COMMON COMMODITIES AND INDUSTRIES

BUTTER AND CHEESE

C. W. Walker-Tisdale & Jean Jones

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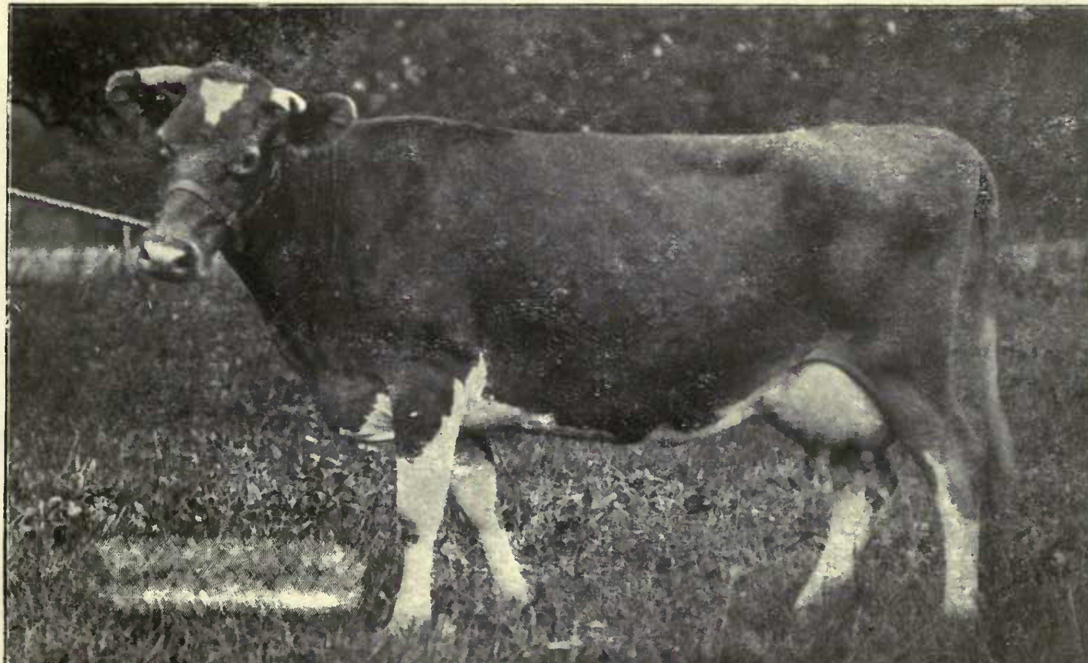

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FIRST PRIZE WINNER IN THE GUERNSEY COW CLASS AT THE LONDON DAIRY SHOW, 1919

Frontispiece

PITMAN'S COMMON COMMODITIES
AND INDUSTRIES

BUTTER AND CHEESE

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LONDON
SIR ISAAC PITMAN & SONS, LTD., 1 AMEN CORNER, E.C.4
BATH, MELBOURNE AND NEW YORK

PRINTED BY SIR ISAAC PITMAN
& SONS, LTD., LONDON, BATH,
MELBOURNE AND NEW YORK

PREFACE

THE object of this short manual is to set before the reader, in language as free from technicalities as possible, a description of the production of butter and cheese.

The book embodies most of the points in the manufacture of both these articles of dietary, and it is to be hoped that it will prove of service both to the butter and cheesemaker as well as to the uninitiated for whom it is specially written.

Once the principles of manufacture are thoroughly understood it is not a difficult matter to become versed in the practice of both butter and cheesemaking.

We are much indebted to the firms mentioned in list given below for the loan of illustrations used in this book: The Dairy Supply Co., Ltd., London ; Perfect Dairy Machines, Ltd., Dublin ; Pond & Son, Blandford; Vipan & Headley, Leicester ; Messrs. Baird & Tatlock, London.

C. W. WALKER-TISDALE
JEAN JONES

THE DAIRY,
NORTHALLERTON,
January, 1920.

(1431c)

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BUTTER AND CHEESE

CHAPTER I

INTRODUCTORY

THE growth of Dairy Farming in the British Isles has progressed at a very rapid rate during the past 25 years, and so far as concerns the supply of fresh milk for the public it has kept pace with all the requirements.

The consumption of fresh milk has increased very considerably year by year, but the increased demand has always been met by the increased output of British dairy farmers.

The development of the dairy industry dates from the time when corn-growing became unprofitable, and gradually very large tracts of arable land were converted into pasture, as the production of milk was found to be a source of profit where corn-growing could not be successfully continued.

In butter and cheese production the British farmer has been quite unable to meet the requirements of the nation, and the majority of these commodities are imported.

According to recent estimates it is calculated that of the milk produced in the country 897,551,000 gallons or 72·7 per cent. is consumed fresh: 229,635,000 gallons or 18·6 per cent. is converted into butter, which amounts to 820,000 cwt., and 74,076,000 gallons or 6 per cent. is converted into cheese, representing 661,400 cwt. of cheese, and 33,334,000 gallons are converted into cream, condensed milk, etc., representing 2·7 per cent.

Comparatively little butter or cheese is exported, and the figures available for 1912 show that the total amount of cheese sent to foreign countries and British possessions does not amount to more than 8,542 cwt., while practically no butter is exported.

On the other hand an enormous quantity of both butter and cheese is annually imported, comprising a total of 4,005,159 cwt. of butter of a total value of £24,354,193. Of this quantity 3,105,535 cwt. come from foreign countries and the remainder from British possessions.

In respect to cheese the imports show a total of 2,308,787 cwt., of which the greater portion, that is, 1,897,897 cwt., come from British possessions and the remainder from foreign countries.

The total value of the cheese imported for 1912 is estimated at £7,414,091.

The War has undoubtedly altered the conditions in connection with the output of home agricultural produce, and the Government has at last concentrated its energies on the development of home-grown products. Prior to this agriculture had received little support from the Government of the country, as all its energies had been centred on the development of commerce. Now that the importance of production in Great Britain is realized, the land will be used to a greater advantage, and enormous reserves of its wealth, so far as food production is concerned, will be utilized.

The figures here given are offered for the purpose of indicating that, whilst the British public is well supplied from its own country with fresh milk, the amount of cheese and butter produced is comparatively small, and hence we are mostly dependent on other countries for the necessary supplies of these commodities.

The object of this hand-book is to describe as far as possible (without the use of unnecessary technical terms) the modern practice of Butter and Cheese production. The science of butter and cheesemaking, whilst still far from fully known, has received a considerable amount of attention both at home and abroad, and the efforts of various County Councils in promoting technical dairy education has in its limited way produced very useful results.

Dairying in all its branches is a commercial undertaking, and the best results can only be obtained where the best possible products are manufactured on up-to-date lines.

CHAPTER II

BRITISH BREEDS OF DAIRY CATTLE

In this country we possess an unequalled variety of breeds of cattle suitable for dairying purposes. The particular breed to be kept will depend upon the locality, soil, and conditions generally, and also upon the branch of dairying to be adopted, *i.e.*, milk selling, buttermaking, or cheesemaking. Any one of these branches of dairying may be carried out whatever the breed of cattle kept. The following rough classification shows the special suitability of different breeds for different purposes.

Breeds most suitable for—

Milk Selling.	Buttermaking.	Cheesemaking.
Shorthorns	Jerseys	Ayrshires
Lincoln reds	Guernseys	Shorthorns
Welsh	South Devons	
Red Polls		
Kerries		
British Friesian		

Breeds most suitable for good land—

Shorthorns	Jerseys
Lincoln Reds	Guernseys
Red Polls	S. Devons

Breeds most suitable for exposed localities—

Ayrshires	Welsh	Kerries

Points of a Dairy Cow.—A dairy cow is quite different in appearance from one belonging to the beef-producing breeds. An ideal dairy cow should be somewhat wedge-shaped when looked at from behind, tapering towards the head. The head and neck should be fine and clean with a thin dewlap, while the horns should be small and not coarse-looking, the whole appearance being feminine. The back should be lean and open jointed, the hips wide apart, the rump long and wide, and the tail fine and well set on. The udder should be full behind and should extend well forward, being capacious but not fleshy ; it should appear after milking like loose folds of soft skin. The teats should be evenly placed, wide apart and of good size, while the milk veins should be large and prominent.

Shorthorn.—The shorthorn is a very old established breed—formerly there were two well-known types, the Booth and the Bates, the former noted as beef-producers and the Bates as milkers. At the present day the two types are not distinct, though we still have a milking and a beef-producing shorthorn. The dairy shorthorn of the present day is noted for giving a large quantity of milk of average quality. If a cow is of a good milking strain and kept under good conditions it may yield 1,000 gallons or more per year. The colour of the dairy shorthorn is usually red, or red and white, but it varies a good deal and may be roan or white. It is the most widely-distributed breed in this country or even in the world, and as a dual-purpose cow takes first place.

The milk is suitable either for sale, for buttermaking, or for cheesemaking. The average yield of milk for a herd is 600 to 700 gallons per head per year, containing about 3·5 to 3·7 per cent. fat.

Welsh.—There were formerly four distinct varieties or Welsh cattle, but there is only one recognized at present. Cows of this variety yield a fairly large quantity of milk of good quality. The milk is rarely found to fall below the Government standard of fat.

The average yield is about 550 gallons per year containing from 3·8 to 4 per cent. of fat.

Red Polls are chiefly found in Norfolk and the adjoining counties. They are fairly good milk-producers and are particularly suited to their district. The period of lactation in this breed is longer than in most others. The yield is from 500 to 550 gallons a year with an average of about 4 per cent. fat.

Kerries are an Irish breed of cattle and are often known as "the poor man's cow," they will thrive on very inferior pastures where other breeds would starve. They are quite good milkers, and in this respect may be said to be as good as any of the British breeds if size be taken into consideration. The colour is black, and they have excellent constitutions. They yield about 450 gallons of milk a year containing from 3·5 to 3·7 per cent. fat.

Ayrshires.—The Ayrshire is a Scotch breed chiefly found in Ayrshire and the upper Clyde districts. It is a typical dairy cow producing a good quantity of milk with fat globules of small size. This makes its milk particularly suitable for cheesemaking.

Ayrshires cross well with Shorthorns, the crossbreds possessing good milking properties and improved feeding qualities as compared with the pure Ayrshires.

The colour varies, and it may be black and white, red and white, or brown and white. They thrive on poor pasture, and under such conditions share the credit with Kerries of producing more milk than any other breed.

Ayrshires yield on an average 600 gallons per year with 3·5 to 3·6 per cent. fat.

British Friesians are a breed suitable for milk production as they give a large quantity of milk; it is, however, not very rich in fat as compared with other dairy breeds. The colour is black and white, and the cows are not so large as the original Dutch cattle. The average yield of milk is 800 gallons a year containing 3·2 to 3·3 per cent. of fat.

Jerseys.—The Jersey is the most popular of the Channel Island breeds in this country. It is essentially a buttermaking cow owing to the high percentage of fat found in the milk. Unless sold to customers who are prepared to pay a little more for the extra richness of their milk, they cannot be said to be suitable for milk-selling farms.

Jersey milk is exceptional for the size of the fat globules and the rich, deep colour of the fat. Jerseys are of no use for feeding, being small in size whilst the meat is deficient in flavour. They are not suitable for cold districts and exposed situations. In appearance they are small, with a deer-like head, crumpled horns, and a broad, dark-coloured muzzle. The udder is somewhat rounded with large and prominent milk veins. The skin is thin, mellow, and of a yellowish colour.

Jerseys are usually either fawn, grey, dun, or cream in colour. They yield about 500 gallons a year with an average of 4·8 per cent. of fat.

Guernsey.—The Guernsey is a larger, coarser breed than the Jersey, but it has the same qualities. It is a dairy cow specially adapted for buttermaking. Guernseys are frequently broken-coloured and generally of a lighter shade than the Jerseys, but they yield an even deeper-coloured butter fat. Jerseys are the more popular as five can be kept at the same cost as four of the Guernseys. The average yield is 520 to 550 gallons containing 4·5 per cent. fat. One or two Jerseys or Guernseys in a herd of Shorthorns or crossbreds greatly improve the milk for butter making. It makes churning easier and the butter is of better texture, colour, and flavour

CHAPTER III

MILK: ITS PRODUCTION AND COMPOSITION

MILK is an opaque, yellowish-white fluid composed of water, fat, proteids, sugar and mineral matter. It is very nutritious and digestible, but owing to its perishable nature it requires skilful and careful handling, more particularly in hot weather.

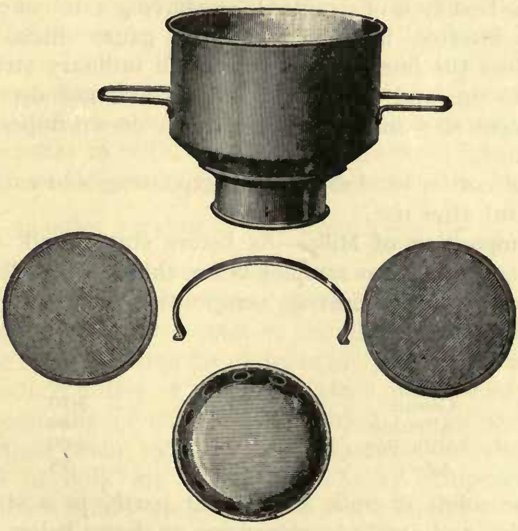
The value of milk as a food is shown by the fact that 1 qt. of milk is equivalent in food value to $\frac{3}{4}$ lb. rump steak, 10 eggs, or 4 lb. of cod fish.

Whether intended for sale as fresh milk or for manufacturing into butter or cheese, it is highly important that milk should be of good quality, wholesome, and produced under clean conditions. No amount of skill and care in the after treatment will make up for carelessness or indifferent handling of the milk at first.

Milk varies in quality both as regards its composition and cleanliness; the former is not always entirely under control, but the latter is. If the milk is to be wholesome only healthy cows should be kept, and they should have a plentiful supply of good food; musty or bad-flavoured cakes and meals should be avoided as well as an excess of roots and cabbages. A good supply of pure water is an absolute necessity for milk production. The cow-sheds should be clean and airy, the old-fashioned ones in many cases were deficient in ventilation, but modern sheds are usually fairly good in this respect.

The milker's hands and clothing should be clean, the udder should be wiped with a damp cloth immediately before milking or, if necessary, washed and dried. If the milking pails and other utensils are to be kept in proper condition they should be thoroughly washed immediately after using and then well scalded, or better still, steamed and kept in a clean, airy place free from dust.

The practice of feeding cows immediately before or



MILK STRAINER OR FILTER

A thin pad of cotton wool is placed between two discs of fine wire gauze, and the milk allowed to filter through. The sediment is retained in the wool pad which is burnt after use.

during milking is to be condemned, hay and straw raise a lot of dust while roots have a strong smell which is readily absorbed by the milk and thus the flavour of the produce is spoiled.

It must be remembered that milk, especially while still warm, very readily takes up odours and bad flavours which may be difficult to get rid of ; for this reason it should be removed from the cowsheds immediately after milking and then strained. Even under the cleanest conditions there will be some impurities in the milk and some of these may be dissolved if straining is delayed.

The best type of strainer is one having a disc of cotton wool inserted between two wire gauze discs. This removes the finest dust, etc., which ordinary strainers fail to do, and milk thus filtered does not deposit a sediment on standing as it frequently does if imperfectly strained.

The cotton wool discs are inexpensive, and each one is burnt after use.

Composition of Milk.—As before stated milk varies in quality, no two samples being alike. The following is an average percentage composition of a number of samples—

Water	87·55
Fat	3·60
Casein	3·10
Albumin	·40
Milk Sugar	4·60
Ash	·75

The solids of milk are present partly in a state of solution and partly in suspension as shown below—

Constituents.	*In suspension.*	*In solution.*
Fat	all	none
Sugar	none	all
Albuminoids	casein	albumin
Ash	partly	partly

The term " Total Solids " applied to milk includes all the solid constitutents, while " Solids non-fat " includes the casein, albumin sugar, and ash, but not the fat.

WATER constitutes nearly 90 per cent. of milk and depends in amount on the breed of cow and to some extent on the food. It is practically ordinary pure water.

FAT.—This is the most important constituent from a buttermaker's point of view, the greater the percentage of fat the larger the yield of butter. For cheesemaking, milk containing a good percentage of fat produces a greater weight of cheese per gallon, and it is also of better quality than the cheese produced from poor milk.

