SUMMARY AND CONCLUSIONS

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Dietary bulk and low frequency of feeding have been identified as the two probable factors in the etiology of Protein Energy Malnutrition (PEM) in the 6-36 months age group. While the latter is dependent on the socio- economic conditions and cannot be altered, the former is determined by the composition of the diets consumed. In india as well as the other developing countries a cereal/millet/or starchy root forms the staple and constitutes 70-80% by weight of the total diet. This cereal/millet/root flour is generally cooked with water as a porridge or gruel for young child feeding. Owing to the high starch content, the flour has immense water binding capacity and can hold 5-6 times its weight of water. The resultant gruel thus has a high viscosity which increases further on cooling as the starch sets into a gel.

On the other hand, low consistency gruels are preferred for children 6-12 months. This prompts the mother to dilute the gruels with water thereby, lowering the energy density. Thus the porridges/gruels used for young child feeding are characterised by high viscosity and/or low energy density often referred to as the "Dietary bulk". Therefore, in order to address the problem of PEM it is imperative that the underlying problem of "dietary bulk" be solved by reducing the viscosity and/or increasing the energy density.

Of the several technologies tried and tested, addition of Amylase Rich Food (ARF) to any habitually consumed weaning food has been found to be a culturally acceptable and economically viable option.

Keeping the above factors in mind the present study was planned with the following objectives :

I Restandardisation of conditions for steeping and germination for the preparation of ARF from cereals, millets and legumes.

II To study the effect of concentration of ARF on viscosity reduction.

III To study the effect of temperature on the activity of ARF.

IV To study the effect of the period of germination on the hydrocyanic acid (HCN) content of ARF; its distribution in the grain and the sprouts and the effect of heat treatment on the HCN content.

V To study the microbiological quality of ARF, and uncooked and cooked gruels prepared using ARF that has been stored for 1 to 6 months under ambient conditions.

VI To study the effect of addition of jaggery and salt on viscosity and the viscosity reduction power of various ARFs in gruels prepared from cereal + pulse mixes, donated foods and commercial weaning foods.

VII To compare the invitro carbohydrate digestibility of gruels with ARF versus gruels without ARF from selected cereal+pulse mixes.

The study was carried out in five phases in order to fulfill the objectives stated previously.

Phase I : consisted of restandardisation of the conditions for steeping and germination for the preparation of ARF from wheat, sorghum, pearlmillet, maize, green gram, bengal gram and soya bean and identifying the potential sources for the preparation of ARF.

Phase II : studied the effect of addition of ARF at graded levels viz 1-7% of solid contents and the effect of temperature of slurries on the viscosity reduction of ARF.

Phase III : involved testing the safety of ARF with respect to hydrocyanic acid content as well as microbiologically.

Phase IV : studied the thinning effect of ARF on the following :

a) traditional gruels prepared from wheat, sorghum, pearlmillet and maize in combination with green gram and bengal gram in the ratio of 4:1. b) Gruels from donated foods namely Corn Soya Milk (CSM), Corn Soya Blend (CSB) and Energy Food. c) Commercial weaning foods namely Farex, Farex Vegetable, Nestum rice and Cerelac wheat.

Phase V : studied the comparative starch digestibility of gruels with and without ARF from selected cereal+pulse mixes.

The parameters used to fulfill the objectives were as follows :

	OBJECTIVES	PARAMETERS
1.	Standardisation of steeping period	By percentage germination method
2.	Standardisation of the germination period. standardised Brookfield synchrolectric viscometer RVT 50 model.	By viscosity reduction method using a
3.	Effect of concentration of ARF and temperature on viscosity reduction	Using a standardised Brookfield synchrolectric viscometer RVT 50 model
4.	Estimation of hydrocyanic acid	By the method of Indira and Sinha (1969)
5.	Microbiological quality	Total plate count, E. coil and yeast and mold count by IS (1969)
6.	Viscosity reduction by ARF on varios gruels	Using standardised Brookfield synchrolectric viscometer RVT 50 model
7.	In vitro digestibility of starch	By the method of Kon et al (1971)

The results of the study are presented briefly as per the objectives of the study.

The steeping period for proper germination of wheat, sorghum and corn was 12 hours and that for pearlmillet was of 6 hours. A germination period of 24-48 hrs was found to yield an ARF with desirable liquifying power in case of cereals and millets. The time required for this step in the earlier standardisations was 72-96 hrs. The level of amylases elaborated in legumes however was low even after 72-96 hrs of germination. It was thus concluded that legumes were not suitable for ARF preparation.

The ARF prepared from cereals and millets namely wheat, sorghum, pearl millet and corn was required in catalytic amounts viz 4% of the total solid contents for optimum viscosity reduction. Ranking the cereals and millets on the basis of their liquifying effect revealed that sorghum had the maximum amylase activity followed by pearl millet, corn and wheat.

All the ARFs brought about maximum viscosity reduction (80-90%) when added to the slurries held at 80C. Even at this temperature sorghum ARF brought about the greatest reduction in viscosity viz 98% followed by pearl millet 96%, corn 83% and wheat 72%. In the temperature range of 50-70C viscosity reduction was much less.

