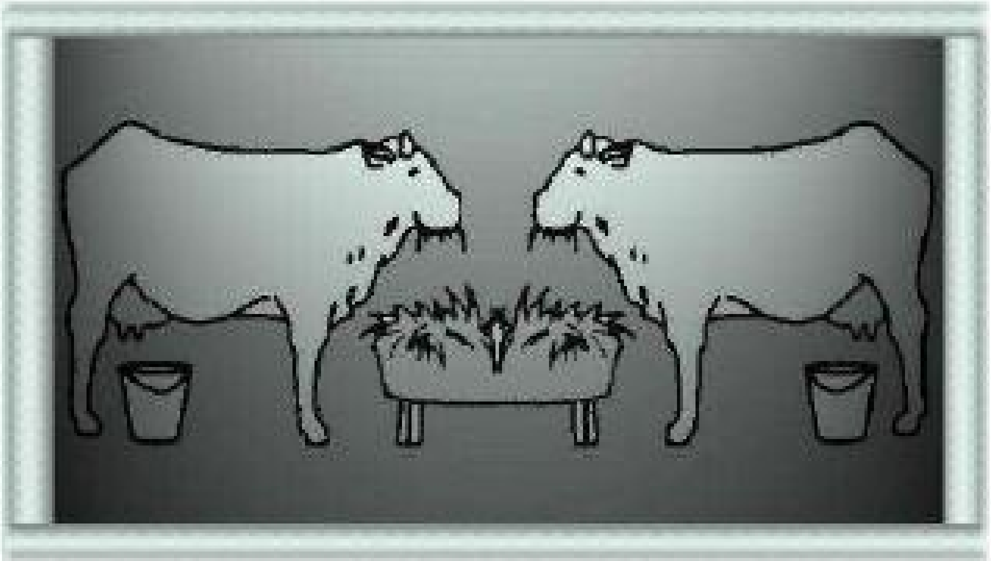

Small-scale

dairy farming manual

Regional Dairy Development and Training Team
for Asia and Pacific
Chiangmai, Thailand

Regional Office for Asia and the Pacific
Bangkok, Thailand

FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS
Rome, 1999

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Small-Scale Dairy Farming Manual

Regional Dairy Development and Training Team for asia and the Pacific, Chiangmai, Thailand.

Regional Office for Asia and the Pacific, Bangkok, Thailand.

ENTER

GCP/SAM/007/FRA

"Establishment of a Regional Information Centrefor Milk Pasteurization on a Semi-Industrial Scale in the Pacific Region, South Samoa.

Organized by FAO with the financial assistance from the Governmant of France.

Electronic version created by Dr. Roopa Rajah

How to use this manual?

After you have reached this page, if you click on the word "continue" at the end of this page, it will take you to the "contents" page. In each page if you scroll down to the page ther are two red buttons with arrows to take you forward or backward along the manual.

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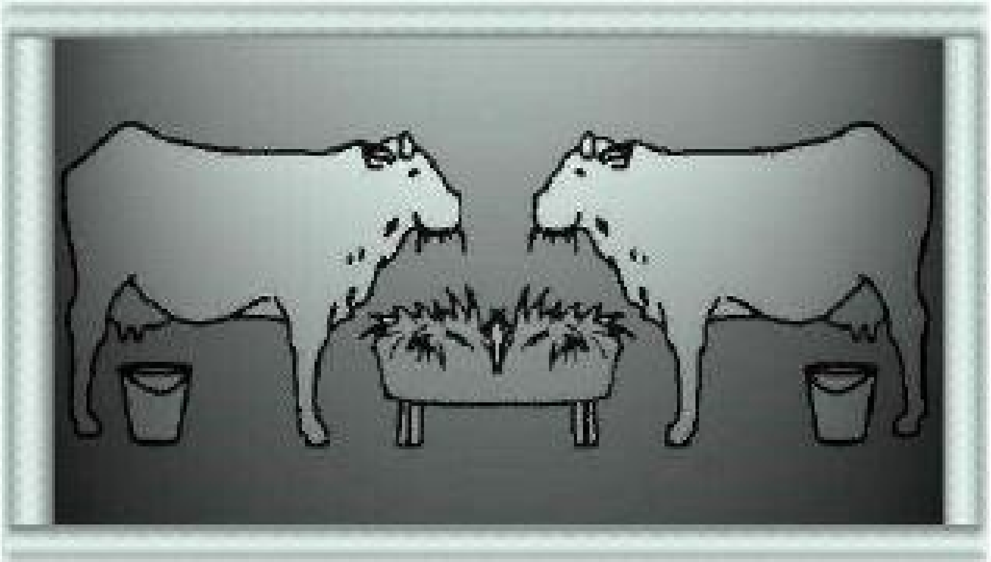

Small-scale

dairy farming manual

Volume 1

Technology
Units 1 to 11

Regional Dairy Development and Training Team
for Asia and Pacific
Chiangmai, Thailand

Regional Office for Asia and the Pacific

expressions of any opinions whatsoever on the part of the Food and Agricultural Organization of the United Nations concerning the legal status of any country, territory, city or area of its authorities, or concerning the delimitation of its frontiers or boundaries.

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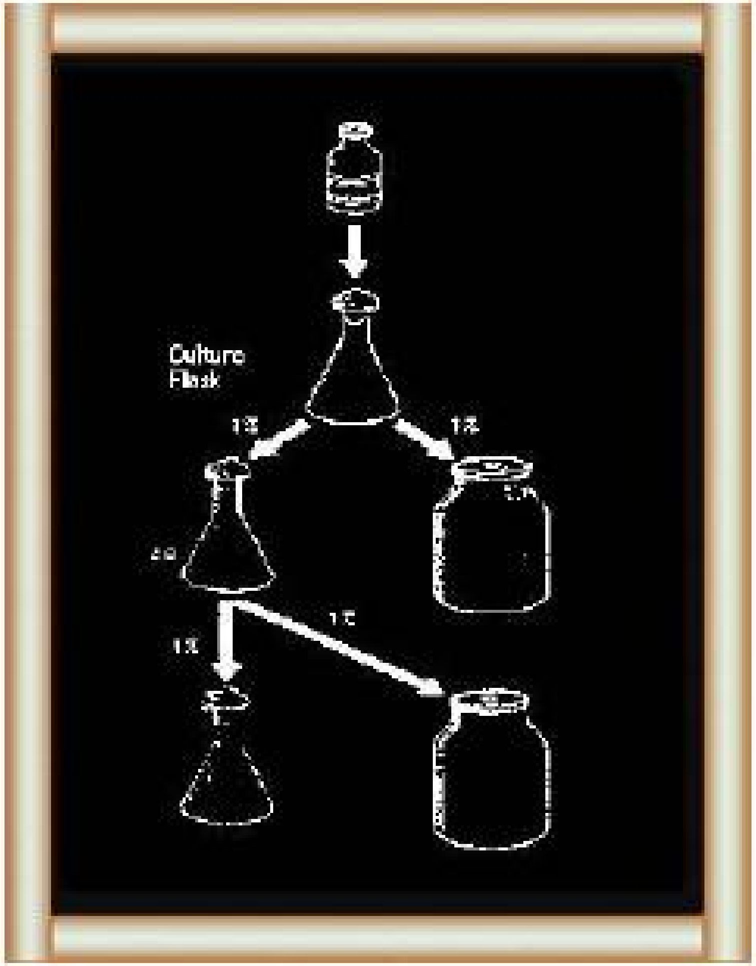
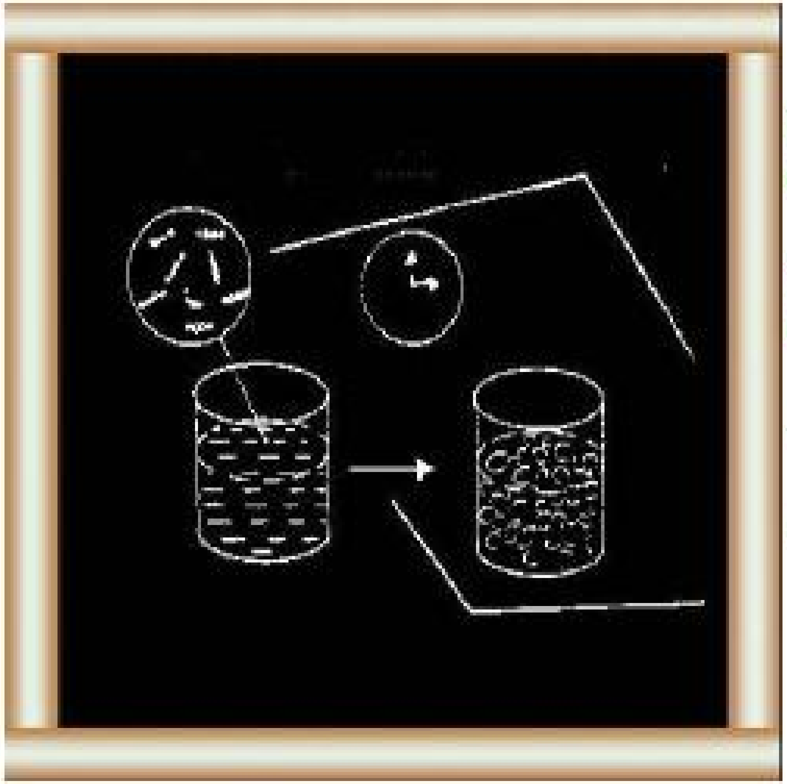
Starter Cultures


Culture
Flask

Extension Materials

What should you know about starter cultures?



What is a starter culture and why use it? (5-11)

1 A starter culture is a milk product which:

- contains lactic acid bacteria

- controls the souring of milk.

What types of starter culture are there? (12-20)

2 There are many types.
Choose one for your:

- local conditions

- the product you want to make.

How do you prepare and maintain a starter culture? (21-36)

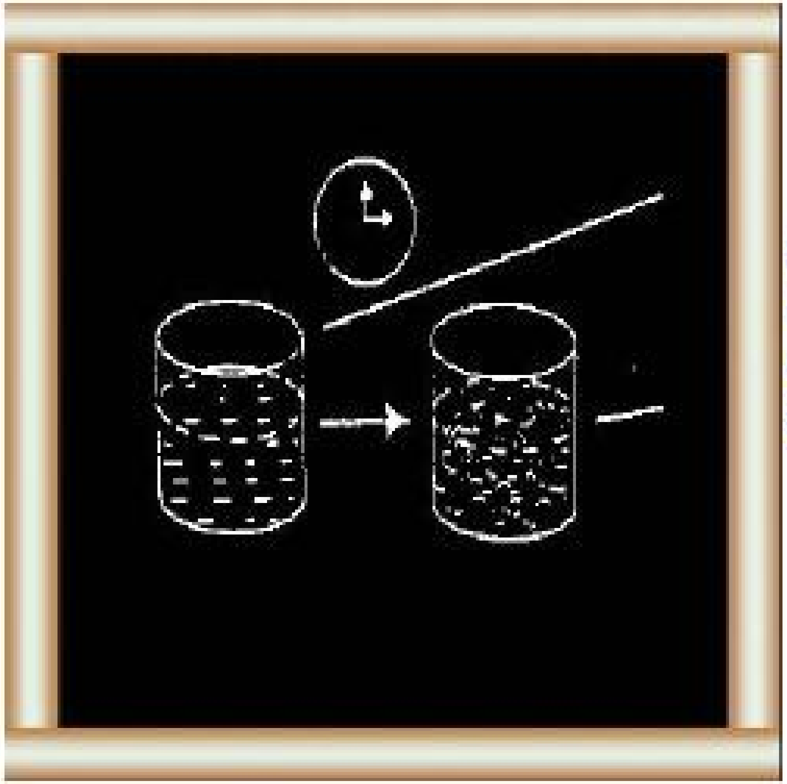
3 You need:

- clean and disinfected equipment

- the correct starter culture and high quality milk

- to do the right things at the right time.

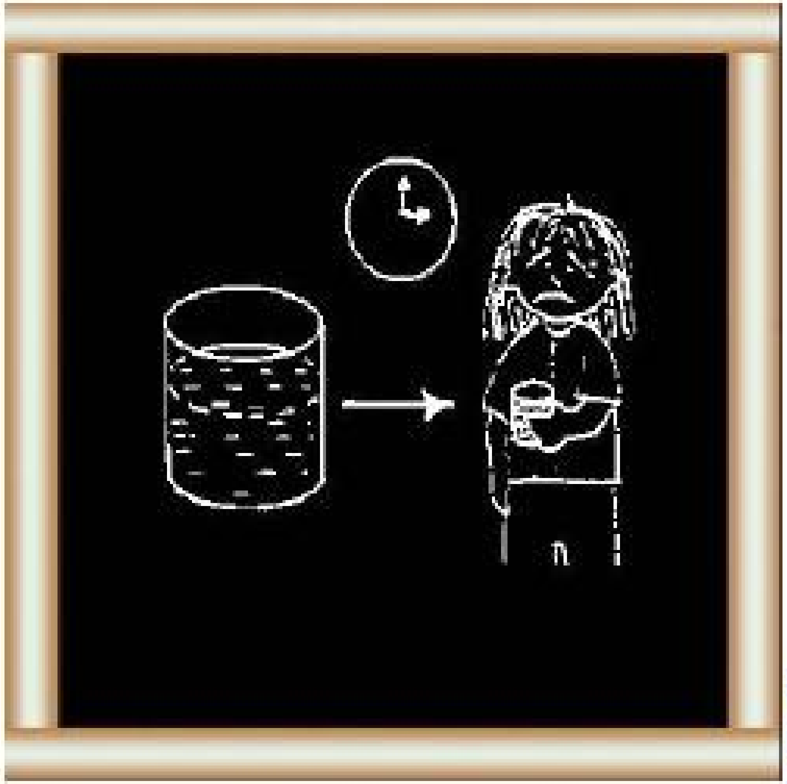
4 By using different starter cultures at different temperatures.



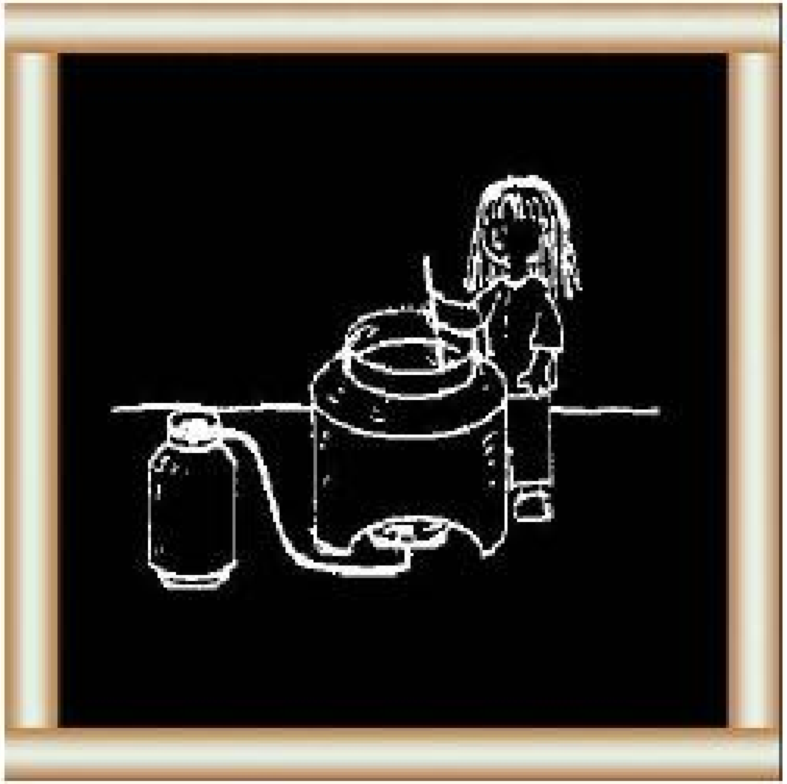
6 It changes the milk sugar (lactose) into acid (lactic acid) so that the milk becomes sour (fermented or cultured).

7 To control fermentation.

Raw milk always contains different microorganisms.



8 These microorganisms turn your milk sour but you cannot control the fermentation.



microorganisms.

10 By using a commercial starter culture with pasteurized milk, you can control the souring of milk

11 and make:

- butter
- cheese
- yoghurt

and many other products.

Optimum growth temperature
13 Mesophilic cultures grow best at about 30 C.

Thermophilic cultures grow best at about 43 C.

Physical state

14 Starter cultures can be:

- liquids

- solid (deep-frozen)

- powders (freeze-dried).

15 Powder cultures are useful

because:

- they have good keeping qualities (more than 6 months at -20 C)
- you can send them long distances

by airmail.

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Type of lactic acid bacteria.

17 Some lactic acid bacteria produce only lactic acid.
Others produce lactic acid gas and aromatic compounds.

Some common lactic acid bacteria used in cultures are:

Mesophilic	Thermophilic	
Pure	Pure	Mixed
Sc. lactis	Sc. thermophilus	Sc. thermophilus
Sc. cremoris	Lb. helveticus	+
Sc. diacetylactis	Lb. bulgaricus	Lb. bulgaricus
Lc. cremoris	Lb. acidophilus	

Note:

Sc. = Streptococcus, Lc. = Leuconostoc, Lb. = Lactobacillus

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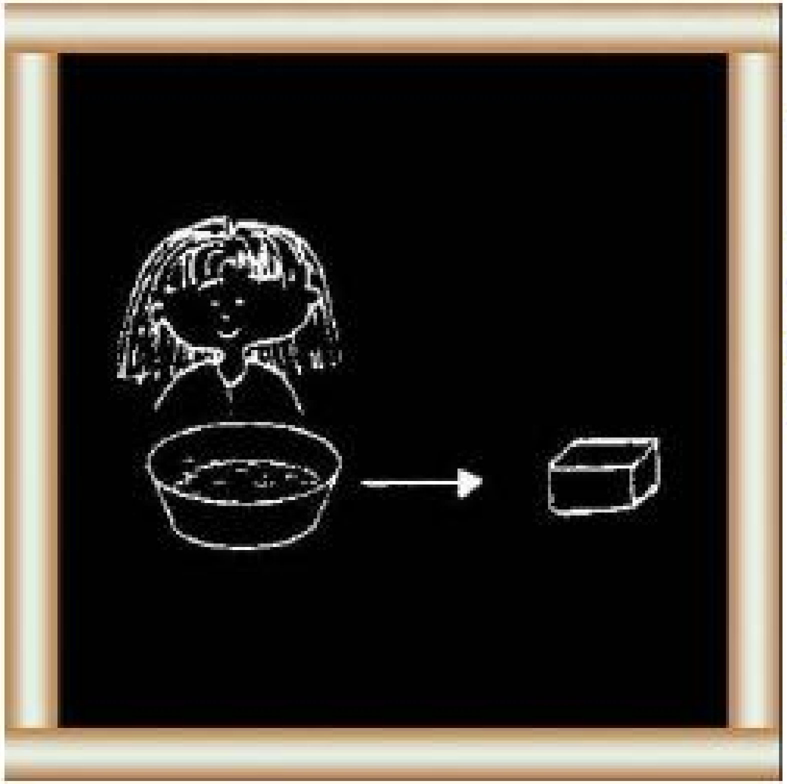
18 When you order, say which product you want to make.

For example:



Butter

19 You use a mesophilic culture which produces gas (carbon dioxide) and aromatic compounds (acetin and diacetyl).

Yoghurt and soft cheese

20 You can use a thermophilic culture.

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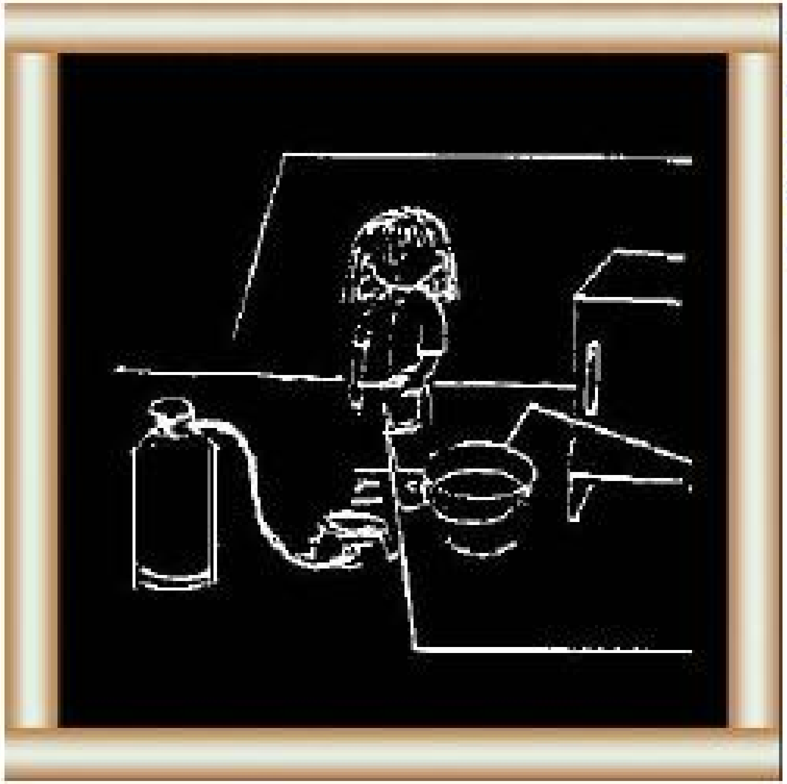
How do you prepare a starter culture?

Hygiene

21 Clean, sterilize and rinse with boiling water all utensils before using.

22 Any dirt or chemicals will change the action of the starter culture.

Equipment and materials



23 You need:
-source of heat
-raw milk (with or without cream)
-starter culture powder
-refrigerator or freezer

24
-pans and glass pots with lids

-measuring breaker
-thermos flask
-thermometer
-wooden spoon
-place to maintain temperature
(e.g. a hay box).

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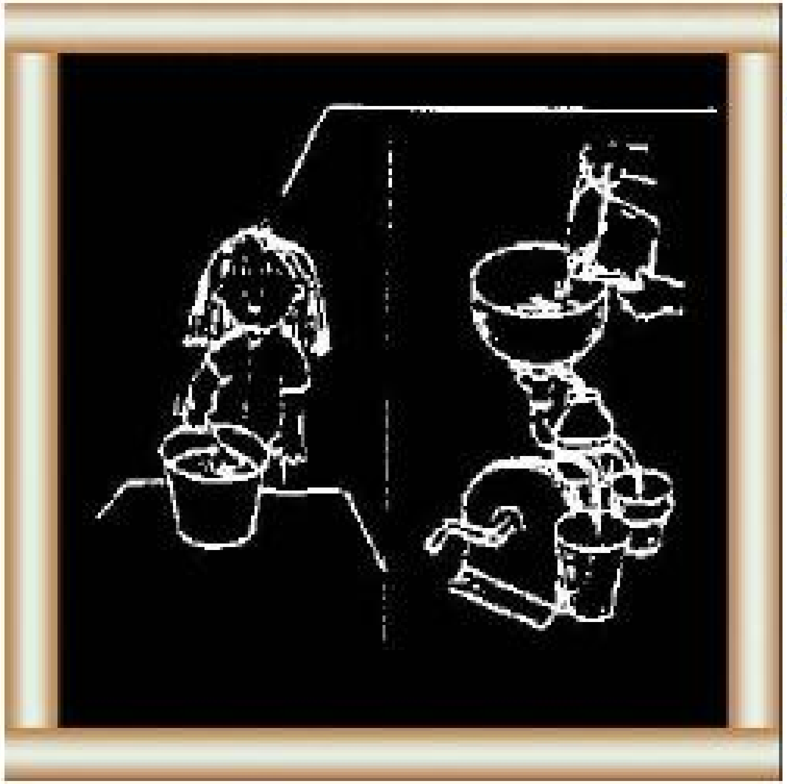
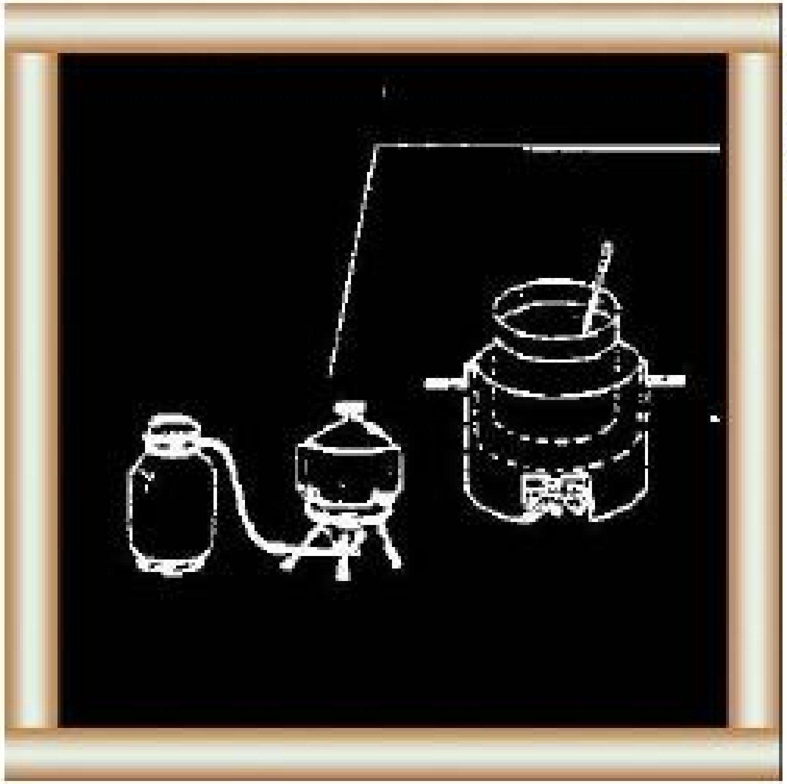
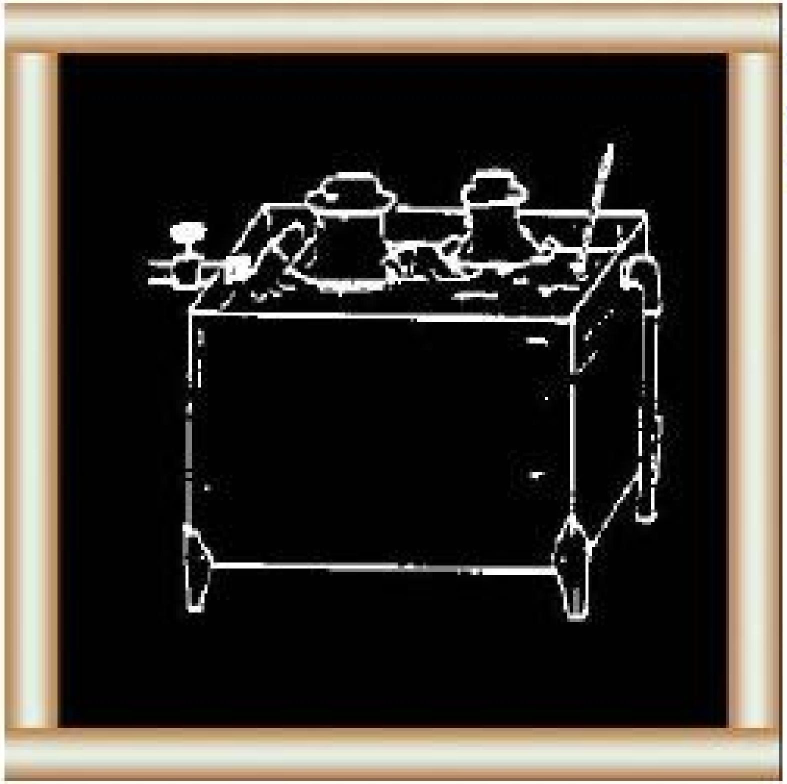


Preparing the milk

25 Remove the cream from high quality milk by skimming or with a hand separator.



26 Heat treat the skim milk in a closed pot or jacket vat at 90-95 C for 30-60 minutes.



27 Cool the milk to the inoculation temperature (see instructions on the starter culture packet.)

Preparing the culture

28 Defrost the packet 30 minutes before use.
Shake the powder to the bottom of the packet.
Disinfect the top part of the packet with alcohol before opening.

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29 Add the starter culture to the treated milk and stir thoroughly (10-15 minutes).
You can also make the culture into a paste first with a little boiled milk.

Maturing the culture

30 Keep the culture at the correct temperature for 24 hours (see packet) by:
-using a hay box or
-wrapping in cloth in a cupboard or
-using a thermos flask.

Maintaining the culture

31 If you keep the mother culture for a long time, it gets weaker.

32 Use the clean measuring breaker

to inoculate treated milk with 0.5% mother culture (5 ml culture to 1 l treated milk):
-daily if you have no refrigerator
-weekly if you have one.

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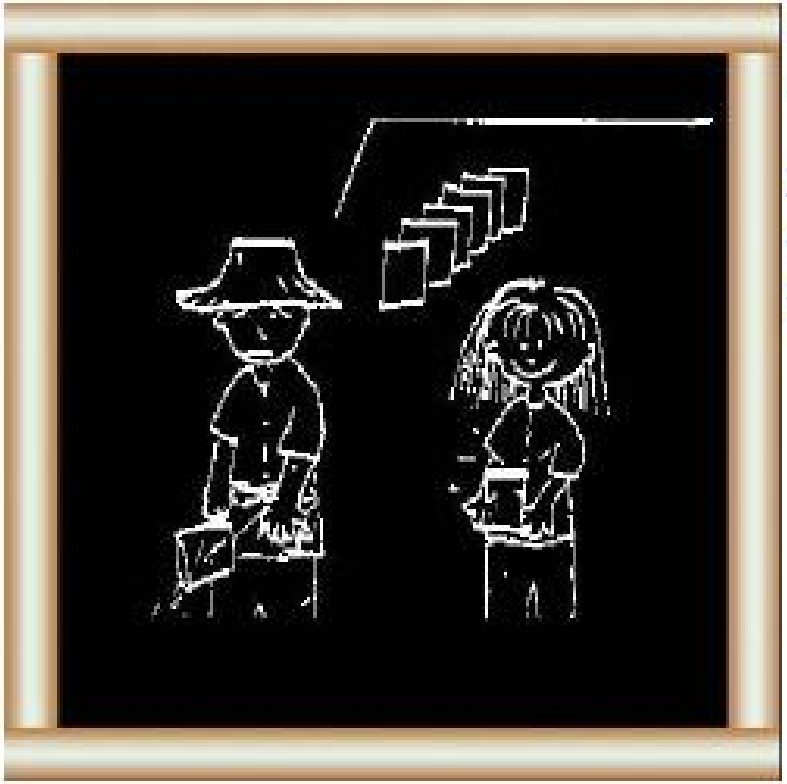
Important points

33 The amount of mother culture for inoculation depends on the storage temperature.

Try different amounts until it works well.

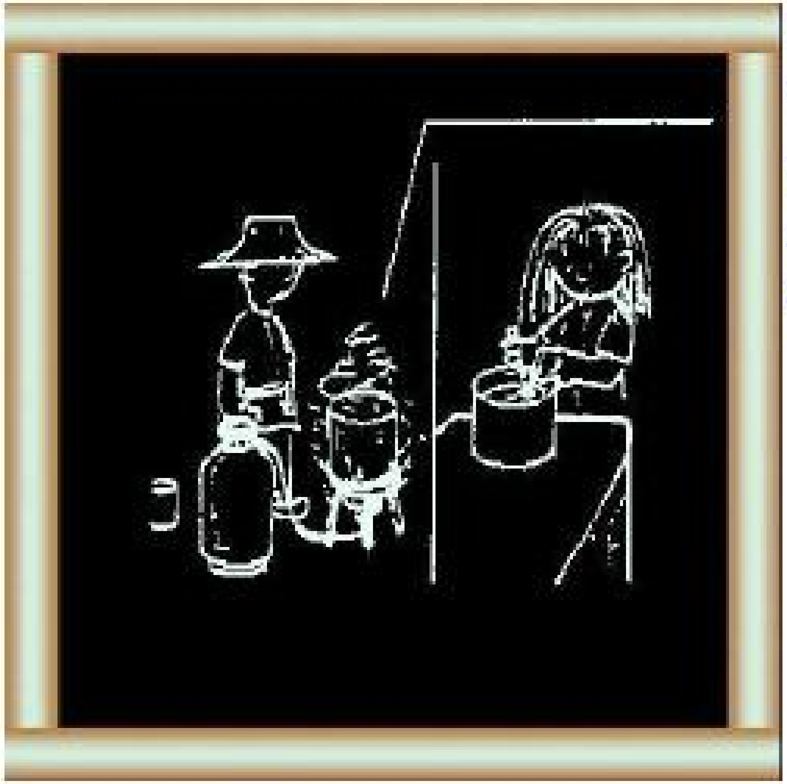
34 Keep the culture in clean glass pots, not more than half full.

Take the culture from the freezer only when necessary and defrost before use.



35 The mother culture gets weak after some time.

Although it costs more, it is safer and better to use new starter culture powder after each period.



36 If you use milk powder make sure the water is boiled.

You can improve your raw milk for starter preparation by adding 2-3% skim milk powder.

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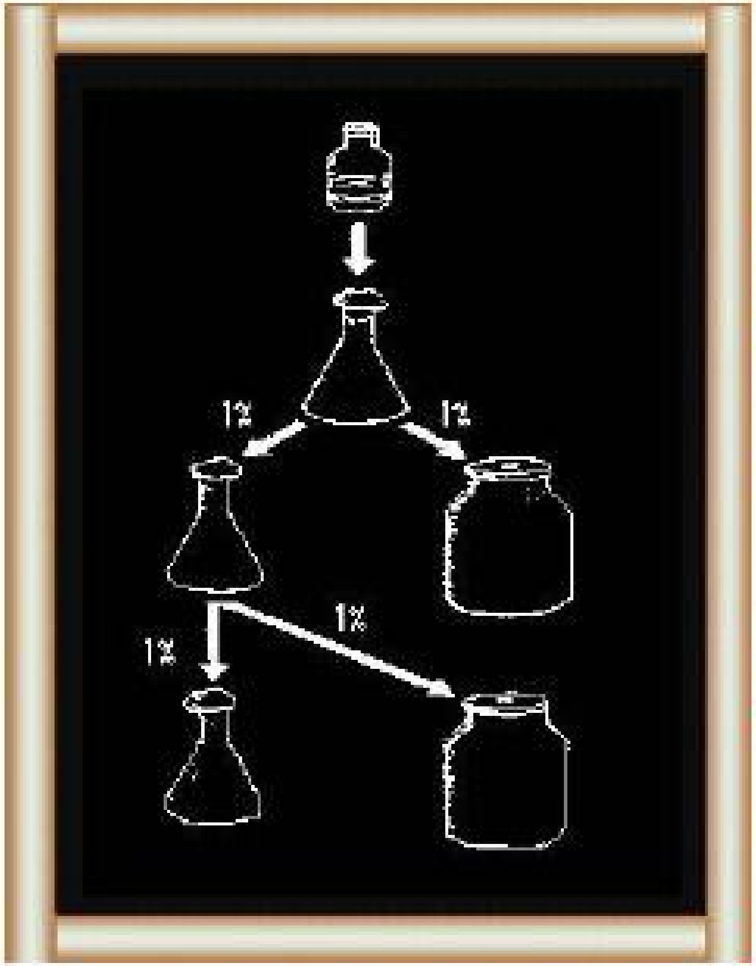
How can you prepare mother cultures for making cheese and yoghurt?

Starter culture for cheese-making

37

Lyophilized Starter Culture (mesophilic)



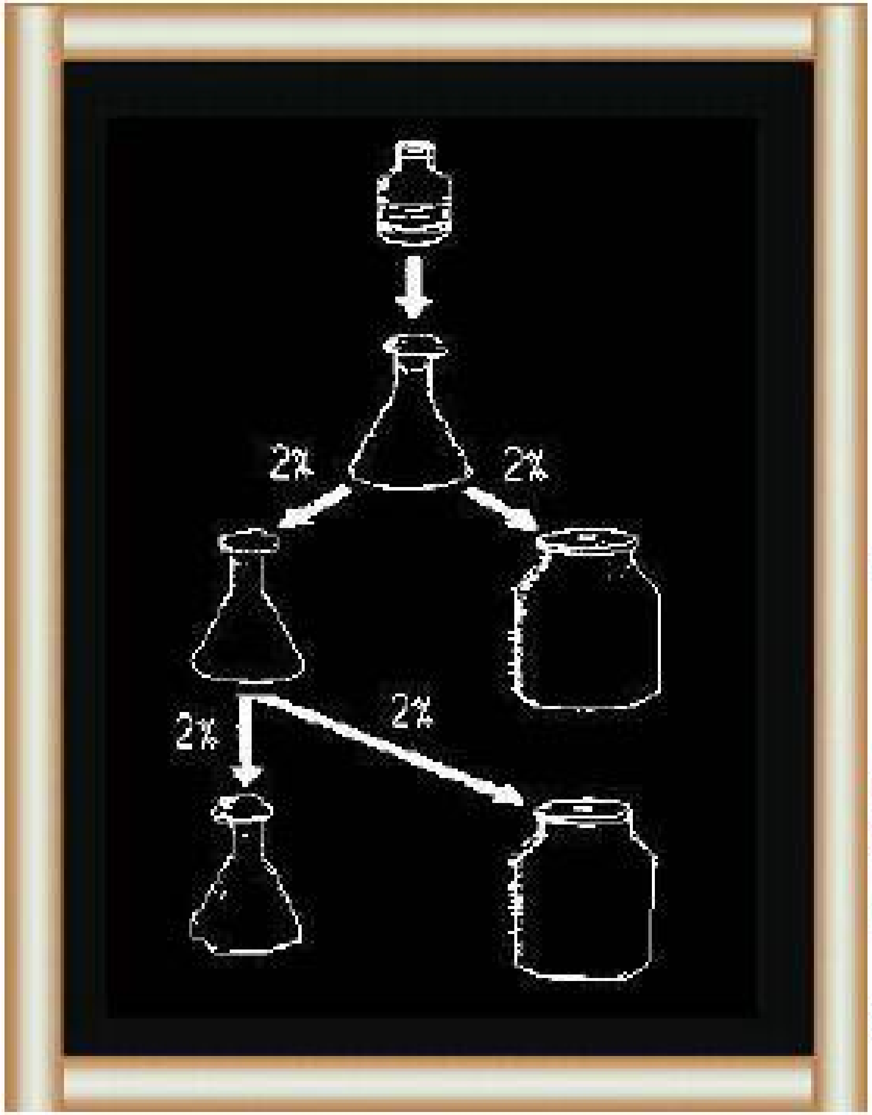
Mother culture 16h at20 C
in a flask acidity 80-90^{0}
D=
0.8-0.9% lactic
acid

Second Mother Starter
Culture
Culture 16h at 20 C
5 l of treated
milk

Third Mother Starter Culture
Culture 16h at 20 C

Starter culture for yoghurt-making

38



Lyophilized Starter Culture (thermophilic)

Make sure that the treated milk is stable at 45 C before adding the starter culture.

Mother culture in a flask

4h at45 C acidity

80^0D = 0.8 lactic acid

Second Mother Culture

Starter

Culture 4 h at 45 C
5 l of
treated milk

Third Mother Starter
Culture
Culture 4h at 45 C

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What do you know about starter cultures?

Starter cultures and their use

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Small-Scale

Dairy Farming Manual

Volume 1

Technology Unit 10.2

Small Scale Butter Making

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What should you know about making butter?

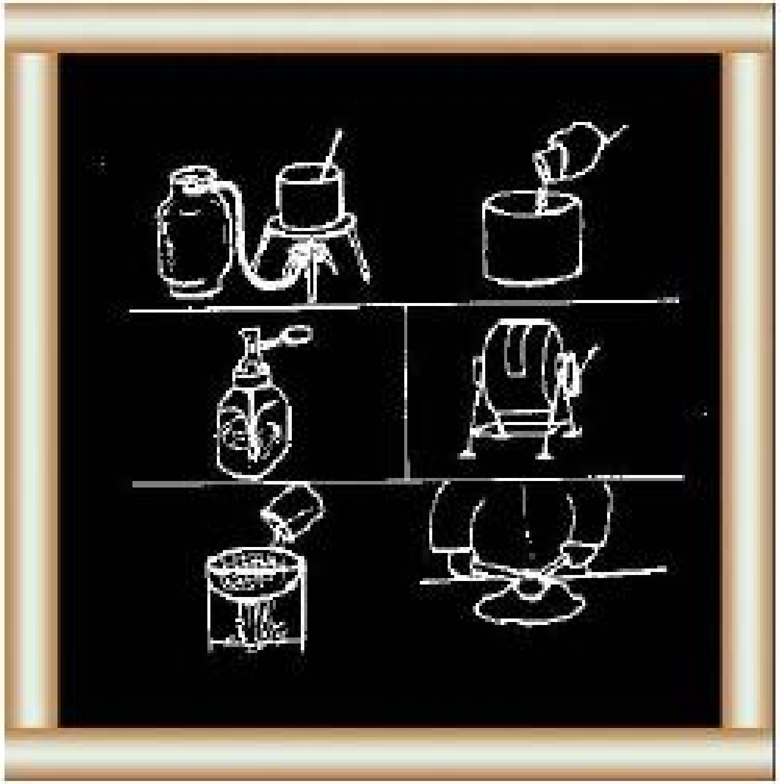
What is butter and what types are there? (5-11)

1 You should know:

- what is in butter e.g. butterfat and water

- the different types of butter e.g. salted and non-salted, sweet and cultured butter.

How do you make butter? (12-59)



2 Prepare milk or cream by heat treatment and ripening (for cultured butter).
Churn on a small or a larger scale.
Wash and work the butter.

What can you do with buttermilk?

(60-63)

3 You can use it for:

- drinking or making milk products

- animal feed.

What can be wrong with butter? (64-75)

4 If your butter has a bad smell, taste, texture or appearance, check your:

- husbandry

- raw materials

- method of making butter.

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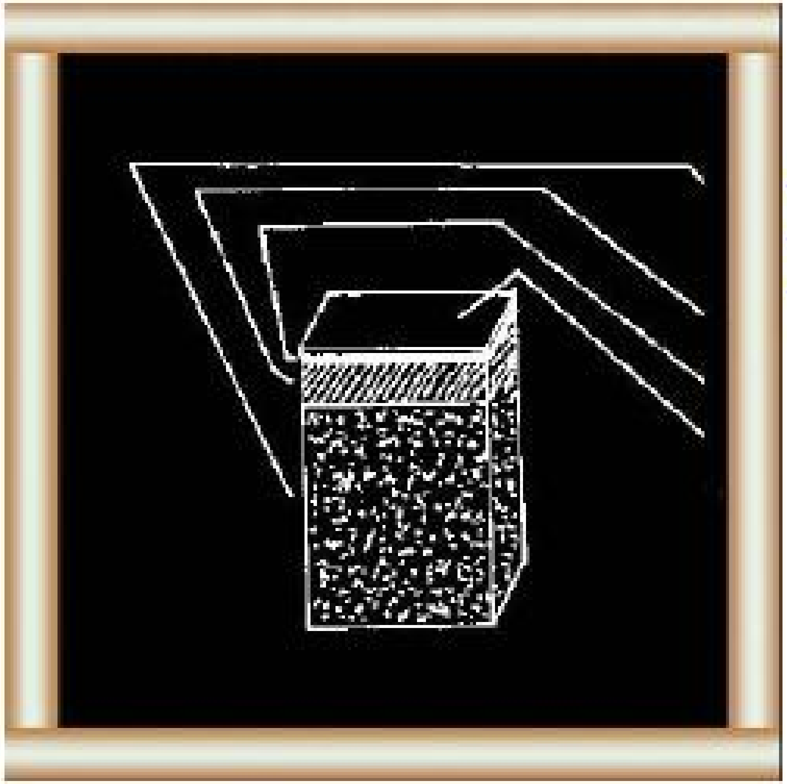
What is butter?

5 Butter contains about:

- 80 % butterfat (minimum)



- 16 % water (maximum)
- 1-2 % solids-not-fat
- 0.2 % salt.

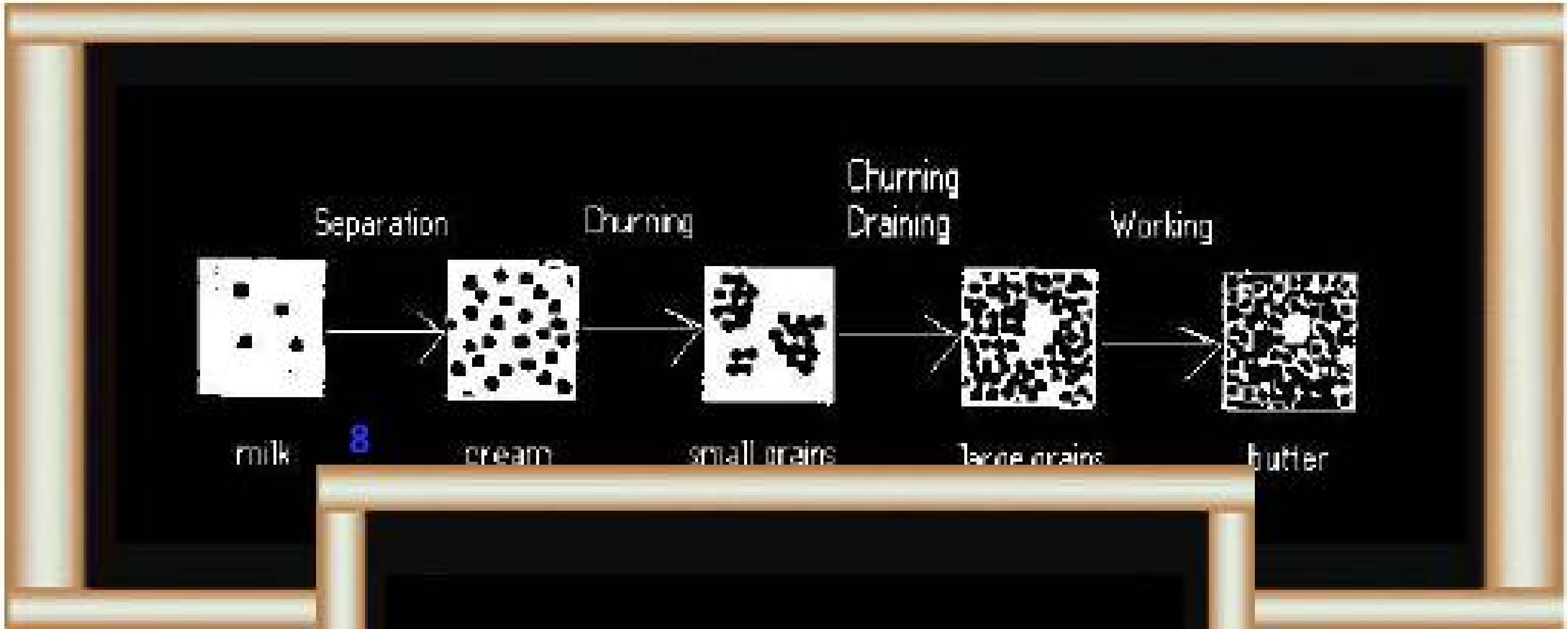
6 You can make butter from:

- milk or

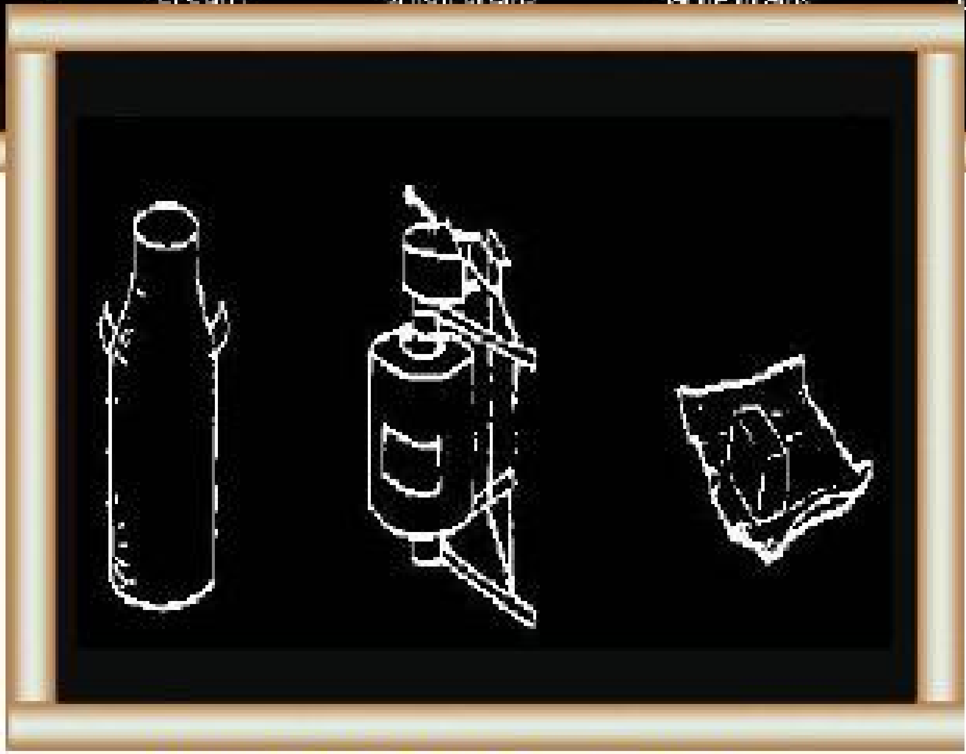
- cream.

1 l of cream makes about 300-400 g butter.

7 The steps in making butter are:



8



MILK -> CHURNING MIXTURE -> BUTTER

approx. min. 3.5 - min. 80 -

4.2 % fat approx. 40 % fat approx. 83 % fat

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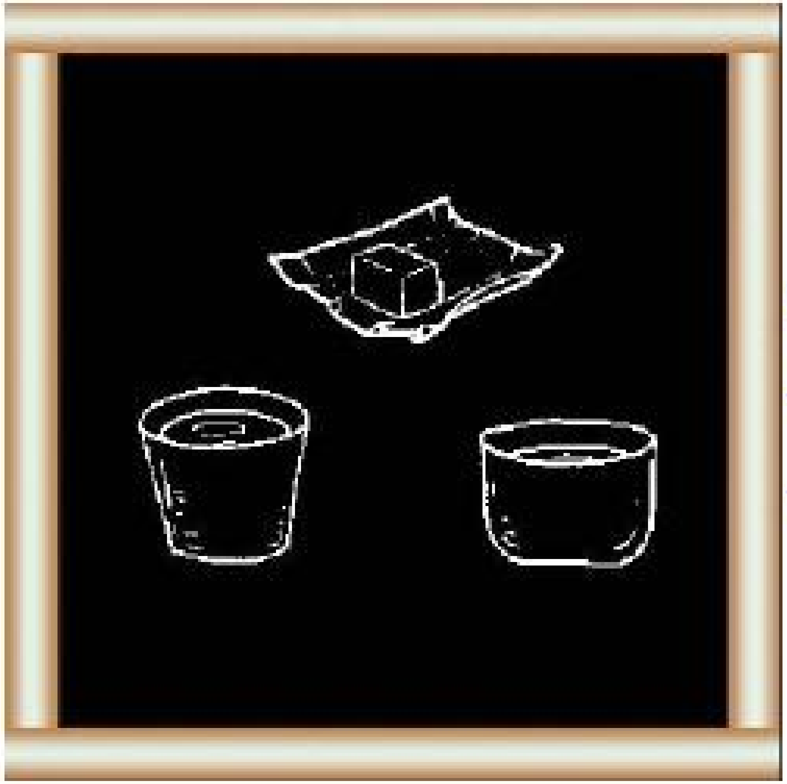
What types of butter are there



9 You can make butter from:

- fresh cream

- cultured cream.

10 You can make butter:

- without salt

- with salt.

11 For cooking purposes you can make herb butter by adding:

- parsley or

- garlic.

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12 How do you make cultured butter?

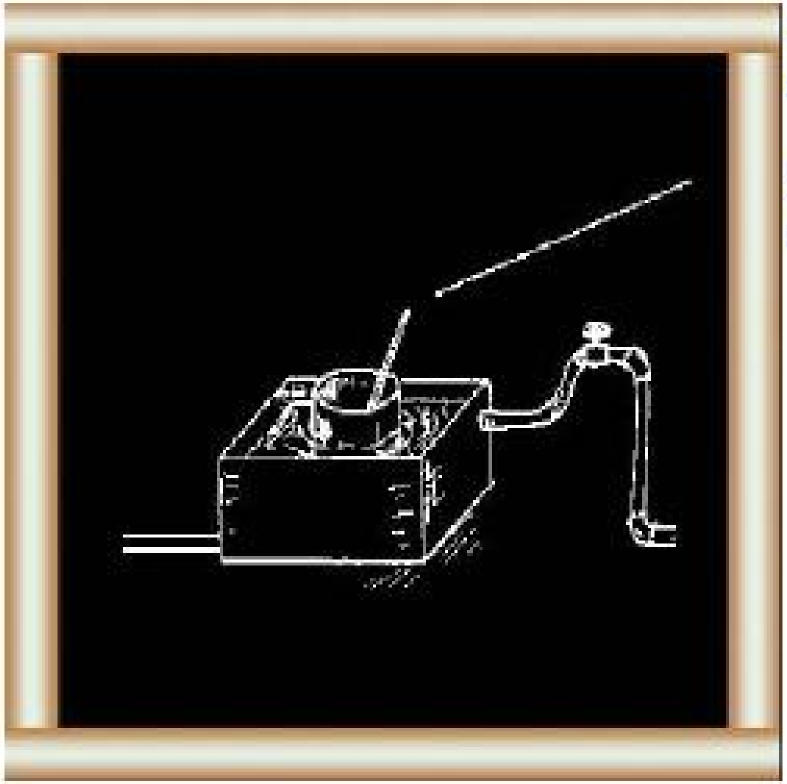
The following recipe is for cow or goat's milk.

You may need to change it for other types of milk.

Heating

13 Heat the milk or cream to 80 C-90 C.

Cooling



14 Then cool it quickly to 18 C in running water.

Use a thermometer to measure the temperature accurately.

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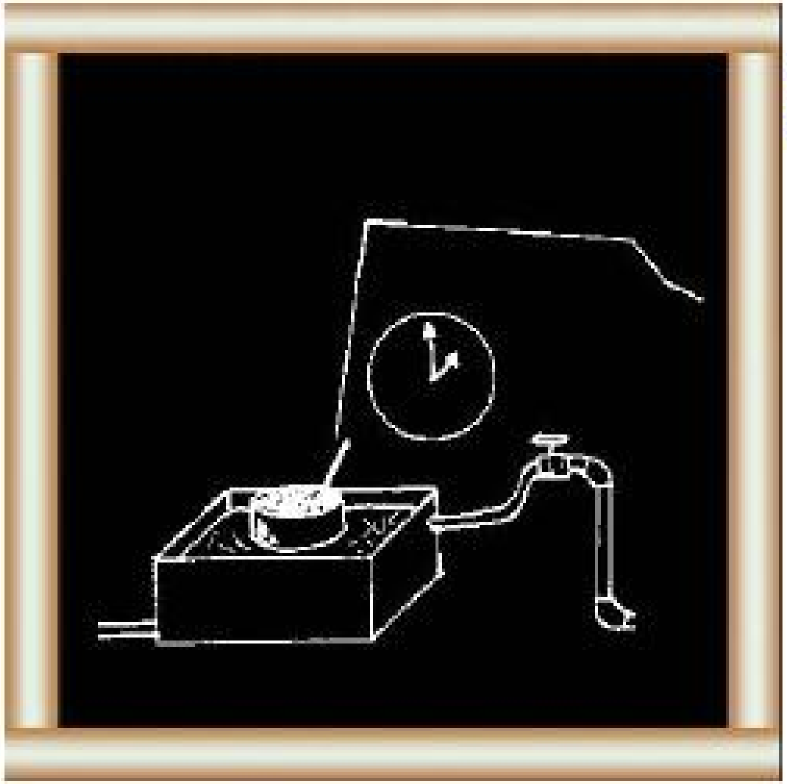
15 Ripening

Then ripen.

For each 1 1 of milk or cream:

add 50 cc of (3 desert spoons) of sour butter milk or mesophilic starter;

-stir this into the milk or cream



16 Cover container and leave for 24 hours at 18 C.

17 You can use raw milk or cream which is sour naturally if it still tastes and smells fresh.

Do not ripen it.

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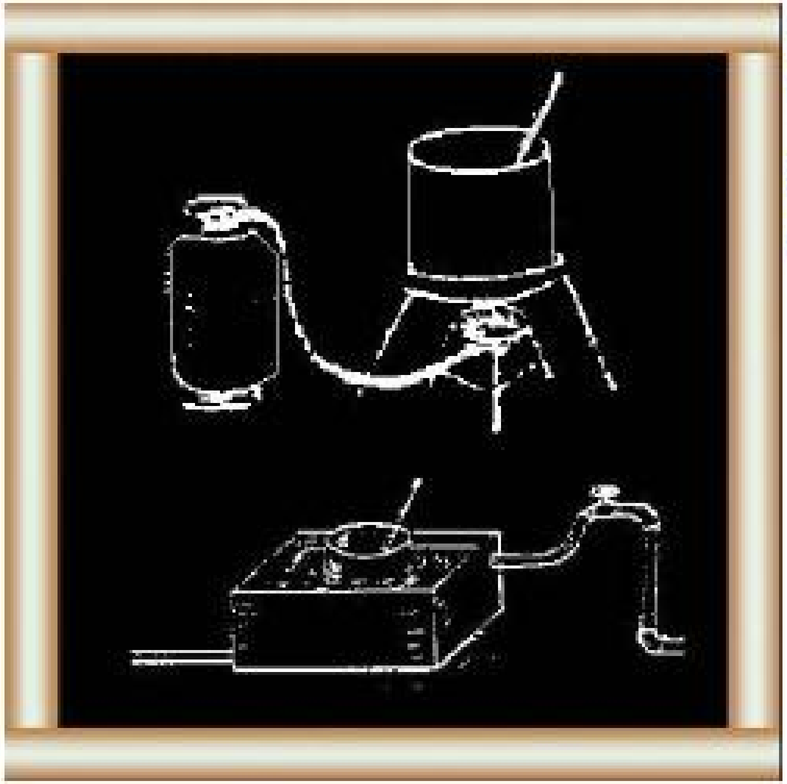
18 You can also make non-cultured or sweet butter from sweet cream.

If you collect cream for several days, check the acidity before pasteurizing.
The cream should have 0.10-0.15 % lactic acid.
If your cream is very acid, you can reduce the acidity by adding chemicals.
Ask your extension worker for advice.



19 Heat the cream as before to 80-90 C.

Cool the cream to the lowest possible temperature.

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What do you need to make butter from sour cream or milk?

Raw materials

20 You need:

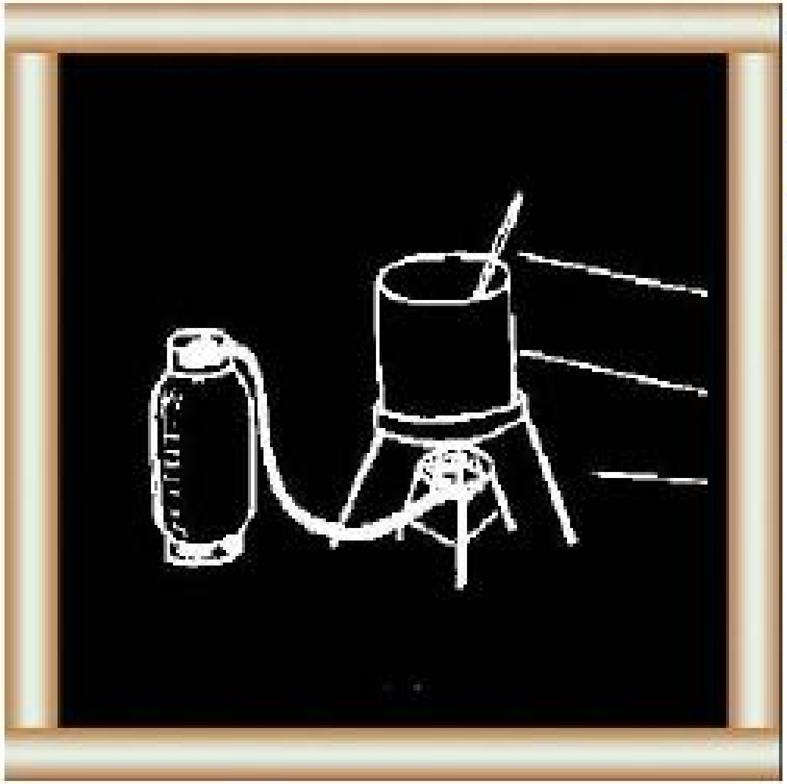
- milk or cream

- sour buttermilk or starter

- fine salt

- clean water.