Butter fat is a mixture of various fats, some of which are peculiar to milk, and it is characterized by its fine flavour and digestibility. It is present in the form of small globules varying in size from $\frac{1}{2,000}$ to $\frac{1}{20,000}$ of an inch in diameter, and which can only be seen by the aid of a microscope. These globules vary in size, and the largest ones are found in the milk of the Channel Island cattle. Large fat globules are usually considered to produce butter of superior texture and flavour. At the beginning of the lactation period the fat globules are larger than towards the end. Some of the fats found in milk are liquid at ordinary temperatures, others are solid—the proportion is not fixed but varies with the feeding, the period of lactation, and other factors.

Butter fat is the lightest constituent of milk. When whole milk is allowed to stand for a few hours, a layer of cream forms on the surface and this contains most of the fat. The large fat globules rise to the top more quickly than the smaller ones, while some of the latter never reach the surface at all and are lost in the skim milk. It is found that when milk has been cooled before being allowed to stand the cream does not rise so quickly or so thoroughly. The fat is the most variable constituent in milk, but the average percentage found is about 3·6 per cent.

ALBUMINOIDS.—The chief albuminoids of milk are casein and albumin, there are traces of others present, but casein and albumin are the only ones of importance. Albuminoids are the flesh-forming portion of a food and are therefore very valuable.

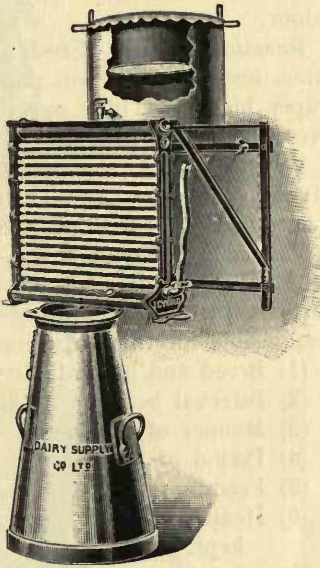
Casein is present to the extent of about 3 per cent. It is very nutritious and is the principal constituent found in cheese, it is also largely used in the manufacture of various food preparations. Casein is coagulated by rennet (as in cheesemaking) and by acids, *e.g.*, by lactic acid in the souring of milk, but is not coagulated by heat. It is soluble in alkalies and strong acids.

Albumin exists in milk in solution to the extent of about ·5 to ·7 per cent. It differs from casein in the fact that it contains no phosphorus but about twice the amount of sulphur. It is coagulated by heat but not by acids or rennet, and when milk is converted into cheese the albumin passes off in the whey. It is similar in character to the albumin found in the white of an egg. In colostrum, the milk given for the first few days after calving, about 15 per cent. of albumin is present, which causes the milk to coagulate when boiled.

MILK SUGAR OR LACTOSE is the sugar peculiar to milk which is present to the extent of 4½ per cent. and varies very little in quantity. It is not so soluble or so sweet as ordinary sugar and exists in complete solution. In cheesemaking nearly all of it passes with the water into the whey. Milk sugar is very unstable, and is readily acted upon by bacteria and converted into lactic acid. When about ·7 to ·8 per cent. of lactic acid is present the milk curdles. Commercially, it is prepared from whey by evaporation.

ASH OR MINERAL MATTER is that portion of a substance not destroyed by burning. Although present in milk in such a small proportion—·75 per cent.—it is very valuable and contains lime, potash, and phosphoric acid, together with traces of other salts. It is very constant in proportion.

GASES PRESENT IN MILK.—Milk, when drawn from the cow, generally contains from ·1 to ·3 per cent. of gaseous constituents.



REFRIGERATING MILK

Warm milk is filtered into a feed pan from which it flows over a corrugated-lined copper cooler, through which cold water is continuously flowing. From the cooler it passes to the railway milk churn, ready for despatch by rail. The milk is thus cooled to a low temperature and aerated, by which its keeping properties are enhanced.

Colour of Milk.—The yellowish colour of whole milk is supposed to be due to the presence of a body called "Lactochrome" present chiefly in the fat. The colour varies with the breed of cow, period of lactation, and the feeding. The cows of the Channel Island breeds give a deep-coloured milk and so do freshly-calved cows, while grass gives a deeper colour than any other feeding stuff. The white appearance of skim and separated milk is due to the casein.

Flavour and Odour.—New milk has a sweet flavour, and when freshly drawn has a "cowy" taste and odour, which passes off on exposure to the air. The flavour may be adversely affected by the food given to the cows and also if kept in a stuffy atmosphere such as a cow-shed, or even when stored with foods having a strong odour.

Reaction of Milk.—Fresh milk gives a double reaction when tested with litmus paper, *i.e.*, it turns red litmus paper blue, and blue paper red. This is due to the presence of acid phosphates and alkaline carborates.

When tested with phenol phthalein as an indicator it gives an acid reaction. The neutral acidity of new milk varies from ·17 to ·19 per cent.

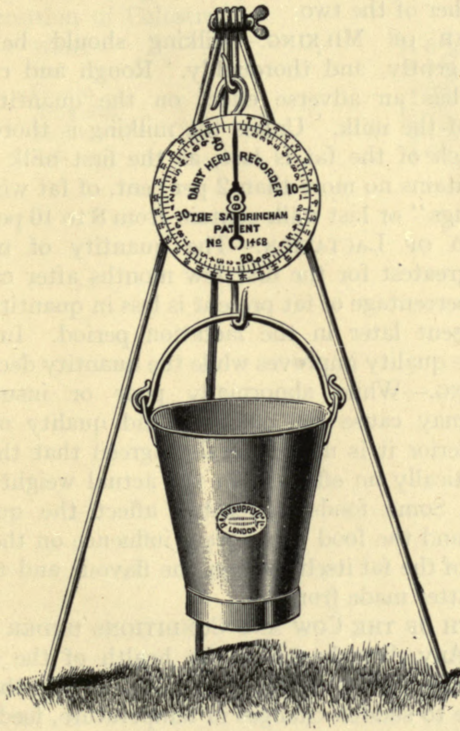
Variation of Fat in Milk.—As before stated, the percentage of fat in milk varies more than any other constituent. The following are some of the factors responsible for this variation—

(1) Breed and individuality of cow ;
(2) Interval between milkings ;
(3) Manner of milking ;
(4) Period of lactation ;
(5) Feeding ;
(6) Health of cow and conditions under which kept.

Breed of Cows.—There is a considerable difference in the quality of milk given by the various breeds of cows. The cows of the Channel Island breeds give the richest milk though the quantity is less, while the milk of the Dutch or Holstein cows contains the least fat, but the quantity of milk given in this case is much greater.

Individual cows also vary greatly in the quality of their milk irrespective of breed. Hence the importance of keeping milk records both for quantity and quality in order to eliminite those cows giving poor milk and yielding only a small profit or none at all.

INTERVAL BETWEEN MILKINGS.—The longer the interval between milkings the poorer is the milk in quality.



DAIRY HERD RECORDER

A weighing machine by which the milk of each cow is weighed and recorded. Cows yielding less than 600 gallons of milk a year are not considered profitable.

This is one reason why mornings' milk is usually poorer in fat than that of the evening as the interval between evening and morning milkings is longer in most cases. When the cows are milked at exactly equal intervals the difference is less, though, as a rule, the evening's milk is the richer of the two.

MANNER OF MILKING.—Milking should be done quickly, gently, and thoroughly. Rough and careless milking has an adverse effect on the quantity and quality of the milk. Unless the milking is thoroughly done much of the fat is lost, as the first milk drawn often contains no more than 2 per cent. of fat while the "strippings" or last milk contain from 8 to 10 per cent.

PERIOD OF LACTATION.—The quantity of milk is usually greatest for the first few months after calving, but the percentage of fat present is less in quantity than that present later in the lactation period. In other words the quality improves while the quantity decreases.

FEEDING.—While abnormally poor or insufficient feeding may cause the quantity and quality of milk to be inferior it is now generally agreed that the food has practically no effect upon the actual weight of fat present. Some foods noticeably affect the quantity of milk, and the food has a great influence on the composition of the fat itself and on the flavour and texture of the butter made from it.

HEALTH OF THE COW AND CONDITIONS UNDER WHICH KEPT.—Any disturbance in the health of the cow is liable to affect both the quantity and quality of the milk. Exposure to sudden changes in temperature, feeding, or other conditions, may also have an ill effect upon the secretion of milk.

Colostrum is the milk given by a cow for the first few days after calving, and it is abnormal both in composition and properties. It differs from ordinary milk in that it contains a higher percentage of albuminoids and ash, and coagulates on heating. In appearance it is thick, rather slimy, and deep coloured. Colostrum is not fit for use in butter or cheesemaking until it will boil without curdling, usually in three to five days.

Composition of Colostrum—

Water	71·6%
Fat	4·1%
Casein	4·0%
Albumin	15·3%
Sugar	3·4%
Ash	1·6%

CHAPTER IV

MILK ANALYSIS

THE most accurate method of determining the quality of milk is by means of chemical analysis, and in this way the exact amount of each constituent may be ascertained. Owing to the somewhat complicated apparatus used, and the time necessary for carrying out the process this method is impracticable for an ordinary dairy. Some of the large dairy companies employ their own analysts, but for farmers and for general commercial use some simpler method is necessary. A number of means for easily and quickly testing the quality of milk have been devised, but until the introduction of the Babcock method of estimating the percentage of fat in milk, none of these simple methods gave accurate or reliable results.

Sampling of Milk for Testing.—In any method of testing milk it is most important that the sample is properly taken. It should truly represent the bulk of the milk from which it is taken, therefore careful and thorough mixing is necessary.

Where the quantity of milk is small, it may be mixed by pouring from one vessel to another several times, but if the sample is being taken from a can or churn the milk should be well stirred with a plunger, or a sampling tube may be used. The sample is put into a small bottle or jar properly labelled, and immediately before testing it is gently shaken to ensure thorough mixing. If the sample has been kept until sour it will require special preparation before being tested.

One of the earliest and simplest methods of testing the quality of milk was by the use of the Creamometer or cream tube. The Creamometer is a cylindrical glass vessel of uniform diameter with a scale graduated from zero downwards. It is graduated to hold 100 parts of milk so that the amount of cream may be read off directly as a percentage. The milk to be tested is well mixed, the glass filled to the zero mark, and it is then left to stand for, say, 24 hours, when the percentage of cream may be read off.

When a number of samples are being tested, or if the results are required for comparison from day to day, the temperature of the room, and the length of time the samples are allowed to stand must be the same in each case. A room temperature of 60° Fahrenheit is a suitable one. There may be from 12 to 15 per cent. of cream on the milk and anything above 10 per cent. may be considered as being quite satisfactory. It must be remembered that this test does not show the amount of fat there is present in the milk, but merely that which rises to the surface in the form of cream. The percentage of cream does not altogether depend upon the amount of fat in the milk, as the size of the fat globules and the conditions under which the milk has been allowed to stand affect the quantity and quality of the cream which rises.

Specific Gravity.—The quality of milk was also estimated from its specific gravity. The specific gravity of any substance is the weight of a given volume of it compared with the weight of an equal volume of water at a temperature of 60° Fahrenheit. Water is taken as the standard and its specific gravity as 1.

Milk contains about 12½ per cent. of solid matter, a part of which (the fat) is lighter than water, the remainder of the solids being heavier than water. As the solids non-fat are present in greater proportion than the fat, the specific gravity of milk is naturally higher than that of water.

The average specific gravity of whole milk is 1·032, but it may vary from 1·028 to 1·034 at a temperature of 60° Fahrenheit. In other words, if a given quantity of water weighed 1,000 lb., an equal quantity of milk at the same temperature would weigh 1,032 lb. Milk containing a high percentage of fat will have a comparatively low specific gravity, while poor milk containing a small amount of fat will have a higher specific gravity.

Determination of Specific Gravity.—The specific gravity of milk may be determined either by weighing, or by the use of the lactometer—the latter being the quicker and simpler method.

The lactometer, of which there are several forms, usually consists of a fine glass tube with a bulb at the lower end which is weighted with shot or mercury to keep the instrument in an upright position. On the narrow upper tube is a scale usually graduated from 0 to 40. The zero mark at the top represents the specific gravity of water, so that if the lactometer were placed in water at a temperature of 60° Fahrenheit, the zero mark would be level with the top of the water. If placed in a liquid lighter than water it would sink still further, but when placed in milk, which is a heavier substance, the instrument will not sink so deeply. The lactometer must not be considered a reliable means of determining the quality of milk. The specific gravity in conjunction with the percentage of fat is useful as a basis for calculating the total solids, but taken alone the results are unreliable and often misleading. If some of the fat is removed from milk, and water judiciously added, the specific gravity will still be quite normal, or if separated milk were added to rich milk the specific gravity of the mixture might still be regulated to 1·032 or thereabouts.

In using the lactometer it is essential that the temperature of the milk is correct, as the specific gravity of any liquid varies with the temperature. The temperature should be 60° Fahrenheit, but if the milk is a few degrees higher or lower than this, the result may be corrected by adding ·001 to the specific gravity for each degree above 60° Fahrenheit, or subtracting ·001 for each degree below 60° Fahrenheit.

Some lactometers are provided with a thermometer so that both the temperature and the specific gravity may be shown at once.

The milk should be thoroughly mixed before the sample is taken, and the sample itself well stirred before pouring it into the jar. This jar should be deep and wide enough to allow the lactometer to float without touching the bottom or sides, and any froth or bubbles on the surface should be cleared off before reading the result. It is easier to get an accurate reading if the surface of the milk is on a level with the eye and the jar should be perfectly level. The lactometer reading prefixed by 1·0 will give the specific gravity of the milk.

To Determine Specific Gravity by Weighing.—The specific gravity of milk may be more accurately determined by weighing, but a chemical balance is

	Grams.
Weight of milk and bottle . . .	40·821
,, bottle	15·021
,, milk	25·800

$$\frac{25{\cdot}800}{25{\cdot}000} = 1{\cdot}032 \text{ specific gravity of milk.}$$

required for this. A special bottle, which holds 25 grams of water at 60° Fahrenheit, is used. The empty bottle is first weighed, then filled to the 25-gram mark with milk and weighed again. The difference represents the weight of the milk, and this divided by the weight of the water gives the specific gravity of the milk. For example see foot of page 21.

The Board of Agriculture regulations assume that genuine milk should contain not less than 3 per cent. of fat and 8·5 per cent. of solids non-fat.

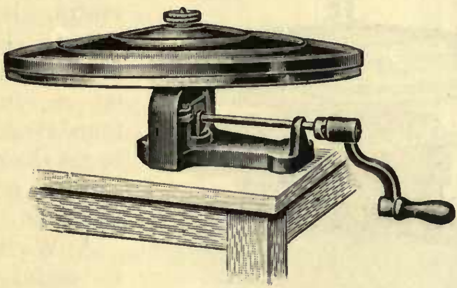
Estimation of Fat in Milk.—Several methods have been introduced for determining the percentage of fat in milk volumetrically. The first to be generally adopted was that invented by Dr. Babcock, and this method is still largely used in America. In this country the Gerber Test, which is a modification of the Babcock, is more popular. The Gerber Test gives a rather more accurate result than the Babcock and is more quickly carried out. The principle in both cases is the same—the fat is liberated from the casein and other solid constituents by the action of strong sulphuric acid. The mixture is then subjected to centrifugal force which causes the fat to separate, the percentage present may then be read off by means of the scale provided on the test bottle. A second re-agent is used in the Gerber method—amyl alcohol—and this prevents the formation of charred matter which so often interferes with the reading of the test when only acid is used.

Apparatus Required for Gerber Method.—TEST BOTTLES.—The bottles used have a long, narrow neck on which a graduated scale is marked. They are obtainable with either round or flat-shaped necks, the latter shape are much easier to read. The tubes are fitted with rubber stoppers and are numbered so that the different samples of milk may be easily recognized.

Pipettes.—The milk and the chemicals are measured into the test bottles by means of pipettes. Three of these are necessary, viz.—

One of	11 c.c.	capacity	for	milk.
,,	10 c.c.	,,	,,	acid.
,,	1 c.c.	,,	,,	alcohol.

