	89.6	92.3	11.0	12.5	14.0	14.8	48.0	48.5	47.5	48.5
5.1	5.7	105.2	106.7	16.5	17.0	16.7	16.9	52.0	52.5	49.5	50.5
2.4	2.1	84.2	100.6	12.0	14.0	15.2	15.7	50.0	50.5	48.5	51.5
2.2	2.8	86.0	88.5	11.0	11.5	14.9	15.2	47.0	47.5	48.0	48.5
2.1	3.4	92.3	94.1	12.0	13.5	15.0	15.3	48.5	49.0	48.5	51.5
2.4	3.0	86.0	88.1	9.5	10.5	12.8	13.3	47.0	47.5	47.5	48.5
3.8	4.2	97.4	100.2	13.5	14.5	15.0	15.6	50.0	50.5	52.0	53.0
3.2	3.8	90.6	92.8	11.5	12.0	14.2	14.6	48.0	48.5	50.0	51.0
3.3	3.9	92.5	92.9	11.5	13.0	13.6	14.0	46.0	48.0	50.0	51.5
3.3	3.9	93.3	96.7	12.5	13.5	15.4	15.9	47.5	48.5	50.0	51.5
4 Anganwadi Centre 96								Total Subjects 26			
5.0	5.6	103.6	106.4	15.5	16.5	15.0	15.5	46.5	48.0	51.0	53.5
4.1	5.5	104.7	106.5	15.0	15.5	15.0	15.5	51.0	52.0	52.0	53.0
5.1	5.7	104.0	106.7	19.0	20.0	16.5	16.9	50.0	51.0	56.5	58.0
3.1	4.4	91.6	94.3	13.0	15.0	14.7	15.3	50.5	51.0	51.0	52.5
4.2	4.8	94.3	97.8	13.0	14.0	15.0	15.4	49.5	50.0	49.5	51.0
3.6	4.0	87.2	92.0	12.5	13.5	15.5	15.8	47.5	49.0	49.5	53.0
3.1	4.4	91.5	93.5	14.0	15.0	16.4	16.9	49.0	50.5	50.0	53.0
3.2	3.8	90.0	92.3	13.5	14.0	15.3	16.0	48.5	49.5	51.5	52.5
2.1	3.5	91.0	95.6	15.0	15.0	15.7	16.5	49.5	50.5	49.5	52.0
3.1	4.5	89.5	91.9	12.0	13.0	15.5	15.9	49.0	49.5	50.0	51.0
3.9	4.3	93.4	97.9	12.5	13.5	13.8	13.9	48.0	49.0	51.5	52.5
4.0	4.6	99.8	103.8	14.0	15.5	15.7	15.8	48.5	49.5	51.5	53.5
3.3	3.9	94.0	96.9	14.0	15.0	14.7	15.3	50.0	52.0	49.5	53.0
4.0	4.6	97.4	98.2	14.5	15.0	15.4	16.1	46.5	48.0	52.0	52.5
2.4	2.1	89.8	90.4	11.0	11.5	14.3	14.7	47.5	48.5	48.0	50.5
5.6	6.0	108.0	109.3	17.0	18.0	16.0	16.8	49.0	49.5	51.5	54.5
4.1	5.4	98.5	100.9	15.0	16.0	15.0	15.7	50.5	51.5	50.5	51.5
2.7	3.1	91.5	94.2	14.0	16.0	15.1	16.3	48.0	49.5	48.5	54.5
5.0	5.6	96.9	97.4	14.0	14.5	15.1	15.6	46.5	48.0	49.5	52.0
3.4	3.1	97.5	99.9	16.0	17.0	16.0	16.8	50.5	51.0	50.1	54.5

contd..........

2.9	3.3	88.5	90.1	11.0	12.0	13.6	14.2	46.0	47.5	48.0	51.0
5.5	5.1	112.8	114.9	16.5	18.5	16.0	16.8	50.0	51.0	54.5	56.5
2.2	2.8	87.6	89.3	11.5	13.5	14.8	15.4	49.0	50.0	49.0	52.5
5.9	6.3	92.0	95.4	12.5	13.5	15.0	15.8	47.0	48.0	48.5	55.0
2.4	2.1	88.9	90.1	11.5	12.5	13.9	14.4	46.5	48.0	49.5	50.5
2.9	3.3	91.5	94.4	14.5	15.5	15.9	16.3	48.0	49.0	50.5	53.0
4.7	5.1	100.5	101.3	15.0	16.0	15.0	15.5	50.0	52.5	51.5	53.5
3.7	4.1	94.0	94.7	12.5	14.0	14.6	15.9	46.0	48.5	50.0	51.5

