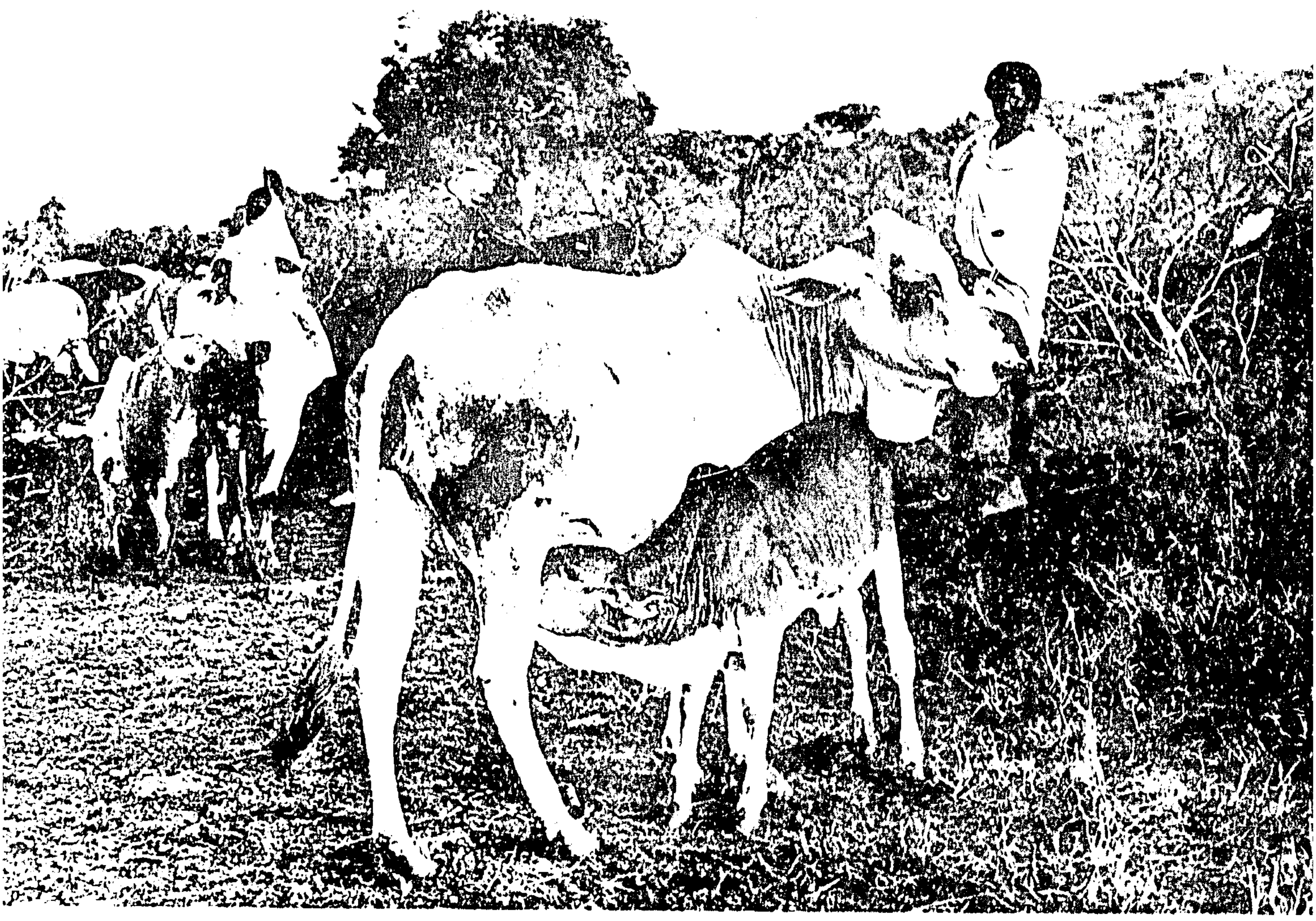
TRADITIONAL CHEESEMAKING MANUAL



International Livestock Centre for Africa

TRADITIONAL CHEESEMAKING MANUAL

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Correct citation: O'Connor C B. 1993. *Traditional cheesemaking manual.* ILCA (International Livestock Centre for Africa), Addis Ababa. Ethiopia.

ISBN 92-9053-273-4

Traditional Cheesemaking Manual

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Preface

Throughout the world and particularly in countries with a developing dairy industry the milk of several mammals is processed by traditional methods into a variety of products for immediate consumption or for later use during times of reduced milk production.

In many countries there exist several traditional milk products whose processing techniques and technologies are handed down from generation to generation through demonstration and experience. However, most of these products have a comparatively short shelf-life and loss of valuable milk nutrients often occurs particularly during periods of high milk production. The need, therefore, to manufacture products with a long shelf-life is evident and a number of cheese varieties exist which provide the ideal vehicle for the preservation of the milk nutrients.

This manual contains recipes for a number of cheese varieties which can and are being made by traditional methods at smallholder level. It is hoped that the manual will be useful to the individual milk processor and to extension workers in their efforts to develop milk processing and preservation.

1993 Charles O'Connor

Acknowledgements

In the preparation of this manual the author is grateful for the advice, assistance and encouragement of a number of colleagues. To the staff of the Dairy Technology Unit and Dr M E Smalley, Director of Training and Information, for their interest and many helpful comments I am very grateful. My thanks are due to Wzo Menbere W Giorgis, Head Photolaboratory, for the photographic work and to Wzt Fantu Yimer for typing the script.

My thanks are due to Paul Neate, Head of Publications, for his many comments and helpful suggestions and to Anne Nyamu, Science Writer and Editor, for her critical and helpful editing and overall layout of the manual I am extremely grateful.

To the staff of the Publications Department for their care in printing the manual I offer my sincere thanks.

Introduction

Sub-Saharan Africa has the most rapidly growing population of any region of the world. The human population is about 500 million and it is expected to reach about 1300 million by the year 2025. In 1990 354 million people, 71% of the population of sub-Saharan Africa, lived in rural areas and by the year 2025 this figure will have increased by more than 68% to about 590 million.

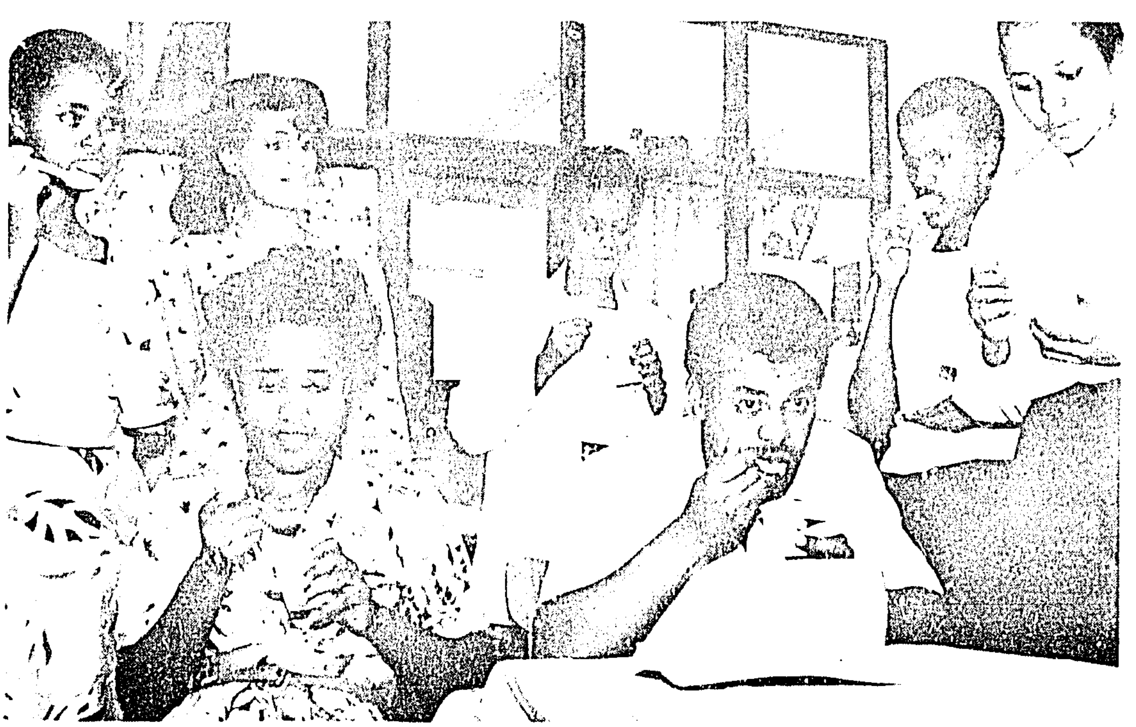
Cities in sub-Saharan Africa are growing much faster than the overall rate of population increase. Urban areas now account for almost 30% of the population of the region but by 2025 more than half of the population, or about 650 million people, are expected to live in urban areas. This rapid population increase in sub-Saharan Africa with expanding rural populations and growing urban popuiations will create even greater markets and demand for food including livestock and livestock products.

The average annual consumption of dairy products (Figure 1) in sub-Saharan Africa is about 27 kg ranging from 58 kg in the eastern subregion to around 10 kg in the central subregion. In tne 1970s the proportion of dairy products supplied by imports increased from 9% to 23% but since then imports have been cut back to 17% of total supply in 1986 and to 11% of consumption in 1989. Annual milk imports fell from a peak of 2.5 million tonnes in 1985 to 1.2 million tonnes in 1989.

The demand for dairy products in sub-Saharan Africa continues to increase with the overall growth rate in the consumption of milk and milk products being estimated at about 2.1% per annum. The growth in demand results from rapidly rising populations, urbanisation and some increase in per capita income. On the basis of population growth alone (about 15 million per annum) and a constant per capita consumption level of 27 kg the total requirement for dairy products would increase by 400 million kg each year. An increase in per capita incomes would add to this demand and it is projected that total demand will grow by at least 500 million kg, i.e. by around 4% per annum at current levels of production.

This increasing demand for milk and dairy products affords great opportunity and potential for the smallholder milk producer and for the development of the milk production and processing industry.

Figure 1. *Eating yoghurt*



Milk composition

Milk is a white fluid secreted by female mammals for the purpose of rearing their offspring. The earliest tribes of ancient Egypt and South-West Asia discovered sometime around 5000 BC that cow milk was a nourishing human food. While the ancient Egyptians recognised that cow milk was a wholesome and sustaining food they could have had little knowledge of its composition. The earliest evidence of knowledge of the composition of milk is dated at about 350 BC when Aristotle wrote "Casein, fat and water are all the known substances of milk."

Since the middle of the 19^{th} century a knowledge of the chemistry of milk has been developed and today there is extensive literature on the chemistry of the major and minor constituents of milk, especially cow milk. Variations exist in the composition of milk for the various species (Table 1). The composition of cow milk varies for a number of reasons, e.g. the individuality of the cow, the breed, age, stage of lactation, health of the cow, climatic conditions and herd management which includes feeding and general care.

Table 1. *Approximate composition of milk from various species of mammals.*

Animal	Fat	Casein	Lactose	Albumin	Ash	Water
	%					
Cow	3.75	3.0	4.75	0.4	0.75	87.3
Goat	6.0	3.3	4.6	0.7	0.84	84.5
Ewe	9.0	4.6	4.7	1.1	1.0	79.6
Camel	3.0	3.5	5.5	1.7	1.5	84.8
Buffalo	6.0	3.8	4.5	0.7	0.75	85.0

The breed of a cow has a great influence on the gross chemical composition of milk. Among the exotic breeds the fat content may vary from about 3.5% to 5.0% with the protein content varying from about 3.0% to 3.5%. Table 2 gives a comparison of the composition of milk from a temperate cow and from a tropical zebu cow.

Table 2. *The composition of milk from a temperate type cow and a tropical zebu cow.*

Cow type	Fat	Protein	Lactose	Minerals	Water
	%				
Temperate	3.7	3.4	4.8	0.7	87.4
Zebu	5.4	3.1	4.6	0.7	86.2

Age is not an important factor affecting the composition of milk although there appears to be a tendency for the fat content to decrease with increasing age. However, the health of the cow may affect milk composition considerably. Cows suffering from mastitis or inflammation of the udder give milk low in fat, casein and lactose and high in chlorides.

The composition of milk varies appreciably over the period of lactation. The milk given immediately after calving (colostrum) contains a very high percentage of total solids (up to 19%) due mainly to the very high content of protein and fat. During the first week after calving there is a progressive change towards normal composition. The quality of feed also has an effect on the composition of the milk. Poor quality feed depresses the protein content and continuous underfeeding results in milk of lower fat content.

There is considerable variation between the fat content of the first portion of milk drawn (fore milk) and that of the last portion of milk drawn (strippings). The difference in the fat content of fore milk and strippings may be as high as 7%. Table 3 shows the difference in fat content of different portions of milk as it is drawn from the cow. Unequal intervals between successive milkings result in wide variations in the fat percentage of milk causing it to be low after a long interval and high after a short interval. With equal intervals, the fat percentage does not differ greatly between morning and evening milkings. Unequal milking intervals do not cause a variation in the solids-not-fat result.

Table 3. *Variation in the fat content of different portions of cow milk.*

	Cow A	Cow B	Cow C
Portion		% Fat	
First	0.9	1.6	1.6
Second	2.6	3.2	3.2
Third	5.3	4.1	5.0
Strippings	9.8	8.1	8.3

The composition of milk is very important for the manufacture of dairy products. The yield of butter and cheese obtained from milk depends on the quantities of the major constituents present in milk. Butter yield depends on the fat content of the milk while cheese yield depends on the fat and protein contents. In addition, depending on the type of cheese being made, the ratio of fat to protein (casein) in the milk will affect the quality of the cheese.

Clean milk production

Milk produced under hygienic conditions from healthy cows should contain not more than 50 000 bacteria per millilitre. It is important that milk, whether it is for liquid consumption or for the manufacture of dairy products, is of good hygienic quality. Milk that is of poor hygienic quality may cause disease to humans and will result in poor quality products with low consumer acceptability. Milk produced under unhygienic conditions or from unhealthy cows may cause illnesses to humans including tuberculosis, brucellosis, sore throats, diarrhoea and abdominal pains. Preventing the entrance (Figure 2) and subsequent growth of bacteria in milk presents a constant challenge to those concerned with milk production and processing. The nutritive value of milk makes it essential that it is handled and treated with care. The bacteria that are normally in milk as it comes from the cow as well as bacteria from exterior sources, e.g. the surroundings and utensils, must be prevented from growing. Milk is an ideal medium for the growth of bacteria and if it is kept at above 16°C the bacteria present will multiply rapidly thereby causing a deterioration in quality and a reduction of its shelf-life. At temperatures below 10°C the growth of bacteria is considerably reduced. Table 4 shows the effect of temperature on the growth of bacteria in milk.

Table 4. *The effect of temperature on the growth of bacteria in milk.*

Temperature (°C)	10	15.5	21	27
After 24 hrs	10 000	39 000	10 M*	48 M
After 48 hrs	15 000	7.7 M	990 M	1470 M

Milk with 6400 bacteria incubated at different temperatures.

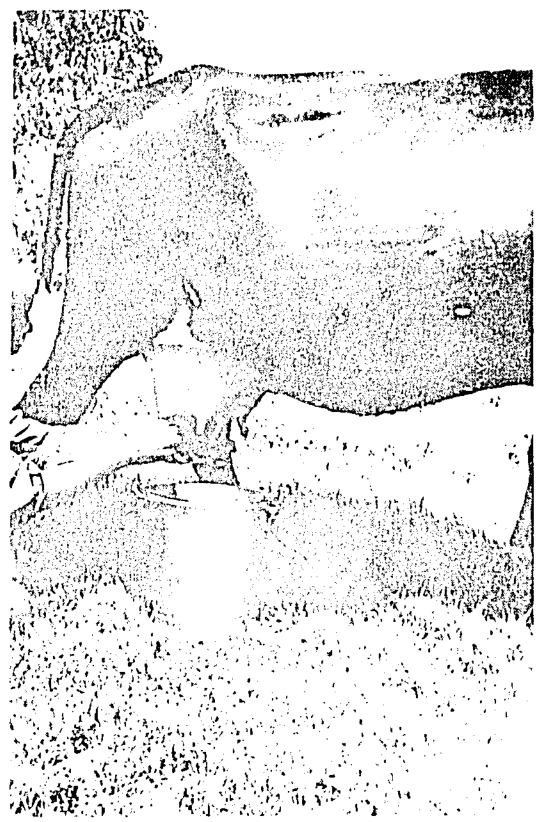
*M = Million

Sources of contamination

The cow may be a significant source of bacteria in milk, i.e. bacteria may enter milk from inside or outside the udder. The health of the cow is important in maintaining milk yields and also in the transmission of diseases. During and after milking the milk is susceptible to contamination from a number of sources, such as the vessels and equipment used for milking and storage of milk. The air and the milking surroundings can also lead to bacterial contamination of milk. In order to produce milk of good hygienic quality it is important to have clean healthy cows and clean utensils for milking (Figure 3) and storage of the milk. Milk with minimum contamination and low bacterial numbers is essential for the manufacture of dairy products such as butter, cheese and fermented milks.

Figure 2. *Cleaning a cow's udder.*

Figure 3. *Milking a cow using a clean utensil.*



Cheese and cheesemaking

The origin of cheesemaking is lost in unrecorded history. There is evidence to suggest that cheese was made as far back as 7000 BC. There are numerous references to cheesemaking in the Bible while the writings of Homer and Aristotle indicate that cheese was made from the milk of cows, goats, sheep, mares and asses. Around 300 AD trade in cheese between countries especially on sea routes became so great that the Roman emperor Diocletian had to fix maximum prices for the cheese.

Cheese is made in almost every country of the world and there exist more than 2000 varieties. Despite the large number of varieties cheese may be classified into different groups, i.e. ripened and unripened cheese, cheese with low or high fat content and cheese with soft or hard consistency. Unprocessed milk held at high ambient temperatures has a shelf-life from 2-3 hours up to 24 hours. Cheese, however, has a shelf-life from 4–5 days up to five years depending on the variety. Cheese therefore provides an ideal vehicle for preserving the valuable nutrients in milk and making them available throughout the year. Cheese is an excellent source of protein, fat and minerals such as calcium, iron and phosphorus, vitamins and essential amino acids and therefore is an important food in the diet of both young and old people. Table 5 gives a comparison of the nutritive value of cheese and some other foods.

Table 5. *Nutrients in cheese and other foods, per 100 g of food.*

Food	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Thiamin (mg)
Cheese					
Cheddar	26.0	33.5	800	0.5	0.04
Cottage	13.6	4.0	60	0.1	0.07
Yoghurt	5.0	1.0	180	0.09	0.09
Bread					
Wholemeal	8.8	2.7	23	2.5	0.26
Egg	12.3	10.9	52	2.0	0.09
Potato	2.1	0.1	8	0.5	0.11
Butter	0.4	82.0	15	0.16	0

Cheesemaking

Although cheesemaking survived as an art form for more than 7000 years the advance of scientific knowledge has led to a better understanding of the raw material, milk, and the cheesemaking and ripening process. A number of developments have taken place which aid the cheesemaker to produce a better and more consistent quality cheese. These developments include the findings of Pasteur in 1857 that bacteria harmful to the cheese process as well as pathogenic microorganisms could be destroyed by heat; the introduction of pure cultures of microorganisms (starters) to produce acid at a reliable and consistent rate; the refinement of the extraction of rennet from calves resulting in better quality cheese curd and the development of objective methods, e.g. the acidimeter, for the assessment of curd and cheese quality. Therefore, the cheesemaker who had relied on the art of the process now has a better knowledge and better facilities to guide the process according to the cheesemaking recipe.

A cheesemaking recipe is a guide for the manufacture of a specific variety of cheese and contains steps which, when followed, will result in a cheese of good quality. Due to variations in the chemical and microbiological quality of milk and cheesemaking ingredients such as starter, rennet and salt it is not always possible to produce the best quality cheese. This is particularly true of cheesemaking at farm level where facilities similar to those at factory or large-scale manufacture do not exist. However, the experienced cheesemaker is able to control the process and modify the recipe to limit the harmful effects of less than good quality ingredients. The importance of good quality milk and cheesemaking ingredients to produce good quality cheese cannot be over-emphasised.

Ingredients for cheesemaking

There are a number of ingredients which are essential for cheesemaking but some ingredients, e.g. colouring, added chemicals etc are not required for all varieties of cheese.