Equipment



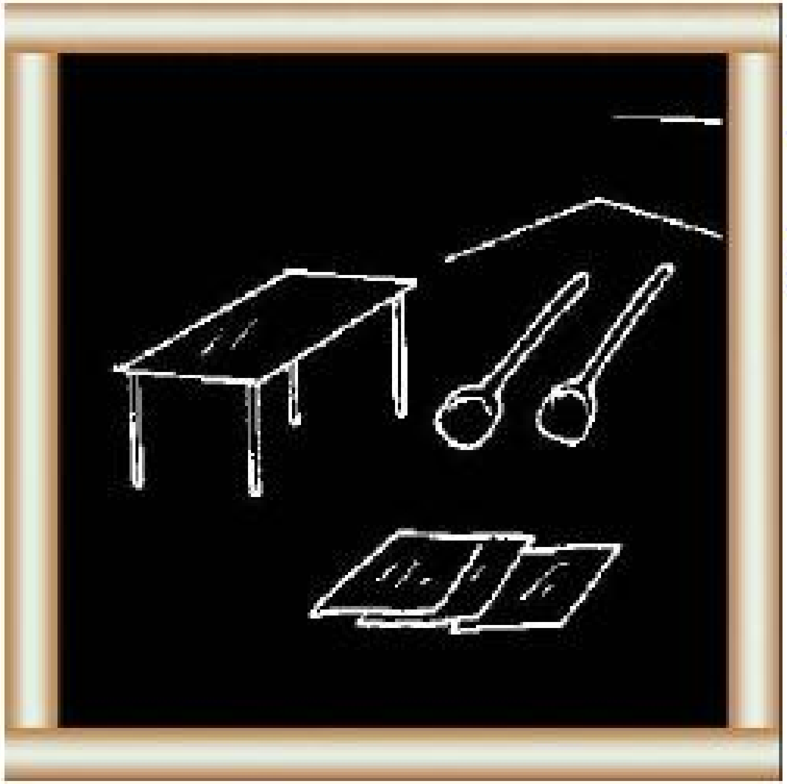
21 You need:

- a heater
- a container for the milk or cream
- a thermometer to measure temperature

22

- a churn
- a sieve or coarse cloth
- a skimmer
- a bowl

23



- a working table
- wooden spoons
- greaseproof paper for wrapping the butter.

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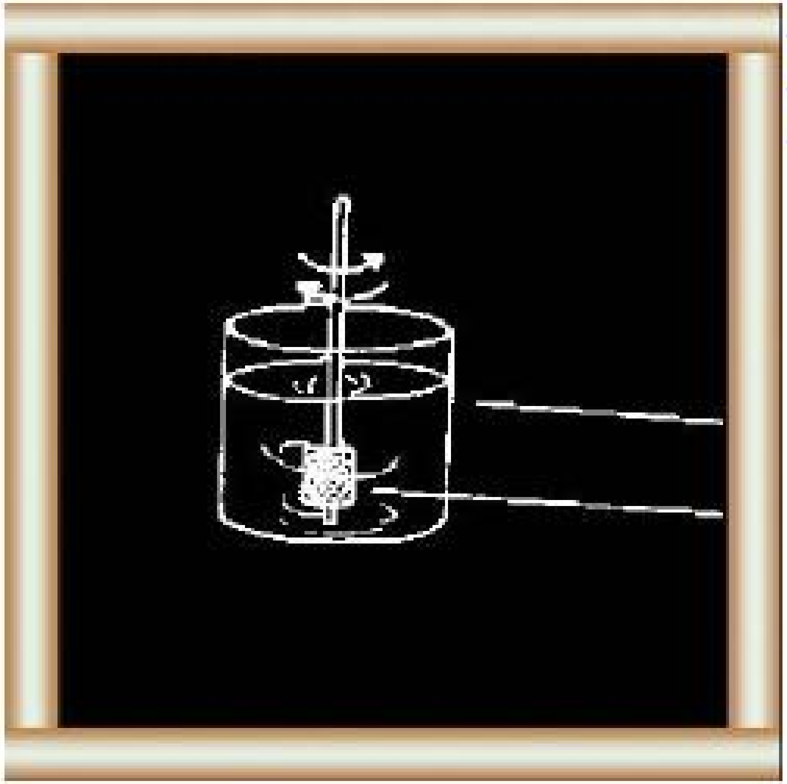
Small-scale churning

24 You can churn milk or cream:

- by shaking in a sealed bottle

- by rotating in a milk can
but it can be difficult to remove the butter

25



- by whipping in a bowl:
- bowl with cream or milk
- rotating whippers

- by plunging in a container
- tub or can
- lid with hole
- plunger, moves up and down
- wooden disc with holes.

27 This is a small household glass churn:

- screw lid
- glass container
- rotating whippers.

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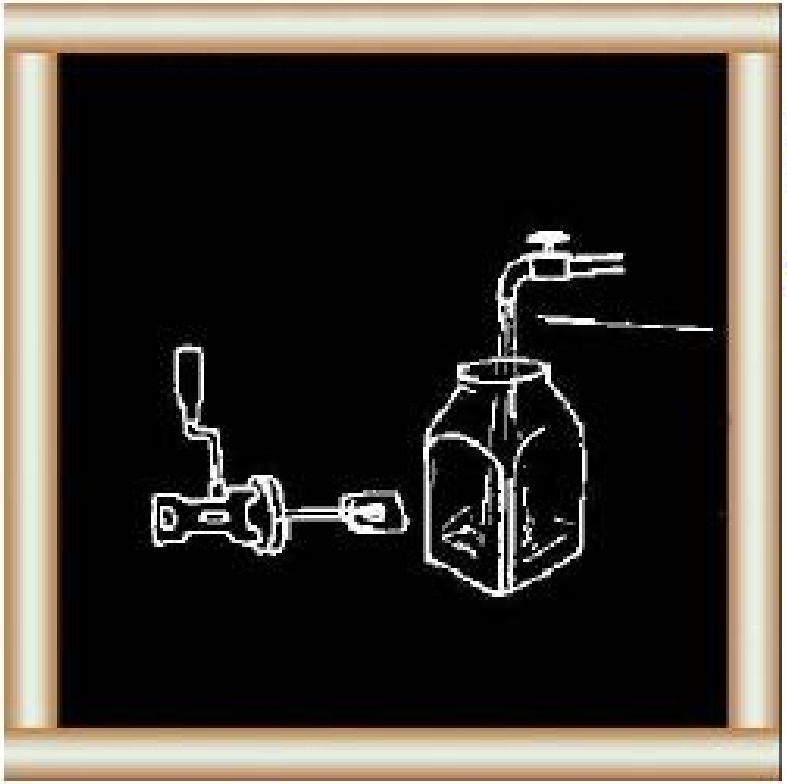
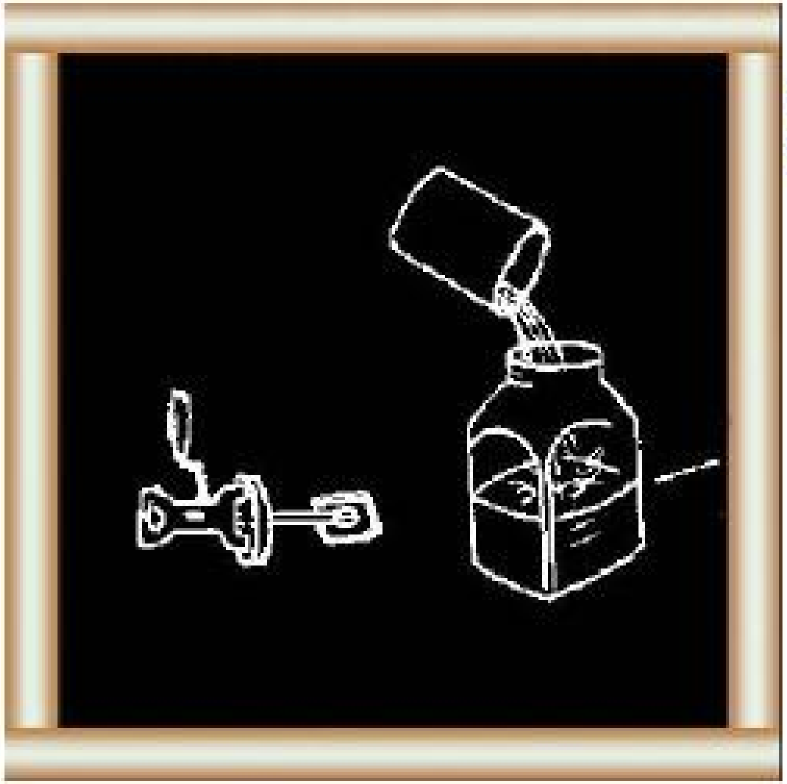


28 Rinse the churn with clean water

This prevents sticking.



29 Half fill with sour milk or sour cream.

30 Churn with a regular movement until:

- the pieces of butter are as big as peas

- the buttermilk looks watery. Do not let the pieces of butter become one large lump.

31 If there are no pieces of butter after 30 minutes:

- change the temperature by adding clean cool or warm water

- churn again.

For cream do not add more than 25 % water.

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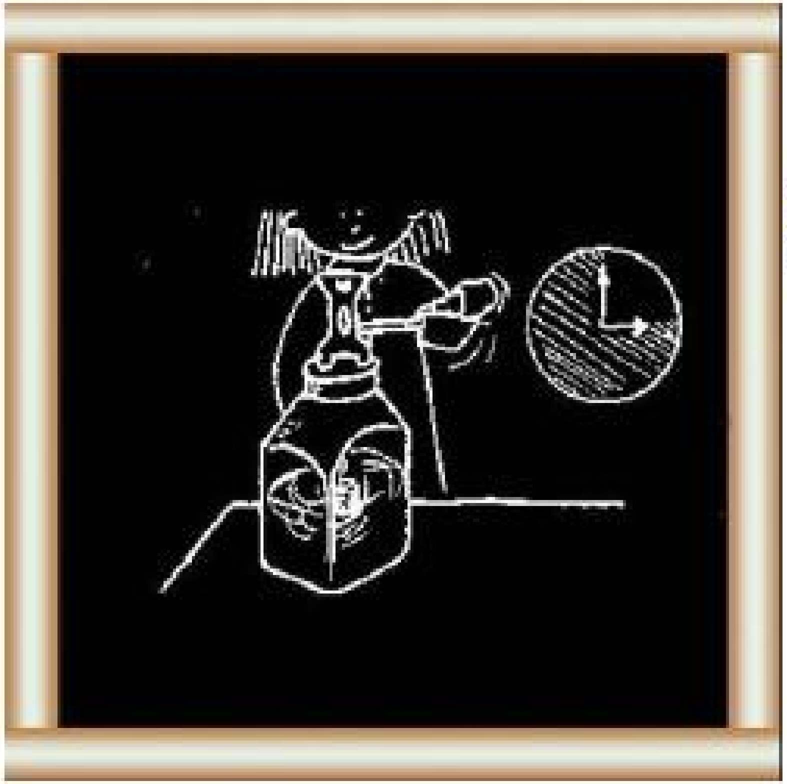
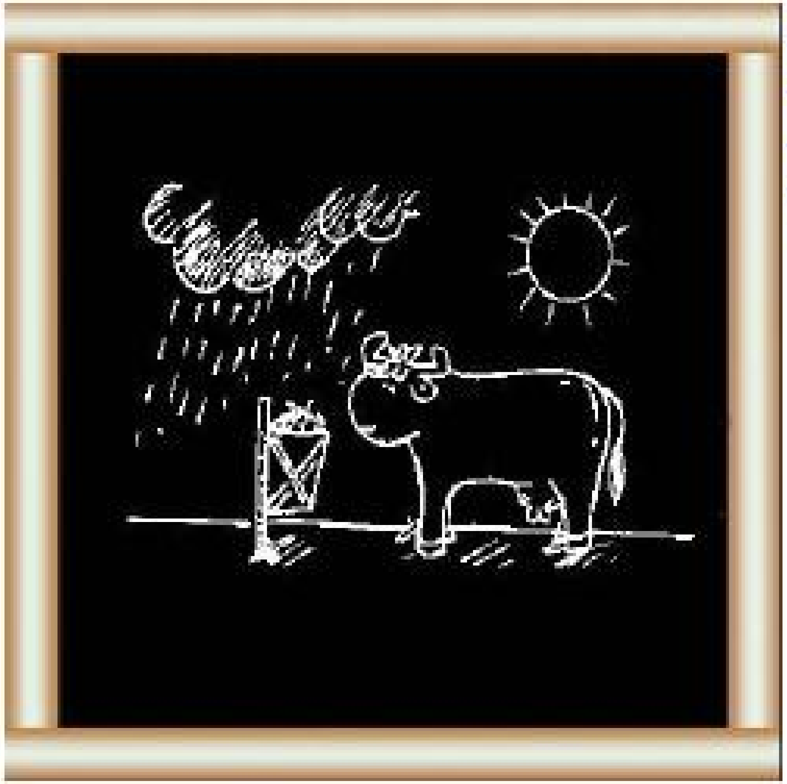


32 Churning may take from 15 to 60 minutes.



33 The time depends upon:
- the time of year
- the type of animal
- the type of feed

34

- the temperature
- the type of churn
- the fullness of the churn
- the fat content of the milk or cream.

35 Carefully remove the pieces of

butter from the lid and side with clean, cold water.

The water with butter will float on top of the buttermilk.
Do not use too much water.

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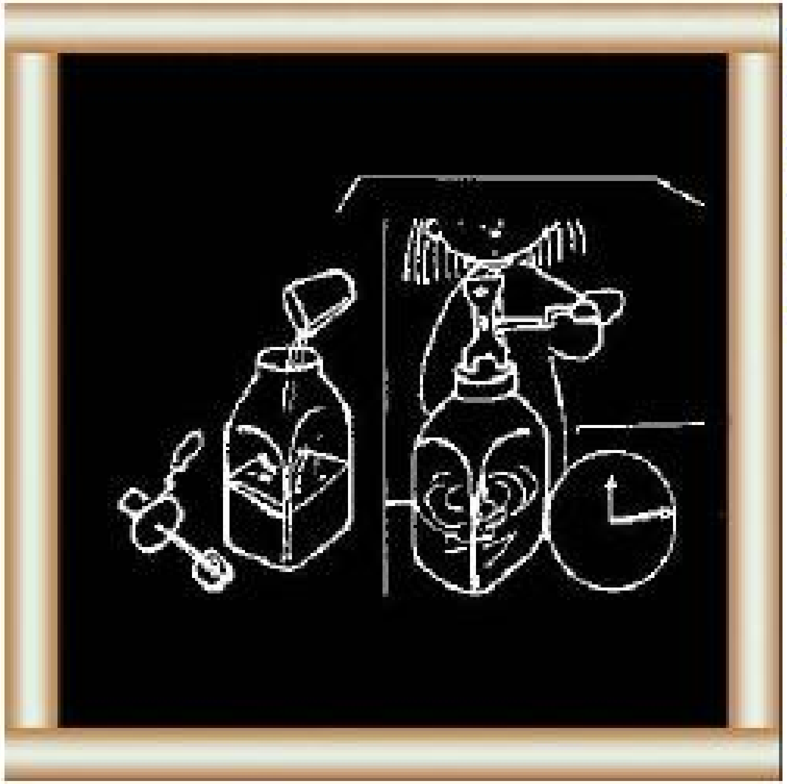
36 Pour off the buttermilk through a coarse sieve.

Washing

37 Wash the butter to remove the buttermilk - the more buttermilk



you remove, the better your butter.
Either wash the butter in the churn:

- half fill the churn with clean cold water
- churn for at least 10 minutes

- use a skimmer to remove the pieces of butter floating on the water

39 Or wash the butter in a sieve:
- sieve the butter and buttermilk

- put the buttermilk on one side
- turn the butter over while washing with clean cold water. Do not let the butter become a large lump.

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40 If you wash your butter carefully you can:

- lower the water content

- keep it longer.

Yoghurt and soft cheese

20 You can use a thermophilic culture.

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How do you prepare a starter culture?

41 Do not overwash.

Your butter will have:
- less solids-not-fat
- a poor smell.

Salting

42 Salt your butter according to taste:

- lightly work about 10 g of salt into every 1 kg of butter
- leave overnight
- work again the next day.

Working (kneading)

43 Working improves the structure and the quality of your butter.

Rinse the working table with clean water

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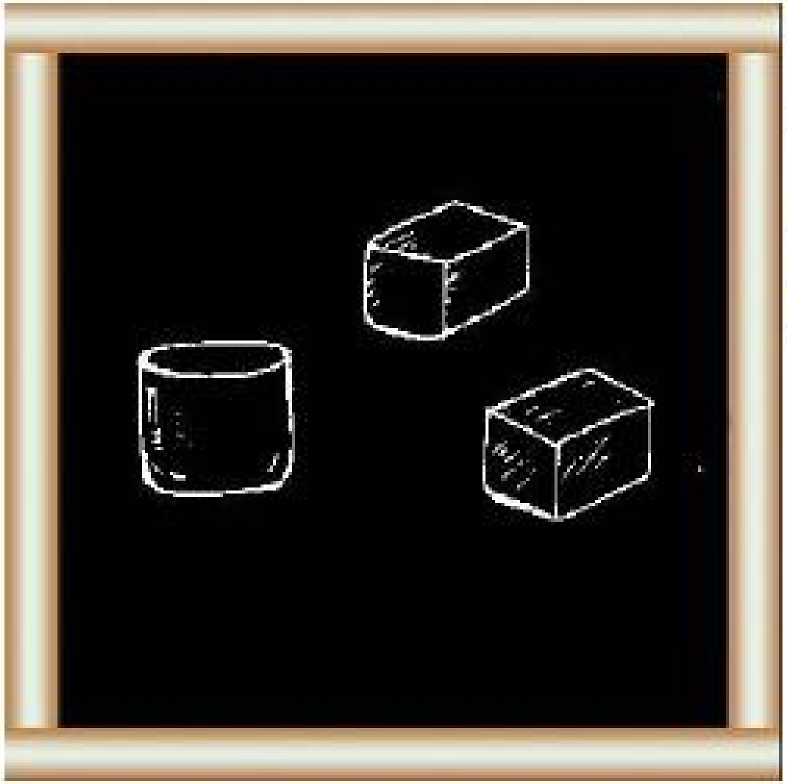
44 Work the butter with damp wooden spoons or a damp roller until it has a smooth surface and you can see no more drops of water.
As you work, remove any water.



Storage

45 Store butter in a cool place:

- in a pot or
- wrapped in grease proof paper or aluminum foil.

46 Sprinkle a little salt on the surface of butter in a pot:

- this prevents fungus.

47 You can freeze butter but it becomes rancid quickly after

defrosting:

- divide the butter into many small parts
- defrost only what you need.

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48 Do not freeze salted butter:

- it easily becomes fatty or oily and smells fishy.

49 If you keep butter for too long, it tastes rancid or develops fungus.

50 You can keep it longer by making ghee.

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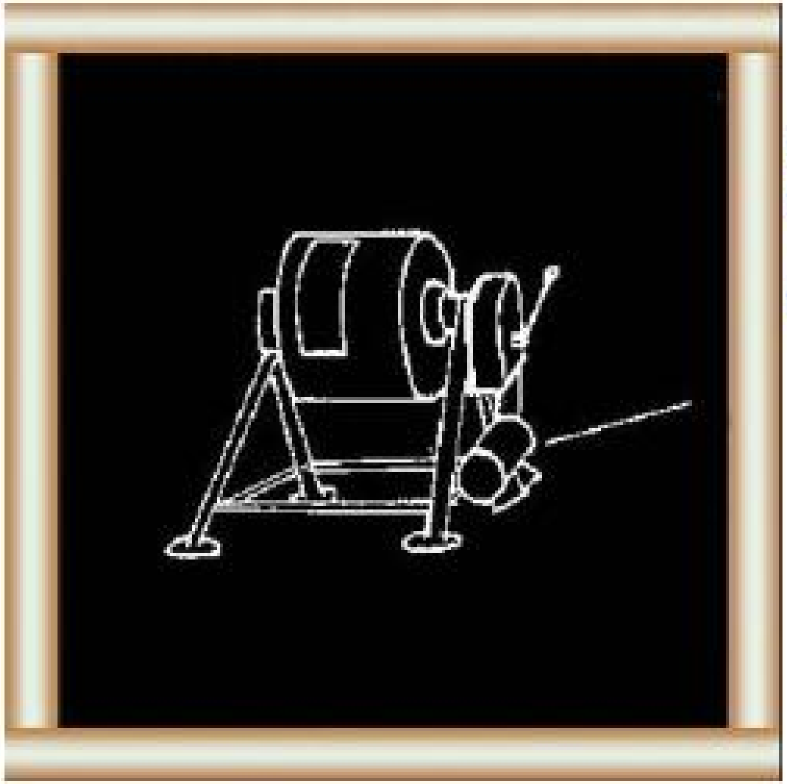
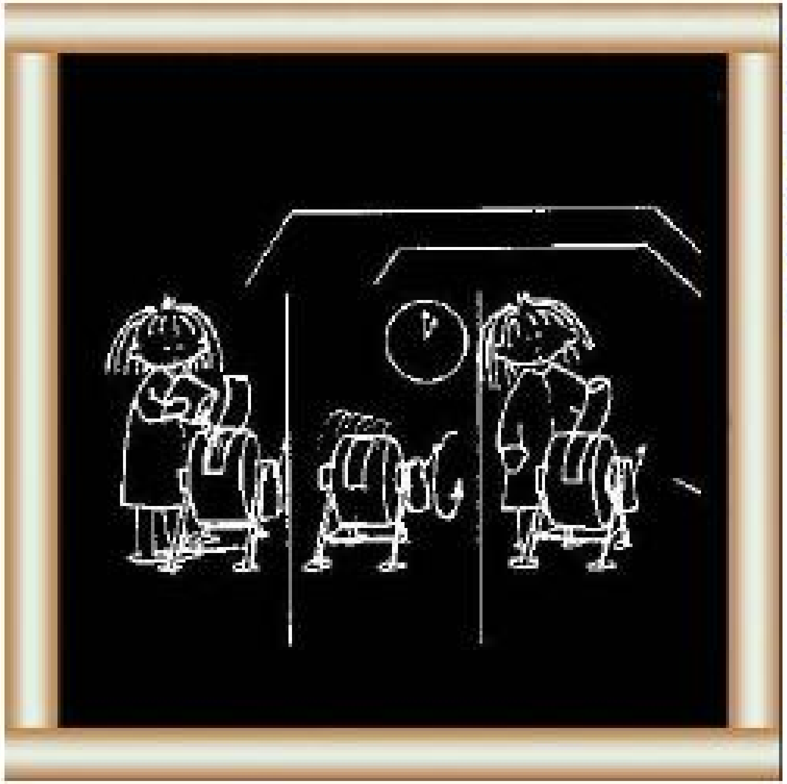
Large-scale churning



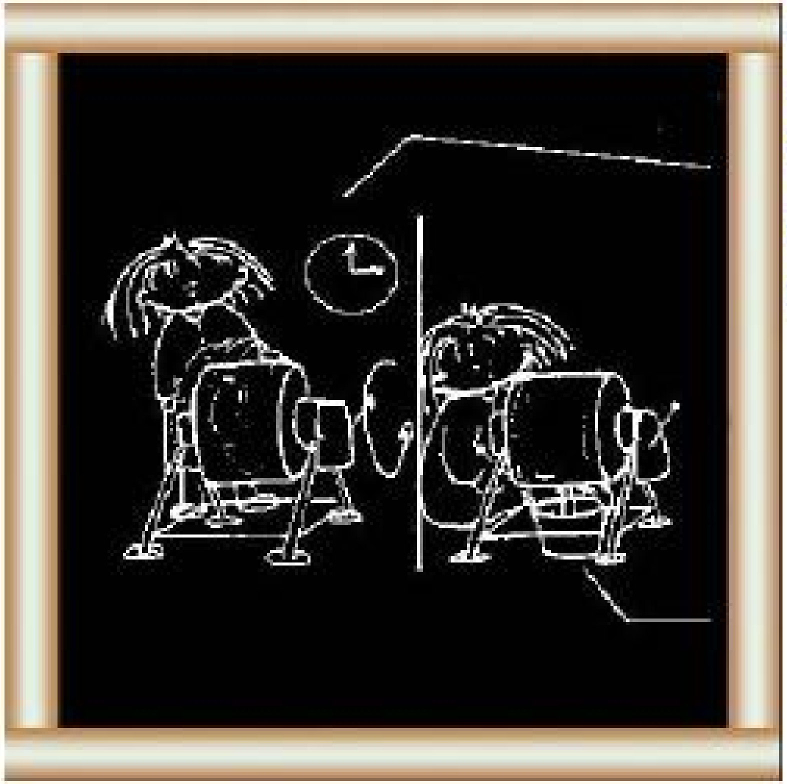
51 You can work this churn by hand or use an electric motor.

It holds 30-50 l of milk or cream.

52 Half fill the churn with milk or



cream.
Churn for 5 minutes (the speed depends on the shape, size and construction of the drum).
Stop the churn and release the gases.



53 Churn again for 35-45 minutes or until the butter pieces are about 2 cm in diameter.

Pour off the buttermilk through the valve into plastic pails.

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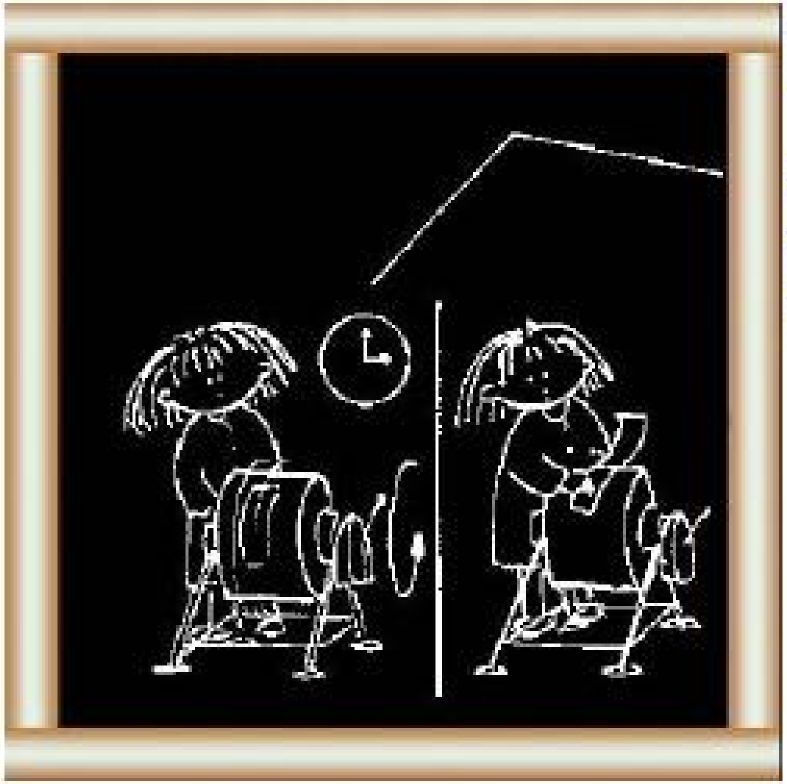
54 Add the same amount of water as buttermilk you remove.

Churn at 10-15 rpm for 5 minutes.

Pour off the water.



55 Churn at 10-15 rpm for about 10-20 minutes.

Check the water content and if correct remove the butter from the churn.

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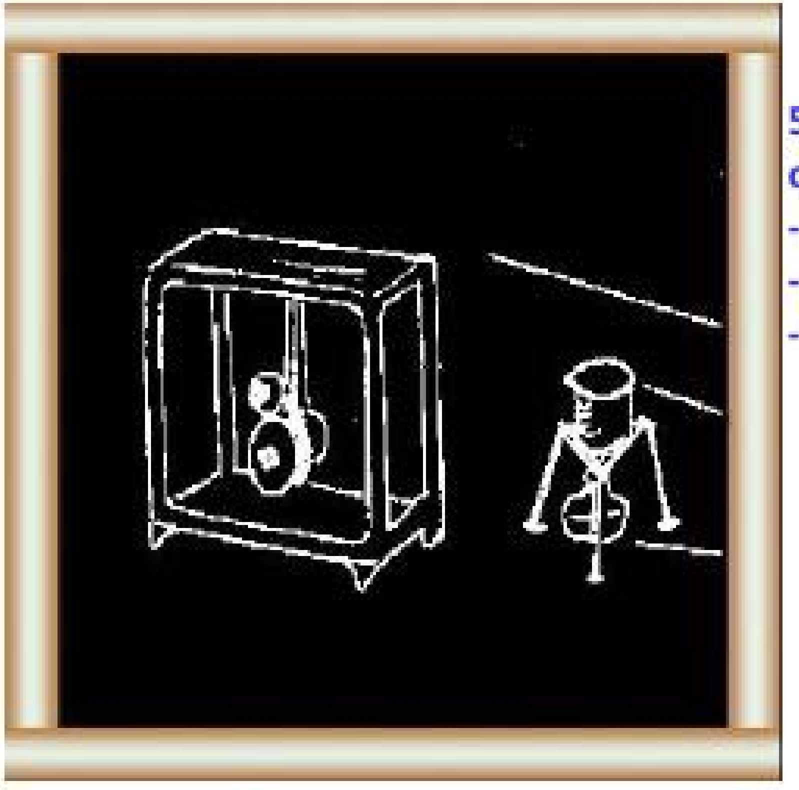
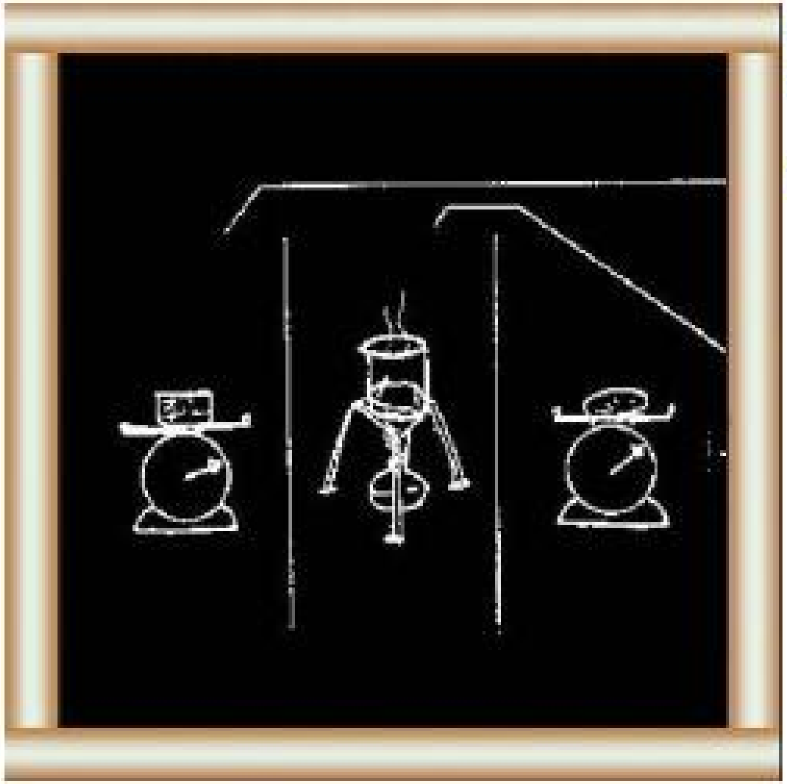


56 You can check the water content of your butter by using a:
- special balance
- beaker for melting butter
- burner.



57 Weigh some butter accurately.
Evaporate the water by heating.

Weigh the butter again.

58 If you know the weight of butter and the weight of water lost, you can find the % of water in the butter.

59 You can then:

- add water if you want a higher moisture content

- churn for longer without adding water if you want a lower moisture content.

page215

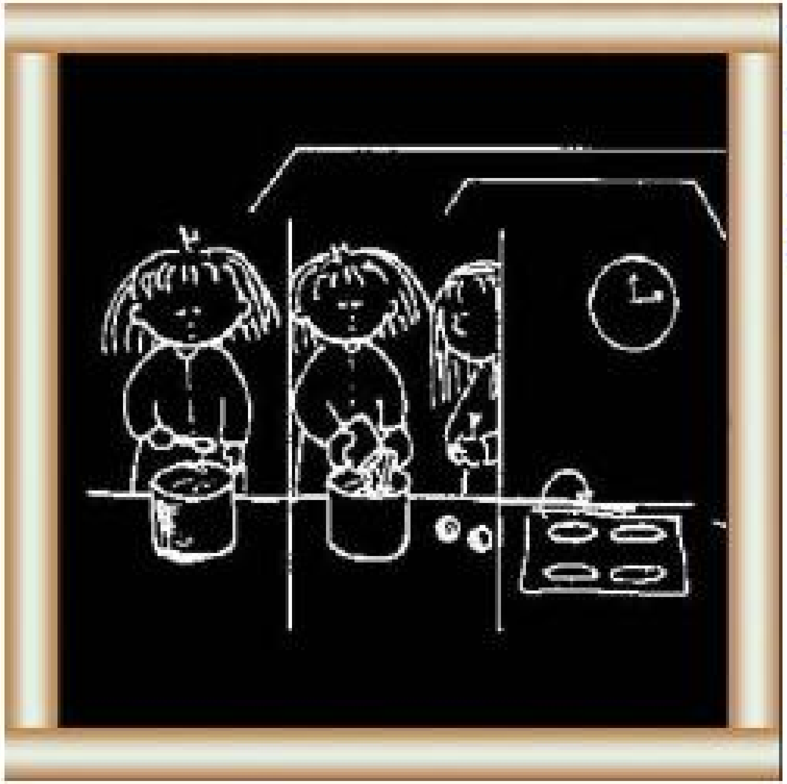
What can you do with buttermilk?

60 Buttermilk is good for:

- drinking
- putting in soups or salads
- making into cheese.

61 You can use it for animal feed:
- warm it for chickens
- as it is or with feed for calves.

62 You can make Trahana:
- leave buttermilk to become sour



and add a little salt
- add flour or semolina, make a stiff dough and shape into balls
- flatten these and dry on a clean cloth, turn over every hour

63

- rub these through a sieve
- spread the crumbs on a clean

cloth to dry
- store them in a closed pot or bottle.

You can keep the crumbs for several months and use them in soup instead of pasta or rice.

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What can be wrong with your

butter?

Smell and taste

64 If your butter is sour your starter may have bad bacteria.

Use a new starter and wash and sterilize all equipment.

65 If your butter has a feed flavour check the quality of your feed especially silage, onions etc.

66 If your butter is green or malty use a new starter.

67 If your butter is oily or tallowy check the quality of the milk and

cream you are using to make your butter:

- increase the heat treatment
- make less-cultured butter
- use less salt
- work the butter less.

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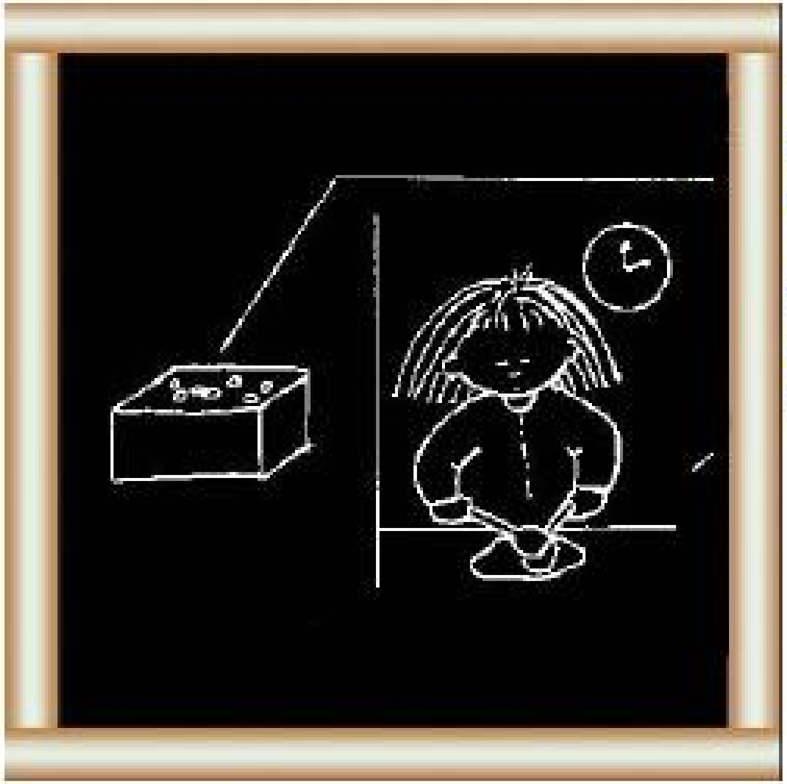
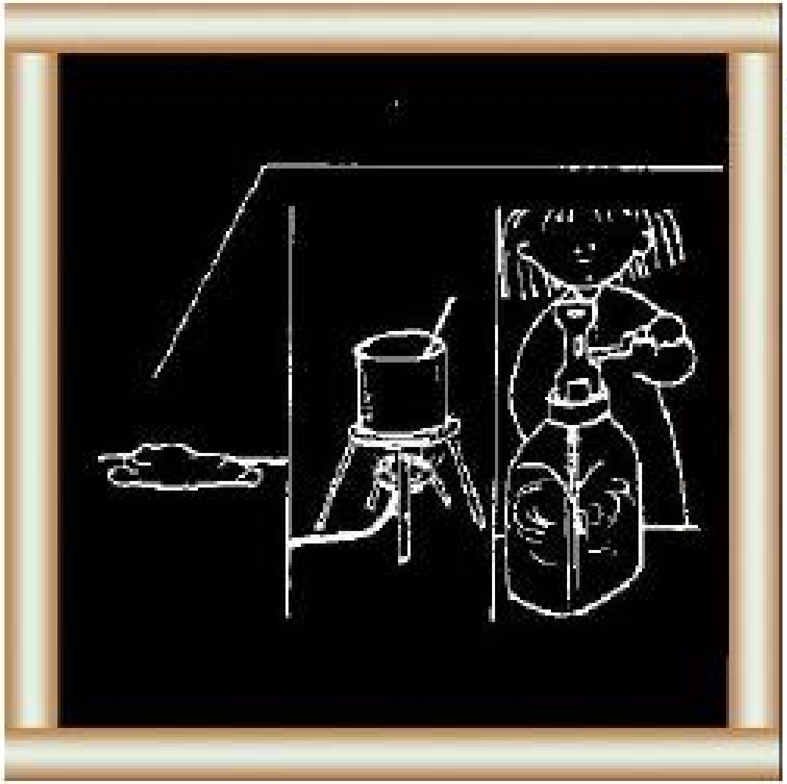


Texture

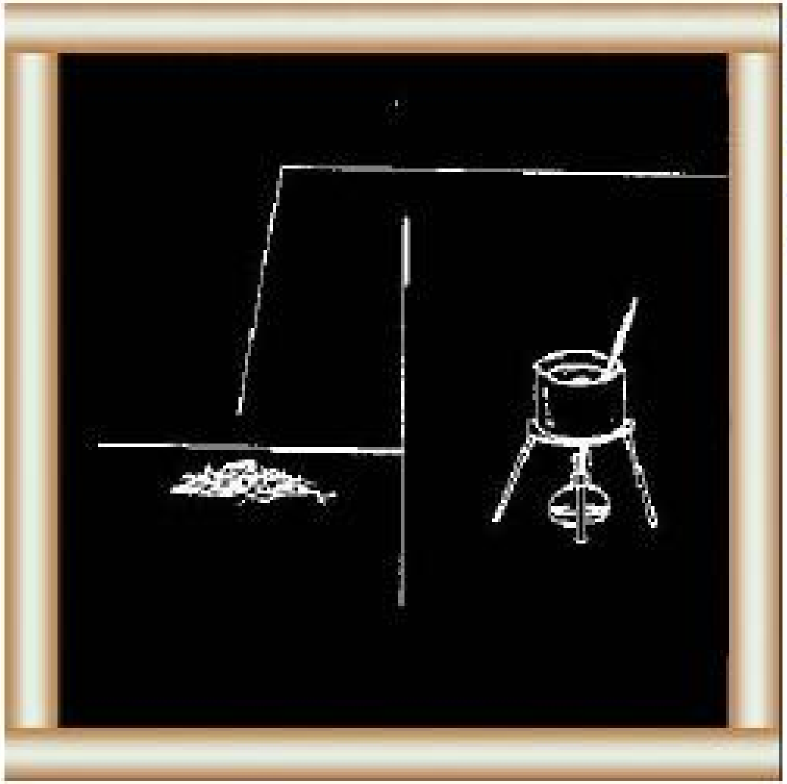
68 If there are drops of water on your butter, knead it more.

Your butter should be dry before packing - bacteria multiply quickly in damp butter.

69 If your butter is oily you see droplets of oil when you cut it:
- you churning time is too long.



70 If your butter is soft, check your mixing.



71 If your butter is crumbly or has a high melting point, check:
- **your feeding**
- **your heat treatment**
- **your churning.**

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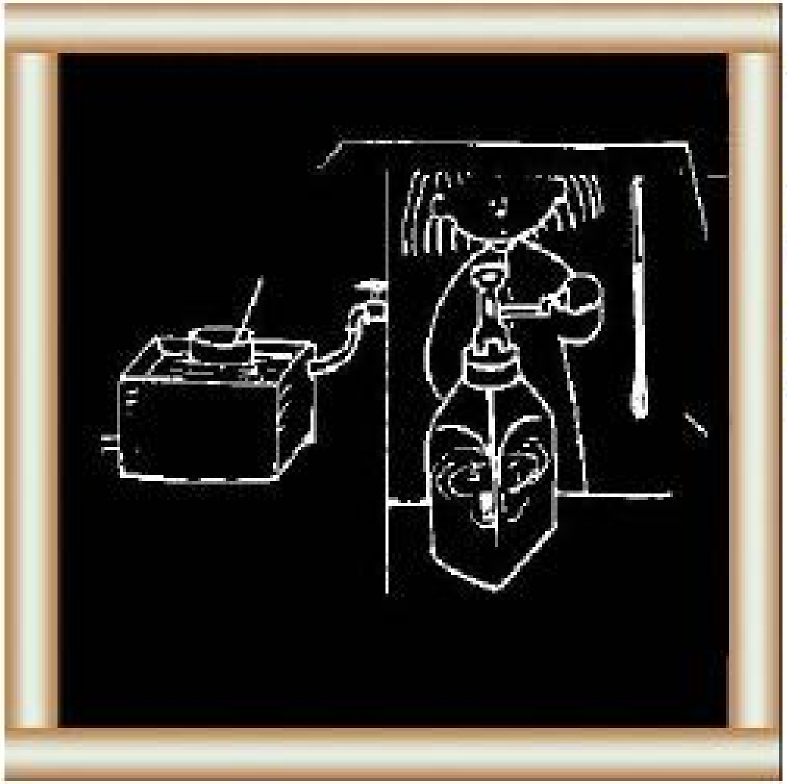
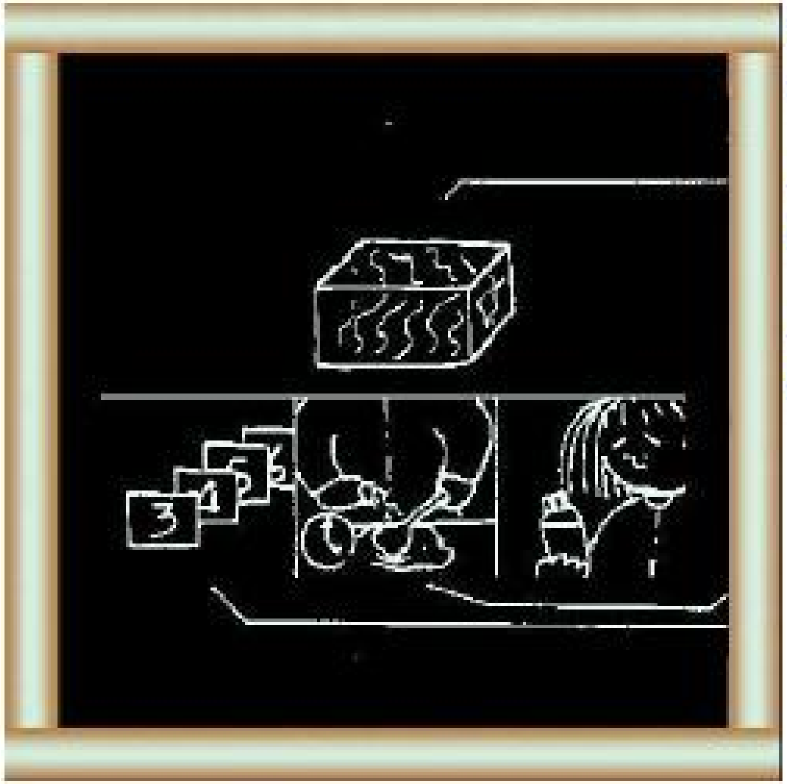


72 Make sure:

- you cool your cream enough after pasteurization

- you do not churn your butter at a high temperature.

Appearance

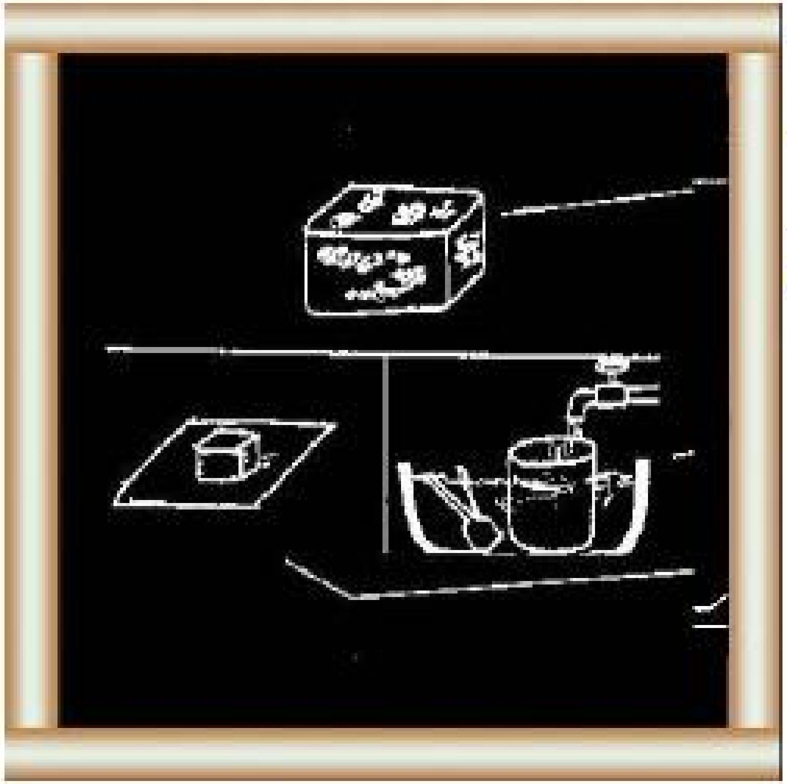


73 If your butter has streaks, make sure:

- you do not mix butter from different days' production

- you knead the salt into your butter for long enough.

74 If your butter is mouldy, make

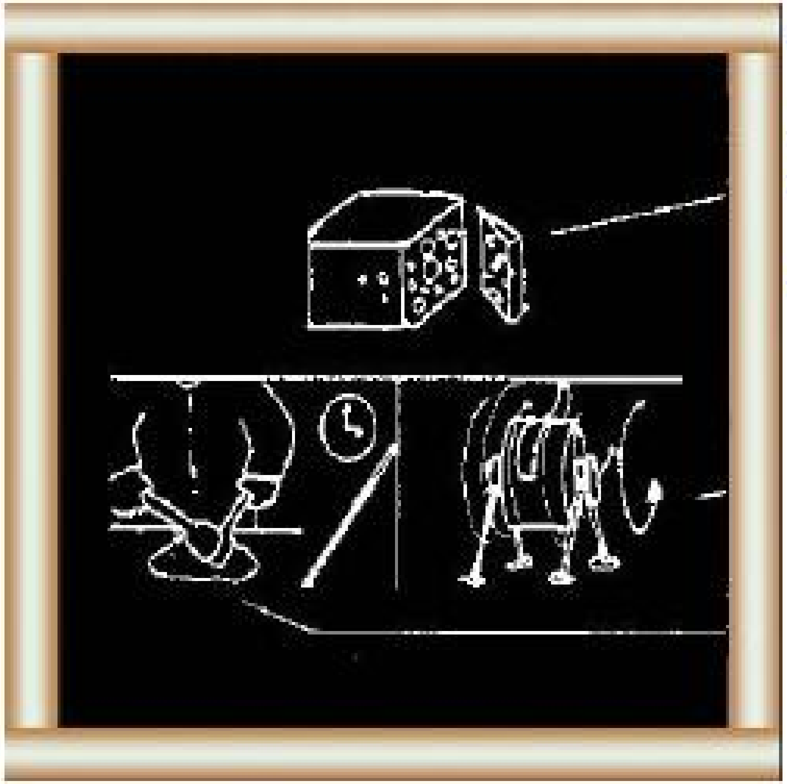


sure:

- you are wrapping it properly

- all equipment and materials are clean.

75 If your butter has holes, make



sure:

- you do not work it for too long or at too high a temperature

- there is no air in your butter.

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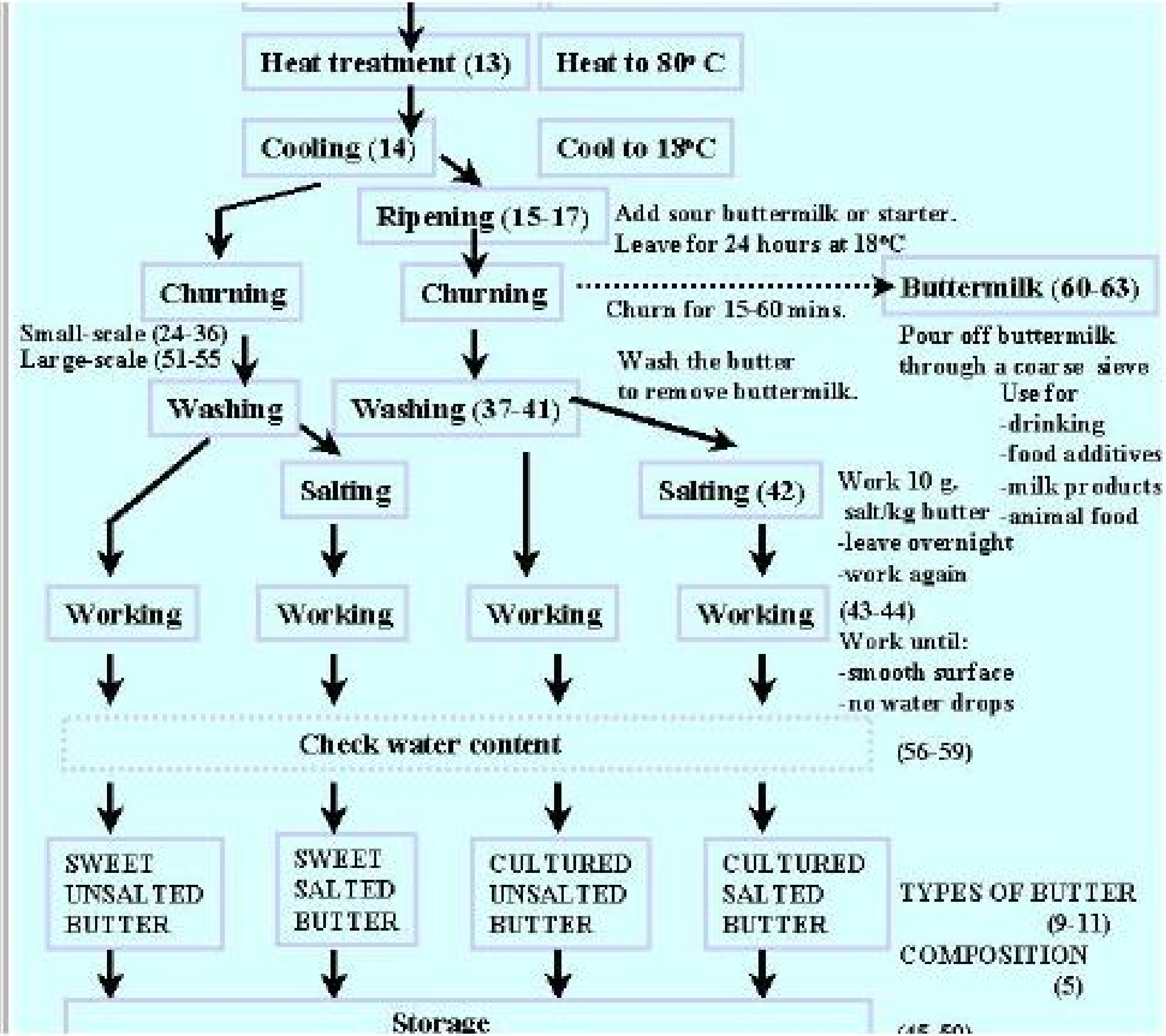
What do you know about making butter		(5)
Raw materials: milk or cream (20)	Equipment	(9-11)
↓		(13)
Check acidity (18-19)	Optimum 0:10-0:15 % lactic acid	(14)



(15-17)
(18-19)
(20)
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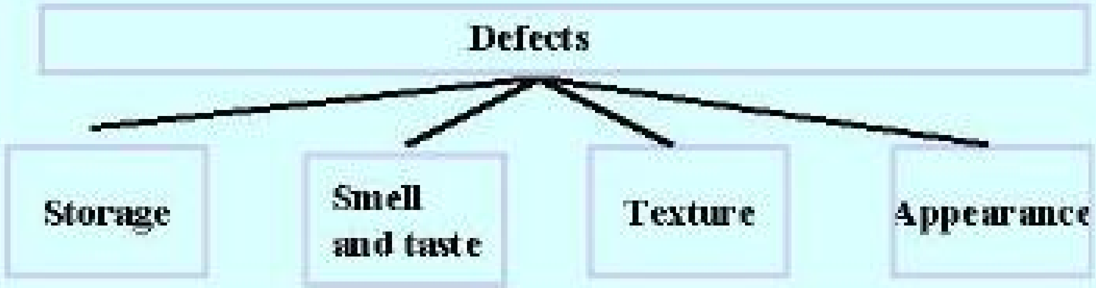
(37-41)
(42)
(43-44)
(45-50)
(51-55)
(56-59)



(64-75)

Store in cool place in:
- pot
- grease proof paper
- aluminium foil

(60-63)
(64-75)

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Small-Scale

Dairy Farming Manual

Volume 1

Technology Unit 10.3

Small Scale Cheese Making

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Technology Unit 10.3:

SMALL SCALE CHEESE MAKING

Technical Notes

Note: These technical notes are not indexed to illustrations numbers. They are taken from:

CHEESE MAKING TRAINING COURSE
RIT Lampang
24th - 28th October 1989

CHEESE

General introduction

The changing of milk into cheese generally goes through four stages:

1. Coagulation: physical and chemical changes in the casein micelles (protein) due to the action of proteolytic enzymes and/or lactic acid leading to the formation of a protein network.

2. Drainage: separation of the whey after mechanical cutting and agitation of the coagulum followed by moulding and, depending on the kind of cheese, pressing. By this means, cheese is obtained.

3. Salting: incorporation of salt by dry salting on the surface or within the body of the cheese, or by immersion in brine (salt water).

4. Ripening: biochemical changes in the cheese brought about by mainly bacterial enzymes.

Coagulation

Milk contains two different groups of proteins. These are:

- the casein complex (75-80 % of total protein);
- the whey proteins (20-25 % of total protein).

It is the casein that coagulates when making cheese.

The components in milk are present in different physical states such as true solution, colloidal dispersion or emulsion.

What should you know about cheese?

1 What is important in cheese making?(5-50)

There are different:

- textures

- ways of ripening

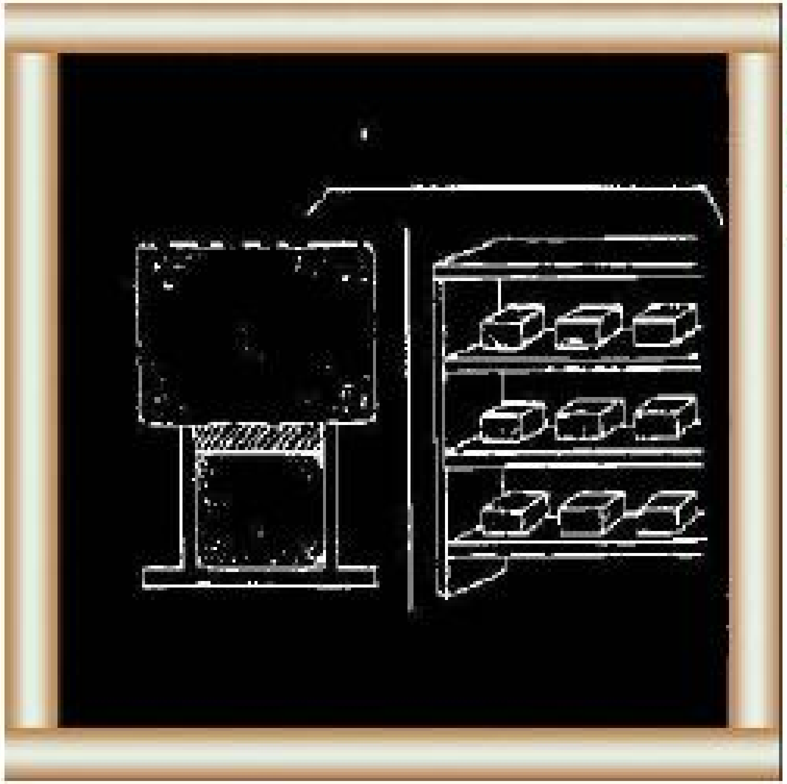
- compositions.

2 How can you make fresh cheese? (51-86)

By taking good quality milk and:

- cooking
- renneting
- straining.

3 How can you make semi-hard



cheese? (87-131)

By taking fresh cheese and:
- pressing
- ripening.

4 What defects are there in cheese?

(132-136)

There are defects of:
- flavour
- texture
- appearance.

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A component in colloidal dispersion will precipitate if the factors which make it disperse are changed (hydration, ionization (net charge)) (casein).

A component which is present as an emulsion will

precipitate or rise to the surface by the force of gravity if left to stand (milk fat).

The casein is present in the milk as small micelles. The outsides of these micelles have a large excess of negative charge. The effect of this is that the micelles repel each other. Thereby avoiding aggregation ---> sedimentation.