5 Anganwadi Centre 97 Total Subjects 17

5.4	5.1	105.3	108.1	15.5	14.5	15.2	15.4	50.0	50.5	50.5	52.0
4.0	4.6	99.8	102.0	15.5	16.5	15.5	16.4	50.0	50.5	51.5	54.0
5.0	5.6	109.2	113.5	16.5	18.5	15.0	15.6	48.0	49.0	53.0	56.0
4.0	4.6	97.5	100.2	13.0	14.5	14.9	15.2	48.0	48.5	49.5	52.5
Š5.7	6.1	110.5	112.9	16.5	18.5	16.2	16.4	49.0	49.5	53.0	55.0
4.2	4.8	95.5	97.0	14.0	15.0	15.2	15.5	51.0	51.5	52.0	54.5
4.9	5.3	99.2	101.7	14.5	15.0	14.5	14.8	50.0	50.5	51.0	52.5
3.2	3.8	90.8	96.4	12.0	13.0	14.4	14.9	47.0	48.0	49.5	52.5
5.0	5.6	98.5	100.1	14.0	14.5	15.5	15.7	46.5	48.5	51.0	43.0
3.2	3.8	109.0	112.0	16.0	17.5	15.2	15.5	48.5	50.5	55.5	57.5
3.2	3.8	95.0	97.1	15.0	15.5	15.8	16.3	50.0	50.5	53.0	54.0
4.6	5.0	96.6	98.2	15.5	16.0	15.5	15.8	49.5	50.5	52.5	53.5
2.5	2.1	91.7	94.3	13.0	13.5	15.5	15.9	50.0	50.5	49.5	51.0
4.1	5.5	105.5	108.9	15.0	16.0	15.0	15.4	48.5	49.0	54.5	56.5
4.9	5.3	107.0	108.8	15.5	17.0	15.1	15.4	46.0	47.0	52.0	53.0
3.5	3.1	89.5	90.6	12.0	13.5	14.8	15.2	49.0	49.5	50.0	52.0
3.8	4.2	95.0	99.5	14.0	16.0	15.7	15.9	49.0	50.0	51.5	53.5
4.2	4.8	92.0	96.1	11.5	13.0	13.3	13.5	47.0	48.0	48.5	50.5
2.6	3.0	99.2	99.8	16.0	16.5	15.6	16.1	50.5	51.5	51.5	53.0
2.4	2.1	83.4	87.6	11.0	12.5	15.1	15.6	47.0	49.0	47.0	49.5

Control Anganwadi Centre 91 Total Subjects 21

4.8	5.2	95.6	99.1	15.0	16.5	15.0	15.4	51.0	51.5	49.5	53.5
4.0	4.6	88.6	93.1	12.0	12.5	14.5	14.6	50.0	50.5	48.5	52.0
5.9	6.3	107.1	109.6	16.5	17.0	15.5	15.7	48.5	50.0	51.5	52.0
4.2	4.8	86.5	92.2	13.0	14.0	14.4	15.6	46.0	48.5	50.5	53.0
4.9	5.3	82.0	91.7	11.0	13.0	14.0	15.9	47.0	48.0	51.5	52.5
4.9	5.3	79.2	84.4	9.5	10.5	12.5	14.6	45.5	46.5	46.5	49.0
5.1	6.3	105.5	107.3	16.0	16.5	14.3	14.6	47.5	50.5	51.0	52.0
4.1	5.5	92.4	96.9	13.0	14.5	14.8	15.0	49.0	50.0	50.0	52.0
2.9	3.3	84.0	90.7	11.5	12.5	14.3	15.0	46.0	47.0	48.5	50.5
5.5	5.1	96.5	99.8	13.5	14.0	13.1	13.7	46.5	47.5	49.0	52.0
4.5	4.1	97.5	102.4	14.5	15.0	14.0	14.2	47.5	48.5	51.0	52.0
4.6	5.0	107.0	113.0	18.5	18.0	16.6	16.7	49.5	53.0	56.0	57.0
4.7	5.1	96.5	103.6	15.0	15.5	15.7	15.9	47.5	48.0	50.0	51.0
3.1	4.5	95.2	100.5	14.0	15.0	15.7	15.8	46.0	48.0	51.5	52.5
4.6	5.0	95.0	100.6	13.0	14.0	14.5	14.6	48.5	48.5	50.5	52.0
4.8	5.2	100.0	103.4	15.0	15.0	14.0	14.5	50.5	51.5	53.0	54.0
5.1	5.7	96.7	103.4	13.5	14.0	13.9	14.3	46.5	48.5	48.0	50.0
4.9	5.3	91.2	91.6	11.0	12.0	14.1	14.4	47.5	50.5	48.0	48.5
2.1	3.5	81.0	82.7	11.0	11.5	14.0	14.6	49.0	49.5	49.0	50.0
4.1	4.7	95.3	96.3	14.0	14.0	14.5	14.8	50.0	50.5	51.0	52.0
4.2	4.8	95.3	95.8	14.0	14.0	14.3	14.7	48.0	49.5	50.0	53.0

SUITABILITY OF FOOD MIXES DEVELOPED BY KAU AS FOOD SUPPLEMENT UNDER ICDS

By
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ABSTRACT OF THE THESIS
SUBMITTED IN PARTIAL FULFILMENT OF REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN HOME SCIENCE
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DEPARTMENT OF HOMESCIENCE
COLLEGE OF AGRICULTURE
VELLAYANI, THIRUVANANTHAPURAM
2001

ABSTRACT

The study entitled "Suitability of food mixes developed by KAU as food supplement under ICDS" was undertaken with an objective to test the feasibility of using supplementary food mixes developed by KAU as supplements under ICDS.