Milk. Good quality milk from the cow, sheep, goat etc is required. A knowledge of its chemical composition and bacteriological quality is desirable if cheese of consistent quality is to be made.

Starter. Certain cheese varieties require starters (pure cultures of lactic acid bacteria) containing organisms with specific functions, e.g. flavour development. The recipe will indicate the type and quantity of starter to be used and temperature conditions.

Colour. The recipe and the market will determine if colouring matter should be used. Occasionally it is required to bleach the original colour of the milk and to whiten the curd.

Chemicals. Chemicals such as calcium chloride and sodium nitrate are recommended in recipes for some varieties of cheese to improve curd quality and prevent the growth of organisms which may cause problems during the ripening or maturing of the cheese.

Coagulant. Rennet is the usual coagulant used but the juice extract of some fruits and plants, e.g. lemons and *Calotropis procera* may be used for some cheese varieties.

Salt. Salt (sodium chloride) may be added to some varieties of cheese, the quantity and method of addition depending on the recipe. Salt may be added directly to the milk or curd pieces; it may be rubbed into the finished cheese or the cheese may be immersed in a brine solution.

Steps in cheesemaking

Below are listed the principal steps in cheesemaking. Not all these steps are used for all cheese varieties and such steps as may be used will be determined by the recipe.

Milk treatment. Milk may be heat treated, e.g. 73°C for 15 seconds, to destroy pathogens and reduce microbial numbers. The milk may be standardised, i.e. the fat content may be increased or reduced or the casein-to-fat ratio may be adjusted.

Starter. Good quality starter is required. The type and quantity will be determined by the cheese recipe. For some cheese varieties commercial starter preparations are not used; natural fermentation or whey from the previous lot of cheese made may be used.

Coagulation. Various coagulants are used, e.g. rennet and lemon juice. The coagulants bring about, under defined conditions of temperature, quantity and time, the coagulation of the milk into a firm jelly-like mass.

Cutting the coagulum. The coagulum may be cut with knives (Figure 4) into curd particles of a defined size, e.g. 1–2 cm, or it may be ladled into containers or cheese moulds. The cutting or ladling of the coagulum is a very important step in the manufacture of some cheese varieties as it determines the rate of acid development and the body (firmness) and texture of the cheese.

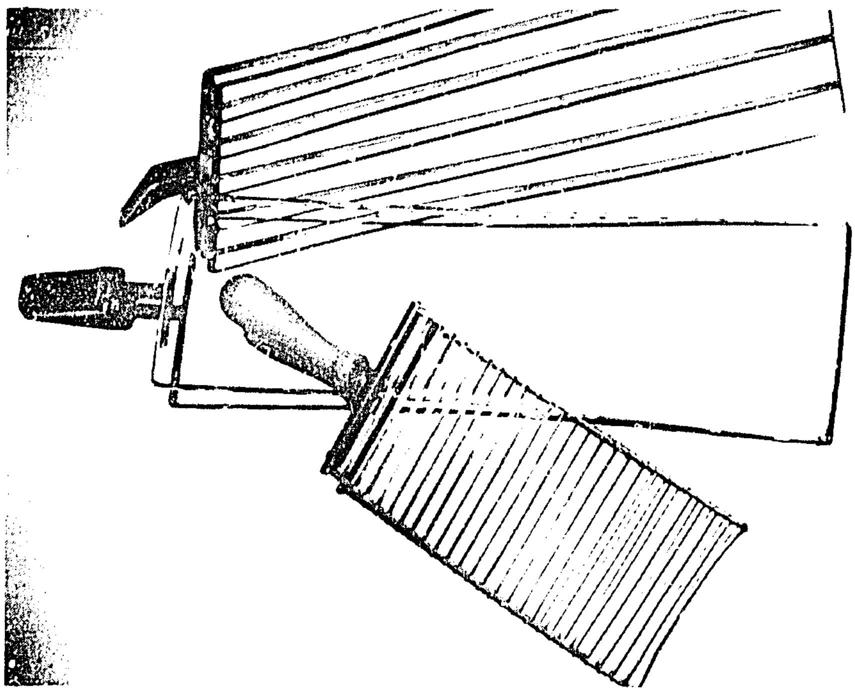
Heating or cooking the curd. Heating (40–45°C) the curds and whey affects the rate at which whey is expelled from the curd particles and the growth of the starter microorganisms. For some cheese hot water may be added to the curds and whey. During heating the curds and whey may be stirred to maintain the curd in the form of separate particles.

Whey removal. After heating and stirring and when the curd particles have firmed and the correct acid development has taken place the whey is removed allowing the curd particles to mat together.

Curd texturing. It is a characteristic of some cheese varieties that the curd mass is allowed to develop a texture along with further whey drainage and acidity development.

Milling the curd. When the curd has reached the desired texture it is broken up into small pieces to enable it to be salted evenly. Milling the curd can be done either by hand or mechanically.

Figure 4. *Horizontal and vertical curd-cutting knives.*



Salt addition. Salt may be added to the cheese curd as described above or it may be incorporated in the finished cheese by immersion in a brine solution. The addition of salt retards the growth of lactic organisms and slows down acid production. Salt also retards or prevents the growth of bacteria which may cause flavour and other defects in the cheese.

Moulding or hooping the curd. After milling (and salting) the curd pieces are packed into moulds (Figure 5) or containers the size and shape of which are determined by the variety of cheese made. The moulds may be made either of metal, plastic or wood.

Pressing. Pressing the curd in the moulds assists in some whey removal and compacts the curd pieces into the shape of the mould. The temperature of the curd and the extent of pressing are critical to the quality and appearance of the final cheese. The pressing may be done by the appl'cation of weights or, as in large-scale cheese manufacture, by mechanical cheese presses.

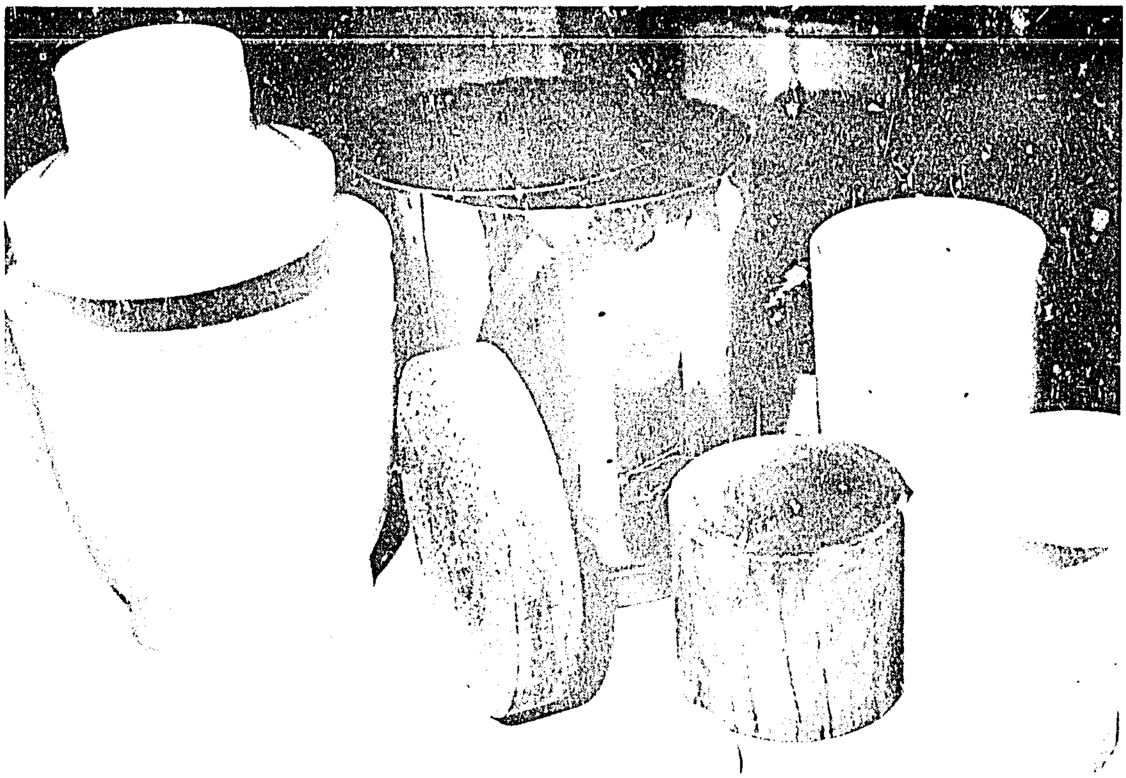
Removal of cheese from the mould. When the cheese has been pressed for the prescribed duration it is removed from the press and the mould. The cheese thus obtained may be further treated by bandaging in cheese cloth, by the application of colour or coating the cheese with wax or a thin layer of butter. Such operations help the cheese to maintain its shape and enhance its appearance.

Storage. The cheese variety will determine the period and the conditions (temperature and humidity) of storage. Market conditions including consumer preferences and prices may exert an influence on the duration and conditions of storage.

Not all of the above steps are necessary in the manufacture of all cheese varieties. Fresh, unripened cheese which can be consumed almost immediately after manufacture requires only the initial steps of heating the milk, coagulation and breaking the coagulum and the separation of the curds and whey. At the other extreme some cheeses involve most if not all of the steps described including several weeks to more than a year of storage.

It is important, however, that the recipe for each cheese is adhered to as closely as possible taking into account the natural variations that can occur in milk and starter quality and minor deviations which will arise during the cheesemaking procedure. The experienced cheesemaker is capable of dealing with minor adjustments to the cheese recipe to allow for variable quality raw materials and to produce a cheese of good quality.

Figures 5. *Some moulds used in cheesemaking.*



Milk coagulants

Fermented milks are produced at smallholder level by allowing the milk to ferment naturally, i.e. without the use of added bacterial cultures or materials to bring about the coagulation of the milk. These naturally fermented milks provided the first available 'starter' cultures to be used for the precipitation of the protein (casein) with other milk constituents such as fat, lactose (milk sugar) and vitamins. When the liquid serum (whey) is separated by filtering or decanting the precipitation or mass of curd remaining is a soft lactic curd type cheese. Cheese curds may also be formed by adding to milk the juice extracts of fruits and plants or extracts from the stomach or intestines of animals. These extracts contain enzymes (substances which bring about chemical change) that, when added to milk, bring about the formation of a coagulum or convert the milk to a semi-solid mass. When this jelly-like coagulum is cut into small pieces with knives (Figure 4) the whey is released and, after draining, the cheese curd remains.

Cheese curds may be formed by using acids or by using enzymes. Acids such as acetic acid, citric acid, lactic acid, vinegar and lemon juice have been used for many years in the manufacture of some cheeses. Ricotta cheese (a variety common in Italy), made from a mixture of skimmed milk and whey, uses vinegar or citric acid to precipitate the curds. Another cheese of Italian origin, Mozzarella, which is used as a topping for pizzas, is made with lactic or acetic acids as acidulants. Lactic starters are also used. Queso Blanco cheese, which has its origins in South America, is made from low fat milks using lemon juice as the acidulant. Wara cheese from West Africa uses the juice extract of the plant *Calotropis procera* as the milk coagulant. The above examples serve to illustrate that a number of cheese varieties may be made without importation of commercial preparations of lactic acid bacterial cultures and milk coagulants.

Enzyme coagulants

Coagulants from plant and animal sources have been used for centuries. With developments in biotechnology and microbiology coagulants obtained from bacteria and fungi have been used in recent years. One of the best known coagulants and one that is used widely by cheesemakers for many varieties of cheese is rennet. Rennet is extracted from the stomach of a mammal or more usually from the fourth stomach of a calf (Figure 6). In the absence or unavailability of commercial preparations of rennet smallholders may obtain the coagulant (rennin, pepsin or chymosin) from calves, goat kids or from older fodder-eating bovines.

A crude rennet extract may be obtained from the fourth stomach (abomasum) of goat kids or calves when they are about four weeks old (Figure 6). Male goat kids or calves that have been fed on milk and that are not required for breeding are usually used. To obtain the rennet, the washed fourth stomach of the kid or calf is sliced into strips which are extracted in a sodium chloride (12–20% salt) solution. This salt solution of rennet enzymes and abomasum strips is mixed well and allowed to settle for two to three days at room temperature. The mixture is then filtered through a coarse sieve and a fine mesh (muslin) cloth. Filtering through muslin cloth should be repeated a few times to obtain a clear filtrate. A pinch of boric acid is usually added to the filtrate as a preservative. This crude rennet extract may be used for cheesemaking at rates that will coagulate milk in about 35 minutes.

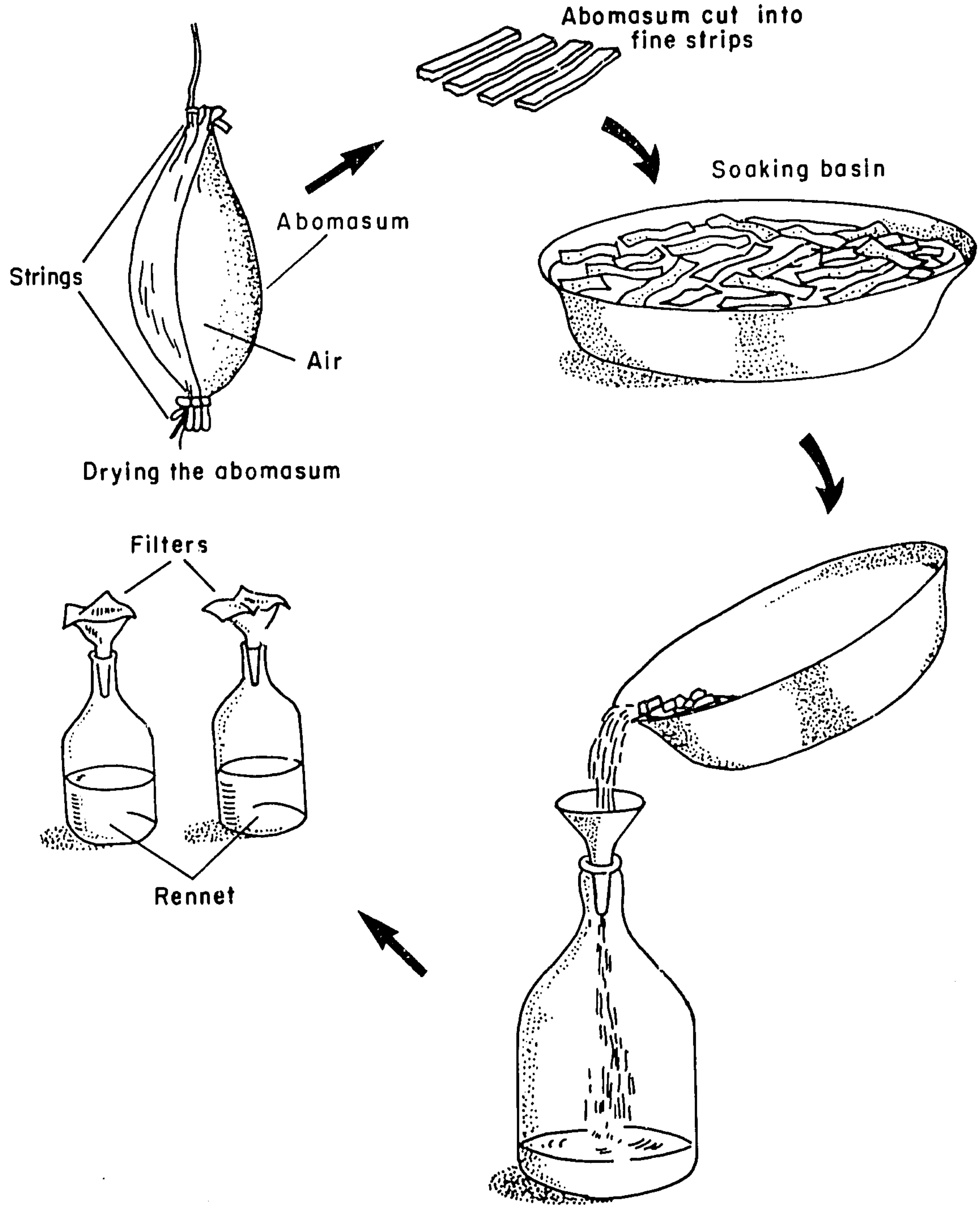
Young calves may not always be available so an alternative source of a milk coagulating enzyme, pepsin, is the abomasum of adult cattle, sheep or goats. Usually the abomasa can be obtained in plentiful supply from abattoirs. To obtain a crude extract of bovine pepsin the abomasum is washed and then cut open. The foldings of the abomasum mucosa or lining tissue contain the bovine pepsin. The mucosa is then scraped off and chopped finely. An adult cow or ox will yield about 500 g of mucosa. A litre of a solution containing sodium chloride (150 g), acetic acid (10 ml) and calcium chloride (40 g) is added to the finely chopped mucosa in a glass jar or beaker and mixed well. The mixture is allowed to stand for about 24 hours and then is filtered through a muslin cloth until a clear filtrate is obtained (Figure 6). This extract can be stored at about 25°C for 5–6 weeks without any significant loss in milk coagulating strength. About 100 ml of the extract are required to coagulate 20 litres of milk in 30–40 minutes. The rennet extract from a young milk-fed calf contains 88–94% rennin and about 6–12% pepsin, while the extracts from the adult bovine contain 90–94% pepsin and 6–10% rennin. There may be a variable amount of pepsin in rennets depending on the age and feeding of the calf from which the extract is obtained. Over the past twenty years milk and cheese production in many developed countries has increased. For economic reasons calf rennets became scarce and this led to the investigation of others sources of a milk coagulating enzyme. Today, in addition to calf rennet, bovine rennet, bovine pepsin, porcine pepsin, calf rennet/bovine pepsin and calf rennet/porcine pepsin mixtures are used. The following types of microbial coagulants (rennet) have become available in recent years: fungal extracts, bacterial extracts and mixtures of calf rennet and fungal and bacterial extracts. It is necessary to store rennet at low temperatures to maintain its efficacy. Exposure to light also reduces rennet strength so it should be stored in light-proof or brown glass containers.

The amount of rennet added to cheese milk is governed by the recipe which requires a suitable coagulum in a specified period of time. The recipe also specifies the acidity and temperature of the milk when the rennet is added.

Plant extract coagulants

Juice extracts from fruits and plants have long been used as milk coagulants. These include extracts from papaya (papain), pineapple (bromelin), castor oil seeds (ricin) and the latex of the fig tree and the plant *Calotropis procera* which grows abundantly in many parts of Africa. These extracts are suitable for softer curd cheese which is consumed within a few days. The extracts are not suitable for hard cheese with long maturing periods on account of their excessive proteolytic activity which leads to bitter flavours in the ripened cheese.

Figure 6. *Preparation of rennet.*



Whey utilisation

Whey is the liquid that remains after most of the fat and the protein in the milk is removed during the cheesemaking process. Whey contains valuable nutrients, i.e. whey proteins, carbohydrate and minerals. The wheys from cheesemaking vary according to the type of cheese made and, therefore, the content of protein, salts and lactose also vary. As whey contains about half of the total solids in the original milk it should not be thrown away as waste but should be used as animal feed or for human nutrition.

There are many uses for whey and its constituents. Where cheese is made on a small or farm-house scale the quantity of whey available does not justify the manufacture of the more exotic or sophisticated products where large quantities of whey are required along with expensive, large scale equipment. At farm level whey should be fed to animals or consumed by humans. Some of the uses of whey include pig and poultry feeds, addition to bread to increase the nutritive value, fermented drink, manufacture of alcohol, manufacture of lactose and producing whey cheese by evaporating the moisture. In recent years whey proteins extracted from whey by ultrafiltration have found many uses in the food industry.

Cheesemaking in Africa

Compared with the quantities produced in Europe and North America the amount of cheese produced in Africa is quite small. Most of the cheese produced in Africa is made on a small scale and generally at farm level. There is very little scientific information available on the cheese made at farm level; the recipe or the process is passed on from parents to children by observation and practical experience. The quality of the farm-made cheese can be variable because the ingredients and techniques used are so dependent on local conditions and available facilities. Different methods of coagulation of the milk may be used, e.g. the juice extract from local growing plants, acid precipitation combined with heating and rennet coagulation may be employed. In addition, defined starters are generally not used (they may not always be available and are expensive) and therefore acid production by the naturally occurring microorganisms or whey from previous batches are likely to be rather variable. Even though produced in small quantities cheese is a very valuable food and source of nutrients and cash for many people in Africa.