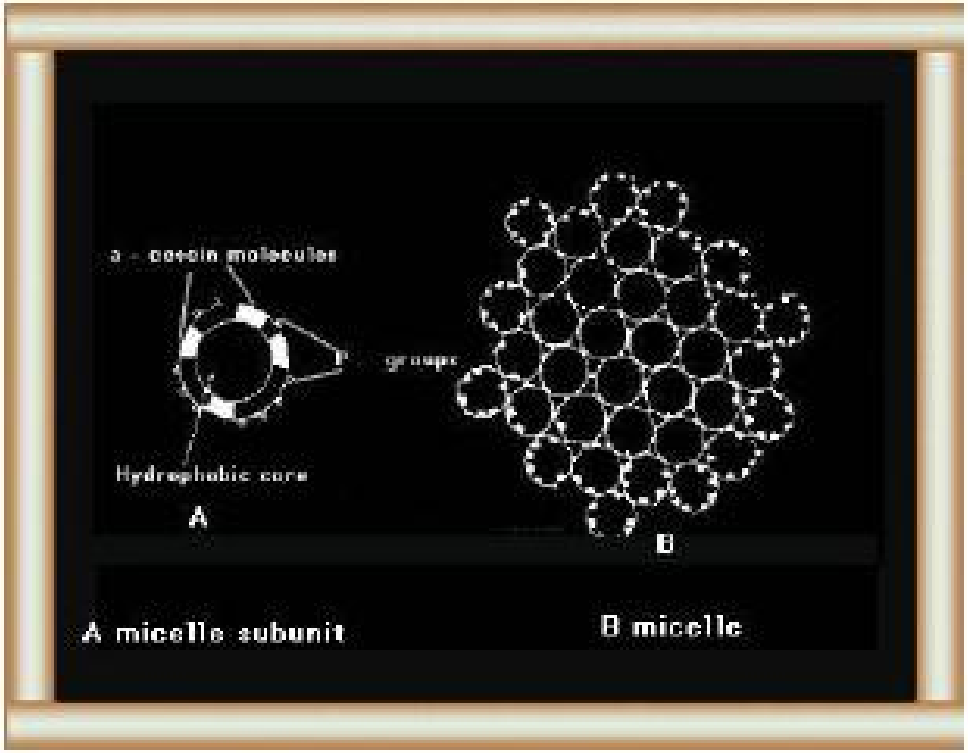


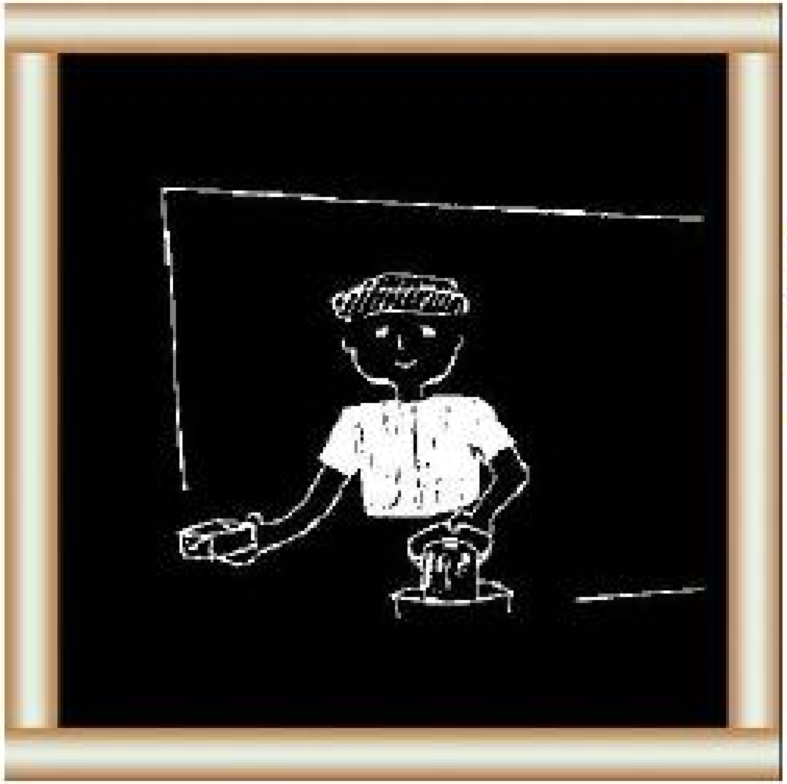
Figure 1: Structure of the casein micelle

The casein micelles also bind a lot of water (hydration). This bound water protects the micelles against aggregation.

In order to coagulate the milk (casein) it is necessary to destabilize the casein dispersion. This can be done by acid or enzyme.

Acid coagulation: By adding acid (H+) to the milk, pH is lowered and the ionization is reduced. When so much acid has been added that there is a neutral charge on the micelles (- and + equals), (isoelectric pH = 4.2) and the hydration is significantly reduced, a coagulum will form. This reaction depends very much on temperature. At higher temperatures the coagulum will form at a higher pH (less acid).

What is cheese?



5 Cheese is the solid part of milk: curds separated by chemical reaction from the liquid part of milk: whey.

6 You can make the curds separate from the whey by adding acid, bacteria culture and/or rennet (starter).

7 This causes the milk protein,casein, to curdle.

8 Acid or starter culture produce a soft curd which breaks up easily.

Rennet produces a firm and elasticcurd

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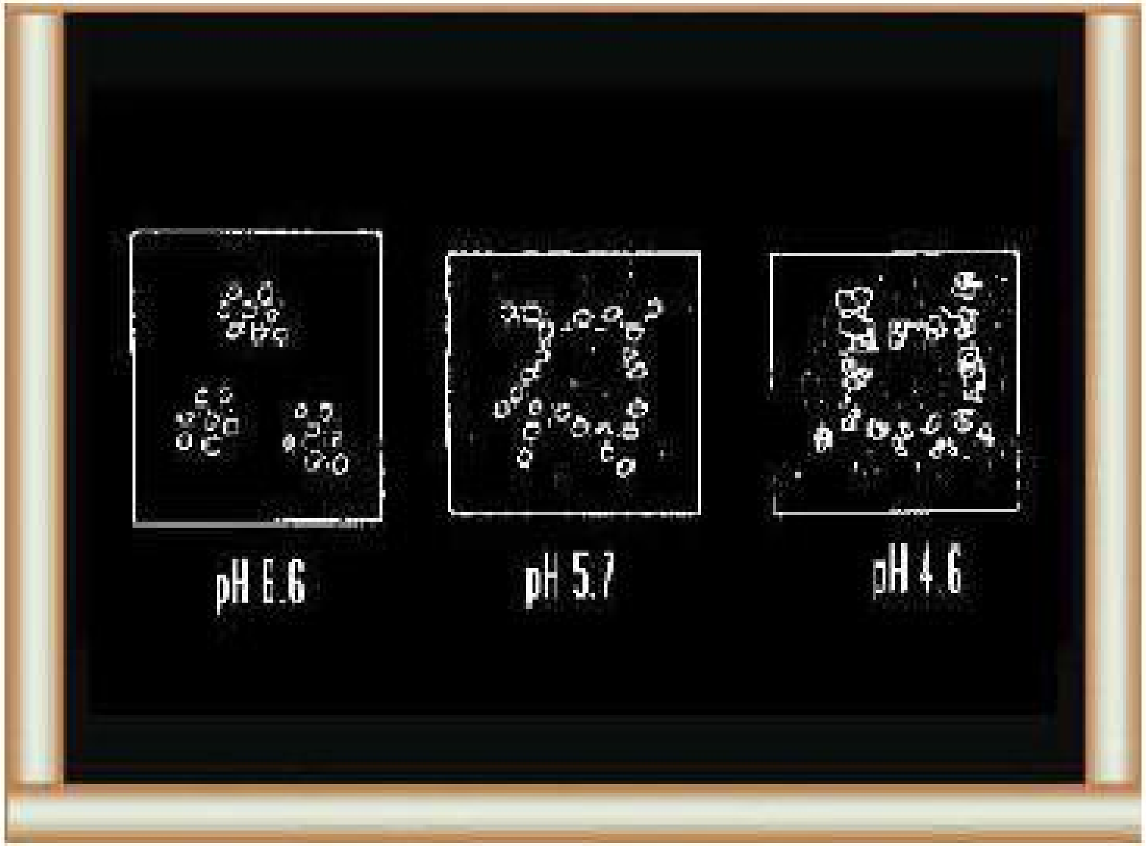

Figure 2: Changes in micelle structure in the course of acidification

Enzyme (rennet) coagulation: the coagulation of milk by the action of rennet occurs in two stages (phases).

Primary phase: **Also called the enzymatic phase. The enzyme attacks the stabilizing components of the**

micelles. A piece of the casein which has a strong negative charge is cut off and hydrophobic (water rejecting) bonds between the casein micelles can be established. The enzymatic phase is in particular influenced by temperature, pH and amount of enzyme. The optimum temperature for rennet enzyme is 40 - 42 C but usually a temperature of around 30-32 C is used because of other factors which will be explained later. The effect of pH can be seen from Figure 3 below.

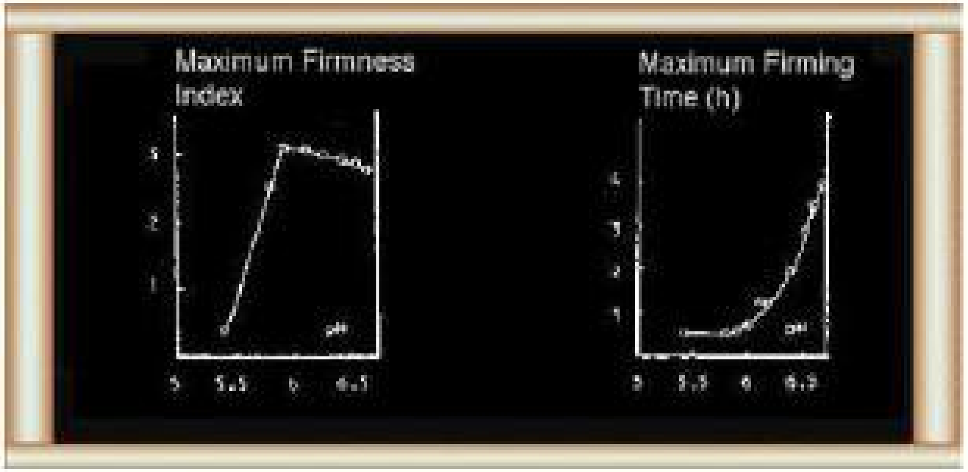

Figure 3: Effect of pH on the firming rate and the maximum firmness of rennet coagulum

Secondary phase: **Also called the coagulation phase. The aggregation of changed casein micelles (para-**

casein) takes place. The presence of Ca^{++} and to some extend Mg^{++} plays an important role in this reaction. The positive calcium and magnesium ions (cations) helps in neutralizing the negative charges on the casein. For this reason additional calcium is sometimes added to cheese milk, to increase velocity of coagulation and to get a firmer coagulum. It is usually added in the form of calcium chloride ($CaCl_2$).

The total time for the primary and secondary phase is from 30 to 45 minutes depending on the factors mentioned.

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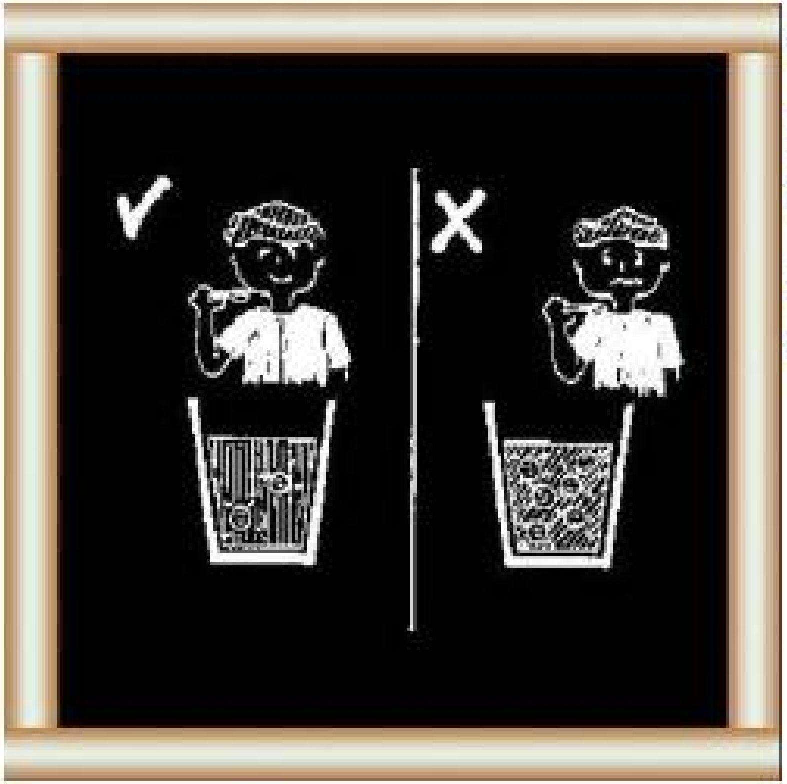
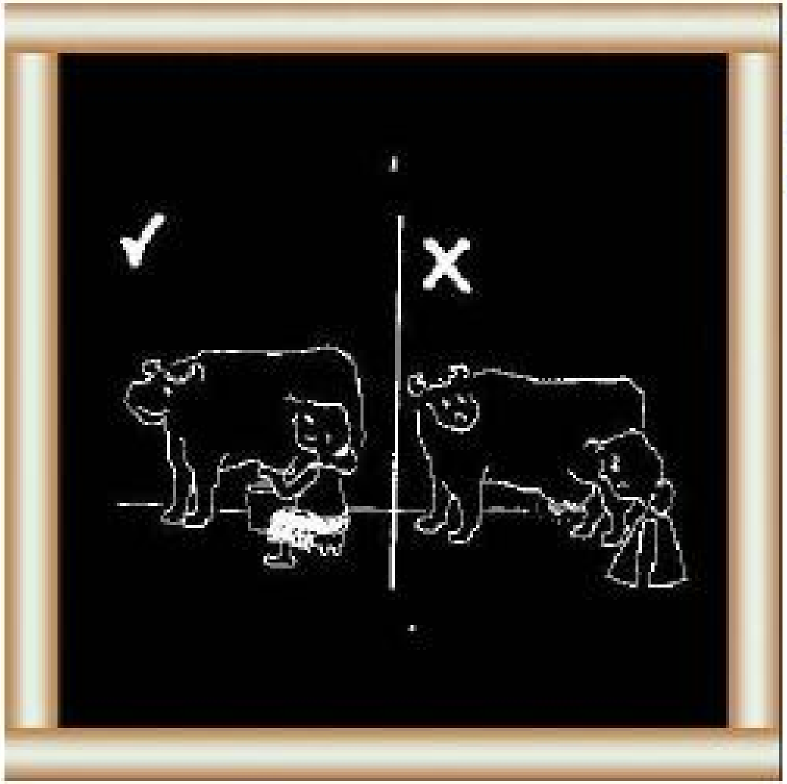
What do you need to make cheese?



Good quality milk

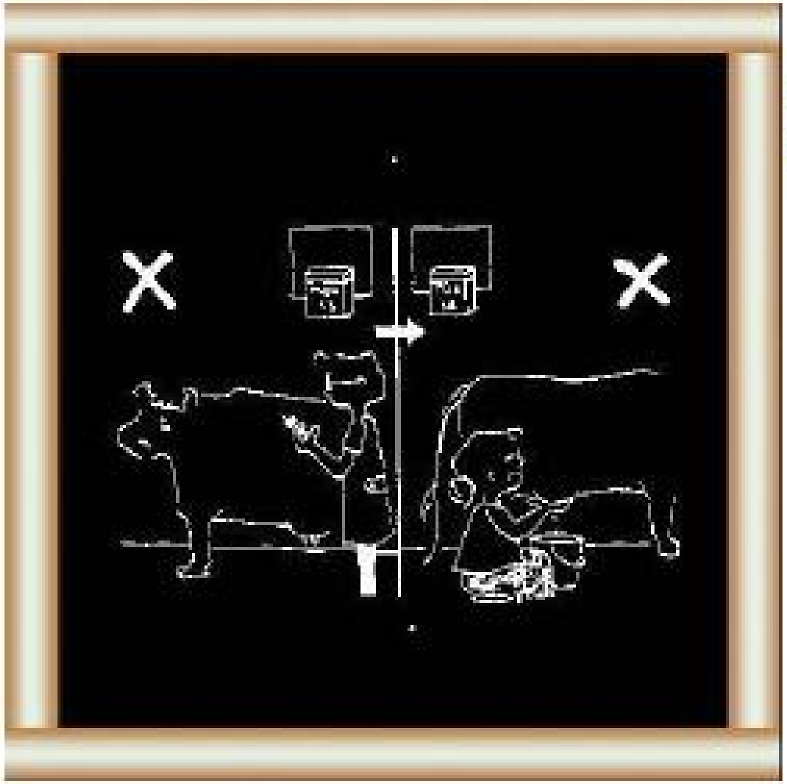
9 You need good quality milk with few bacteria.

Cheese made from milk with high bacteria content has a bad flavour.

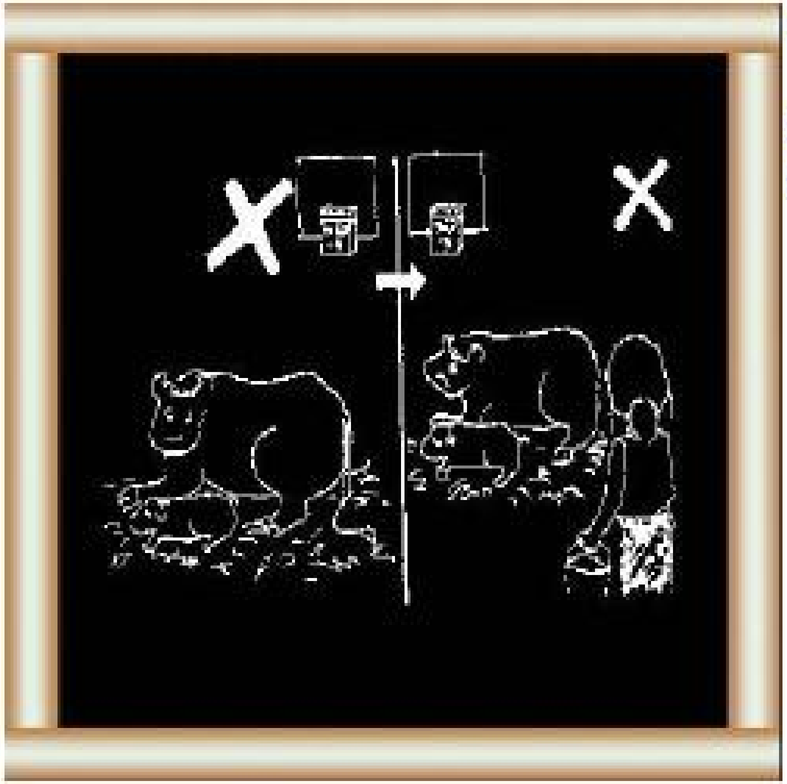


10 Use milk from healthy cows.

Do not use milk from cows with mastitis or other diseases.



11 Do not use milk which contains antibiotics.



12 Do not use colostrum.

It turns into curd on heating and the curd is too soft.

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Drainage: **Some time after the addition of starter culture and rennet fine droplets of water (whey) are observed on the surface of the milk (curd). The droplets grow larger and eventually they join together and form a liquid envelope around the coagulum. At the**

same time the coagulum decreases in volume. This process is called SYNERESIS.

By CUTTING the coagulum into smaller pieces the total surface becomes much bigger and the expulsion of whey (syneresis) increases. In order to control the drainage it is very important to cut the coagulum in equal-sized cubes.

This can only be done by using a proper sharp instrument and by cutting when the coagulum has reached a proper firmness. If cutting is done roughly or with poor instruments too many fine curd particles will be the result. These particles (fines) are lost in the whey resulting in lower cheese yields.

After cutting, the curd is usually left undisturbed for a while so that more whey comes out thus resulting in firmer cubes which can stand STIRRING. The stirring is at first done very gently to avoid damage to the cubes. As the cubes become firmer the stirring can be intensified. The stirring has two major purposes. It prevents the cubes from settling and sticking together and it makes the cubes bump into ONE ANOTHER

whereby whey is pressed out.

While stirring the curd is usually cooked (scalded) as well. The COOKING increases the whey expulsion. Cooking means heating to a certain temperature, depending on the type of cheese produced. Two different methods for cooking are possible.

- direct addition of hot water or steam
- hot water or steam in the double jacket of the cheese vat.

When adding hot water direct into the curds, 1/3 of the whey is often removed first. Apart from raising the temperature, the addition of water will lower the concentration of the dissolved components of the whey and the curd. A lower lactose content in the curd will result in lower acid production and consequently higher water content in the final cheese.

Cooking should be done carefully, the temperature should not rise too quickly and it is important that the whey-cheese grain mixture is stirred continuously.

After cooking stirring is continued for some time to

expel more whey.

When the curd reaches the required firmness (when it is dry enough) it is processed according to the type of cheese to be made.

This may involve:

- Forming into cheese-loaves and pressing before salting in brine and ripening i.e. Gouda, Tilsitter

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13 Make sure you clean and

sterilize your milking utensils.

Pasteurization does not destroy all bacteria from dirty utensils.

14 Rinse your utensils thoroughly

in clean water.

Cleaning agents and disinfectants in cheese milk kill lactic acid bacteria which are necessary for cheese.

15 Do not use poor quality silage.

This contains some bacteria which pasteurization does not destroy.

16 These bacteria produce butyric acid which gives cheese a bad taste and shape.

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- Ripening curd in the cheese vat, milling, salting, pressing and ripening i.e. Cheddar
- Ripening the curd in the cheese vat, milling, heating, kneading/stretching, salting, moulding i.e. Mozzarella and other pasta filata cheeses.

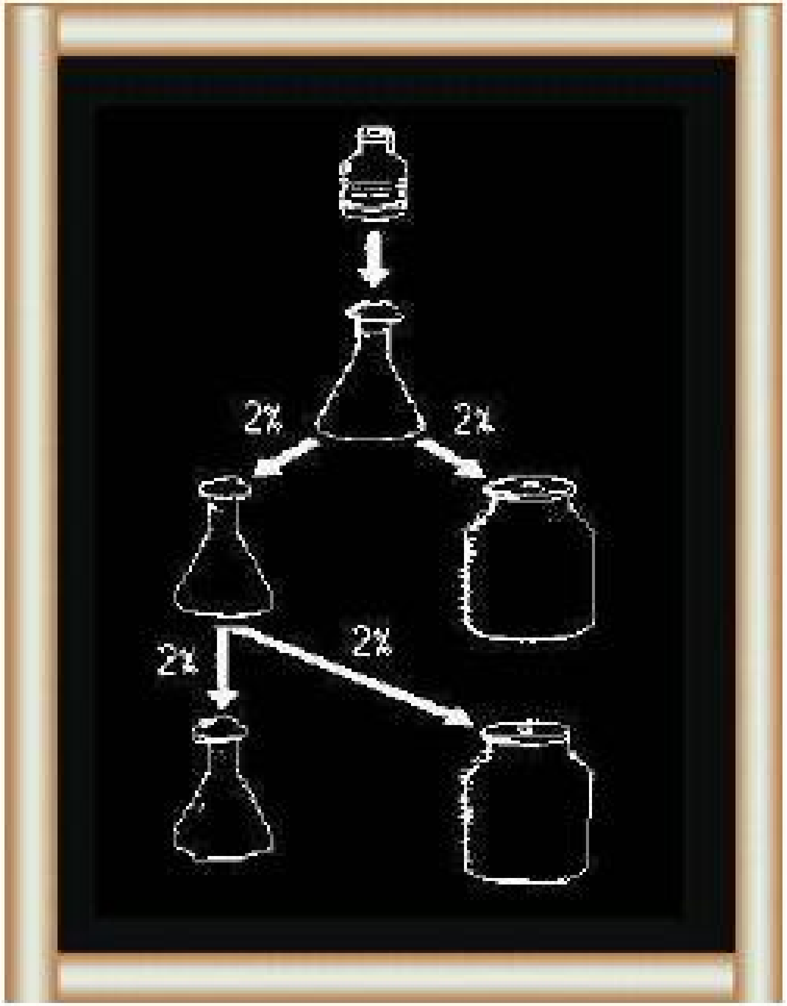
STARTER CULTURE

The mother culture to be used for cheese-making is usually a mesophyllic culture. This means that the bacteria have an optimum growth temperature of about 25-30 C and that they will grow between 10 and 45 C.

For Mozzarella, however, the same bacteria as for yoghurt are used. These are thermophilic cultures with an average optimum growth temperature of about 50 C and they will grow between 10 and 80 C. The two most common strains used are Lactobacillus bulgaricus and Streptococcus thermophilus, both with optimum growth temperatures between 40 and 45 C. These bacteria are used for Mozzarella because of their fast growth and high acid production.

The yoghurt culture is usually supplied from the manufacturer as a freeze-dried culture (Lyophilized Culture) or concentrated deep-frozen culture.

The preparation of yoghurt culture is shown below.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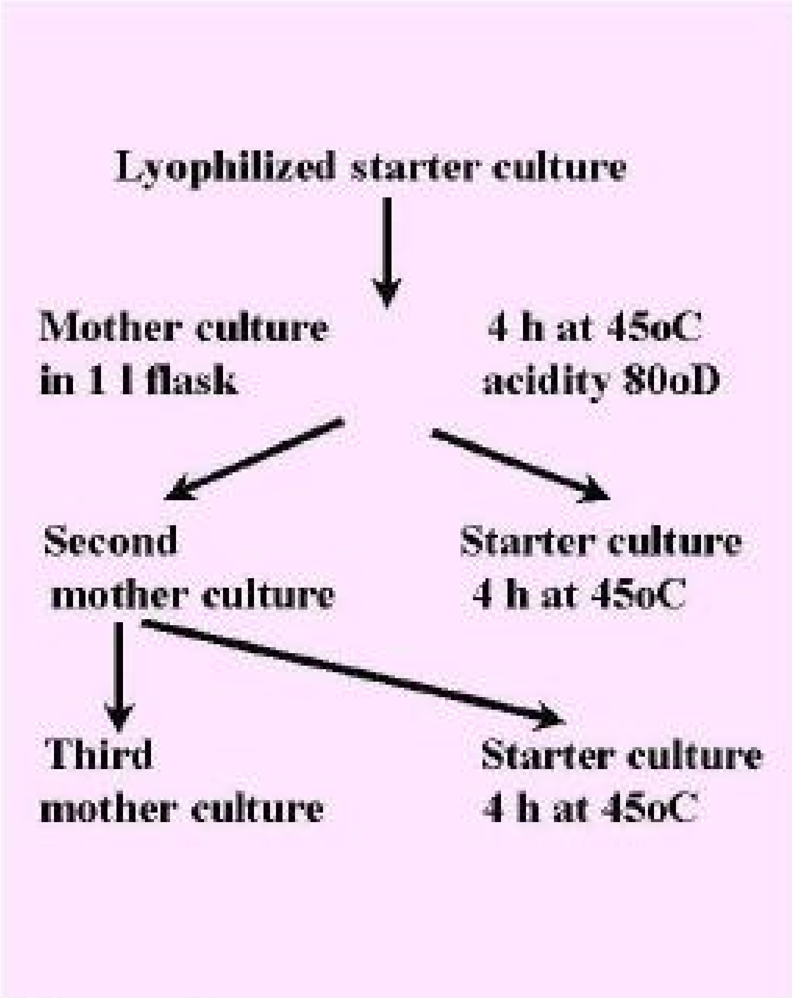

Figure 4

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17 You can test the quality of your cheese milk by:

- tasting
- smelling

bad tastes and smells go to your cheese

18

- boiling

sour milk or milk with colostrum precipitates.

19 Your milk collecting centre worker can test the quality of your cheese milk by:
- a colour reduction test e.g. methylene blue test which shows the number of bacteria

20

- an acidity test e.g. pH or titrated acidity test which shows souring and number of bacteria.

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The milk for the starter culture should be heated to 90-95 C for 20-30 minutes. Then cooled down to 43-45 C before adding the culture, and incubating at 43-45 C in either a water-bath, thermo-box or an electric incubator. All the procedures should be carried out under hygienic conditions and with sterile equipment. Stir vigorously before use.

GERBER TEST FOR FAT CONTENT

Reagents:

Sulphuric Acid: sp. gravity 1.816 +/- 0.003, 20 C.

Isoamyl alcohol: sp. gravity 0.811 +/- 0.002, 20 C.

Equipment

Butyrometers
Stoppers
Pipette 10.73 ml
Pipette for H2SO4 10 ml
Pipette for Amyl alcohol l ml
Gerber Centrifuge
Water-bath 67 C
Cloth to hold hot butyrometers

Procedure:

1. Fill 10 ml sulphuric acid into butyrometer.

2. Thoroughly mix the milk sample and, using the milk pipette add 10.73 ml milk.

3. Add 1 ml isoamyl alcohol on top of the milk. Care must be taken not to get milk, sulphuric acid or alcohol on the neck of the butyrometer, if this is allowed to happen the stopper may slip out.

4. Push the stopper in the butyrometer.

5. Shake the butyrometer thoroughly until the milk is dissolved. Hold the stoppered end up. Take care!! The butyrometer becomes HOT.

6. Holding the bottle by the stopper and neck. Invert it about 10 times to mix the acid remaining in the bulb with the content.

7. Adjust the stopper so that the expected fat % can be read.

8. Centrifuge for 5 minutes.

9. Immerse the butyrometer in a water-bath at 67 C for 5 to 10 minutes.

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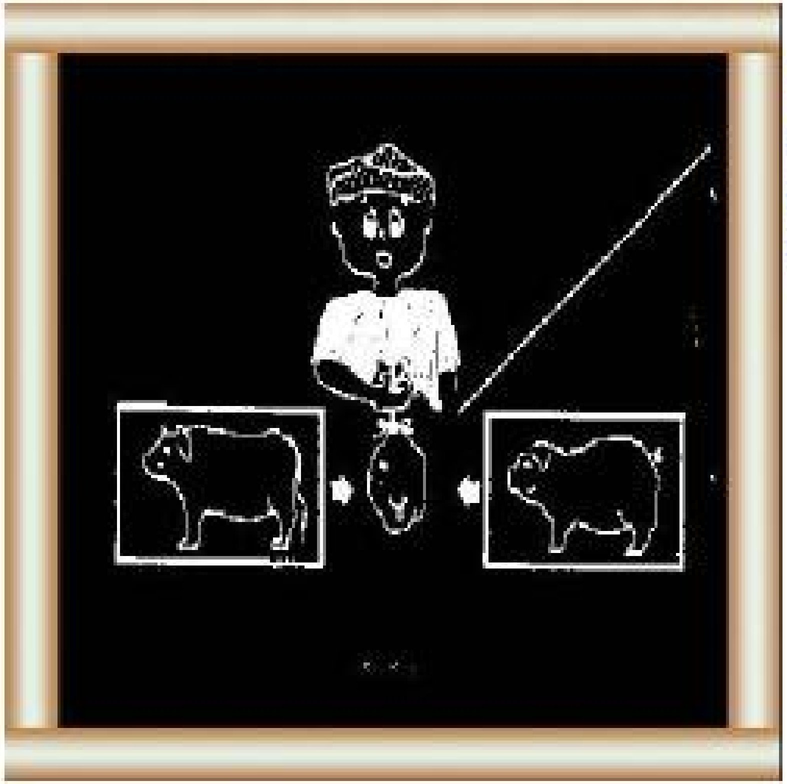
Additives to cheese milk

Rennet

21 You add rennet to milk to coagulate it.

22 You can:
- buy rennet or
- make it yourself.



23 You can make rennet from the 4th stomach of unweaned calves or pigs which contain the enzyme chymosin.

24 Consult your extension worker about the simple equipment and chemicals you need to make rennet.

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Procedure:(Continued)

10. Adjust the fat column onto the calibrated section of the tube and read as shown in the figure below.

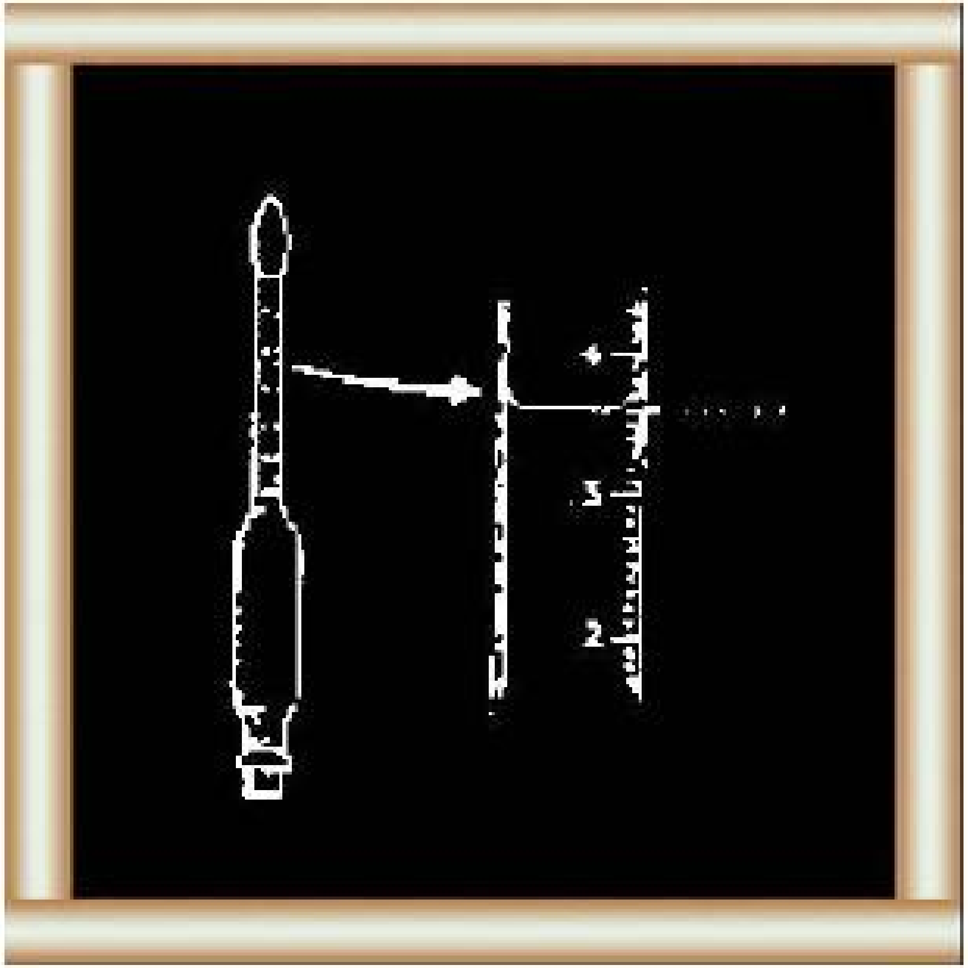


Figure 5

STANDARDIZATION

To guarantee the consumer a product of constant fat content and to meet standards, the fat content for milk

products should be standardized. Usually the fat content of raw milk is higher than the required standards. Manufacturing products with an excess fat content will lead to financial losses. In small scale operations the cost of standardization (i.e. purchase and maintenance of separator, fat testing equipment etc.) may be higher than the profits especially if the cream cannot be sold.

Standardization can be undertaken by:

1. Mixing whole milk with partly or totally skimmed milk.

2. Mixing skimmed milk with cream.

3. Separating whole milk to get the required fat content.

Method 3 requires very sophisticated and expensive equipment so under small scale only methods 1 and 2 are of interest.

Example 1

Suppose 200 kg of raw milk is available. The fat test has shown a fat content of 4.5 % fat. Milk with 3 % fat is required for cheese production. How much raw milk is it necessary to skim (separate). In the calculation it will be assumed that all the fat is removed from the skim milk by separation.

If X = litres of cream with 32 % fat
and Y = litres of milk with 3 % fat

25 You can also get rennet with enzymes which coagulate milk.

26 Always:

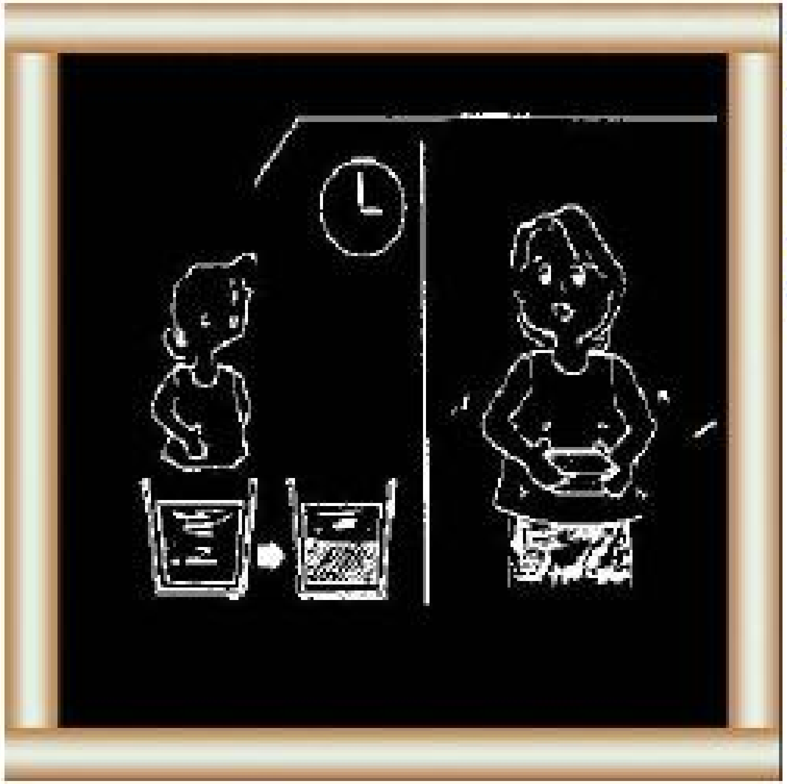
- buy or make small amounts of rennet
- store in a dark, cool place, a refrigerator if possible.

Do not keep for more than 3 months.

Starter (lactic acid bacteria)

27 The starter produces acid which:

- helps when you remove the water from the curd



28

- helps the rennet coagulate the cheese milk quickly

- makes the cheese soft, rubbery, hard or brittle

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Example 1 (Continued)

The following equation may be used.

In the calculation the expression fat unit (fu) means 1 % fat in 1 litre of milk.

Total fat units = 200 1 x 4.5 % fat = 900 fu

I X + Y = 200
II 32X + 3Y = 900

Equation I should be multiplied by 32 so that X will be eliminated by subtraction.

I2 32X + 32Y = 6,400
II2 32X + 3Y = 900

Equation II should then be subtracted from Equation I and the following is obtained.

III 29Y = 5,500
III2 Y = 189.7 l with 3 % fat

The Value Y should be inserted in I:

IV X + 189.7 = 200
IV2 X = 10.3 l cream 32 % fat

Now it only remains to calculate how many litres to skim to get 10.3 l of cream with 32 % fat.

10.3 l x 32 % = 329.6 fu

329.6 fu = 73 litres to be skimmed
4.5 fu/l

Control of calculation:

189.7 l x 3 % fat = 569.1 fu
10.3 l x 32 % fat = 329.6 fu
898.7 ~ 900 fu

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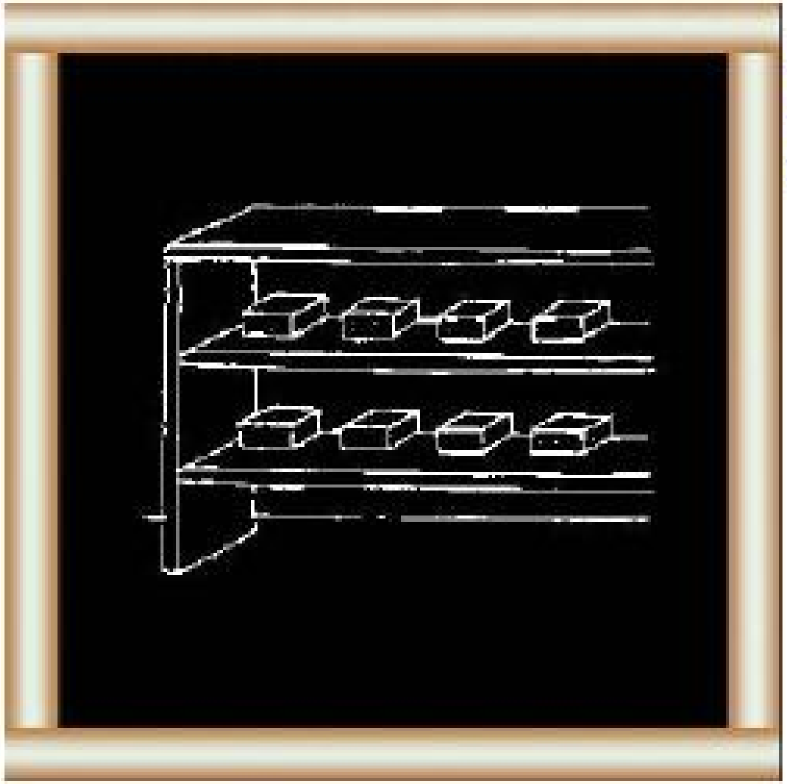
29

- gives the cheese flavour

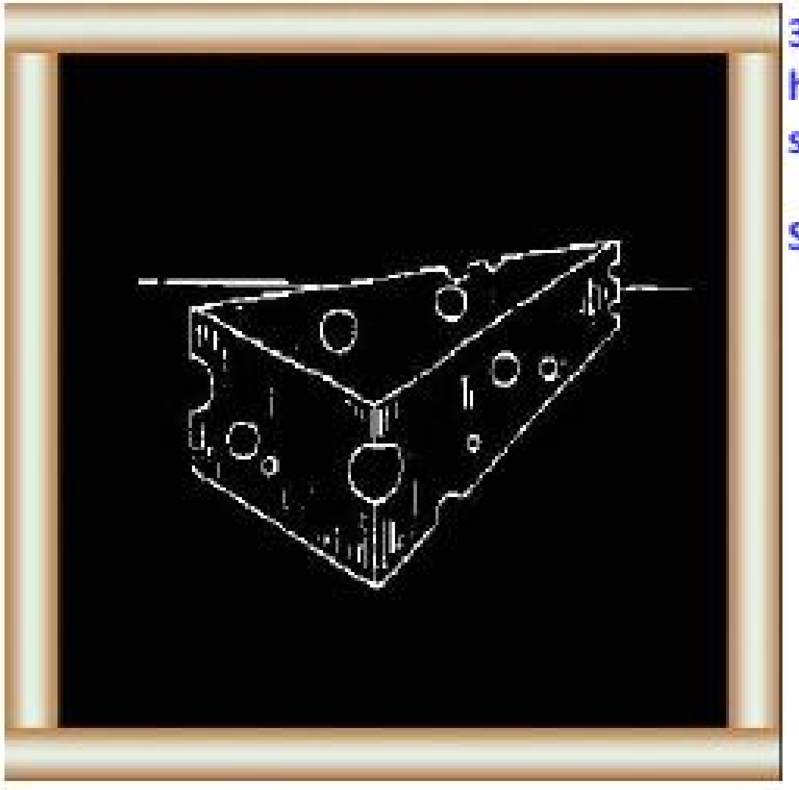
30

- prevents the growth of harmful bacteria



31

- breaks down proteins to help ripening.



32 If you want cheese with eye holes you need to use a special starter.

See T 10.1 Starter Cultures.

Example 2

If skim milk is available for mixing with whole milk to obtain standardized milk with a certain fat content the following mixing square may be used.

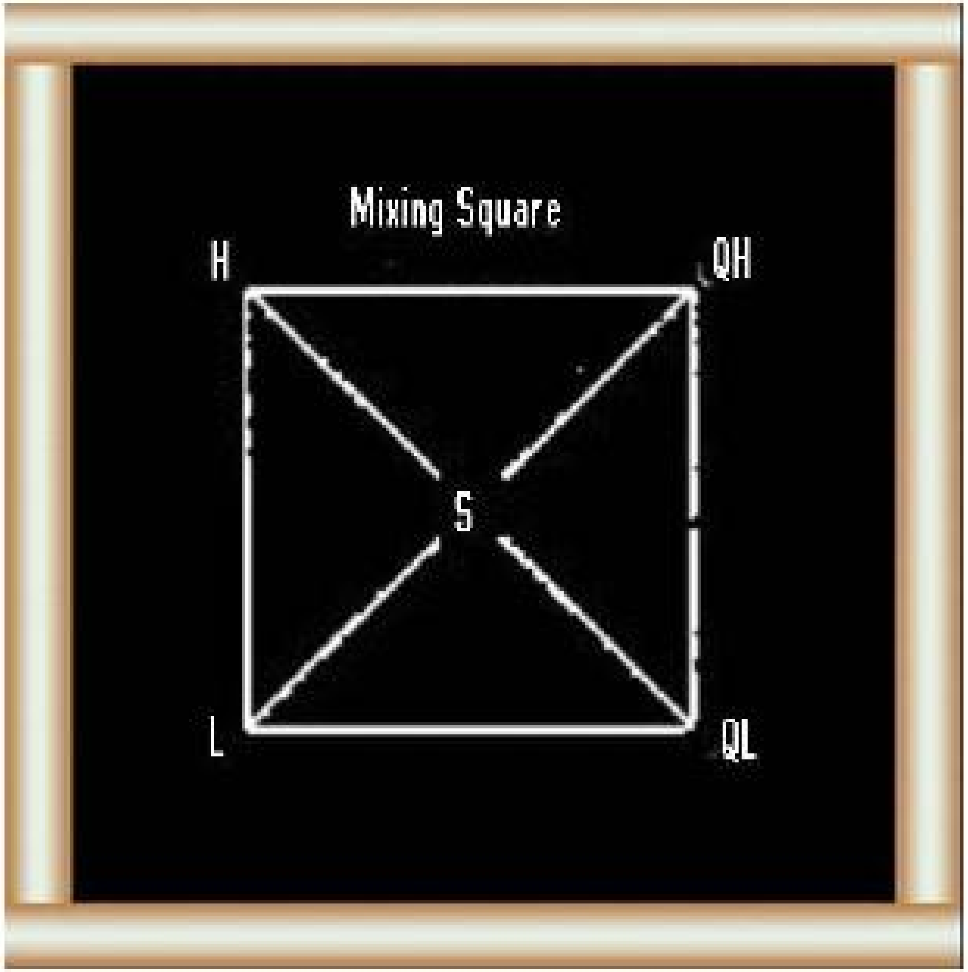


Figure 6

The square shows:

H = fat content of the milk with the highest fat content (e.g. whole milk with 5 % fat)

L = fat content of the milk with the lowest fat content (e.g. skimmed milk with 0.05 % fat)

S = fat content of the standardized milk to be produced (e.g. 3 % fat)

QH = quantity of milk available with highest fat content, that is milk to be standardized

QL = quantity of milk with lowest fat content; to be mixed with milk with highest fat content

In the example, H - S = QL = 5 - 3 = 2, and S - L = QH = 3 - 0.05 = 2.95, which means that for every 2.95 kg of whole milk 2 kg of skimmed milk has to be added to obtain standardized milk with 3 % of fat; in this case that is 4.95 kg of standardized milk.

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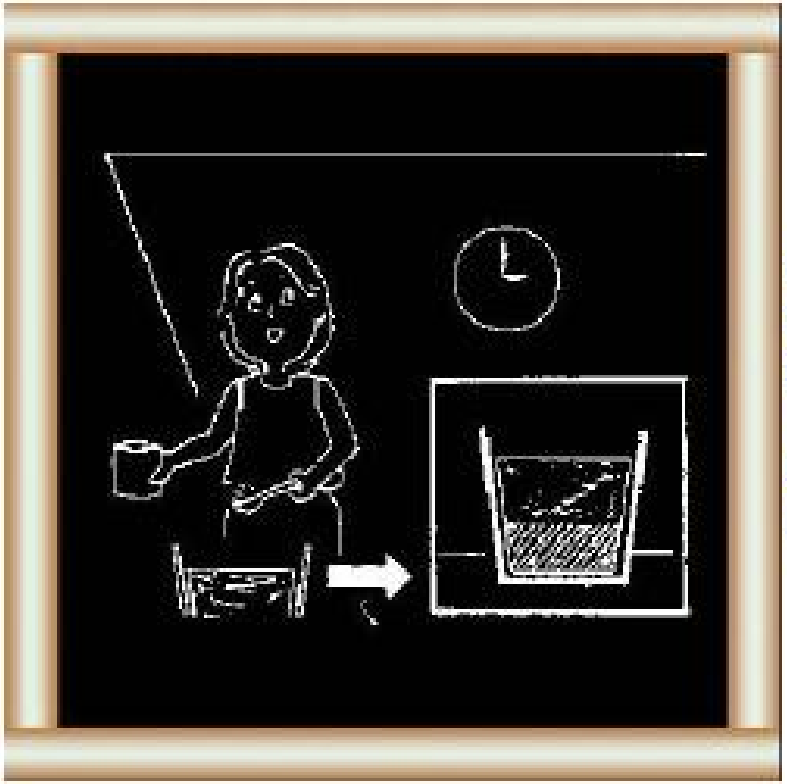
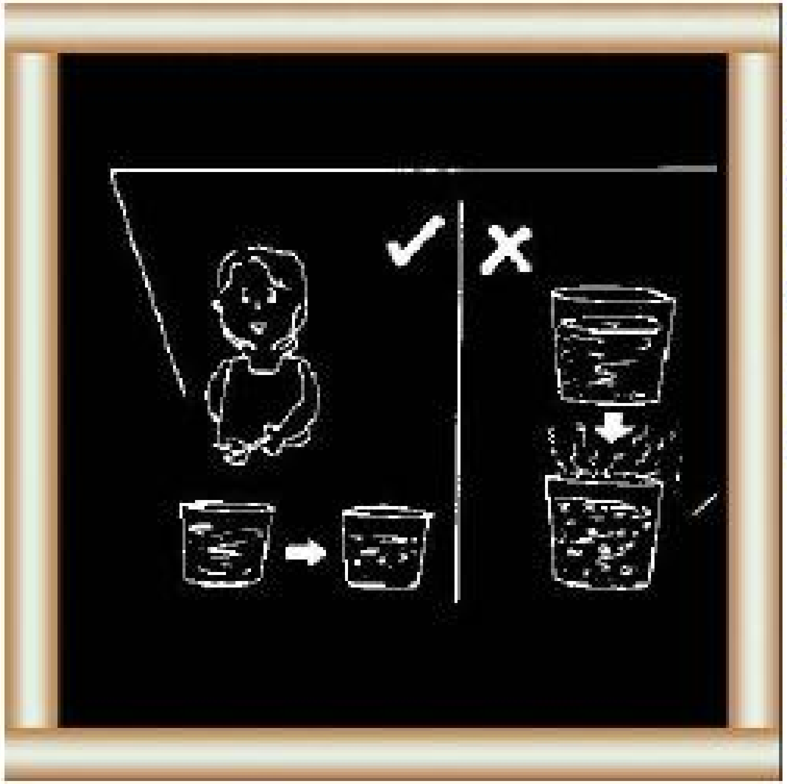


Calcium chloride
33 You can add calcium chloride to coagulate milk faster.

Add 5-20 g calcium chloride per 100 l milk.

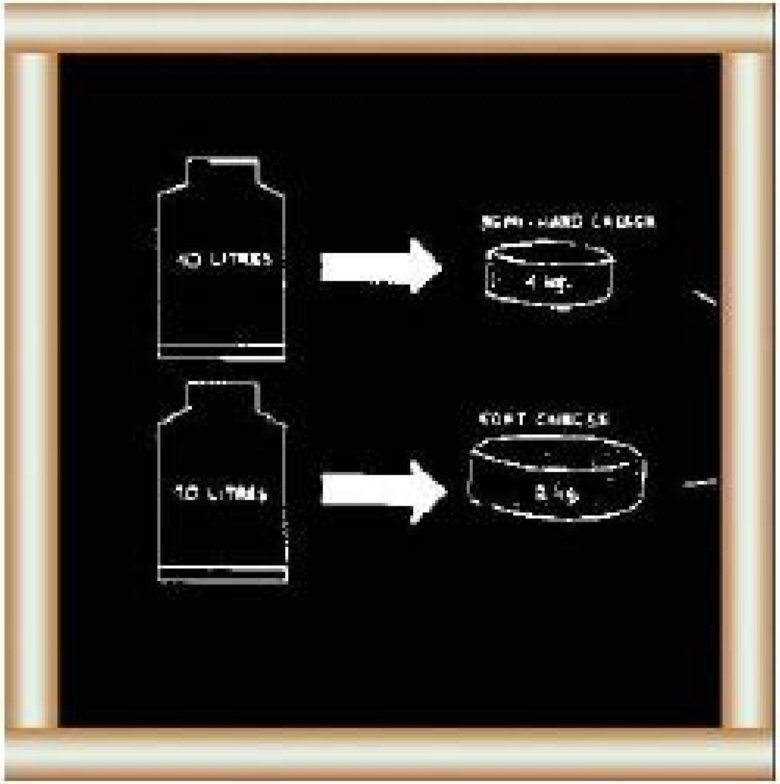


Potassium nitrate

34 You can add potassium nitrate to prevent too much gas in your milk (from coliform or butyric acid bacteria).

Add 10-15 g potassium nitrate per 100 l milk.

How much cheese do you get from



milk?

35 10 l of milk makes
1 kg of semi-hard cheese or
2 kg of soft cheese (it contains
more whey).

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CALCULATION OF EXPECTED CHEESE YIELD

Assumptions:

Approx. 90 % of the fat goes into the cheese.
Approx. 75 % of the protein goes into the cheese.
Approx. 0.5 kg of sugar + ash per 100 kg of milk goes into the cheese.

Calculate the yield from 100 kg of cheese milk with the following composition.

Fat content = 4.2 %
Protein content = 3.4 %

Assumed water percent in cheese = 40 %

Fat yields: $\frac{100 \times 4.2}{100} \times 90\ \%$ **= 3.78 kg ~ 33%**

Protein yields: $\frac{100 \times 3.4}{100} \times 75\ \%$ **= 2.55 kg ~ 22 %**

Sugar + ash yields: = 0.50 kg ~ 4 %

Total dry matter **= 6.83 kg**

Water yields: $\frac{6.83 \times 40}{60}$ % **= 4.55 kg ~ 40**

=11.38 kg ~ 60 %

Kg of milk per kg of cheese $\frac{100}{11.38}$ **= 8.8 kg/kg**

Fat in dry matter $\frac{3.78 \times 100}{6.83}$ **= 55 % = 55+**

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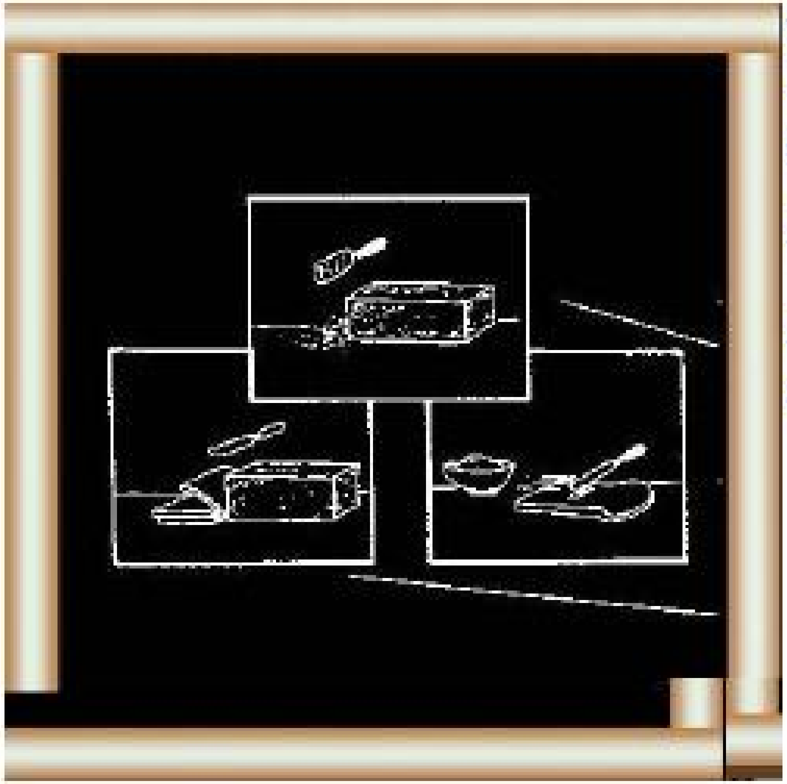
What is important in making different types of cheese?



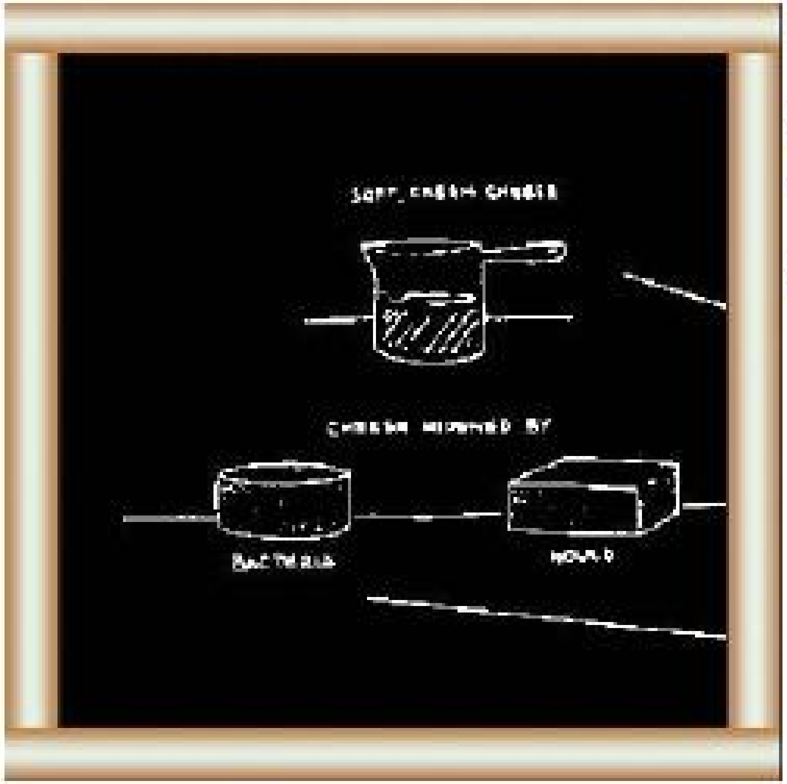
Texture

36 Hard cheese - you can slice or grate.

Semi-hard cheese - you can slice.

Soft cheese - you can slice or spread.

Ripening



37 Fresh cheese

Cheese ripened by bacteria/enzymes

Cheese ripened by mould.

Fat and water content

38 Different cheeses contain different amounts of fat and water.

Type of cheese	% fat	% water
Hard	25 - 30	35 - 40
Semi hard	20 - 35	40 - 50
Soft	20 - 30	40 - 60
Very soft	0 - 35	50 - 85

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ACIDITY TEST

The titratable acidity test is employed to ascertain if milk contains a large amount of lactic acid which might reduce its heat stability, and thereby its suitability for milk products manufacture.

Titratable acidity generally has been presented as the acidity measured by titration with 0.1 N sodium hydroxide, due solely to lactic acid. This is not really so because what is actually measured is the quantity of alkali necessary to bring the pH of the milk to approximately 8.3 at which point phenolphthalein shows the characteristic pink colour. Generally, freshly-drawn milk does not contain lactic acid. Some bacteria which contaminate milk can attack the milk sugar (lactose) and form acids of which the principal is lactic acid. The indicator substance phenolphthalein is colourless in an acid solution but red in an alkaline solution. On adding phenolphthalein to milk it remains colourless because the milk is

acidic, its inherent acidity being due to its natural constituents particularly the protein and phosphates. The addition of a solution of an alkali like sodium hydroxide neutralizes the acid and, when a slight excess has been added, the phenolphthalein turns red.

Method

1. Pipette 9 ml of the well-mixed sample of milk into a 100 ml Erlenmeyer flask.

2. Add 10 drops of 1 percent phenolphthalein solution (prepared by dissolving 1 gm phenolphthalein in 75 ml of 95 % Ethyl alcohol and adding enough distilled water to make total volume 100 ml).

3. Fill the burette with the 0.1 N sodium hydroxide solution, run out a portion to ensure that there are no air bubbles in the column, then adjust to a convenient graduation mark, preferably zero.

4. While agitating the sample continuously, run the sodium hydroxide solution in slowly from the burette until the first permanent pink colour is obtained. A

permanent very pale pink is the correct endpoint.