Five different supplementary food mixes developed by the Department of Home Science, KAU were selected for the study. The five selected supplements were banana based mix, ragi based mix, rice soya based mix, rice based mix and cassava based mix.

All preschool children from five Anganwadi Centres of Kalliyoor Panchayat, Thiruvananthapuram were cooperated for the study as experimental subjects and all presschool children from a nearby Anganwadi Centre were selected as control subjects for comparison.

The five supplements were processed in bulk and were fed to the subjects in the form of sweet puttu for a period of five months, on all working days .The control subjects received the regular ICDS supplement.

To find out which of the five mixes is most effective as a supplement under ICDS the quality attributes of the product as well as response to the feeding trial were taken into consideration. The quality of the products were evaluated based on availability and familiarity of ingredients used, cost, nutritional adequacy, ease of preparation, processing loss, yield ratio, overall acceptability and shelf life of the mixes. The response of the feeding trial was assessed through rate of participation, quantity consumed, clinical profile, morbidity pattern and variation in anthropometric parameters (like height, weight, arm circumference , Chest/Head circumference ratio and BMI) of subjects who took part in the study.

When the quality attributes were assessed ragi based mix had the highest score (17) in terms of availability and familiarity of the ingredients used to prepare the mix and cassava based mix had the lowest score (8). The cost of the mixes varied from Rs. 20 to Rs. 75 per kg and rice based mix was found to be the cheapest while banana based mix was the costliest.

When the nutritional adequacy of the five supplements were compared rice soya based mix was found to be the most suitable as all its ingredients can be fitted into the "Food Square". All the five supplements were found to supply 300 calories and 10gm of protein per serving as per the norms for a supplement under ICDS. Ragi based mix had an added advantage that it supplied additional amounts of iron and calcium, when compared to other supplements.

Based on the steps involved and time taken for processing the ingredients to prepare the mix, the rice based mix and cassava based mix were found to be simple than banana based and ragi based mixes where the processing procedures were complex and time taking. However rice soya based mix had the highest processing loss (0.65) while cassava based mix had the lowest value for processing loss (0.13) and hence had the highest yield (1.94) per unit of raw ingredients processed.

Though all the five mixes had a shelf life of six months, cassava based mix had a shelf life of nine months since there were neither visible changes nor presence of insects or pests. After the storage period of six months the rice based mix had the lowest bacterial count. However the total count was within the acceptable range (50,000/g) range.

When the organoleptic the recipes made from the five mixes were evaluated by expert judges by and selected mothers, sweet puttu prepared from rice based mix secured the highest score (24 out of 25) when compared to that made from other four mixes for its overall acceptability.

Therefore when the quality attributes of the mixes were taken into consideration as a single phenomina, cassava based mix was adjudged as the most suitable mix to be used under ICDS followed by rice based, rice soya based, ragi based and banana based mixes in the descending order.

The suitability of the mixes were also analysed based on the response to the feeding trial. There was a significant variation in the quantity of the five supplements consumed by the subjects.

Statistical analysis of data showed a significant difference in the incidence of minor ailments among the children who received different supplements. Highest diseases incidence was noted among children fed with banana based mix (12.3%) and the lowest incidence was among those who received rice based mix (6.31%) and for the control group it was 6.65%. Maximum recovery after supplementation was observed among subjects who had angular stomatitis (45%). There was a significant variation in the clinical profile of children before and after the feeding trial. When the clinical profile of children was examined before and after supplementation the maximum shift from 'malnourished category 'to 'normal category' was seen among children fed on rice soya based mix followed by rice based, banana based, ragi based and cassava based mixes in the descending order.

When the nutritional status of the subjects were analysed before and after the feeding trial of five months by various anthropometric parameters it was noted that there was a general increase in all the parameters irrespective of the type of supplement given. Though there was a general increase in mean height, arm circumference and Chest/Head circmference ratio, the variation due to supplementation was not statistically significant and hence all five supplements can be considered to be equally effective in bringing about an increase in the above growth indicators.

However, there was a significant variation in the gain weight and BMI between the subjects and the percentage gain was highest among those who received rice based mix (11.8% and 4.1% respectively) and the gain in weight as well as BMI was lowest for those who received banana based mix (1.1%). It was suprising to find that the BMI of the control group had reduced over the period of five months.

When the quality attributes and the response to the feeding trial were combined together to assess the suitability of the mixes as supplement under ICDS, rice based mix was ranked as the most suitable one with score of 109 out of 145 followed by cassava based (106), ragi based (91), rice soya based (79) and banana based mixes (70) in the descending order.

Hence it can be concluded that though all the five supplements developed by KAU had several positive attributes, rice based supplement was found to be the best closely followed by cassava based mix. Therefore, rice based mix can be recommended as a supplement under ICDS since it is cheap, highly acceptable, easy to process and prepare and also because it showed a positive effect on the nutritional status of children.