The acid pipette is fitted with a double bulb to prevent the acid being drawn into the mouth. When a large number of samples have to be tested it is much



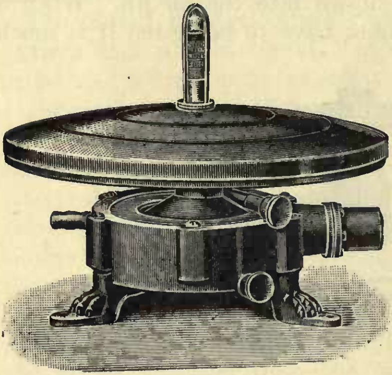
"GERBER" CENTRIFUGAL MILK-TESTING MACHINE

more convenient to use one of the automatic measures for the chemicals. There are several types in common use, and they save a considerable amount of time and trouble as the measuring can be done very quickly and accurately.

Chemicals.—The two chemicals used in this test are sulphuric acid and amyl alcohol. It is essential that these should be of the proper strength, the acid should have a specific gravity of 1·82 to 1·825 and must be kept in a well-stoppered bottle as it soon becomes weaker if exposed to the air. The alcohol used has a specific gravity of ·815, and it should be pure and free from fat.

Centrifugal Machine.—The centrifugal machine is made in various sizes and may hold from two to thirty-two test bottles. The smaller sizes are worked by means of a strap or by a crank handle, but the larger ones are frequently worked by steam or other power.

The machine is fitted with metal tubes in which the test bottles are placed with the narrow graduated necks towards the centre. It is essential to have the machine fixed firmly on a substantial foundation in order to get the necessary speed without vibration.



GERBER CENTRIFUGAL MILK-TESTER

Driven by a steam turbine.

A Water Bath is useful in cold weather when it may be necessary to heat up the samples before reading off the fat percentage. If the temperature is allowed to fall before reading the result obtained is inaccurate.

Process of Testing.—The test bottles are placed in a stand with the open ends uppermost. Ten c.c.'s of acid are then carefully measured in taking care that none of it gets on to the neck of the bottle. The milk is next added, 11 c.c. is taken and run in slowly so that it comes in contact with the acid as gently as possible. Lastly, 1 c.c. of amyl alcohol is added, and the rubber stopper firmly fixed.

In using pipettes it is not necessary to blow out the last drops of the liquid, if as much as possible is allowed to run out, the pipette may then be gently tapped on the bottle to remove the rest. If the contents are blown out, the quantity delivered will not be exactly accurate. The sulphuric acid is always put in first on account of its greater weight ; the alcohol may be added before the milk, but the order given above is found to be the best in practical testing.

After fixing the stopper, the bottle should be gently shaken until the casein has completely dissolved ; as the action of the acid results in a rise of temperature, it may be found necessary to use a cloth for holding the bottle. In very cold weather the bottle may be placed in water at a temperature of 170° Fahrenheit, for a few minutes before being put into the machine. The bottles are placed in the machine with the graduated neck towards the centre, and an equal number placed on each side to maintain the proper balance.

After securing the lid, the machine is rotated for 3 minutes at a speed of 1,500 revolutions per minute, and is then allowed to run down gradually. If the speed is too low, or not maintained for the full time, the fat will not be completely separated and the result obtained will be inaccurate.

On removing the bottle the fat will be

GERBER
TEST BOTTLE
for ascertaining the percentage of fat in milk.

seen at the graduated end. The fat column should be quite clear and is usually of a pale yellow colour, though in winter it is often almost colourless. To read off the percentage it is necessary to bring the lower end of the fat column on to one of the long graduation marks by manipulating the rubber stopper. The space between each of the long divisions is such that it represents 1 per cent. of fat, and the smaller divisions are equal to ·1 per cent. If the fat column is found to occupy three of the larger divisions and six of the smaller ones, the fat per cent. is 3·6.

The reading is made to the *bottom* of the curve at the top of the fat column and not to its highest point. The temperature must not be allowed to fall before the reading is made, and if the fat does not seem clear, or is not properly separated, the bottle should be placed in hot water for a few minutes and again rotated.

It is necessary to keep the glassware, etc., used in making the test in a perfectly clean condition. This is quite easily done if the bottles are emptied and washed while still hot and then thoroughly rinsed till clear. The acid should be poured on a gravel path or on earth, and must not be emptied down a drain or thrown on to grass. The corks will last much longer if washed in water containing a little soda, then rinsed and allowed to dry gradually.

This method of testing may be considered a simple, quick, and accurate one for determining the percentage of fat in milk. If it is carried out with exactness the results obtained are found to compare very favourably with those from gravimetric analyses. The accuracy of the results in this method of testing depend upon—

(1) The use of correctly graduated pipettes and test bottles ;

(2) Careful and exact measuring of the milk and chemicals ;

(3) The use of chemicals of the proper strength ;

(4) Rotating the machine at the proper speed ;

(5) Quick and accurate reading of the result.

Testing Separated Milk, etc.—The same method may be used for testing separated milk, butter-milk, and whey. Owing to the very small quantity of fat present in these liquids it is necessary to heat the tubes after revolving once, and then to replace them in the machine and rotate a second time.

There are special test bottles made for separated milk, etc., in which the neck is of very narrow bore, so that the fat occupies a large space, consequently it is much easier to get an accurate reading.

The Gerber " Sal " Method.—This method of testing is preferred by some people on account of the dangerous nature of sulphuric acid. The same apparatus is used but the acid is replaced by 11 c.c. of the " sal " solution (consisting largely of caustic soda) and butyl alcohol (6 c.c.) is used in place of the amyl alcohol used in the acid test. This method cannot be considered so accurate as when acid is used and the process of testing takes a longer time as the test bottles always require heating once or twice. If proper care is taken there is very little risk of accident when using the acid test.

Testing Cream.—Cream, if diluted, may be tested in the ordinary bottle used for milk. One part of cream and four parts of water may be taken and after careful mixing 11 c.c. of the diluted cream is tested. The result multiplied by 5 will give the percentage of fat in the cream. It is better, however, to use the special cream test bottle, which has a long neck graduated from 0 at the top to 50 at the bottom. Five c.c.'s of cream and

5 c.c.'s of water are taken for the test with acid and alcohol as when testing milk.

To read the result in this case the top of the fat column is brought to the zero mark, and the mark at the bottom of the fat will represent the percentage of fat in the cream.

Composite Milk Testing.—At creameries and factories where the milk is received from a large number of suppliers, and is paid for according to its quality instead of the quantity, it is most important that the amount of fat present should be determined accurately. The labour and time required for testing a number of samples makes daily testing almost impossible, and the composite method is nearly always adopted. A sample bottle of suitable size is labelled for each supplier, and into this is placed a sample of each day's milk both morning and evening. A small quantity of preservative is added to the first sample to prevent the milk from souring before the test is made. The preservatives commonly used for the purpose are bichromate of potash, bichloride of mercury, and formalin. The first two are of a poisonous nature, and if these are used the sample bottles must be properly labelled and precautions taken to prevent the milk from being accidentally used. Bichromate of potash imparts a deep yellow colour to the milk and this is a safeguard. The most convenient form of preservative is that put up in tablet form, as in this case no measuring is required, one tablet being sufficient for each sample bottle. It is necessary to take the sample in proportion to the amount of milk supplied, say 1 oz. to 50 gallons or any convenient proportion. At the end of a week, ten days, or a fortnight, the composite samples are tested, and when the sampling has been carefully done, the results are found to be practically as accurate as if the milk were tested daily.

Estimation of Milk Solids.

(1) By evaporation ;

(2) By calculation.

(1) The percentage of solids in milk may be determined by evaporation. A certain quantity of milk is taken and the water evaporated off, leaving the solid matter which may then be weighed.

A Chemical Balance is necessary for weighing the milk, etc., accurately. In addition to this a water bath is required ; this is simply a vessel in which water may be kept boiling. The lid is provided with openings on which the dishes are placed, and their contents are thus maintained at a temperature of 212° Fahrenheit.

The Water Oven consists of an oven fitted with an outer jacket, and in the space between this and the oven itself water is kept boiling while the oven is in use.

The Desiccator is a piece of glass apparatus with an air-tight fitting lid in which the air is kept perfectly dry by means of calcium chloride, and the dishes are placed in this while cooling.

Process.—A small white porcelain dish is dried and placed in the desiccator to cool and is next weighed.

About 5 c.c. of milk is poured into the dish, which is again weighed. Two or three drops of acetic acid are added to the milk to coagulate it ; this is done to prevent the formation of a skin on the surface of the milk which would hinder evaporation. The dish is now placed on the water bath for about an hour, or until the water has been driven off from the solid matter. The drying process is finished by placing the dish containing the solids in the water oven for two hours. When taken out of the oven it is cooled in the desiccator and then weighed. The difference in weight represents the amount of water which has been eliminated, and the percentage of solids may then be calculated.

EXAMPLE

	Grams.
Weight of dish and milk	28·205
„ dish	23·205
	5·000
Weight before evaporation	28·205
„ after „	23·835
Loss of water from milk	4·370

Solids in 5 grams milk = ·630
Percentage of Total Solids = 12·6

$$\frac{\cdot 630 \times 100}{5} = 12\cdot 6$$

The fat may be separated from the other solids by washing with ether. The solids are broken up and washed with two or three lots of ether which dissolves the fat. When all the fat has been dissolved, the remaining portion will represent the solids non-fat.

(2) **Estimation of Solids by Calculation.**—The percentage of solids in milk may also be determined by calculation, when the percentage of fat and the specific gravity of the milk are known. The results obtained, if the testing for fat and specific gravity have been carefully done, compare favourably with those obtained by analysis. There are several formulae used for this calculation, and the following is one of the simplest—

Per cent. of Solids non-fat =

$$\frac{\text{Lactometer reading at } 60°\text{F.} + \text{per cent. fat}}{4}$$

Example.—A sample of milk contains 3·6 per cent. of fat, and specific gravity at 60° Fahrenheit is 1·032—

$$\frac{32 + 3\cdot 6}{4} = 8\cdot 9 \text{ per cent. Solids non-fat.}$$

The percentage of total solids is obtained by adding the percentage of fat to the percentage of solids non-fat.

Another formula in common use is the following one of Droop Richmond's—

$$T\frac{G}{4} + \frac{6\,F}{5} + \cdot 12.$$

Example.—If a sample of milk contained 4 per cent. at and the specific gravity was 1·032—

$$\frac{32}{4} + \frac{6 \times 4}{5} + \cdot 12 = 12{\cdot}92 \text{ per cent. total solids.}$$

CHAPTER V

BACTERIA IN BUTTER AND CHEESEMAKING

THE fermentations and many of the taints or faults that occur in milk and in the produce made from it are due directly or indirectly to the action of bacteria or germs. Milk forms an ideal medium for the growth of bacteria. When drawn from the cow it is not absolutely sterile, though under clean conditions it may be regarded as being practically so.

The sources of contamination are, briefly, the air of the cow byre, the hairs and body of the cow, the hands and clothing of the milker, the utensils, and possibly the food given—*e.g.*, if hay is fed during milking many germs find their way into the milk with the dust.

Bacteria are the smallest and simplest form of plant life. They consist of a single cell and are mostly either rod-shaped (bacillus) or round (coccus) in form. They are very minute—only about $\frac{1}{25,000}$ of an inch in diameter or less—and can only be seen or studied when magnified about 1,000 times.

Under favourable conditions—a suitable temperature which varies with the kind of germ, food, moisture, and sufficient air—they multiply very rapidly. Their method of reproduction is by simple fission, or the division of one organism into two, and this may be repeated as often as once an hour or less.

It may be noted that while many kinds of bacteria require air for growth and reproduction, others only exist in the absence of oxygen, while a few types can live either in the presence or absence of oxygen.

From a dairying point of view, bacteria may be classified as being either desirable or undesirable, while a few varieties have no effect either way. Although many kinds of bacteria are found in milk, by far the largest proportion are of the lactic acid variety. In fact when milk is produced and kept under cleanly conditions, about 90 per cent. of the total germ content will be of this class. Where the conditions are not so favourable as when the cows are dirty or the utensils not properly washed—in fact, where dirt is present in any shape or form—there will be a greater number of bacteria present in the milk, and among them will be undesirable varieties in sufficient numbers to cause endless trouble and loss.

The bacterial content of milk depends for the most part upon its cleanliness, its age, and the temperature at which it has been kept ; hence, by controlling these factors the number, and to a certain extent the kind of bacteria present, may be regulated.

The lactic acid class of bacteria are those responsible for the souring of milk and cream. For butter and cheesemaking they are desirable and necessary in order to obtain produce of the best flavour. Where milk is sold, the object is to keep it sweet as long as possible. This is done by cooling the milk as soon as obtained to a temperature not exceeding 56° Fahrenheit, and it is still more effective if as low as 50° Fahrenheit. Pasteurization, or heating the milk to a temperature of 150° to 175° Fahrenheit, has also the effect of checking the growth of bacteria ; a large proportion of the lactic acid germs are killed at a temperature of about 140° Fahrenheit : cooling merely checks their growth and action. If the milk is pasteurized it is necessary to cool it thoroughly immediately afterwards.

For cream ripening and in cheesemaking, the object is to encourage the rapid growth of the lactic acid germs —hence the cream or milk is kept at a temperature suitable for this. The best results in cream ripening are obtained at a temperature of from 60° to 68° Fahrenheit, although the lactic acid bacteria increase in activity up to a temperature of 100° to 110° Fahrenheit.

In sour milk the sugar is replaced by lactic acid, and when about ·7 to ·8 per cent. of acid is present, and milk curdles or clots and the lactic acid germs are no longer able to exist. Their place is then taken by a type of bacteria producing butyric acid, and it is this which causes the disagreeable flavour of rancid butter. A troublesome fault in milk which is often, though not invariably, caused by bacteria is ropiness. The organisms causing ropy milk usually find their way into milk from water, either that used for washing utensils, or it is due to the cows wading in muddy ponds and the rubbing off of dried dirt into the milk pail. Gassy curd is also due to bacterial action, the particular germs in this case coming from manure or other filth. It is impossible to overestimate the importance of absolute cleanliness in the handling of milk for the production of first-class butter and cheese.

Starter.—Starter is a substance added to milk or cream to hasten the production of acid in butter and cheesemaking.

Starters are of two kinds—

(1) Natural ;

(2) Artificial.

Sour milk, whey, and butter milk are examples of natural starters, and these have been in common use for years. When produced from clean milk, kept under good conditions, they may give quite satisfactory results. Too often they contain harmful and injurious bacteria, and in this way taints and bad flavours are conveyed to the butter and cheese for which they may have been used.

Starters to be of any use must contain only those bacteria which produce good flavours in butter or cheese, *i.e.*, lactic acid bacteria.

Natural starter, specially and properly prepared, will practically be pure and contain only lactic acid bacteria. A natural starter is prepared in the following manner : About a quart of clean, new milk is placed in a previously-scalded vessel and is allowed to stand in a pure atmosphere till sour. This milk should be drawn from a healthy cow and care be taken to obtain it as clean as possible to prevent the entrance of undesirable germs. If the temperature has been kept at from 70° to 75° Fahrenheit, souring will take place in about 24 hours. The top is skimmed off and thrown away, and the remainder well stirred into 2 or 3 gallons of separated milk, which has been previously heated to a temperature of 185° Fahrenheit, for 20 minutes, and then cooled to 75° or 80° Fahrenheit. This is again put aside for another 24 hours, and it is stirred occasionally at first. By the next day the starter will be ready for use.

A fresh lot of separated milk is inoculated each day with a little of the starter, and a continuous supply thus maintained for use.

Artificial or pure culture starter is prepared from a pure culture of lactic acid bacteria. This may be obtained commercially either in powder or liquid form, and it is also supplied by many of the Dairy Schools. The powder or liquid is well stirred into pasteurized milk cooled as above, and kept at a temperature of 80° Fahrenheit till souring takes place.

A little of the starter is added to fresh separated milk daily to keep a supply ready for use. Sufficient starter should be added to each lot of separated milk to ensure its souring in from 20 to 24 hours. After being in use for some time a starter will need renewing, the length of time will depend upon the conditions under which it is kept. If the atmosphere and surroundings are clean, the separated milk properly pasteurized, and the top always skimmed off and thrown away before using, it will last for a considerable time. Under less favourable conditions it will require more frequent renewal. The starter is always covered with a piece of thin muslin to keep out dust, etc., without excluding the air. The foregoing remarks apply equally to natural and to artificially prepared starter.

