# CHAPTER 1

# INTRODUCTION

Fermented foods and beverages constitute a major portion of peoples' diets all over the world and provide 20-40% of the total food supply (Campbell-Platt, 1994). Apart from providing variety to foods, fermented foods have the advantage of prolonged shelf life due to organic acids such as lactic acid, acetic acid and other acids produced during fermentation which lower the pH, thus inhibiting the growth of spoilage micro-organisms (Fields, Ahmed & Smith, 1981; Sanni, 1993; Byaruhanga, Bester & Watson, 1999). The lactic acid bacteria used in starter cultures may also have other beneficial effects which include viricidal effects, antitumour effects, bacteriostatic and bactericidal effects against several bacteria including enteric pathogens (Nout, 1994). *Lactobacillus* species play a significant role in most of the fermented cereals and cassava roots in Africa (Reddy & Pierson, 1994).

Preparation procedures for most products are still traditional arts and the fermentation is, by and large, uncontrolled. Starter cultures are not normally used and therefore variations in the quality and stability of the products are often observed. These technological problems in the manufacture of traditional fermented foods need to be addressed in order to reduce losses due to wasteful and inefficient fermentation pathways, poor quality and unstable shelf-life of products (Odunfa & Oyewole, 1998).

Most traditional fermented and unfermented foods are based on cereals such as millets, sorghum and maize. In a review by Taylor & Dewar (2001), these foods can be divided into two groups. The first group includes liquid to liquid-like beverages, gruels and porridges while the second group includes solid pancakes and flat breads. The former exhibit a continuum in consistency, from thin liquids such as *pito* beer of Nigeria through viscous liquids such as African (opaque) beer and gruels such as *mohoto oa mabela* of Lesotho to porridges such as *ting* of Botswana. What

characterises these products is that they have undergone some form of lactic acid fermentation and therefore they are to a greater or lesser degree sour in taste.

An example of a fermented beverage/food that is popular in many parts of Southern Africa, including Zimbabwe and South Africa, is *mahewu, amahewu,* also known as *maheu, magou* or *mageu*. As is the case with most cereal-based foods, *mahewu* has a low protein content (7-9% on dry basis) and the proteins are of a low biological value. It is also a poor source of calcium, sodium, niacin, vitamins A and C (Schweigart & Fellingham, 1963; Ashworth, 1982). Because of the low protein quality and the high moisture content of most cereal-based foods, protein-energy malnutrition is a major problem in Africa (Odunfa & Adeyele, 1985). In Tanzania, as in most countries in Eastern, Central and Southern Africa, it was estimated that about 50% of young children were chronically malnourished and 7-10% of these were severely malnourished (Lorri & Svanberg, 1995). It is important to note that the foods that are generally used for weaning are cereal-based gruels (Nout, Haustvast, van der Haar & Rombouts, 1988).

The nutritional value of fermented foods is therefore an important factor that needs to be addressed. If a fermented cereal product such as *mahewu*, which is already acceptable, could be fortified, it might become a more valuable source of nutrients particularly for pre-school children, children of school going age, pregnant women, nursing women and people recovering from illnesses. Methods of fortifying *mahewu* that have been suggested include use of milk, whey, sour milk products, skim milk powder, whey protein, soya flour, food yeast or fish flour (Hesseltine, 1983). One litre of such a fortified product could produce about 30% of the daily assimilable protein requirements for an adult male as well as 20 – 30% of the requirement for nicotinamide and thiamine (Schweigart & de Wit, 1959).

In addition to the nutritional benefits that are associated with fermented foods, they also offer good keeping quality as a result of the acidity which is produced by lactic acid bacteria (pH < 4.5) (Mensah, 1997). It has been estimated that over three million

children under the age of five years die annually as a result of diarrhoeal diseases and that 70 % of all diarrhoeal diseases are due to the consumption of food that is conatminated (Nout & Motarjemi, 1997). The sources of contamination include polluted water, flies, dirty utensils and pots, food handlers and cross-contamination during food preparation. One of the major factors leading to food contamination is time-temperature abuse during preparation which, in turn, leads to survival and/or growth of pathogens as well as the production of toxins (Adams & Nicolaides, 1997). If the basic rules for safe food production (e.g. using safe water, washing hands thoroughly and keeping food preparing premises meticulously clean) were to be observed, the contamination, growth and survival of pathogens in foods would decrease. This in turn would reduce the incidence of diarrhoeal diseases. This application of basic rules for safe food preparation is not always possible in communities where safe water supplies are inadequate, where fuel for hot-holding or thorough heating are in short supply and where time to prepare food properly prior to each meal is not available. Lactic acid fermentation needs to considered seriously as an alternative to conventional methods of preservation such as dehydration or refrigeration.

In this study, a cereal-based traditional gruel from finger millet was combined with milk and fermented using starter cultures under controlled conditions. The traditional product from which the composite gruel was prepared is referred to as *mahewu* or *maheu* among the *shona* and m*anyika* speaking people and *amahewu* by the *ndebele* speaking people in Zimbabwe. Traditionally, *mahewu* is prepared by boiling a maize, sorghum or finger millet porridge of about 8-10% solids into which, on cooling, a handful of malt made from finger millet or sorghum is mixed. The malt serves as a source of inoculum of lactic acid bacteria. The α-amylase enzyme in the malt probably also serves to thin the gruel by facilitating the breakdown of starch to dextrins since the gruel tends to retrograde and hence solidify upon cooling. Another source of inoculum could be the walls of the clay pots that are used as the fermentation vessels. Although this beverage is most popular during the hot summer

months as a refreshing drink and thirst-quencher, it is boiled and served hot in winter by the *korekore* people in the Mashonaland province in central Zimbabwe.

### 1.1 Aim of the project

To investigate the processes involved in the preparation of a cereal-dairy composite gruel based on finger millet and skim milk and to study its microbiological, nutrient and physico-chemical characteristics.

### 1.2 Objectives of the project

1. To determine the effect of microbiological cultures and fermentation conditions (temperature of incubation and period of incubation) on the acidity, pH and lactic acid bacterial count in the gruels.
2. To assess the effects of varying the proportions of finger millet to skim milk on the pH, consistency, whey syneresis and the firmness of the gruels.
3. To assess the effects of varying the proportions of finger millet to skim milk on the energy, starch, protein and lysine content of the gruels.

### 1.3 Justification

1. The problems of quality, especially the poor nutritional quality and the low biological value of the cereal proteins can be addressed through fortification with a high protein product such as milk. The nutritional value and physico-chemical properties of such supplementary foods need to be investigated.
2. Problems in the microbiological aspects of fermentation need to be investigated to prevent wasteful fermentation pathways through proper selection of starter cultures and the creation of optimal conditions for lactic acid fermentation.