INTRODUCTION
CHAPTER I

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The period of an infant's life during which there is a gradual change over from exclusive breastfeeding to the family diet, is a critical one. This period which extends from 6 to 24 months has been identified as a period when the child's nutrient needs are the greatest and his growth rate is most rapid (Ghosh 1980, Burman 1982). Studies sponsored by WHO (1981) on patterns of breastfeeding indicated that in most countries infants who are fully breastfed do well up to the age of 4 to 6 months. However, after the sixth month, breast milk alone is no longer sufficient to sustain the rapidly growing infant (Waterlow 1979, Scrimshaw and Underwood 1980) and if breast milk is not supplemented with food then growth falters at this period (Boter et al 1982, Devdas et al 1984, Harper and Jansen 1985).

Undernutrition usually occurs among children who have passed unsuccessfully through the weaning period and nutrition intervention has occurred too late (Graham et al 1963). Effective interventions must take place during the weaning period (Rhode 1987). Therefore, weaning nutrition should be given the highest priority in research and implementation.
In most developing countries, including India, traditional weaning foods are non-milk family foods based on the local staple usually a cereal such as wheat (Triticum aestivum), rice (Oryza sativa), maize (Zea mays) and sorghum (Sorghum vulgare) (Jelliffe 1968, ICMR 1977) or non-cereal starches like Cassava (Manihot esculenta), sweet potato (Ipomoea batatas) and plantain (Musa paradisaca) (Mellander and Svanberg 1984). When these staples are prepared as a weaning food, they are normally made into a thick porridge or a more liquid gruel. Prepared in this way, these starch rich staples will bind large amounts of water and thus become voluminous with a low nutrient and energy density. Even if such a food can provide adequate nutrition for adults, small children cannot be adequately nourished in this way. Their high energy requirement in relation to the body size and their small stomachs simply make it impossible for them to eat enough food particularly if the number of meals per day is low. If the volume is decreased by lower dilution of the food with water, the thickness/viscosity of the food will increase and thus make it less easy to consume especially for the younger children whose swallowing capacity is not yet fully developed. Either way, the gruel intake is limited among younger children due to high volume or high viscosity. This high volume viscosity characteristic of the diet is usually referred to as the dietary bulk.
Dietary bulk is often mentioned as a possible or even a probable factor in the etiology of malnutrition in the young child (Gopalan and Rao 1971, Nicol 1971, Jones and Pereira 1972, Chamberlin and Stickney 1973, Waterlow and Payne 1975, Sushila and Rao 1983). Based on their habitual meal pattern, young children are not able to consume sufficient amounts of this diet to meet their energy requirement.

Results of several longitudinal studies on children have shown that the main bottleneck in their dietaries is a primary calorie deficiency and not a protein deficiency (Rao et al 1969, Gopalan and Rao 1971, Jones and Pereira 1972, Rutishauser 1974, Martorell et al 1978, NNMB 1983, Indirabai et al 1984). Studies on growth trials of infants have further proved that when undernourished children were fed with calorie-rich diets, their growth improved strikingly (Ashworth 1969, Gopalan et al 1973, Martorell et al 1978, Devdas et al 1984). It is now clear that through the adequate and judicious use of inexpensive locally available cereal-legume based diets, it is possible to prevent and even to cure undernutrition in children.

However, cereal-rich foods, as mentioned earlier would limit the intake of calories because of the dietary bulk. Hence efforts need to be made to reduce the dietary bulk of starchy foods. In developed countries, the problem of dietary bulk of weaning foods has been solved through
advanced technologies like pre-cooking, high pressure extrusion and enzyme treatment (amylases). These methods are highly sophisticated and not suitable for small scale processing in a house or village among low socio-economic populations. Therefore alternative bulk reducing technologies suitable for such a population need to be investigated.

Weaning foods prepared from locally available foodstuffs using household technologies have several advantages, the most important being high acceptability due to familiar taste, flavour and texture and better acceptance due to low cost and simple methods of preparation. Desikachar (1982) developed weaning foods using traditional technologies like roasting, flaking, puffing, parboiling and malting. Hot paste viscosity of slurries from these processed foods showed that malted gruels had the lowest viscosity and were most suitable for child feeding where dietary bulk was concerned (Brandtzaeg et al 1981).

For the last seven years, this department has been working extensively with fully malted multimixes from various combinations of cereals such as wheat, rice or ragi (Eleusine coracana) and pulses such as bengal gram (Cicer arietinum) or green gram (Phaseolus aureus Roxb) and oilseeds such as groundnut (Arachis hypogaea) (Tajuddin 1981, Gopaldas et al 1982, Gopaldas 1984, Nayak 1985). The cooked
slurries of these multimixes had a much lower viscosity or dietary bulk and a much better acceptability among mother-child units. It was also noted that children fed cooked slurries of these malted mixes consumed much more of these slurries per sitting as compared to their roasted counterpart mixes. However, the overriding constraint was found to be the time, labour and space required for their production. Hence, this proved to be a strong barrier to the transfer of this technology to the community or household level.