CHAPTER VI

BUTTER

Butter consists of the fat of milk, but it is not exclusively fat. It contains in addition a certain amount of water, casein, sugar, and usually a small quantity of salt added in the process of manufacture. The relative proportion of fat and other matter depend upon the making.

Well worked butter contains about 12 or 12½ per cent. water, but in some samples as much as 15 to 20 per cent. of water will be found. Butter containing so large an amount of water is rarely of the best quality, being dull in appearance and having poor keeping qualities.

The amount of curdy matter present is also regulated in the process of making—if the butter is not washed, or is washed insufficiently to remove the buttermilk, there will be more casein and sugar present in consequence.

The following table shows the composition of well-made butter, also of separated milk and of buttermilk—

	Butter.	*Separated Milk.*	*Buttermilk.*
Water	11·9	90·39	91·44
Fat	85·0	·10	·20
Casein, Albumin	·6	3·90	3·56
Milk Sugar	·5	4·85	4·10 (with lactic acid
Ash	2·0 (including salt)	·76	·70
	100	100	100

Really good butter has a fine flavour and aroma, though it must be admitted that much of the butter sold does not possess these qualities in a very high degree. It is the most digestible and finely-flavoured fat in existence. The flavour of butter is believed to be derived from the products of ripening which are absorbed by the fat, and to obtain perfection of flavour the cream should not be excessively thick, or there will be insufficient milk serum present to produce proper ripening. Butter made from sweet cream does not possess the fine flavour of that made from ripened cream. The flavour of the butter produced is influenced by the food given to the cows, and the best-flavoured butter will be made when the cows are on grass, providing there are no weeds in the pastures to give objectionable taints. Good hay, crushed oats, bran, cotton cake in moderation are also good foods for butter production. All strong-flavoured foods must be avoided altogether, or used only in moderate quantities. The chief difference between butter and margarine, or artificial butter, lies in the fact that the former contains about 10 per cent. of volatile fatty acids while the latter has only about 2 to 3 per cent. It is the presence of these volatile fatty acids that impart to butter its superior quality and flavour. Even in genuine butter the proportion of these fats is found to vary very considerably ; in the milk of a freshly-calved cow a large proportion will be present, while towards the end of the lactation period the more solid non-volatile fats will be largely found. The proportion of the harder fats will be greater where foods rich in albuminoids are fed freely, *e.g.*, cotton cake produces a hard and somewhat pale butter. The keeping properties of butter depend on the cleanliness of the milk, the proper ripening of the cream, and upon the removal of most of the caseous matter during the process of manufacture.

The addition of salt has a slightly preservative action, and it also helps to bring out the flavour of the butter if not used too freely.

Bad-keeping butter is the result of dirty milk or dairies, improperly or over-ripened cream, failure to remove the buttermilk sufficiently, and occasionally the cause may be found in the water used in buttermaking or for washing up.

The colour of the butter produced from cows newly calved is superior to that made later on in the milking period, and individual cows vary greatly in the colour of the butter fat.

Grass produces butter of the best colour ; there is rarely cause to complain of pale or poor-coloured butter while the cows are in the pastures. The colour of butter may be adversely affected by overwashing as well as by exposure of either the cream before churning or the butter afterwards to strong light or direct sunlight. It is unfortunate that so large a quantity of indifferent and bad butter is produced in this country. One of the greatest complaints is that of lack of uniformity in the quality and keeping properties of the butter made in many dairies. Good creamery or factory butter can be relied upon at all times of the year, even though not so fine in flavour as really well-made farm butter.

With care and skill it is possible for the farmer to turn out butter second to none, and this high pitch of excellence is reached by some at the present time.

Points of Good Butter.—FLAVOUR.—The flavour should be sweet and nutty, free from acidity or oiliness. The salt should be evenly distributed and properly dissolved.

AROMA.—The aroma of good butter is mild, pleasant, and delicate.

TEXTURE.—The butter should be firm, neither too hard nor too soft. When cut half through and then broken the upper part should be solid and waxy in appearance, free from holes and cavities, and the broken part should show a distinct fracture and should not appear sticky or greasy.

Moisture.—Well-made butter contains about 12·5 per cent. of water. This water should be present in a finely-divided state and it should be clear and free from milkiness.

Colour.—The colour should be even throughout, and of a pleasing shade.

Appearance.—The butter should be nicely made up, should be clean, and free from patches and streaks. It should not have a dull appearance or be greasy or sticky looking.

Keeping Properties.—Butter varies very much in its keeping properties. Well-made butter should keep at least a week in Summer and two or three weeks in winter before the flavour begins to change.

Judging Butter.—The flavour is of the greatest importance, and any sample with a disagreeable odour need not be further examined. The colour and general appearance is next noted, a neat finish and appetising appearance makes a considerable difference in the result. The butter is cut half through and then broken, thus showing the texture, solidity, and grain. The amount of moisture present and the uniformity of salting is also taken into consideration. Judging is usually done by a scale of points, most Judges using their own. The following is a useful scale for the purpose—

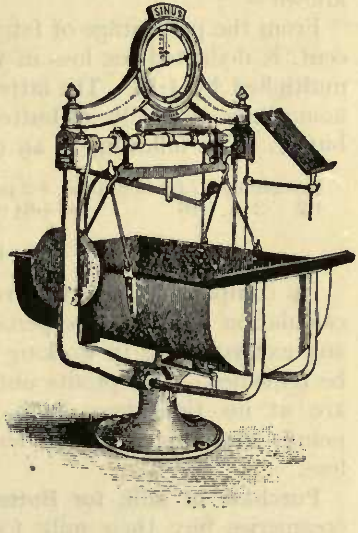
Flavour and aroma	50
Texture	20
Freedom from moisture Salting	15
Colour and appearance	15
	100

Butter Ratio.—Butter ratio is the proportion of butter obtained from milk; it varies very considerably in practice, the chief factors being—

(1) The quality or the percentage of fat in the milk used;

(2) The loss which occurs during the process of manufacture.

It can readily be seen that it will require a smaller quantity of milk rich in fat to produce a pound of butter than it would if the milk were poor.



MILK WEIGHING MACHINE

As used for the purchase of milk by creameries. A gallon of milk weighs 10.3 lbs.

With milk of average quality the butter ratio will be about 1·25, or 1 lb. of butter from 25 lb. ($2\frac{1}{2}$ gallons) of milk. If rich milk such as that of Jersey or Guernsey cows is used, it will require only about 18 lb. of milk to produce 1 lb. of butter, while with poor milk it may require as much as 30 to 35 lb. of milk to produce the same amount of butter. It is therefore quite evident that buttermaking from poor milk is not a particularly profitable enterprise. The second factor influencing the butter ratio is the loss of fat in the process of manufacture, *i.e.*, in separating and churning.

In no case should this exceed ·2 per cent. with careful management, though it is to be feared that in many cases the loss is very considerably higher. It has been found possible in well-managed creameries to reduce this loss to ·15 per cent. or even lower.

The butter ratio of any milk is easily determined by the following method if the percentage of fat is known—

From the percentage of fat present in the milk ·2 per cent. is deducted for loss in working and the result is multiplied by 1·16. The latter factor is based on the assumption that 1 lb. of butter-fat will produce 1·16 lb. butter. The following is an example—

Percentage of fat in milk	= 4·2 per cent.	
4·2 – ·2 × 1·16	= 4·64 lb. butter from	100 lb. milk.
	1 ,, ,,	21·5 ,, ,,

Butter ratio 1 : 21·5.

By comparing the actual results of churning with a calculation based on the percentage of fat in the milk, any excessive loss in working will be apparent and can be remedied. The profits obtained from buttermaking are at no time very high, and attention to these points may make the difference between profit and loss.

Purchase of Milk for Buttermaking.—A good many creameries buy their milk for buttermaking at prices which are based upon the amount of fat the milk contains. That is, milk containing a high percentage of fat will be paid for at a higher rate than poor milk. A gallon of rich milk is worth more for buttermaking than the same amount of poor milk, and requires no more time and labour in handling, hence the profit is necessarily greater.

The milk of each supplier is sampled daily, the amount of the sample being in proportion to the quantity of milk supplied. At the end of a week, or fortnight, this composite sample is tested and the price of the milk based on the percentage of fat found. Where butter is made commercially, it is much more satisfactory and profitable to buy milk according to quality instead of paying a fixed price per gallon irrespective of the amount of fat it contains.

CHAPTER VII

CREAM PRODUCTION

Cream is composed of the fat of milk with a varying proportion of water, sugar, and casein. It varies considerably in thickness and richness. Hence it is difficult to state a definite composition. The following table shows the composition of thick and thin cream and also of Devonshire cream—

	Thick Cream.	*Thin Cream.*	*Devonshire Cream.*
Water . . .	43·4	65·43	33·30
Fat	50·0	26·20	60·25
Casein . . .	4·0	3·25	4·75
Sugar . . .	2·0	4·52	1·20
Ash	·6	·60	·50

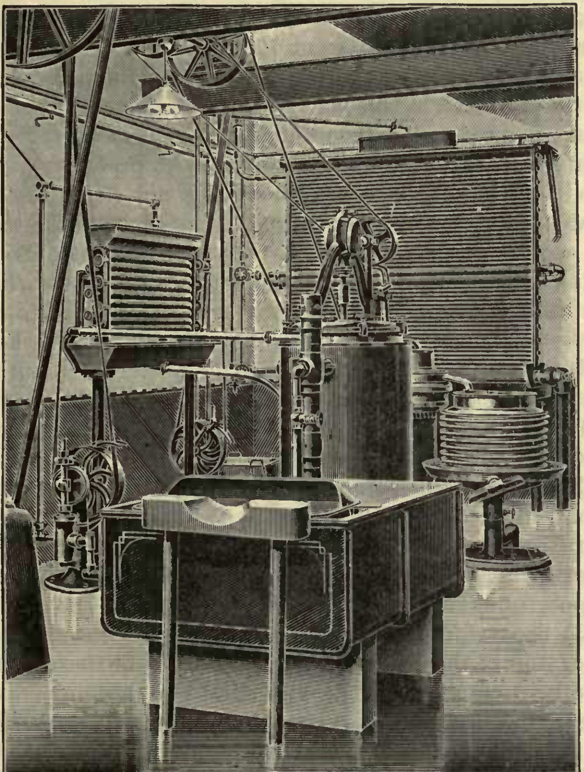
The thickness of cream is not always an indication of its richness, sometimes the thickness of cream is due to the fact that it has been separated at a high temperature and cooled immediately and thoroughly. Really rich cream when fresh and not well cooled may often be thin in appearance. Cream is obtained from milk either by the action of gravity as in the setting systems, or by centrifugal force as in mechanical separators. In both cases separation is due to the fact that the fat is very much lighter than the milk serum. In the former method the separation requires at least 12 hours to be effective, in the latter it is only a matter of a few minutes.

The three systems of cream raising are—

(1) Shallow pan system ;

(2) Deep setting system ;

(3) Separator system.



DAIRY PLANT

Showing milk-receiving tank, milk pump, regenerative heater, pasteurizer, separator, cream cooler, and large milk cooler in two sections, one for water and the other for brine-cooling.

(1) In the shallow setting system the milk while warm is strained into pans about 6 or 8 in. deep. It is then allowed to stand from 12 to 24 hours, when the cream is skimmed off with a perforated skimmer. The cream produced in this way is usually thick and of good quality, and under favourable conditions, as regards cleanliness and feeding of the cows, it produces very good butter. If, however, the milk is not clean, or the cows are fed on strong-flavoured foods, the cream is apt to acquire a disagreeable flavour by the time it is obtained. Added to this is the fact that in hot weather the milk will sometimes become sour before the cream is skimmed. The skim milk obtained by this method will contain a greater proportion of butter fat than is found in separated milk.

The Devonshire system and the use of leads are modifications of the above.

(2) In the deep setting system the milk is set in cans about 15 in. deep with, or without, lids. The cans are immersed in cold running water and by this means a large quantity of cream is produced, but it is thin and of poor quality as regards the percentage of fat.

(3) **Separator System.**—The use of the mechanical separator is the modern method, and if buttermaking is to be profitable it is the only one to be recommended. The first mechanical separator was introduced as recently as 1877 by Gustaf de Laval of Sweden.

Since that date great improvements have been made in the construction of these separators, and they are now practically perfect. A good make of separator properly used will leave no more than ·1 per cent. of fat in the separated milk, and consequently much more butter is obtained from the milk than in the older methods. The increase in yield may be quite 12 per cent.

For example, if a cow gives 250 lb. of butter in a year where a separator is used, the yield if shallow pans were used for the cream raising would be at least 35 lb. less. Taking 2s. 6d. per lb. as the value of the butter made, this means a needless loss of £4 7s. 6d. per year for each cow.

The advantages of using a separator are briefly these—

(1) More butter is produced, and therefore the profit is greater ;

(2) The cream and separated milk are perfectly fresh.

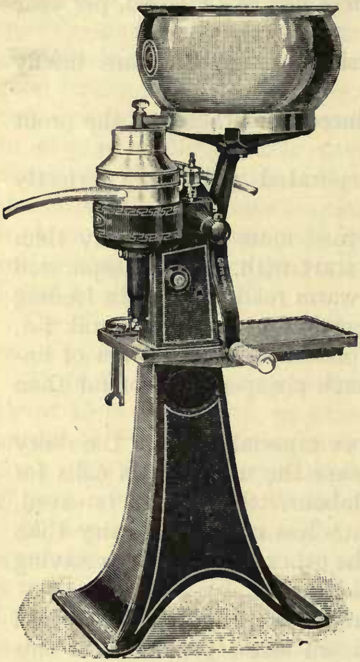
The cream may be ripened more satisfactorily than when it is partly sour to start with, and the separated milk is also sweet, and is warm ready for use in feeding calves, etc. The latter certainly contains less milk fat, but this may easily be replaced by the addition of linseed or cod-liver oil, a much cheaper form of fat than butter fat.

(3) Labour is saved more especially where the dairy is a large one, in which case the use of pans calls for an enormous amount of labour. Space, too, is saved, a separator taking up much less room in a dairy than the utensils necessary in the other systems. The saving of time is also considerable.

(4) Cream may be obtained of any thickness desired by simply altering the cream screw provided for this purpose. Both cream and separated milk are cleansed by being passed through the separator.

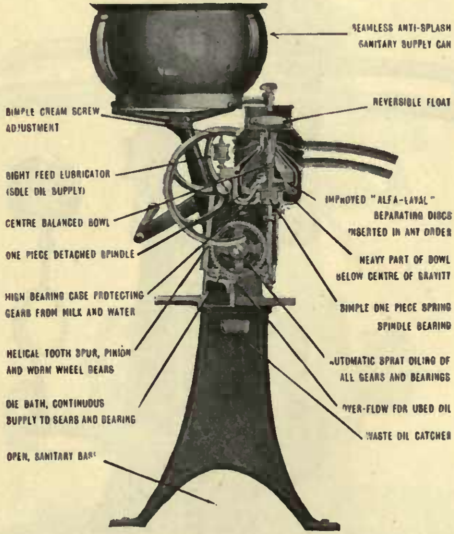
A glance at the sides of the bowl after separating, especially in winter, will confirm this. In the setting systems this dirt forms a sediment at the bottom of the pan and has a detrimental effect on the butter produced tending to impart to it taints and bad flavours.

There is a large number of different makes of separators on the market, many of them being quite satisfactory. The principle in all cases is the same, the cream being separated by centrifugal force. Centrifugal force is that force which causes bodies to be thrown from the centre of revolution. The higher the speed the greater the separating force. In milk there is present the cream, which is light in comparison with the serum. When the milk passes into the separator bowl, which is revolving at a high speed, the heavier part is thrown to the outside of the bowl, while the lighter cream remains in the centre each escaping through a separate outlet. The speed of the bowl varies in the different makes, and may be from 5,000 to 13,000 revolutions per minute. The construction of the bowl also differs, some being fitted with discs, others with plates, etc., the object in each case being to improve the skimming by dividing the milk into layers and thus increasing the time it takes in passing through the bowls, and in



SMALL HAND-POWER ALFA LAVAL CREAM SEPARATOR consequence a greater thoroughness of the separation is secured.