5. Read off the quantity of alkali used and calculate the amount of titratable acidity as percent lactic acid.

$$\text{Titratable acidity} = \frac{\text{ml 0.1 M NaOH} \times 0.009 \times 100}{\text{Volume of sample}} = \text{\% lactic acid}$$

Example: **Volume of sample 20 ml**

ml 0.1 M NaOH = 29 ml

$$\text{Titratable acidity} = \frac{29 \text{ ml} \times 0.009 \times 100}{20 \text{ ml}} = 1.3 \text{ \% lactic acid}$$

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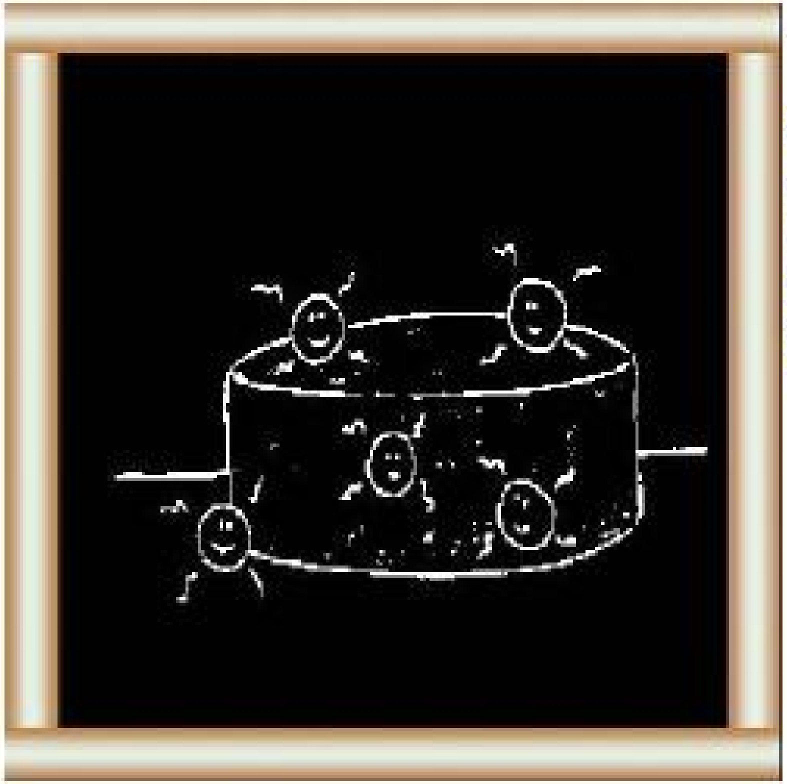
Whey content

39 The amount of whey in the curd affects the

- taste

too much whey makes the curd sour

40



- keeping quality

too little whey makes it easy for bacteria to attack the curd.
We usually remove more whey from fresh cheese than from cheese for ripening.

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SMALL SCALE MOZZARELLA CHEESE MANUFACTURING

Essential equipment:

Cheese vat, jacketed 100-200 l
Curd cutting knife
Agitator
Scale
Thermometer
Heat source (gas-burner)
Basin for heating water in
Basin for heating cheese in water
Knife
Sieve
Cheese cloth
Bucket
Gloves
Moulds
Wrapping material
Freezer/Refrigerator

Optional equipment: pH-meter

Lactodensimeter
Fat testing equipment
Acidity testing equipment
Electric incubator

Vacuum packing machine
Separator

Materials:

Milk (standardized fat %)
Yoghurt starter culture
Rennet (powder or liquid)
Salt (NaCl)
Ice

Procedures:

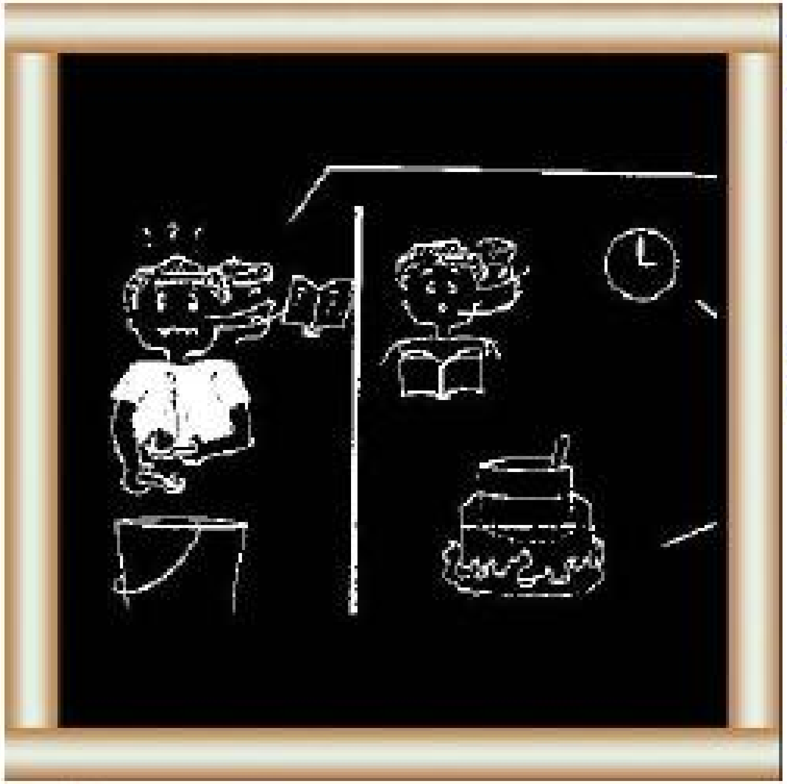
1. Raw milk is poured into the cheese vat through a cloth. The temperature should be > 32 C

2. 1.25 % yoghurt starter is added and the milk is thoroughly stirred. Leave to stand for 30 minutes.

3. Add rennet according to instructions from supplier. Stir milk to ensure equal distribution of rennet. Leave untouched until a shiny firm coagulum has formed (35-45 minutes).

41 Because the composition of milk is not always the same, you must adaptthe recipes.

42 Try out different:



- quantities of rennet or culture
- times for curdling
- temperatures for curdling.

Each time you make cheese, keep records:

Date:

beginning .... pressing ....

ripening ....

Quantity of: **Quality:**

milk ....

type ....

culture/acid/rennet ....

hardness ....

salt ....

taste ....

Temperature:

adding culture/acid/rennet ....

curdling ....

Time:

for curdling ....

Next time you can **adapt** your recipe and **improve** your cheese.

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Procedures: (Continued)

4. Cut the curd into equal sized cubes of 1 to 1.5 cm. Cut horizontally first, then twice vertically, if cubes are too big cut again vertically.

5. Start heating with low fire and leave to stand for 15 minutes.

6. Start stirring gently and put on full fire. Gradually intensify stirring. Keep on stirring and heating until the temperature is 47 C. Stop heating and keep on stirring for about 30 minutes.

7. Stop stirring. The cheese grains will then sediment on the bottom of the vat. Remove with a clean bucket as much whey as possible. Pour the whey through a sieve into a milk churn or another container. Push cheese grains away from the outlet, insert a sieve in front of the hole and remove remaining whey through outlet.

8. The cheese grains will stick together within 5 minutes after removal of the whey. Cut the lot into pieces of approx. 25 x 25 cm and turn them. Put lid on the vat.

9. Cut, turn and pile the cheese every 30 minutes for 1 1/2 hours of until pH has reached 5.1 - 5.3. The cheese should be like boiled chicken meat.

10. Cut the cheese into ribbons of approx. 25 x 8 cm. Weigh out 2.2 kg, put them into a basin with holes in the bottom of the side.

11. Insert basin into another basin containing water at 82

- 85 C. Leave the cheese there for 10 minutes.

12. Take basin with cheese out, knead and stretch the cheese vigorously while it is hot. Add salt (one spoonful per 2 kg) and knead again.

13. Insert cheese in hot water for short time (1-2 minutes) take it out, shape it and fill it in the mould.

14. Put mould with cheese into ice-water.

15. Cool the cheese in the ice-water until it becomes firm, about 1 hour.

16. Let the surface of the cheese dry before packing.

17. Put the packed cheese in the freezer or refrigerator.

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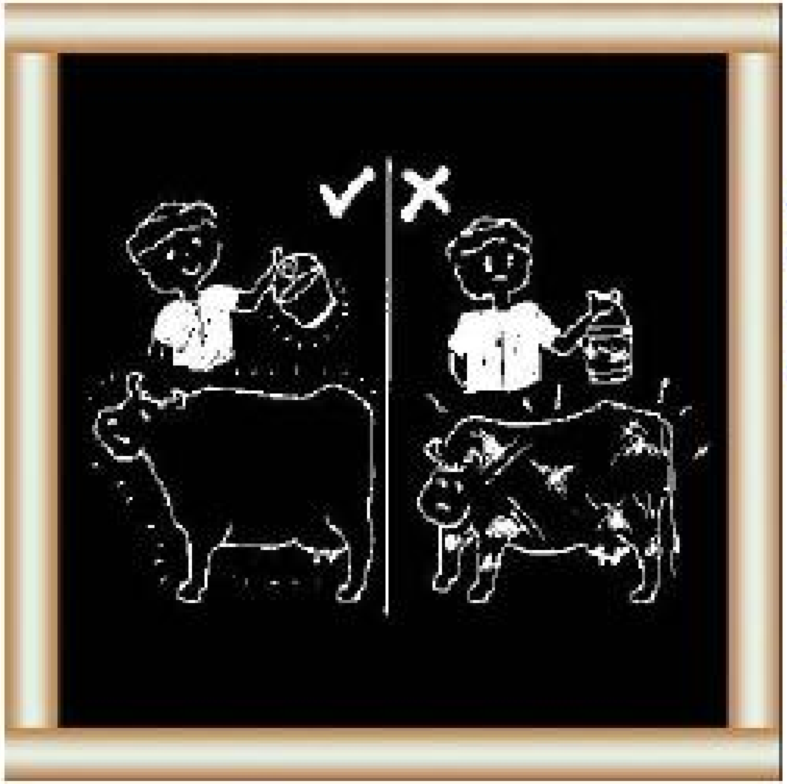
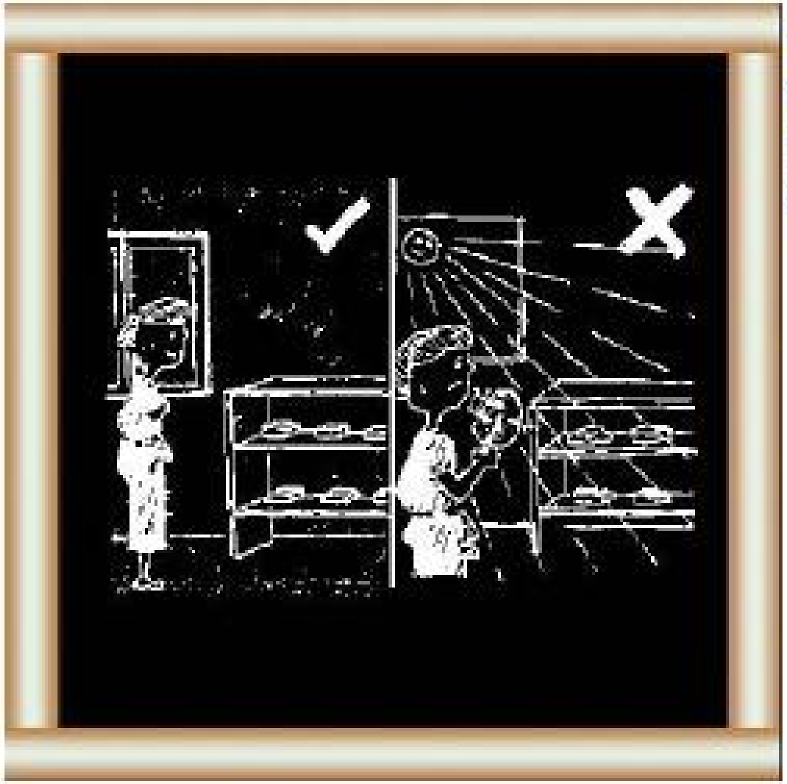
What are the problems of making cheese in the tropics?



43 Hard and semi-hard cheeses require a high quality of milk and a very hygienic method of production.



44 Ripening cheeses requires lower temperatures and higher humidities, than available under normal conditions.

45 Farmers should produce cheese which people like and has a good market (e.g. with a good flavour and smell for consumers).

46 For these reasons, farmers usually produce soft, fresh cheese in the tropics.

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REFERENCES

1. Gary H. Richardson, Ph.D.; Standard Methods for the Examination of Dairy Products, 15th edition.

2. Jeremija Lj. Rasic, Joseph A. Jurmann; Yoghurt, Fermented Fresh Milk Products, Volume 1.

3. Egil Waagner Nielsen; Maelkekemi, 1985.

4. J.C.T. van den Berg; Dairy Technology in the Tropics and Subtropics, 1988.

5. C.D. Thomson, A. Eck; Cheese Making, Science and Technology.

6. J.C. Lambert; Village Milk Processing, FAO Animal Production and Health Paper No. 69.

7. G.H. Wilster, Ph.D.; Practical Cheesemaking, Thirteenth Edition, 1980.

8. Frank Kosikowski; Cheese and Fermented Milk Foods, Second Edition, 1978.

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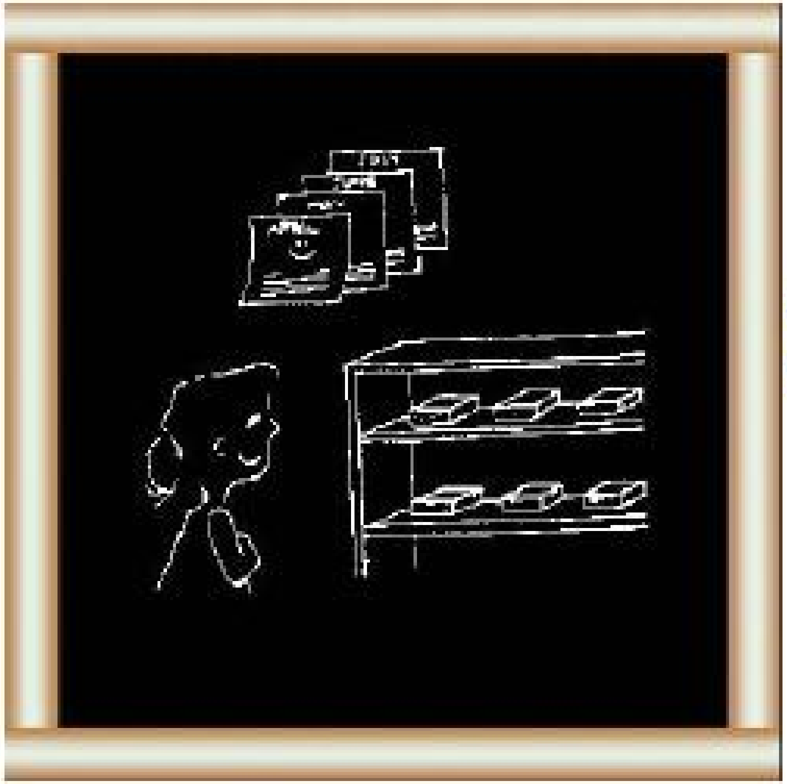
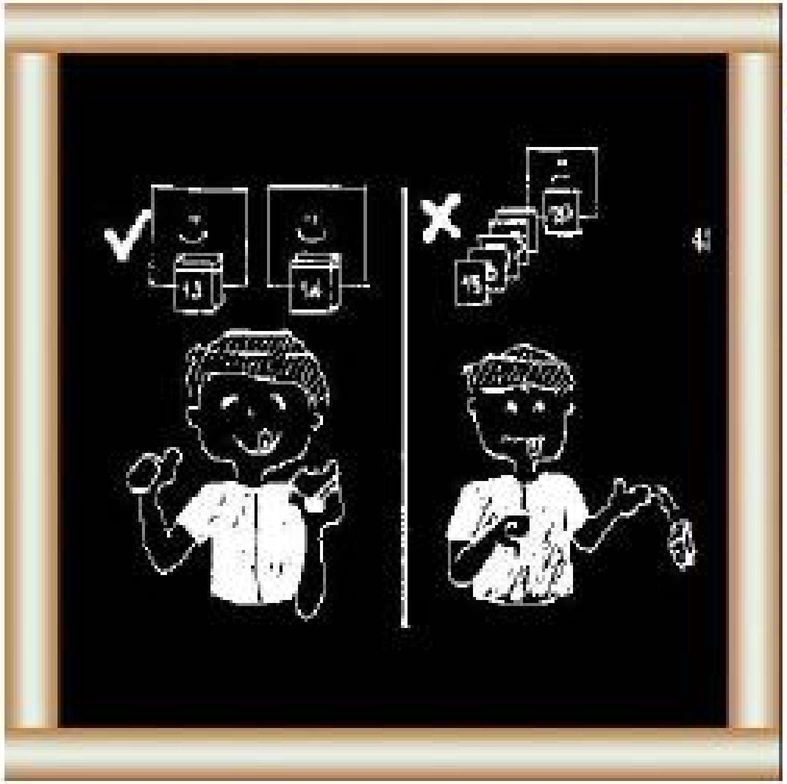
What are the keeping qualities of cheese?



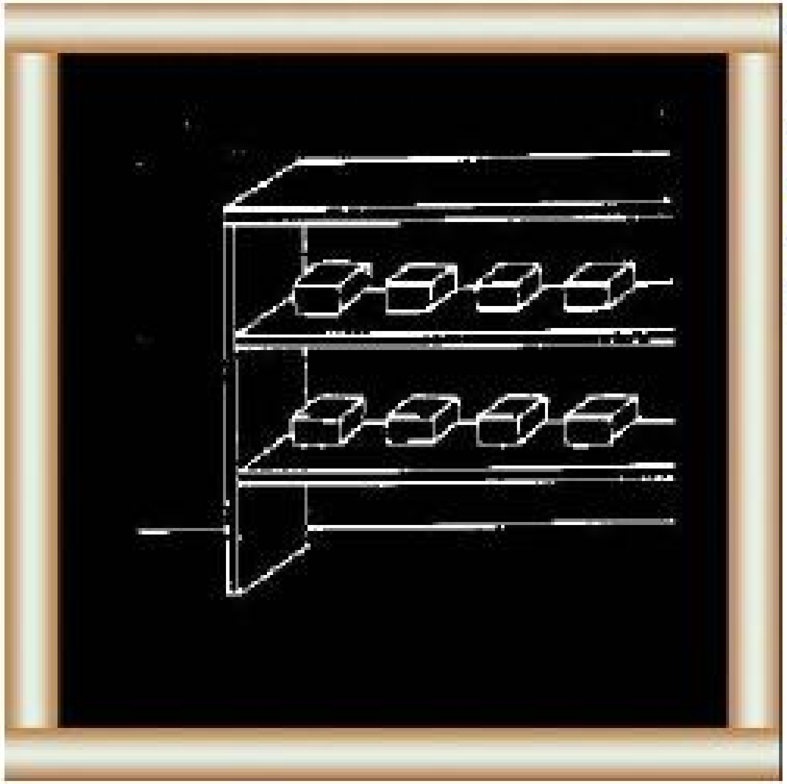
47 Making cheese from milk is one method of preservation.



48 Fresh and soft cheeses are very perishable and you should eat them within 1-2 days.

49 You can keep them longer by salting heavily.

50 You can keep semi-hard cheeses



for 3-4 months.

Cheeses which are ripening should be kept in a cool place at 10-15 C until they are ripe, not in a refrigerator.

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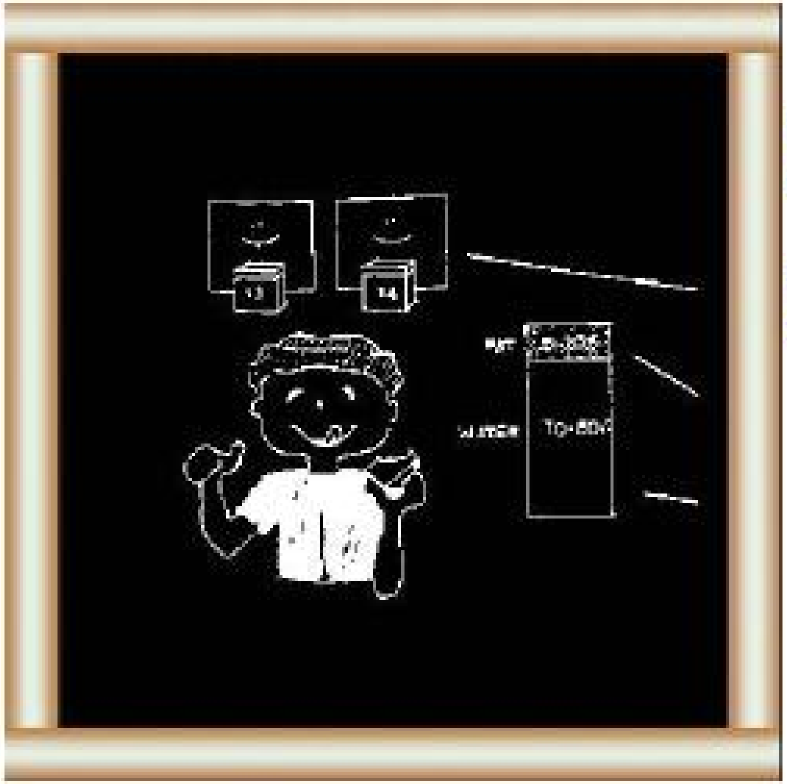
What is fresh cheese?

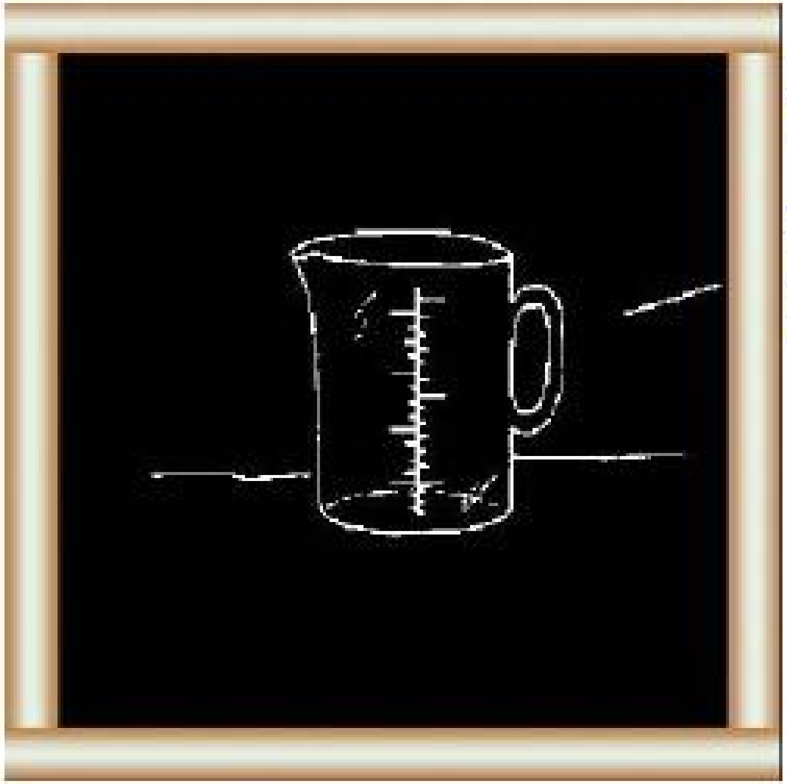


51 Fresh cheese is cheese you can eat immediately after making.

It has a high water content (70-80 %) and a fat content of 5-20 %

52 You can keep fresh cheese in a refrigerator (4-6 C) for 1 to 2 weeks.

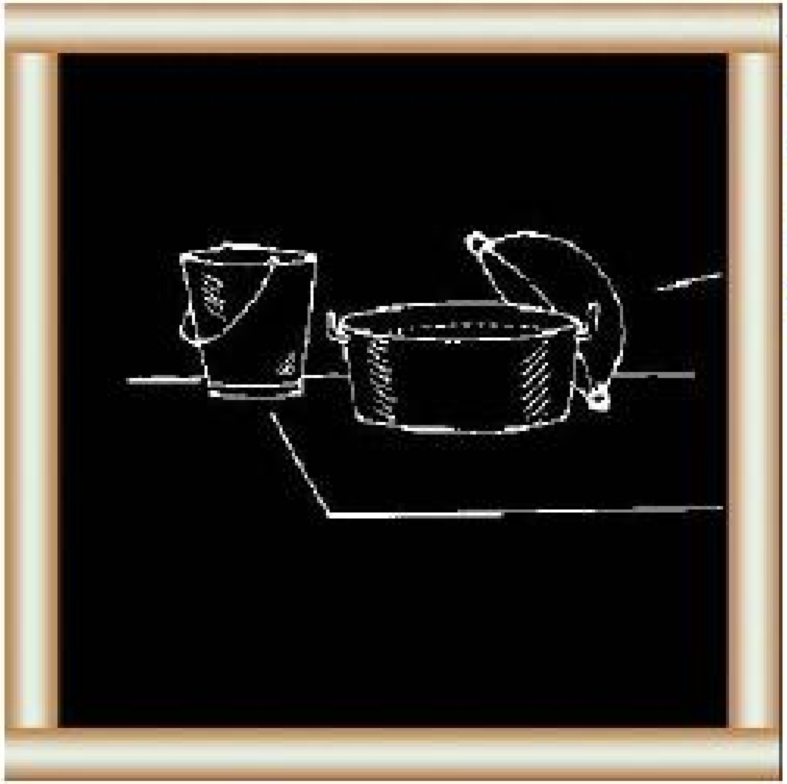
What equipment do you need to make fresh cheese?
Important: All equipment should be stainless steel and must be clean.



53 A measuring beaker made of glass or stainless steel.

Try not to use plastic as it is difficult to clean and absorbs smells.

54 A cheese vat:



- you can use a pan or a bucket made of stainless steel or aluminium.

Do not use iron or zinc as these can corrode quickly.

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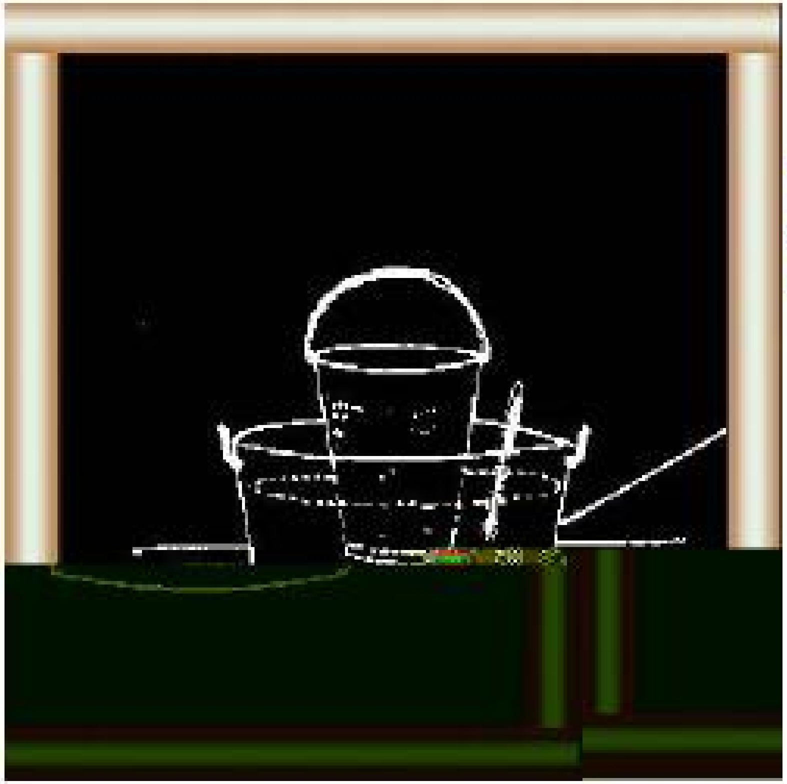
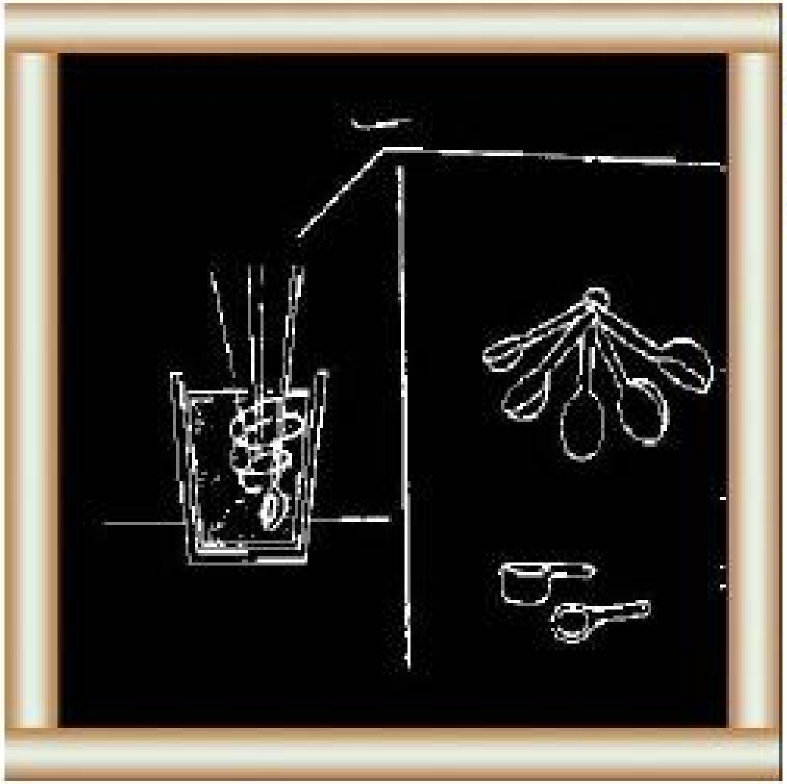


55 A water bath for indirect heating and cooling of the milk/curd in the cheese vat.

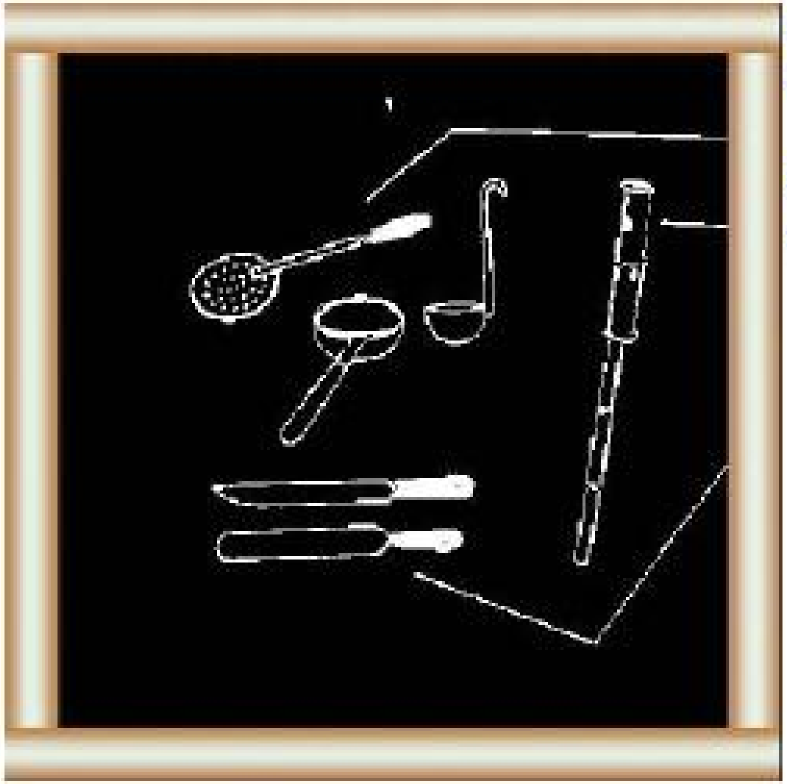
56 A source of heating e.g. gas, wood electricity.

A source of cooling e.g.ice, water.



57 A ladle or long-handled spoon for stirring the milk.

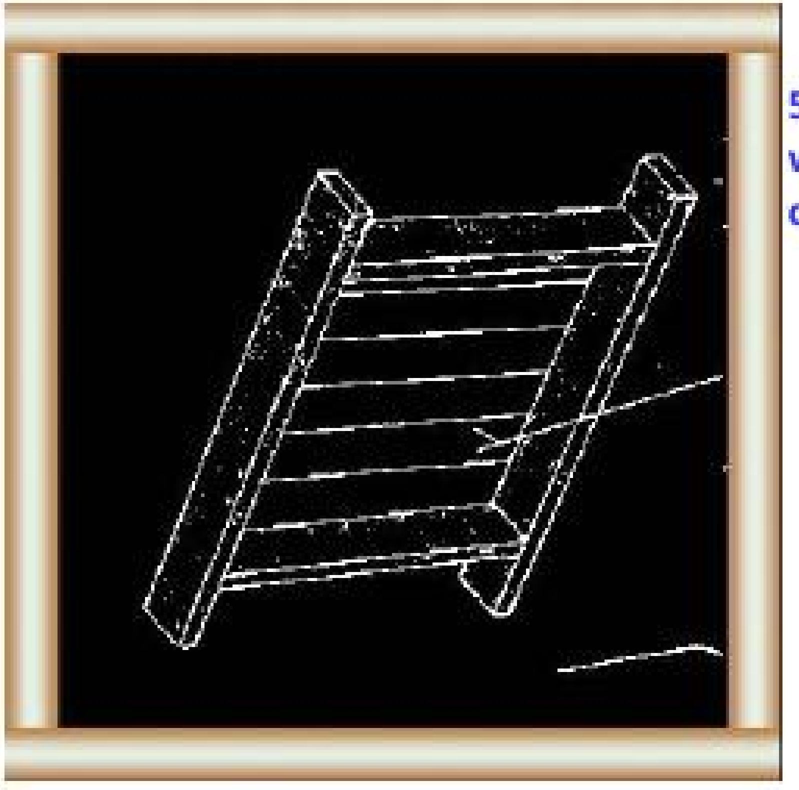
A spoon for measuring the culture.



58 A skimmer for removing curd from the cheese pan.

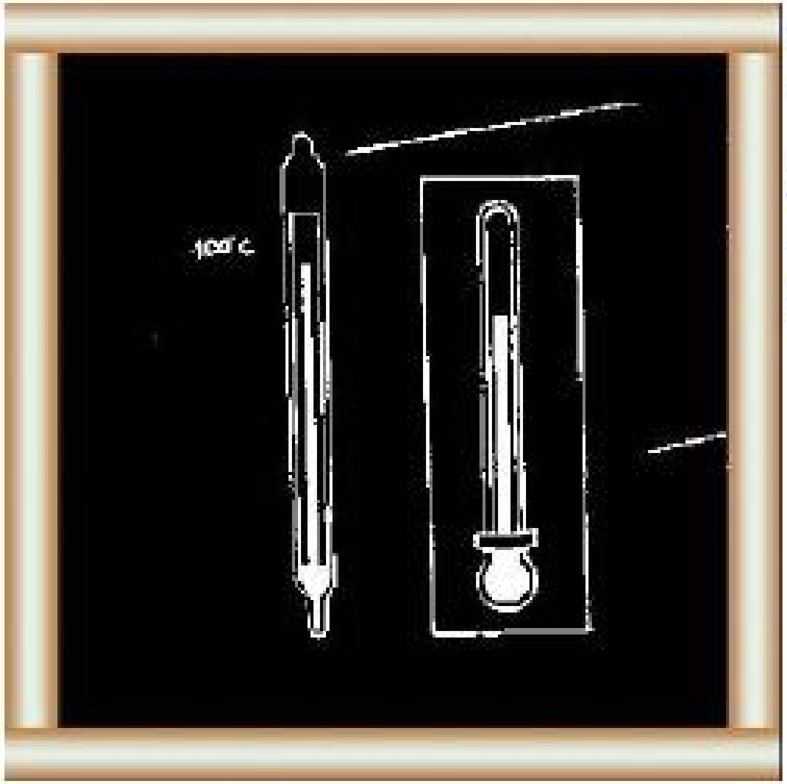
Knives with long handles or split cane bamboo for cutting the curd.

page **252**



59 You can also use a square frame with wires about 15 mm apart for cutting the curd.

60 A thermometer with a maximum temperature of 100 C for measuring

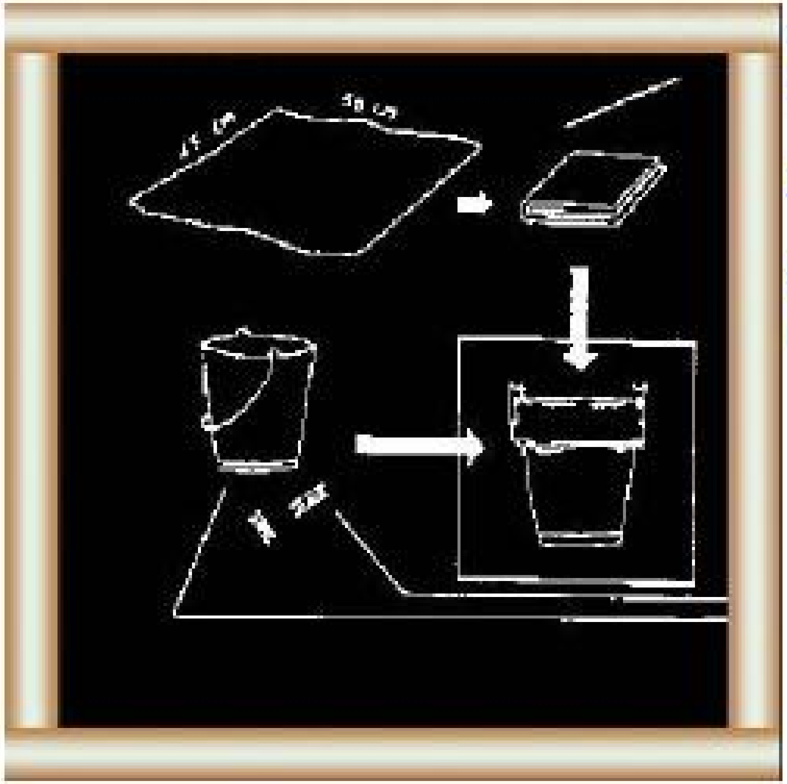


the temperature of the heated milk.

A thermometer for measuring outside temperature for making culture and ripening cheese.

61 A cheese cloth made of fine cotton for draining off the curd.

It should measure about 45 x 60 cm



and you should use it folded double.

A bucket for collecting the whey.

Clothes pegs for holding the cloth over the bucket.

62 A sieve or colander made of

stainless steel or plastic for draining the curd.

Wooden draining board on which to place the cheese mould while it drains.

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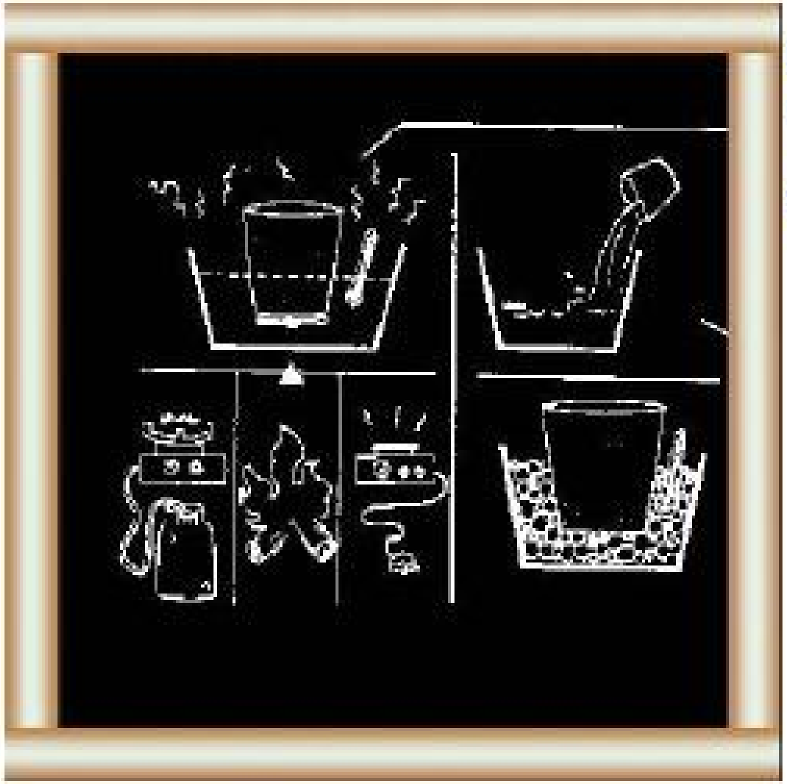
How can you make fresh cheese?

63 Prepare your equipment and collect the materials you need:

- milk
- starter culture
- rennet
- flavours.



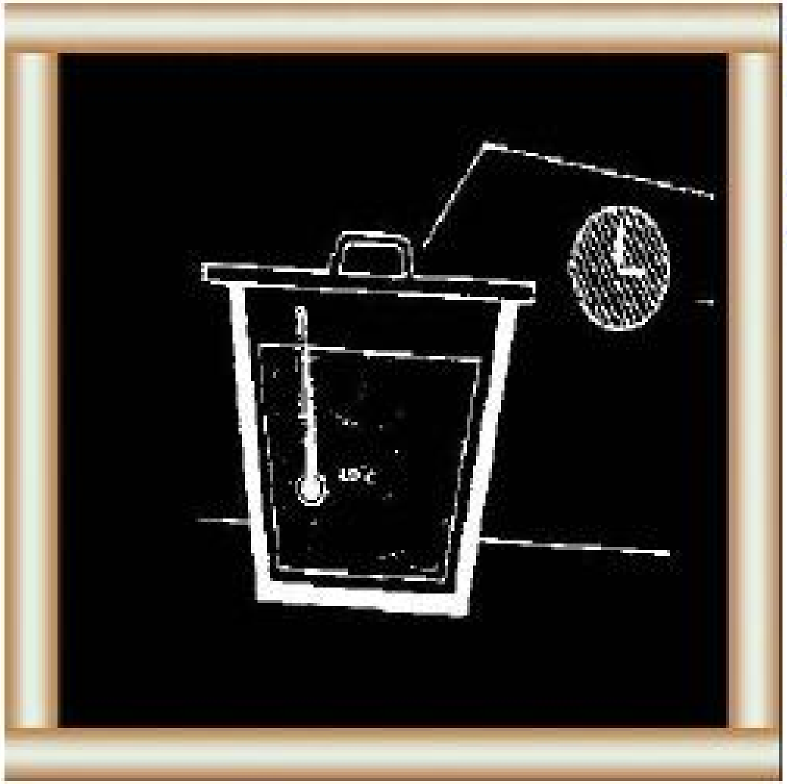
64 Heat the milk to 63 C for 30 minutes.

Then cool to 20 C

65 For each 10 l of milk:

- add $^1/_2$ l mesophyllic starter culture

- add rennet according to the instructions on the bottle or packet.



66 Cover the milk and leave the milk to stand for 24 hours at 20 C.

In this time the milk sours and curdles.

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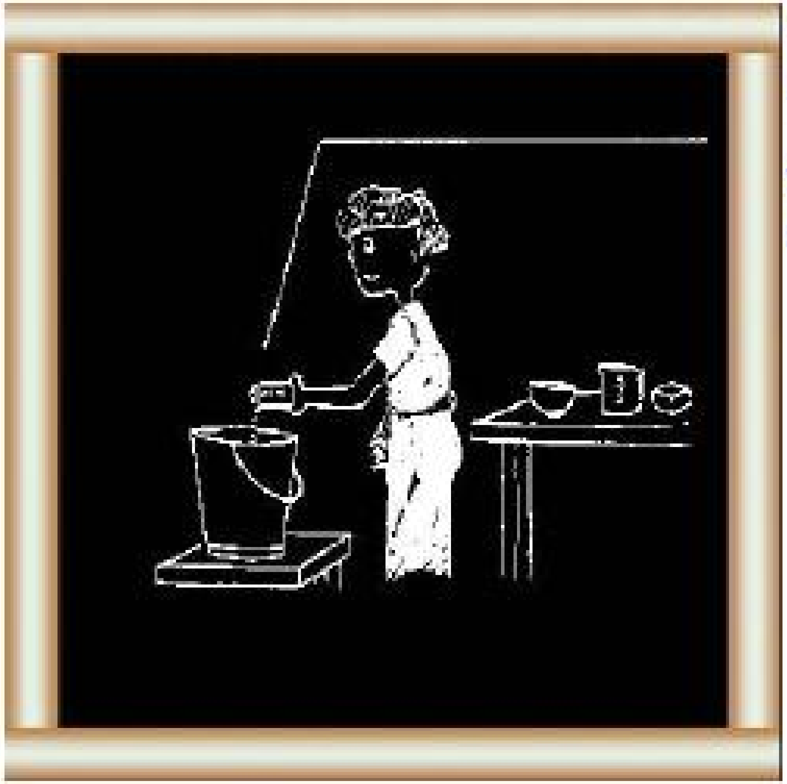
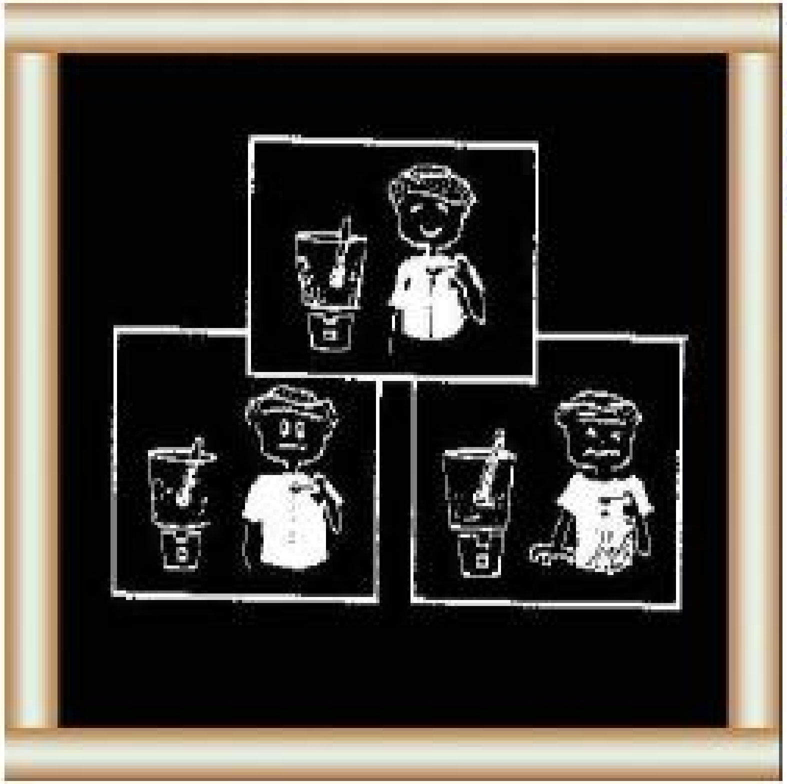
67 Rennet works well with warm milk but does not work at temperatures above 55-60 C.

68 Rennet works better with milk which is slightly sour (acid).



69 You must add the right amount of rennet.

Too much rennet (or too high a temperature) makes the curd soft.



70 You can make your cheese hard or soft by changing the temperature and the sourness of the milk when you add rennet.

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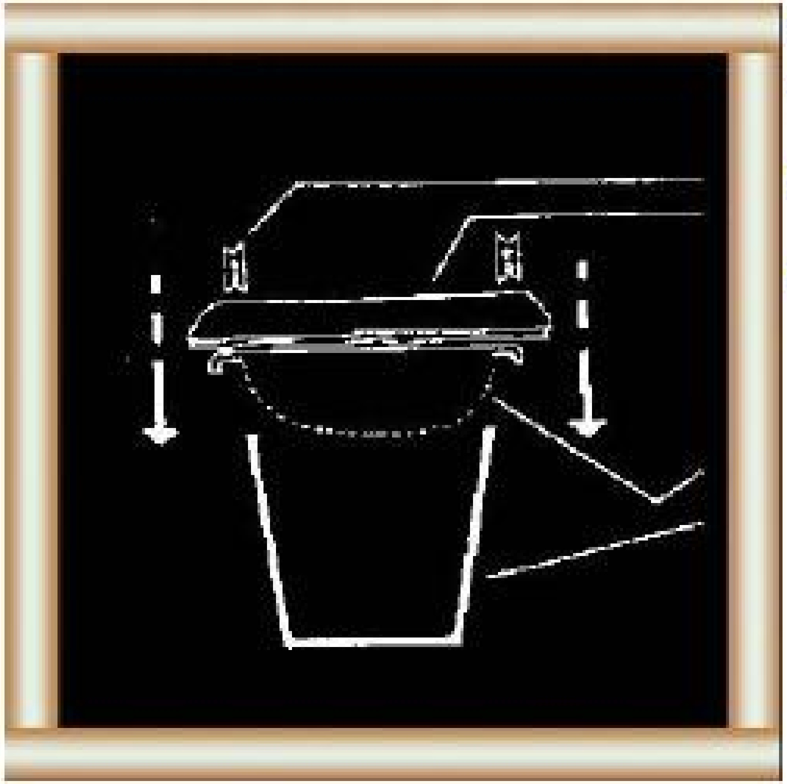

71 Spread a clean cheese cloth over a sieve.

Fit into a bucket.

Fix with clothes pegs.

72 Put the curdled milk on the cheese cloth.

The curds remain on the cloth and the whey filters through.

73 After another 24 hours, most of the whey filters through.

74 Put the curd in a cheese vat and stir well.

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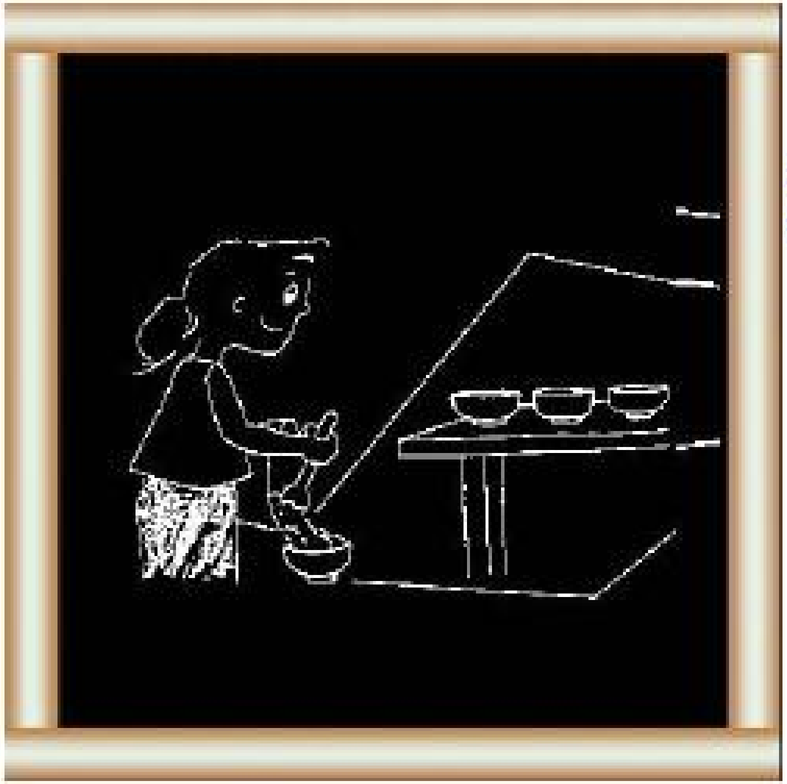
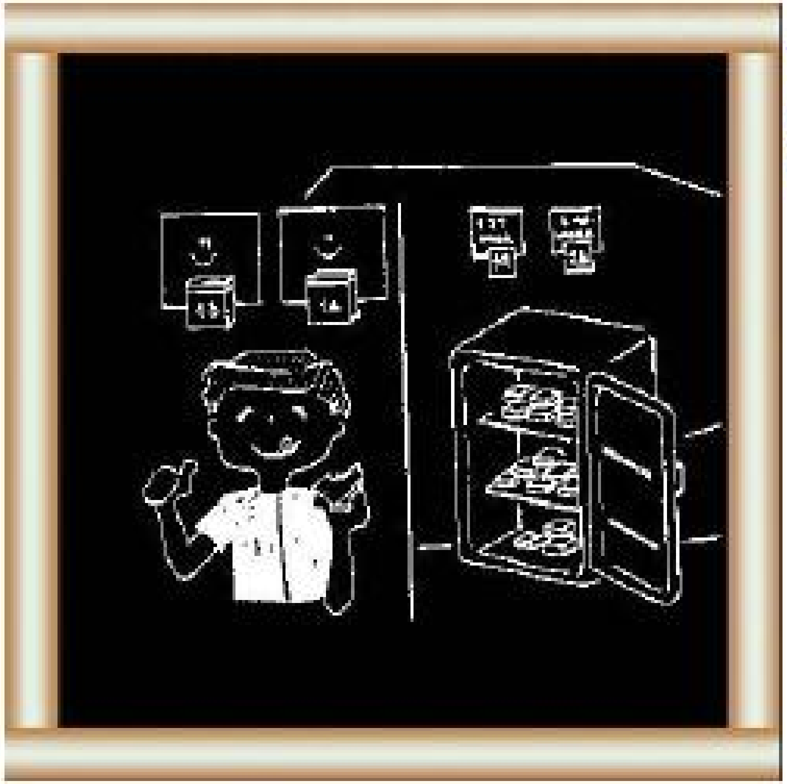


75 Transfer the fresh cheese to bowls or small containers.

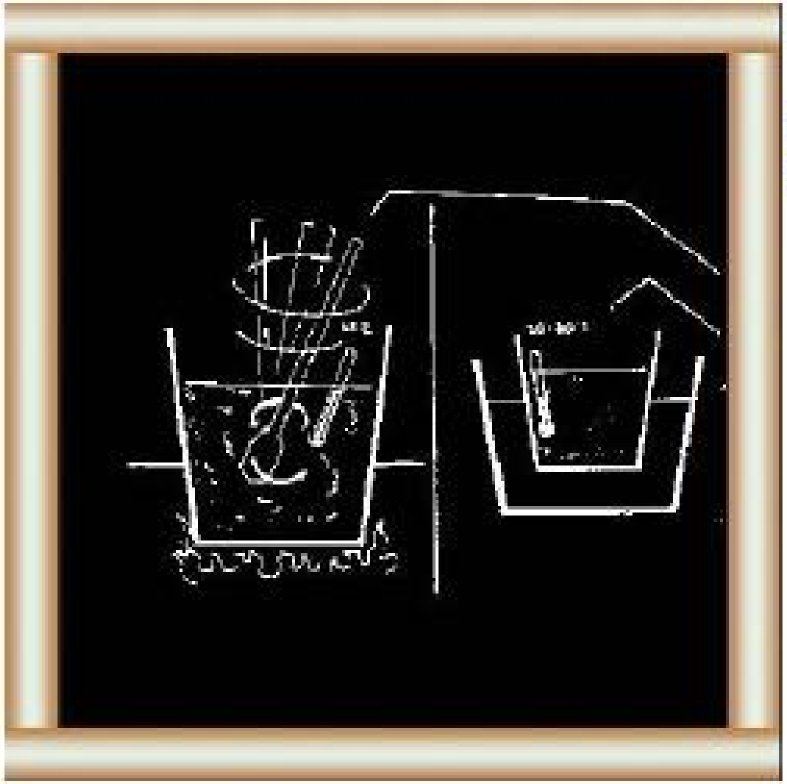


76 You can eat the cheese immediately or keep it in a refrigerator for 1-2 weeks.

What can you do if you have no starter culture?

77 If you cannot get starter culture, you can use acid from fruit or vinegar.

78 Pasteurize the milk at 63 C for



30 minutes.

Stir all the time.

Cool to 20-30 C.

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79 Add the lemon juice (or vinegar, citric acid) until the milk curdles.

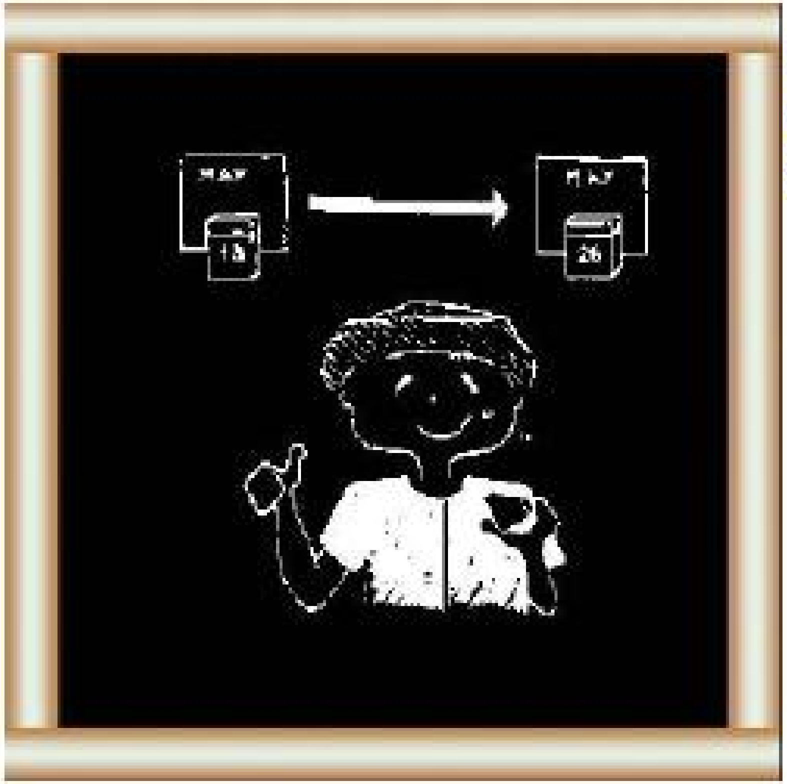
80 Put the curdled milk into a

cheese cloth and let the whey filter through for about 6 hours.

The outside temperature should be cool.

Can you add flavours to fresh cheese?

81 Yes, you can add flavours such as salt, curry, chili, garlic or other herbs and spices.



82 Adding chili or garlic flavours may help you to preserve fresh cheese.

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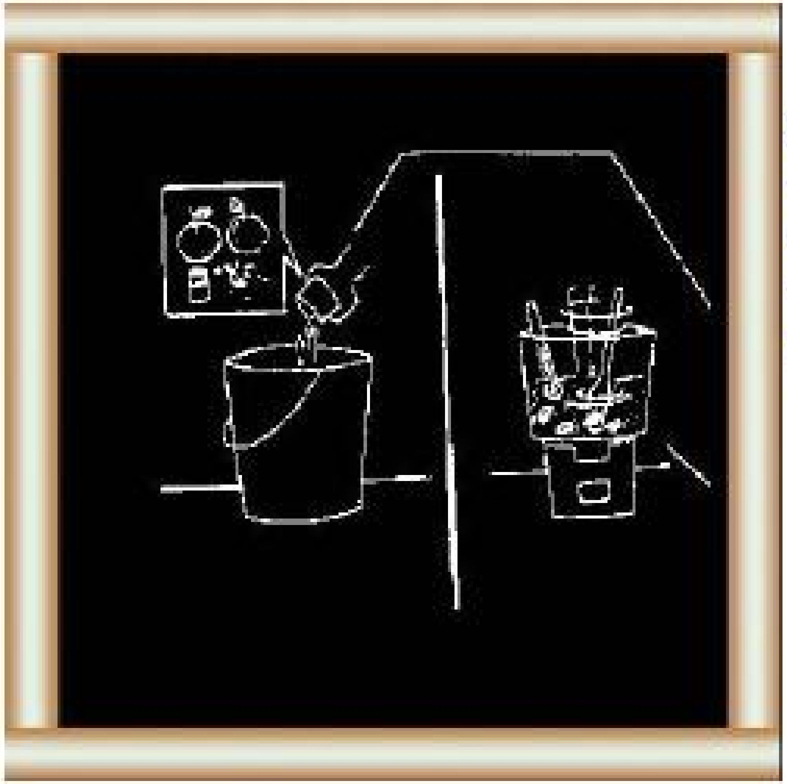
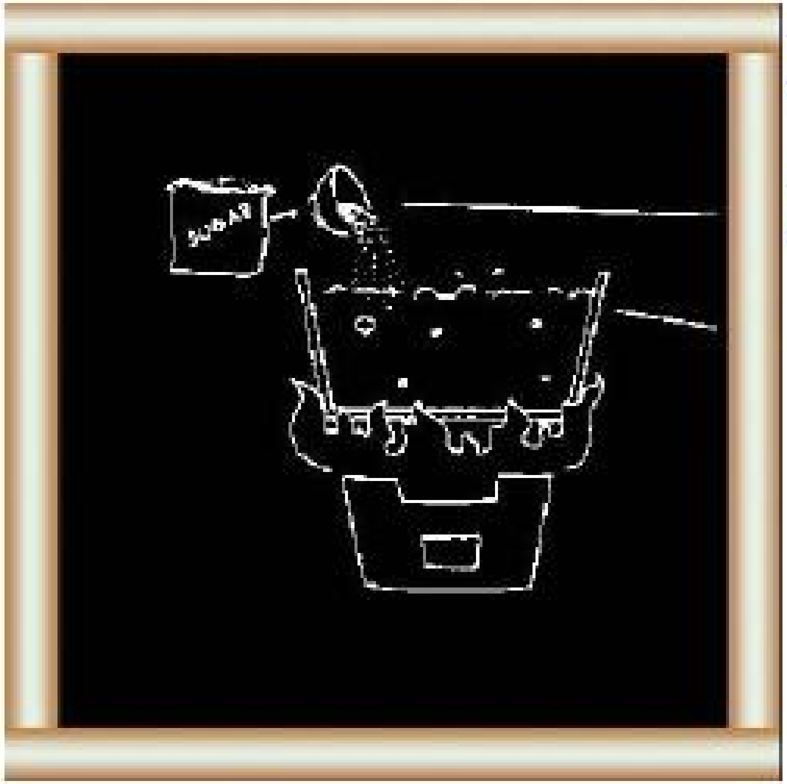
What can you do with the whey?