Cheesemaking in Africa is largely dictated by tradition and, of course, the availability of milk supplies. Generally the cheese (excluding concentrated fermented milks which may be classified as a soft curd cheese) is consumed very soon after manufacture primarily because of the immediate requirements of the family and partly because of the poor shelf-life of the product under ambient conditions. This poor shelf-life of the cheese often militates against the efficient utilisation and preservation of valuable milk constituents in the comparatively large volumes of milk available during certain periods of the year. Thus valuable human nutrients and a source of cash income may be lost. Problems are compounded by the fact that during periods of surplus milk production (to domestic requirements) prices for milk, butter and cheese are considerably lower than in periods of lower milk production. The main objective should be the maximum and efficient utilisation of all milk constituents and the preservation of these constituents in a form and type of product which has a good shelf-life and is therefore available in times of low milk production and of milk product scarcity.

In suggesting milk products and processes to the smallholders of Africa a number of factors must be recognised and taken into account. These include the facilities or equipment available, the availability of ingredients such as starters and coagulating agents and the variability in the chemical and microbiological quality of milk. The type of product and, in particular, the type or variety of cheese recommended for manufacture to smallholders must have appropriate quality characteristics, general consumer acceptability and market demand. In the following pages are details of the manufacturing processes (recipe) for a number of cheese varieties that meet the criteria outlined above of acceptability and appropriateness with regard to facilities, equipment and availability of raw materials. There are a number of cheese varieties which are indigenous to Africa, e.g. Domiati, Ayib, Karish, Wara, Gybna and Mudaffara. Table 6 gives information on some of these indigenous varieties.

Table 6. *Some cheese varieties made in Africa.*

Name of cheese	Type	Country	Raw materials
Aoules	Hard	Algeria	Goat milk
Ayib	Curd	Ethiopia	Buttermilk
Braided	Semi-hard	Sudan	Cow, goat or sheep milk
Mudaffara	Semi-hard	Sudan	Cow milk
Country cheese	Hard	Nigeria	Cow milk
Fromage	Semi-hard	Madagascar	Cow milk
Fromage blanc	Soft	Madagascar	Skimmed milk
Gybna	Soft	Sudan	Cow, goat or sheep milk
Mashanza	Soft	Zaire	Cow milk
Wara	Soft	Benin, Nigeria	Cow milk
Wagashi	Soft	Several countries, e.g. Mali, Nigeria and Benin	Cow milk
Wagassirou	Soft	Benin	Cow milk

Cheesemaking recipes

The following are suggested recipes for selected cheese varieties. It is appreciated that it may not be possible at farm level to monitor such parameters as temperature and acidity. In addition, the suggested recipe may differ somewhat to the process practised by smallholders. It is anticipated that the modifications to the recipe will give a better and more consistent quality cheese with maximum yields. To make good quality cheese it is necessary to have milk of good hygienic and compositional quality, good quality raw materials, clean equipment and to give careful attention to the manufacturing process.

Ayib

Ayib is a soft curd type cheese made in many parts of Ethiopia. It is made from the buttermilk resulting from the churning of sour whole milk. Ayib may also be made from skimmed milk, i.e. the milk remaining after the removal of the fat by mechanical or gravitational means. The composition of Ayib which varies considerably from smallholder to smallholder is about 76% water, 14% protein, 7% fat and 2% ash. The expected yield of cheese depends on the composition of the milk and the final cheese but generally one kilogram of cheese will be obtained from about nine litres of buttermilk or skimmed milk.

Method

1. Heat the buttermilk or skimmed milk gradually to about 50°C until a distinct curd mass forms. Higher temperatures (65°C) may also be used and will result in a cheese of longer shelf-life because of the destruction of harmful bacteria. Temperatures above 65°C may result in a cooked flavour.
2. Cool the curd mass for about one hour.
3. Separate the cheese curds from the whey either by ladling the curd into a separate container or by pouring the curds and whey through a sieve or fine mesh cloth and allowing the whey to drain into a container. (The whey, which contains about 0.75% protein, can be consumed by humans or fed directly to animals). Mix the curds retained in the sieve to ensure that there are no pockets of whey which could lead to off-flavours and defects in the firmness of the curd.
4. The cheese is not pressed–most of the whey has been allowed to drain away. To obtain a firmer curd the cheese may be slightly pressed but this will reduce the yield of cheese.
5. Add about one gram of salt to every 100 g of cheese to give a slightly longer shelf-life (in Ethiopia salt is not added to the cheese curd).
6. Store the cheese in a clean container in a cool place. At ambient temperatures of about 30°C the shelf-life of the cheese is no more than about two days while at 4°C it is about seven days.

Wara, Woagachi

The names Wara, Woagachi, Warankasi, Nigerian white cheese and West African soft cheese refer to the same type of cheese. The manufacture of Wara cheese is widespread in Nigeria and a similar cheese called Woagachi is made in the northern provinces of the Benin republic. While the manufacturing process of Wara and Woagachi are essentially the same there are significant and interesting variations. Woagachi cheese is larger (600 g) than Wara (60 g) cheese. This is because of the size of the basket type mould which is used. In Benin one or two larger cheeses are made during a single process while about 10–20 pieces of Wara are made at any one time. Woagachi cheese is usually coloured in a hot solution of the leaves and stems of red sorghum while Wara cheese is sold uncoloured.

The preferred coagulating agent is the juice extract of *Calotropis procera* but the juice extract from papaya leaves and stems is sometimes used. Wara cheese is invariably sold on the day of manufacture and is brought to the market in a container of cool water. However, Woagachi may be stored for several days after it has been dipped in a salt solution for a few hours followed by immersion in the hot red sorghum solution for a few seconds. The manufacturing process, i.e. heating the milk, cooking and ladling of the curds and whey into baskets (moulds) is similar for both types of cheese. During heating a skin (fat and protein) forms on the top of the unstirred milk. Traditionally this skin is skimmed off and is either discarded or used for cooking purposes. This practice leads to some losses of valuable milk nutrients and reduces the cheese yield. In addition, heating the milk without stirring causes burn-on of milk solids on the base of the container and results in some discoloured particles in the finished cheese. It is recommended therefore, that the milk is stirred gently and intermittently during the heating process to avoid the formation of skin and the burn-on of milk solids.

Botanists will be aware of the many reputed uses of the juice extract of *C. procera*. Among its reported uses are medicinal, i.e. putting it on a cut or flesh wound or as an aphrodisiac and also as a poison to kill animals or human beings. That *C. procera* juice extract contains toxic substances may give cause for alarm but there is no evidence to suggest that consumers are adversely affected or are in any danger to their health following consumption of Wara or Woagachi cheese. It appears that toxins in the *C. procera* juice extract are destroyed by the high temperatures (95°C) to which the milk is heated. Both types of cheese are generally sold within a day or, in some cases, within hours of manufacture. The yield of cheese varies with its composition; the higher the moisture content the greater the yield. The moisture content of Wara and Woagachi is about 65%. Wara cheese is unsalted and uncoloured. About one kilogram of cheese will be obtained from about five litres of milk.

Method

1. Fresh morning milk is usually used. Transfer whole milk (about five litres) from the milking vessel to a metal pot.
2. Place the metal pot over a slow burning fire or a fire of smouldering wood and heat to a temperature of about 50°C. This usually takes about half an hour.
3. Stir the milk gently during the initial and subsequent heating and cooking.
4. Add the *Calotropis procera* juice extract to the warmed milk.[1] To prepare the extracts, finely chop about eight medium-sized leaves of *C. procera* and add them to about 100 ml (about half a cup) of warm water. After about five minutes sieve this water/juice extract into 5–6 litres of already warmed milk.
5. Heat the milk slowly with intermittent stirring until it reaches boiling point.
6. Keep the milk at boiling point until it coagulates and there is visible separation of curds and whey.
7. Remove the pot from the fire.
8. Ladle or pour the curds and whey into baskets placed over a container for whey collection. The basket or mould facilitates whey drainage and also gives the cheese (Wara or Woagachi) its characteristic shape and size (Figures 7, 8, 9 and 10).
9. When the cheese is firm enough to retain its shape remove it from the basket and place it in a container of cool water (Figure 9).
10. Soak Woagachi cheese in brine (20% NaCl) for 12–15 hours then dip it for a few seconds in a hot solution of the stems and leaves of red sorghum.[2]

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1. The method of addition of the juice extract depends on the preference of the cheesemaker. While some cheesemakers prefer to swirl the crushed leaves and stems in the milk for a few minutes others prefer to place the crushed leaves and stems in a piece of muslin or similar type cloth and swirl the cloth and its contents in the milk for a few minutes. Obviously these methods of juice addition lead to variations in the actual quantities of juice being retained in the milk.

2. Because of the local demand for Wara and Woagachi the question of extending the shelf-life of the cheese does not arise. However, with anticipated increases in milk production and therefore, cheese production, it will be necessary to extend the shelf-life of the cheese to cater for increased storage and transport times. The increased shelf-life may be accomplished by the combined effects of incorporating about 2% salt in the cheese and by pressing the cheese to reduce its moisture content to about 50%.

Figure 7. *Separating curds from whey.*

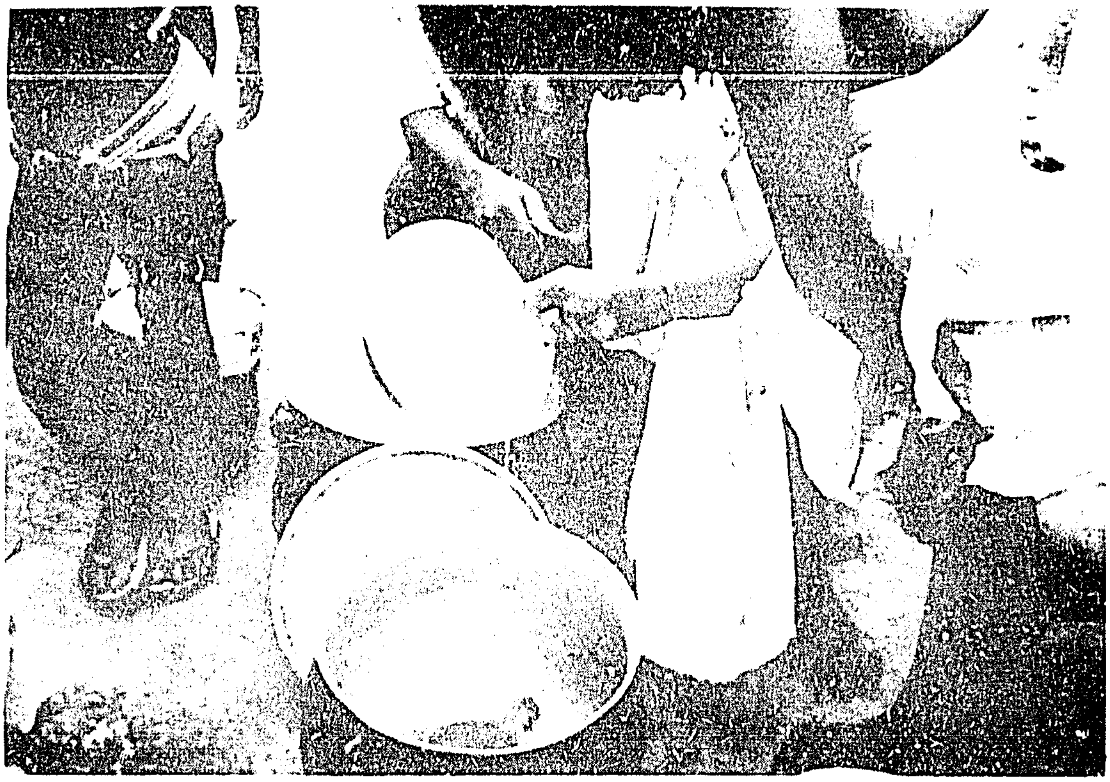
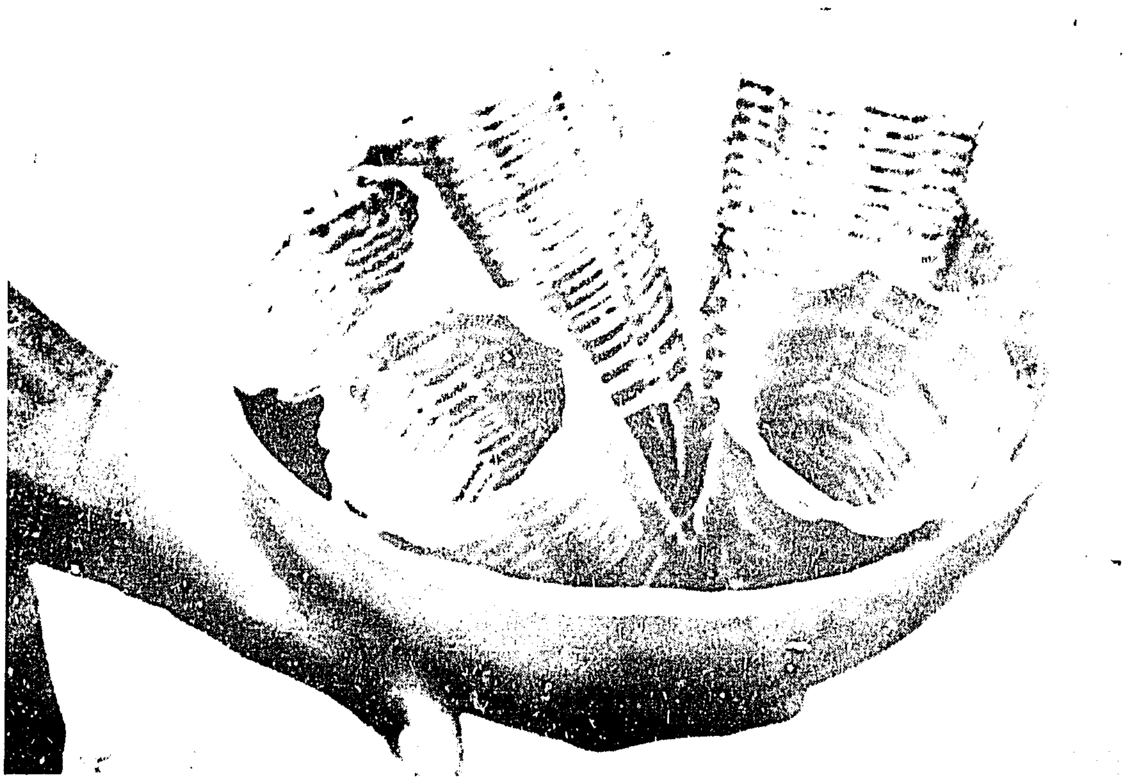


Figure 8. *Ladling curds and whey into a cheese mould.*

Figure 9. *Whey draining and, in the foreground, cheese pieces in cool water.*

Figure 10. *Wara cheese moulds.*



White cheese

Queso blanco (white cheese) is of Latin American origin. It is usually made from milk containing about 3% fat. Starter or rennet is not used and curd precipitation is brought about by an organic acid usually in the form of lemon juice. Queso blanco is a pressed cheese (it contains less moisture than unpressed cheese) and therefore has a longer shelf-life than soft curd cheese. The milk is heated to a high temperature (over 80°C) and this also contributes to the increased shelf-life of the cheese. Queso blanco is an ideal cheese for manufacture by smallholders as all the materials required may be obtained or made locally. The expected yield is one kilogram of cheese from eight litres of milk.

Method

1. Fresh whole milk is used. The fat content of the milk should be reduced to about three per cent. The fat content in milk from local cows is usually between five and six per cent. To reduce the fat content, allow the milk selected for cheesemaking to stand for about one hour then skim off the top layer (high fat milk or cream). The cream can be used for buttermaking.[3]
2. Heat the milk to about 85°C to destroy most of the bacteria present and also to increase yield through precipitation of the whey proteins (Figure 11).
3. Dilute lemon juice with an equal quantity of clean, fresh water so that the lemon juice can be distributed uniformly. Add about 30 ml of lemon juice per litre of milk. Stir the milk while carefully adding the lemon juice (Figure 12). The curd precipitates almost immediately (Figure 13).
4. Continue stirring for about three minutes after adding the lemon juice (Figure 14).
5. Allow the curd to settle for 15 minutes. Separate the curds from the whey by draining through a sieve or a muslin (cheese) cloth (Figure 15).
6. While draining the whey, stir the curd to prevent excess matting.
7. Add salt to the curd at a rate of about 4 g for every 100 g of curd and mix properly (Figure 16). The quantity of salt may be varied to cater for consumer taste preferences.
8. Transfer the curd to a mould (container) lined with cheese cloth. The mould may be cylindrical or square-shaped and may be made from metal, plastic or wood (Figures 17 and 18).
9. Cover the curd by folding over the cheese cloth (Figure 19). Fit a wooden follower neatly inside the mould to enable the curd to be pressed.
10. Press the curd overnight by placing metal weights on top of the wooden follower (Figure 20).[4]
11. Store the cheese as it is or cut it into suitably sized pieces for sale.
12. Coat the cheese with a thin film of butter to enhance the appearance.

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3. The length of time the milk is allowed to stand before skimming can be varied depending on the final cheese quality and consumer acceptability.

4. Different types of mechanical cheese presses are available. The amount of weight to use can be determined through experience. Too much pressure will result in losses of fat in the expressed whey giving reduced yield and a poor textured cheese. If the whey expressed from the cheese during pressing is milky white then too much pressure is being applied. If too little pressure is used the curds do not mat properly and this will give a cheese with poor body and texture. The flavour may also be affected because of entrapped whey between the curd particles. If stored at a cool temperature (15°C) and protected from flies and rodents the cheese has a shelf-life of several months.