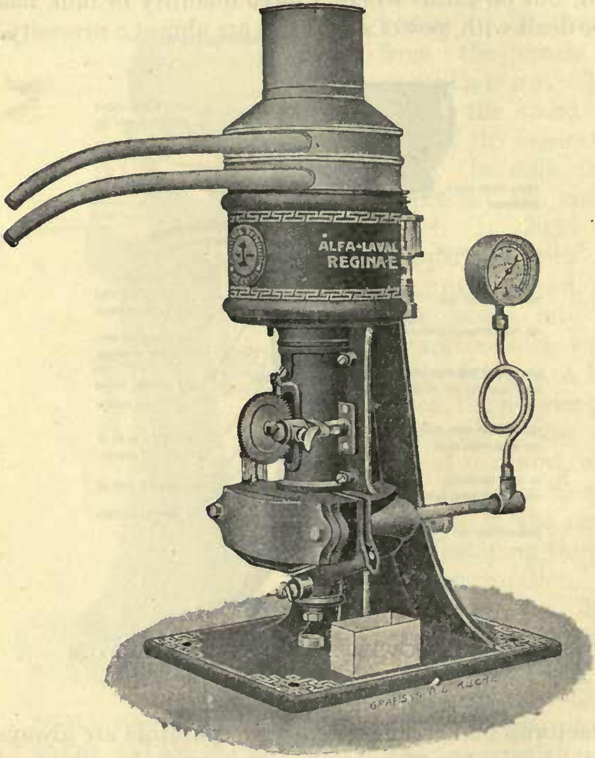
In small dairies separators are usually worked by hand, but on farms where a large quantity of milk has to be dealt with, power separators are almost a necessity.



SMALL HAND-POWER ALFA LAVAL SEPARATOR
(Sectional cut.)

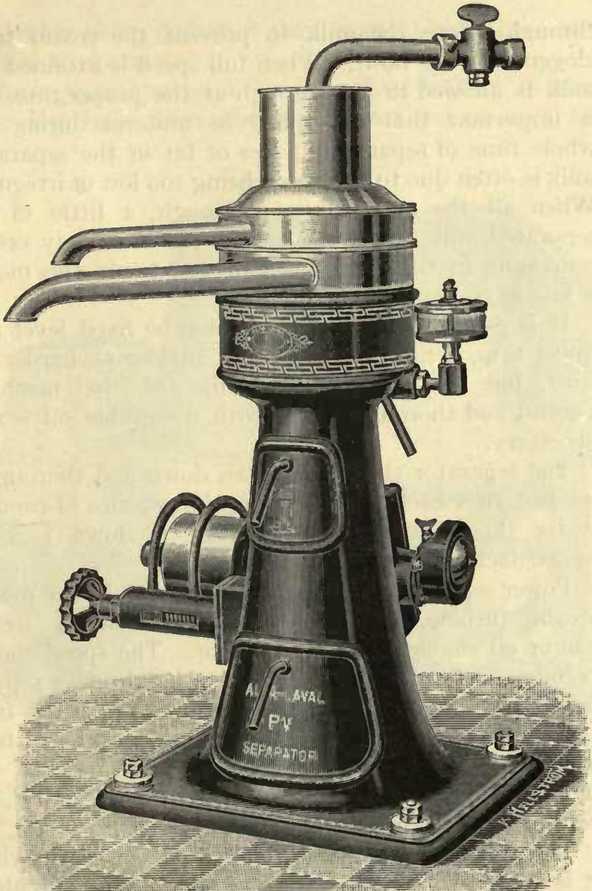
In factories and creameries power separators are always used. Separators for hand power may be obtained capable of separating from 15 to 120 gallons per hour. Power separation may be effective up to a capacity of 800 gallons per hour.

In a farm dairy the milk will be brought into the dairy warm from the cow, that is, at a temperature of about 90° to 95° Fahrenheit, and it is strained before being poured into the receiving bowl. The machine is



ALFA LAVAL LARGE STEAM TURBINE CREAM SEPARATOR

then started gently, the speed being gradually increased to the full. In winter a little hot water should be run



ALFA LAVAL LARGE DIRECT BELT-DRIVEN-CREAM SEPARATOR through before the milk to prevent the cream from clogging in the bowl. When full speed is attained the milk is allowed to run through at the proper rate. It is important that the speed be uniform during the whole time of separating ; loss of fat in the separated milk is often due to the speed being too low or irregular. When all the milk has run through, a little of the separated milk is put through to rinse out any cream remaining in the bowl, the omission to do this means a loss of cream.

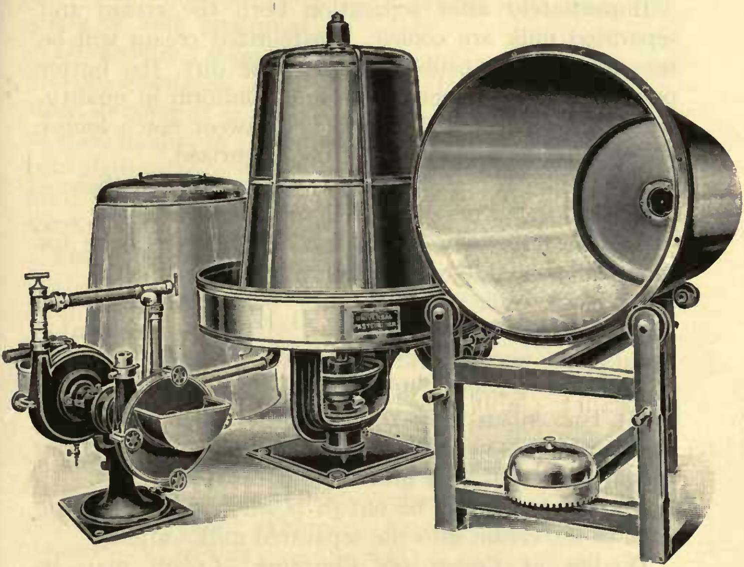
It is essential that the separator be fixed level and quite firm, vibration not only makes it harder to turn, but also shortens the life of the machine. Careful and thorough oiling with a suitable oil is also necessary.

The separator should be taken down and thoroughly washed after each period of use, the practice of running water through instead of taking it down is most unsatisfactory.

Power separators may be driven by an electric motor, steam turbine, or by belt power from a steam, gas or oil engine, or electric motor. The speed should be more uniform than in the case of hand power separators. In factories the process of separating differs from that in a farm dairy. The milk there is obtained from a number of suppliers and will vary in cleanliness, and if made directly into butter as in a farm dairy, the results would often be disastrous.

The milk is first passed through a pasteurizer in which it is heated to a temperature of, say, 180° Fahrenheit. This kills practically all the bacteria present in the milk, some of which might be injurious to the flavour of the butter. It is then passed into the separator, or it may be cooled to a temperature of 130° Fahrenheit first, at this latter temperature there is less likelihood of the separator being damaged than would be the case at a higher temperature.

In some creameries a " regenerative heater " is used. The hot milk from the pasteurizer passes over the



COMBINED PASTEURIZER REGENERATIVE HEATER

Cold inflowing milk in a separate chamber absorbs heat from fully pasteurized milk flowing outwards in another chamber. Thus a great saving is effected in both the amount of heat required to warm up the cold milk and in the quantity of water required to cool the pasteurized milk. The cold milk is raised about 60° F., lost by the pasteurized milk.

corrugated surface, while at the same time the cold milk passes through the inside of the apparatus. The hot milk is thus reduced to a suitable temperature for separating, while the cold milk is partially warmed before entering the pasteurizer, and thus saving is effected in two ways both in heating and cooling. Milk is separated more thoroughly when hot, as little as ·05 per cent. of fat is left in the separated milk when carefully separated at a temperature of 120° to 130° Fahrenheit and at the proper speed.

Immediately after separation both the cream and separated milk are cooled. Pasteurized cream will be free from taints caused by foods or dirt, the butter produced keeps longer and is more uniform in quality, while the separated milk will keep sweet much longer and is safer as a food than if unpasteurized.

The causes of inefficient separation are briefly these—

(1) The speed may be either too low or irregular ;

(2) The milk may be too cold (the temperature for separating should never be below 85° Fahrenheit).

(3) More milk is sometimes passed through the separator than it is intended to deal with a separator should be worked rather below its capacity than above it ;

(4) The cream may be too thick; when separating cream which is very thick, a part is unable to get away quickly, and is forced into the separated milk.

(5) The bowl may be out of position, thus throwing part of the cream into the separated milk outlet.

Quality of Cream for Churning.—Cream may be obtained of any desired thickness by regulating the cream screw provided in the bowl of the separator. For buttermaking, cream containing from 25 to 35 per cent. of fat gives the best results.

If the cream is too thick it is difficult to cool, does not ripen evenly, and does not produce butter of such good grain. Cream that is too thin is not easy to churn on account of the large amount of milk serum present. This prevents the fat globules from coalescing to form the butter.

Where churning is done frequently, the cream may be rather thinner, but where churning takes place less frequently a thicker cream is better as it does not ripen so quickly. A good proportion for ordinary use is 12 per cent., that is, 12 parts of cream from each 100 parts of milk separated.

Devonshire Cream.—Clotted cream is chiefly made in Devon, Somerset, and Cornwall. It is, however, possible to make it in any part of the country where milk of good quality is available. The warm milk is strained into shallow pans 6 to 8 in. deep and allowed to stand undisturbed for 12 or 24 hours, the length of time varying with the time of year.

The pans are now removed to a stove and the milk heated very gradually to a temperature of 170° to 190° Fahrenheit. This should be done very slowly, or the proper flavour is not obtained—about 20 to 30 minutes is the minimum time which should be taken.

The pans are then removed to the dairy and allowed to cool, and in summer they are often placed in cold water. The cream is skimmed off after about 12 hours, using a perforated skimmer. Clotted cream may be churned, but in this case the scald is not so high, 170° Fahrenheit being the maximum.

The old-fashioned method of churning clotted cream was to place it in a tub and stir or beat with the hand till butter is produced. Butter made from clotted cream requires thorough washing to remove the butter-milk or the keeping properties will be poor.

Cream Ripening.—The management of the cream from the time it leaves the separator until it is churned is a matter of the greatest importance. The flavour, the texture, and the keeping properties of the butter are influenced by the conditions under which the cream has been kept. Cream may be churned either in a sweet or in a ripened condition.

In some districts there is a good demand for butter made from sweet cream. This butter is paler in colour than that made from ripened cream, and has a mild creamy flavour. It is usually considered to have poor keeping qualities, but if carefully made and thoroughly washed to remove the buttermilk it will be found to keep in good condition for a reasonable time. The loss of fat is greater in churning sweet or unripened cream, though this loss need not be more than 1 per cent. if the churning temperature is properly regulated.

If the cream is to be churned sweet, it should be thoroughly cooled on leaving the separator and kept at a fairly low temperature for several hours before being churned. This gives a firmer butter than if the cream were merely cooled just before churning. The usual practice is to ripen the cream before churning.

CHAPTER VIII

CREAM RIPENING AND USE OF STARTERS

THE ripening of cream means the development therein of a certain amount of acidity or sourness. The chief agency is the growth of bacteria, which converts part of the milk sugar into lactic acid.

As a result of this fermentation the fat globules are more or less completely liberated from the casein, churning is more complete, and there is less loss of fat in the buttermilk than when the cream is churned in an unripened condition.

Ripening has also an important influence on the flavour of butter. It is very much fuller and more pronounced and the butter usually has better keeping properties than sweet cream butter.

The ripening of cream is influenced by the conditions under which it is obtained and kept, and also by the temperature.

(1) **Conditions.**—In natural ripening the bacteria find their way into the milk from the air and surroundings generally. Where these are clean, the germs present will be mostly of the lactic acid variety and the results satisfactory. Under dirty conditions a large number of undesirable organisms will be present and these adversely affect the ripening, while a dark, damp dairy favours the growth of moulds.

(2) **Temperature.**—The best results are obtained when the cream is kept at a temperature between 58° and 68° Fahrenheit. The flavours produced at low temperatures, and also at temperatures above 75° Fahrenheit, are unsatisfactory and undesirable. When the cream

is ripened at a high temperature, the butter will be soft and lacking in body even when churned carefully.

(3) **Quality and Thickness.**—A large quantity of cream ripens more quickly than small lots, and thin cream ripens more rapidly than rich, thick cream owing to the greater amount of milk serum present.

There are two methods of cream ripening—

(*a*) Natural ;

(*b*) Artificial.

On farms the cream is almost always ripened by the natural method. When skimmed or separated, it is placed in glazed earthenware crocks (or enamelled pails) and covered with thin muslin to exclude dust.

It is placed so that sunlight or direct strong light does not fall on it, or bleaching will result.

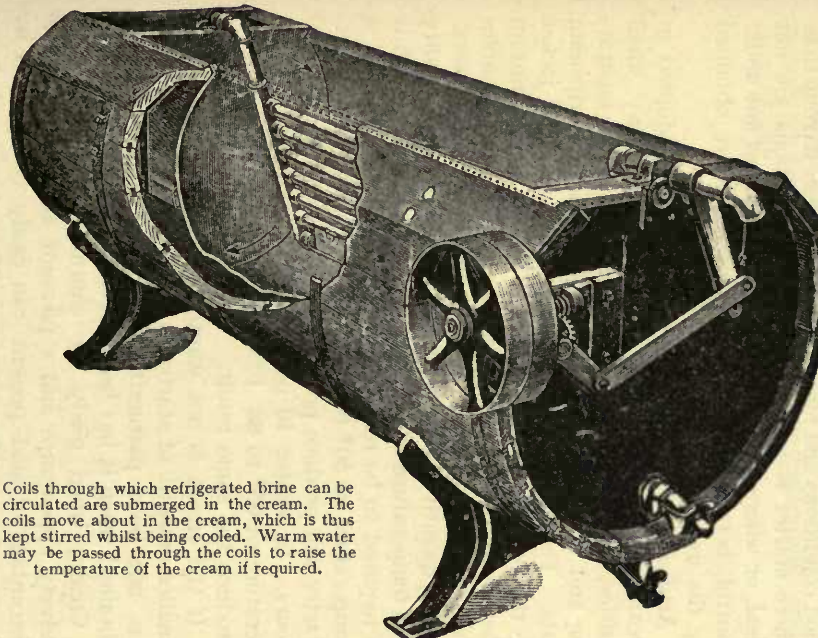
The cream is frequently stirred, especially when fresh lots of cream are added. Stirring helps to admit air to the cream and this is desirable, as lactic acid bacteria flourish best where oxygen is available, while the activity of many of the germs producing undesirable flavours is diminished at the same time. This also explains why cream is not closely covered during ripening.

Naturally-ripened cream, if kept at the proper temperature, is ready for churning in from two to three days in summer and three to four in winter.

Where the best results are desired churning takes place not less than twice weekly ; in all cases butter will keep better than the cream.

Cream should be churned as soon as sufficiently ripe, otherwise the butter produced will be strong and unpleasant in flavour.

The bad flavour of butter made on many farms is due to the fact that the cream is kept too long before churning, and in winter at much too low a temperature which encourages the growth of undesirable



Coils through which refrigerated brine can be circulated are submerged in the cream. The coils move about in the cream, which is thus kept stirred whilst being cooled. Warm water may be passed through the coils to raise the temperature of the cream if required.

CREAM RIPENING VAT AND COOLER

bacteria ; bitter flavours are often the result of low temperatures during the ripening period.

Butter made from cream ripened naturally under good conditions and management is of finer flavour than where starter is used. Where the conditions are not ideal, or where milk is obtained from sources not under control, better and more uniform results are obtained by the use of starter.

Artificial cream ripening is the method adopted in creameries and factories as well as in many small dairies. The milk is usually pasteurized before separating and the cream run over a cooler into the ripening vats. These vats are often fitted with an outer jacket so that cold or warm water can be run in to maintain the cream at the desired temperature, and this enables the process of ripening to be regulated with exactness.

The quantity of starter added varies with the quality and temperature of the cream and the time in which it is required to be ready for churning. In summer at a temperature of 50° to 60° Fahrenheit, 5 to 8 per cent. starter will produce properly-ripened cream in 18 to 20 hours. In winter 10 per cent. of starter and a temperature of 65° to 68° Fahrenheit, will be necessary to produce the same result.

If the cream is not wanted to ripen so quickly, a smaller amount of starter is used even when the milk has not been pastuerized, but the best results are obtained when it has been previously pasteurized.