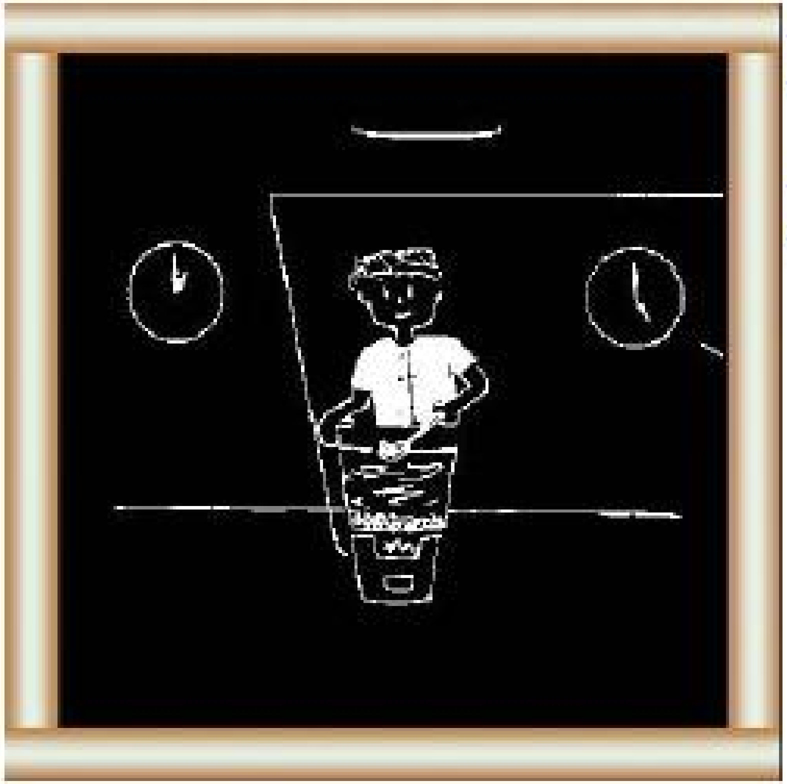
83 Make a tasty drink by:
- adding fruit juice or herbs to the whey
- soaking or cooking grain, pulses or dried fruit in the whey.

84 Make cheese (mysost) by:



- cooking the whey in a pot with a cup

- adding sugar, cloves or cumin for flavour



- lowering the heat when the whey thickens

- gentle cooking for about 5 hours until the whey is nearly solid

86

- putting the nearly solid, brown cheese into cold water.

1 l of whey gives about 200 cc of cheese and you can keep it for a long time.

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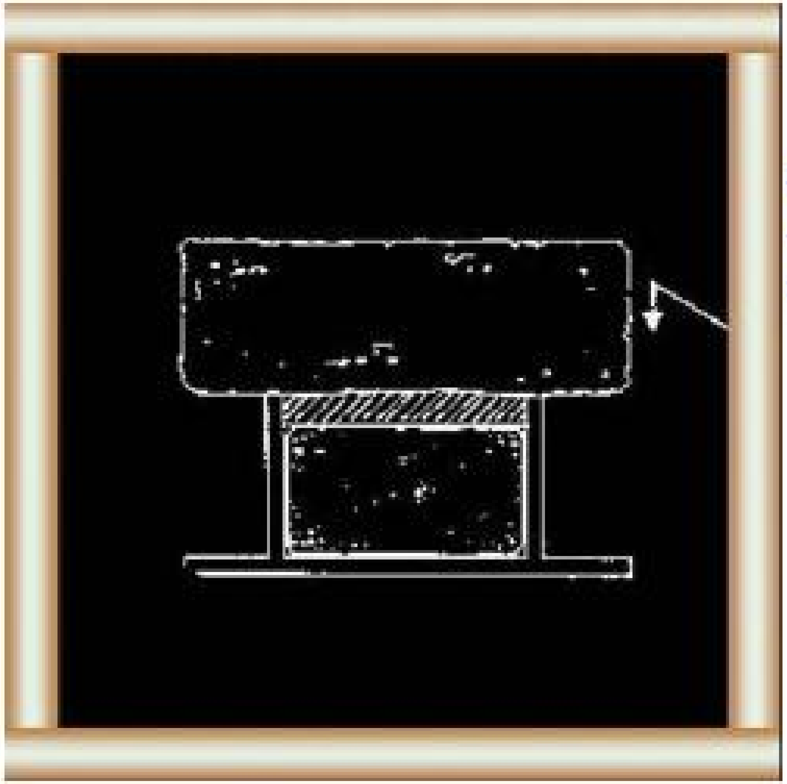
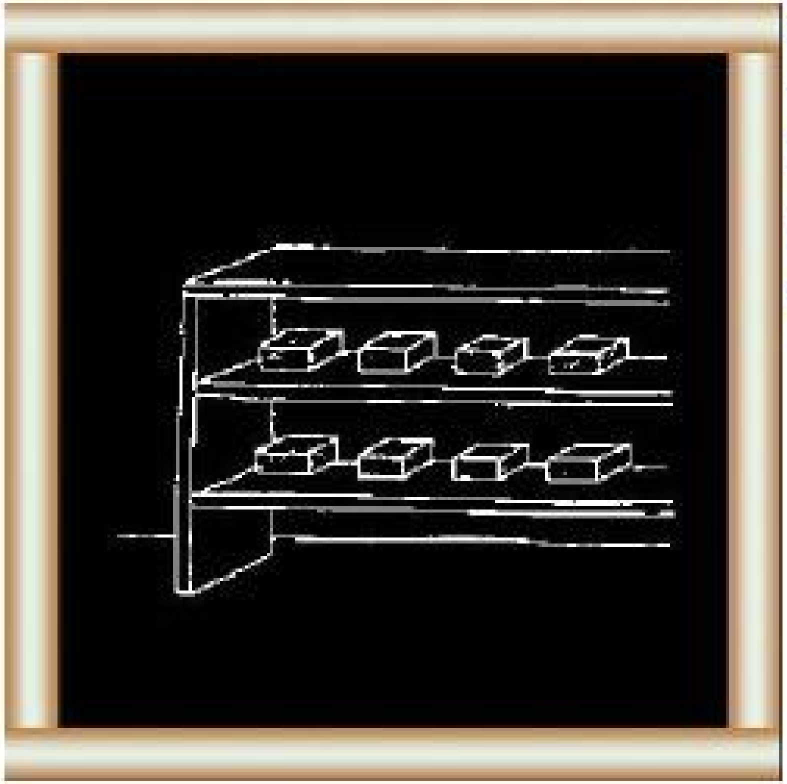
What is a semi-hard ripened cheese?



87 It is a cheese where:
- you press the fresh cheese for a short time

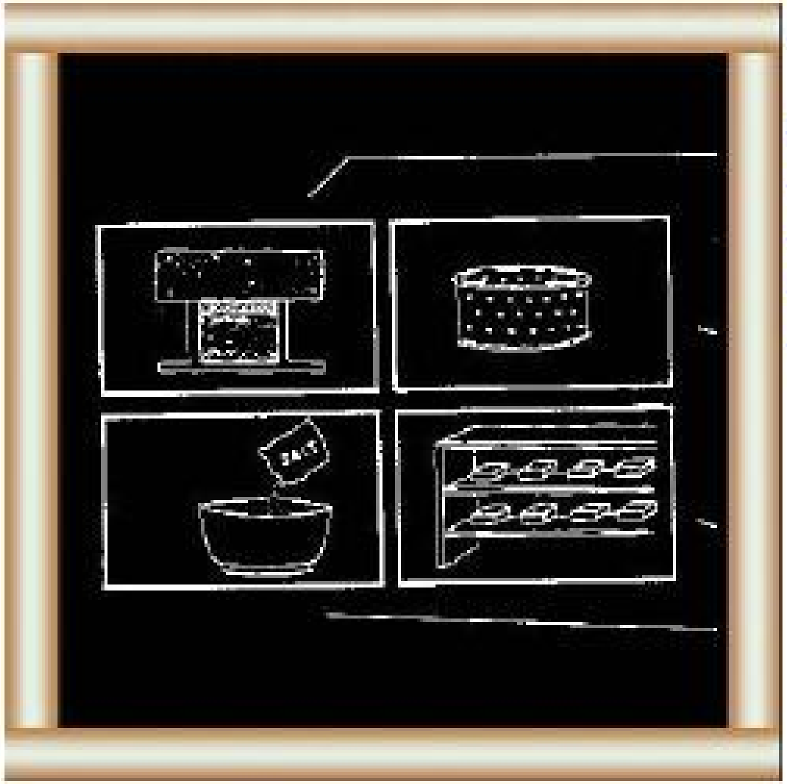


88

- and then store the fresh cheese to ripen.

It has a water content of 40-50 % and a fat content of 20-35 %.

What other equipment to you need to make a semi-hard ripened



cheese?

89 You need equipment for:

- moulding
- pressing
- salting
- ripening.

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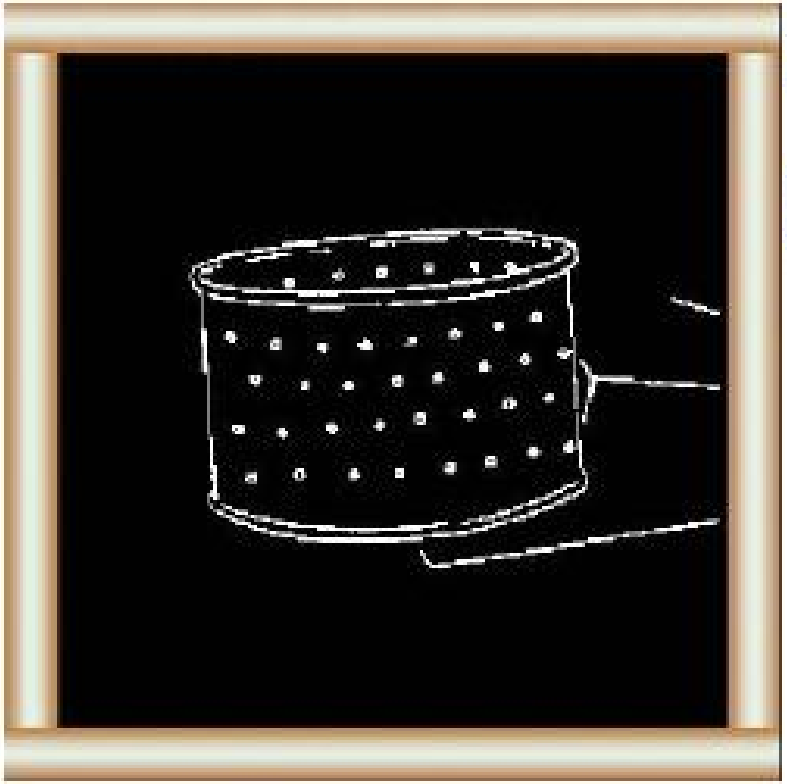
90 You need cheese moulds:

- a flowerpot with holes in the bottom

91

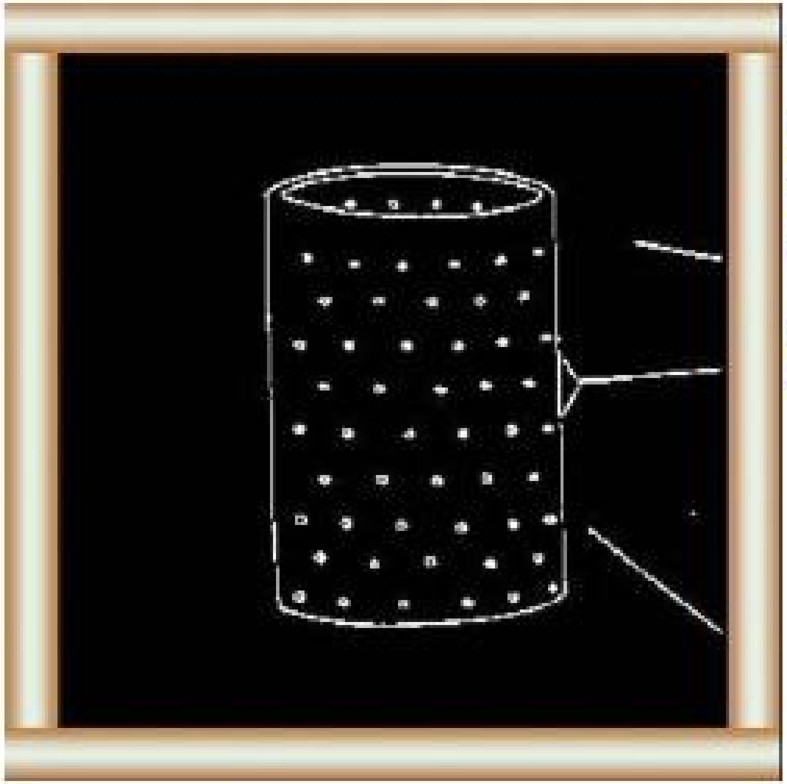


- a cake tin with no bottom and holes in the side

(do not use it for long or it will begin to rust)

92

- a plastic tube with holes in the



side

(do not use plastic tubes from building work as these contain poison).

Important: If possible, make holes from the inside to the outside.

93 Make the edges of the holes

smooth so they do not tear the cheese and it is easy to get the cheese out.

Cheese mould with a lid made from a wooden barrel.

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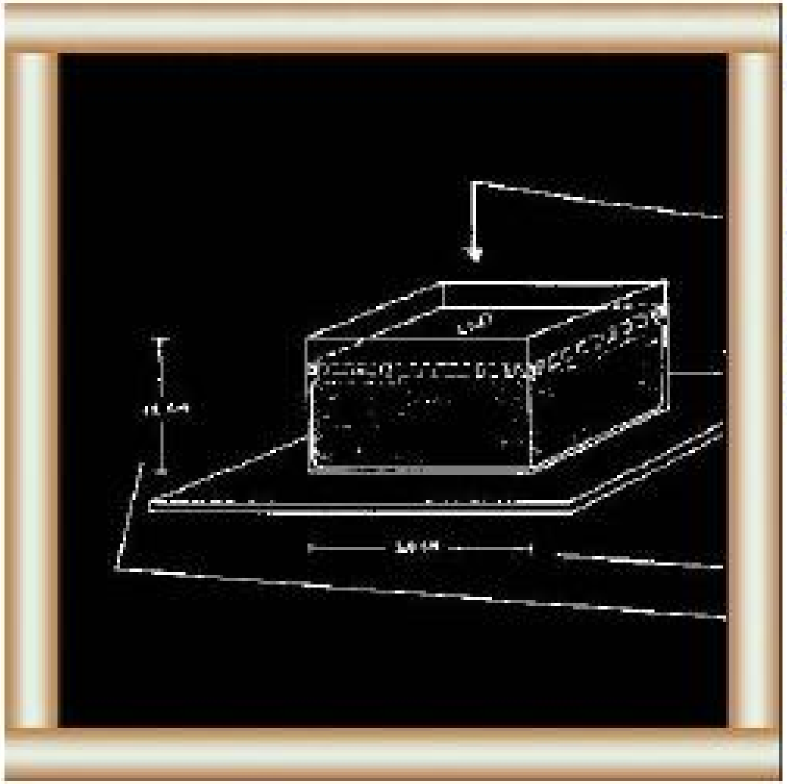
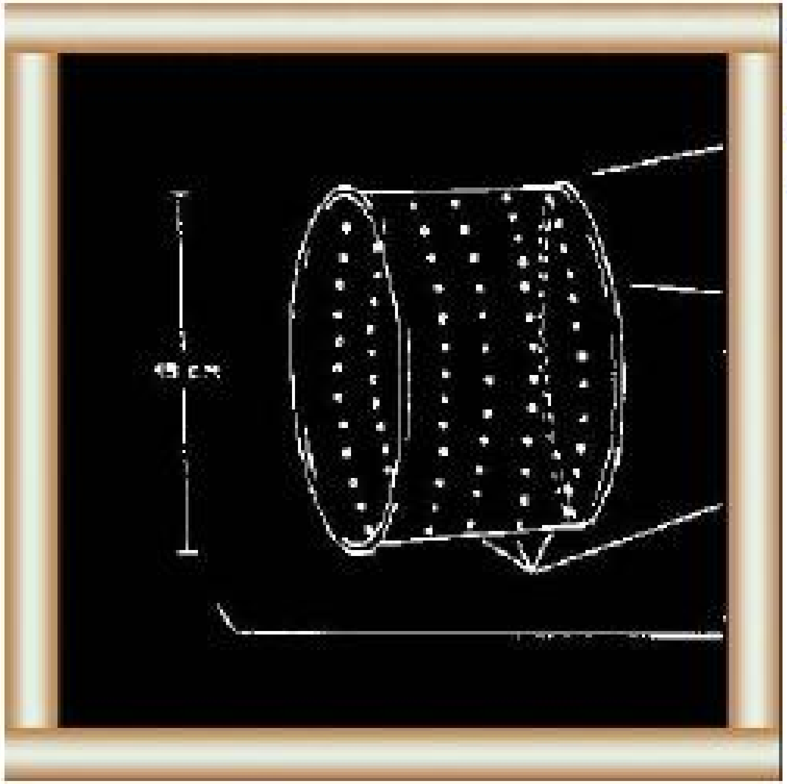
94 You need a cheese press. This cheese mould is made of wooden



planks and is big enough for cheese from 20 l of milk.

It has a lid which is used to press the cheese.
length : 20 cm
width : 20 cm
height : 12 cm

95 This cheese mould is a tin with a

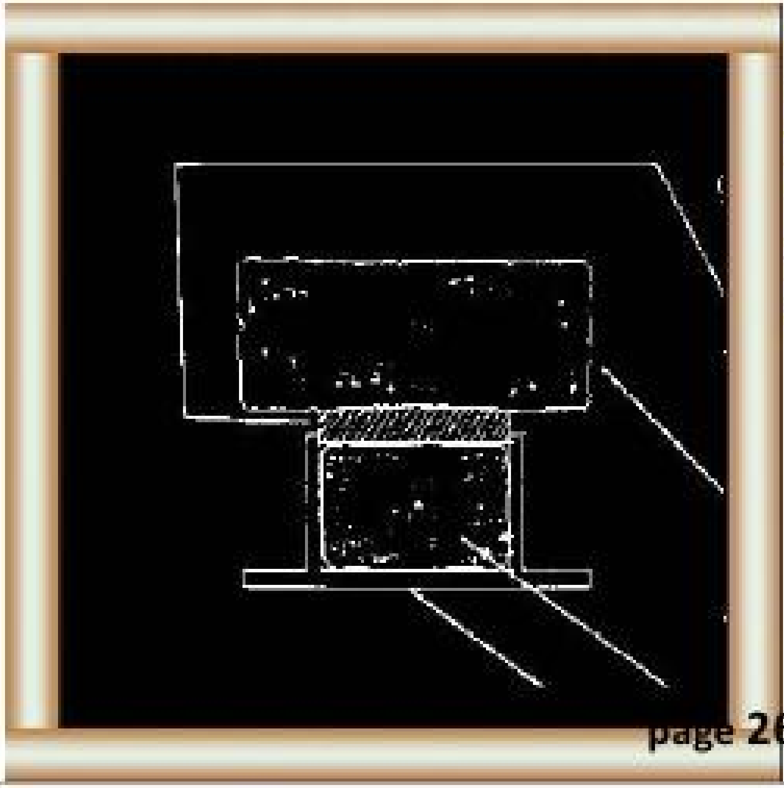


diameter of 15 cm.

It has no ends and holes in the sides.

96 Place:

- the tin on a clean, flat surface



- the cheese inside the tin
- a wooden lid of about 13-14 cm diameter on the cheese
- a large stone on the wooden lid.

This is big enough to press the curd from about 9 l of milk.

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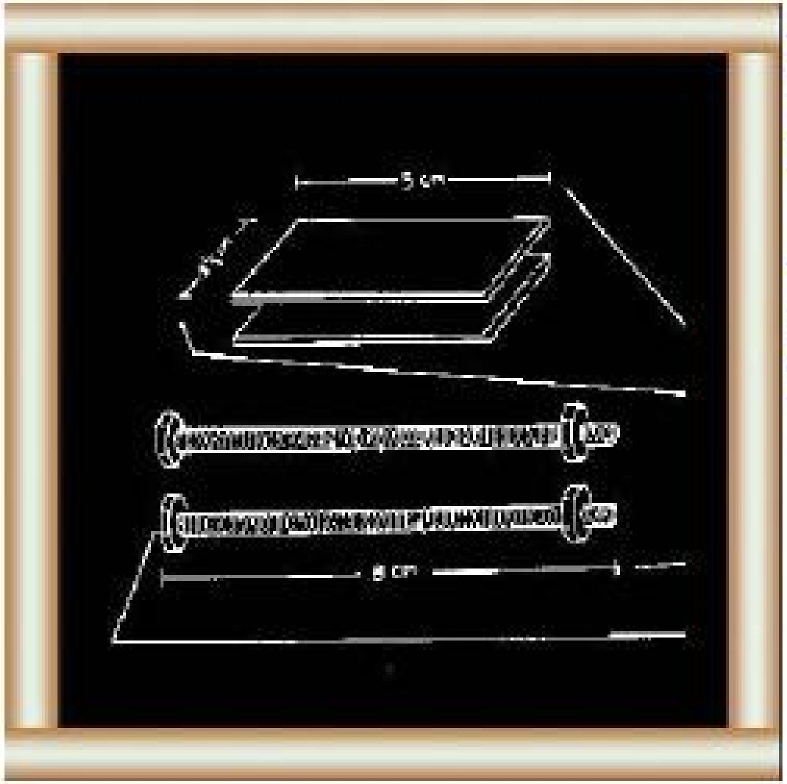
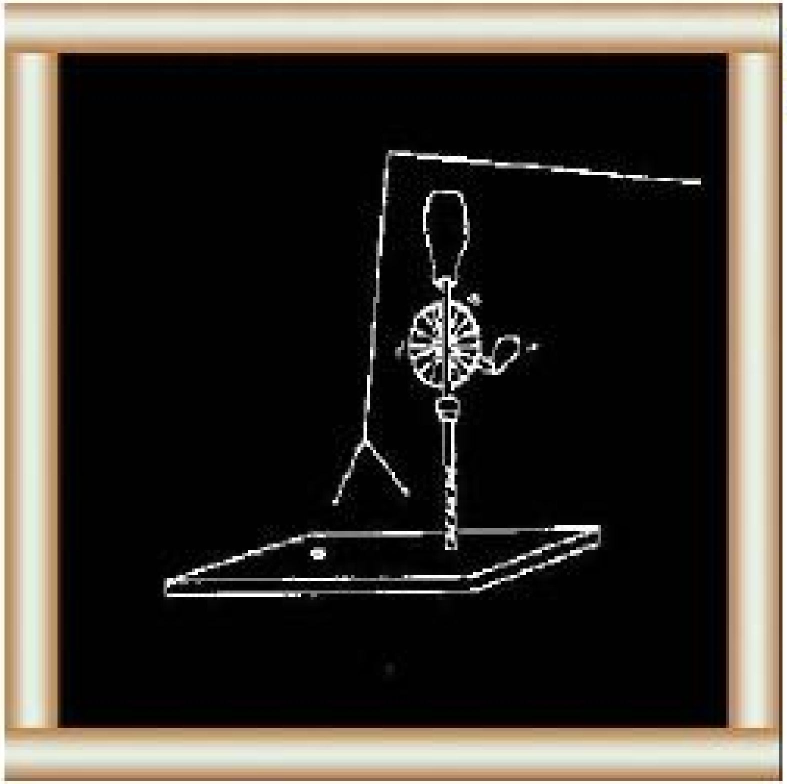
97 You can make a press from the following materials (example measurements):

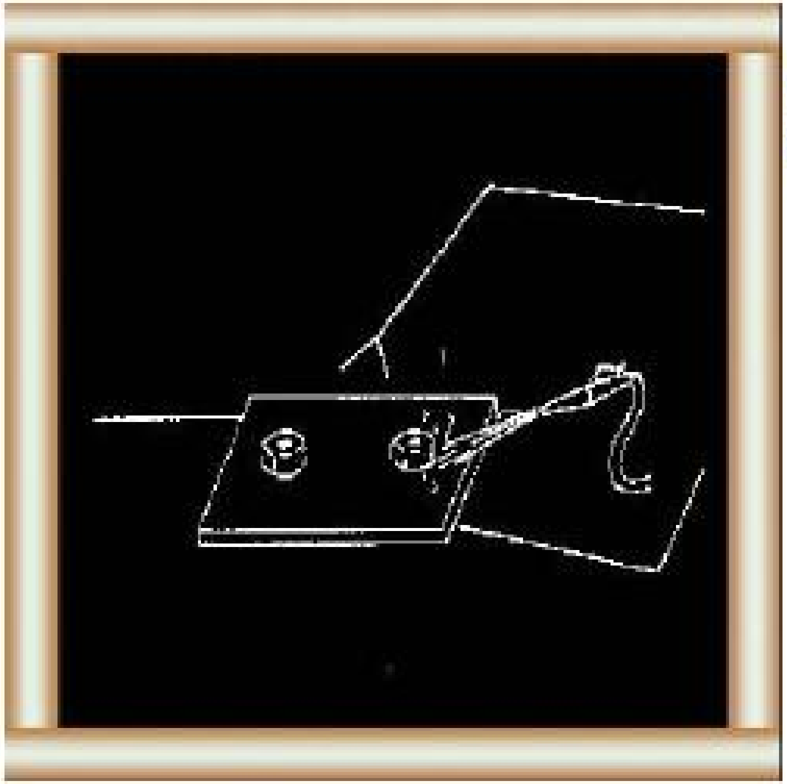


- 2 metal plates 5 cm long by $2^1/_2$ cm wide

- 2 nuts and bolts 8 cm long by $^3/_4$ cm in diameter.

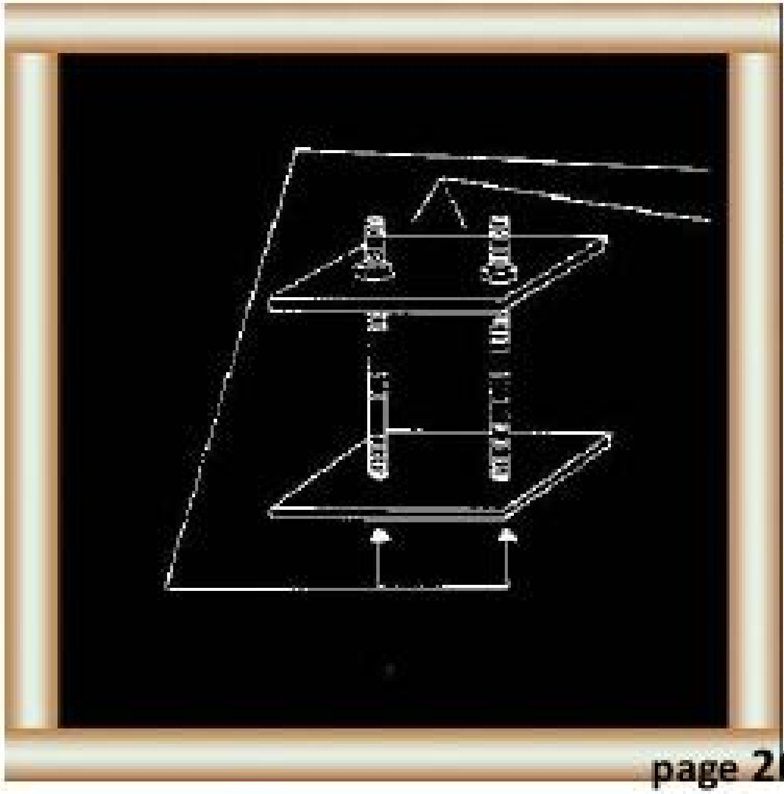


98 Drill two holes in each plate for the bolts to fit through.



99 Weld the nuts over the holes on the top plate.

100 Put the bolts through the bottom plate and screw into the nuts.



The plates can be bigger or smaller as required.

Adjust the pressure often as the cheese shrinks.

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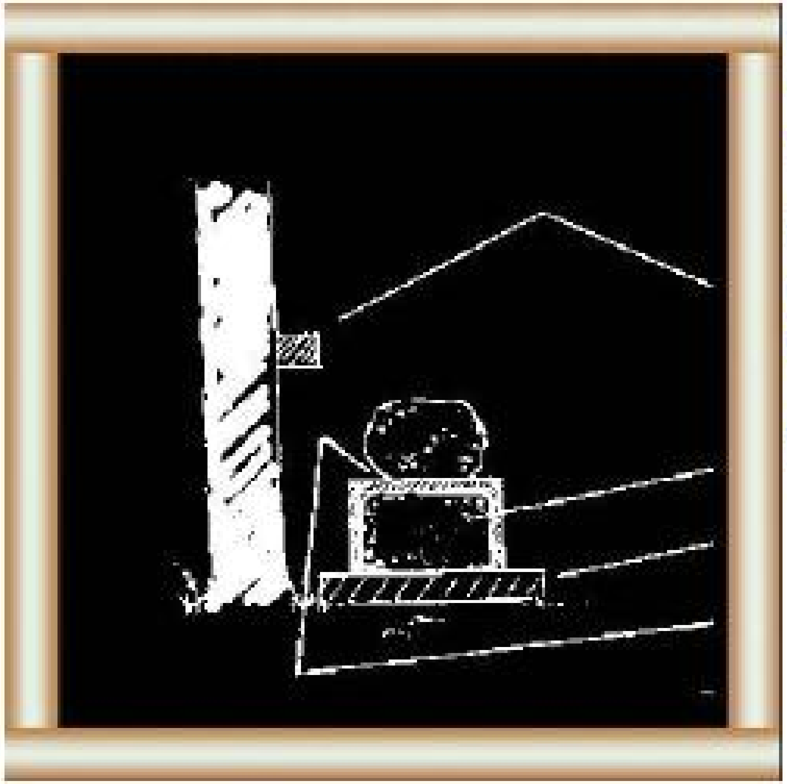
This cheese press works with a



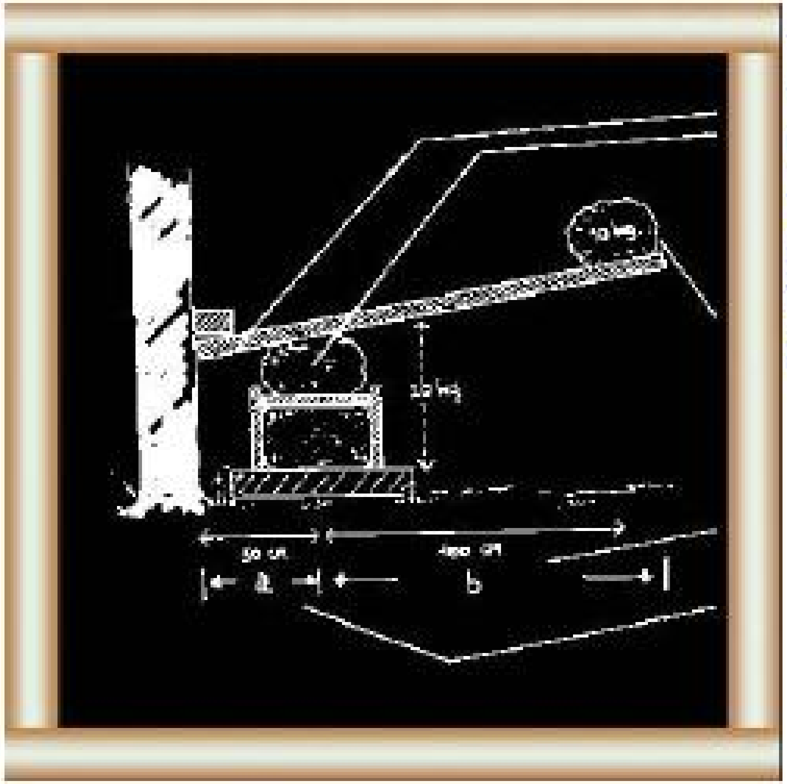
lever.

101 Nail a piece of wood into a tree or wall.

Place the cheese inside a container with no ends and with holes in the sides on a clean flat base.

Put a lid on top.

102 Place:



- one stone on the lid
- a strong pole under the piece of wood on the stone
- another stone on the end of the pole.

The longer b and the shorter a, the stronger your press.

103

If the distances are 50 cm and 100 cm the leverage is 100:50 = 2:1

if the weight of the stone is 10 kg

the press is 10 x 2 = 20 kg.

Important, make sure:

- the materials are not poisonous
- the materials are easy to clean and

disinfect
- the press is strong enough
- you can check the pressure and keep it the same.

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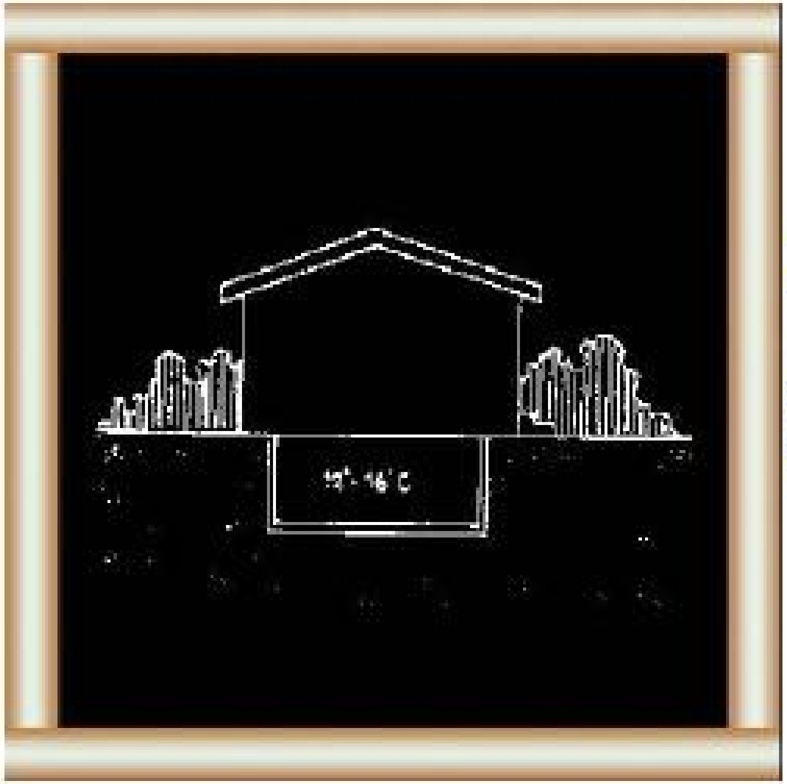
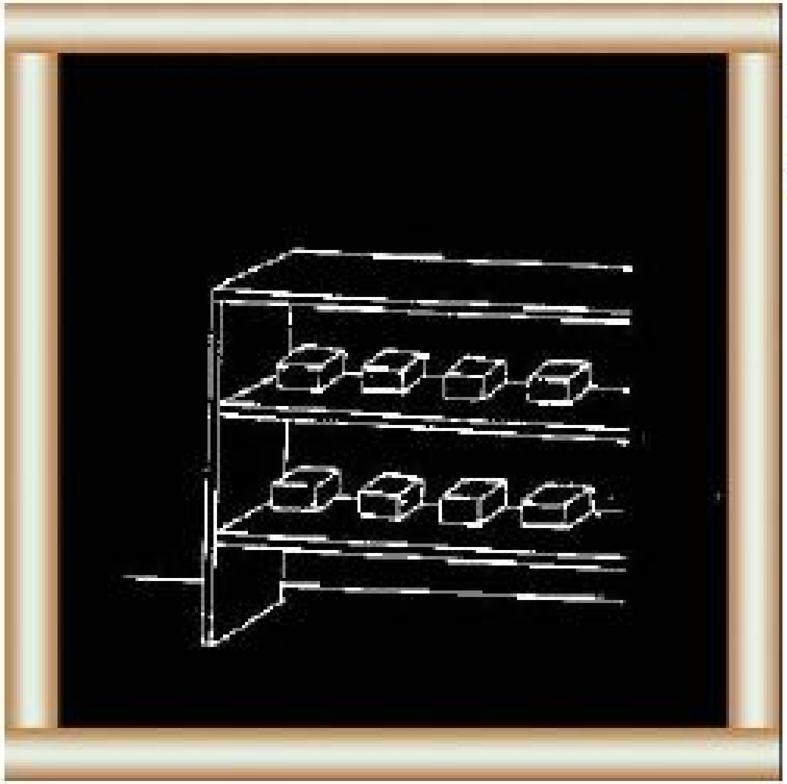
104 You need:
- a brine (salt water) container you can use a plastic bucket or bowl



105
- a place for ripening the cheese

the temperature should be 12-16 C
and it should not be too dry



106
- wooden shelves to store the cheese while ripening

107

- raw milk
- mesophyllic starter culture
- rennet powder or liquid
- salt (NaCl)
- calcium chloride ($CaCl_2$) and

potassium nitrate (KNO_3), optional.

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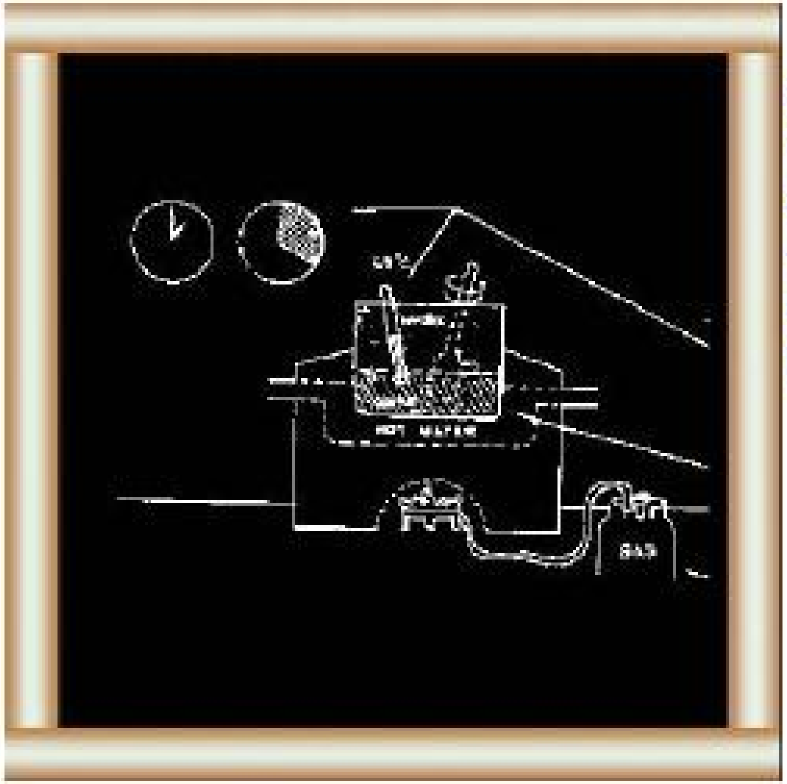
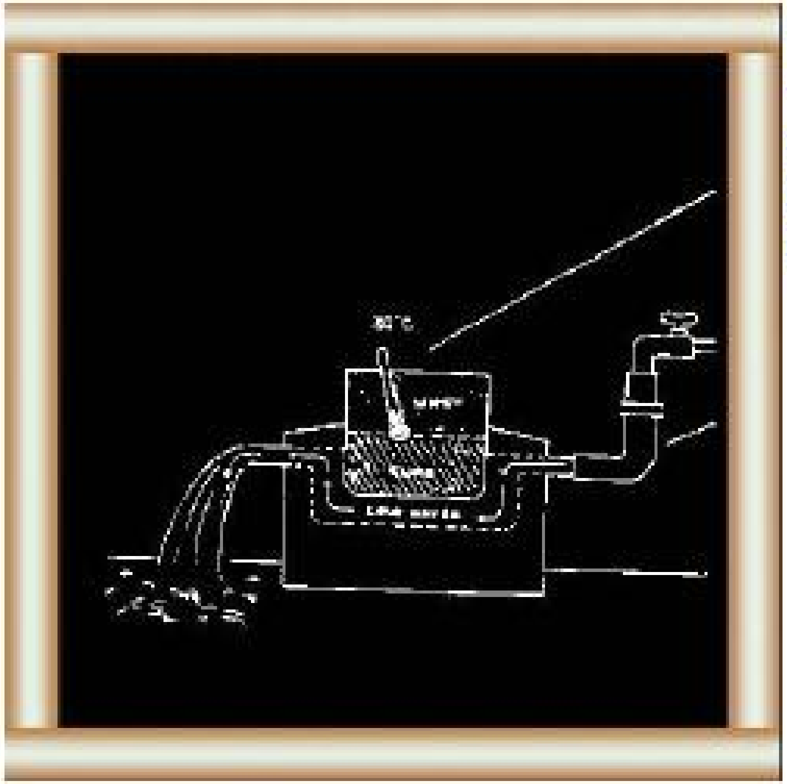
How can you make semi-hard cheesewith 100l of milk?



108 You should:
- pasteurize the milk for 20 minutes
at 65 C
- use indirect heating if possible
and stir all the time
(this heater uses gas)



109
- cool the milk to 30 C by running cold water through the jacket or inserting the vat into a basin with cold water (use ice)

110 (the following is an example but you should follow good advice or instructions)
- dissolve 1.5 g of rennet in a little clean water and add to the milk

- add 1.0 l of mesophyllicstarter culture
- stir well and cover with a lid to make sure the temperature does not fall.

If the rules allow, add 10 g of potassium nitrate (KNO_3).

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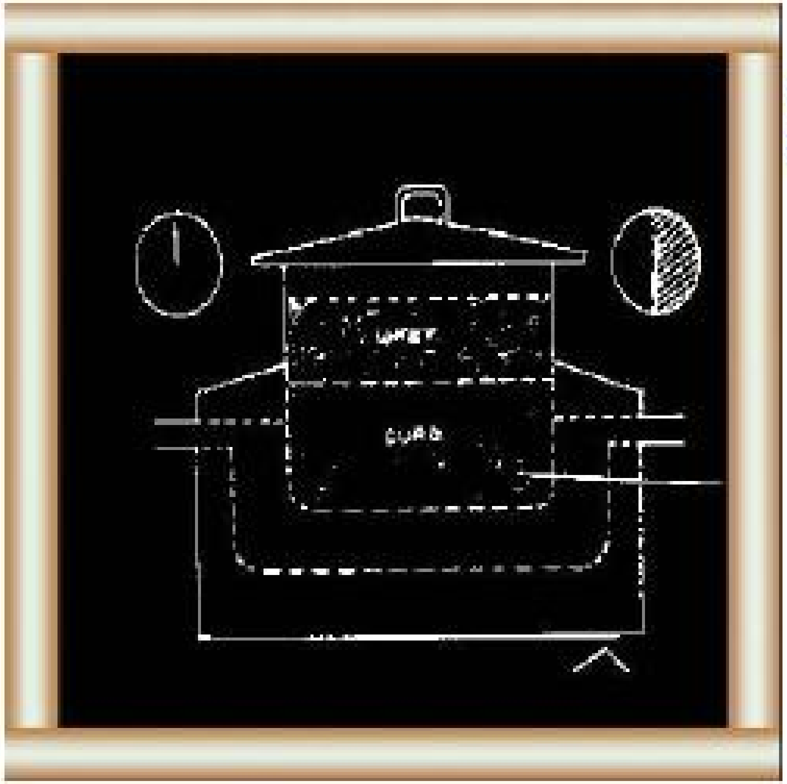
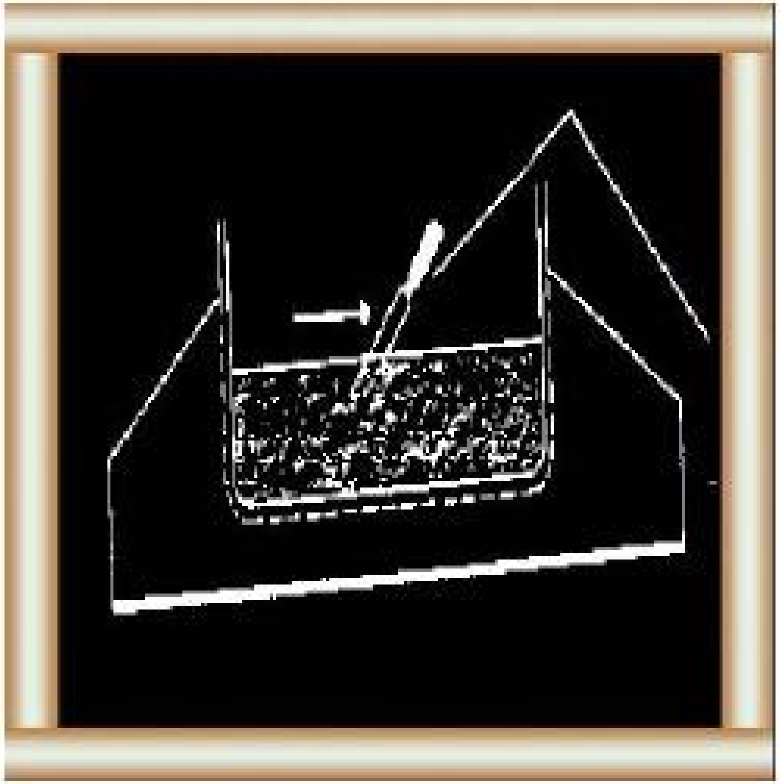
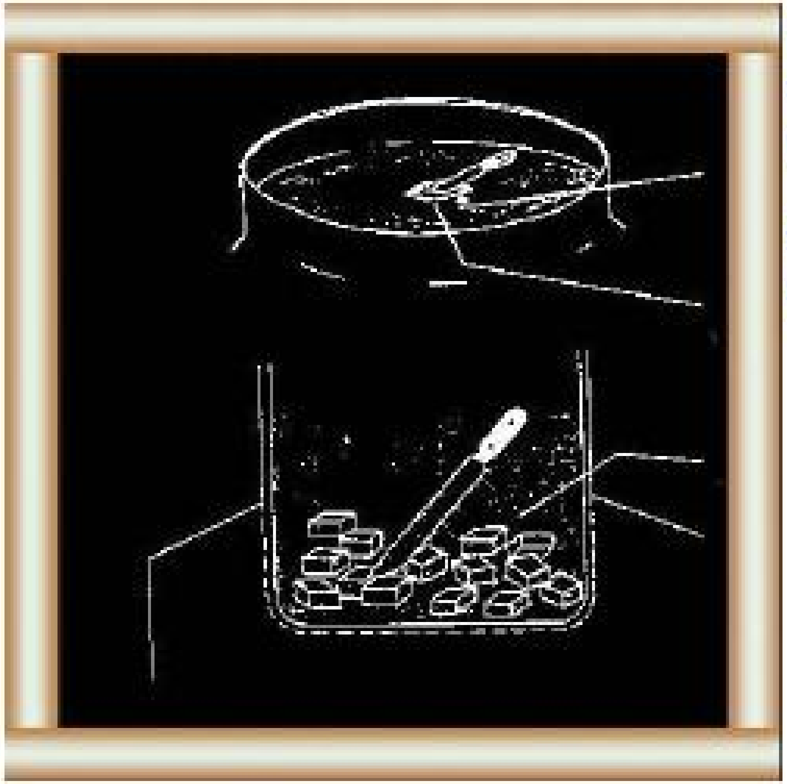


111 Leave the milk for about 30 minutes until the curd is firm.



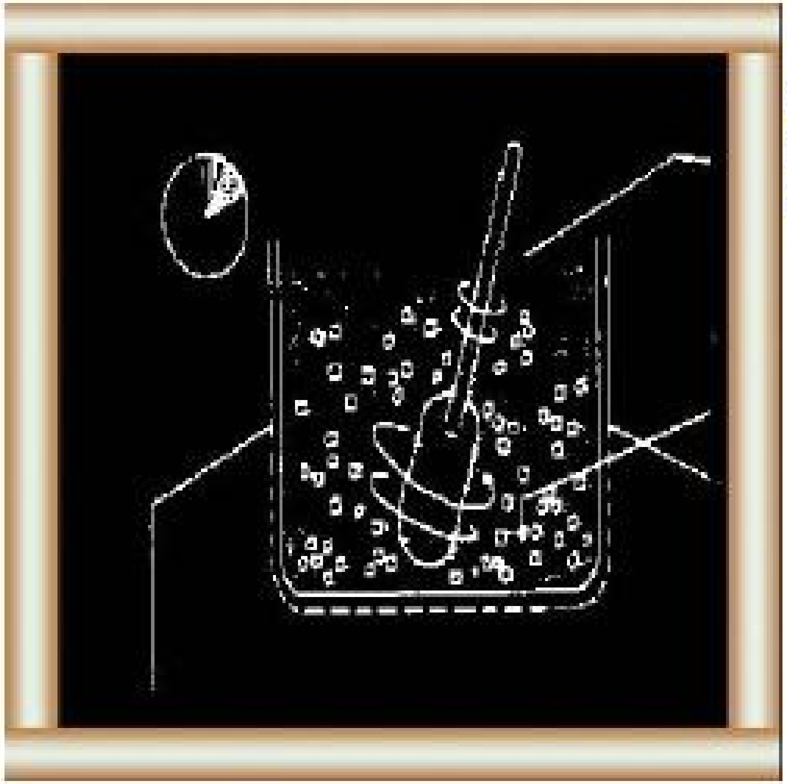
112 To test the firmness in the vat cut the curd with a knife.

Put the knife under the cut and lift up gently.



113 The cut surface should be shiny smooth, yellowish and wet from whey.

Cut the curd into cubes with a side length of 10-15 mm.



114 Wait for 5-10 minutes, then stir the cheese grains gently for 15-20 minutes until they start settling to the bottom.

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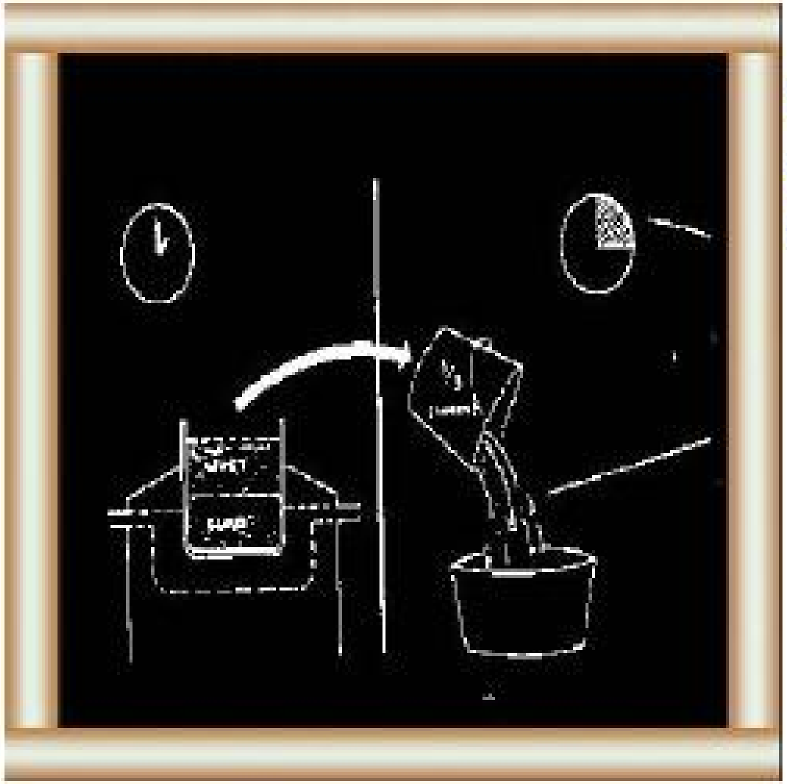
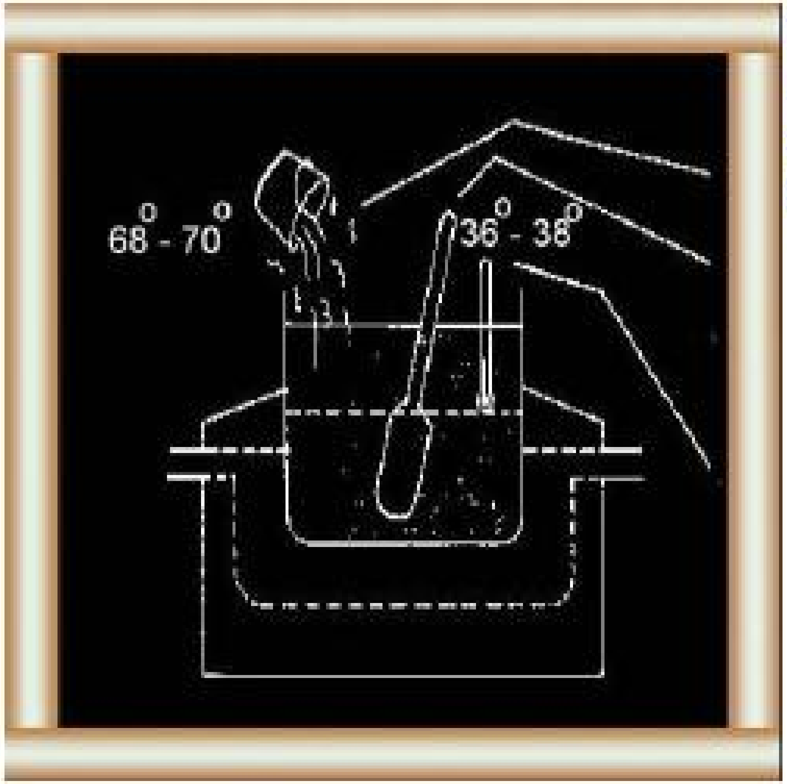
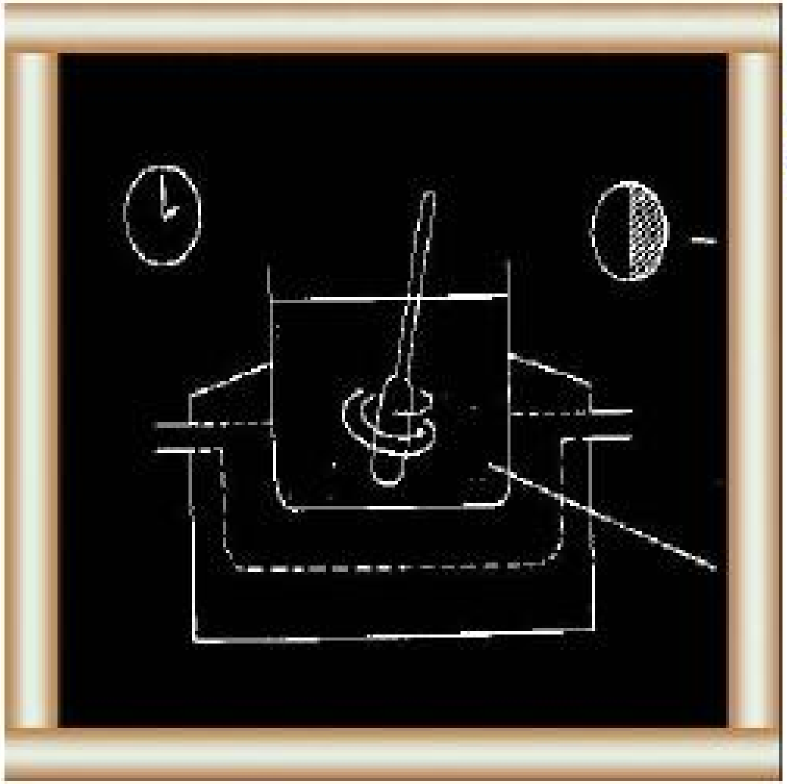


115 Leave the cheese to stand for 15 minutes and then remove $^1/_3$ of the whey.

116 Loosen the curd by stirring.

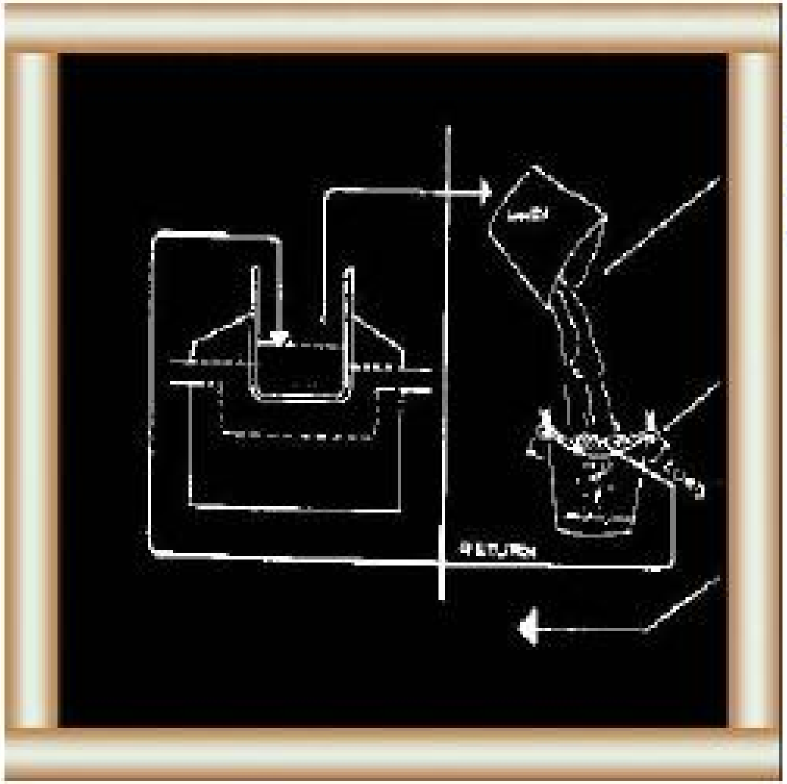


While stirring pour small amounts of hot water at 65-70 C into the cheese until the mixture reaches a temperature of 36-38 C.



117 Keep stirring for about 30 minutes until the cheese grains are firm but not rubbery.

118 Remove the whey to the level



of the curd.

Use a sieve and cheese cloth to catch cheese grains and return to the cheese.

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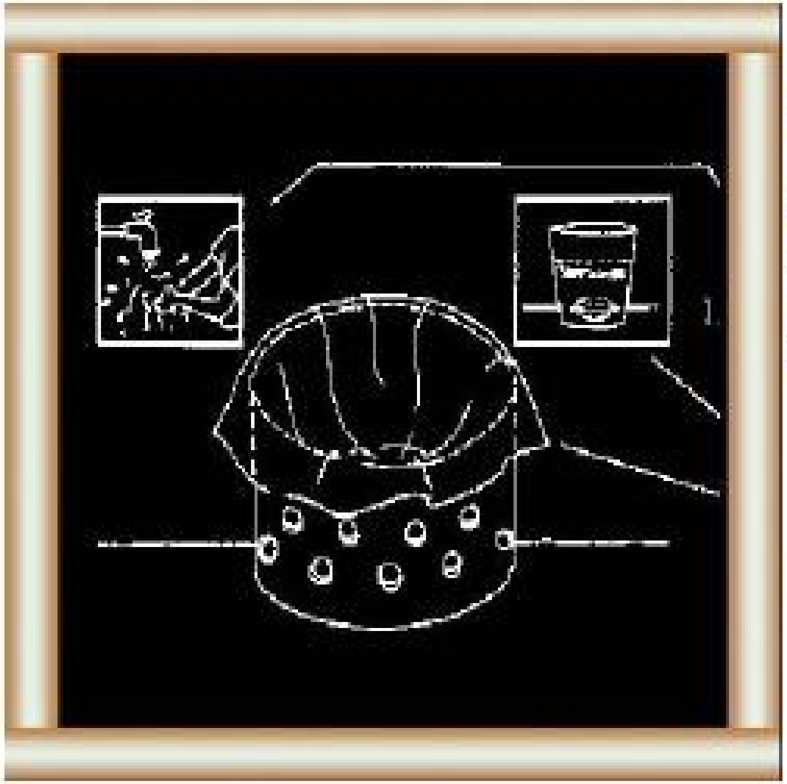


119 Wash your hands.

Place a cheese cloth inside a cheese mould.