Figure 11. *Checking the temperature of the milk.*

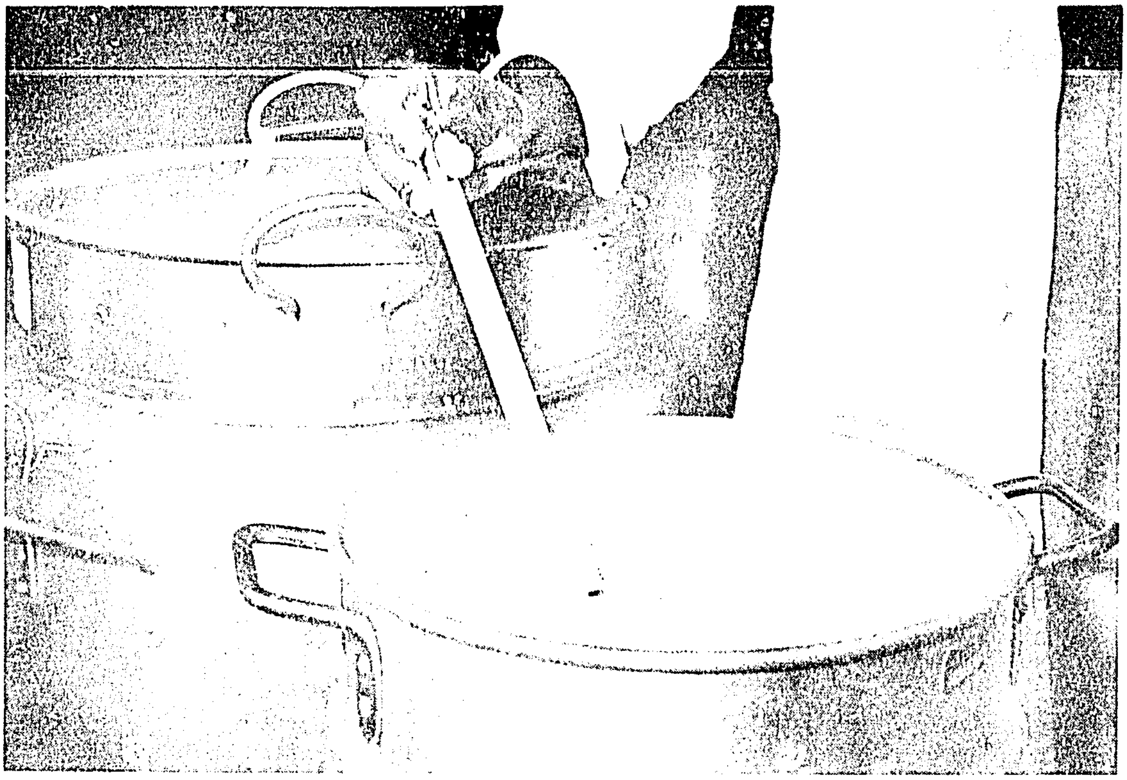


Figure 12. *Adding lemon juice and stirring the milk.*

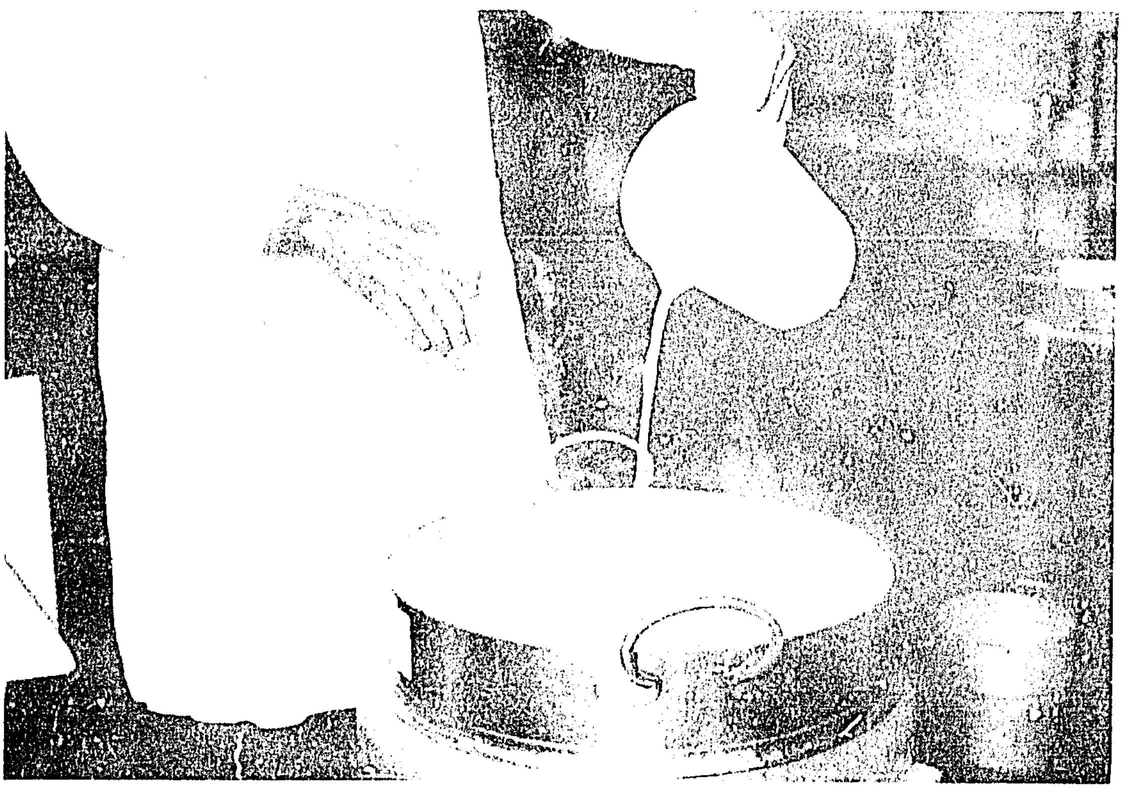


Figure 13. *Curd formation.*

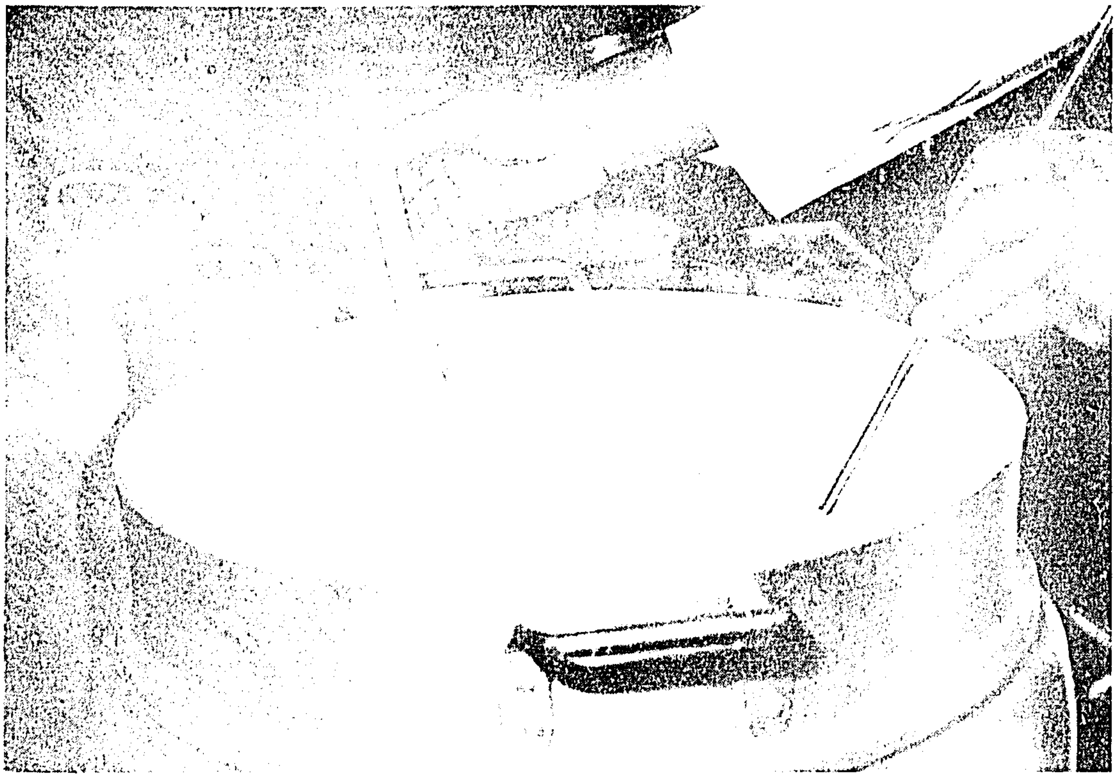


Figure 14. *Stirring the curds and whey.*

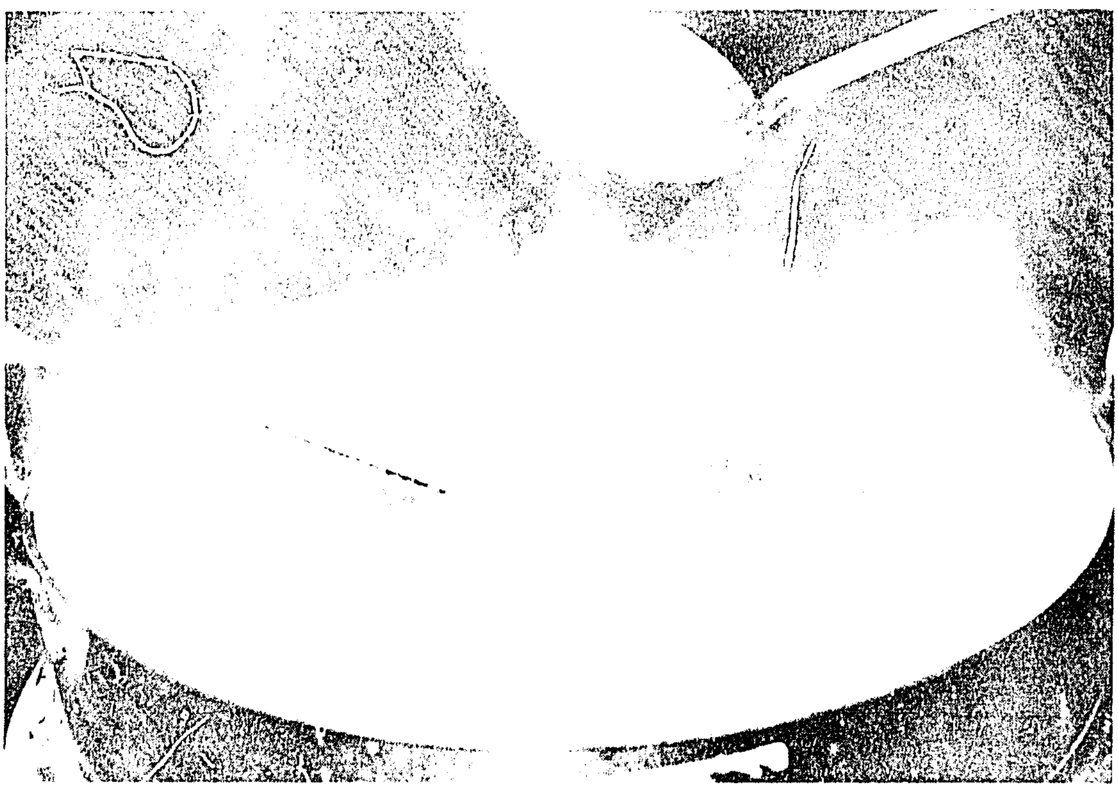


Figure 15. *Separating the curds from the whey using a muslin cloth.*

Figure 16. *Adding salt to curd.*

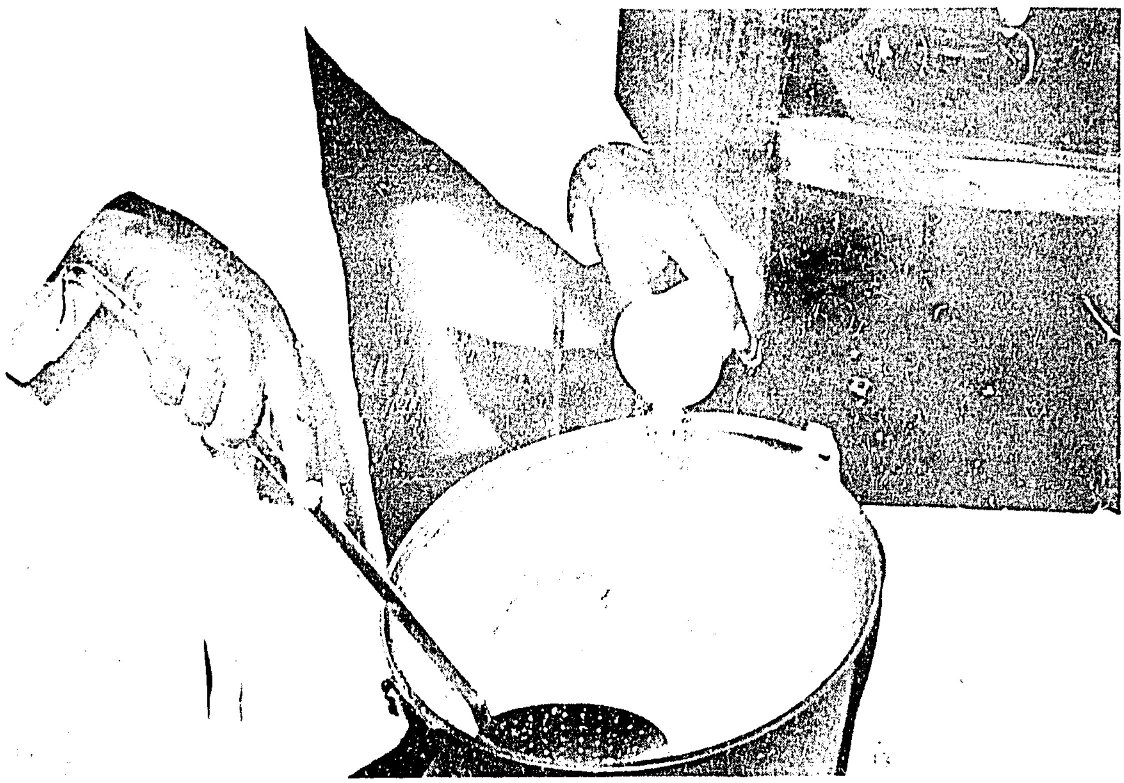


Figure 17. *Wooden cheese mould with holes for whey drainage.*

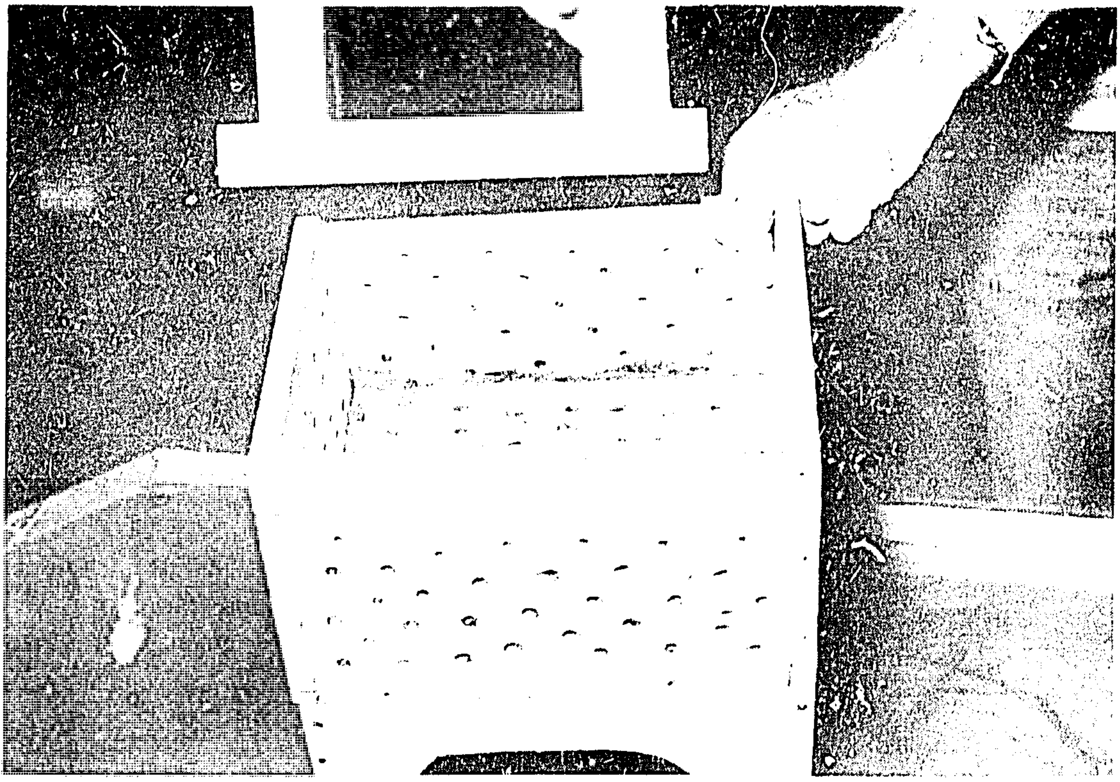


Figure 18. *Adding curd to a muslin-lined mould.*

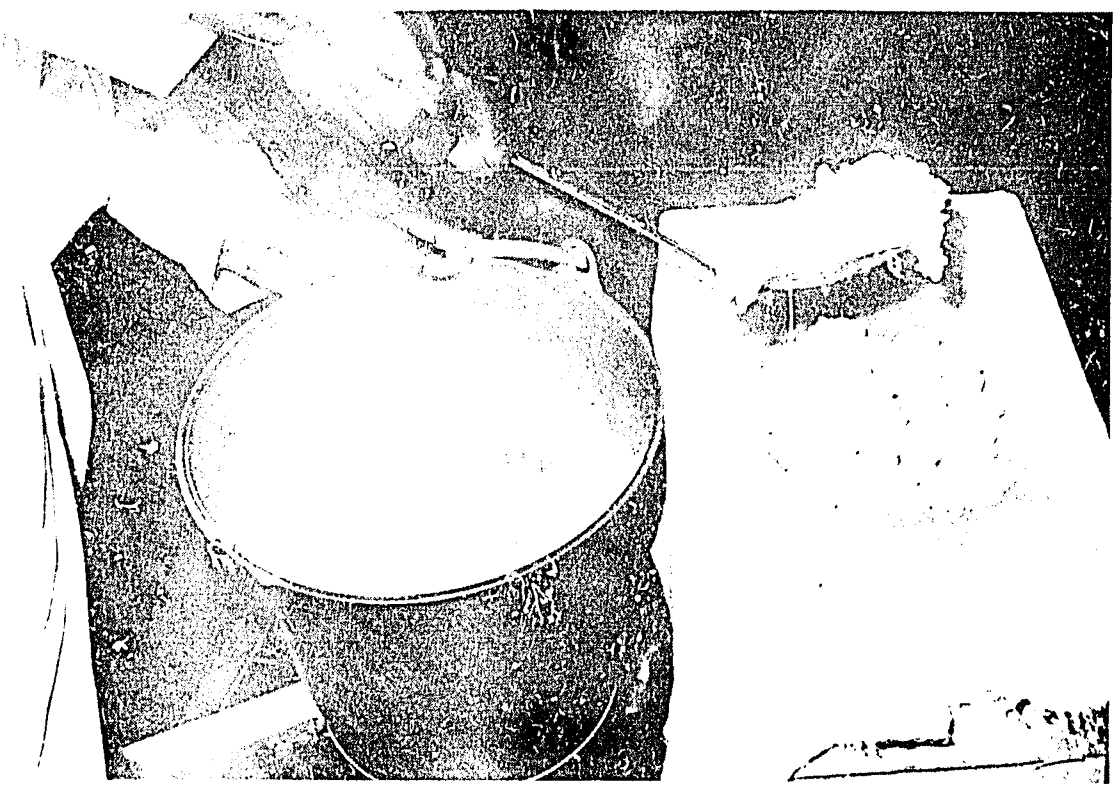
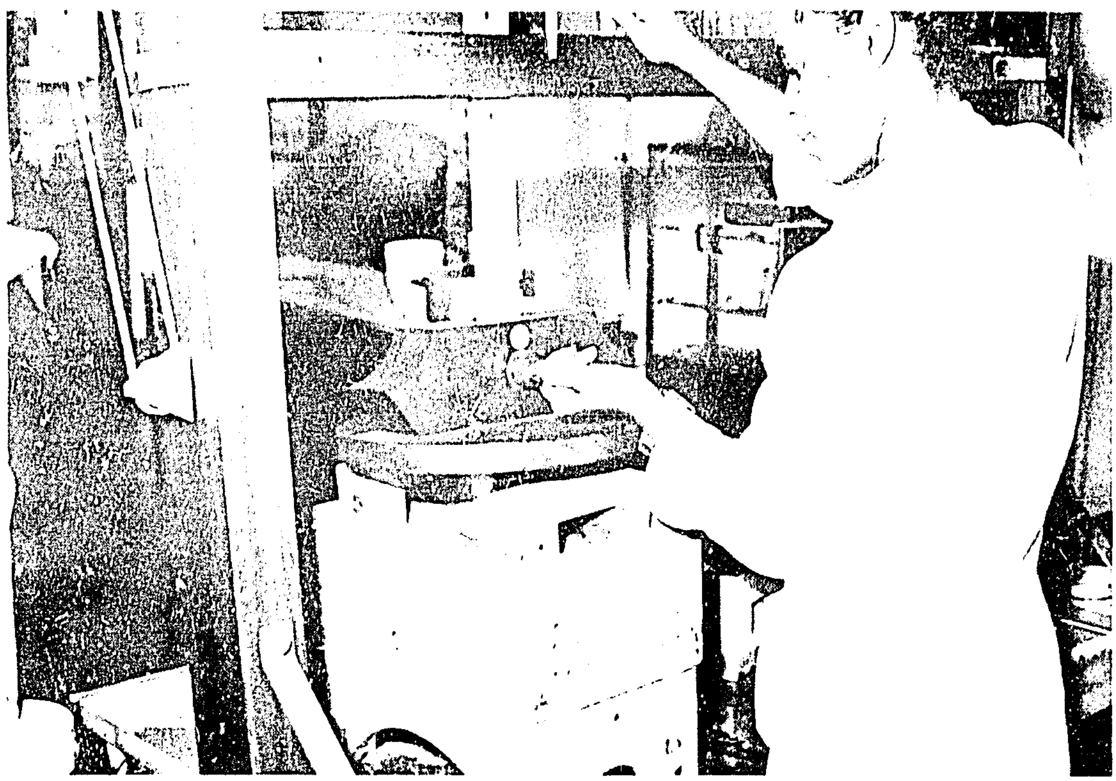


Figure 19. *Covering the curd by folding over the muslin.*

Figure 20. *Pressing cheese.*



Other cheese varieties

If ingredients such as starter cultures and rennet are available, this presents the opportunity for making a much larger number of cheese varieties. Starter cultures may be imported but they can also be produced locally at an Agricultural College or University. Whey from a previously made batch of cheese can be used as a starter culture but its quality may be variable.