Cream, when ready for churning, has a smooth, velvety appearance and a pleasant acid flavour. The percentage of acid present can easily be detected by the use of an Acidimeter, from ·35 to ·4 per cent. being the correct amount.

Cream should be cooled down to the churning temperature for several hours before churning, as this gives much firmer butter than if it is merely cooled down just before churning.

Fresh cream should not be added less than 12 hours before churning; churning sweet and ripened cream together means a loss of fat in the buttermilk, and a lack of uniformity in the produce.

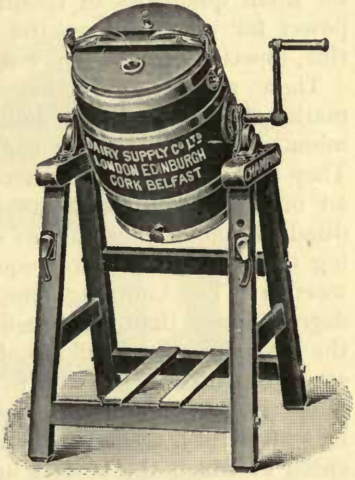
CHAPTER IX

THE PROCESS OF CHURNING

CHURNING is the mechanical process by which butter is obtained from milk or from cream. In some districts the whole milk is still churned, but the more usual method is to first separate the cream by means of a separator or by one of the gravity systems. The churning of milk and cream has been practised in a more or less primitive fashion from the earliest times. In recent years buttermaking appliances have been much improved, and the scientific side of the subject studied so that results are much more uniform and satisfactory. There is still plenty of room for improvement in much of the butter made in this country, both in the production and handling of the milk and cream, in the actual process of making, and in the marketing of the butter. It is quite impossible to make good butter from bad-flavoured or improperly-ripened cream, but it is possible to make butter of poor quality from good cream by want of skill and bad workmanship.

The object of the buttermaker is to produce butter of fine flavour with good texture and keeping properties, and to lose as little butter fat as possible in the process. This requires considerable skill and experience as the working conditions are so variable and are often far from ideal. The apparatus required for buttermaking is simple and comparatively inexpensive. The churn is usually made of wood, oak is generally used and is found very suitable for the purpose as it is durable and not likely to impart any undesirable taste to the butter.

A churn should be simple and strong in construction, and should produce butter in a reasonable time. For the ordinary dairy the best type of churn is undoubtedly the end-over-end barrel shape. These churns are made either with or without a removable division or diaphragm; the diaphragm slightly increases the churning capacity without the disadvantages of fixed dashers or beaters. One end of the churn forms the lid, thus giving an opening large enough to allow the butter to be easily taken out, while the churn is much easier to keep clean than is the case when the opening is small.



SMALL HAND-POWER
END-OVER-END BUTTER CHURN

To avoid waste of time, the fastenings of the lid should be such that it can be quickly removed and securely and easily fixed on. The newer churns are fitted with lever fastenings, these are a great improvement on the screw fastenings and are not likely to get out of order if they are used with reasonable care. With a good fitting lid, a ventilator is necessary to allow the escape of the gas liberated from the cream during churning, and a small glass window enables the worker to watch the condition of the butter at the breaking stage. End-over-end churns may be had in all sizes, and when buying one it should be large enough to dale easily with the amount of cream likely to be churned at a time. Overfilling the churn is one of the commonest causes of long churnings. Other churns include the box pattern, in which beaters are made to revolve while the churn itself remains stationary. These are quite good for small quantities of cream, but they require more power for working than the end-over-end churn, and this, especially in the larger sizes, is a consideration.

There are several makes of rapid churns on the market. These produce butter in from two to five minutes, thus effecting a considerable saving of time. They require a good deal more power for working than an ordinary churn and are also more expensive. A disadvantage of these churns is the difficulty of obtaining the low temperature required for churning in hot weather. The churning temperature must be several degrees lower than when using an ordinary churn, or the butter produced will be soft and greasy. It is much easier to over-churn butter in a churn of this sort, and altogether more skill is necessary if the results are to be satisfactory. The rapid churning is due to the high speed at which the beaters are made to revolve. For the actual churning the only other articles necessary in addition to the churn are a reliable thermometer (a plain glass one and *not* mounted in wooden case), a coarse cloth for straining the cream (a special material of open texture is sold for the purpose), a hair sieve for placing under the churn when removing buttermilk, etc., to avoid the loss of butter grains, and two or three pails for water and buttermilk. A pint or quart-size measure is useful for washing down the butter from the lid and sides of the churn, and a small rubber squeegee for cleaning all the cream from the pail into the churn. A new churn needs careful preparation before it is used or the butter will have a strong flavour of new wood.

The usual plan is to first fill it with cold water, and then allow it to soak for 12 hours. It is next well scalded with hot water containing a little soda, all traces of the latter being next removed by a thorough scalding with hot water. Lastly, the churn is well rinsed with cold

HAND-POWER BUTTER WORKER
The roller is used to roll out the butter and express the water.

water, or better still some separated milk or butter-milk churned in it for 5 or 10 minutes. All new white-wood articles, such as scotch hands, etc., are improved if soaked for several hours in cold water before being scalded for use. For working the butter, a mechanical butterworker is used nowadays in place of the old-fashioned method of working the butter with the hands. It is neither advisable nor necessary to touch the butter with the hands at all. Butterworkers are made of wood and the table may be circular or rectangular in shape. For hand power the latter type is generally used, the circular shape being more used for working large quantities of butter. The table is made of hard wood, with sides 3 in. or 4 in. high, and it slopes to one corner so that the water may drain away easily and quickly. A ribbed or fluted roller is mounted in a carrier on rollers, this enables the roller to be passed backwards and forwards over the table.

The délaiteuse or centrifugal butter dryer is sometimes used in place of, or in conjunction with, the butter-worker. The butter-dryer consists of a circular perforated metal cylinder mounted in an outer case also of metal. The granular butter is removed from the churn and placed in the inner perforated case (first lined with a muslin or straining cloth). The inner cylinder of the dryer is rotated and the water removed by centrifugal force. It can only be used when the butter is in grains and in a fairly firm condition. In winter, unless the temperature is carefully regulated, the butter becomes too hard. The machine requires careful cleaning and drying after use as it rusts very quickly.

One or two pairs of scotch hands fluted or grooved on one side and plain on the reverse are necessary for handling the butter, and later for making it up ; a wooden scoop for lifting the butter from the churn and some butter muslin for wiping up surplus water and for covering the butter when necessary. The butter may be made up on the butter-worker, or a fairly substantial hard wood board can be used if preferred. A set of scales and weights will be required for weighing the butter and salt, and good quality grease-proof paper for packing. In creameries and factories where a large quantity of butter is made, the appliances used are of a different type from those used in small dairies.

The most popular type of churn for creamery use is the stationary horizontal barrel fitted with revolving beaters. The churn has a fair-sized opening fitted with a door. In some cases a butter box is used for washing

LARGE FACTORY BUTTER CHURN

the butter—this is an advantage where several lots of cream have to be churned daily.

When the butter comes it is emptied into the box together with the buttermilk. The churn is then available for another lot of cream while the butter is being washed and made up. The butter-worker used is of the circular shape ; the rollers in these workers are fixed while the table revolves.

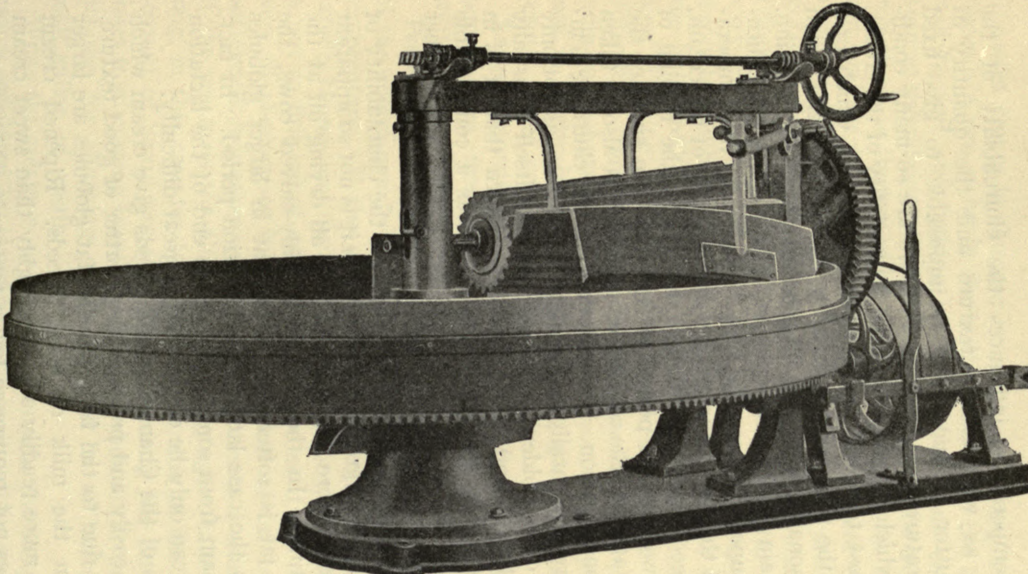
A combined churn and worker is now used in a number of creameries. It occupies less space than the separate churn and worker ; labour is saved, and less time is necessary for churning and making the butter. Another advantage is that the butter is not exposed to the air, and is therefore not likely to become either too soft or too hard for working.

Where a large quantity of butter is made into bricks or pats a machine for moulding saves a great deal of time, and also ensures uniformity in shape, which is a great advantage for packing.

Preparation of Utensils.—The churn and butter-worker are prepared for use so that the butter will not stick to the wood.

This is done by first scalding them with boiling water, the churn is rotated several times ventilating at each revolution to allow the steam to escape. The hot water is emptied out, and enough clean cold water put in to reduce the temperature to that at which churning is to take place. This water is left in the churn till the cream is actually ready to be strained in. In hot weather the scalding is omitted, as it would be difficult to cool down the churn to the temperature required unless ice were available. The churn in this case is well rinsed with cold water, then the lid and slides rubbed with salt using a soft brush for the purpose. The butter-worker and all the small articles are scalded thoroughly, rinsed with cold water, and in hot weather they may be rubbed with salt, paying particular attention to the roller. Cold water is then left on the butter-worker, and the scotch hands, etc., laid in it ready for use, the whole being covered with damp muslins to keep out dust and to prevent the wood from drying up.

Churning Temperatures.—The temperature at which the churning is done is a point of the greatest importance.



LARGE FACTORY BUTTER WORKER

The temperature influences the churnability of the cream as well as the texture and the quantity of the butter produced. It is impossible to give fixed temperatures for churning as there are so many conditions which may influence the churnability of the cream. The best temperature for churning is that which produces the maximum amount of butter from the cream in reasonable time and in good condition for working. The main points to be considered in deciding the churning temperature are the time of year and the temperature of the dairy, the quality and ripeness of the cream, the breed of cow producing the cream, the feeding of the cows and the period of lactation. In summer the temperature of the cold water supply must also be taken into consideration. In cold weather the churning temperature is naturally higher than in summer, as not only is the dairy colder, but the butter fat itself is usually much harder and more difficult to churn than it is in summer. The feeding of the cows has a considerable effect on the hardness of the butter fat, while other foods may make the fat soft and oily.

The period of lactation influences the churnability of the cream to a great extent, though it is not so apparent in a herd where the cows are not all drying off at the same time. In the milk of freshly-calved cows, the butter fat is softer and is present in larger globules than is the case late in the lactation period. In fact, the cream from some cows at the end of the lactation period can only be churned with great difficulty.

Cows of the Channel Island breeds give cream which churns easily and produces firm butter of good texture. This is due to the fact that the fat globules are larger than in the milk of other breeds. Ripened cream churns more readily and thoroughly than sweet cream and does not require so low a temperature in summer.

If sweet cream is churned at too high a temperature, there is a loss of fat in the buttermilk, while the butter will be soft and lacking in body. Under no circumstances should ripened cream and sweet cream be churned together—as the loss of fat would be high and the butter not uniform in colour and quality. Thin, poor cream requires a higher churning temperature than cream of good quality. Generally speaking, the normal churning temperature is 55° to 56° F., but the temperature may vary from 50° to 62° F. Too high a temperature produces butter in a short time, but with a loss of fat in the buttermilk ; while too low a temperature means a long churning and the butter produced will be hard, difficult to work, and the flavour may be tallowy. In summer a churning temperature of from 54° to 56° F., and in winter from 58° to 62° F. will give satisfactory results under normal conditions.

Large quantities of cream require a lower churning temperature, from 48° F. in summer up to 56° F. in winter being satisfactory.

Preparation of Cream.—Before churning, the thickness of the cream usually requires regulating as well as the temperature. If the cream is too thick it churns less rapidly or may not churn at all, and the butter produced is not so firm or of such good texture as if the cream were of the proper thickness. The loss of fat in the buttermilk is greater when over-thick cream is churned. If the cream is too thin the churning again takes too long, in this case the long churning is due to the large amount of liquid present, this preventing the fat particles from coming together. Cream when of the proper richness for churning yields about 3 lb. of butter to each gallon of cream.

When the cream is already thin enough, the temperature is regulated by standing the cream pail in another vessel containing hot or cold water as the case may be. The cream is then carefully stirred until it is of the desired temperature. When the cream requires thinning down before churning clean water is used for the purpose. Both the temperature and thickness may be regulated at the same time by adding the water warm, or cold, as required. Under no circumstances may ice or hot water be put into the cream. Ice cools the cream unevenly, freezing that with which it actually comes in contact and spoiling the colour. If hot water is added to cream it also spoils the colour and makes the butter sticky. If ice is available and found necessary in summer, it is used to cool the water for thinning the cream, and that used for cooling the churn and for washing the butter.

It is found that sudden changes of the temperature of cream immediately before churning are less effective than where the cream is gradually brought to the churning temperature, or near it, and kept there for, say, 12 hours before churning takes place.

In summer, if the dairy is very hot, the cream might be placed in a clean, airy cellar overnight, or failing this the cream vessels may be placed in cold water either kept running or changed frequently. In winter, farm dairies are generally too cold and possess no heating arrangements. The cream in this case may be moved into the kitchen the night before churning and the temperature kept somewhere near 60° F. It is essential that there shall be nothing in the room likely to impart a disagreeable odour or flavour to the cream.

Colouring of Butter.—The natural colour of butter varies with the time of year, the breed of cow, the feeding, and the period of lactation. In winter, the butter is often deficient in colour, and for most markets and customers the use of artificial colouring is necessary.

Butter colouring should be such that it imparts no undesirable flavour to the butter and it should contain nothing injurious. Mineral colourings should be avoided. The safest and best colouring matter is annatto and for buttermaking it is dissolved in oil, thus colouring the cream without affecting the buttermilk. The amount used depends on the strength of the colouring and the depth of colouring required in the butter. The use of too much colouring is not advisable. The colouring is added to the cream just before it is strained into the churn.

Process of Churning.—The cream when ready is strained into the churn through a coarse cloth. In a creamery a perforated metal bucket is used for straining, and in summer this is often half filled with broken ice to cool the cream. The straining reduces the cream to an even consistency and removes any impurities that may be present in it. The amount of cream put into the churn should not exceed its churning capacity, that is, not more than half full if the churn has beaters, and one-third full in a churn without dashers.

Butter is produced by concussion of the cream which causes the fat globules to unite and finally to separate from the buttermilk. If the churn is too full, the cream does not get enough agitation and a long churning is the result. The tub-and-hand method was, and is still, used to some extent in Devonshire for churning clotted cream. The cream in this case is put into a tub and beaten with the hand till the butter separates.

When the cream is in the churn and the lid secured, churning commences. The churn is turned slowly for the first 5 or 6 minutes, ventilating at every few revolutions to allow the gas to escape. The gas liberated in churning is mostly air mixed with a little carbon dioxide, and it may cause the cream to become frothy and difficult to churn if ventilation is neglected.

