# AN INVESTIGATION OF FACTORS CONTRIBUTING TO EXTENDED STORAGE LIFE OF MEAT PRODUCTS FOR THE TROPICS

A THESIS PRESENTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF TECHNOLOGY IN MEAT TECHNOLOGY
AT MASSEY UNIVERSITY

ALBERTO R. CARISO JR.

1987

# ABSTRACT

A combination of factors which could extend the shelf-life of minced mutton meat during storage under warm conditions (30 °C) while still maintaining a low cost product with acceptable sensory and microbiological properties was investigated. The combination of factors studied involved pH values from 5.5 to 3.5 achieved by the addition of acetic acid, water activity ($a_w$) values from 0.99 to 0.91 achieved by the addition of sorbitol and the reduction in moisture contents, heat treatments from 30 to 50 °C, and the use of different packaging materials (cellulose, polyethylene and aluminium foil films).

It was expected (from reported work) that stability would be achieved by reducing $a_w$ to 0.95 and pH to 5.2, but at 30° C the shelf-life was less than one week. Within the limits of the values that were considered, the control of pH was the only significant factor in extending the shelf-life of minced mutton meat stored at 30° C. To achieve a commercial acceptable shelf-life of 8 weeks, a pH of 4.1 or below was required. Minced mutton with pH of 4.1 can be organoleptically acceptable with the addition of the right combinations of spices and seasonings suited to specific localities and countries. The practical value of lowering the pH of meat products below 4.1 must be questioned because no additional microbiological protection will be obtained and the increase of the acid level will only decrease the flavour acceptance. Combinations of low acid and spices and seasonings would appear to be a development area of greater promise for tropical countries than intermediate moisture meats.

# ACKNOWLEDGEMENT

I am thankful to Mr S.L. Oldfield and Dr B.H.P. Wilkinson who helped and guided me during the course of this work. I am also thankful to the New Zealand and the Philippine governments, and to the Food Terminal, Inc. who made it possible for me to study in this country.

Acknowledgement is also extended to the following:

- Christine, Lucy and Noemi who helped me in proof-reading the manuscript.
- Jun 2 who helped me in preparing the raw materials.
- Tua and the Filipinos in Palmerston North who gave me company.
- Mrs V. Fieldsend who typed this thesis.
- My family who sustained me by their love and support.

# TABLE OF CONTENTS

TABLE OF CONTENTS: CONTINUED

TABLE OF CONTENTS: CONTINUED

TABLE OF CONTENTS: CONTINUED

# LIST OF TABLES

LIST OF TABLES: CONTINUED

LIST OF TABLES: CONTINUED

LIST OF TABLES: CONTINUED

# LIST OF FIGURES

LIST OF FIGURES: CONTINUED

LIST OF FIGURES: CONTINUED

# LIST OF APPENDICES

# CHAPTER 1

## INTRODUCTION

The history of food preservation closely parallels the great advances in civilization. Man needed a stable source of food, readily available before he could turn his attention to the development of his culture and society. During the early period of recorded history, dried products were the major stored food items to offset shortages of fresh products. These foods were preserved mainly by removing water but other factors were involved. With a growth of understanding of these other factors producing stability it is now possible to design reliable preservation techniques.

One of the more recently developed areas of food preservation that is showing considerable promise for commercial development in the reasonably near future uses the concept called "hurdle technology". The concept of hurdle technology is being developed mainly as an application for meat products. The preservation of meats by the hurdle concept is based on a combination of factors such as high temperature (F), low temperature (t), water activity ($a_w$), acidity (pH), redox potential (Eh), preservatives (e.g. nitrite or smoke), and competitive microorganisms (e.g. lactic acid bacteria) (Leistner, 1985). Each of the factors is used at an activity level that individually is sub-lethal to spoilage organism, but in combination provides the required protection. Each factor provides a "hurdle" to the growth of microorganisms.

The development and the design of new meat products using the hurdle concept is based on each specific need. In developed countries, the use of the hurdle concept is stimulated for example by the necessity for a reduction of nitrite addition to cured meat products or to save energy during storage of meats.