Starter cultures require proper care and handling in addition to equipment, not normally available at local level, for propagation and storage. Where there are a number of cheesemakers in an area starter cultures which can be added directly to the cheese milk may be provided by a nearby college. In recent years freeze-dried starter cultures specially prepared for a specific cheese variety have become available from commercial organisations. These freeze-dried cultures can be added directly to the cheese milk. They are, however, expensive.

Rennet may be obtained in either liquid or tablet form. Rennet in tablet form is best suited for warm climates as it maintains its strength better than in liquid form. These rennets may have to be imported into countries with a developing dairy industry but we have described earlier how milk coagulating agents (rennin and pepsin) can be produced locally from calves and adult bovines.

Where cheese varieties require the use of starter cultures and rennet, additional skills are demanded of the cheesemaker not only from the point of view of handling and usage of these ingredients but also because of the associated and generally more complicated cheese recipe. Such cheeses include semi-soft, hard, pressed or unpressed varieties like Cheddar, Gouda, Domiati, Gybna beyda, Lactic curd cheese, Pasta filata and Camembert (mould ripened). The skills required to make such cheese can only be gained through experience but great satisfaction is derived when, after weeks or months of storage, a cheese of good quality is available for consumption. The pressed and ripened (stored) cheeses also provide the vehicle for the preservation of milk constituents which might otherwise have been lost. It has already been emphasised that the cheese selected for manufacture by a smallholder or a cooperative of a number of smallholders must be appropriate to the ingredients and facilities available and also the market opportunities for the cheese. Manufacturing and storage costs associated with the cheese variety are of considerable importance.

Lactic curd cheese

Lactic curd cheese can be made using whole, partially skimmed or skimmed milk. Starter cultures are required but rennet may or may not be used. About one kilogram of cheese from about five litres of milk is the expected yield.

Lactic curd cheese is a very nutritious and versatile product. It may be used as fresh curd cheese or with a variety of additives. To obtain a rich creamy product cream may be mixed with the curd. Herbs, spices and fruits such as mint, thyme, garlic, clove, chives, onions, banana, pineapple and orange may be mixed with the curd in different quantities and combinations.

Method

1. Heat the milk to about 85°C and then cool quickly to 24°C.
2. Add the starter at a rate of 3–4% (Figure 21).
3. Allow milk to set and coagulate to a solid jelly-like mass. This may take 3–4 hours but if a little rennet (1 ml per 5 litres) is added (Figure 22) coagulation will take place in about 40 minutes.
4. When a coagulum has formed cut the curd with a sharp knife or special curd cutting knives.
5. Place the curd in a cheese cloth and allow the whey to drain away (Figures 23 and 24). Mix the curd from time to time to prevent pockets of whey forming and to give an even consistency. The length of time of drainage determines the dryness or firmness of the curd. Whey drainage can be accelerated by slightly pressing the cheese.

Figure 21. *Adding starter to milk.*

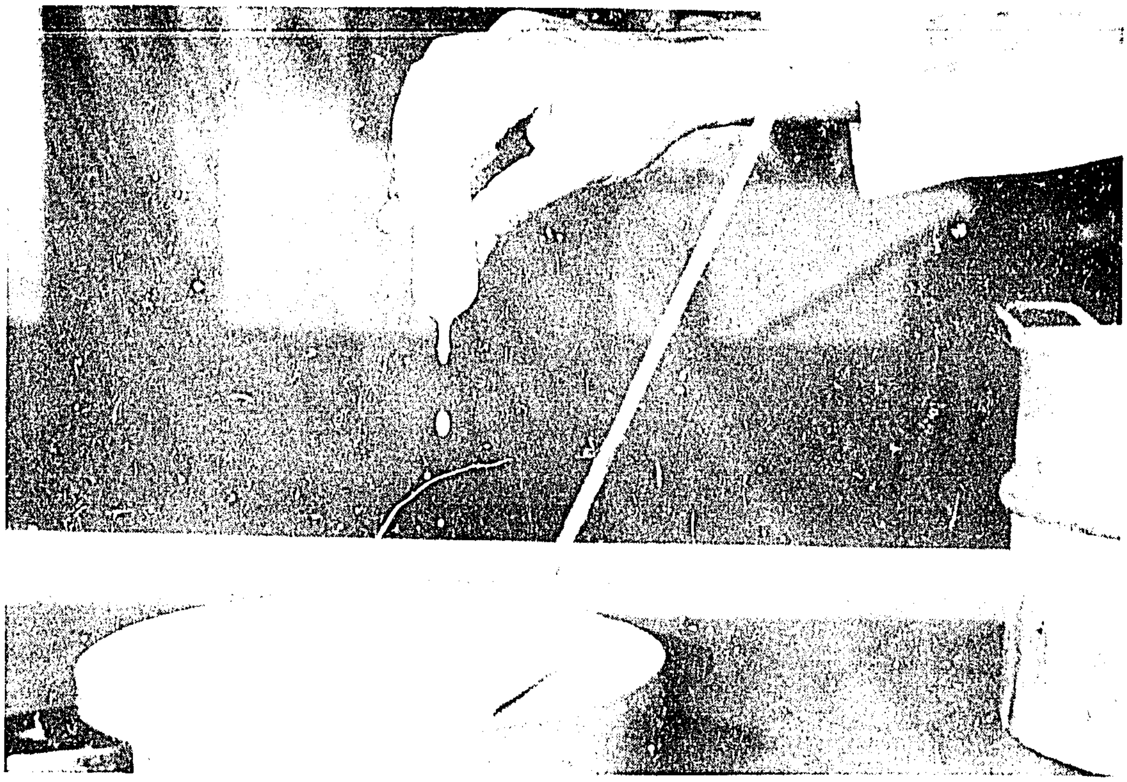


Figure 22. *Adding rennet to milk.*

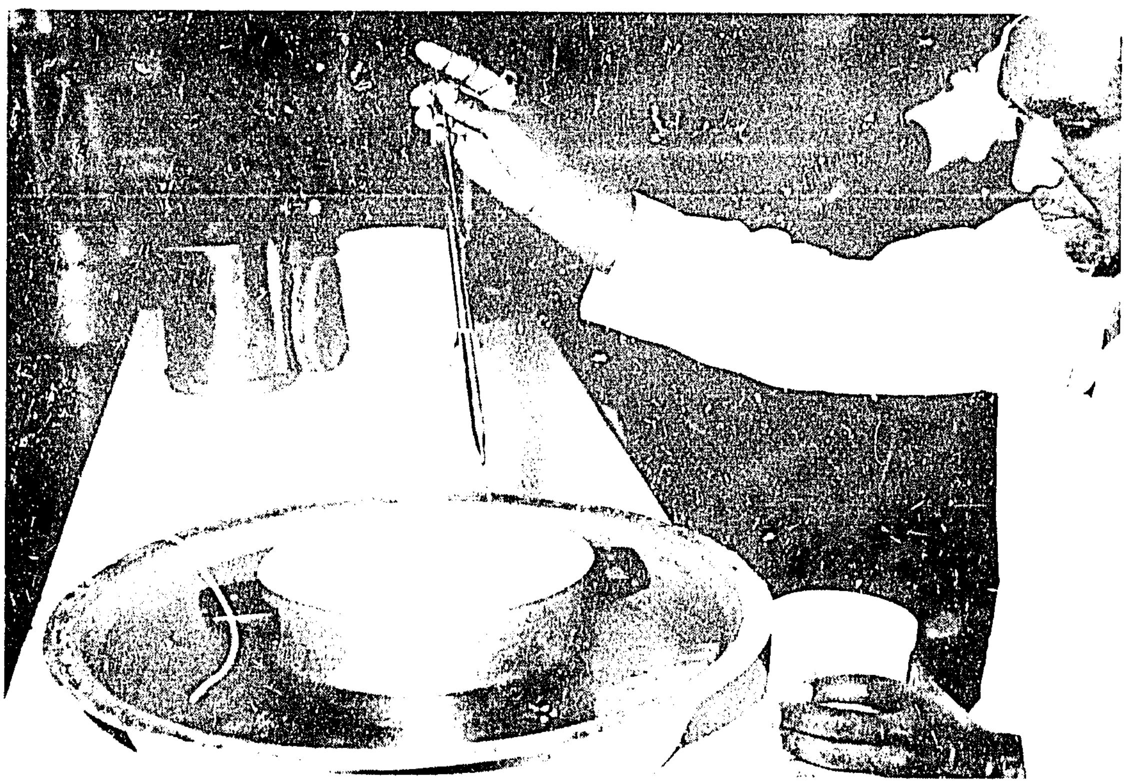
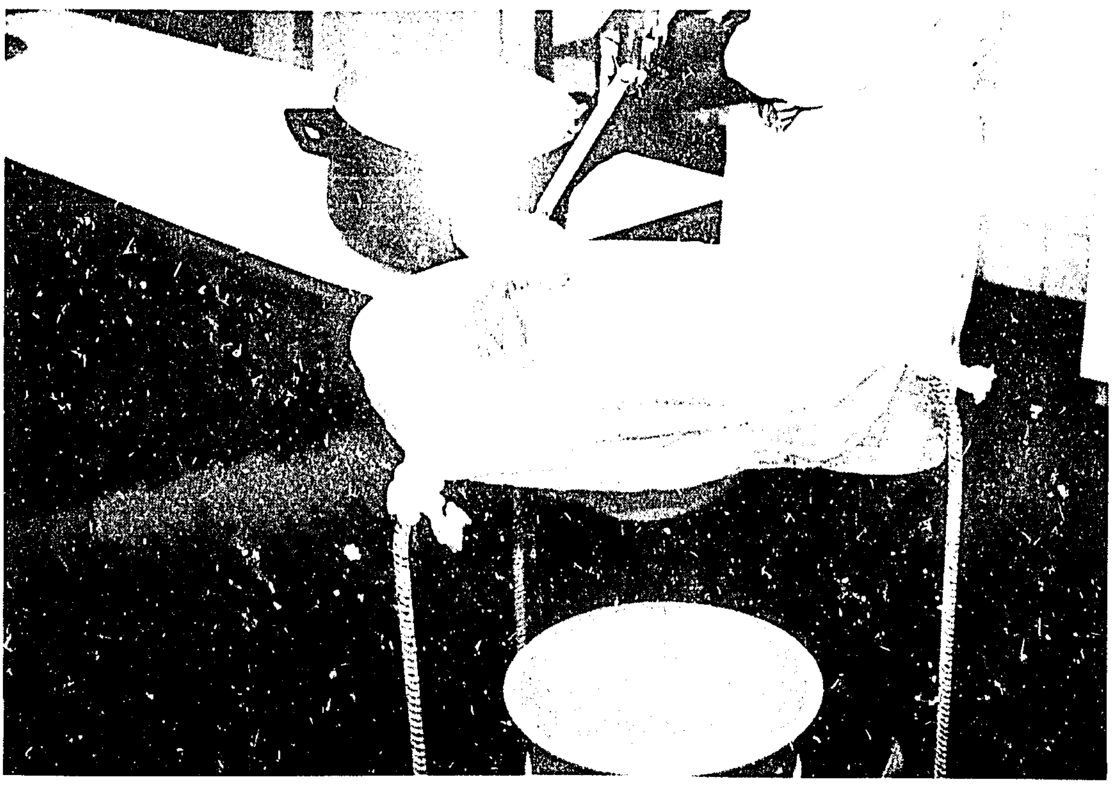


Figure 23. *Removing the coagulum from the pot.*

Figure 24. *Ladling the coagulum into muslin for whey drainage.*



6. Add salt (the rate depending on the taste required) and mix well with the cheese curd (Figure 25). Salt helps to expel excess whey and also, through its preservative action, extends the shelf-life of the cheese (Figure 26).
7. Pack the cheese into suitable containers for sale. The shelf-life of the cheese is 5–10 days at about 20°C.

Halloumi

Halloumi is a firm pickled cheese with its origins in Cyprus where it is made from sheep or goat milk or a mixture of both. It can also be made from cow milk. Starter is not used. The cheese may be eaten fresh or after storage in a cool store. If it is stored at below 12°C it will keep for several months. After salting the cheese pieces may also be stored in plastic bags without brining; if stored at about 10°C the cheese has a shelf-life of two to three months. About one kilogram of cheese will be obtained from nine litres of milk.

Method

1. If necessary pasteurise the milk by heating to 73°C and cooling immediately to 32°C.
2. Add rennet extract (about 3 ml per 10 litres of milk). This should give a firm curd in 40–45 minutes.
3. Cut the curd into 3–4 cm cubes using horizontal and vertical curd cutting knives.
4. Stir the curds and whey mixture gently and heat to 38–42°C. Stir for 20 minutes after this temperature is reached.
5. Allow the curd to settle.
6. Ladle the whey off the curd and scoop the curd into a mould lined with cheese cloth. Press for about four hours.
7. Heat the collected whey to 80–90°C.
8. Remove the cheese from the press and cut it into 10 cm x 10 cm x 2 cm pieces (Figures 27, 28, 29 and 30).
9. Place the curd pieces in the hot whey. At first the curd pieces sink but when properly textured they rise to the surface (Figure 31). Transfer the pieces to a draining table.
10. After about 20 minutes the curd pieces are cool. Sprinkle the curd with 3–5% salt (Figure 32) and fold each piece over (Figure 33).
11. Place the cold curd pieces in containers. Fill the containers with 30% brine.

Gybna beyda

Gybna beyda is a hard white cheese made in Sudan. It is similar to Domiati which is made in Egypt. Starter is not used. The storage life of the cheese may be more than one year. About one kilogram of cheese will be obtained from seven litres of milk.

Method

1. Heat fresh milk to 35°C and add salt to give a 7–10% salt solution in the milk.
2. Add rennet or rennet extract to obtain a firm coagulum in four to six hours.
3. Transfer the coagulum to wooden moulds lined with muslin and allow the whey to drain overnight.
4. Cut the curd into 10 cm cubes. Put the cubes into tins or other suitable airtight containers.
5. Fill the tin or container with whey and seal.