Malting is essentially a 3-step process, viz. steeping, germination and kilning. Steeping hydrates, germination facilitates enzyme elaboration and kilning terminates growth of seedling, facilitates development of aroma and enhances storability of malt (Malleshi 1983). The hydrolytic enzymes synthesized during germination are collectively called diastase, alpha and beta amylases being the most prominent ones. Alpha amylase is known as the liquifying enzyme while beta amylase, the saccharifying enzyme. These enzymes are found in considerable levels in germinated cereals and millets (Norris and Viswanath 1923, Acharya 1934, Kneen 1945, Patwardhan and Narayanan 1930, Varner and Ramachandra 1964, Manners 1974, Gibbons 1980).

Desikachar in 1982 reported that 5% of malted barley flour could, on account of its high amylase content,
substantially reduce the viscosity of a 15% cooked slurry of branded Indian weaning foods such as Nestum, Farex, Cerelac and Balamul. In 1983, the Tanzania Food and Nutrition Centre (TFNC) reported that small quantities of germinated sorghum flour named "Power flour" when added to the traditional African cooked gruels from sorghum flour, could effectively thin these viscous gruels.

Based on this hypothesis that a small amount of any malted flour may act as a catalyst in reducing the viscosity of bulky starchy gruels, the concept of an Amylase-Rich-Food (ARF) was first proposed by this department and work on the development of such ARFs commenced.

Although the preliminary observations of both OFTRI and Tanzania were valuable, yet neither group had systematically worked out feasible and optimum conditions of production and shelf life of ARFs nor had they more importantly, run well controlled acceptability and intake trials on infants and toddlers. ARFs have in turn been studied for their thinning effect on various levels of cooked slurries from rice (Gandhi 1985), sorghum (Chaudhary 1986), maize (Kapoor 1986) and wheat (Deshpande 1987). Higher consumption of ARF added gruels have been reported consistently, irrespective of the ARF and the staple used (Gopaldas et al 1986, Gopaldas et al 1988).
Studies on the amylase activity of sorghum, maize and wheat AEFs have shown that sun drying and oven drying of these germinated grains under controlled conditions of temperature and time showed higher amylase activity as compared to pan roasting as was observed in the case of pearl millet (*Pennisetum typhoides*). Pearl millet was not subjected to sun drying and oven roasting previously. Therefore, it was decided to treat pearl millet by different methods of drying and to observe its amylase activity. It was also observed that, of all the grains studied for their amylase activity, wheat was reported to have the highest amylase activity. Therefore, wheat AEF was used for further experiments in this study.

In India, sago, a non-cereal-starchy food, is commonly consumed as an invalid food or as a weaning food in gruel form and for preparations of sweets, snacks and puddings. Sago is prepared from either tapioca, potato, sweet potato, maize or the sago palm (*Metroxylon sagus*) (Subrahmanyan et al 1959). Sago forms a thick gruel and its consumption among younger children is limited because of its viscosity. Therefore, it was decided to study the effect of wheat AEF on viscosity reduction of sago gruels.

Surplus food commodities from developed countries are donated to less privileged nations to alleviate hunger and
malnutrition prevalent among its masses (Sahn et al. 1981). Supplementary feeding programmes with donated foods are the most common form of nutrition intervention. Soya Fortified Bulgar Wheat (SFBW) donated by World Food Programme to the Integrated Child Development Services (ICDS) of India has been found to be unacceptable by children, especially older infants and toddlers. Therefore, the feasibility of serving SFBW in the gruel form and the effect of ARF on viscosity reduction of these gruels was planned in this study.

The weaning food very often among the low socio-economic group is nothing but a portion of the family food (Wijga et al. 1983). The major foods of the low income group populations in Gujarat are "Chapati" and "Khichdi". It has also been observed that commercial snacks are very popular among all classes of people and are especially liked by children. Commercial snacks like biscuits and bread if consumed daily, can be considered an ideal supply of calories for children (Diwan et al. 1982). The feasibility of reducing the dietary bulk of these processed foods (home processed e.g. Chapati and Khichdi and commercially processed e.g. biscuits and bread) with ARF was also envisaged.

The main aim of producing low bulk gruels with ARF and feeding the same to the vulnerable group (infants and toddlers) is to ensure a higher intake of food energy and
thereby improve their nutritional status. In view of this, it was considered worthwhile to study the effect of ARF gruels and non-ARF gruels on the growth of the target population namely infants and toddlers.

The general objectives of the study were:

1. To screen pearl millet for amylase activity.
2. To develop wheat ARF.
3. To study the catalytic action of ARF.
4. To evaluate the acceptability and intake of gruels with and without ARF on infants and toddlers.
5. To monitor the intake of gruels prepared with and without ARF by infants and toddlers (6–24 months of age) over a period of six months. And also to document their effect on the morbidity profile of these children.
6. To evaluate the calorie and protein intake of infants and toddlers subjected to the above feeding trial.
7. To investigate the impact of gruels with ARF and those without ARF on the growth and nutritional status of the child subjects (6–24 months) in the six months growth trial.