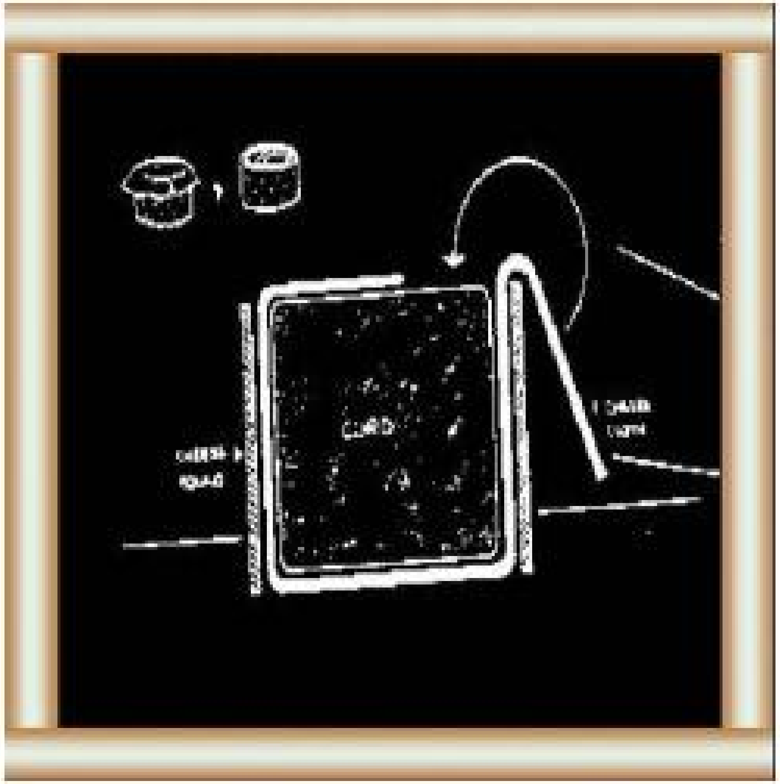
Warm in hot water just before use.

120 Fill the mould with curd very

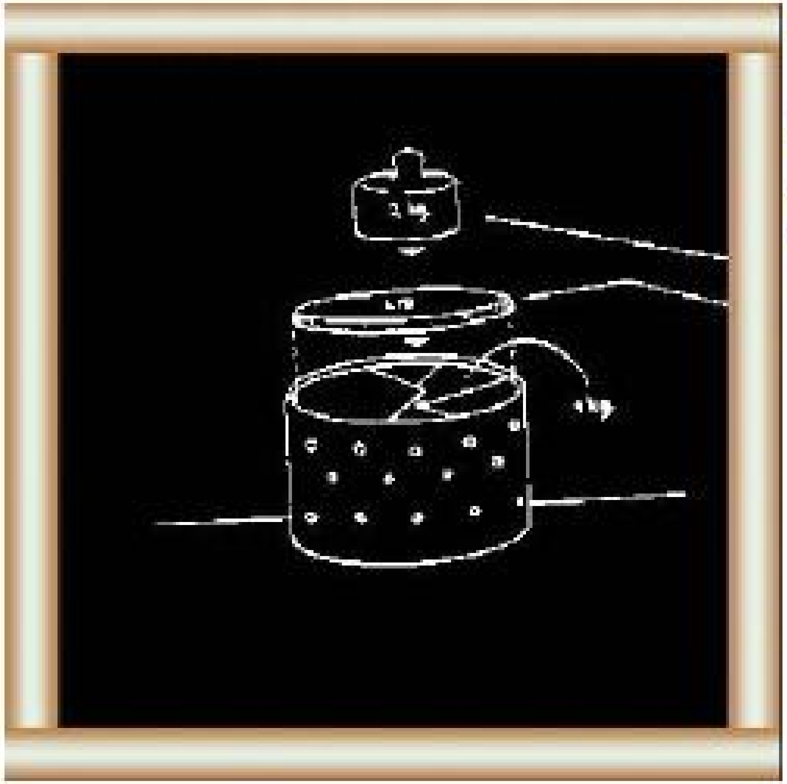
quickly.

Do not let the curd cool.

Use only clean hands for filling.



121 Fold the cheese cloth smoothly over the curd.



122 Put the lid on.

Press with twice the weight of the cheese (for every 1 kg cheese use 2 kg press).

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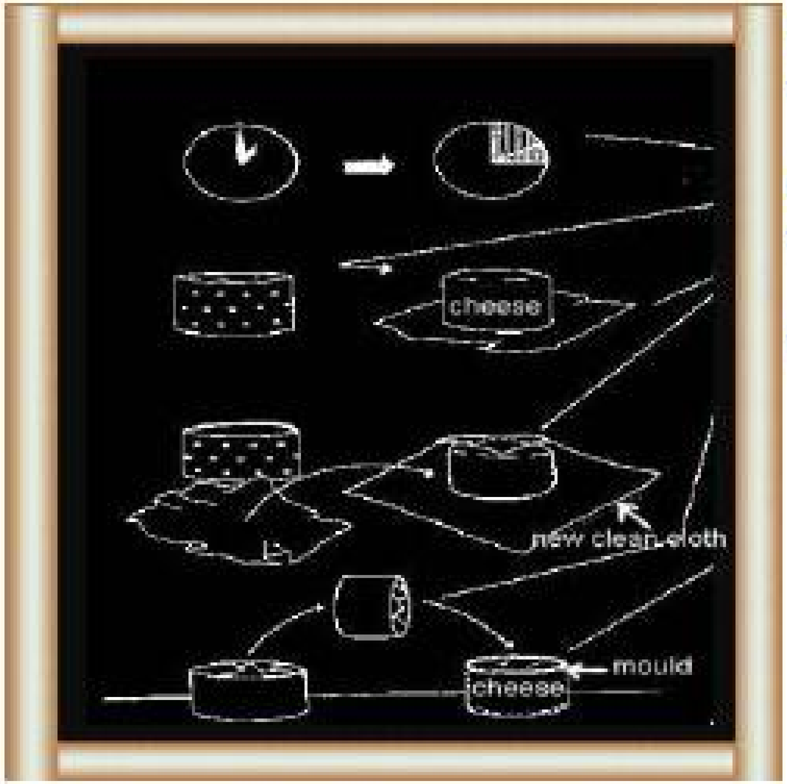
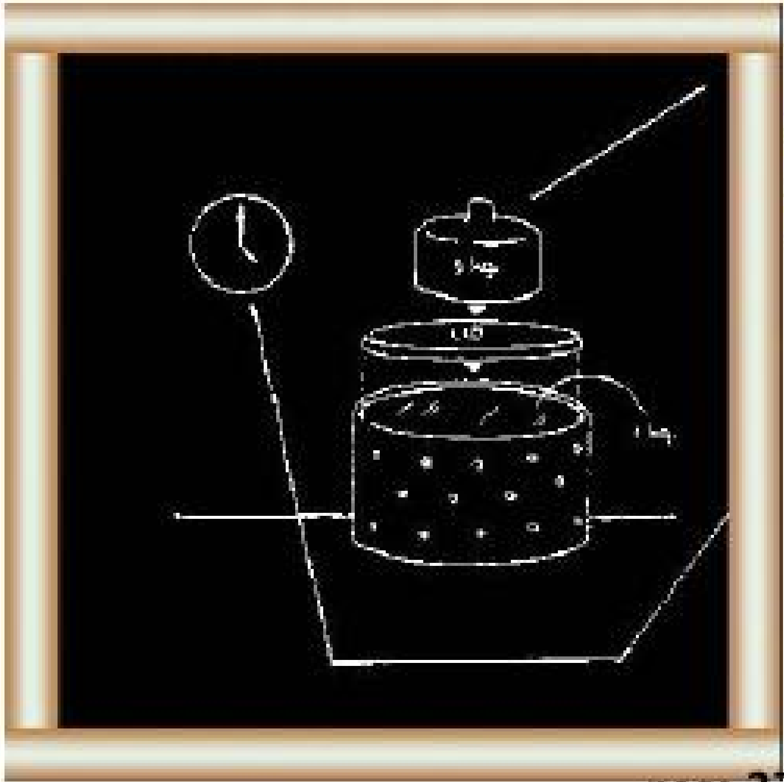


123 After 1-2 hours of pressing take the cheese out of the mould

wrap the cheese in a new, clean cheese cloth and turn upside-down

put the cheese back in the mould.

124 Press again with five times the weight of the cheese (for every 1 kg



cheese use 5 kg press).

Press for 2-3 hours for lighter cheeses and 4-5 hours for heavier cheeses.

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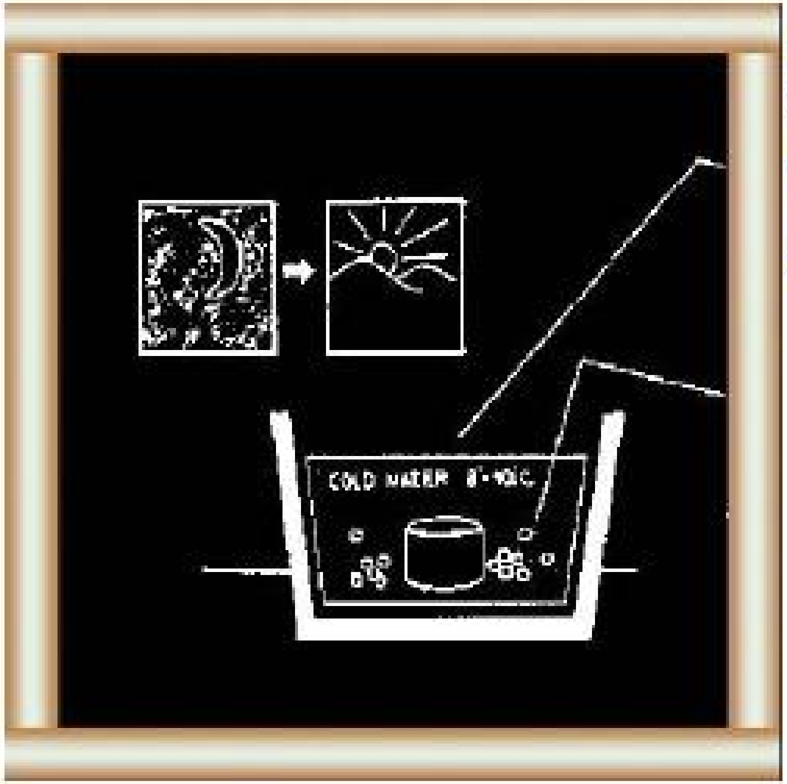
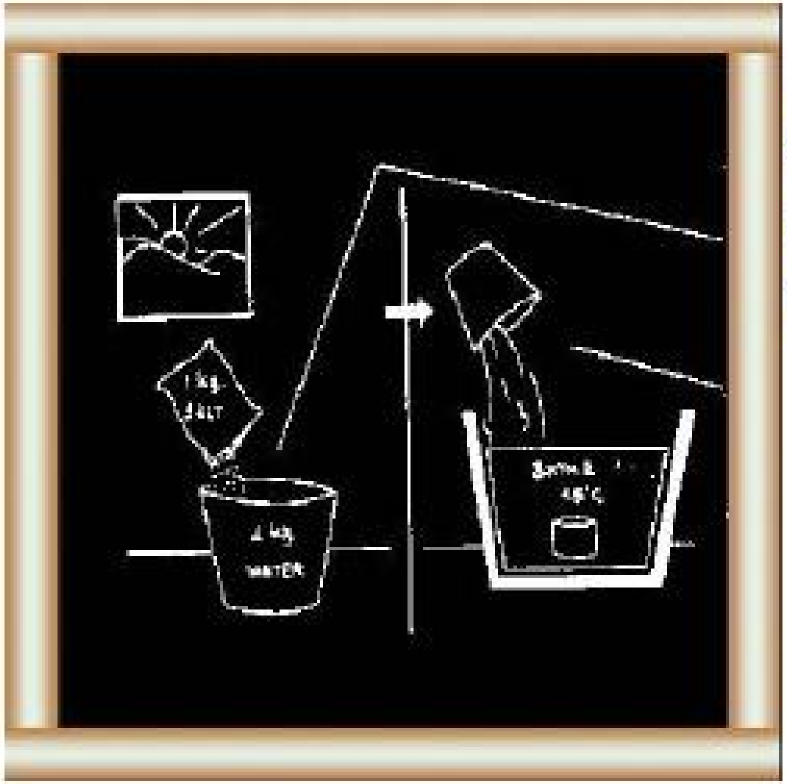


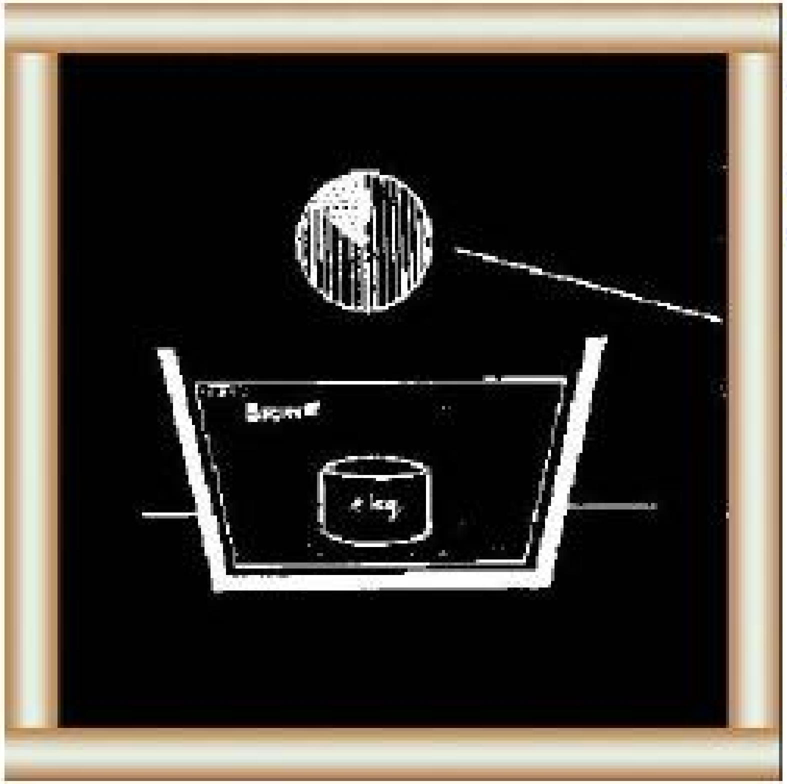
125 After pressing, put the cheese in cold water 8-10 C until next morning.

Use ice if necessary.



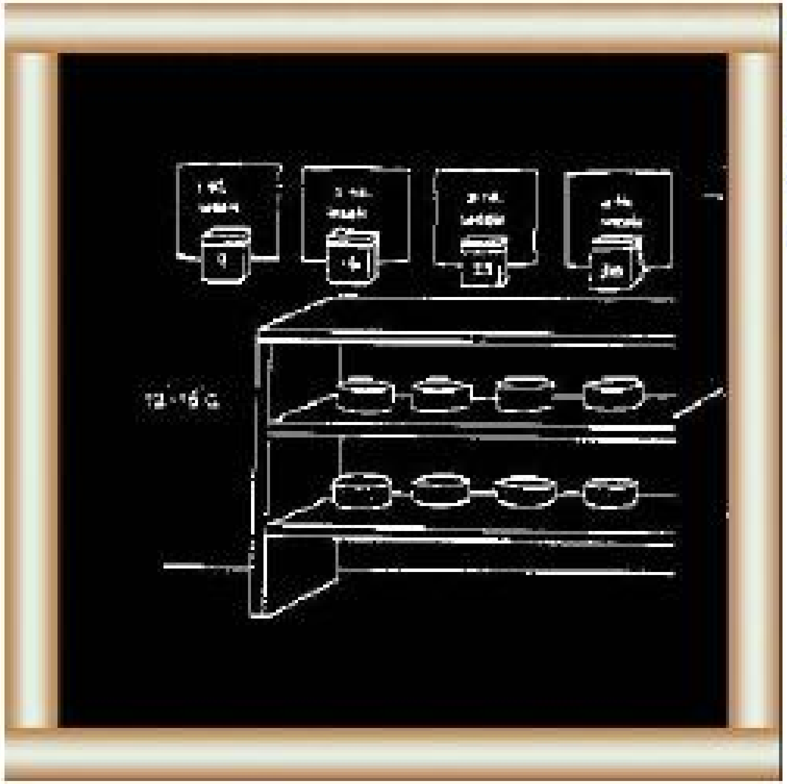
126 Next morning, make brine (1 kg salt for every 4 kg water).

Put the cheese in the brine at a temperature of about 15 C.



127 For a 1 kg cheese, leave in brine for about 20-24 hours.

Make the time longer or shorter by taste.



128 After salting, dry the cheese.

Ripen it on clean wooden shelves for at least 4 weeks at a temperature of 12-16 C.

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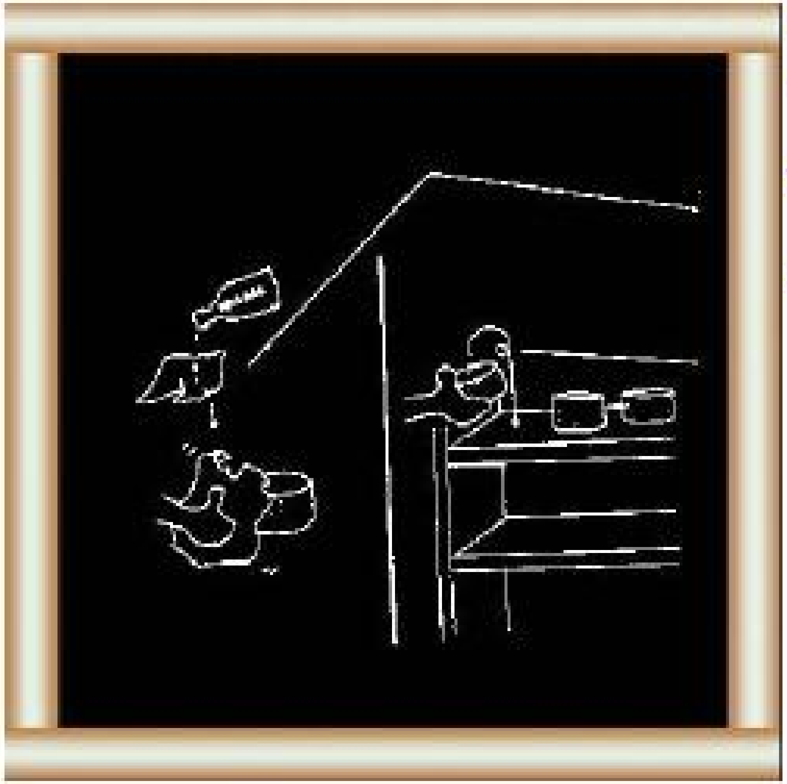
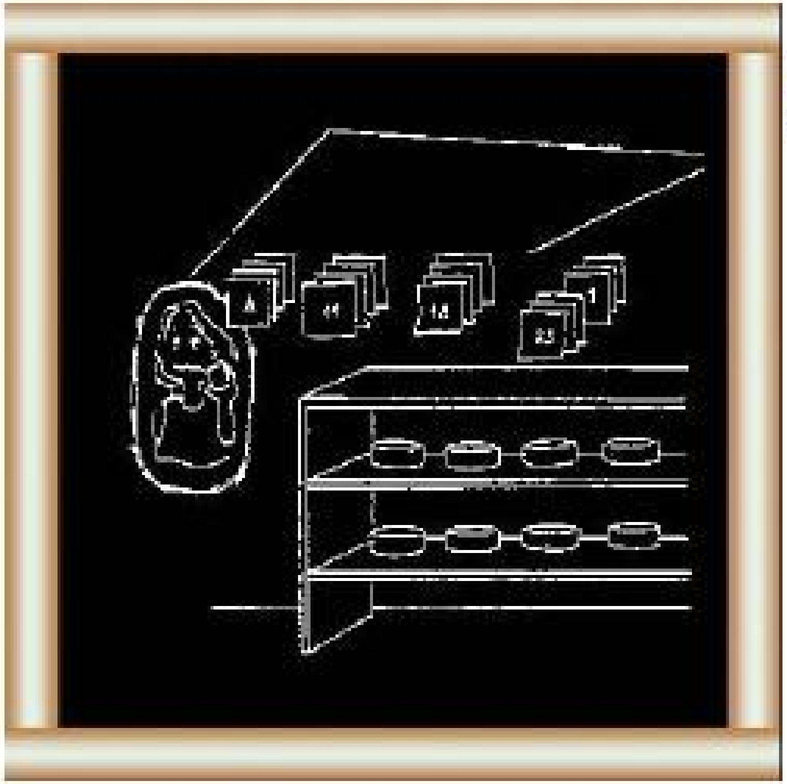
129 During ripening, take the cheese off the shelves every 3 days.



130 Put vinegar on a cloth and wipe the cheese.

This prevents fungi.

Put the cheese back upside down.



131 The longer you ripen cheese, the stronger the flavour.

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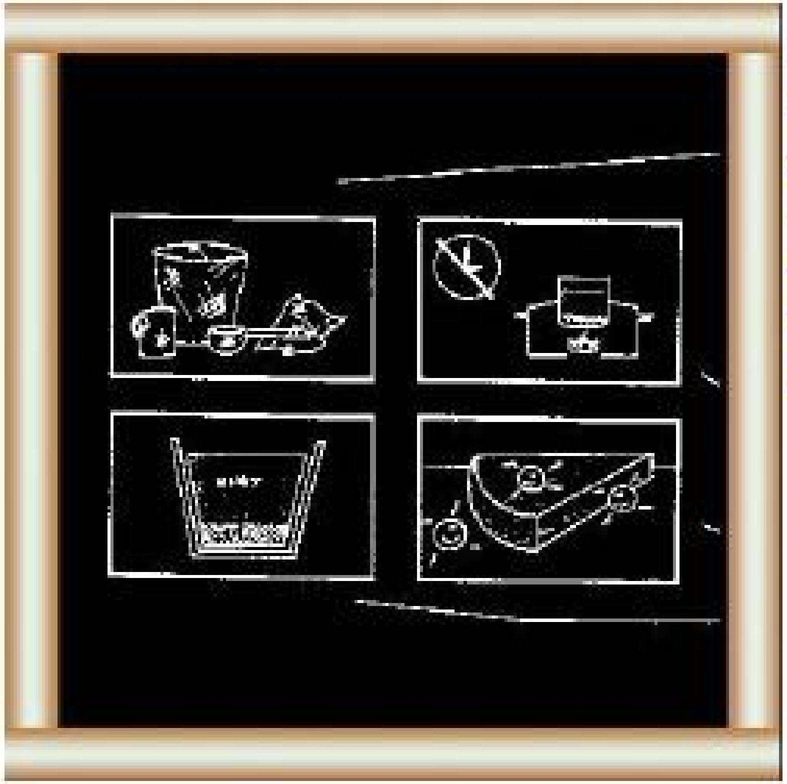
What defects are there in cheese?



Flavour defects

132 Taints and off-flavours can come from:

- dirty equipment

- lack of cooking of curd

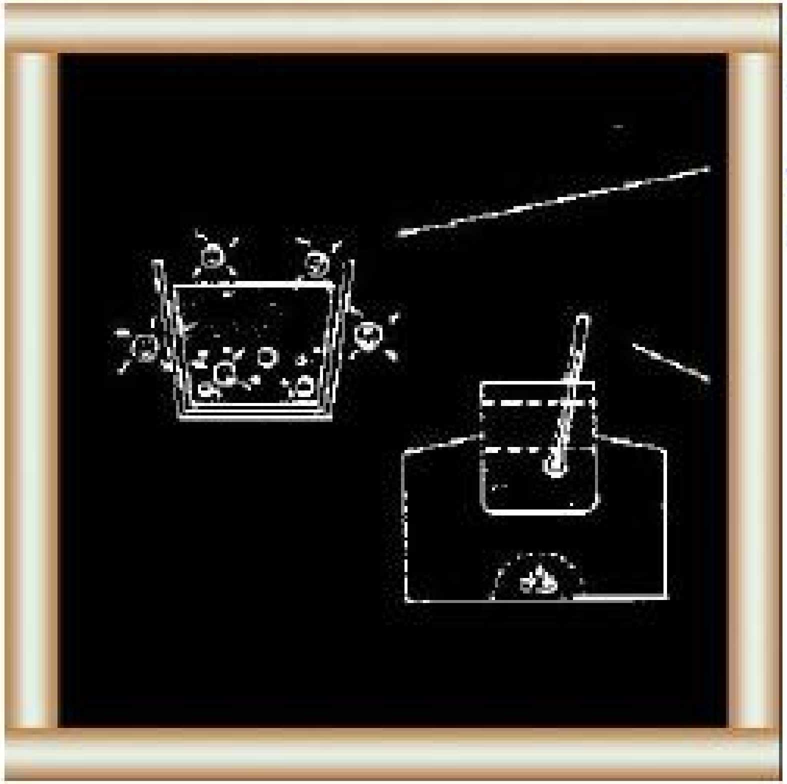
- too much whey in curd

- bacterial growth.

133 Sour flavours can come from too much acidity.

Bitterness can come from protein breakdown.

Textural defects



134 Gassy curd comes from bacteria.

Tough curd comes from too high a temperature at cooking.

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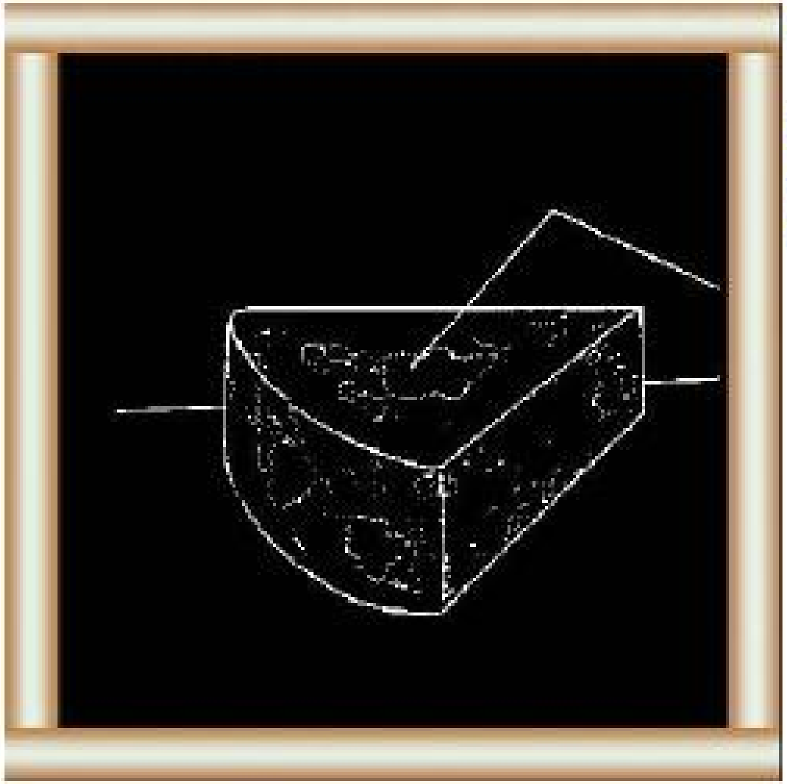
135 If your cheese is very soft:
- it contains too much water and

does not keep long

- your starter culture is too old

- your milk contains chemicals that stop bacteria multiplying e.g. antibiotics from mastitis treatment. Always wait 5 days after antibiotic treatment before using milk.



136 Defects in appearance

Slimy growths may be white to yellow/brown and come from moulds or bacteria.

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What do you know about cheese?

What cheese is

(5-

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Small-Scale

Dairy Farming Manual

Volume 1

Technology Unit 11

BASIC PRODUCTION AND BUSINESS CALCULATIONS FOR MILK PROCESSING PERSONNEL AND MILK COLLECTING CENTRES

---

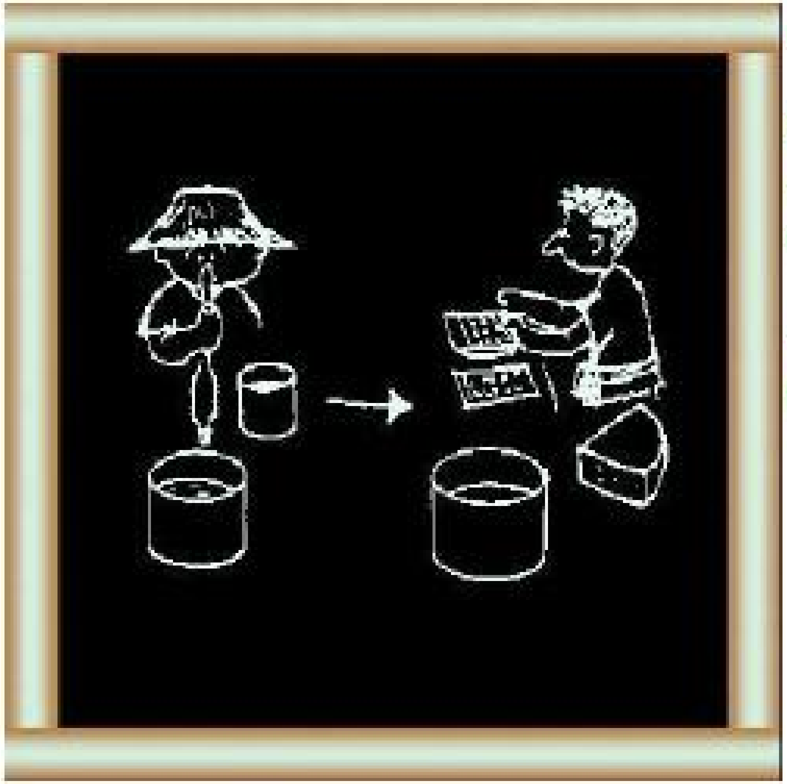
page **277**

What should you know about basic production and business calculations?

1 How can you keep reception records?(4)

You should know how to keep records of the quality, price etc. of milk coming into your centre.

2 How can you calculate fat



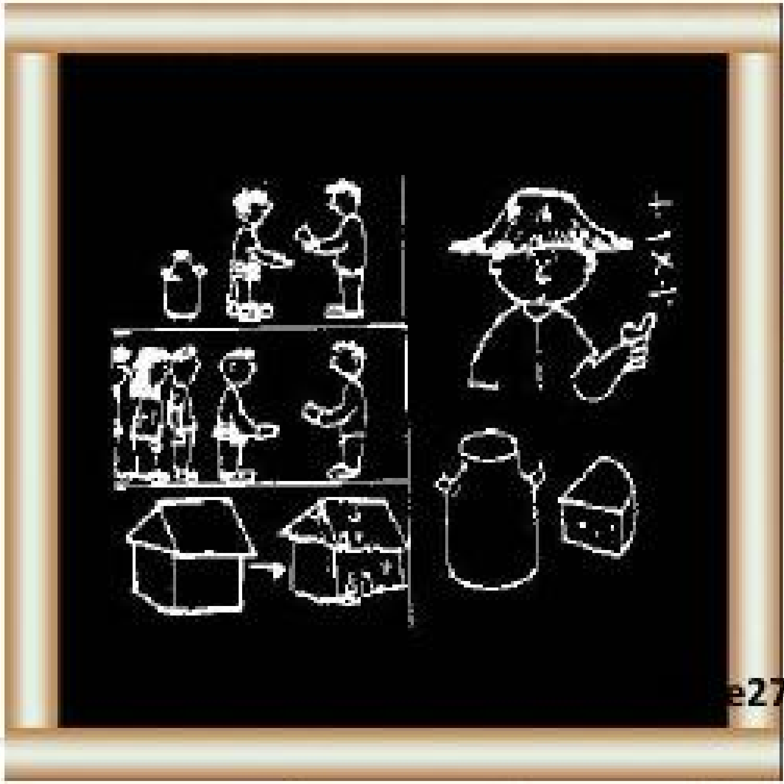
contents for standardization?(5-10)

You should know how to:
- find the fat content of your cream and skim milk so you can

- calculate the fat content of your products.

3 How can you calculate production costs?(11-27)

You should know how to find the



costs of:
- raw materials
- wages
- depreciation etc.

so that you can calculate the cost of each litre of milk, kilogram of butter etc.

e279

How can you keep reception records?

4

Name......................... No...................................... Week..................................

Day	Milk (l)	Fat (%)	Quality/ Class	Fat Units (fu)	Purchase (mu)

Tuesday	100	4.00	I	400.0	211
	95	4.10	I	389.5	
	98	3.90	II	382.2	
	97	3.90	I	378.3	
	100	4.00	II	400.0	
Total	490		II	1,950fu	211 mu

Note: 1 fu = 1 part fat in 100 parts milk

How can you calculate fat contents for standardization?

5 Before you can adjust the fat

content (standardization), you must separate:

- the cream from

- the skim milk.

Note: See also T8 Milk Payment.

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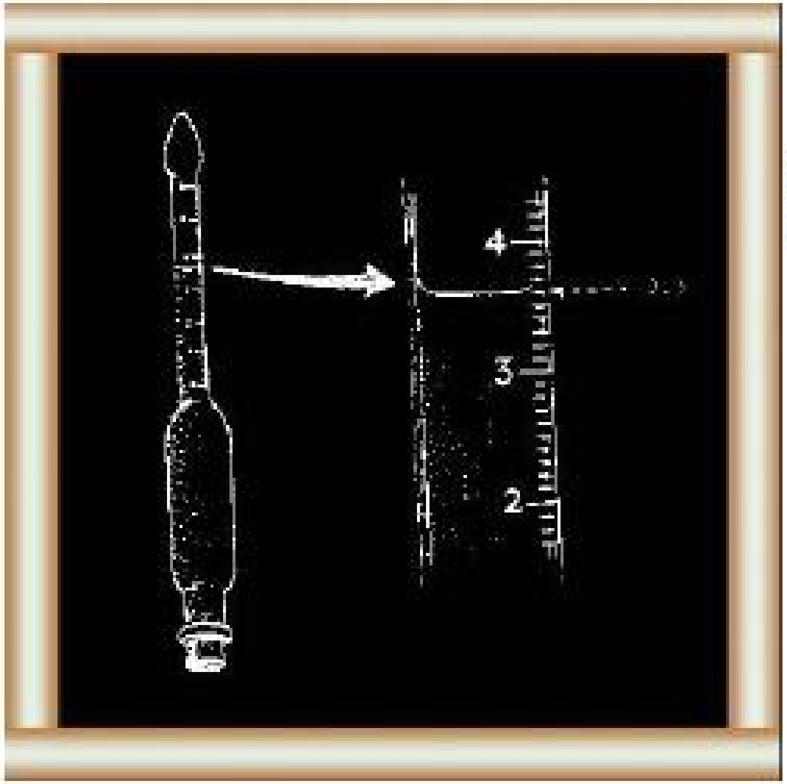

6 Check the fat content of your cream and whole milk or skim milk.

7 Calculate the amounts of:
- cream
- skim milk

- whole milk
you mix to get the correct fat content for your product.

Note: See T3 Milk Quality Control for a method of checking the fat content.

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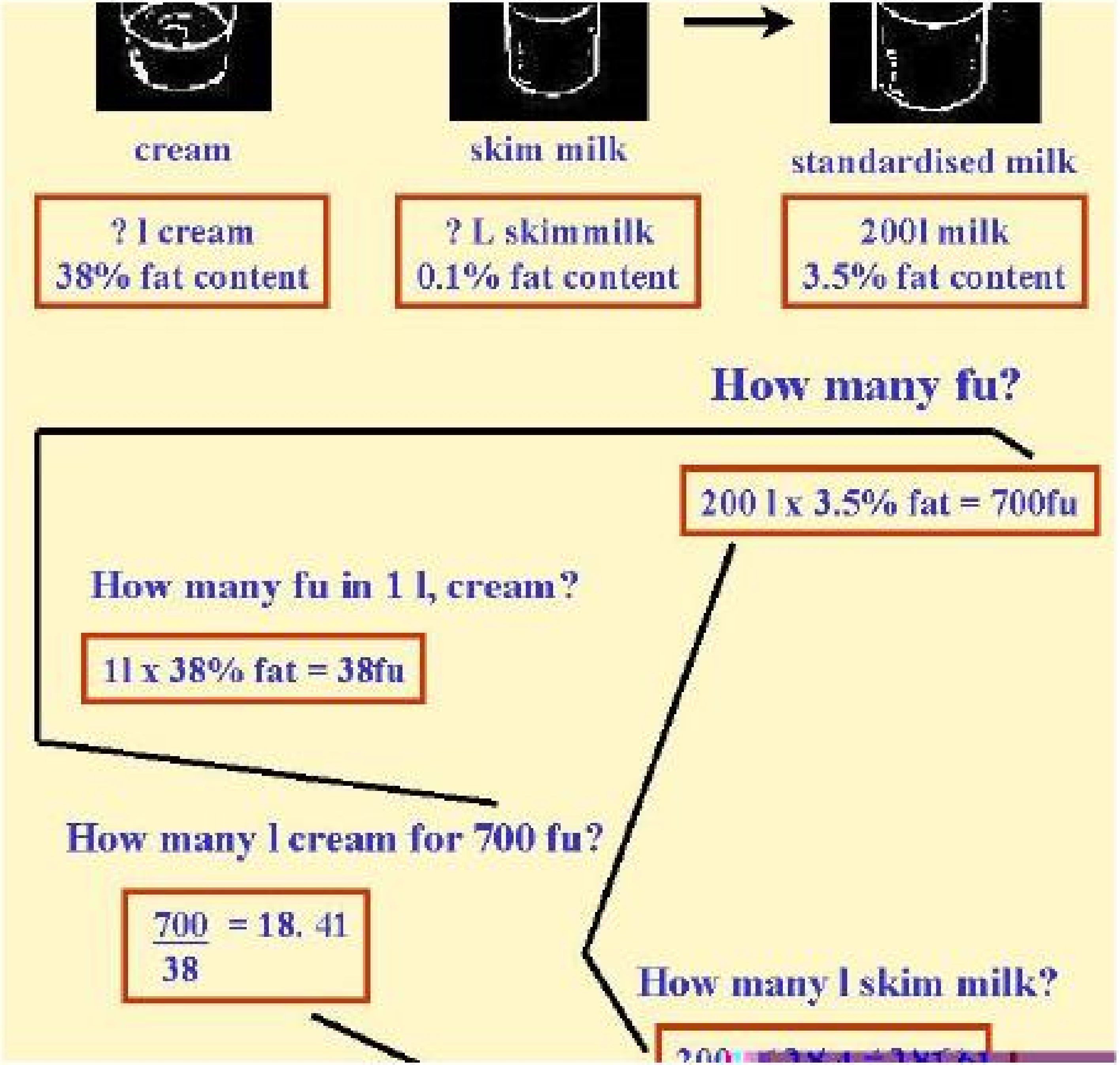
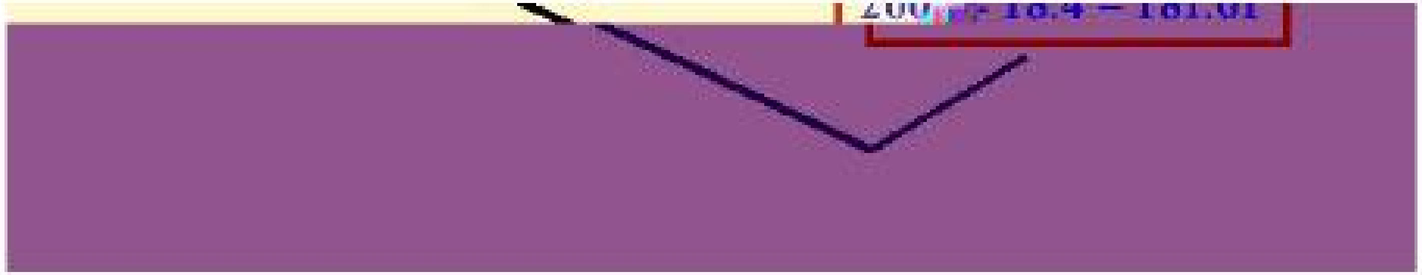
Example 1: Fat content of standardized milk

8


cream
skim milk
standardised milk
? l cream
38% fat content
? L skimmilk
0.1% fat content
200l milk
3.5% fat content
How many fu?
200 l x 3.5% fat = 700fu
How many fu in 1 l, cream?
1l x 38% fat = 38fu
How many l cream for 700 fu?
700 / 38 = 18. 41
How many l skim milk?



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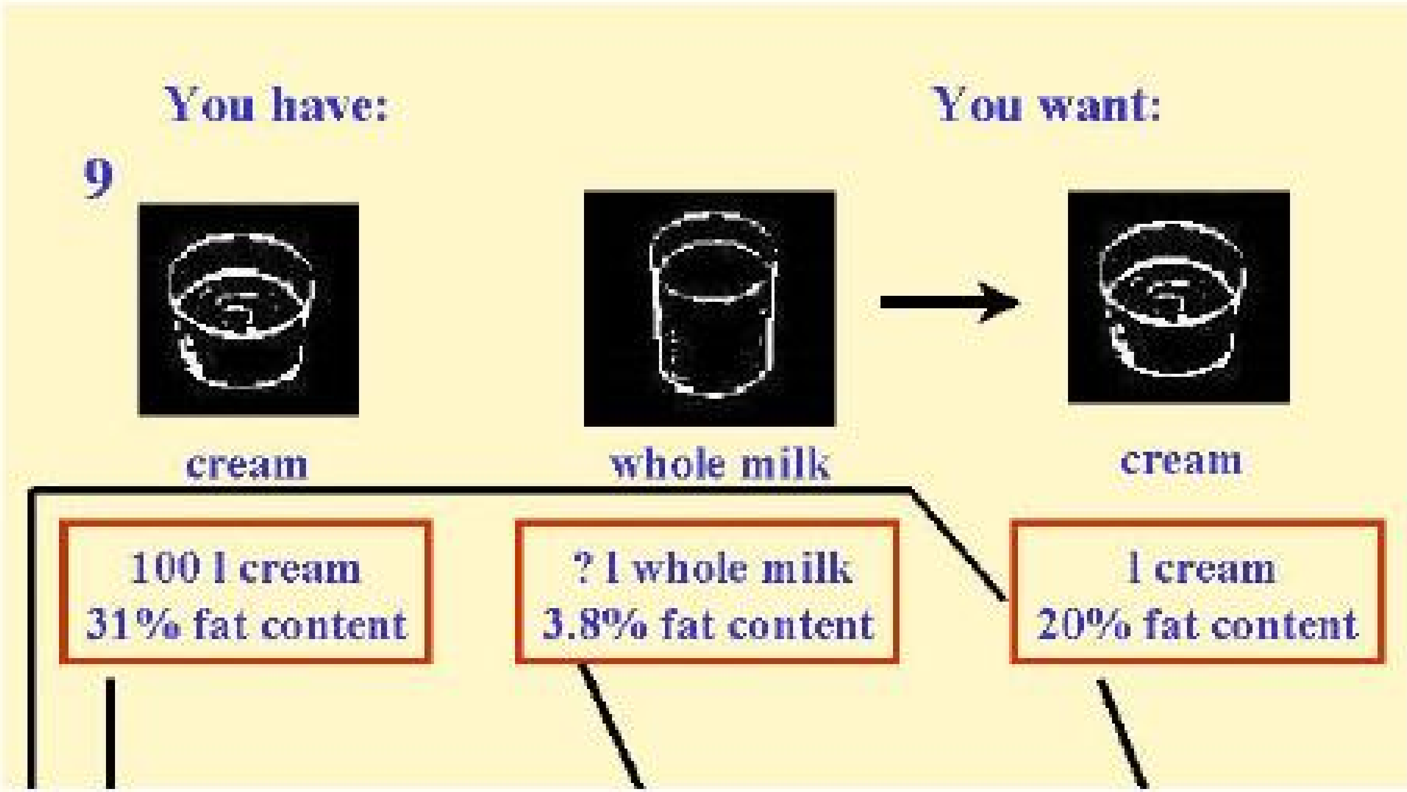
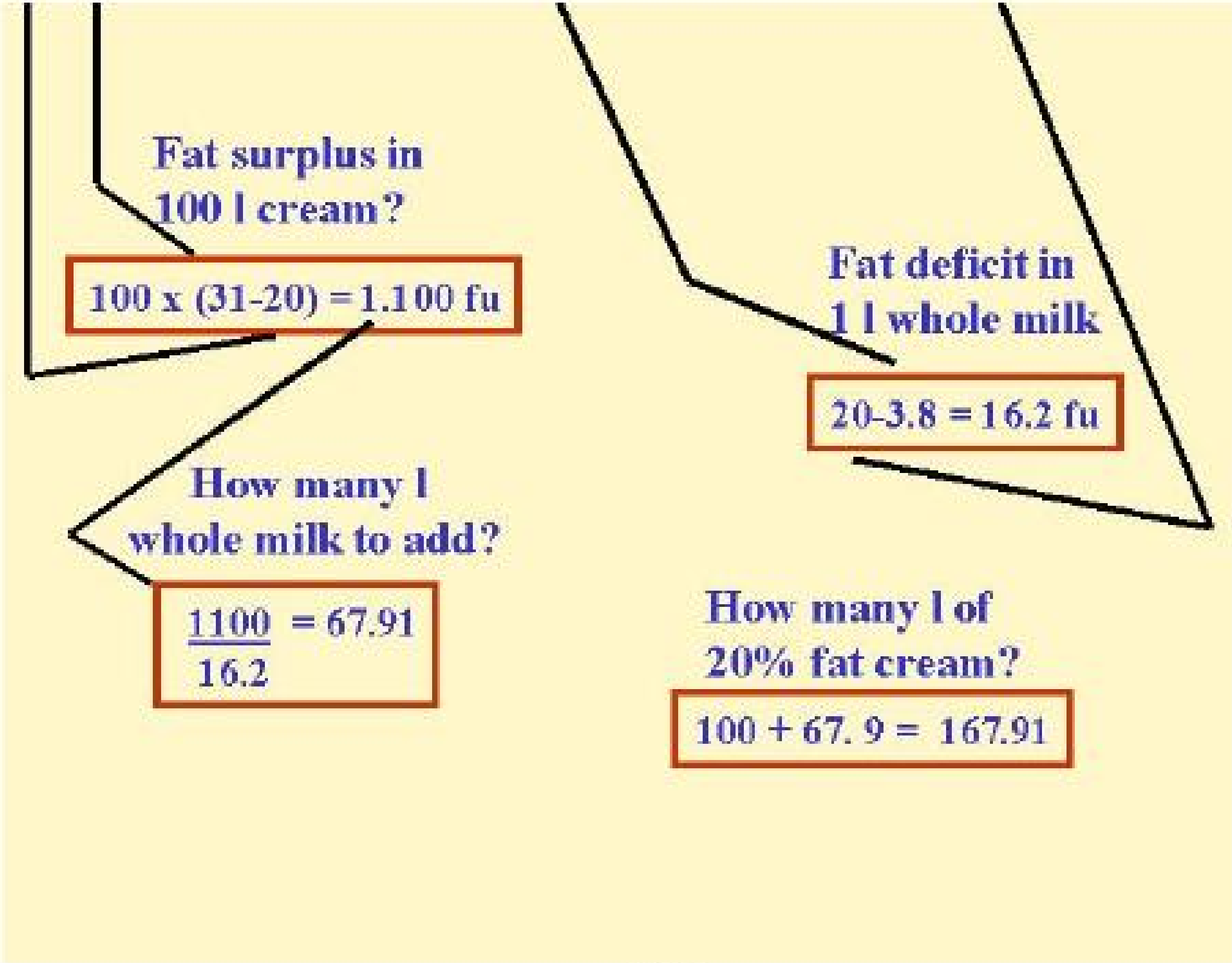
Example 2: Fat content of cream

9





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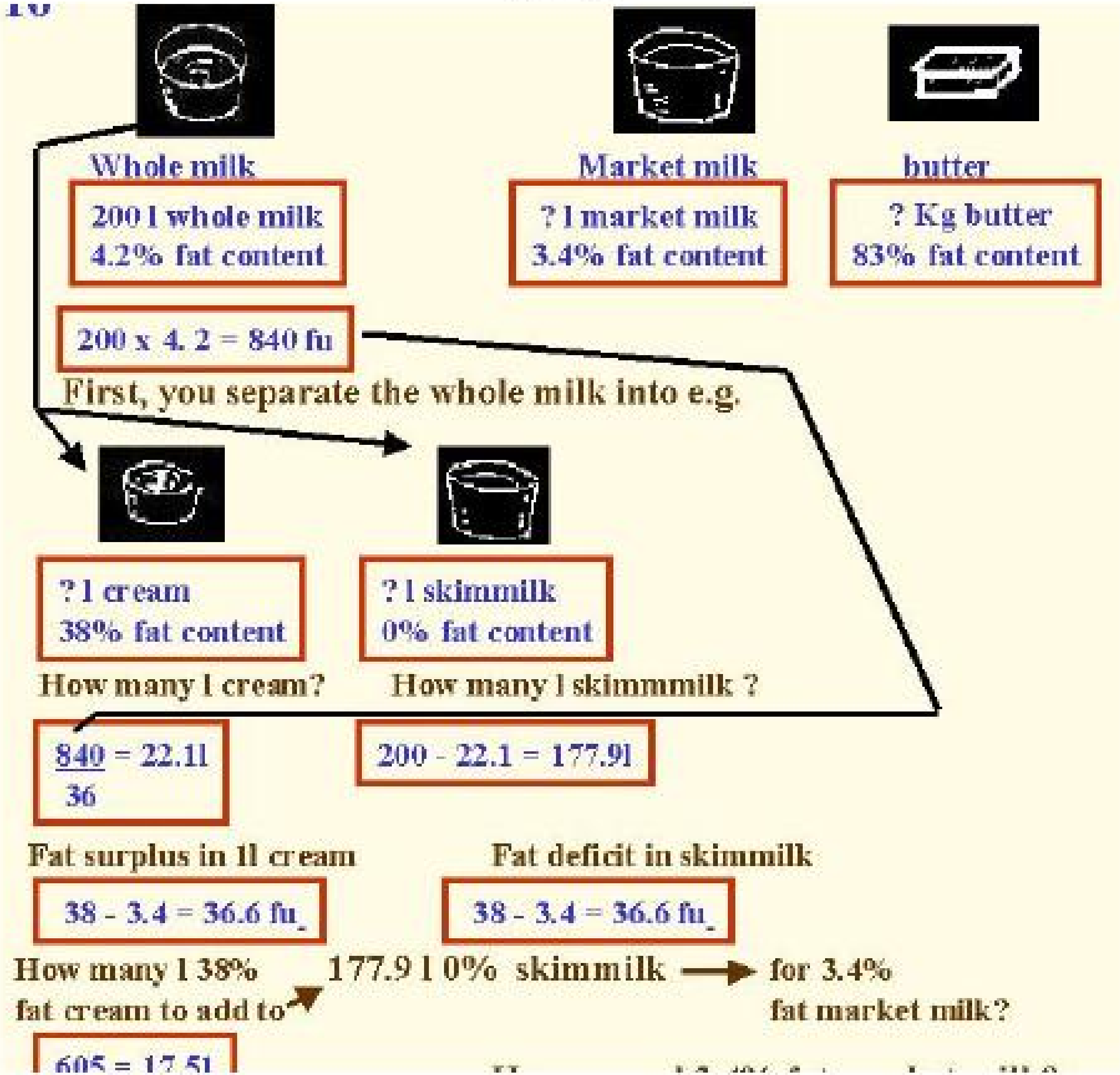
10

You have: You want:


Whole milk
200 l whole milk
4.2% fat content
Market milk
? l market milk
3.4% fat content
butter
? Kg butter
83% fat content
200 x 4. 2 = 840 fu
First, you separate the whole milk into e.g.
? l cream
38% fat content
? l skimmilk
0% fat content
How many l cream?
How many l skimmmilk ?
840 = 22.1l
36
200 - 22.1 = 177.9l
Fat surplus in 1l cream
38 - 3.4 = 36.6 fu
Fat deficit in skimmilk
38 - 3.4 = 36.6 fu
How many l 38%
fat cream to add to
177.9 l 0% skimmilk
for 3.4%
fat market milk?

34.6

How many l cream left?

22.1 - 17.5 = 14.61

How many fu?

4.6 x 38 = 174.8 fu

How many l 3.4% fat market milk?

177.9 + 17.5 = 195.41

How many kg 83% fat butter?

$\frac{174.8}{83} = 2.1$ kg

Note: When you make butter, you always lose some fat in the buttermilk (0.5-0.8%)

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How can you calculate production costs?

11 You know:

- how much you pay farmers for their milk from

the milk payment scheme

- how many l of milk you buy from the farmers every week or everymonth

13

- how much you pay for electricity
or for wood, fuel oil etc.

14

- how much you pay for processing aids e.g. starter culture, detergents, rennet, salt etc. from the bills

page285

15

- the costs of equipment e.g. trucks, tanks

- buildings

16

- the wages you pay your workers

17
- how many units you produce of each product.

18 When you calculate the costs of

each product

remember:

fat is more expensive than skim milk.

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Example 4:

Production costs of market milk and butter

This month, the prices are: Milk price: 10 mu/l

fat content: 4.2%

18

Assuming fat value is 50 % of the milk price 1.19 mu/fu

The cost of 1 fu is:
10 mu x 50% x 1 =

4.2 mu

From Example 3, each day:

you receive: you produce:

200 1.2 fat whole milk > 195.4 13.4% fat + 2.1 kg 83% fat

pasturized market milk butter

Your daily payment to the farmer for milk is:

200 1x 10mh = 2000 mu/day

Cost of l milk: Cost of 2.1 kg

milk (50%)=5mu fat

4.6 kgx38%vfat

x

1.19mu = 208 mu

\+ +

fat 3.4 fu x 1.19mu/fu milk

4.6 x 5 mu

=4.05

mu =23 mu

=9.05

mu =231 mu

Cost of 195.4 l milk
195.41 x 9.05 mu

= 1,768 mu

1,999 mu ~ 2,000 mu

Cost 1 kg <u>231</u>

<u>mu</u> = 110 mu

2.1

kg

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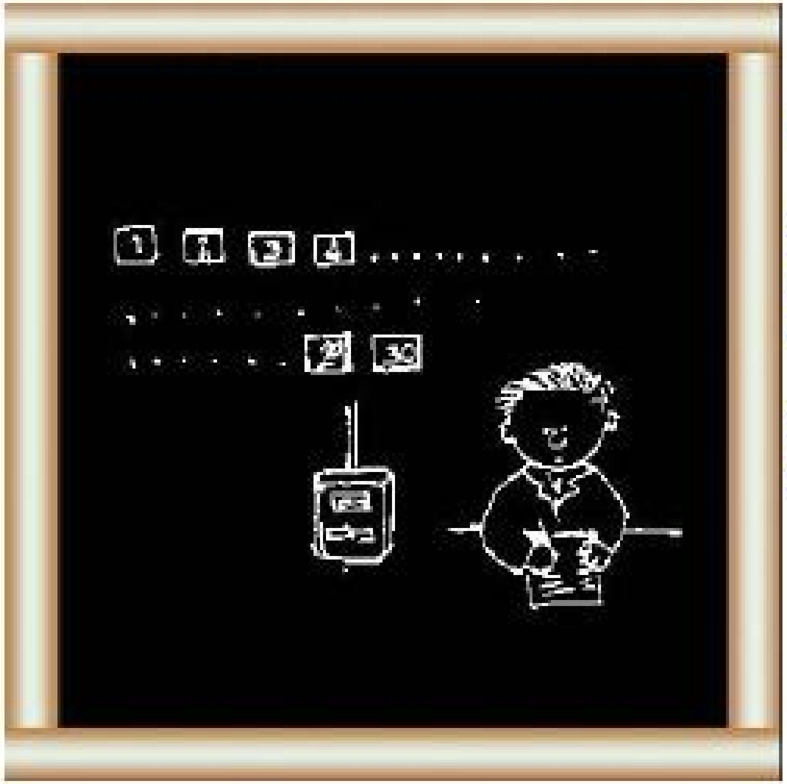
You can calculate costs for each litre of milk you receive.

19

Each day you receive 200 l milk.

Each month you receive:

200 l x 30 days = 6,000 l milk.



Electricity costs

20 If your electricity bill for 1 month is 6,000 mu, your electricity costs are:

$$\frac{6{,}000 \text{ mu/month}}{6{,}000 \text{ l/month}} = 1 \text{ mu/l milk.}$$

Costs of chemicals

21 If your bill for chemicals is 1,500 mu for 1 month. Your chemicals costs are:

$$\frac{1{,}500 \text{ mu/month}}{6{,}000 \text{ l/month}} = \frac{1}{4} \text{ mu/l milk.}$$

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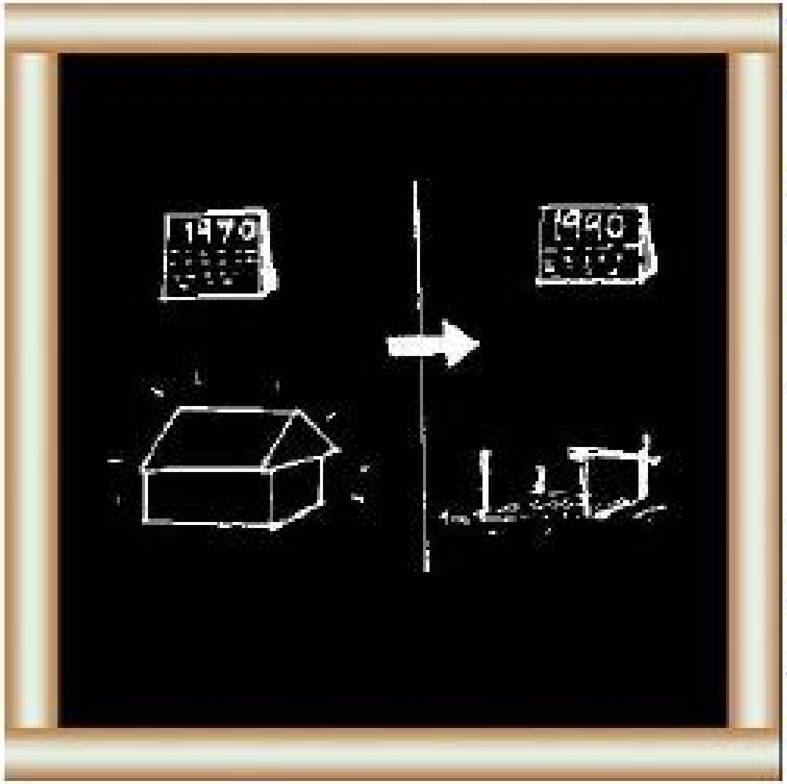
Depreciation costs

22 When new, your buildings cost 100,000 mu.

After 20 years, you assume:

- their value is 0 mu.



They lose value each year: annual depreciation.

Assuming they lose the same value each year, depreciation costs/month:

$$= \frac{100{,}000 \text{ mu}}{20 \text{ years} \times 12 \text{ months}} = 417 \text{ mu/mon}$$

You assume your milk production stays the same.

Therefore depreciation costs/l milk:

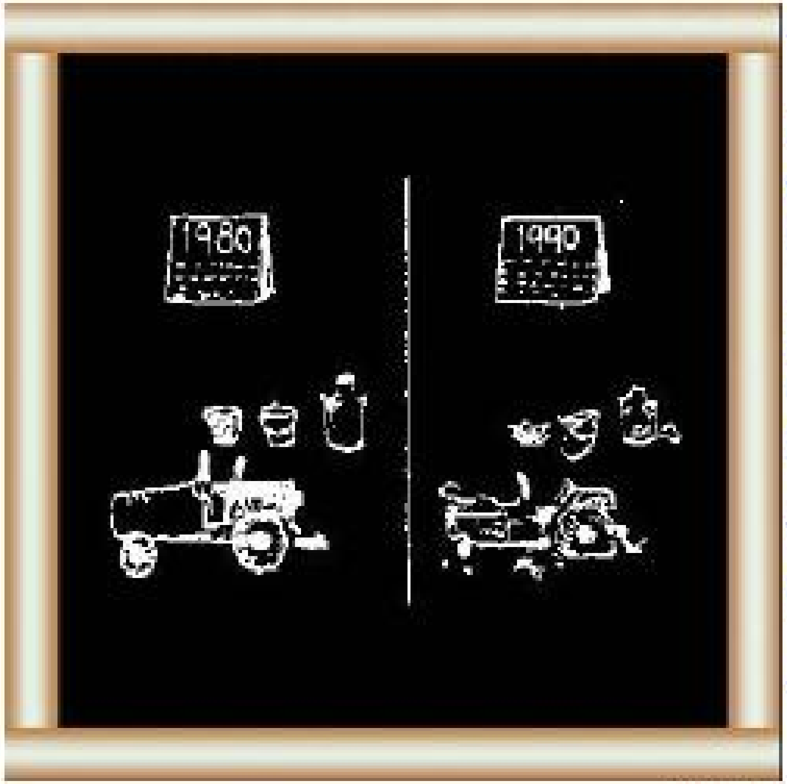
$$= \frac{417 \text{ mu/month}}{6{,}000 \text{ l/month}} = 0.07 \text{ mu/l.}$$

23

When new, your equipment costs are:

300,000 mu.