The ARF from the red cultivar of sorghum (GJ 35 variety) had the highest hydrocyanic acid content at all the periods of germination. The values being 102 ppm after 24 hrs of germination, 197 ppm after 48 hrs, 371 ppm after 72 hrs, 504 ppm 96 hrs and 608 ppm after 120 hrs. In contrast after 24 hrs of germination sorghum varieties GJ 36 and the market variety had a HCN content of 91 ppm and 40 ppm respectively. The other grains studied namely wheat, pearlmillet, and corn had negligible HCN content even at the and of 120 hours of germination. In all these grains the HCN content increased with the period of germination it being maximum in the sorghum variety GJ 35 at all germination periods. Eighty percent of the total HCN was concentrated in the sprouts and the rest in the grains. Treating the ARF at 90C destroyed the HCN almost completely in the sprouts and the grains for all the ARFs.

The microbial load of the ARF and the wheat flour was similar when stored for 0-6 months and assessed using total viable count, E.coil count and yeast and mould count. The uncooked gruels prepared without and with ARF stored for 0-6 months had more or less similar microbial profile thereby indicating that, the catalytic amounts of ARF added to the gruel did not affect the overall microbial quality of the gruels. The major contributors to the microbial load were water, wheat flour and jaggery since these were the macro constituents. Thus it is evident that factors other than ARF namely, the flour and the water used in the preparation of gruel play a decisive role in determining the microbiological profile of the gruels.

On cooking the gruels without and with ARF, all the microorganisms were destroyed. These cooked gruels when stored covered in household utensils under ambient conditions (temperature 35+3C : relative humidity 72%) could be kept safely for 3 hours beyond which the total microbial count exceeded the specified limit and E. coil (though not necessarily pathosenic) and yeast and mould were detected.

Slurries prepared from cereal/millet + green gram had a lower viscosity than the cereal/millet + bengal gram mix. A maximum solid contents level of 25% could be achieved for all the slurries prepared from cereal/millet + pulse mixes. The viscosity reduction brought about by the addition of jaggery and oil to corn, sorghum, pearlmillet and wheat gnil was 84%, 86%, and 81% respectively. A maximum slurry concentration of 20% could be achieved on substituting jaggery with salt. Addition of pearlmillet ARF at 4% of total solid contents was adequate for desirable viscosity reduction in all the gruels. Pearlmillet ARF at 4% solids level was required for desirable viscosity reduction in 25% solid contents gruels prepared from CSM, CSB and Energy Food when added either to the dry mix or added prior to cooking

Farex, Farex vegetable, Nestum rice and Cerelac wheat on reconstitution as per the manufacturer's instructions had a solid concentration of 27.7%, 20.8% 10.1% and 25.0% and a viscosity of 4720, 2560, 2260 and 5400 cp units respectively. The energy content per g of feed was 1.1, 0.8, 0.42 1.05 respectively. Though the viscosity of the reconstituted product was suitable for feeding a young child, the product was lumpy and had a low energy density. Addition of ARF at 5% solids level yielded a product with smooth texture and low viscosity thus providing a scope for increasing the solid contents of the feed. The feeds thus obtained from Farex, Farex vegetable, Nestum rice and Cerelac wheat had a solid concentration of 38%, 31%, 20% and 35% and an energy density of 1.5, 1.3, 0.83 and 1.5 kcal/g of feed respectively.

The results of the in vitro starch digestibility studies indicated that the gruels from CSM, CSB and Energy food had higher digestibility than those from cereal/millet and cereal/millet in combination with pulse flour. Gruels from cereal/millet with green gram had higher digestibility than those from cereal/millet + bengal gram. Further, the addition of ARF was found to improve the digestibility of all the gruels 1.5-2 times.

The important conclusions that emerge from this study are.

- ARF can be prepared using any cereal/millet locally available in the region to reduce the bulk of diets habitually fed to the infants and young toddlers. The technique developed is simple, inexpensive, effective and more importantly a familiar one and hence can be adapted at the household level, the community level or at the commercial level too. Since the ARF can be prepared from any staple grain namely wheat, sorghum, pearlmillet and corn it can be transferred to any part of India or the developing world.

- Since legumes cannot yield a satisfactory ARF an alternate cereal/millet source source needs to be identified for the regions especially the S E Asia where germinated legumes are utilised extensively. The efficacy of catalytic amount of ARF to reduce the viscosity of gruels, irrespective of the substrate, implies its easy adaptability in the community nutrition programs. If the same is incorporated in the commercial weaning foods it can yield a product with improved texture, consistency and energy density.

- The ARF from sorghum can be safely utilised for infant feeding provided the grains are devegetated and the gruels are cooked for atleast 5 minutes.

- The ARF per se is not the determinant of microbial safety of the gruels and has been found to have a good shelf life of six months. However, mothers should be discouraged from feeding their young child a gruel stored for 3 hours or more in the hot and humid climate of India and S.E. Asia.

- The ARF added gruels have a better digestibility which can be an important attribute in the feeding of very young infants and rehabilitation of children recovering from diarrhoea and other GIT disturbances.

- It a consolidated and whole hearted effort is made to disseminate the technique of ARF preparation and its utilisation in developing low bulk gruels we can come a step closer to alleviating the Protien Energy Malnutrition in the vulnerable young child population.