CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

It was possible to produce fermented finger millet-dairy composite gruels with a pH of 4.5 or lower using yoghurt-type bacterial starter cultures such as V2 and YC380. It has been shown by many workers that most pathogenic as well as spoilage micro-organisms are unable to grow when the pH of the environment is 4.5 or lower. From a food safety point of view, these results are of significance particularly in those areas where methods of preservation such as refrigeration are not readily available. The fermented gruels can be stored under ambient conditions and used as refreshment beverages for adults or supplementary foods for infants as and when required with minimal risk of diarrhoeal diseases provided hygienic procedures are observed during the preparation and storage of the fermented gruels. The availability of such a microbiologically safe product would also contribute positively towards the nutrition of infants who are particularly susceptible to diarrhoeal diseases and yet require frequent feeding. The use of starter culture JC, which was developed to ferment cereals, was not successful in all the gruels that contained milk since the type of coagulum formed was not desirable.

Generally, the starter cultures that were used to produce the fermented composites seemed to prefer thermophilic conditions. A higher temperature of incubation may be desirable since it leads to rapid acid production which minimises the risk of proliferation of spoilage and particularly pathogenic micro-organisms. When starter culture JC was used for fermentation, the reduction in pH to 4.5 or lower occurred only when finger millet was present.

Increasing the proportion of skim milk in the gruels increased the viscosity and the firmness of the gruels. It was also observed that some of the gruels that had low proportions of skim milk, or no skim milk at all, had high consistency and firmness

values. This may have been due to retrogradation of starch, especially when the gruels were stored at 7°C.

Generally, gruels with a thick consistency were obtained when an incubation temperature of 45°C was used compared to 37°C. In the manufacture of yoghurt, an incubation temperature of 40 to 45°C is preferred since the rate of acidification is optimal for a product of the desired consistency and firmness.

The composite gruels that were obtained when starter culture V2 was used for fermentation had a smooth, slimy consistency while those that were obtained when starter culture YC380 was used had a grainy consistency. It is known that some bacterial starter cultures that are used for yoghurt manufacture produce mucous substances called exopolysaccharides which may increase the viscosity of the product. Starter culture V2 may be such a culture. One of the problems that is encountered in the production of fermented products containing milk is whey separation. If starter culture V2 is one of these starter cultures that produce exopolysaccharides, the need to add stabilisers to prevent whey separation may be minimised.

Syneresis was observed in the composite gruels that had higher proportions of skim milk. Since milk was the component that contributed more to syneresis compared to the finger millet gruel, reducing its proportion in the composite gruels may therefore have led to a decrease in syneresis. The presence of starch in the gruels may also have played an important role in reducing syneresis with starch acting as a stabiliser. Starch is sometimes used as a stabiliser in the manufacture of yoghurt.

During the preparation of the gruels, the amount of finger millet flour that could be used was limited to 5%. Attempts to use more flour resulted in a thick gruel that quickly solidified upon cooling. From a nutritional point of view, the water content of gruels is important since it contributes to the poor nutritional quality of cereal-based gruels by reducing their energy and nutrient densities. While replacing some of the finger millet gruel with skim milk markedly improved the energy content of the composite gruels, this

was not sufficient to meet all the daily energy requirements for an infant or an adult. In situations such as weaning where infants require a gruel with high energy or even for adults who might need a high energy refreshment beverage or snack, consumption of the composite gruel as opposed to the gruel that has cereal only would be preferred from a nutritional point of view. Ways that have been suggested of improving the contribution of gruels to daily energy requirements would be the addition of malt (power flour) and/or vegetable oil to the fermented gruels.

A product with decreased fat content, as was present in the composite gruels with increasing proportions of skim milk, might be favoured by adults who are interested in reducing the amount of fat in their diet. No significant changes were observed in the amount of fat as a result of fermentation. It is important to note that a limited degree of lipolysis would be desirable as it contributes towards the flavour of fermented products.

The replacement of some of the finger millet gruel with skim milk in the composite gruels and the use of lactic acid bacterial starter cultures YC380 and V2 led to a decrease in the lactose content of the gruels. It is generally accepted that many individuals tend to eliminate dairy products, which are a valuable source of calcium from their diets as a result of lactose intolerance. On the other hand many workers have shown that if the lactose content of dairy products is reduced through fermentation or even enzymatic hydrolysis, lactose-intolerant individuals will be able to benefit from the consumption of such products without experiencing the discomfort associated with the symptoms of lactose intolerance.

The proportion of starch decreased as some of the finger millet gruel was replaced with skim milk. The use of bacterial starter cultures did not significantly affect the starch content of the gruels. Since starch is such an important source of dietary energy, changes as a result of fermentation which do not lead to the complete break-down of starch and its loss as a nutrient are preferred. Such changes would include the partial hydrolysis of the starch.

The reduction in the dietary fibre content of the gruels as a result of replacing some of the finger millet gruel with skim milk in the composite gruels means that infants, who do not require high levels of fibre in their diets, will benefit from consuming the composite gruels compared to a situation where they consume gruels with cereal only where the fibre content is higher.

The protein content of the composite gruels was significantly improved by replacing some of the finger millet gruel with skim milk. The improvement in the protein content of cereal-based foods with supplementation using milk or legumes has been observed by other workers. Since cereals tend to be low in protein, feeding cereal-based diets on their own to infants would lead to inadequate protein intake. As a result of their higher content of protein, the composite gruels contributed more to the protein requirements of both adults and infants compared to the gruels that had cereal only.

The quality of the protein as measured by the lysine content was higher in the finger millet-skim milk composite gruel compared to the gruels with finger millet only. The improvement in the lysine content with the addition of skim milk was such that the pattern for requirements for infants was met in the 50% finger millet and skim milk composite gruel. It has been suggested that the improvement probably results from the proteolytic activity of bacterial starter cultures which leads to an increase in the free amino acid content of the gruels. This is important in the development of weaning foods for infants who have a high requirement for a high quality protein for growth, the maintenance of tissue integrity and health.

On the whole, the results that were obtained in this study show that it is possible to produce a fermented finger millet and skim milk composite gruel using bacterial starter cultures such as YC380 and V2 which are normally used in the manufacture of yoghurt. A pH of 4.5 or lower can be achieved if incubation is carried out at 37°C or 45°C even when the level of skim milk is low. From a nutritional point of view and in agreement with work published by other workers, the composite gruel is superior when compared with the gruel that is prepared using cereal only.

It is, however, important to appreciate that optimal nutritional value, when a composite gruel such as the one prepared in this study, is used for weaning, as a supplementary food for pre-school children and children of school-going age or as a high energy snack/beverage for adults, optimal nutritional benefits are observed only when the composite is part of a total balanced diet. Ultimately, balanced nutrition comes from a wide choice of foods belonging to all the major food groups i. e. dairy, meat and poultry, cereals and legumes and fruits and vegetables.

In terms of future research on the finger millet-skim milk composite, it might be important to look at the effect of adding different levels of skim milk to a constant quantity of finger millet gruel as one possible way of further improving the energy density. The possibility of tannins (which have been found to be present in red varieties of finger millet) influencing protein digestibility of the composite gruels may also need to be investigated. This would provide information on how much of the protein present is available for utilisation as a nutrient.