After 10 years, you assume:



- its value is 50,000 mu.

Assuming it loses the same value each year, depreciation costs/month =

$$\frac{300{,}000 - 50{,}000 \text{ mu}}{10 \text{ years} \times 12 \text{ months}} = 2{,}083 \text{ mu/mon}$$

Therefore, depreciation costs/l milk:

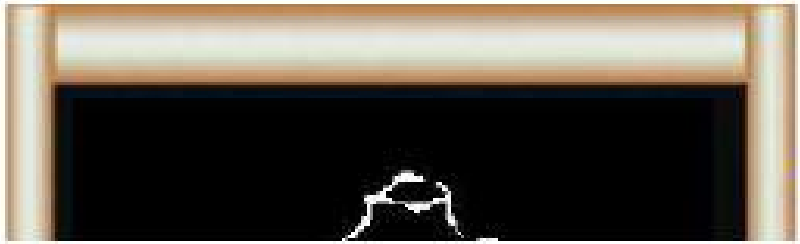
$$= \frac{2{,}083 \text{ mu/month}}{6{,}000 \text{ l/month}} = 0.35 \text{ mu/l.}$$

page289

Example 5: Total milk production costs of market milk

See Example 4 where 3.4 % pasteurized market milk cost 9.05 mu/l.

Your total production costs for 1 l market milk are:



24

	mu
Milk	9.05
Electricity	1.00
Chemicals	0.25
Depreciation (0.07 + 0.37)	0.44
Wages (estimate)	0.50
Packing materials	0.25

Total production costs for

1 l 3.4 % pasteurized milk = 11.49mu

Note: For your own production,add all of your other costs e.g. Transport, water etc.

25

You must add your profit to the total production costs.

	mu
Total production costs of 1 l market milk	11.5
30 % profit $\frac{11.49 \times 30}{100}$	3.5
Sale price	15.0 mu

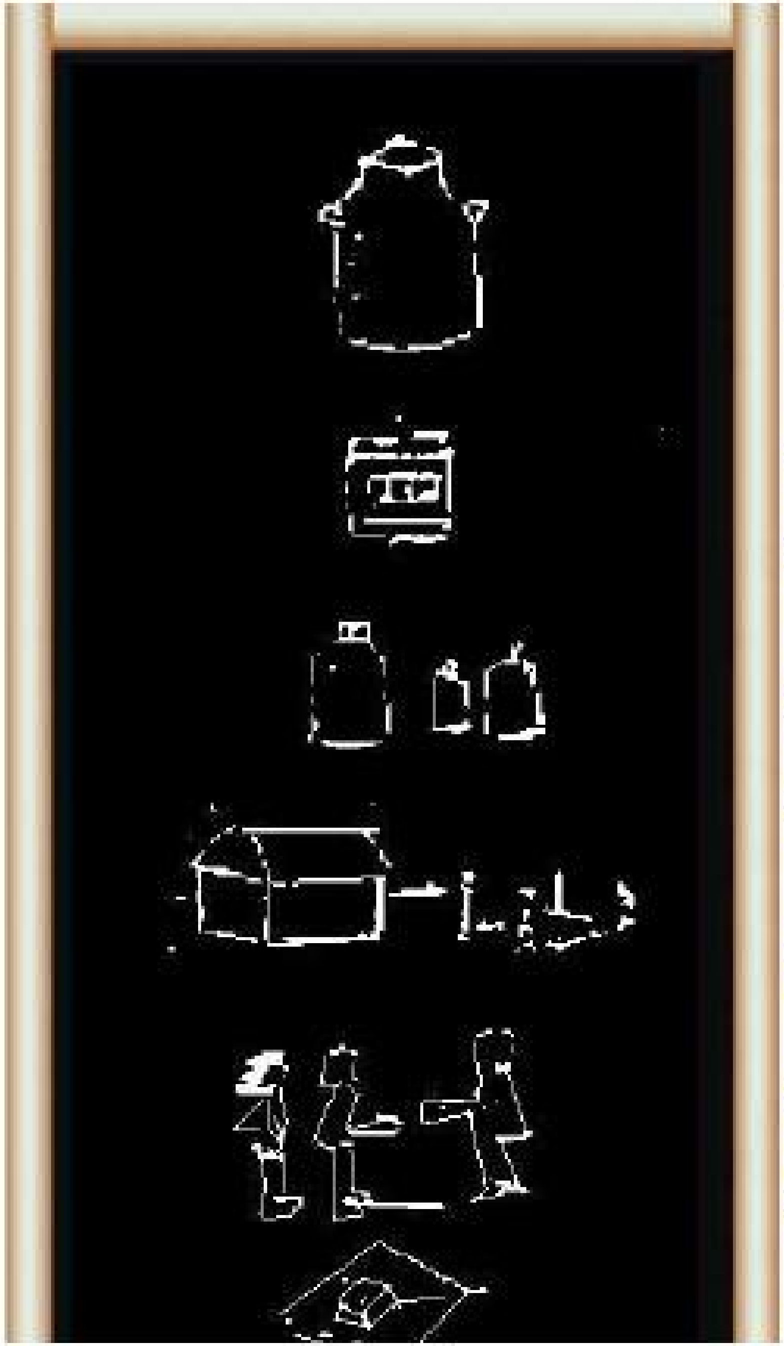
page290

Example 6: Total production costs of butter
See Example 3 where you need:

4.6 l of cream to make 2.1 kg of butter

So for 1 kg of butter, you need $\frac{4.6}{2.1}$ = 2.2 l cream.

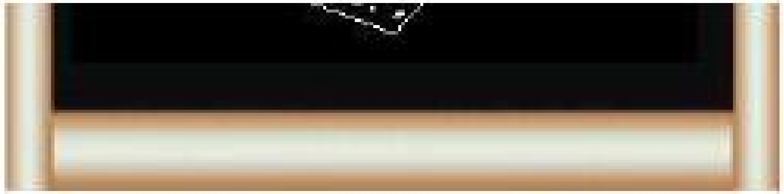
Your total production costs for 1 kg butter are:



26

	mu
butter	110.30
electricity (2.2 l cream x 1 mu)	2.20
chemicals	0.25
depreciation (2.2 l cream x 0.44)	0.97
wages (2.2 l cream x 0.50)	1.10
packing materials	0.25

Total: 115.07mu/kgbutter



27

Total production costs mu

of 1 kg butter 115.00

+

30 % profit 35.00

Sale Price 150.00 mu/kg

page291

What do you know about basic production and business calculations?

Keep accurate reception records	(4)

Standardization

Separate Whole milk

into: **(5)**
cream skimmilk

Check for contents and calculate amounts for: **(6-10)**

products: market market butter **(7)**
milk cream

Calculate production costs

Cost of: **(11-**
raw milk **12)**
electricity **(13)**
processing aids **(14)**
buildings and equipment **(15)**
wages **(16)**

Divided by:--------------------------------= Unit **(17-**

Production Cost 21)

amount of butter produced

+

Other costs (22-23)

= Total Production Costs (24-27)

+

Profit

Sale Price

page292

Examples	**Page**

page293

Small-Scale

Dairy Farming Manual

Volume 1

Technology Unit 1

Milk Composition - Part 1

Technical Notes

Introduction (5 - 8)

The following notes refer to milk from cows.

Milk is an excellent food for human beings because it contains essential nutrients which are easily digestible. Milk provides both energy and essential body-building compounds.

Milk is an all-round food stuff and helps give a

balanced diet.

as milk supplies protein, calcium and phosphorus rather than energy,

it is a good supplement to food-stuffs with high energy and low protein,

calcium and phosphorus content.

(Numbers in brackets refer to illustrations in the Extension materials of the Manual)

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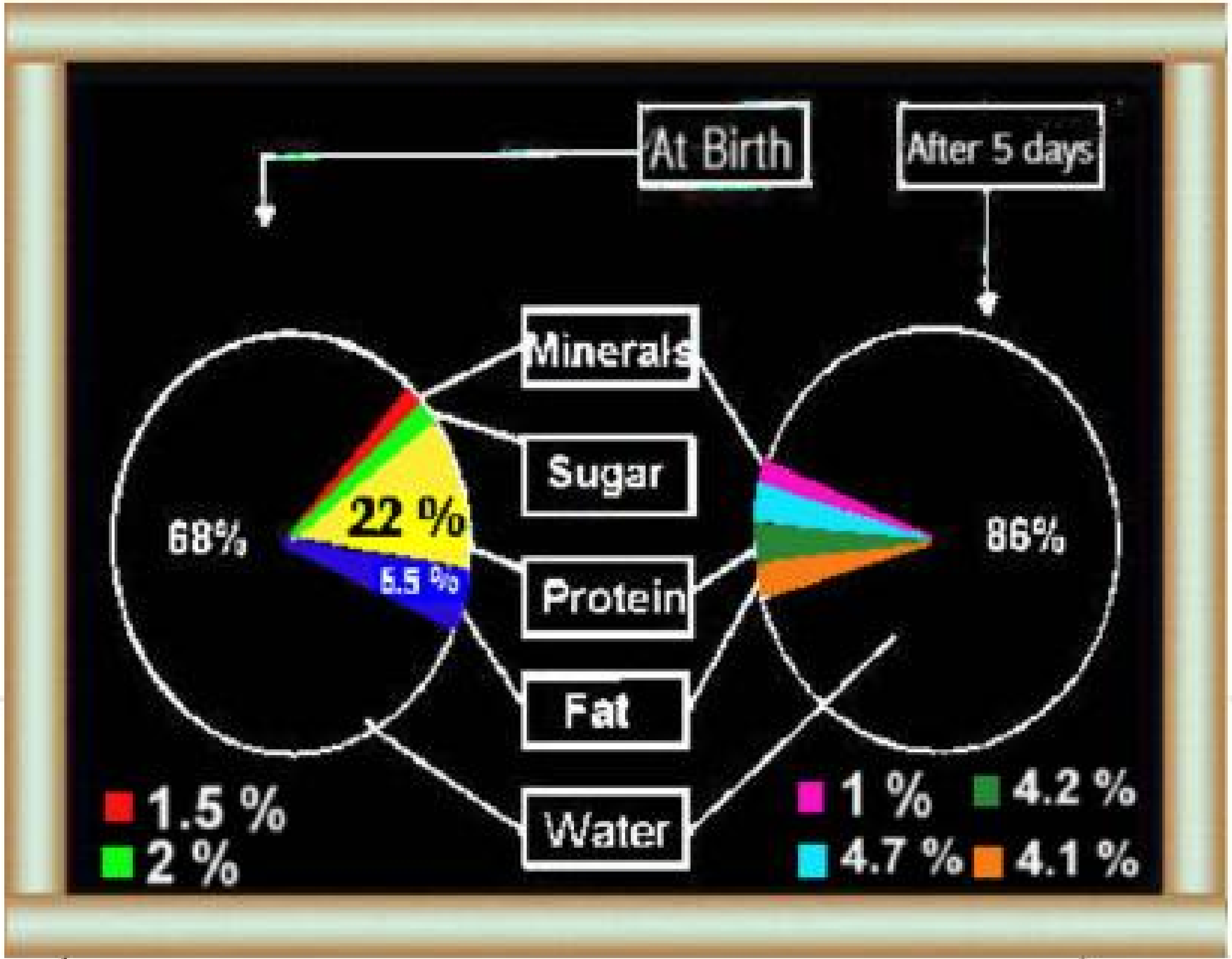
page i

MILK COMPOSITION


At Birth
After 5 days
68%
22 %
5.5 %
Minerals
Sugar
Protein
Fat
Water
86%
1.5 %
2 %
1 %
4.2 %
4.7 %
4.1 %

What should you know about Milk Composition?

Why should you drink milk ? (5 - 8)

1. You should know about the **nutrients** in milk.

What is milk like ? (9 - 12)

2. You should know what good quality milk:
looks like
smells like
tastes like.

What does milk contain ?
(13 - 46)

3. You should know milk contains:
some things you can see;
some you can not.

What affects milk composition ? (47 - 58)

4 You should know:

environment
breeding
affect milk production.
things you cannot see
(without microscope)

Note: pages 2-15 use cow's milk as an example.

page1

Why should you drink milk ?

Milk contains substances which:

5 -give energy

6 - build your body

7 - keep you healthy

8 Milk does not contain much:

-iron;
-vitamin C and D.

You need to give food which contains these substances especially for infants and young children.

page 2

Properties of Milk

State and Colour (9-10)

Milk is yellowish -white liquid which is secreted from mammals to feed the new-born.

Freezing Point (11)

The freezing point of milk is not dependent on fat and protein content. Salt is the decisive factor together with lactose. These substances are completely dissolved. As the quantity of salt and lactose in the milk is almost constant, the freezing point will be constant too (between -0.53 and --0.55 C). Deviation from this show that the composition of the milk is abnormal and that probably been adulterated.

Specific Gravity (Density) (12)

The specific gravity of milk measured at 15^{O}C or 20^{O}C is normally 1.028 - 1,033 kg/litre. The specific gravity depends on the protein and fat content. The specific gravity of fat is 0.93, solids-non-fat, 1.6 and water 1.0 kg/litre.

If the milk is mixed with air, by pumping for example, the specific gravity will be lower. The specific gravity of the milk collected by a tanker is usually between 1.015 and 1.020 kg/litre. If the specific gravity is lower than 1.01 kg/litre, this may indicate extraneous water (water

content higher that normal).

page 3

What is milk like ?

9 Fresh milk is

a liquid.

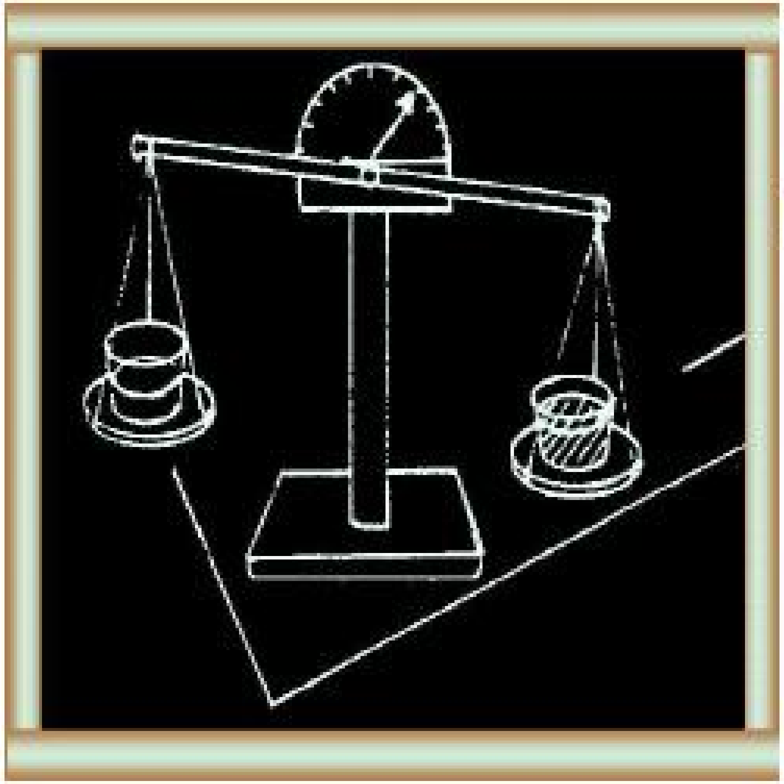
10 It has a:
yellowish-white colour and

pleasant, sweetish smell.

11 If you make milk cold, it will freeze

at a slightly lower temperature

than water.



12 Milk is

slightly heavier
than water.

Constituents of Milk (13)

In general, milk consists of water, fat, protein, lactose, minerals, vitamins and enzymes. The composition of milk depends on the kind of mammal, feeding (type and quantity of fodder), cycle of lactation and number of lactations.

Figure 1: Composition of Milk

Milk fat (14 - 16)

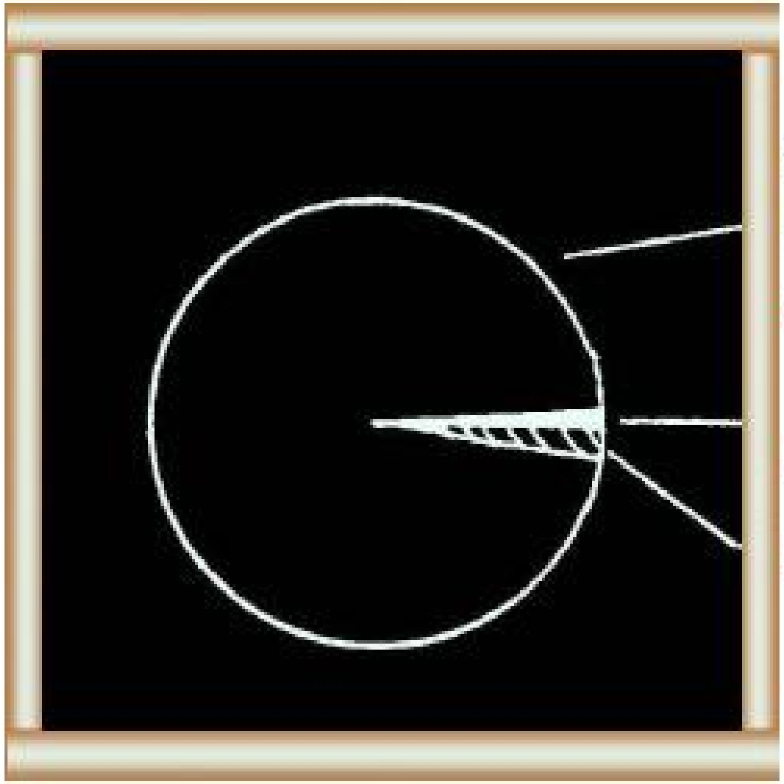
Milk fat is present in milk in the form of very small globules. The globules are dispersed in the plasma. they vary from 0.1 to 15.0 um. but differ markedly between species and breeds of milch animals. Ranking the milk of the four important species of domestic livestock by average size of globule gives: buffalo milk, cow milk, goat milk and ewe milk. Comparing breeds, milks with high fat content will usually contain larger globules than milks with a low fat content. The globules at the beginning of lactation are comparatively large. Towards the end of the lactation, there is a tendency for the animal to produce small globules.

Percentages of milk fat are:

cream (3.5 - 5%)
skim milk (95 - 96.5%).

page 5

What does milk contain ?

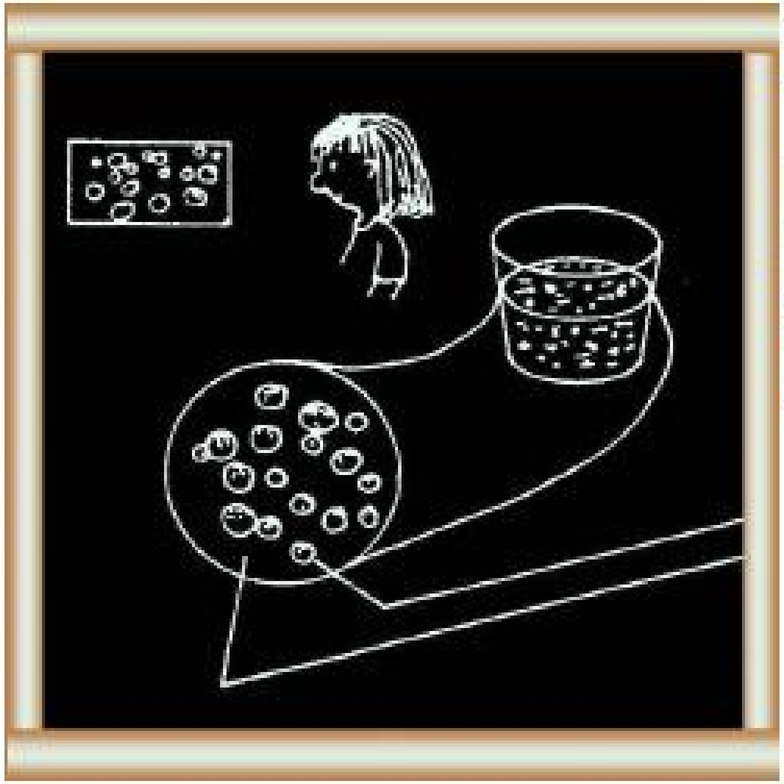


13 Whole milk from cows contain approximately:

87% water

4% butter fat

9% solids-not-fat



14 Milk contains some things we can see.

Fats

There are many small fat globules in milk.

-fat globules

-skim milk

15 If you leave milk to stand,

yellowish fat or cream (3.5 - 5%) rises to the top of bluish-white skim milk.

page 6

Milk fat (continued)

Each globule is surrounded by a membrane consisting of a thin layer of proteins and phospholipids and a number

of other compounds. The membrane protects the globlule, preventing it from joining other globules. Without such a protective layer, the globules would unite and form large masses of fat. Some of the copper contained in the milk and about three-quarters of the phosphatase enzyme is concentrated in the membrane. (18-19)

The membrane also protects the fat from being broken down by the enzymes present in the milk and thereby causing rancid flavour.

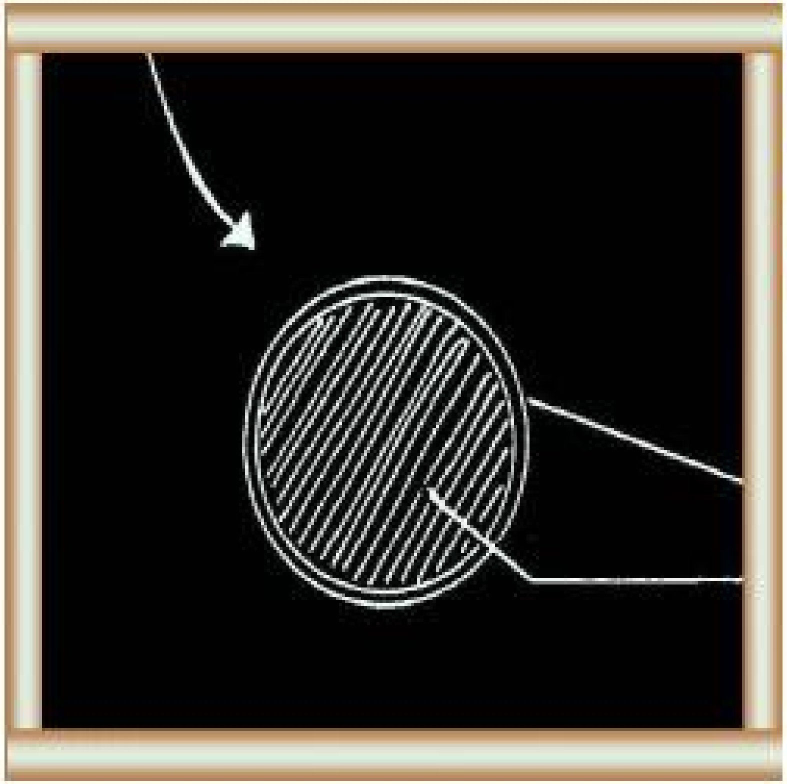
The enzyme that causes this chemical reaction (catalysis) is called Lipase.

16 Fat is not soluable in water.

If you look closely,
you can see

small globules of fat.

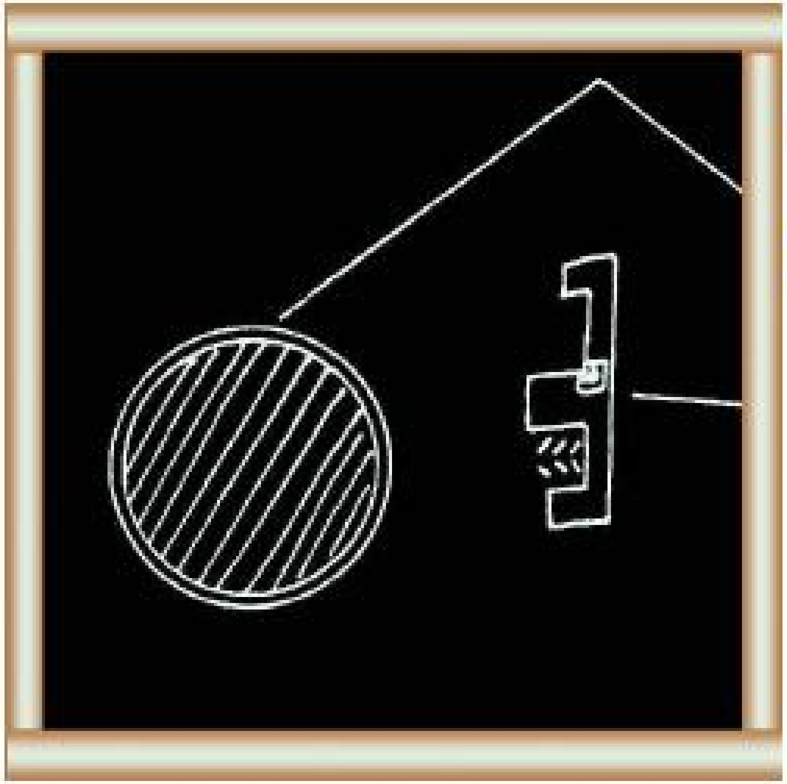
17 If you look at a fat



globule through a microscope,
you can see:

a membrane on the outside
fat on the inside

18 The membrane protects



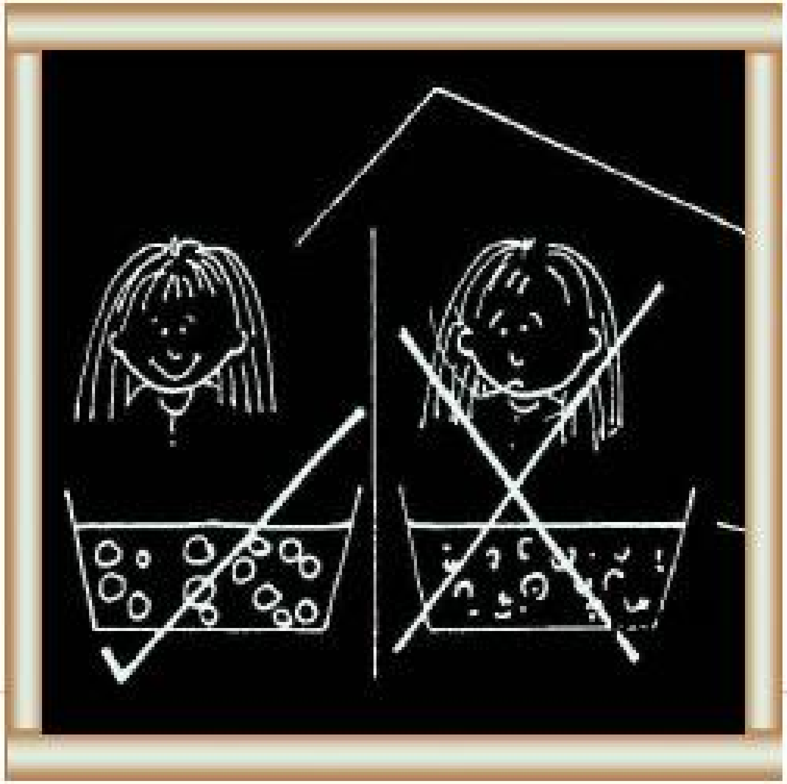
the fat from

enzymes in the milk

which break down fat and cause bad taste.

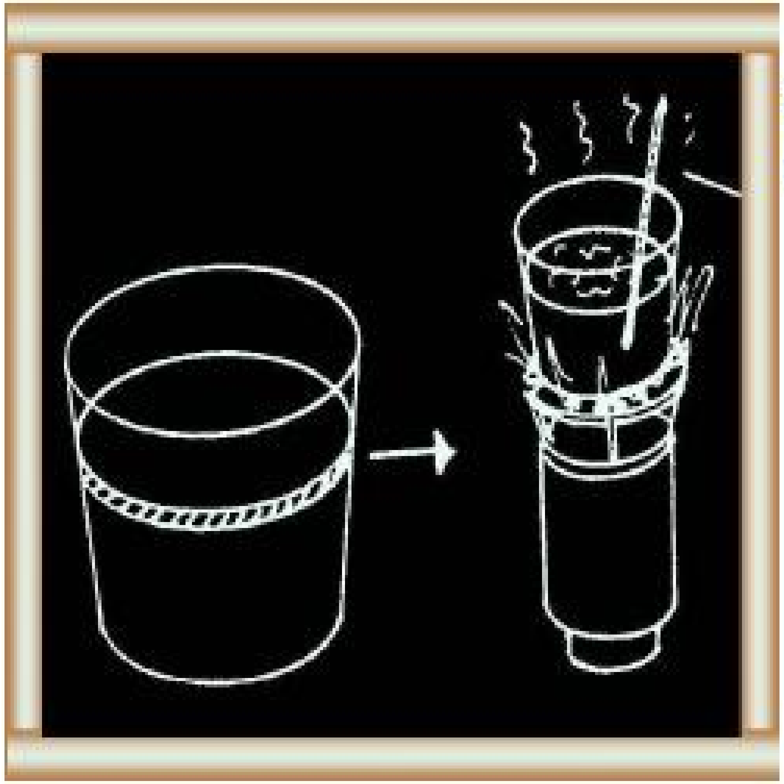
19 Gentle treatment of milk is important

to protect fat globules. Large globules rise faster from the skim milk than



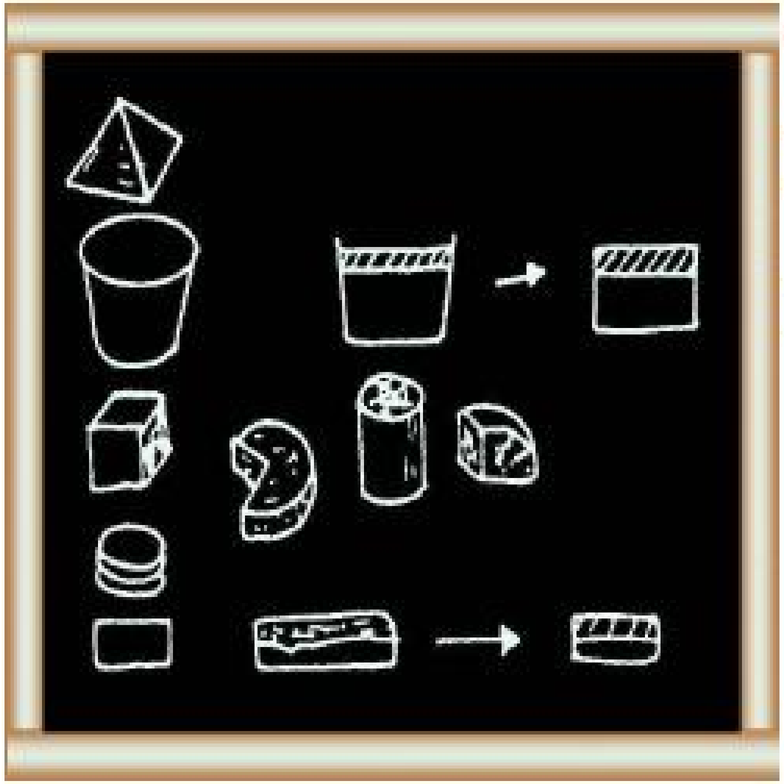
small ones.

Rough treatment **breaks down** the membrane that protects fat.



20 Milk fats melt at between 18-40^{O} C.

21 Milk products contain



different amounts of fat:

- cream
- cheese 10-60%

- ghee
- butter 80-90%

page9

Protein (23-25)

Protein is built up of amino acids. There are about 20

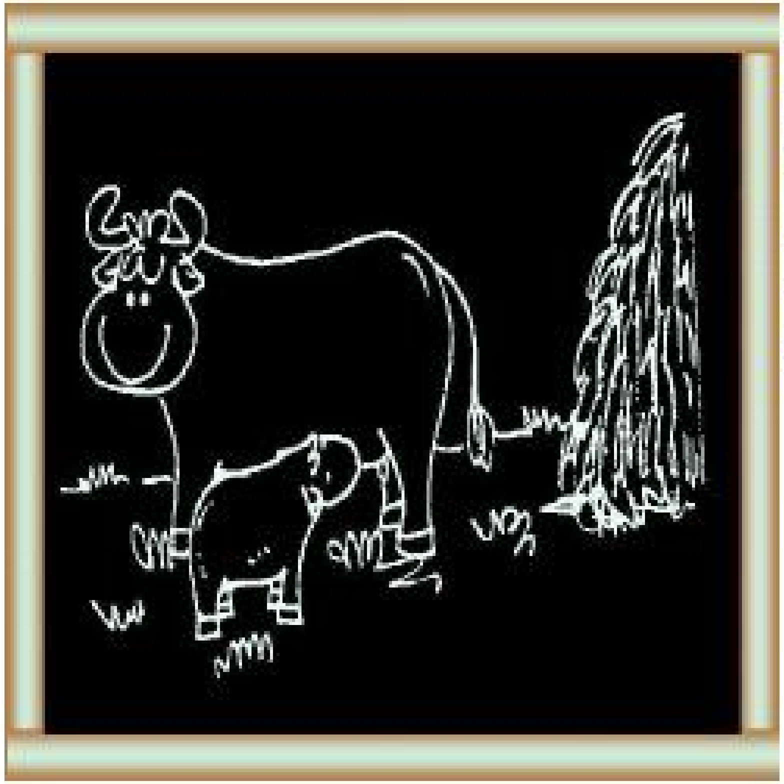
different amino acids of which 8 are essential for adults and 9are essential for children. These essential amino acids must be found in your food every day so that your body could build up and maintain skin, hair and muscles. Milk protein is rich in these amino acids and has, therefore, a very high nutritional value and a high coefficient of utelization compared to proteins from vegitable food, for instance soya.

1 glass of fresh milk (200 cc) provides about 9% of an adult's daily protein requirement and about 8% of child's.

22 Milk also contains some things

we cannot see.

Proteins



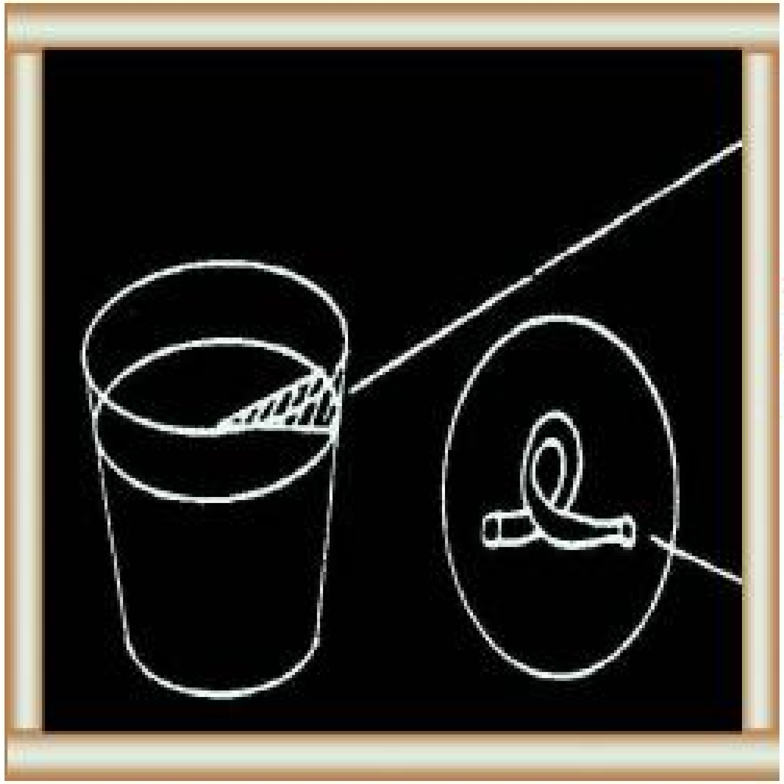
23 For 2-3 days after calving the milk (colostrum) contains:

- high amounts of proteins
- antibodies which protect calves from disease.

24 You cannot use

colostrum for dairy products because it coagulates when heated. So do not deliver milk to the dairy for 4-5 days after calving.

25 Normal milk contains



3.4 - 4% proteins
which help to build up our bodies.

page 11

Milk proteins (26-27)

Milk proteins consists of 2 major groups.

Casein

About 80 % of milk protein is casein which is made up

of a number of components together forming complex particles.

Casein is not significantly altered by normal pasteurization procedures. Heating at high temperatures for some time will change the properties of the casein complex and break down certain amino acids. These changes are organoleptically observed as cooked flavour and brown colouration; physically they are observed as changes in the heat stability and rennetability of the milk.

The composition of the casein complex varies within and between species. Thus the procedures to be followed for the manufacture of certain dairy products vary according to the kind of milk being used. The micella in buffalo milk, for example, are much larger than those in cow milk; moreover, they contain more calcium and phosphorus.

There are two different methods of precipitating the casein:

- by souring the milk either by the direct addition of

acid or by bacterial acid production;

- by coagulation after the addition of certain enzymes.

Different names are used for the various states in which casein can exist:

- as it occurs in milk, whether raw or after heat treat-ment (casein complex);

- as it is precipitated by enzymes (sometimes called the paracaseinate complex);

- as it is precipitated by acid (acid casein).

Whey proteins (serum proteins)

If the milk has not been heat treated, the water-soluble whey or serum proteins stay in the milk serum after the casein has been precipitated by acid or by rennet.

Most of the whey proteins react with casein when the milk is heated to temperatures of 63 C and above. The higher the temperature and the longer the treatment, the more of these proteins will associate with the casein micella. At normal HTST pasteurization only very small

quantities are denaturized in this way. Cheese curd from milk, heated to a high temperature, will not release whey as ordinary cheese curd does. Milk-serum proteins in general, and lactalbumin in particular, have very high nutritional values. Their amino-acid composition is very close to a biological opti-mum. Whey protein preparates are widely used in the food industry.

page 12

---

26 There are two main types of protein in milk:

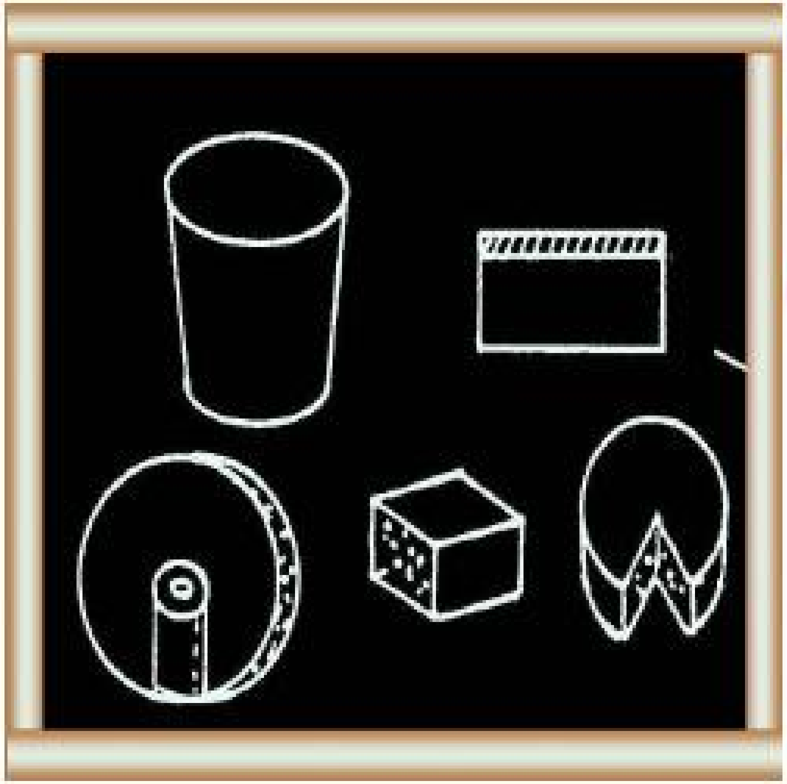
caseins and whey proteins.

When you sour milk or add rennet (enzyme),

the whey is liquid and

casein precipitates (curdles).

27 Milk products contain



different amounts of protein:

cream 2-3 %

cheese 20-40%

page 13

Small-Scale

Dairy Farming Manual

Volume 1

Technology Unit 1

Milk Composition - part 2

Enzymes (28-29)

Enzymes are a group of proteins produced by living organisms. They have the ability to start chemical reactions and to affect the course and speed of such reactions. Enzymes do this without being consumed. They are therefore sometimes called biocatalysts. An enzyme probably takes part in a reaction, but is released again when it has completed its job.

The action of enzymes is specific; each type of enzyme only catalyses one type of reaction.

Two factors which strongly affect enzymatic action are temperature and pH. Enzymes are usually most active in an optimum temperature range between 25 and 50 C. The activity drops if the temperature increases beyond optimum, stopping altogether somewhere between 50 and 120 C. At these temperatures the enzymes are more or less completely destroyed (inactivated). The temperature of inactivation varies from one type of enzyme to another - a fact which has been widely utilized for the purpose of finding the degree of pasteurization of milk. Enzymes also have their optimum pH ranges; some function best in acid solutions, others in alkaline solutions.

The enzymes in milk come either from the cow's udder or from bacteria. The former are normal constituents of milk and are called original enzymes. The latter, bacterial enzymes, vary in type and number according to the nature and size of the bacterial population. Several of the enzymes in milk are utilized for quality testing and control. Among the more important ones are

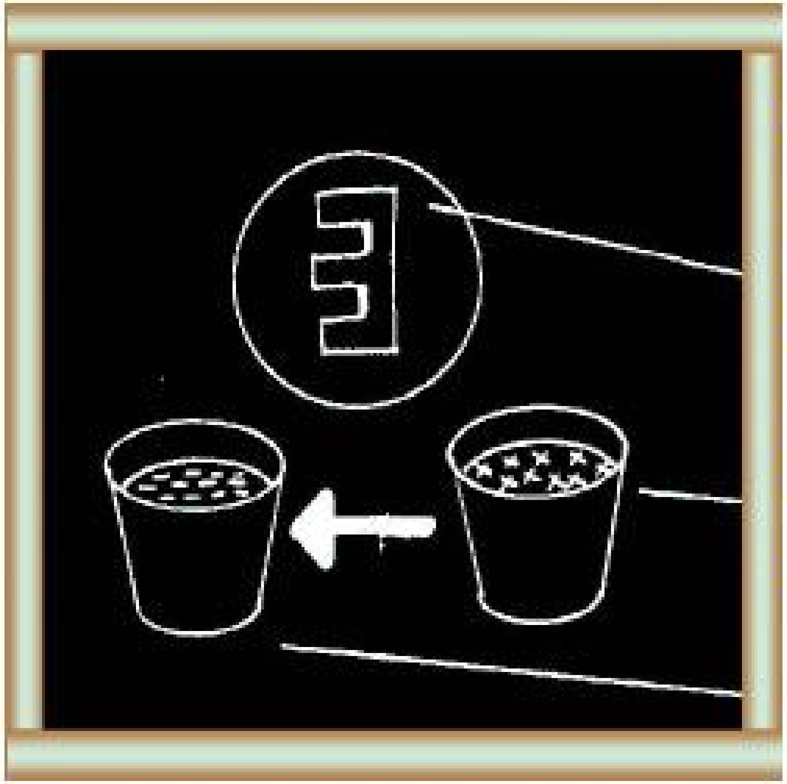
peroxidase, catalase, phosphatase and lipase.

Lipase (30-31)

Lipase splits fat into glycerol and free fatty acids. Excess free fatty acids in milk and milk products result in a rancid taste. The action of this enzyme seems, in most cases, to be very weak, though the milk from certain cows may show strong lipase activity. The quantity of lipase in milk is believed to increase towards the end of the lactation cycle. Lipase is, to a great extent, inactivated by HTST pasteurization, but higher temperatures are required for total inactivation. Many microorganisms produce lipase. This can cause serious problems as this enzyme is very resistant to heat.

page **14**

Enzymes



28

Enzymes start chemical changes:

- one substance in milk changes

to other substances.

29 Some enzymes come from

the udder.

Pasteurization usually destroys them.

30 Other enzymes come

from bacteria,
e.g. on dirty equipment, and change the milk
to have a bad taste and smell.

Pasteurization does not always destroy them.

31 Milk products made from this milk are poor quality.

page **15**

Lactose (32 - 35)

Lactose is a sugar and belong to the group of organic chemical compounds called carbohydrates.

Carbohydrates are the most important source in our diet. Bread and potatoes, for example, are rich in carbohydrates, an provide a reservoir of nourishment. They break down into high-energy compounds which can take part in all biochemical reactions, where they provide the necessary energy. Carbohydrates also supply material for the synthesis of some important chemical compounds in the body. They are present in muscles as muscle glycogen and in liver as liver glycogen. Blood sugar is also composed of carbohydrates.

Glycogen is an example of a carbohydrate with a very large molecule. Other examples are starch and cellulose. Such composite hydrocarbons are called polysaccharides and have giant molecules made up of many glucose molecules. In glycogen and starch the molecules are often branched, while in cellulose they are in the form of long, straight chains.

The lactose content of milk varies between 3.6 and 5.5 %. Figure 2 shows what happens when lactose is attacked by lactic acid bacteria. These bacteria contain an enzyme called lactase which attack lactose, splitting its molecules into glucose and galactose. Other enzymes from the lactic acid bacteria then attack the glucose and galatose, converting them into various acids of which lactic acid is the most important. This is what happens when milk goes sour, i.e. fermentation of lactose to lactic acid. Other micro-organisms in the milk generate other breakdown products.

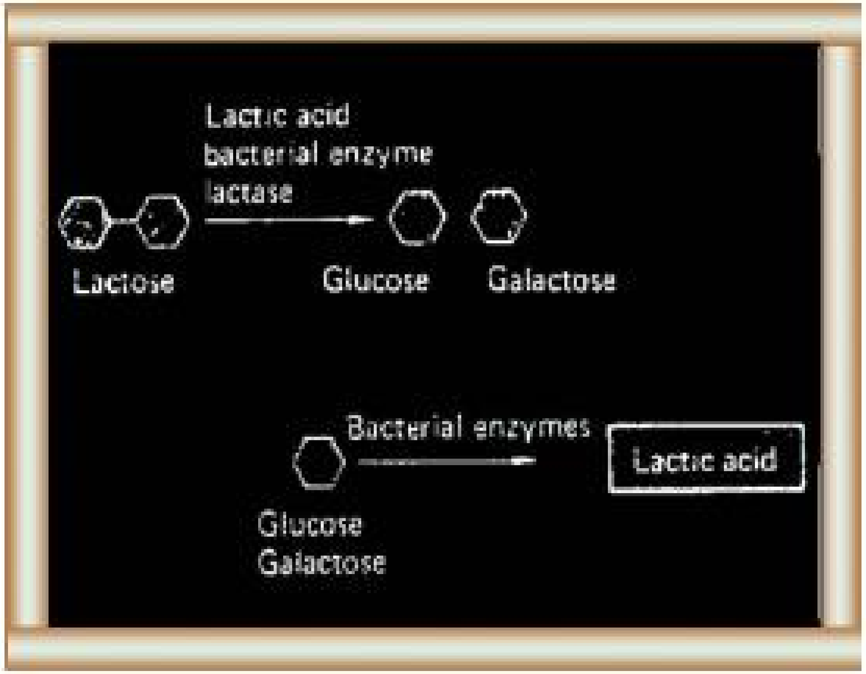


Figure 2: Break Down of Lactose to Lactic Acid

If milk is heated to a high temperature, and is kept at

that temperature, it turns brown and acquires a caramel taste. This process is called caramellization and is the result of a chemical reaction between lactose and proteins, the so called Maillard reaction.

Lactose is water soluble, occurring as a molecular solution in milk. In cheese-making most of the lactose remains dissolved in the whey. Evaporation of whey in the manufacture of whey cheese increases the lactose concentration further. Lactose is not as sweet as other sugars; it is 30 times less sweet that cane sugar, for example.

Lactose

32 Lactose is a milk sugar and

milk contains 4.6 - 4.7%.

It gives milk a slightly sweet taste and is soluble in water.

33 Lactose is a carbohydrate and

gives our body energy.

34 Lactose changes into lactic

acid with helps from

lactic acid bacteria and produces the fresh sour taste in sour milk, yoghurt, cheese and other products.

35 After strong heating, the lactose gives the milk

a brownish colour and a caramel taste.

page 17

Vitamins (36)

The vitamins in milk can be divided into two groups, those soluble in fat and those soluble in water. Vitamins are organic compounds, whose presence in the

organism is necessary for its normal functions. They cannot be produced by the organism itself, and therefore they must be taken in through the food.

The fat soluble vitamins in milk are A, D, E, and K. Milk fat also contains carotene which can be changed to vitamin A. The B and C vitamins make up the water soluble vitamins. The B vitamin complex consists of a series of vitamins of which the following can be found in milk: Thiamin (B_1), Riboflavin (B_2), Niacin, Folic acid, Pyridoxin (B_6), Biotin, Kolin (B_{12}) and Inositol.

The water soluble vitamins are partly destroyed by heat treatment. Among the fat soluble vitamins only vitamin A can be denatured in milk. This is done by oxidation.

Vitamin A (37)

1 glass of full-fat milk provides about 8 % of an adult's and about 10 % of child's daily vitamin A requirement.

Deficiency of vitamin A can cause eye diseases.

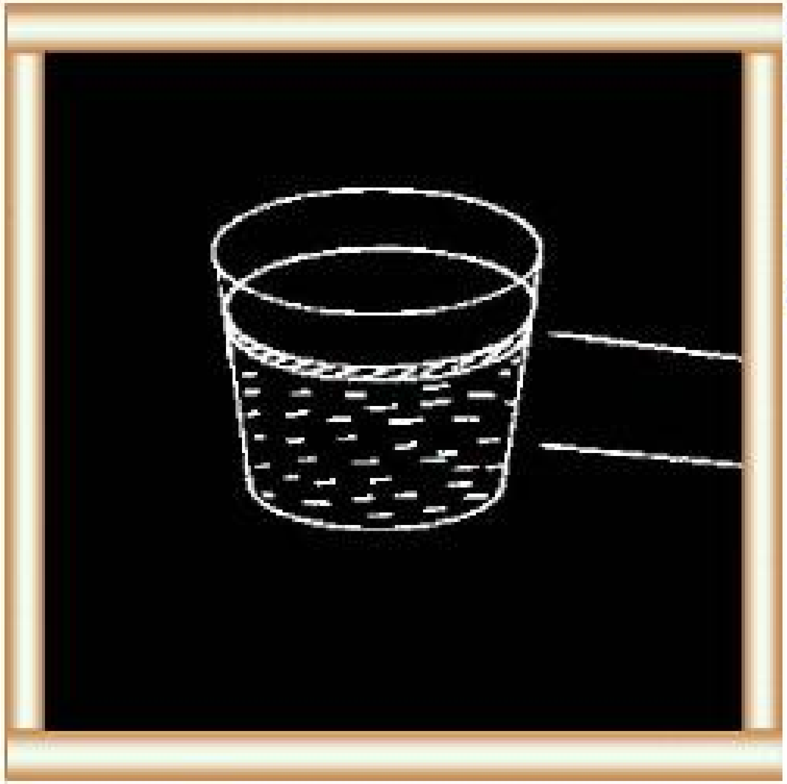
Vitamin B_2 (38)

1 glass of fresh full-fat milk provides about 12 % of a child's and of an adult's daily vitamin B_2 requirement.

page 18

Vitamins

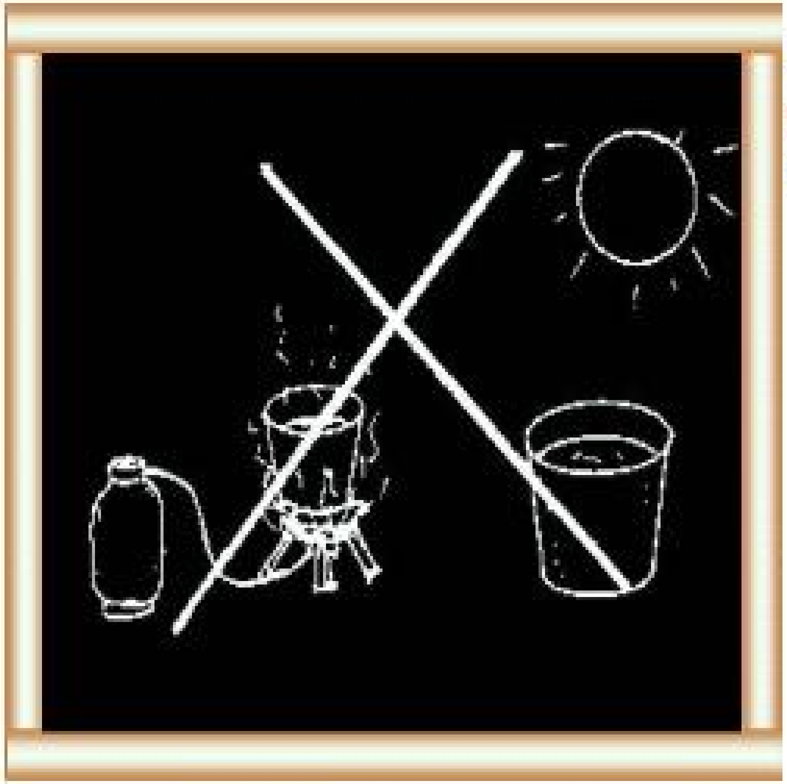
36 Milk contains many vitamins. If our body lack vitamins we get disease.



Some vitamins are soluble in cream (A, D, E, K).

Other vitamins are soluble in skim milk (B, C) i.e. they are water soluble.

37 A lot of vitamin A gives the milk fat a rich yellowish colour because of carotene.



38 leaving milk in strong light reduces the amount of vitamins B2 and C.

page19

Minerals (39)

Milk contains a number of minerals. The total concentration is less than 1 %. Mineral salts occur in

solution in milk serum or in casein compounds. The most important salts are those of calcium, sodium, potassium and magnesium. They occur as phosphates, chlorides, citrates and caseinates. Potassium and calcium salts are the most abundant in normal milk. The amounts of salts present are not constant. Towards the end of lactation, and even more so in the case of udder disease, the sodium chloride content increases and gives the milk a salty taste, while the amounts of other salts are correspondingly reduced.

Calcium (40)

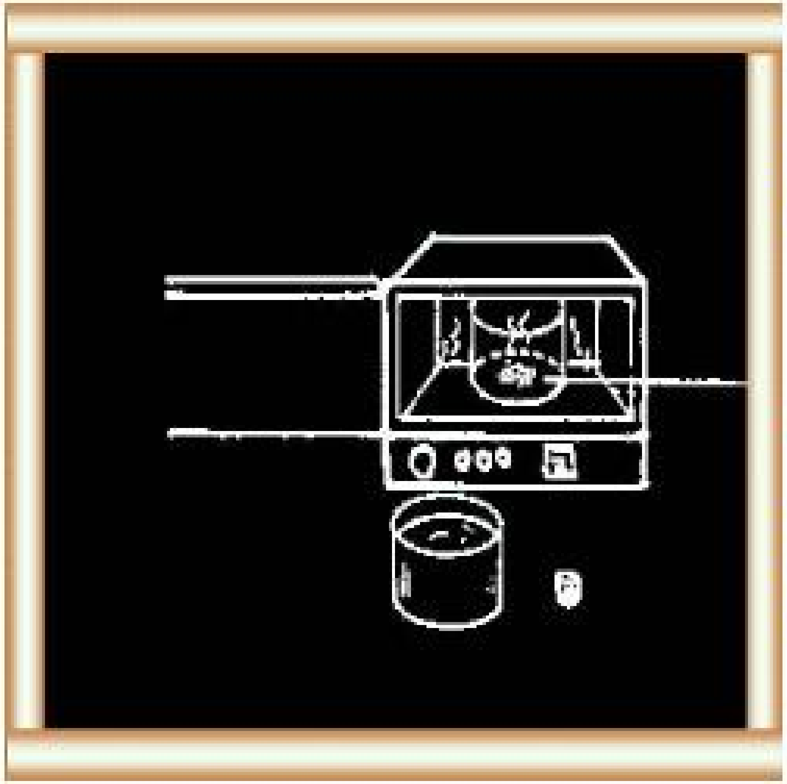
Calcium is necessary to build up children's teeth and bones and to maintain adult's bones. Calcium also serves many other functions in the body. Other calcium sources are fish (where the bones are eaten as well) and leafy vegetables.

1 glass of milk provides about 40 % of an adult's and 30 % of a child's daily calcium requirement.

White corpuscles (41-42)

Milk always contains white blood corpuscles (leucocytes). The content is low in milk from a healthy udder, but increases if the udder is diseased - usually in proportion to the severity of the disease.

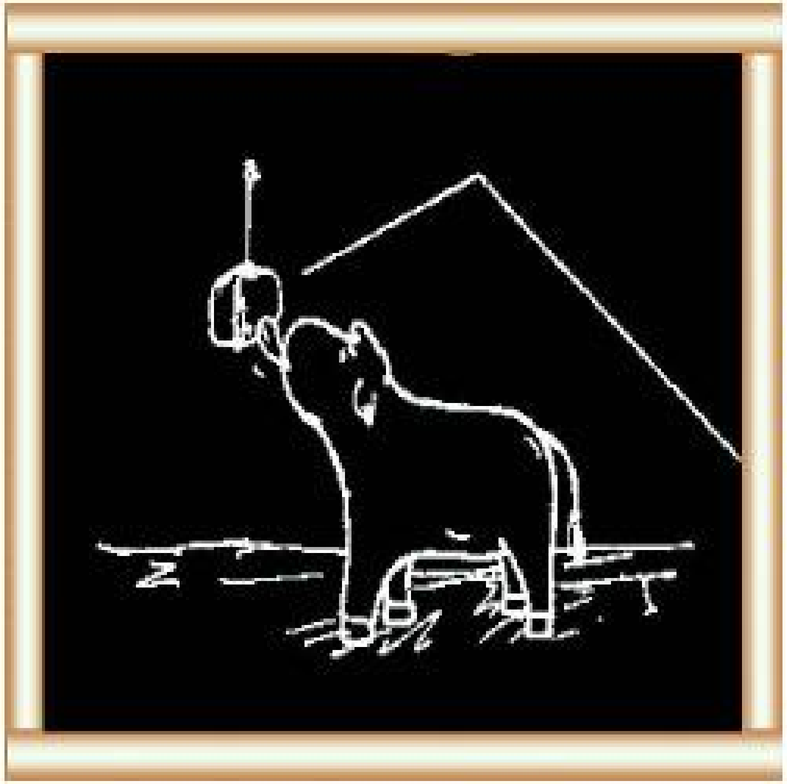
Minerals



39 When the dry matter in the milk burns,

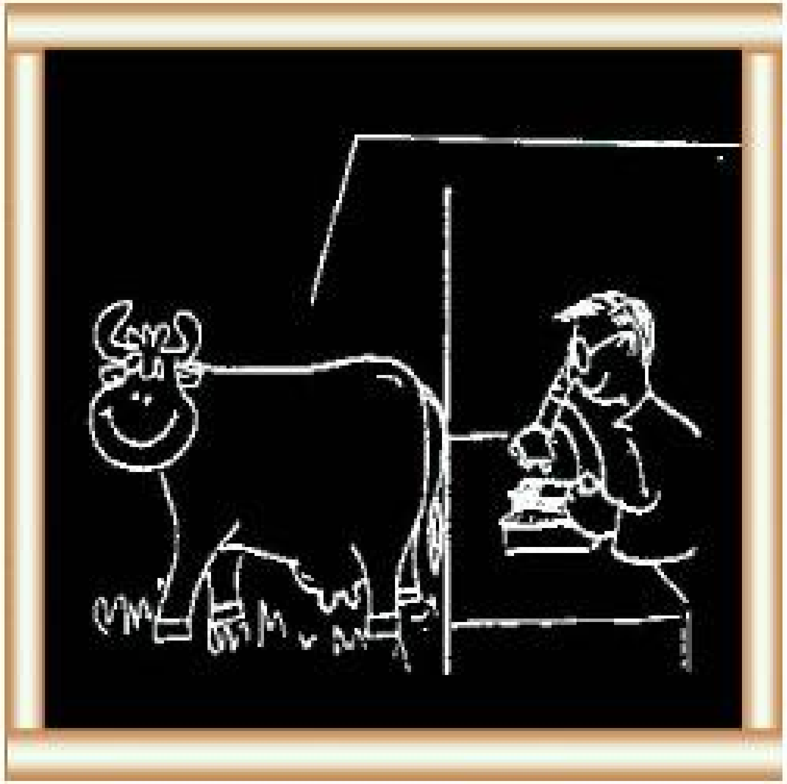
ash remains.