Figure 25. *Mixing salt and curd.*

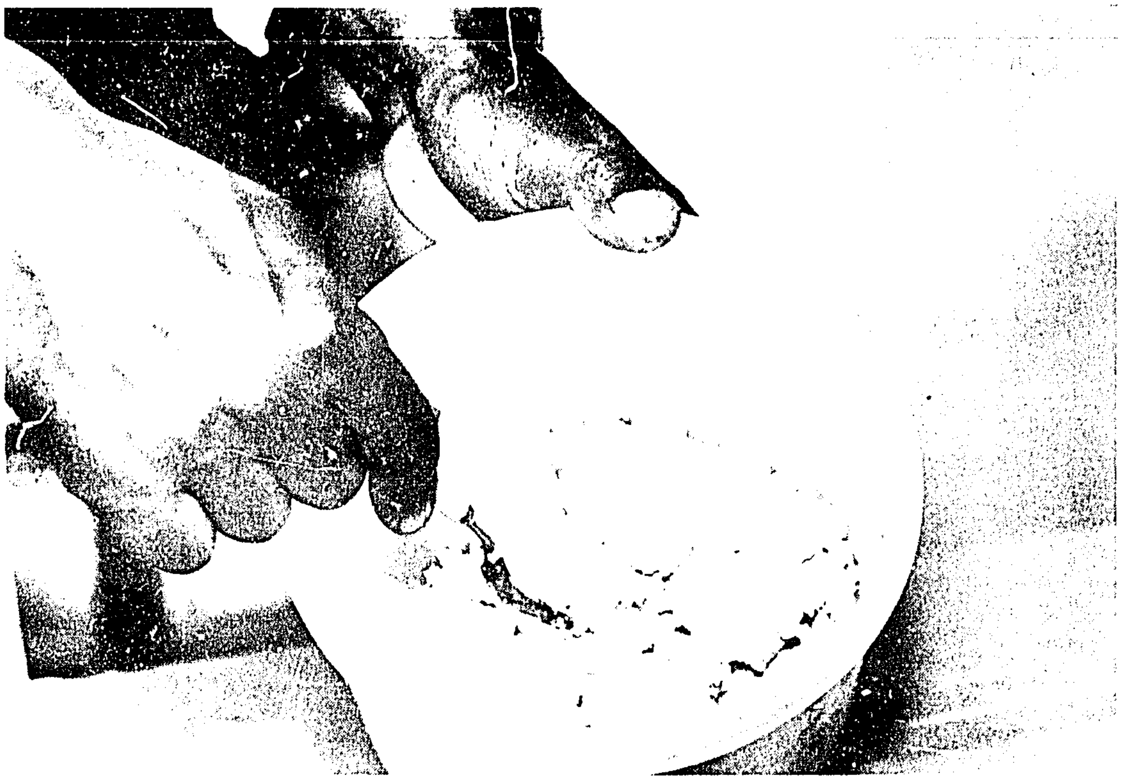


Figure 26. *Finished product – Paté fraîche type cheese.*

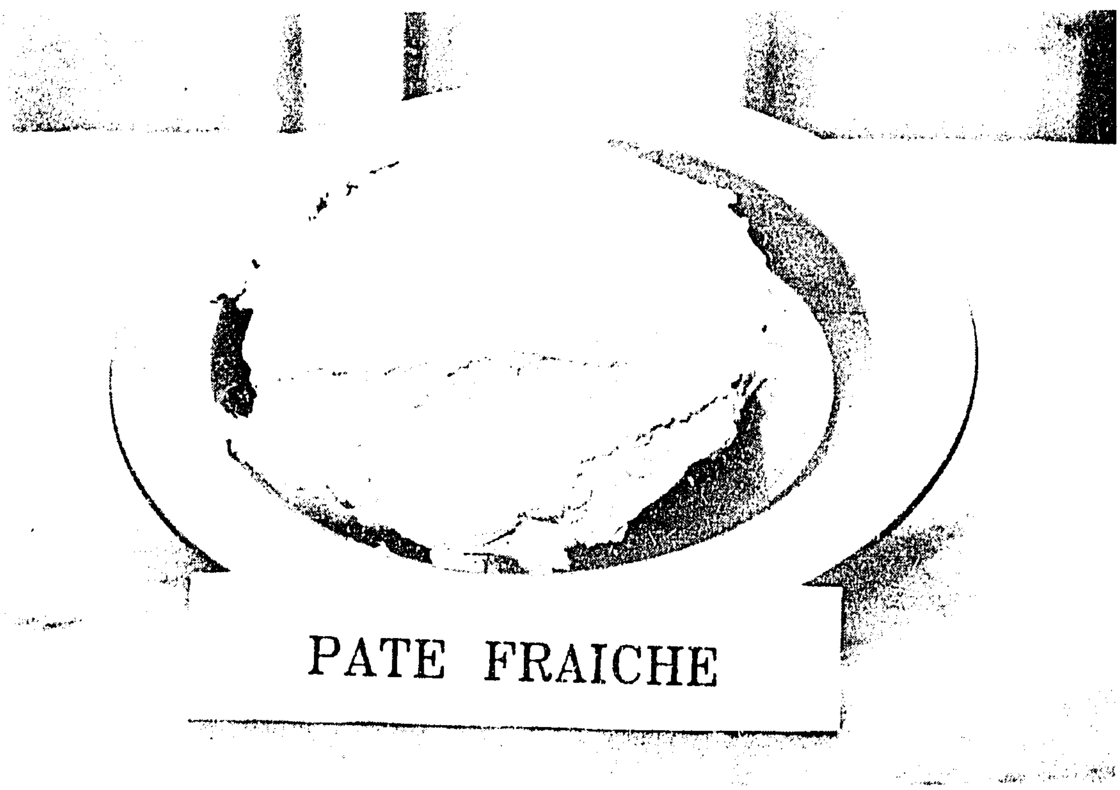


Figure 27. *Compacted curd removed from the cheese mould.*

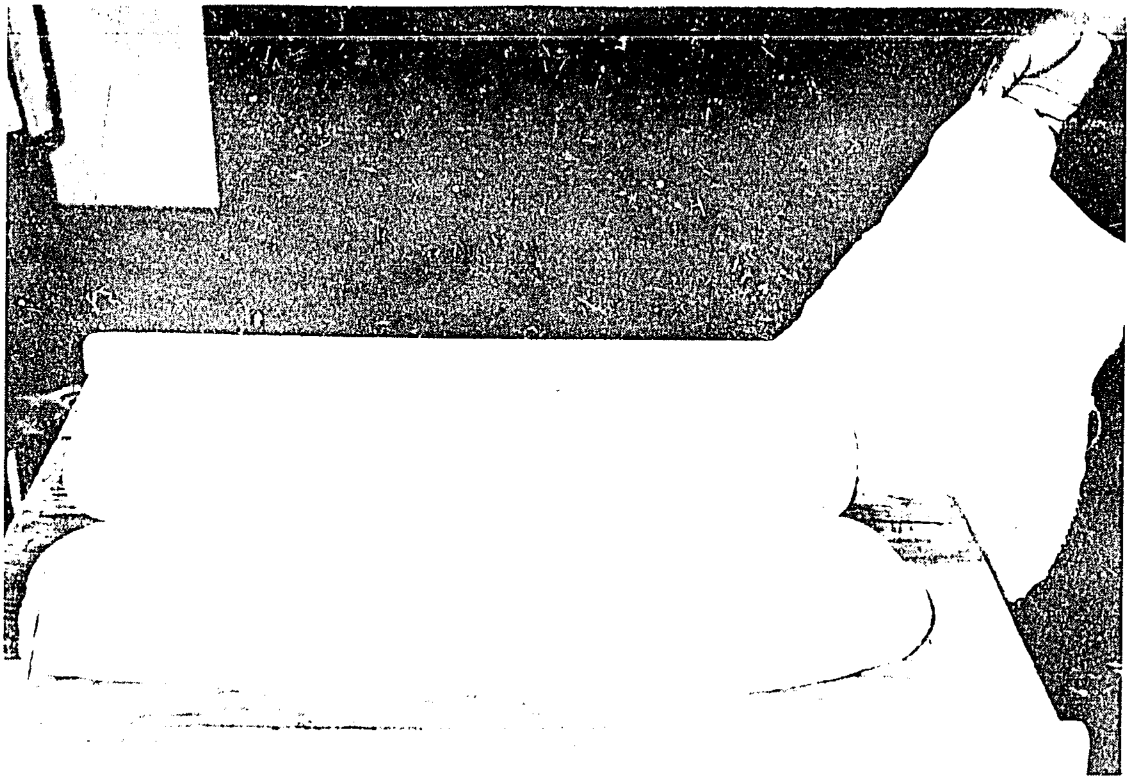


Figure 28. *Cutting the curd mass.*

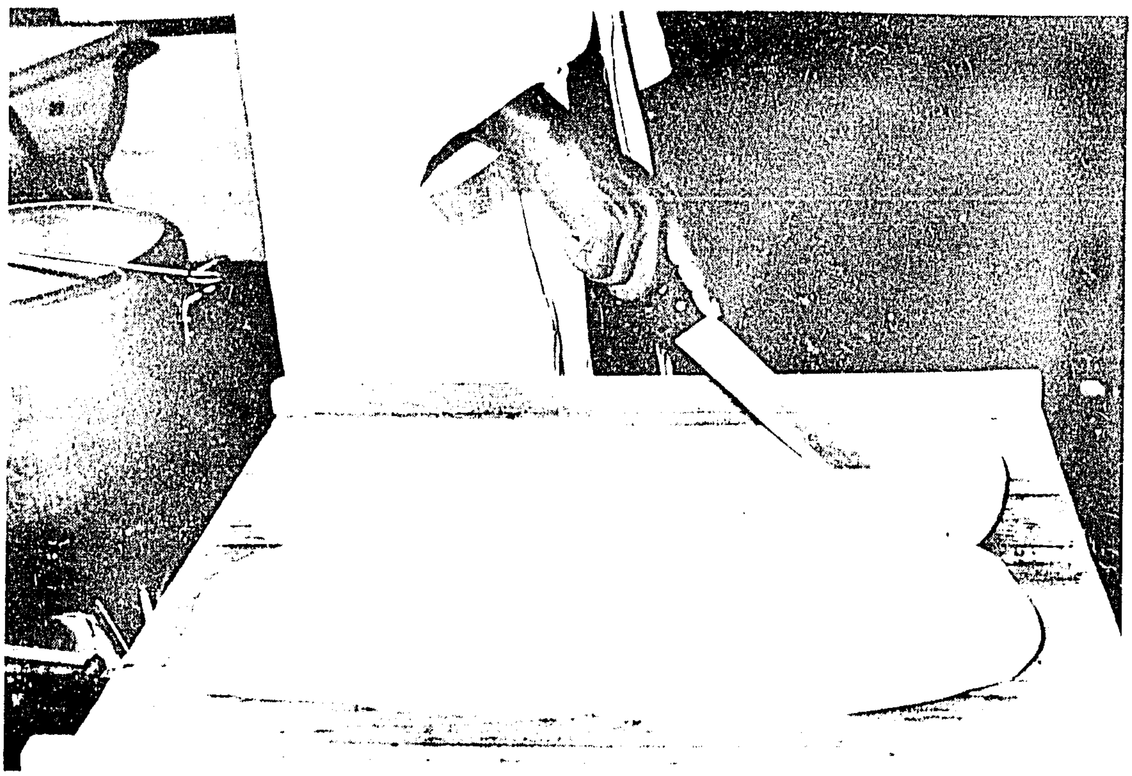


Figure 29. *Pieces of Halloumi cheese.*

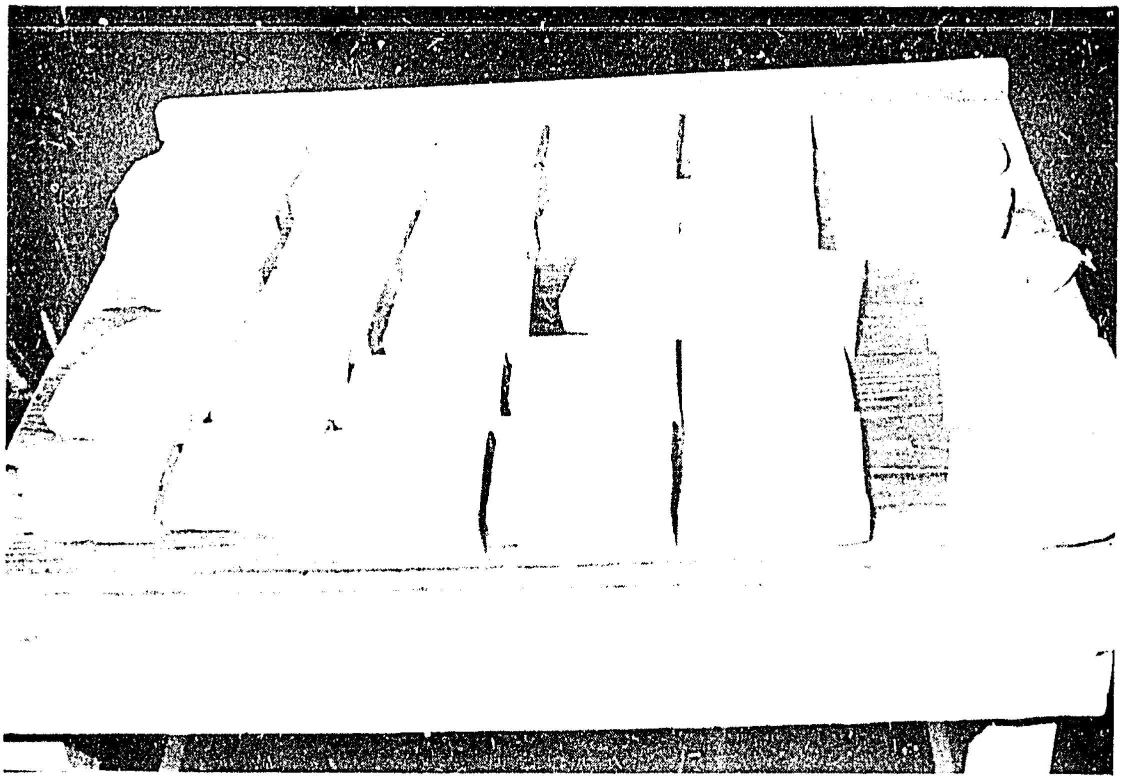


Figure 30. *Slicing the cheese pieces.*

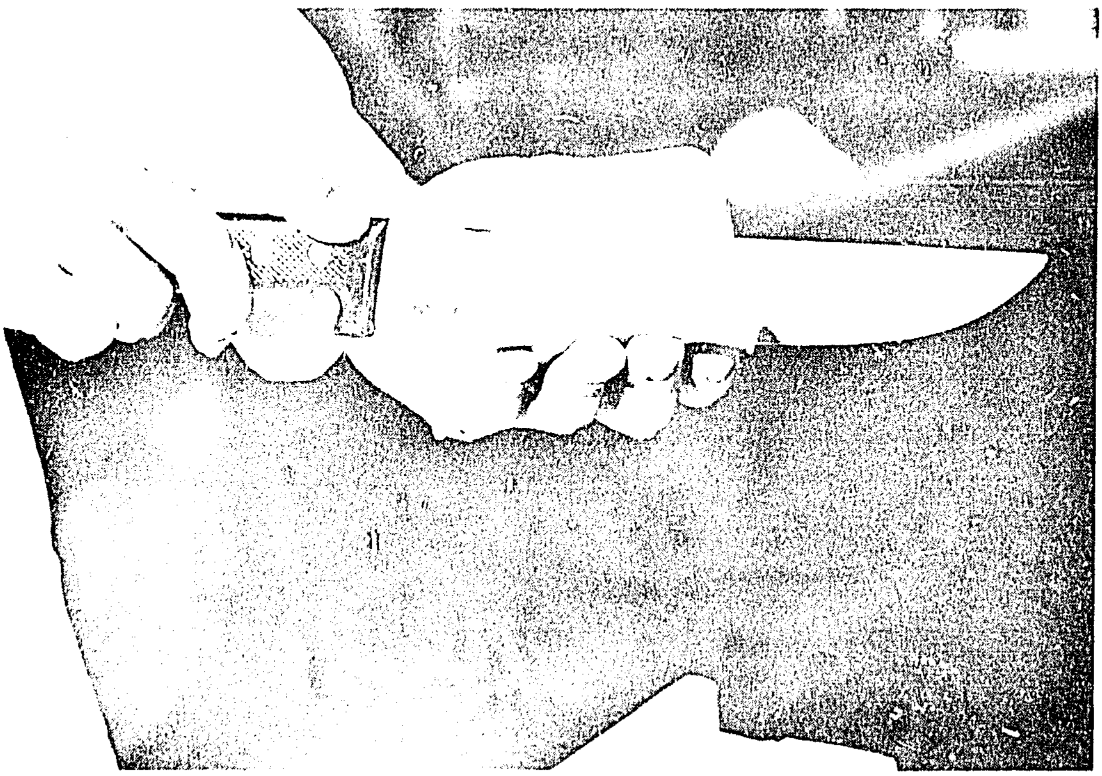


Figure 31. *Floating cheese pieces.*

Figure 32. *Rubbing salt on the cheese.*

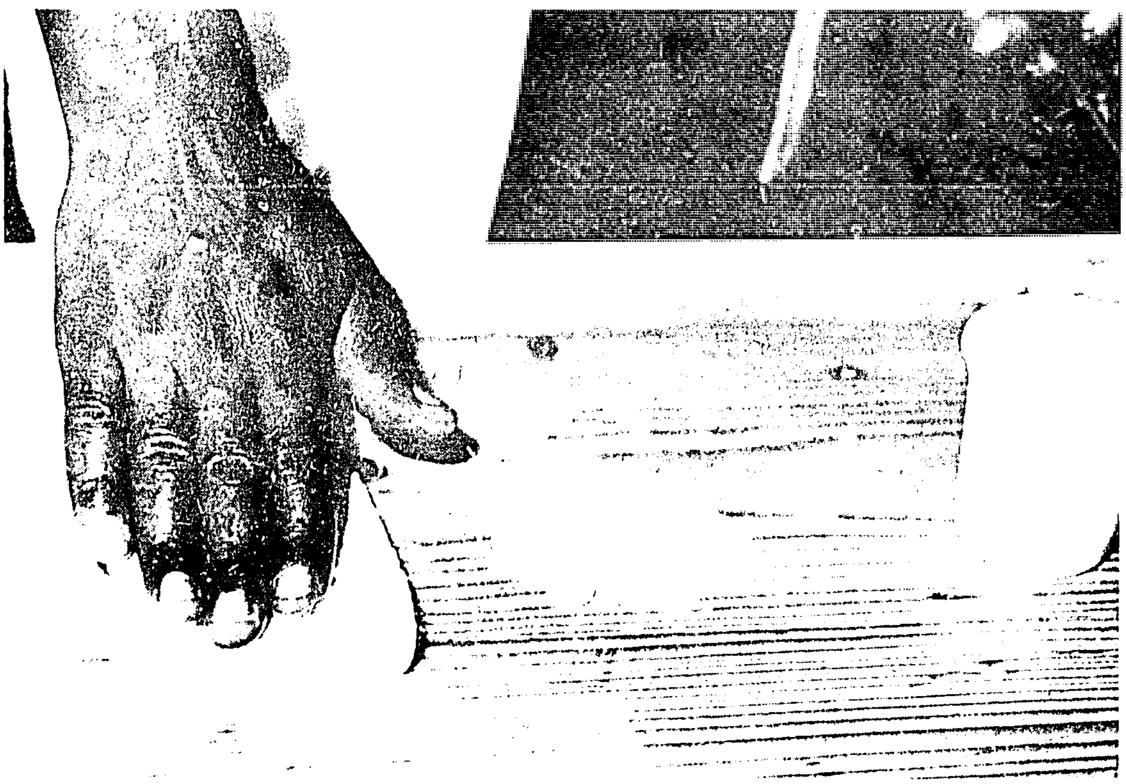
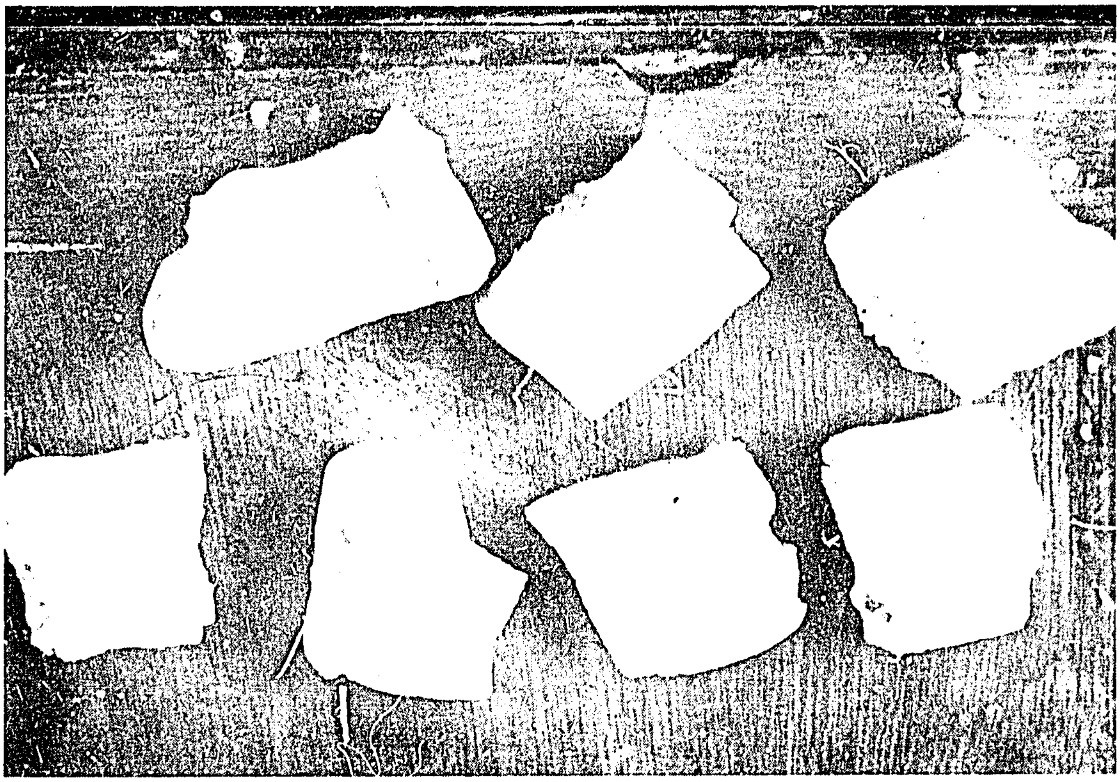


Figure 33. *Cheese pieces folded over after salting.*



Scamorza

Scamorza is a Pasta filata type cheese produced by smallholders in some regions of East Africa, e.g. Tanzania and Kenya. Other Pasta filata type cheeses are Kashkaval, Caciocavallo and Mozzarella. Scamorza cheese is made from whole or standardised milk (some of the fat is removed). The cheese, which weighs about 400 g, is ready for consumption when it is between three and five weeks old.

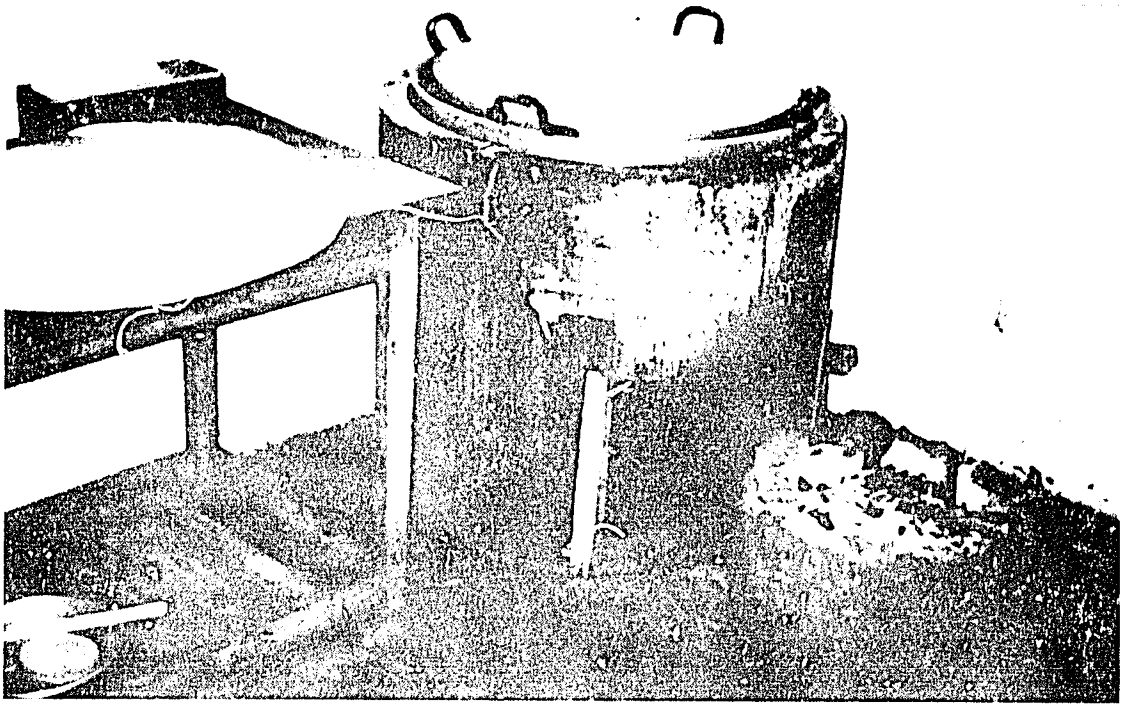
For the market place it is important that the shape, size and quality of the cheese is uniform and consistent. The appearance may be enhanced by applying a thin coating of butter to the surface of the cheese. This may also reduce evaporation thereby increasing yields.

As a result of work carried out at ILCA (International Livestock Centre for Africa) the following is a recipe for the manufacture of Scamorza cheese at smallholder level. About one kilogram of cheese will be obtained from 10 litres of milk.

Method

1. Standardise fresh whole milk to about 3.3% fat by allowing it to settle for one hour and skimming off a portion of the fat. This fat may be used to manufacture butter.
2. Heat the standardised milk to 36°C (Figure 34). Add 2% of a yoghurt-type culture.
3. Ripen the milk (develop acidity) for 30–40 min after which time the acidity of the milk should have increased by 0.02% lactic acid.
4. Add rennet (1 ml per 5 litres milk).
5. After about 40 min the milk has coagulated. Cut the coagulum into 1 cm cubes using a sharp knife.