The speed of churning depends upon the type and make of the churn and the quantity of cream in it. With an end-over-end churn from 45 to 50 revolutions per minute is the usual speed, always turning more slowly for the first few minutes and later when the cream thickens and is about to " break." In the largest sizes of factory churns, a speed of 40 revolutions per minute should not be exceeded. Where only a small quantity of cream is being churned, the speed must be lower, or the cream will simply hang round the sides of the churn and thus get no concussion. If the churn is over-full the speed again is lower, in order to allow the cream time to drop at each revolution of the churn. The time taken in churning may be from 15 to 40 minutes. The churn is turned as regularly and evenly as possible, and when the cream thickens the speed is reduced a little. If the churn is turned too quickly at this stage, the cream, especially if it is inclined to be thick, " goes to sleep." This simply means that the cream hangs round the sides of the churn and goes round with it instead of falling at each turn. When the butter comes, the difference in sound is noticeable and the glass window becomes partially clear. When the butter appears in the form of small particles on the glass, churning is stopped and the " breaking water added." This water is from 3° to 10° lower than the churning temperature. In summer, say 42° to 45° F., or as cold as possible, and in winter 3° to 4° below the temperature at which churning has been done.

The object of adding this breaking water is to reduce the temperature, which rises during churning, and to harden the grains of butter so that their size may be increased without the risk of churning the butter into lumps. The addition of the water also assists in getting rid of the caseous matter. The amount of water to be added cannot be definitely stated, but must be left to the judgment of the buttermaker, as it depends largely on the thickness of the cream and the condition of the butter and size of the grains when the water is added. It is usually found advisable to use two or three small lots of breaking water rather than adding it all at one time, in this way the size of the grains can be more easily regulated and an even-sized grain produced. In summer, and when churning a quantity of butter, a fairly large grain is advisable—say of about the size of wheat. A large grain gives firmer butter and holds up less water than a small grain, less working is therefore required which is a distinct advantage in hot weather. In winter a smaller grain is better, though it must not be too small or there will be difficulty in working the butter. In examinations and competitions a great deal of importance is attached to the size, form, and evenness of the grain, and much time is spent in producing a more or less perfect grain. In practical buttermaking all that is necessary is to obtain butter in an even granular condition, the size of the grains varying with the temperature of the air. When in granular condition the butter is easily and thoroughly washed. The object of washing the butter is to get rid of the buttermilk and thus to improve the keeping properties.

Washing and Brining.—Granular butter may be salted by means of brine, but if it is churned into lumps brining is impossible.

The old-fashioned method of churning the butter into large lumps made it impossible to wash out all the buttermilk, and the result was often streaky and mottled butter frequently possessing poor keeping properties.

Churning the butter into lumps also spoils the texture and to some extent the colour of the butter. When the butter grains are considered large enough, the butter-milk is drawn off through the sieve (covered with a piece of muslin) in order to avoid losing any of the small particles of butter. The washing water is then strained in, using enough to float the butter properly, and the churn is rotated a few times. This water is removed and the process repeated. If the cream is properly ripened two washings are usually sufficient, but if the last water appears milky another lot is used. Over-ripe cream and sweet cream both require very thorough washing. The temperature of the washing water should be a little lower than the churning temperature, and may vary from 44° to 56° F. If the butter is soft and inclined to be sticky, the first lot of water should not be too cold, it is far more satisfactory to harden the butter gradually. The last lot of water may be colder and the butter allowed to stand in it for a little time. Overwashing and prolonged soaking in water has a bad effect on the butter, spoiling the colour and the flavour. It is much better to use brine if the butter has to be left in the churn for some time to harden. In winter, the washing water must not be very cold, or the butter becomes too hard to work. The aim should be to have the butter in just the right condition for working, avoiding extremes of temperature. Unless the butter is to be salted by brining it is now ready for working. Brining is an easy method of salting butter, the salt being evenly distributed without any risk of streakiness. It is advantageous in summer, as the salt reduces the temperature of the water several degrees and thus helps to harden the butter. The colour of the butter is slightly improved by brining. The brine is made by dissolving 1 or 2 lb. of salt in each gallon of water used. It is strained into the churn, and after rotating a few times the butter is allowed to stand in the brine with the lid on the churn for from

5 to 20 minutes, according to the degree of saltness required. It is impossible to obtain salt butter by brining, the amount of salt taken up by the butter being comparatively small even with a strong brine. Brining is only possible where the amount of butter is small, on account of the cost, and is therefore not practicable in creameries. The next stage is the working of the butter. This is necessary to remove the excess of water and to consolidate the butter into a solid mass. If the working is carelessly done, the colour, the texture, and to some extent the flavour of the butter is spoiled.

Overworking the butter and exposing it to a warm atmosphere for too long during the process of working have a bad effect on the quality and appearance. The old-fashioned method of working the butter with the hands is giving place to the use of the butter-worker, and where a butter-worker is used the butter need not be touched with the hands at all. Before using the worker the water left standing in it is run off, and in summer it is a good plan to rinse the worker well with fresh cold water just before it is to be used. The roller is pushed to the top end of the worker, and the granular butter which is removed from the churn by means of the scoop and sieve is placed just in front of it, keeping the butter well to the centre of the worker. As much butter as possible is removed with the scoop, care being taken to avoid rubbing the butter on the sides of the churn. The remainder of the butter is rinsed out with a little cold water, leaving the churn perfectly clean. To use the worker, the roller is slowly and carefully passed over the butter so that the water is pressed out without damaging the texture. The roller is first passed over the butter, and then, with a reverse movement, the butter is formed into a roll. This is turned lengthways and the process repeated, the number of rollings required to dry the butter depending upon the size of the grain and the conditions of the butter. It is almost impossible to remove the water from extremely soft butter. If placed in a cool place on a slab or slate, or marble, and covered with damp muslins, the butter will become firm and then may be worked dry. The moisture is wiped from the table after each rolling with a piece of butter muslin wrung out of cold water. If the butter is to be dry salted, this is done during the working process. The butter is rolled once and the salt then dredged on in two or three lots to insure even distribution.

It is important that pure salt in a dry and fine condition is used ; if the salt is damp and coarse it is impossible to work it into the butter properly. After the salt is added, the butter is left covered with a damp muslin for 15 to 20 minutes to allow the salt to dissolve properly.

The amount of salt used depends upon the market requirements. A quarter of an ounce to the pound gives a mild salted butter ; half an ounce a medium salted, and three quarters of an ounce a heavily salted butter. The salt is carefully weighed, and the weight of the butter estimated from the amount of cream churned, or the butter may be weighed if preferred. The use of preservatives in butter is unnecessary and undesirable unless it has to be kept for a long time before being marketed.

After allowing the butter to stand for about a quarter of an hour the working process is completed. Well-worked butter is solid, free from holes and large drops of water, the moisture present being in a finely-divided state and free from milkiness. The granular condition should not be destroyed during the working process, but show distinctly when a piece of butter is broken.

If the temperatures have been too high or the butter overworked, the butter will not break with a distinct fracture, but will be sticky and greasy.

Making Up.—The butter is now weighed into pounds or half pounds and made up into the shape required for the market, either rolls, round prints, or oblong blocks. The latter are easy to make up and to pack, and the tops may be ornamented with a design printed with the edge of a scotch hand.

Neatness and uniformity with an attractive appearance are the main points to be observed in the making up of the butter, badly made-up butter is never attractive even if the flavour is good. The best grease-proof parchment paper is used for packing, each half pound or pound being wrapped up neatly in the dry paper. If the butter is very soft it may be left in a cool place (covered with damp muslin) to harden before being packed up.

Ornamental butter is chiefly seen at shows, etc., in the form of flowers, fruit, etc. It requires a great deal of time and skill for making, and although beautiful in appearance is not of much use. It is made up mostly by hand, a few moulds and small wooden hands being used in addition. Firm butter and a good supply of ice are necessary for making ornamental butter.

Washing Up.—All utensils used for buttermaking are thoroughly washed immediately after use, first with hot water to remove the grease, and then well scalded with boiling water and finally dried with a clean cloth. The rubber band is removed from the lid of the churn and not replaced till the churn is again required for use, and the ventilator requires to be taken out and cleaned occasionally. All bright parts are then cleaned and the screws, bearings, etc., oiled. It is not advisable to use soda or soap in cleaning a churn. If soda is found necessary, the churn should afterwards be scalded with several lots of water to remove all traces of it, or it may cause delay in churning the next lot of cream. If the water is hard or the butter-worker has become greasy, a little soda may be used in the water used for washing it. The brush used in washing up should not be too stiff and hard. If the brush is hard or used too heavily, the wood is roughened and the butter will be certain to stick. The use of too much salt has also a tendency to roughen the wood. When the table becomes worn and rough, the sides may be removed and the boards planed till smooth and level, and then finished off with sand-paper.

Churning Whole Milk.—The churning of whole milk is still practised on farms in North Wales, in Lancashire, the West of Scotland and in Ireland, usually where there is a good demand for buttermilk.

Fewer utensils are required than where cream is separated for churning. The labour of churning is greater owing to the quantity to be dealt with, and the churn is usually worked by horse power.

The whole milk is kept till sour and just on the point of thickening and is then churned, though in some cases only the top half of the milk (that containing most of the fat) is churned.

Whole milk requires a higher churning temperature than is necessary for cream owing to the much smaller amount of fat present. Apart from this, the process of churning is similar to that for cream, overchurning is to be avoided, and the butter should be thoroughly washed or the keeping properties will be poor. The colour of butter churned from milk is paler than that obtained from cream. The quality of the butter made on this system may be good with careful management, but the returns are not so good as when the milk is passed through a separator and the cream churned.

Preserving Butter.—When butter is cheap and plentiful it may be preserved for winter by potting; if properly potted it remains in good condition for several months at least. It is essential that only properly-made butter of good quality is used for potting. The main points to be attended to in making the butter are, to have the cream properly ripened, neither under nor over-ripe, and to churn the butter into granular form and wash well to remove the buttermilk. When working the butter, a little more salt is used, from $\frac{3}{4}$ to 1 oz. per lb., and the butter is worked thoroughly. The butter should be drier than that required for immediate use. It is then packed in clean glazed earthenware crocks, care being taken to make it perfectly solid and free from cracks or holes. The top is covered with a layer of dry salt, or with brine, and a piece of parchment paper tied down over the jar. The crocks are stored in a cool dry place till the butter is required for use.

Packing and Marketing.—If butter is to be marketed in first-class condition, careful packing is essential, and the packing materials used should be such that no objectionable flavour can be imparted to the butter. When it is delivered direct to the consumer, as is often the case in a farm dairy, the butter is first wrapped in grease-proof paper of good quality and then packed into a clean basket, or box, which has been lined with muslin. It is not advisable to wrap the butter in leaves, as they are likely to affect the flavour. Rhubarb and cabbage leaves are frequently used for the purpose, but parchment paper of good quality is far better in every way.

When the butter is sold to shops, the small card or chip boxes are useful for preserving the shape of the butter and preventing it from becoming soft with handling. These boxes are made in pound and half-pound sizes and are quite inexpensive. For a small extra charge the name of the dairy can be printed on the outside, and if first-class butter is made it is quite worth while having this done.

For postal delivery there are special boxes made in strong cardboard and also in thin wood. These answer the purpose admirably and are obtainable in many sizes from one pound upwards. For rail delivery the same boxes may be used for small quantities of butter, but they are hardly strong enough in the larger sizes. For this purpose the stronger returnable boxes are more suitable ; or the boxes sold by the Railway Companies for packing farm produce may be used. The boxes should be lined with clean white paper cut to fit, allowing enough to fold over the top of the butter. Each pound or half-pound is wrapped in parchment paper before packing into the box. It is essential that the butter should be made up in a uniform shape and of a size to fit the box exactly. Bricks are by far the easiest shape for packing. Where a quantity of butter is made it is much more convenient to buy the paper cut ready than to buy it in sheets and cut it by hand.

Creamery or factory butter in this country is usually packed in boxes or kiels containing either 1 cwt. or $\frac{1}{2}$ cwt. each. The packages should be made of well-seasoned wood and strong enough to stand transit. It is also important that they are clean and in good condition, free from moulds, etc.

In some creameries the butter-boxes are soaked in strong brine and scalded before using, while Colonial creameries often line the boxes with a coating of odourless paraffin wax. In any case the boxes are lined with parchment paper and weighed before the butter is packed in. In packing it is necessary to press the butter in carefully, especially at the bottom and sides, to avoid having holes and cracks where moisture may collect, and which spoil the appearance of the butter when turned out.

Good weight is allowed to cover the loss during storage, and the top of the butter should be nicely finished off before covering down and fixing on the lid. Before despatching from the creamery it is a good plan to wrap the boxes in canvas covers, so that the outside does not get dirty in transit. After packing, the butter should be stored in a cool place till despatched. In many creameries butter is also sent out in rolls or bricks for which a higher price per lb. is paid.

These rolls are packed in strong boxes lined with parchment paper and holding twelve or twenty-four 1-lb. rolls or twelve 2-lb. rolls. If properly stored, good butter should keep for two or three months, but if badly made or stored in an unsuitable place, the keeping qualities are not nearly so good.

Where the butter is kept in cold storage it will keep for a much longer time.

CHAPTER X

CHURNING DIFFICULTIES AND INFERIOR BUTTER

CHURNING difficulties are frequently met with in farm dairies, more especially in spring and autumn. In practically all cases the cream will produce butter if the cause of the trouble can be found and removed.

The trouble may be due to the condition of the cream. Cream that is too thin or too thick does not churn readily, and cream from cows at the end of the lactation period is often difficult to churn owing to the hardness of the butter fat and the small size of the fat globules. This is more noticeable in a dairy where the cows are all drying off at the same time. Some foods also cause the butter fat to be hard, and this is frequently the cause of long churnings in the winter. If the cream has not been properly ripened there may be difficulty in churning it, and occasionally the trouble may be the result of the use of soda for washing the churn. If soda is used, the churn should be thoroughly scalded with one or two lots of water to remove all traces of it. The temperature at which churning is done may not be properly regulated. The temperature should be governed by the particular cream to be churned and the working conditions and not by a fixed rule. At low temperatures cream thickens and becomes more viscous and this hinders churning. Where churning is done in a cold room the temperature rapidly falls, even if it were correct in the first place ; if possible the churning should be done in a room where the temperature is not too low. If the butter fat is hard, or the cream is thin and poor, the churning temperature should be several degrees higher than for normal cream.

Sleepy-Cream.—One of the commonest churning troubles is that known as "sleepy cream." This is the term used when the cream thickens and fails to drop at each revolution of the churn. This condition may be due to one or more of the following causes—

Neglect of ventilation, overfilling the churn, or churning too quickly, the cream being too thick, or too low in temperature.

Remedy.—The churn may be reversed two or three times giving it a sharp jerk at each turn. If this fails the lid should be removed and the temperature of the cream noted. A little water is added, warm or cold as required, and churning is resumed, turning the churn slowly and ventilating carefully.

Frothy Cream occasionally causes delay in churning. This may be due to improper ripening of the cream or to churning at too high or too low a temperature. A little water should be added to the cream, warm if necessary, and the churn allowed to stand for a few minutes before proceeding with the churning. If the cream is already too thin the addition of water would make churning still more difficult. In this case the churn should be stopped for awhile, then the cream taken out and warmed to the required temperature.

Should the trouble continue, the best plan is to scald the cream immediately after separating, and ripen it by means of starter for a few weeks at least.

Causes of Inferior Butter.—BAD FLAVOURS.—The feeding of the cows is often blamed for the bad-flavoured butter produced in farm dairies, and in some cases the feeding may be the sole causes of the trouble. The excessive use of roots and cabbages for dairy cows gives a strong-flavoured butter, and musty cakes and meals may also affect the flavour of the produce. If the roots, etc., are fed in small quantities and given *after* milking, not just before or during milking, the flavour should not be affected. The only remedy, apart from stopping the supply of the food which causes the trouble, is to scald the cream as soon as separated and then ripen it by means of starter. Weeds and plants picked up in the pastures or hedgerows, dead leaves eaten with the grass in autumn, may also give the butter a disagreeable flavour. The management of the cream during the process of ripening may not be good, improper ripening and over-ripened cream are common causes of bad-flavoured butter.

The cream should be churned as soon as ready and not held over for a few days after that stage is reached.

If the cream is kept at a high temperature the butter will have an oily flavour, while if stored at too low a temperature and kept too long bitter flavours are apt to develop. The use of the dairy as a general storeroom for foods, etc., has a disastrous effect on the flavour of the butter. Milk and cream readily absorb any odours, and for this reason the atmosphere of the dairy should be absolutely pure. The flavour of the butter may be affected by the temperature at which churning is done, if this is very high the butter has an oily greasy flavour, whilst a low temperature is apt to produce a tallowy flavour. The flavour of the butter may be impaired by over-churning, by over-washing, and by over-working, and the use of too much ice in summer is apt to give an insipid or flat flavour. Lastly, though by no means least in importance, is the want of cleanliness. It is impossible to be too particular in this respect when handling milk and its products. Cleanliness may be regarded as the foundation of success in buttermaking, the utensils must be kept in good condition and the dairy thoroughly clean if butter of good quality is to be made.