The ash contains minerals which make up about 1% of the milk.



40 Milk is rich in some minerals.
e.g. calcium and phosphate for bones and teeth,
but poor in others e.g. iron - calves need a supplement to prevent anaemia.

White Corpuscles



41 Healthy cows have

few white corpuscles in their milk.

42 If the udder is diseased the milk will have

many white corpuscles.

Do not use milk from diseased udders
for drinking or for making products.

page20

Bacteria (43-46)

The quality of milk is largely determined by the number

and the types of bacteria present in the milk.

Each bacterium consists of only one cell. Bacteria multiply by dividing into new cells. This process can be very rapid. Some bacteria need only twenty minutes to divide into two new bacteria.

So, after forty minutes there may be four bacteria, after one hour eight, etc. After four hours, one single bacterium may have multiplied to four thousand!

Milk is a very good medium for bacteria and in a relatively short time large numbers of bacteria can develop in milk if it is not properly cooled. Cooling of the milk prevents the growth of most types of bacteria to a considerable degree. If milk has to be stored for 12 - 18 hours only, cooling down to 8^{o}C is enough. If milk must be stored for one day or longer, cooling down to 4^{o}C is necessary.

Types of bacteria

Lactic acid bacteria change milk sugar into lactic acid. They are found everywhere: in the air, the stable, on

clothes and on milking equipment (especially if not properly cleaned). Milk is easily contaminated with these bacteria.

Coli bacteria also change milk sugar, but not only into lactic acid. They also form gases. Coli bacteria are mostly found in faeces.

Infectious bacteria are commonly found in soil and water, but also on milking equipment which is not properly cleaned. In the latter case they can infect milk. They affect the protein and sometimes the fat in milk, giving it a bad flavour.

Butyric acid bacteria are commonly found in (bad quality) silage. By feeding this during milking, the milk will be contaminated. Therefore, silage should only be fed after milking is finished. The presence of butyric acid bacteria in milk causes problems if the milk is used for cheese making.

Mastitis bacteria are present in milk when the udder of the cow is not healthy and has developed udder infection.

On the farm, proper cleaning and disinfection of the milk equipment helps to prevent the development of a large number of the above mentioned bacteria.

Note: Dust or dried cow dung may contain as many as 1,000,000,000 bacteria per gram!

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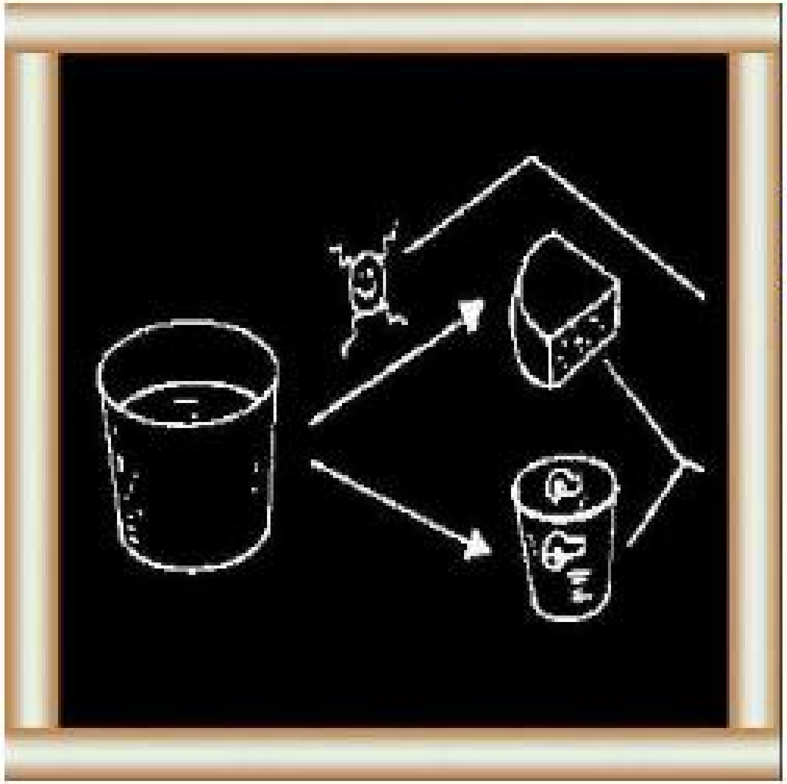
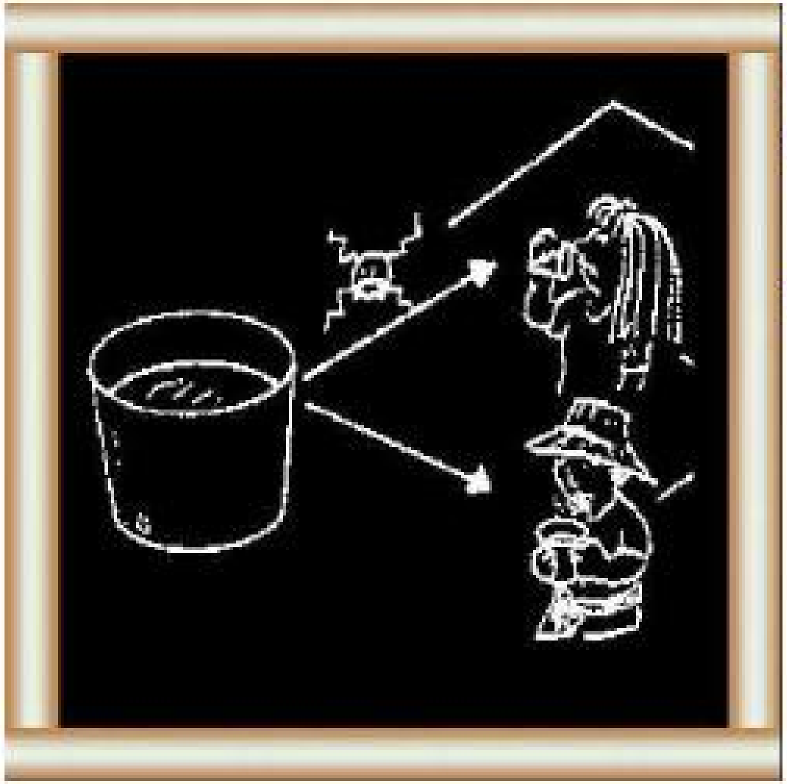
Bacteria

43 All milk contains bacteria.



Some bacteria cause useful changes

e.g. in making cheese,
yoghurt
and other milk products.



44 Other bacteria cause harmful changes such as bad flavours or smells

and bad keeping quality.

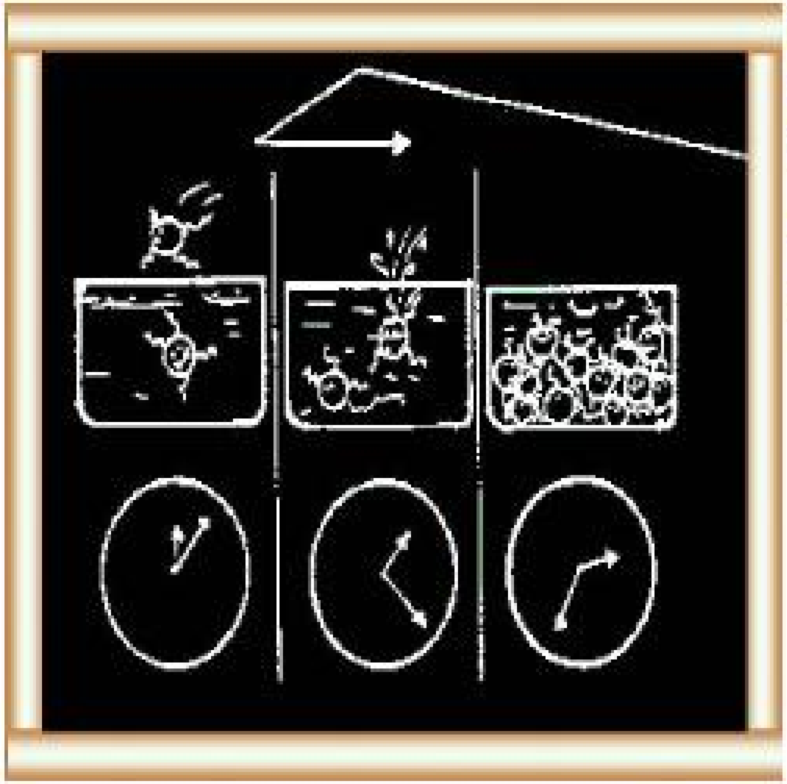
45 There are more bacteria:

-on dirty udders, hands and containers

-in diseased udders

at warm temperatures.

46 Bacteria reproduce quickly.



Try to slow the reproduction of bacteria by keeping your milk:

-cool
-clean.

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Small-Scale

Dairy Farming Manual

Volume 1

Technology Unit 1

Milk Composition - part 3

Lactation Period

The composition of the milk varies throughout the lactation cycle. During the first days of the laceration cycle composition of the milk varies a lot from the resting period. The milk which is secreted during the first days after calving is called colostrum; it has an

increased content of protein and ash. Colostrum contains 20-30% dry matter. The variations in milk in the remaining lactation cycle is shown in Figure 3. Together with increase in fat content , the content of the protein and ash also increase mainly due to an increase in the salt content.

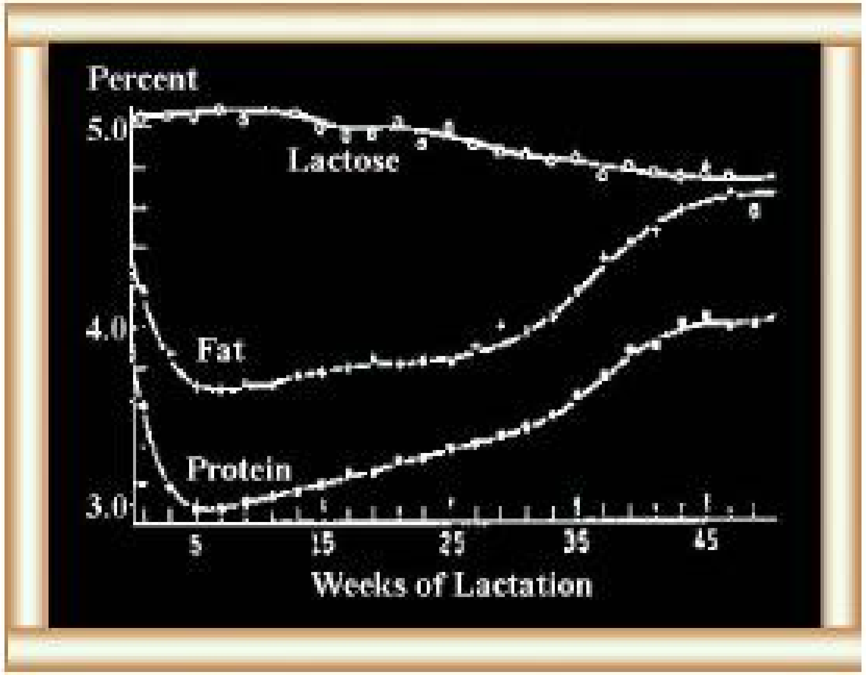

Figure 3: Variations in milk Composition During the Lactation Period.

Right after calving, the milk is called Colostrum milk:

	Water	Fat	Protein	Sugar	Salts
at birth	66,4	6.5	23.7	2.1	1.4
after 12 hrs.	79.1	2.5	13.7	3.5	1.1
after 24 hrs.	84.4	3.6	7.1	4.2	1.0
after 48 hrs.	86.0	3.7	4.9	4.4	0.9

Colostrum milk cannot be delivered to the milk factory. About 3-5 days after calving the milk will have reached its normal composition.

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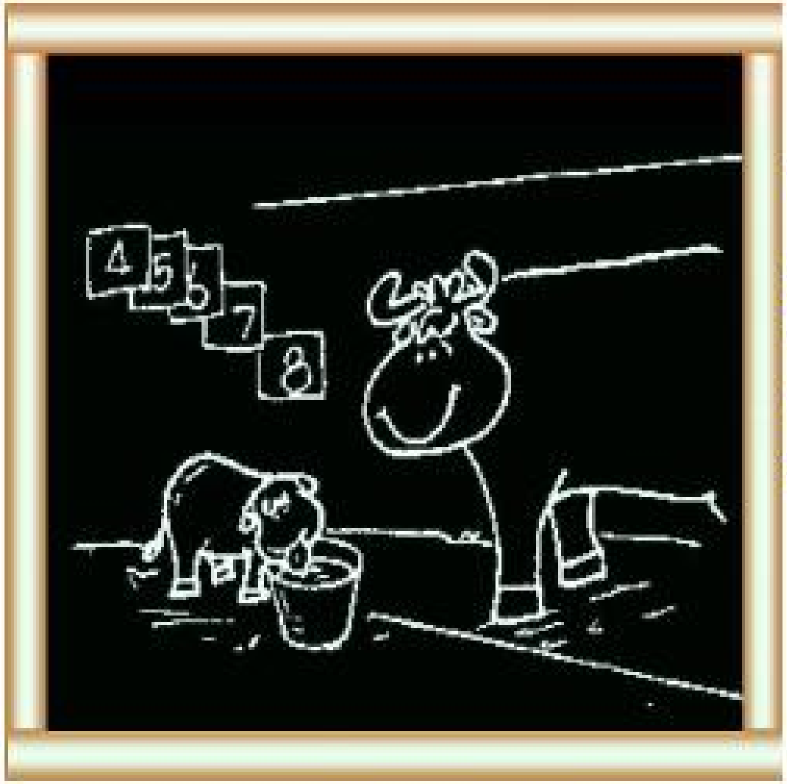
What affects milk composition ?

Lactation Period



47 Right after calving,

your cow gives colostum milk.

You cannot deliver this to the milk collecting centre.

48 After 4-5 days

the composition is normal

and you can deliver your milk.

49 Compare the differences in milk

- at birth and

- after five days.

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Time of Milking

Cows are normally milked twice a day: early morning

and late afternoon. Milk obtained at the morning milking is much lower in fat (e.g. 3 percent) than at the afternoon milking (e.g. 5 percent).

This is not because fat secretion is reduced in the longer night interval but because there is a net carryover of residual milk rich in fat from the night to the day interval.

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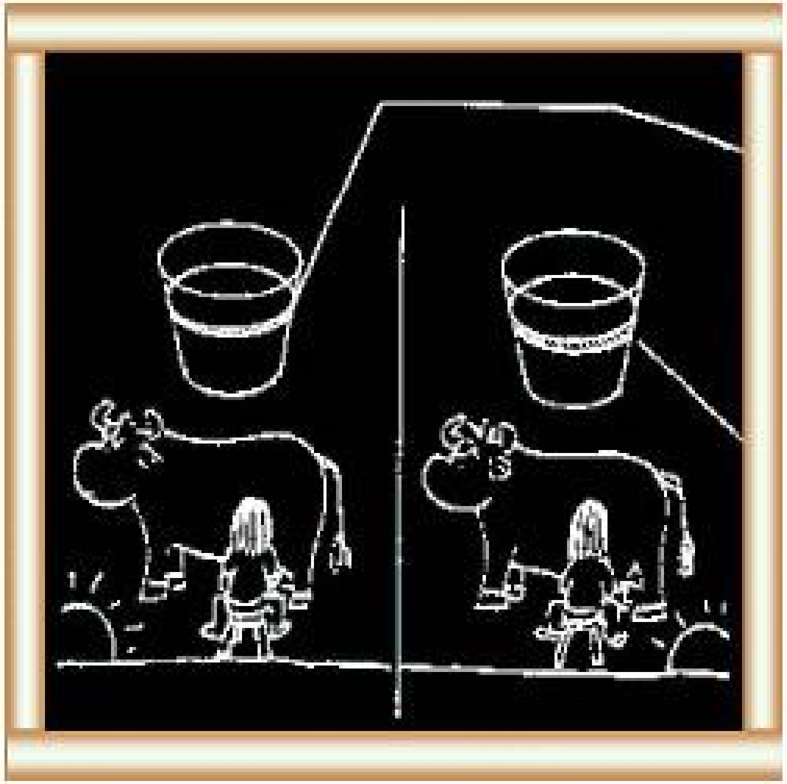
Time of Milking

50 Morning milk has



lower fat content (about 3 parts in 100)

than evening milk (about 5 parts in 100).

Type of Milk

51 There are many types of milk.

Three major types are:

Vitamin A

	Fat Content	Energy	and D
Whole Milk		High	High
Low fat Milk		Medium	Medium
Skim Milk		Low	Low

All three kinds contain almost the same amount of protein.

Type of Animal

Table 2 gives representative values for the main constituents of nutritional importance of the milk of humans and the milch animals. The composition of milk not only differs from species to species but varies widely within any one species and even within breeds or races of one species. Many factors determine composition: physiological variability of the individual, nutrition, stage of lactation, age, season of the year, amount of milk produced - to name only a few. It is clear, therefore, that

the values given in the tables can only serve as a general guide and departures from them will be found in quite normal individual animals or herds. The main milch animals have been bred for centuries to produce quantities of milk far in excess of the amounts needed by their young. The milk of these domesticated and highly specialized animals retains the main characteristics of that of the wild stock. As a rule, however, the milk given in much smaller quantity by the wild or less domesticated animals is "richer" in that it contains more nonfatty solids and often more fat. The cow is more generally used throughout the world than any other milch animal and more is known about its milk, hence the examples quoted for it in the tables are likely to be more accurate.

Species	Fat	Solids (nonfat)	Protein (Nx6.38)	Lactose (Anhydrous)	Calcium	Physiological energy
	g / 100 g					Calories/100g
Human	4.62	8.97	1.23	6.94	0.03	73
Cow:						
Friesian	3.50	8.65	3.25	4.60	0.115	62
Guernsey	4.65	9.10	3.65	4.70	0.13	75
Buffalo:						
	7.45	9.32	3.78	4.90	0.19	100

Indian	4.50	8.70	3.30	4.40	0.13	71
	7.50	10.90	5.60	4.40	0.20	105
Goat	1.60	8.50	2.20	6.00	0.09	47
Ewe	1.50	8.60	2.10	6.20	0.08	46
Mare	4.20	8.70	3.70	4.10	-[1]	70
Ass	7.00	10.90	5.20	4.60	-	100
Camel	3.20	10.30	3.90	5.30	-	65
Yak	22.50	14.20	10.30	2.40	-	250
Llama						
Reindeer						

Table 1: Representative values for some major constituents of good quality milk of different species

[1] In the table a dash (-) denotes lack of information or unreliable information.

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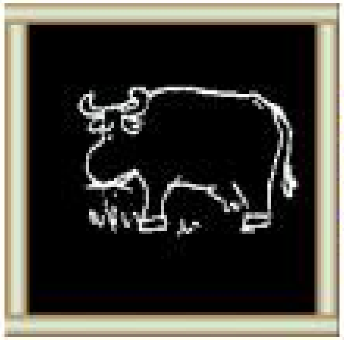
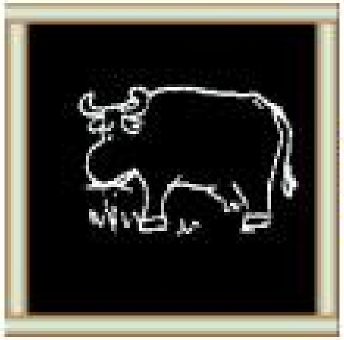
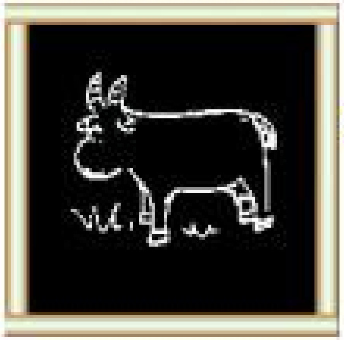
Type of Animal

52 Milk from different animals has different compositions (g/100g).

		Fat Content	Solids-not-fat	Note
	Human	4.6	9.0	
	Pure breed cow	3.5-5.0	8.5-9.0	Rich in vitamin A poor in vitamin B
	Zebu cow	5.0-5.5	8.5-9.0	Higher fat content Lower yield



Goat	4.5	8.7	Smell unpleasant, boil soon after milking
Ewe	7.5	10.9	Curdles sooner than cow's milk, cheese matures slower
Mare	1.6	8.5	
Ass	1.5	8.6	
Camel	4.2	8.7	
Yak	7.0	10.9	
Llama	3.2	10.3	
Reindeer	22.5	14.2	

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Other Factors

The following also affets the composition of milk.

53 Breeding

54 Feeding

55 Hygiene

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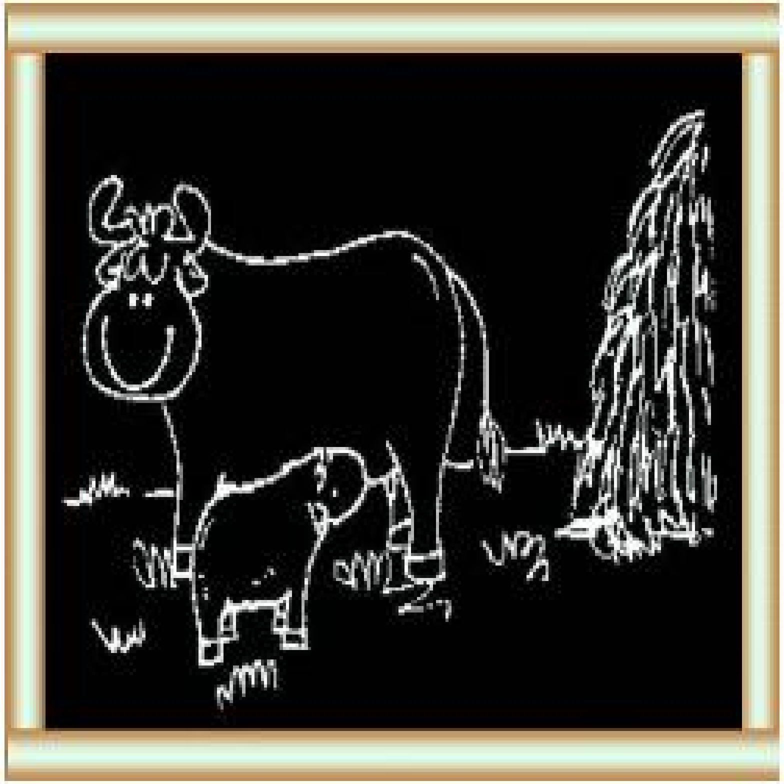

56 **Health**

Age

57 Temperature

58 Handling

Ask your extension worker for advice about these factors.

page 30

What do you know about milk composition ?

Reasons for drinking milk

1. **Energy** (5)
2. **Health** (6-7)

Preparation of milk

1. **Liquid at room temperature** (9)
2. **Yellowish-white colour and sweetish smell** (10)
3. **Freezes at slightly lower temperature than water** (11

4.	Slightly heavier than water	(12)

Composition

1.	Fats	(14-21)
2.	Proteins	(22-27)
3.	Enzymes	(28-31)
4.	Lactose	(32-35)
5.	Vitamins	(36-38)
6.	Minerals	(39-40)
7.	White corpuscles	(41-42)

Factors affecting milk composition

Small-Scale

Dairy Farming Manual

Volume 1

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Milk Quality

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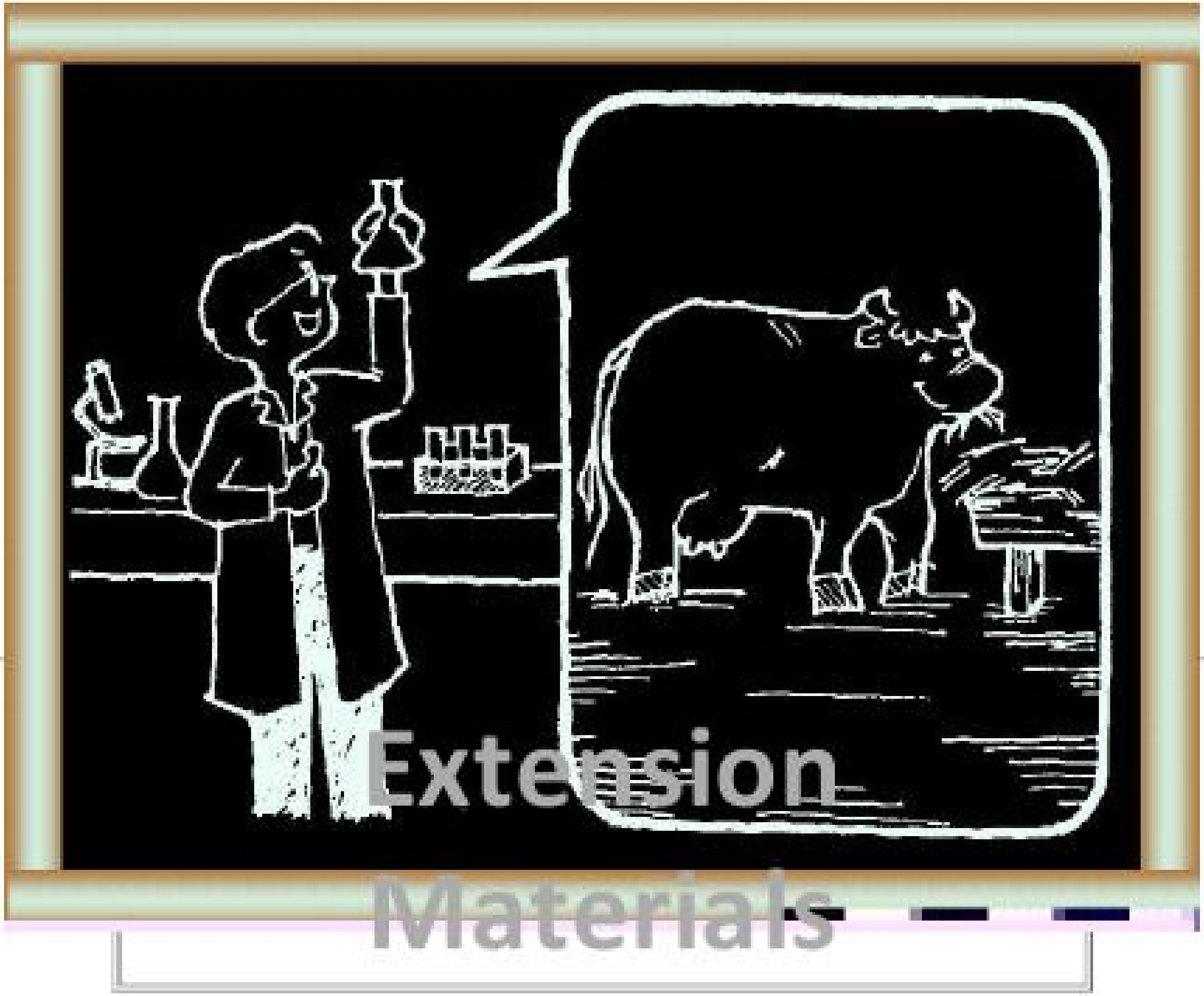
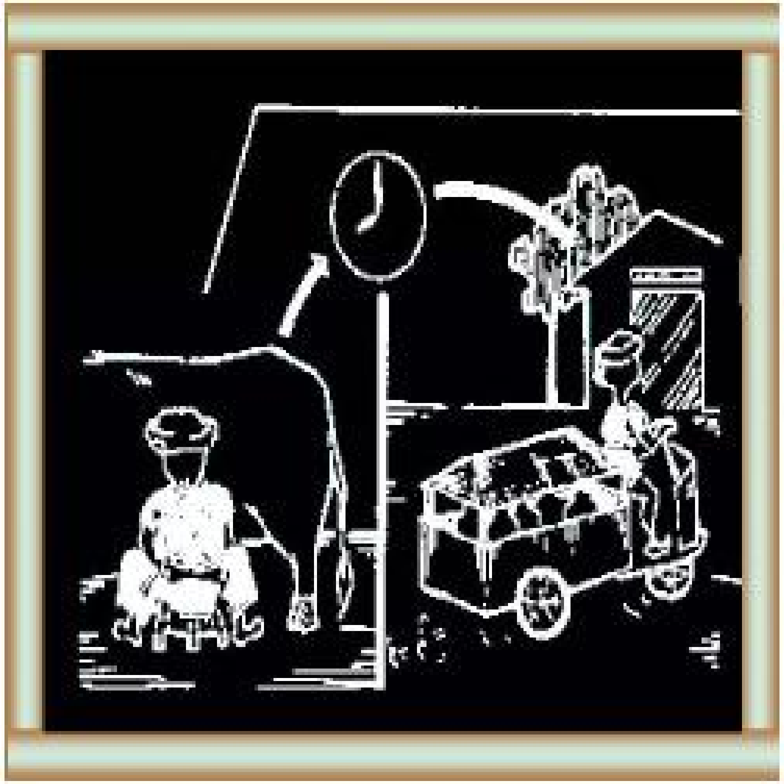


What should you know about milk quality ?

Why should you produce high quality milk ? (5 - 8)

1 High quality milk:
- earns you money
- is better for you
-keeps longer.

How can you produce high quality milk ? (9 - 12)



2 Make sure:
-you and your cows are healthy
-everything is clean
-you keep your milk cool and deliver quickly.

What affects the quality of your milk ?

3 The number

ofbacteria in your milk (13 - 31) and the health of your cows (32 - 34).

4 Thequality of your feed

(35 - 36)
and thepurityof
you milk
(39 - 43).

page35

Why should you produce high quality milk ?

5 They test your milk at the collecting centre -

high quality milk gets a

good price.

6 High quality milk has

many nutrient and

few bacteria.

7 So it tastes good and

makes you

strong and healthy and keeps.

8 Milk with

many bateria

tastes bad and does not keep.

page 36

How can you produce high quality milk ?

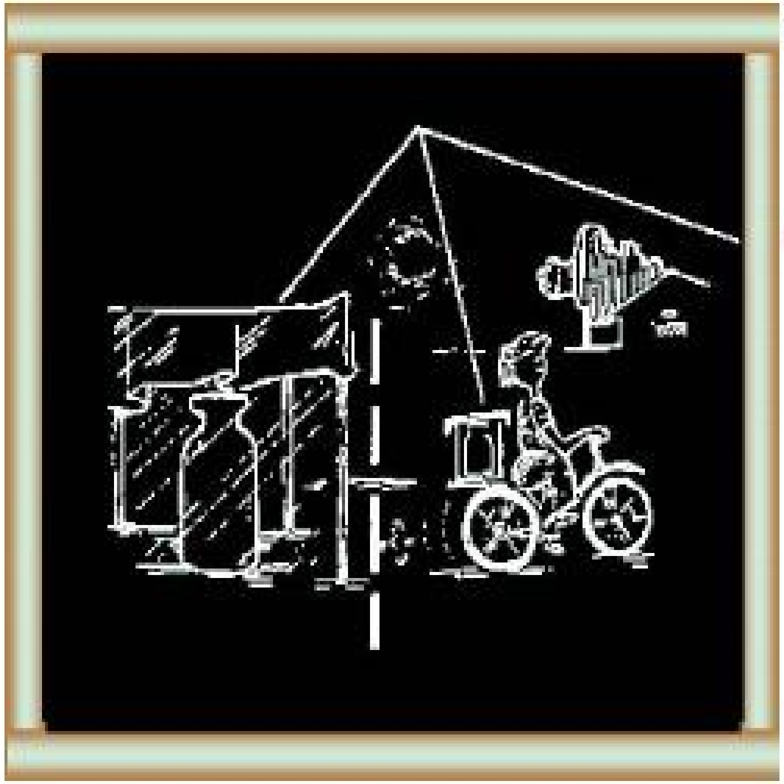
9 Make sure:

- your cows are healthy

10 you are clean

your cow is clean

every thing at the milking
place is clean



11 you keep your milk

cool

12 you get your milk

to the collecting centre

in the shortest time possible

page37

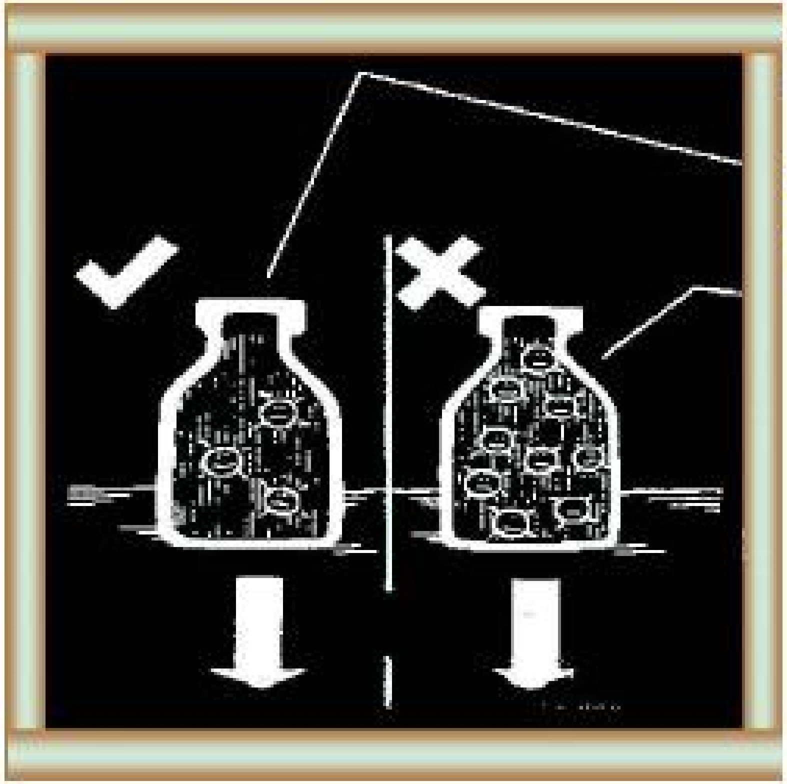
What affects the quality of your milk ?

Bacteria

13 all milk contains

some bacteria

14 Milk with few bacteria is of



high quality. Milk with many bacteria is of low quality.

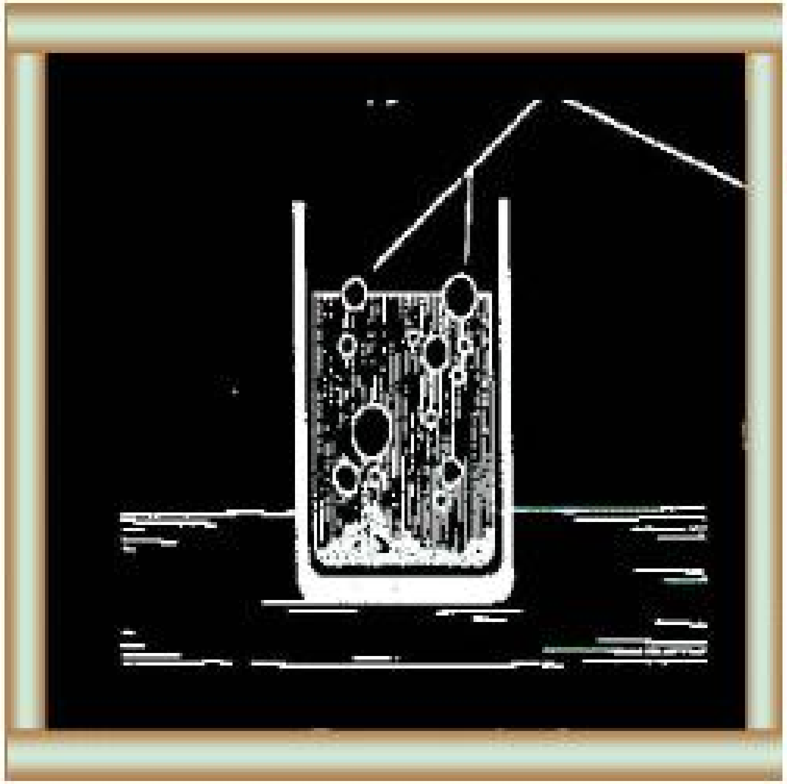
You get more money for high quality milk.

15 if your milk is of low quality and contains many bacteria,

you get less money
and the milk collection
centre
may reject your milk.

16 Some bacteria produce acids

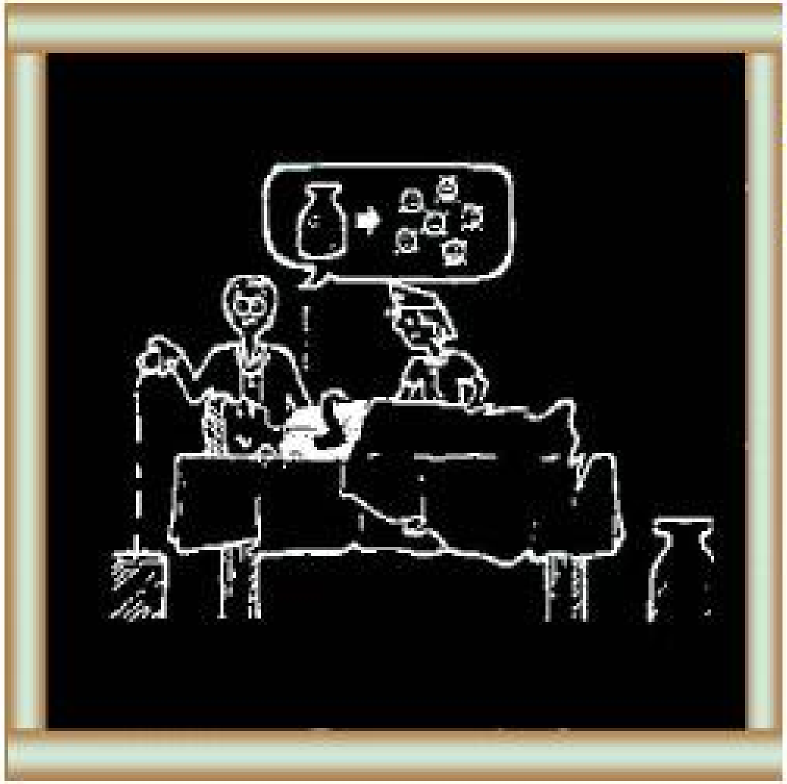
and turn the milk sour.



17 Some bacteria produce gas and spoil your milk.

18 Most bacteria breakdown your milk

and reduce the nutrient value.



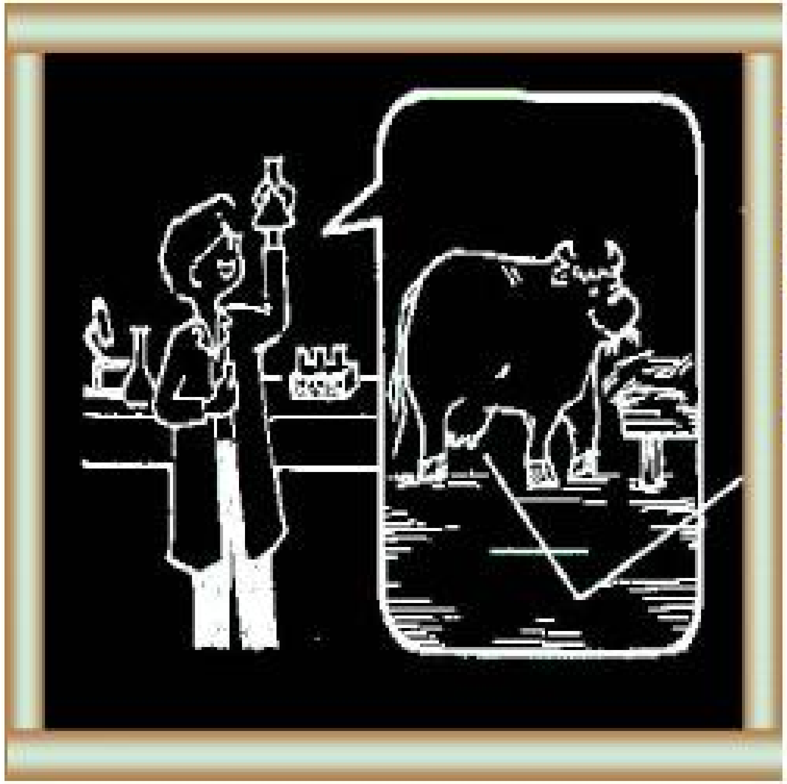
19 Some bacteria

can make you ill

or even kill you.

page 39

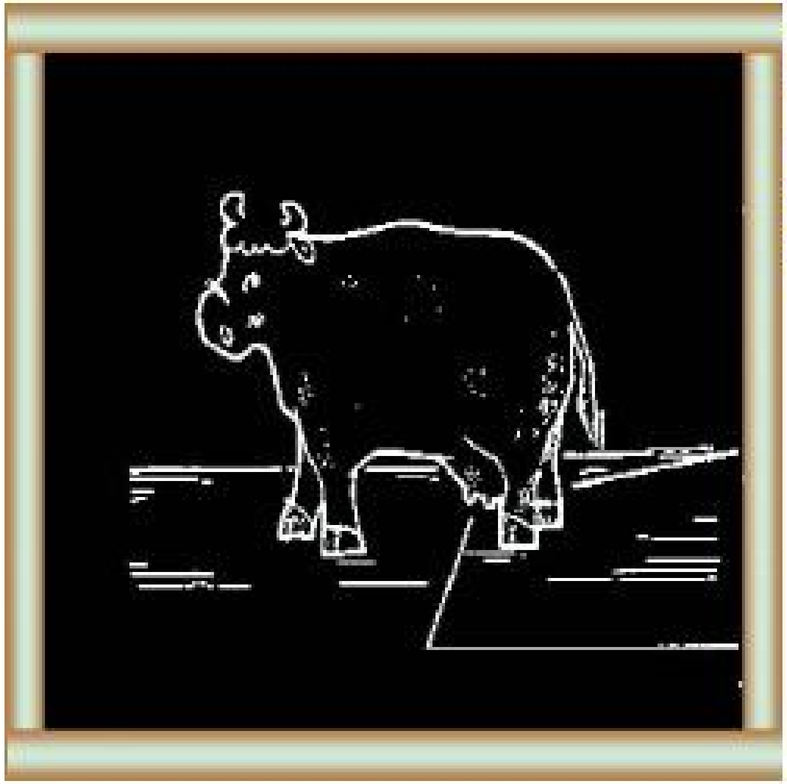
Where do the bacteria come from ?
Your cattle



20 Healthy udders produce a few bacteria, but only a few.

They do not harm your milk.

21 Diseased udders produce many bacteria, which can harm your milk and you.



22 Bacteria come from:
- dirt and faeces on the hind legs, udder and teats.

23 You:

-sneezing and coughing
- dirty hands and clothes
- inflamed wounds.

page 40

Milking Utensil

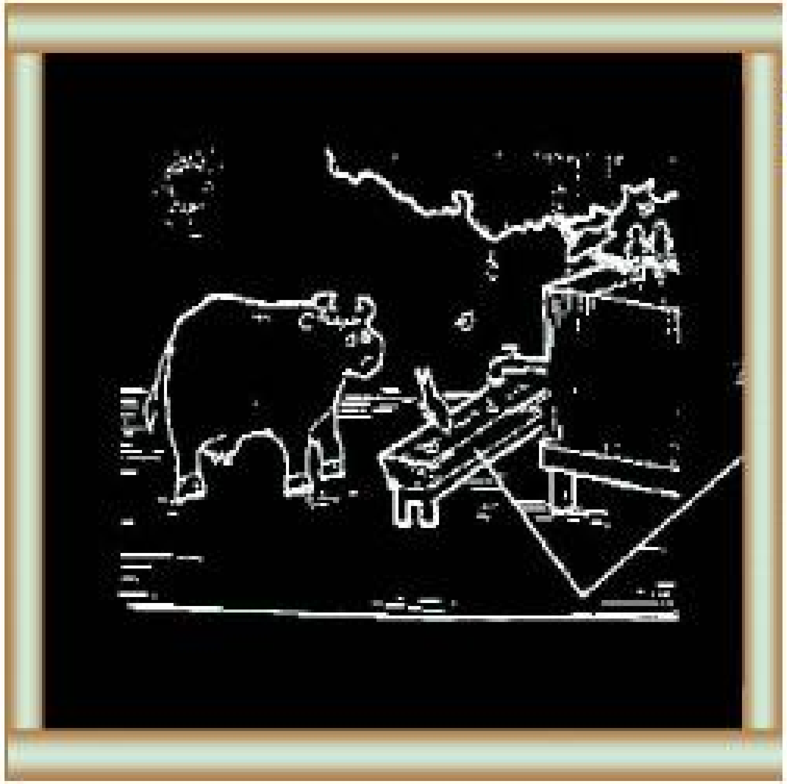
24 Bacteria come from:
- dirty pails
- dirty strainers
- dirty churns
- dirty udder cloths

Environment

25 Dirty walls and floors

26 Dust carries

bacteria from:
- the surroundings
- the manure heap
- residues
- the soil



27 Dirty water contains many bacteria.

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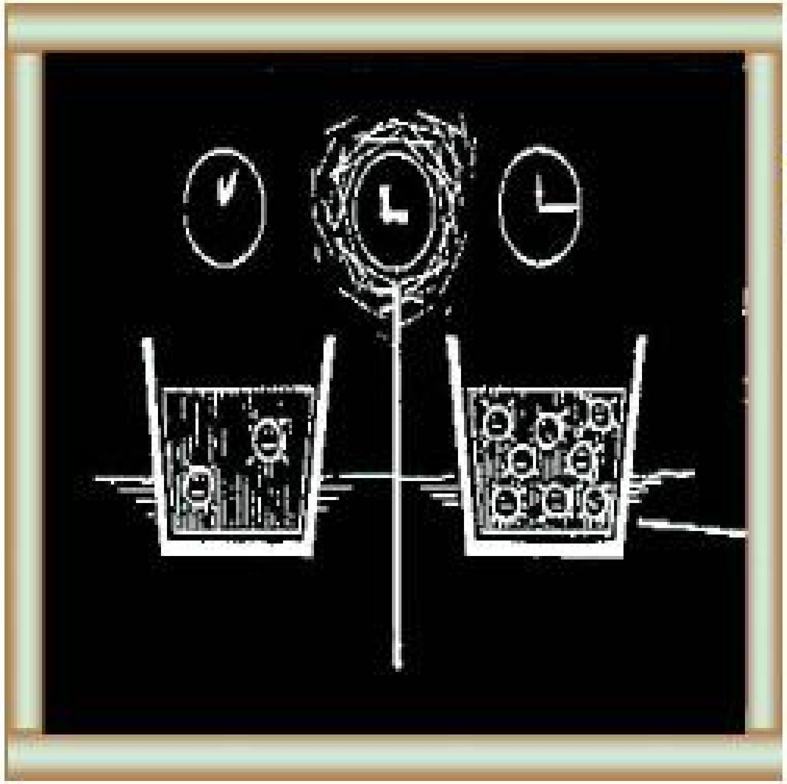
How can you keep the number of bacteria in your milk low ?

During milking

28 Keep milk clean by:
- milking in a clean cow shed
- using clean milking utensils
-using clean milking practices.

During storage



29 Bacteria multiply quickly in a warm place.

30 Keep the collected milk in cans in a shady and cool place.
Dip the cans in cold water before and after nilking.

During transport

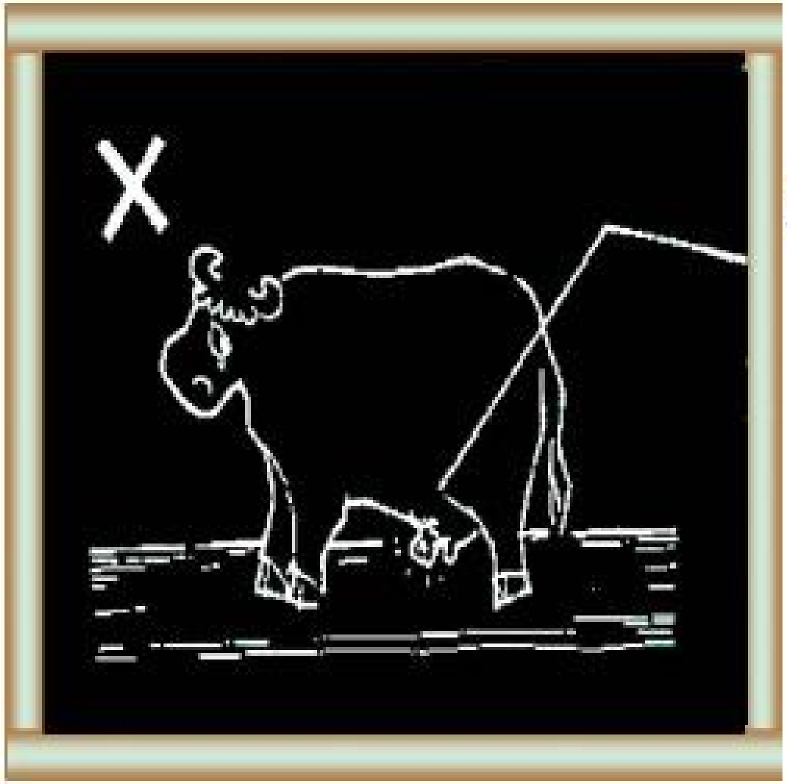
31 Get your milk to the collecting centres as soon as possible after milking.

page **42**

Health

32 High quality milk
comes from healthy cows.
If your cow is sick,
consult your extension worker.

33 If your cow has



mastitis, do not deliver your milk.
The collecting centre will reject it.

34 If your cow had

antibiotic injections,
do not deliver your milk
until you consult your veterinatian
or extension worker.

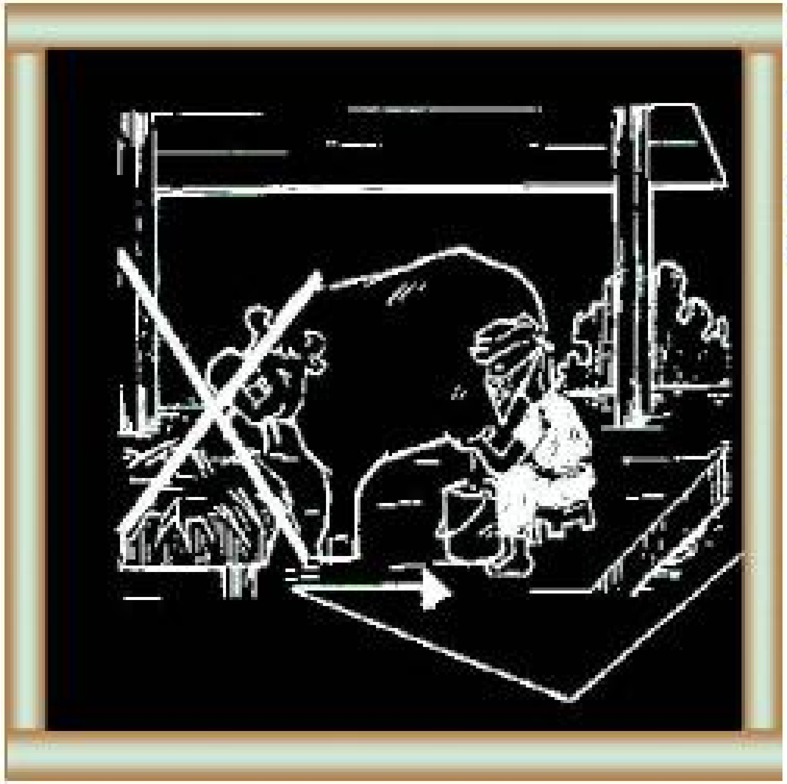
page43

Feeding

35 If your milk has bad taste or smell, you may have to improve:

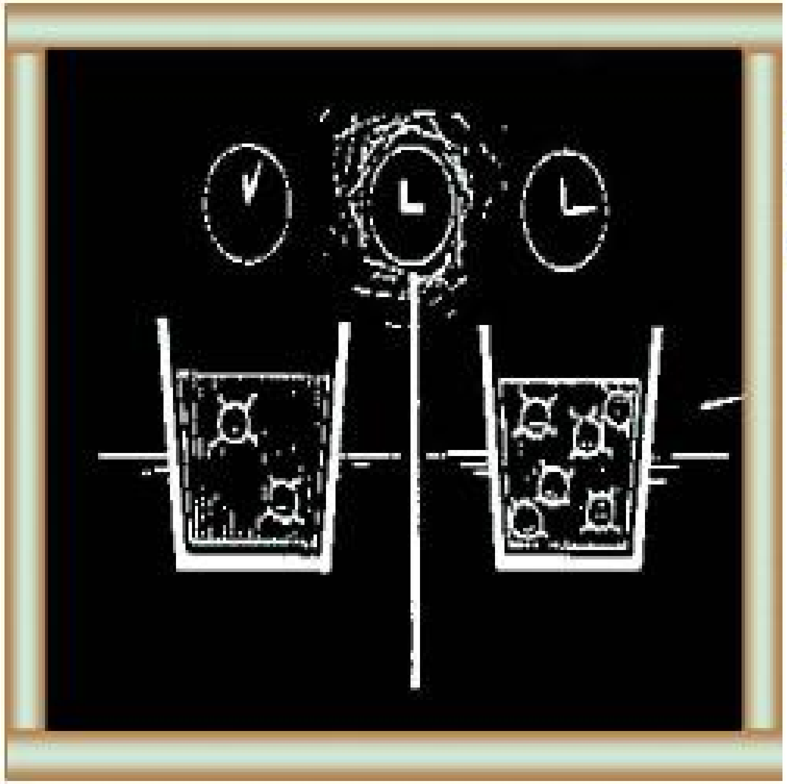
- cleaning
- handling
- storing

of milking utensils.

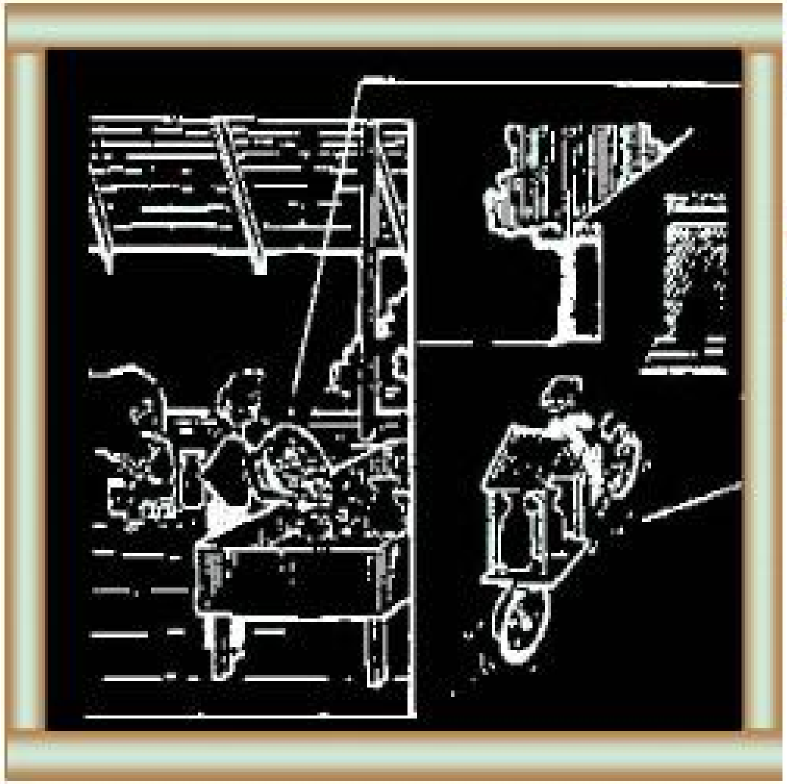


36 Do not feed silage and wet crop residues at the milking place. Smells from this and other feed may pass to your milk.

Temperature



37 Bacteria multiply in warm milk. Your milk has a bad smell and taste and spoils quickly.



38 Cool your milk after milking or deliver your milk

immediately to the collecting centre.

page 44

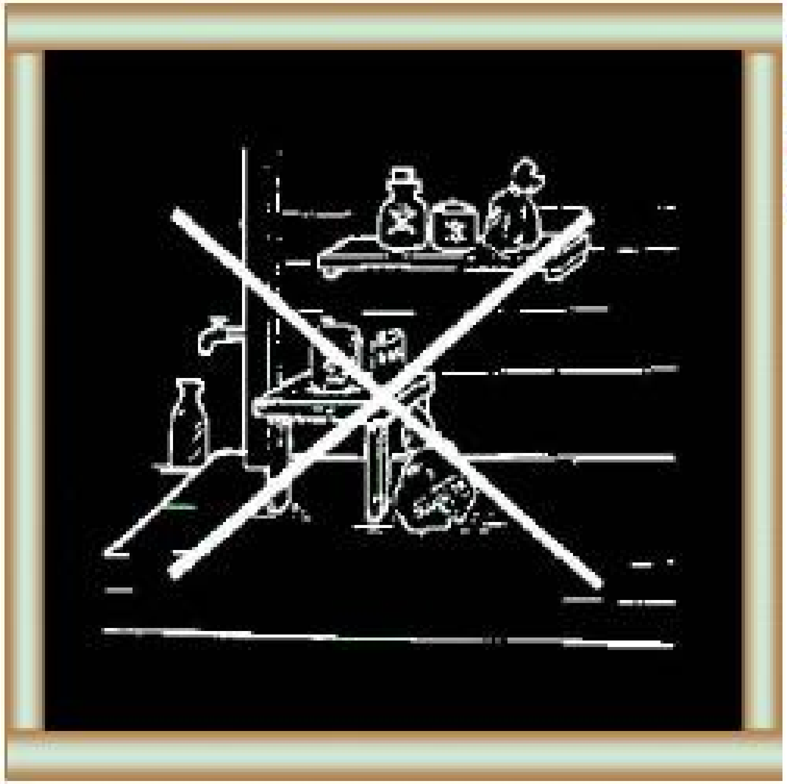
Purity

How do you make sure your milk is pure ?

39 Never add water
or anything else to your milk.

40 Make sure you use detergents and disinfectants to clean your milking equipment.

Follow instructions carefully and consult your extension worker.



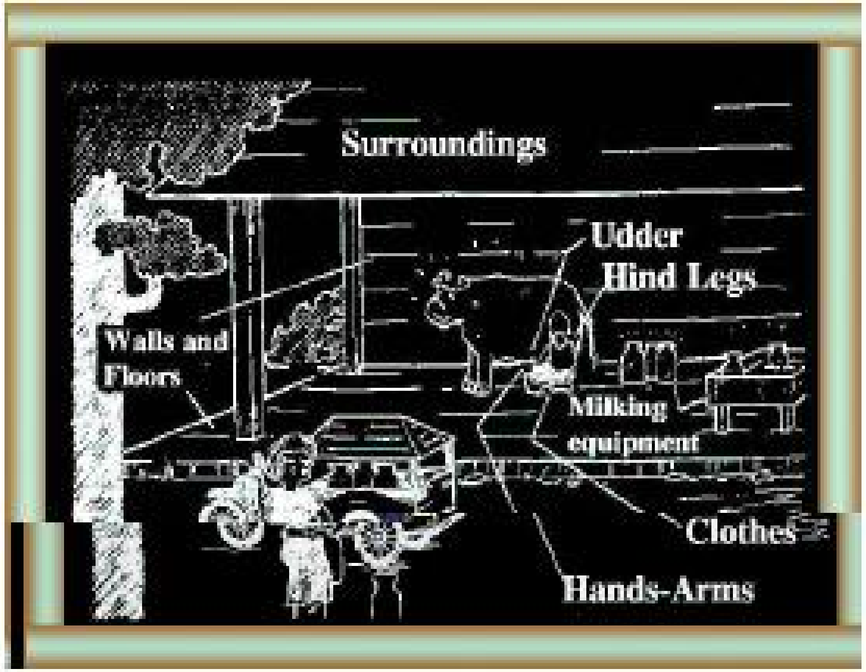
41 Keep insecticides, pesticides and other chemicals away from the milking shed and the water supply.

page 45

Hygiene

What do you clean ?

42 Everything



Milking

43 Prepare yourself,

your equipment and your cow well before milking.

Apply the proper hand milking practice.
(see H 7.2 Milking)

page 46

What do you know about milk quality ?

Reasons for producing high quality milk

1. **Higher price** (5)

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