Figure 34. *Heating milk indirectly in cheese container.*



6. Gently stir the curds and whey mixture and heat to 42°C over a period of 30 min.
7. Allow the curds to settle in the whey. Remove about 60% of the whey from the container.
8. Keep the curds and remaining whey at 42°C by removing some whey and replacing it with hot whey. The acidity continues to increase giving the curd the desired texture.
9. Carry out the following test to determine if the curd has developed the required texture. Dip a piece of curd into very hot water (80–85°C) using a spoon or perforated ladle. When the curd can be stretched into an elastic, continuous string of about one metre the correct texture has developed (Figure 35).
10. Separate the curds and whey (Figure 36) and add sufficient boiling water to cover the curd.
11. Work and fold the curd pieces (sufficient to give a finished cheese of about 400 g) into a ball (Figure 37), place in a mould and allow to cool for one hour in water at 10–12°C (Figure 38).
12. Remove the cheese from the mould and place it in a salt solution (15%) for two to three hours.
13. Ripen (mature) the cheese for about four weeks (Figure 39).

Cheddar

Cheddar cheese has its origins in Britain. Traditionally the cheese was made in different sizes from about 0.5 to 25 kg. The procedure for making Cheddar may be considered difficult and tedious by the inexperienced but the resultant mature cheese with its characteristic nutty flavour and close texture makes the task worthwhile. The Cheddar cheese recipe can be manipulated to give a cheese which may be consumed in four weeks or stored for up to two years. Therefore Cheddar offers the opportunity to preserve milk constituents in times of surplus milk production.

In order to obtain a cheese of good body and texture it is necessary to use milk with about 3.3% fat. If milk with excess fat content is used there will be high losses of fat in the whey and the cheese will have a weak, pasty body.

Figure 35. *Testing the curd for stretchability.*

Figure 36. *Cheese curd mass.*

Figure 37. *Working and folding the curd after removal from hot water.*

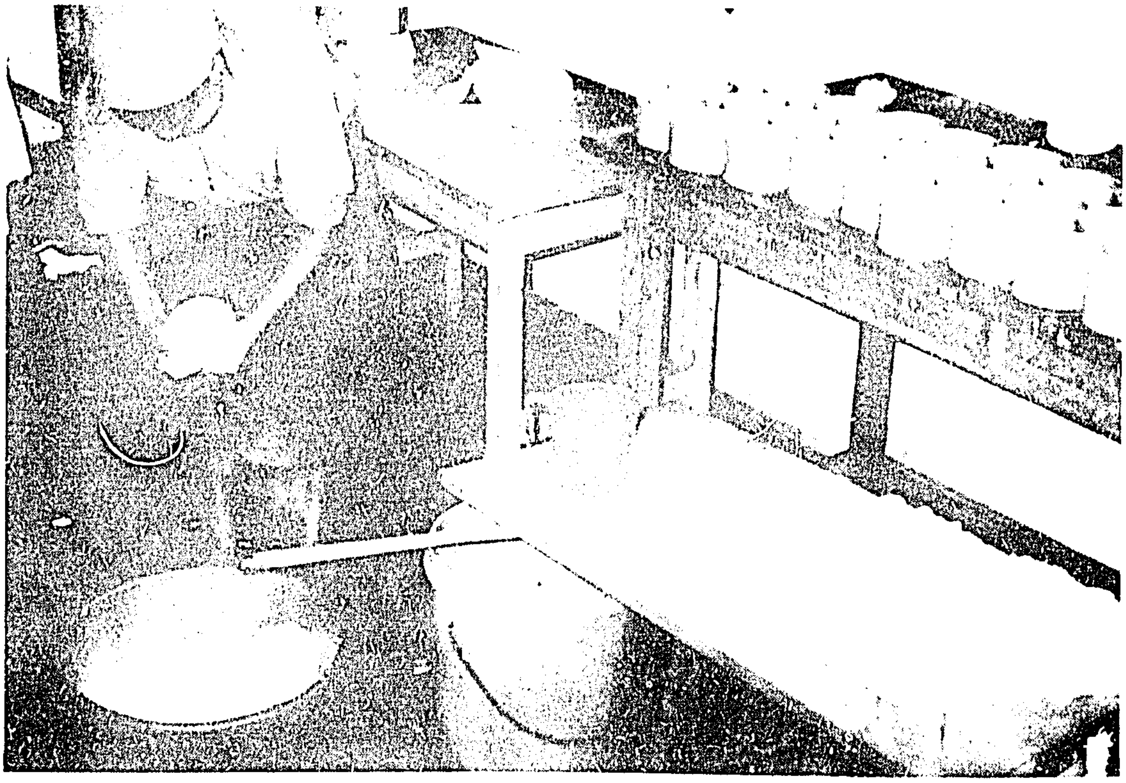
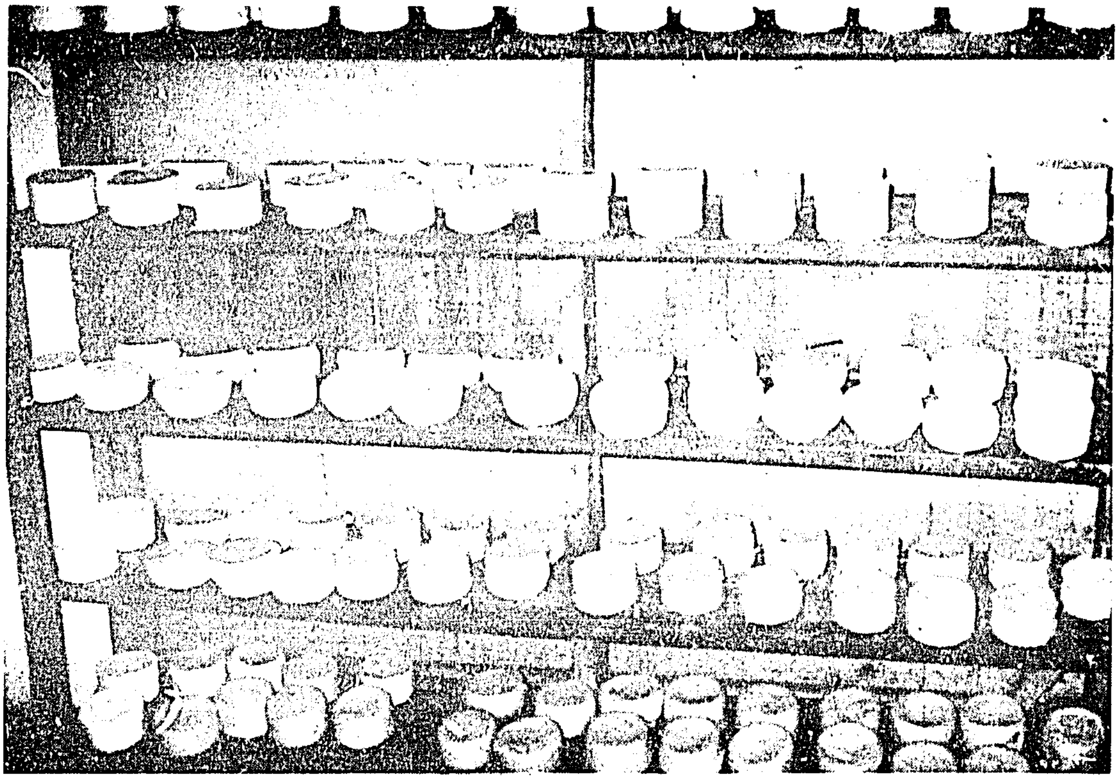


Figure 38. *Cheese in mould placed in cool water.*

Figure 39. *Cheese placed on wooden shelves for ripening.*



Method

1. Use milk containing about 3.3% fat. Warm it to 30°C.
2. Add starter (2%) to the warm milk.
3. After about half an hour add rennet at a rate of 1 ml per 4 litres of milk. Before adding the rennet, dilute it five to six times with clean cold water.
4. When the curd is firm enough (Figure 40), i.e. in 40–50 min, cut it into 1.25 cm cubes (Figures 41 and 42).
5. Stir the curds and whey and heat gradually to 38–40°C in about 50 min.
6. Continue stirring until the curd pieces have firmed and an acidity of 0.20% lactic acid has been reached.
7. Drain off the whey (Figure 43); the curds mat together (Figure 44).
8. When a small quantity of milk (10 litres) is used the curd is left as one piece but where large quantities of milk are used the matted curd is cut into appropriate sized blocks (Figure 45).
9. Keep the cheese block or blocks (Figure 46) warm (30°C) and turn frequently until the correct texture and acidity is reached (Figure 47). This process (Cheddaring) may take 1.5-2 hours after the whey is removed.
10. Break up the cheese blocks into small pieces (milling) about 3–4 cm long.
11. Add salt to the curd pieces (Figure 48) at a rate of 2–2.5%. Distribute the salt evenly and mix well with the cheese curd.