In developing countries it is possible that the hurdle concept could also be used to design meat products equivalent to existing products in price and able to be distributed and displayed for sale without the need for refrigeration facilities or the use of high priced packaging materials. Hurdle technology may be a suitable technology for the processing of meat in such countries where refrigeration facilities are scarce and income levels of the population are low.

Intermediate Moisture Food (IMF) and Shelf Stable Products (SSP) are both examples of food preservation techniques based on hurdle technology. The production of IMF is an extension of the traditional drying of foods. That is instead of removing the bulk of the water in the product, just enough water is removed or tied up through the addition of humectants to insure that the growth of microorganisms is prevented or greatly reduced. Intermediate moisture foods which have $a_w$s in the range of 0.90 to 0.60 are able to be stored without refrigeration and have been thought of possible benefit in applications particularly in tropical countries. Newly developed IMF based on meat, however, have not provided the break-through expected and have encountered difficulties in introduction for general use. The reasons for these are that the newly developed IMF often have an unfamiliar taste (sweet or bitter), contain too many additives ("chemical overloading" of the food), and pose legal problems in the need to obtain approval of new additives (Leistner, 1985).

To overcome the above difficulties a new generation of meat products was introduced based on the principle firstly explored by Leistner and Karandjundic (1970) named Shelf Stable Products (SSP) for high moisture food products with $a_w$ in the range of 0.95 to 0.90. The $a_w$ of SSP is only depressed below 0.95 and above 0.90 which is possible by legally approved additives in relatively low concentrations

or by removal of water by a slight drying process. SSP are mildly heated (70-90° C core temperature) in sealed containers (can, glass, jar, pouch, casing, etc.), but sufficient to inactivate non-sporing microorganisms. Recontamination after heat processing is avoided because of sealed containers and therefore only spores of bacilli and clostridia are of concern. The growth of surviving spores however, is inhibited by sufficient decrease of $a_w$, pH and Eh. For instance, in processed meats adjusted by salts or sugars or by the removal of water to an $a_w$ below 0.95, growth of bacilli and clostridia does not occur, and the number of viable spores present even declines during storage (Leistner, *et al.*, 1979).

According to Leistner (1985) SSP meats offer the following advantages:

1) Mild heat treatment, which improves the sensory and nutritional properties (e.g. retention of vitamins) of the product and saves energy.

2) No refrigeration required, which simplifies the distribution of the products and saves much energy during storage.

3) Reduced addition of nitrite ( < 50 ppm), since nitrite is necessary only for odour and flavour of the products, but not for their preservation.

Leistner (1985) further claimed that at present, for industrialized countries, meat products of the SSP type are more feasible than IMF, because the reduction of micro-organism, except for spores of bacilli and clostridia, by the heat treatment makes the stabilization of SSP much easier than that of IMF. If the $a_w$ is decreased below 0.95, SSP should be stable (Leistner *et al.*, 1979), whereas the $a_w$ of IMF must be decreased to 0.85 if fungistatic substances are added, or even below 0.70 without addition of such substances. In most of this experimental work, ambient temperatures are assumed to be around 20°C.

It would therefore be interesting to evaluate the potential and the feasibility of SSP meat products for application in developing countries which are characterized by warm and humid conditions.

The purpose of this research topic is to investigate some of the problems and look for answers to the vastly complex and challenging area of hurdle technology. In particular to identify the combination of hurdles (F, $a_w$, pH, Eh) which would ensure stability in meat products to be distributed in tropical countries such as the Philippines where cost factors are also important. It is always important and also a responsibility of the food technologist to make food of high nutritional value such as meat products, more easily available to the people in a densely populated country in order to combat not only hunger but also malnutrition.

The specific objective of this study was to investigate practical combinations of hurdles (F, $a_w$, pH, Eh) which could extend the shelf-life of minced mutton meat stored at 30$^{o}$C while still maintaining a product that has acceptable sensory properties.