Figure 40. *Checking the coagulum before cutting.*

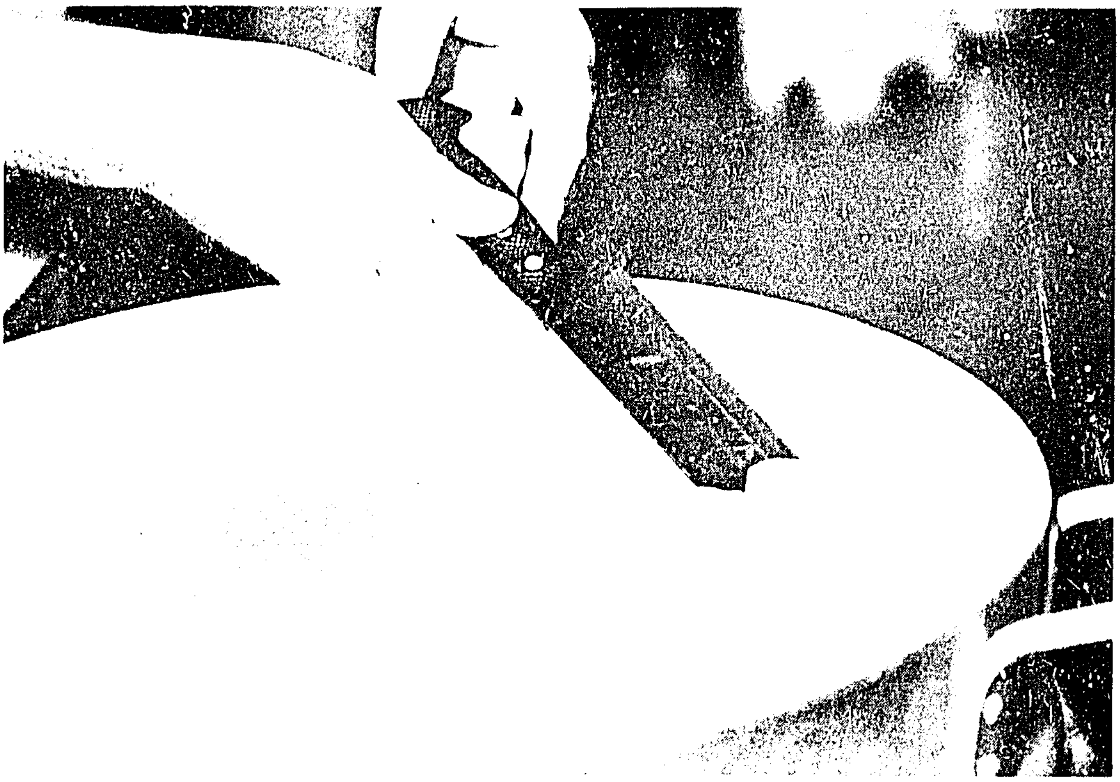


Figure 41. *Cutting the coagulum with a vertical knife.*

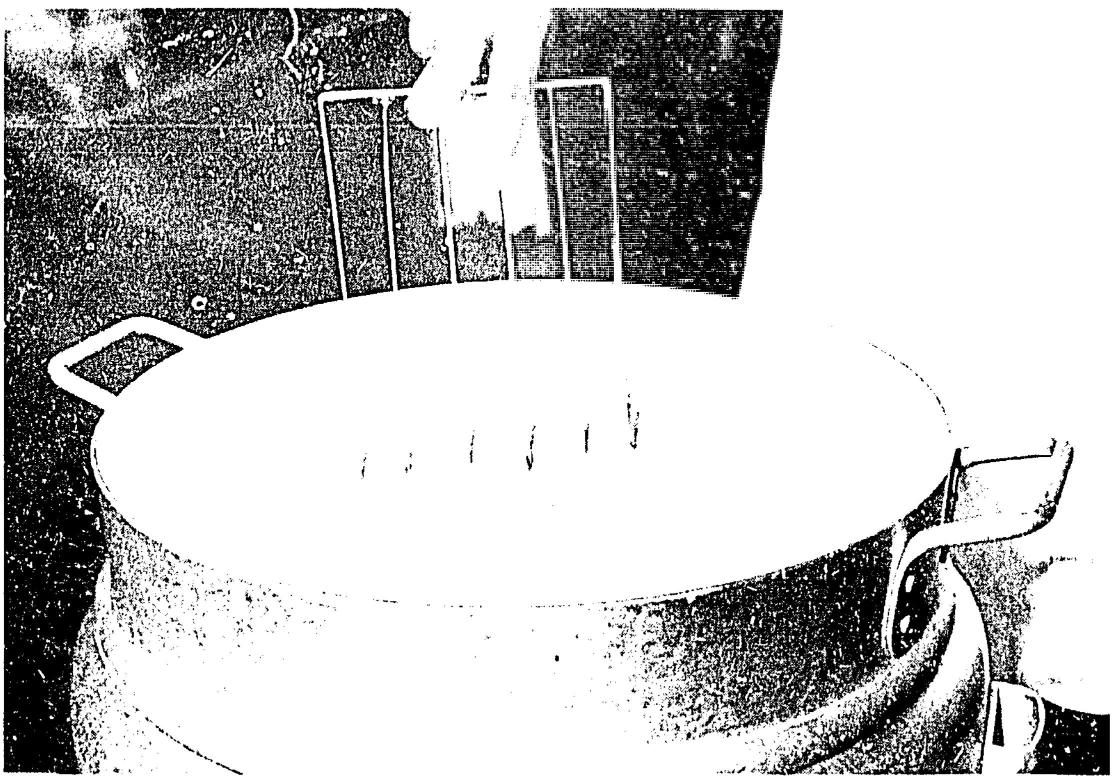


Figure 42. *Cutting the coagulum with a horizontal knife.*

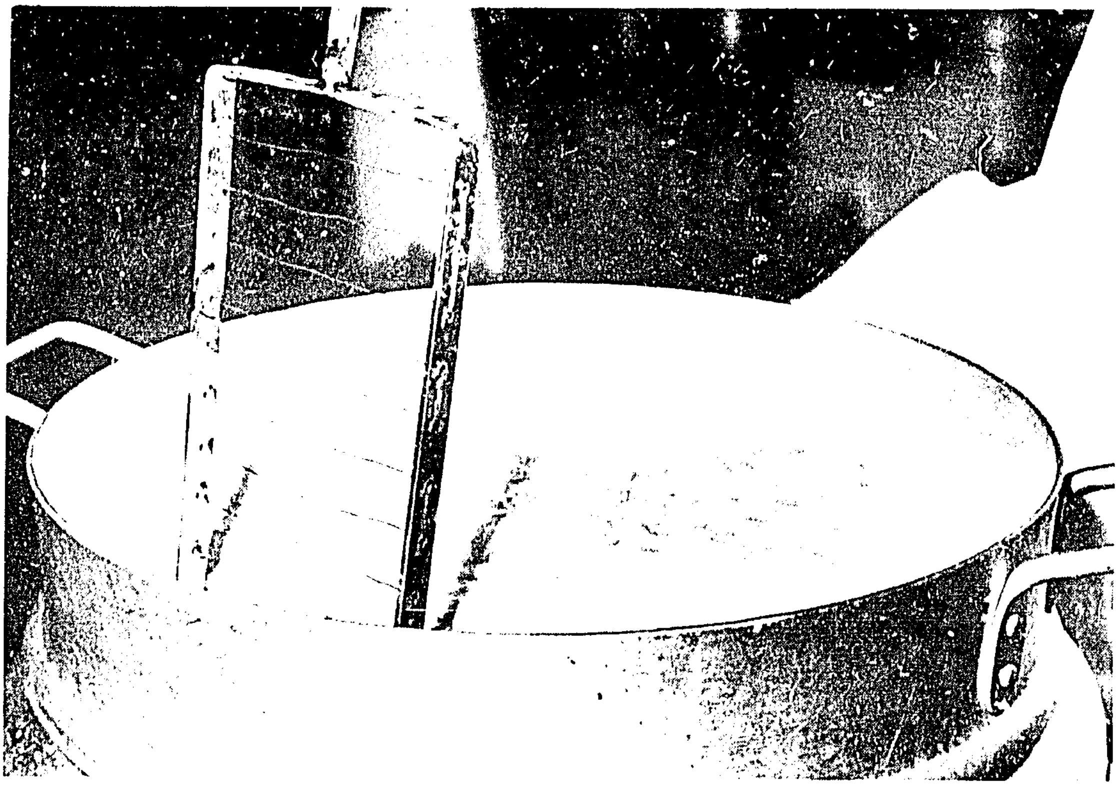


Figure 43. *Separating curds from whey.*

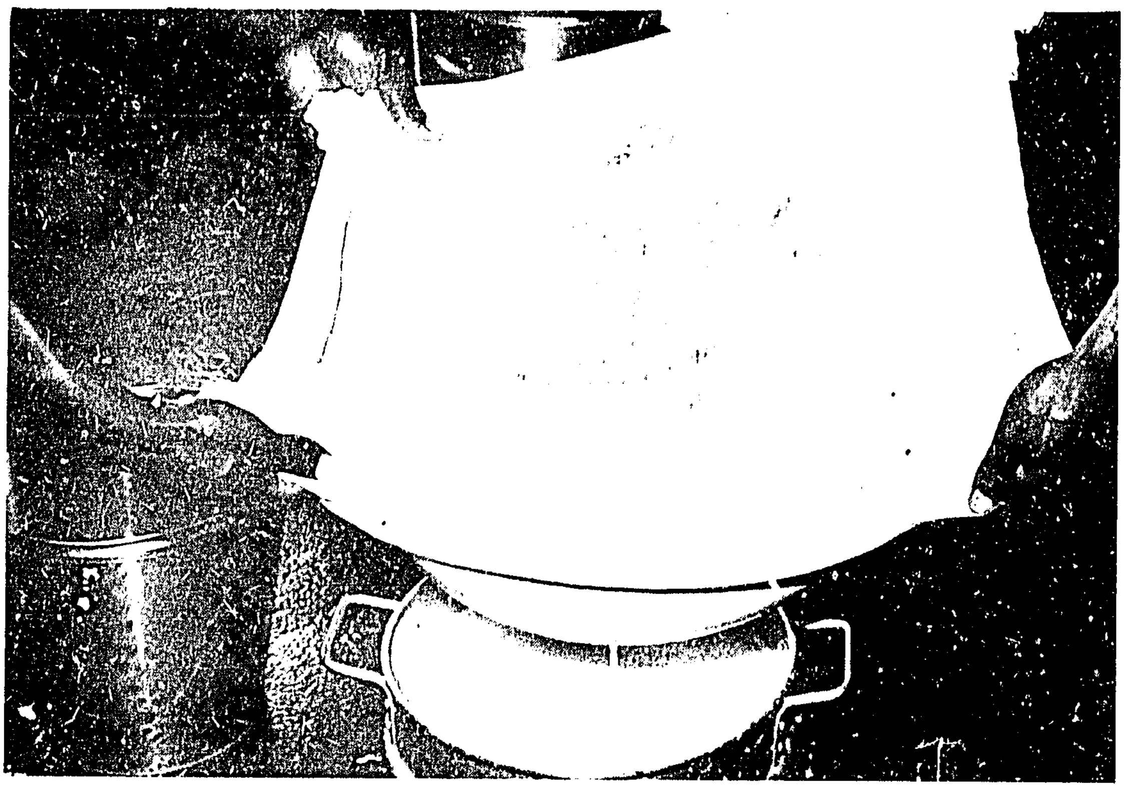


Figure 44. *Cheese curd.*

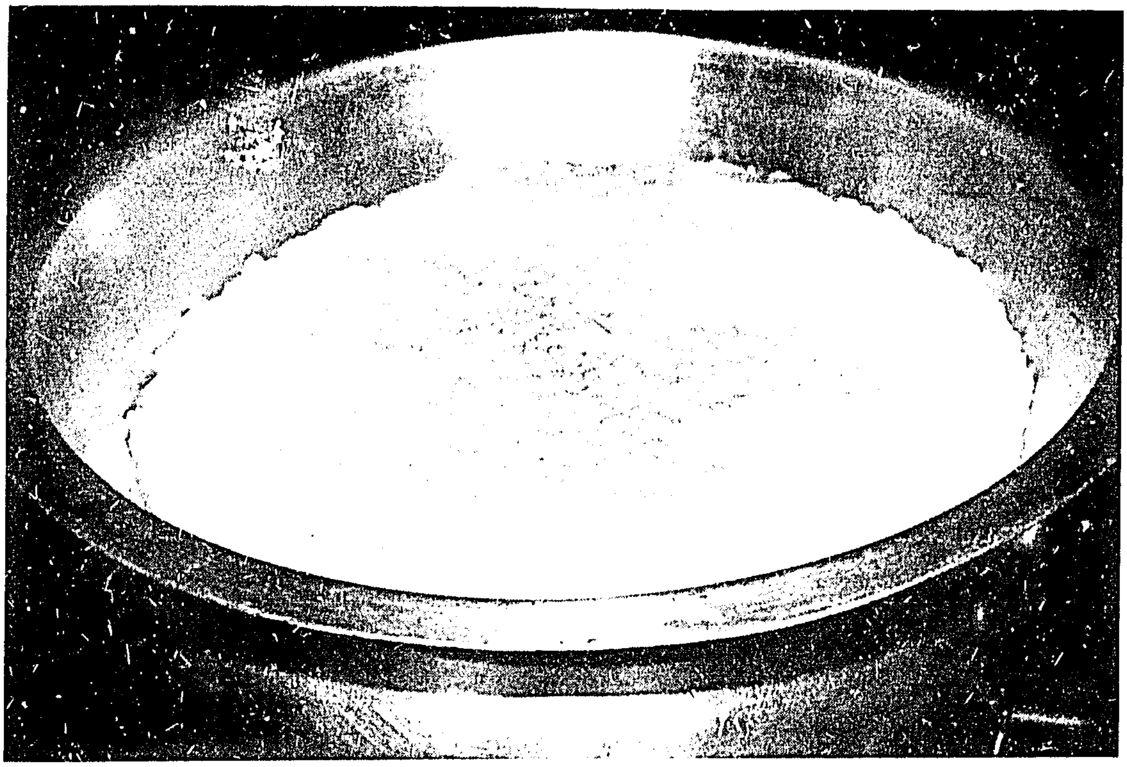


Figure 45. *Cutting the cheese curd.*

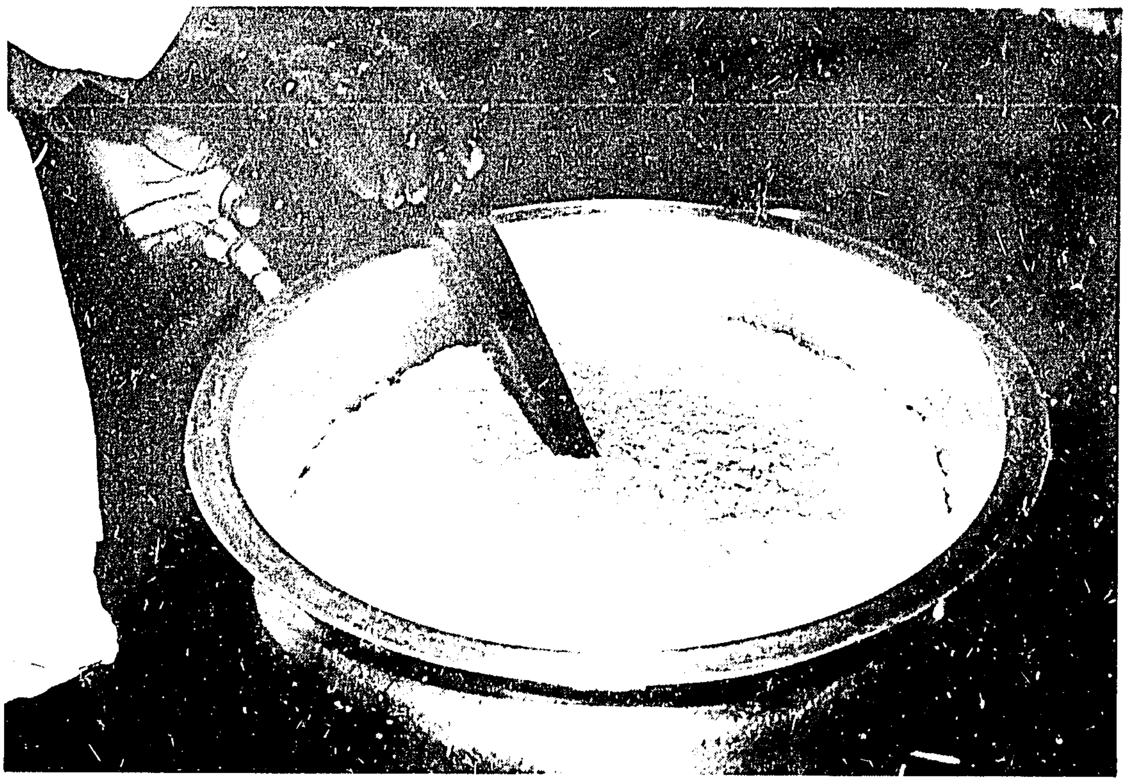


Figure 46. *Checking the temperature of the curd.*

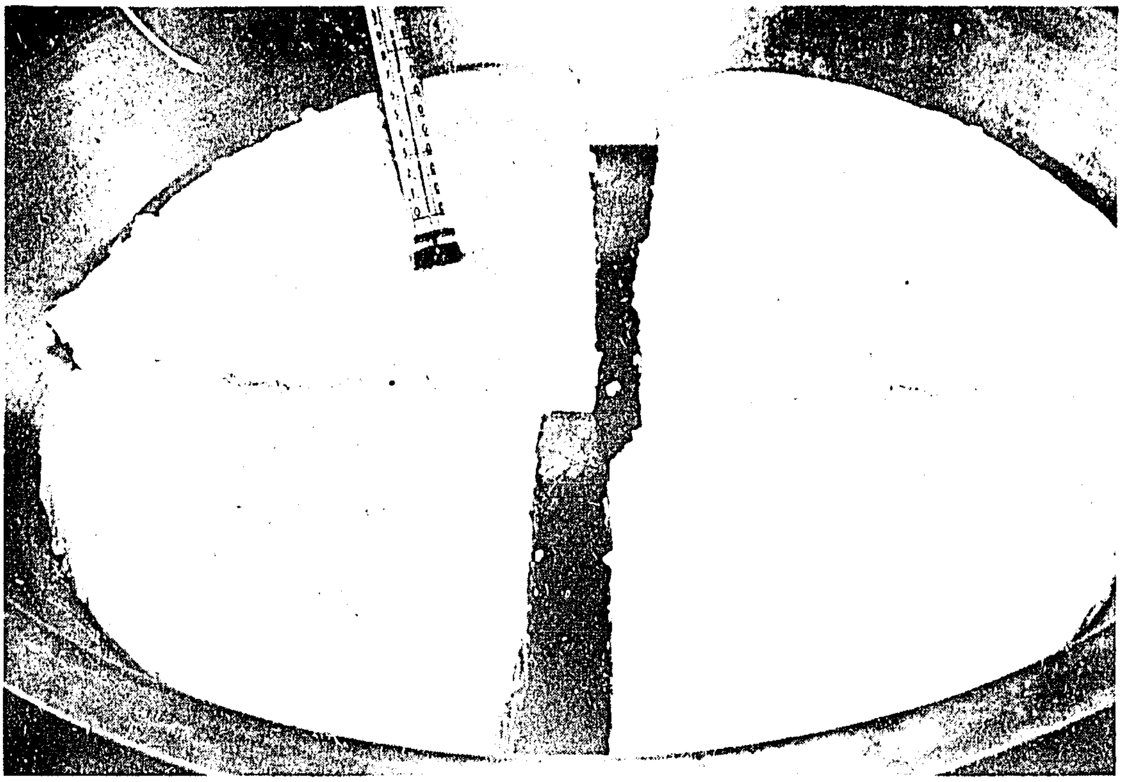


Figure 47. *Covering the curd with cheese cloth to keep it warm during Cheddaring.*

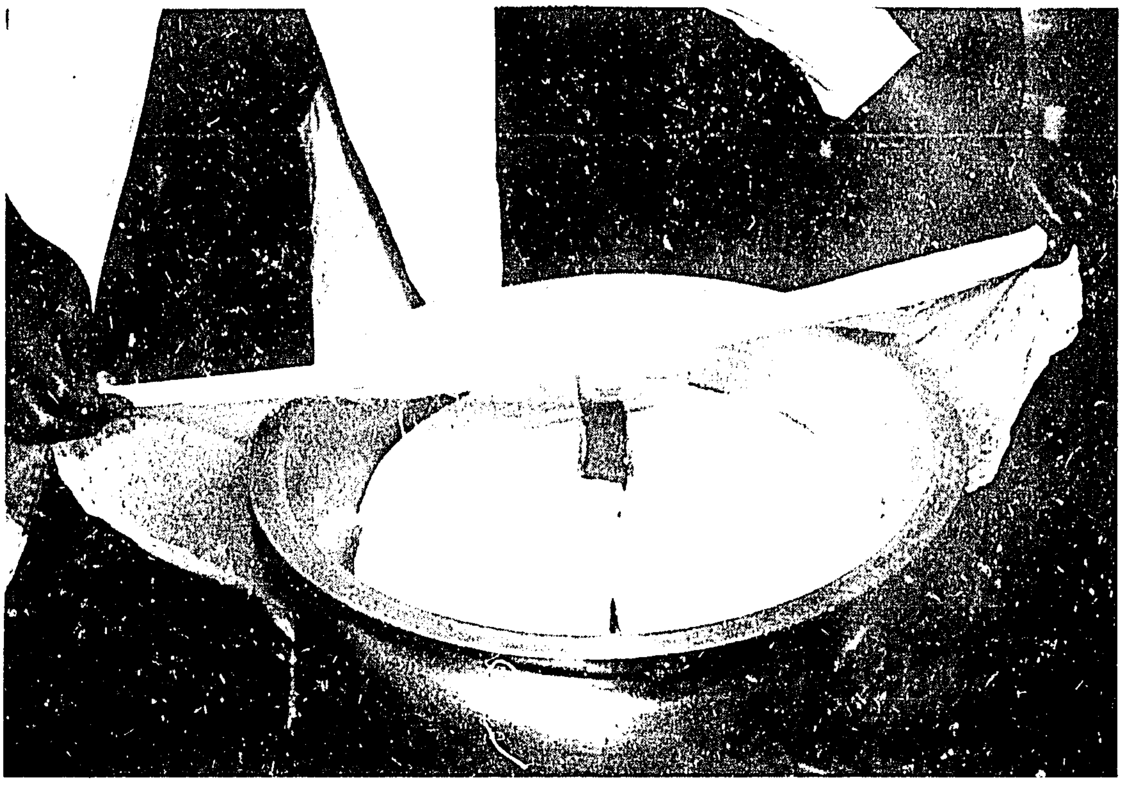


Figure 48. *Adding salt to the cheese pieces.*

12. Pack the salted curd into moulds lined with cheese (muslin) cloth and press (Figures 49, 50 and 51). Apply pressure gently at first and then increase to ensure that the curd pieces mat. If too much pressure is applied the expressed whey from the curd is milky white indicating high fat losses while too little pressure results in poor matting of the curd pieces and a cheese which will not retain its shape during storage.
13. Store the cheese at ambient temperature; lower temperatures (15°C) will slow down the rate of ripening. Storage temperatures can therefore be varied to give a rapid or slow maturing cheese.
14. The ripening or storage period of the cheese (Figure 52) can vary from four weeks to two years depending on the manipulation, e.g. rate of acid production of the recipe and temperature of storage.

Mysost

Mysost cheese has its origins in Norway; it is made from whey. Mysost has a dark colour and a sweet taste. The sweet taste is due to the high sugar content of the evaporated whey and the final cheese may contain up to 40% sugar.

Method

1. Use equal quantities of fresh milk and whey.
2. Heat the mixture carefully until it simmers without boiling and stir frequently.
3. Continue heating until the mixture thickens.
4. Transfer to a shallow container (3 cm deep) and as it hardens cut it into suitably sized pieces.
5. The cheese may be eaten fresh or stored in an airtight container.

Figure 49. *Putting the cheese into a muslin-lined mould.*

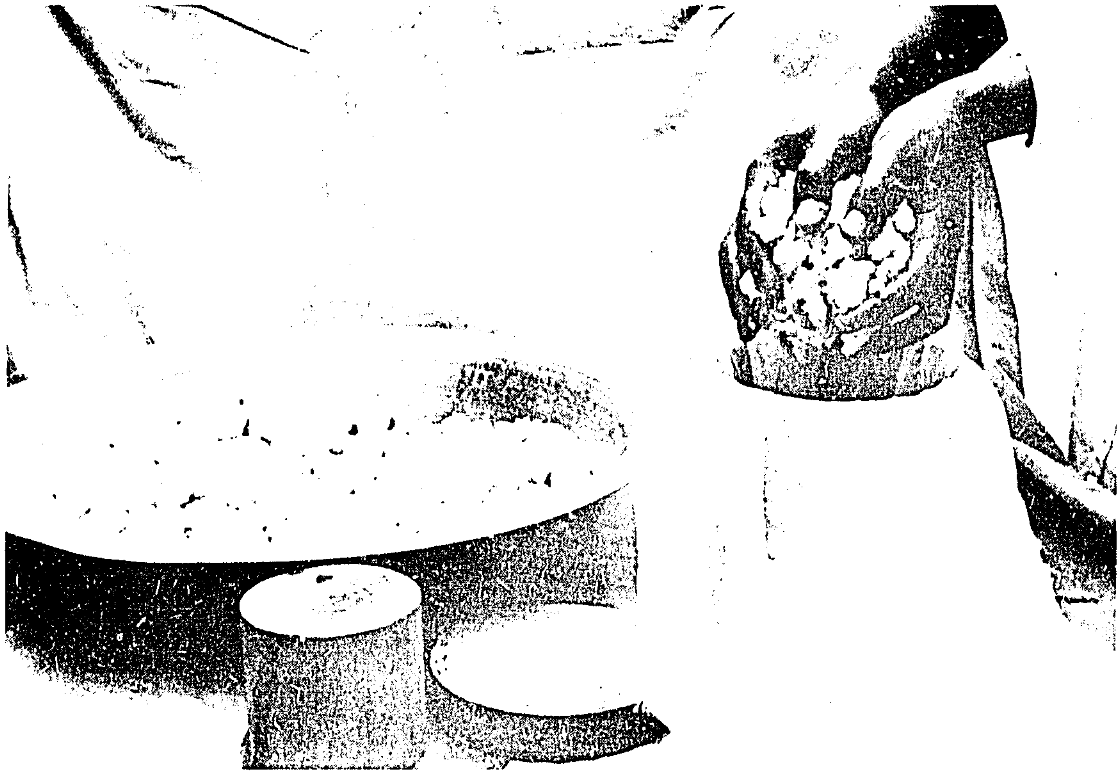


Figure 50. *Wooden lid (follower) placed in the cheese mould.*

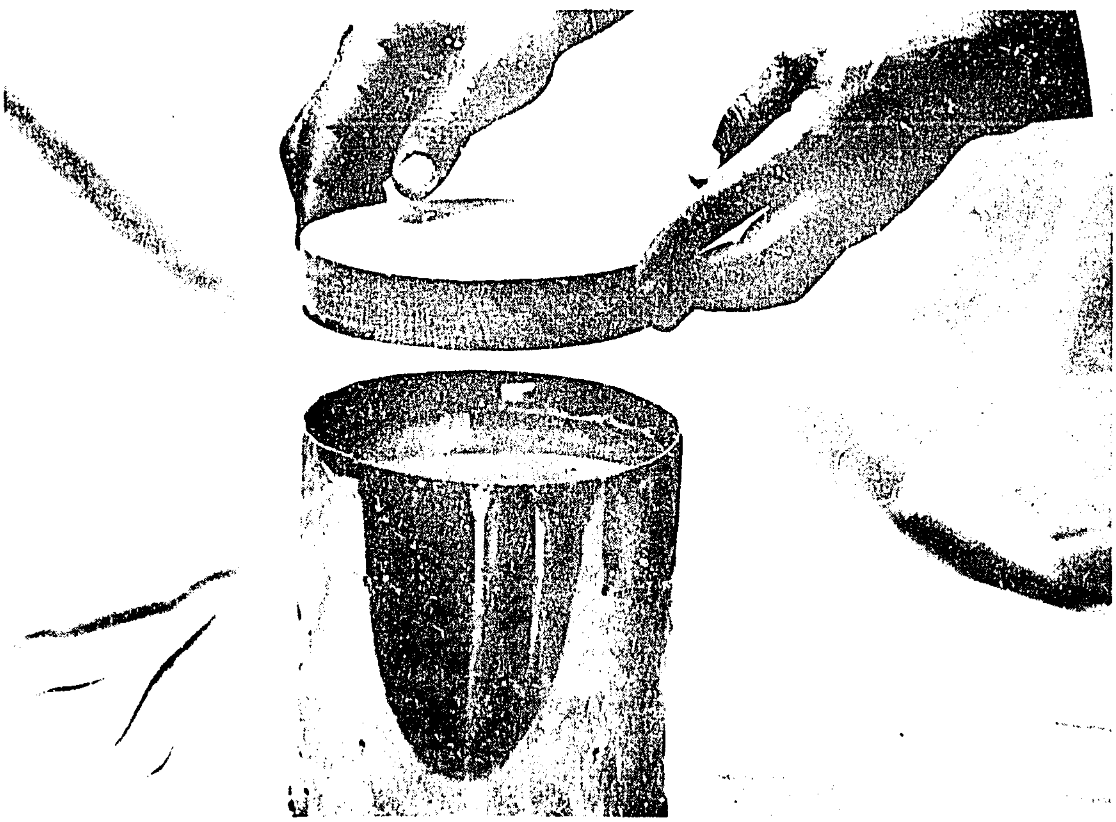


Figure 51. *Cheese ready for pressing.*

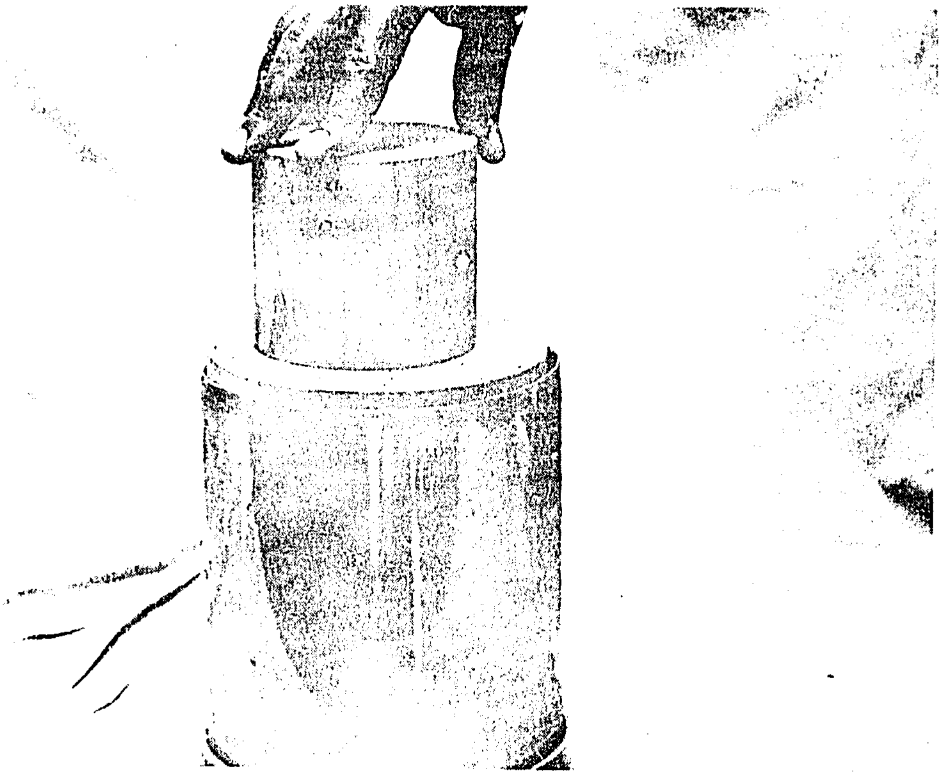


Figure 52. *Ripened Cheddar cheese.*