The water supply is occasionally found to be the cause of bad butter. Only pure water should be used for washing the butter and for cleaning the utensils, etc.

BAD-KEEPING BUTTER may be due to over-ripened cream, but is chiefly caused by leaving too much buttermilk in the butter ; this decomposes rapidly and the butter soon becomes rancid.

If colostrum is used, the butter produced has poor keeping qualities, and the flavour may be affected as well.

STREAKY AND MOTTLED BUTTER.—Butter with a mottled appearance is the result of improper salting. Streaky butter is also caused by the addition of salt before the buttermilk has been removed.

If the salt is fine, dry, and of good quality and the butter washed properly while in a granular condition, these faults should not occur.

The presence of small white specks in the butter is the result of over-ripened cream, or the cream may not have been stirred sufficiently during ripening, thus allowing the casein to become precipitated in the form of small pieces of curd.

Both the cream and the butter will become bleached if placed in a strong light, or where direct sunlight may fall upon them.

CHAPTER XI

VARIETIES OF CHEESE

THE number of varieties of cheese made in different parts of the world is very large. A great many, however, are similar in type, and the following list includes the chief varieties of different countries. It will be noted that of those named 18 are British, and no doubt this country excels in its varieties of hard-pressed cheese.

Hard Pressed.

Country of Origin.	
Great Britain . .	Cheddar, Dunlop, Cheshire, Leicester, Derby, Double Gloucester, Single Gloucester, Lancashire, Caerphilly, Wiltshire, Cleveland
United States . .	Pine Apple Cheese.
France . . .	Cantal, Port du Salut.
Holland . . .	Edam, Gouda.
Switzerland . .	Gruyère or Emmenthaler.
Italy . . .	Parmesan (skim milk), Caccio-cavallo.

Blue Veined (unpressed or lightly pressed).

Great Britain . .	Stilton, Wensleydale, Cotherstone, Dorset Blue or Blue Vinnies (skim milk).
France . . .	Roquefort, Gex.
Italy . . .	Gorgonzola.

Soft Cheese (unpressed).

Great Britain . .	Cambridge or York, Colwick or Slipcote, Cream.
France . . .	Bondon, Brie, Camembert, Coulommier, Gérome, Gervais, Livarot, Mont d'Or, Neufchatel, Pont l'Eveque.
Belgium . . .	Limburg.
Switzerland . .	Vacherin.

With the exception of a few varieties all kinds of cheese are made from whole milk or milk just as it comes from the cow, and only in a few cases is there an admixture of the cream with the milk before it is made into cheese.

Any variety of cheese usually takes its name from the district in which it is manufactured, and many of the varieties having different names are very much the same in type.

It was thought at one time that a particular variety could only be made in a particular district, but with the increase of knowledge in connection with cheese-making, it has been clearly shown that it is knowledge of the method of manufacture that chiefly influences the kind of cheese produced. Thus it is not essential that Stilton cheese should be made in Leicestershire, its county of origin, for this cheese can be made successfully in any part of the world where good milk is obtainable, and we have seen samples of this and other makes produced in New Zealand which compare very favourably with the home manufactured variety.

As milk is essentially the basis of all cheese, it is evident that it is the system of manufacture which chiefly influences the kind of cheese produced.

The old idea that certain varieties of cheese could only be produced on certain pastures where the herbage was of a particular character is no longer held, yet it should be borne in mind that although milk from different sources is much the same in composition, there are variations in its properties which are not without influence on the character of the cheese produced. Thus it is generally recognized that milk from limestone land is more suitable for the production of good cheese than that from low-lying heavy clay soils, and if a chemical examination of the mineral matter present in the milk is made, it will be found that the proportion of the different salts composing this mineral matter varies considerably in these two instances.

The different varieties of cheese may be classified under three separate headings—

(1) Cheese which is hard pressed in the process of manufacture ;

(2) Cheese which is unpressed or only lightly pressed ;

(3) Soft cheese or fancy cheese.

Soft cheese contains a very high percentage of moisture, and sometimes consists of a mixture of ripe cheese, fresh curd, butter, etc.

Commencing with milk the cheesemaker so controls the various stages in the manufacture as to obtain curd of the particular type necessary to produce the variety required, and it then remains for the ripening process to be so arranged as to produce the particular flavour desired.

The science of the ripening of cheese is as yet not fully understood, and it has only been worked out in connection with one or two different varieties, but it is upon the particular bacterial and other fermentations, which take place in the ripening, that we depend for the proper flavour and aroma of the finished cheese.

The ripening process is more fully gone into in the section on Ripening Cheese, for this is an art essential to the cheesemaker's success.

The primary object of cheesemaking is to preserve the nutritive materials of milk.

Milk itself is a perishable article which rapidly goes bad unless treated in some way, and cheese is one of the most useful forms in which its constituents may be preserved for future consumption.

The average composition of Cheddar Cheese shows that it contains—

Water	34·38
Fat	32·71
Casein	26·38
Sugar and Lactic Acid	2·95
Ash or Mineral Matter	3·58

When cheese is freshly made, *i.e.*, soon after it has come out of press, it is termed "green," and contains much more moisture than subsequently, as there is a loss of moisture during the ripening process.

The constituents of all cheese are the same, and it is only the proportions of these constituents which vary. Thus, for example : cheese made from extremely rich milk will have present in it more fat. On the other hand, milk of poor quality will produce cheese in which the fat contents are low. It is the fat in cheese, together with the moisture, that tends to produce mellowness in the ripe cheese. Where there is a deficiency in fat the cheese lacks moisture and also becomes dry, hard, and unappetizing. It is the casein or proteid material which gives to the cheese its high nutritive value.

Good cheese is wholly digestible in addition to being of a highly nutritive value. The fact that ¼ lb. of cheese is equivalent in food value to nearly ¾ lb. of rump steak or 10 eggs, gives an idea of its nourishing and sustaining character, and there is probably no better complete food in existence.

CHAPTER XII

PRINCIPLES OF CHEESEMAKING

It is essential to the success of cheesemaking that the milk should be clean and of sound quality. Milk containing particles of dirt such as cow manure, etc., is infected with bacteria of a prejudicial character, and these interfere with the proper flavour and aroma of cheese.

Where there are the wrong kinds of organisms present in milk they hamper the growth of others which it is desirable to encourage, and these latter are then unable to perform their work properly. In a great many instances where inferior cheese is produced at a dairy, it is solely owing to the fact that the milking of the cows is not carried out in a cleanly manner.

Cows' flanks should be properly groomed, and if the udders are dirty they should be washed prior to milking, and it is further essential that the milker should milk with clean hands.

Milk is a food which rapidly takes up taints of various descriptions, and it ought not to be allowed to stand in the stuffy air of a cowhouse, but should be removed at once to the dairy where it should be carefully strained through a cotton-wool filter. This consists of a layer of cotton wool placed between two wire gauze discs. The cotton wool retains any sediment however fine that may accidentally get into the milk. Such sediment always harbours bacteria prejudicial to the production of the best cheese, and as the growth of bacteria in warm milk is very rapid, milk so infected would become badly tainted in the course of a few hours.

The system of cheesemaking on a farm differs somewhat from that followed at a factory. The farmer has better advantages for the production of the best-flavoured cheese than those which are obtained at a factory, because milk brought in direct from the cowshed may be handled more successfully than where it has travelled either by road or by rail, since in the latter case it deteriorates in transit. Moreover, the farmer has complete control over his own supplies, and if proper care as regards cleanliness is taken the best results must follow. At a factory, on the other hand, milk of very different classes may arrive and these supplies are mixed together, with the result that the production of the finest-flavoured cheese is rendered very difficult if not impossible.

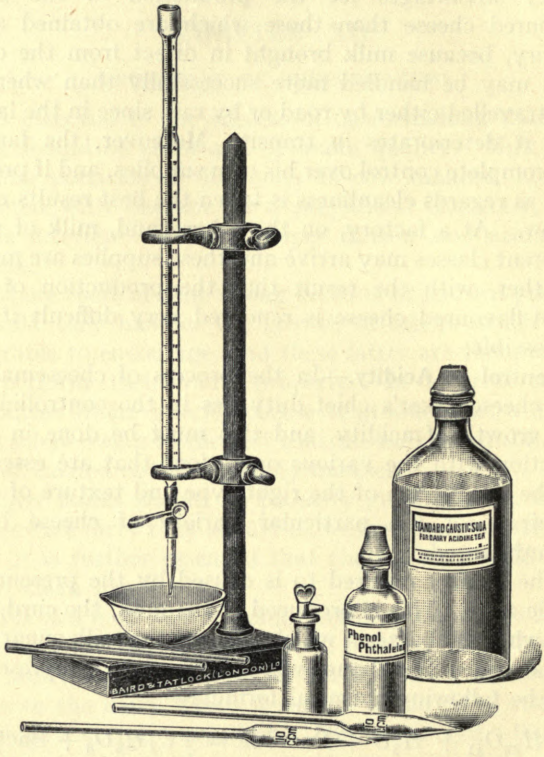
Control of Acidity.—In the process of cheesemaking the cheesemaker's chief duty lies in the controlling of the growth of acidity, and this must be done in conjunction with the various operations that are essential to the production of the right type and texture of curd required for the particular variety of cheese being manufactured.

The acidity referred to is caused by the presence of lactic acid. This is produced in the milk, the curd, and the whey by bacteria which convert the milk sugar into lactic acid. The change which takes place is represented by the following chemical formula—

$$C_{12}H_{22}O_{11} + H_2O + \text{Bacteria} = 4\ C_3H_6O_3 + \text{Bacteria}.$$

The various operations in cheesemaking are regulated so as either to hasten or retard the development of acidity as required, but in order to get the best results, acidity must develop in accordance with the condition of the curd at the various stages.

Cheesemakers formerly depended largely upon the senses of taste and smell in judging the amount of acid developing in curd during cheesemaking, and the only



DAIRY ACIDIMETER

Showing Burette on stand, porcelain dish, and stirring rods, 10 c.c. pipette for measuring milk. Drop bottle containing phenolpthalem solution (indicator), and stock bottle of ninth normal caustic soda solution.

aid employed in addition to the senses was the Hot Iron test. Nowadays, fortunately, chemistry has come to the aid of the cheesemaker, and a rapid and accurate test for acidity has been devised. This was first introduced to cheesemakers by Prof. F. J. Lloyd who carried out lengthy investigations into the manufacture of cheese for the Bath and West of England Society.

The test, which is a simple one, is now employed by all up-to-date cheesemakers who wish to utilize modern methods. It is a volumetric test, and as it depends on the principle of the neutralization of acids by alkalies, it is known to cheesemakers as the Acidimeter Test. Thus, knowing that the liquid to be tested contains acid, and that the variety of acid present is mainly lactic acid, caustic soda (an alkali) of definite strength is used to neutralize it.

The apparatus employed to make the test consists merely of a burette for measuring the alkali, a small porcelain basin with a glass stirring rod and a pipette of 10 cubic centimetres (c.c.) capacity for measuring the liquid to be tested. As indicator a liquid (Phenol Phthalein) is employed to show when the acid in the liquid tested has been neutralized by the alkali added. The peculiar property of the Phenol Phthalein is that it is colourless when acid, but pink when alkali. Where, as is frequently the case, the acidimeter is used daily in cheese and butter factories, the caustic soda may be fed semi-automatically from a stock bottle.

To make the test 10 c.c. of the milk, or whey, to be tested are measured out into the small porcelain dish and 2 or 3 drops of the indicator added. The caustic soda from the burette is then slowly run into the dish whilst the contents are stirred as the soda is added. Immediately the milk, or whey, turns faintly pink sufficient soda has been added, and the amount required to produce the colouration may be read off from the burette.

Now, as caustic soda is made up of the strength of one-ninth normal its character is such that each c.c. is capable of neutralizing ·01 grams of lactic acid. If this amount of lactic acid were present in 100 grams of milk the percentage would obviously be ·01 ; if it were contained in 10 grams of milk the percentage would be ·1.

Now, 10 grams of milk are approximately equivalent to 10 c.c. which is the amount taken for the test. It therefore follows that each c.c. of soda required to produce the pink tinge will represent ·1 per cent. of lactic acid, and each tenth of a c.c. will represent ·01 per cent.

In the manufacture of most varieties of cheese, the mixed milk, when ready for the addition of the rennet, should contain from about ·18 to ·22 per cent. of acidity. If the test, therefore, shows that 2·2 c.c.'s of caustic soda have been necessary to produce the pink colouration, this amount indicates the presence of ·22 per cent. of lactic acid in the milk.

As the coagulation of milk is brought about by the addition of rennet, and rennet is always available where cheesemaking is in operation, a test for acidity, in which rennet is employed, is very popular amongst cheesemakers, and some prefer it to the acidity test above described, though it is not nearly so reliable and accurate. The principle of the test is that the action of rennet is considerably influenced by the amount of acid present in the milk, and within limitations the more acid present in the milk the quicker is the action of rennet. Thus, if a definite quantity of milk at a set temperature is coagulated by a fixed quantity of rennet, the degree of acidity is indicated by the time taken by the milk in coagulating. Unfortunately, however, the strength of rennet varies very considerably, and unless the same stock of rennet is always used the results differ very widely.

The rennet test employed by cheesemakers in this country is as follows—

Four ounces of the milk to be tested are carefully measured into a glass and the temperature raised to 84° F. Another glass should be slightly warmed, and into it should be measured exactly 1 dram or 3·55 c.c.'s of rennet. On the rennet 3 or 4 small pieces of straw are put. A stop watch is necessary. The milk is stirred vigorously for 10 seconds and caused to swirl round in the glass with the straws going round on the surface. The moment the straws stop (which is the point at which coagulation takes place), the watch-hand must be stopped and the time taken in coagulation read off. This time may vary from 12 to 30 seconds. If the milk is ready for renneting the time required, as indicated by this test, would usually be from 18 to 22 seconds, and the shorter the time, of course, the more acid the milk.

In America, a rennet test known as Marschalls is popular. In this the milk is measured into a vessel, one side of which is graduated in whole and half divisions beginning with zero at the top, and the graduation goes down to 7 at the bottom, while in the bottom of the vessel is a small orifice. One c.c. of rennet, after being mixed with cold water, is added to the milk, and the vessel is so placed that the milk can run through the hole in the bottom. So long as the milk continues to run out of the vessel, coagulation has *not* taken place, but so soon as no more escapes the process is complete.

The comparative acidity of the milk is indicated by the milk that has escaped from the vessel. The less the milk which has escaped thus, the more acid it is.

Milk ready for renneting will show a loss of as much as $2\frac{1}{2}$ of the units on the testing vessel.

Whilst it is possible to get the best results in cheese-making where cultures of special bacteria are not added, it is found that better control of the milk may be obtained where bacteria of beneficial character are added.

This applies with special force to those cases where the milk is of a doubtful character, and where the finest-flavoured cheese is not produced without the addition of starter. In order to secure uniformity, a starter consisting of the right types of bacteria is desirable.

If a sufficient quantity of starter is added, the bacteria so supplied to the milk will develop and preponderate, and organisms of an inferior nature will be so crowded out that their action will not be appreciated. It is a well-known principle in Bacteriology that while one type of germs preponderate, they grow and develop at the expense of others present, and this is the case with the starter used by the cheesemaker.

One of the great points in the use of starter is to know the amount to use, and this knowledge can only be gained from practical experience in dealing with different classes of milk. In some cases, for instance, it would be undesirable to add any starter, whilst in others a large quantity of starter would be desirable. If it is required to hasten the process of cheesemaking, a larger quantity of starter is needed than normally, and if the milk is of an approximately normal character, then a medium or normal quantity of starter is employed.

The percentage of starter usually added to mixed milk for cheesemaking varies from $\frac{1}{4}$ to 2 per cent. In some cases more is used, but this would be only under special circumstances.

In the spring and winter of the year more starter is necessary than in the summer and autumn, owing to the slow growth of bacteria where the temperature of the surrounding atmosphere is low.

The starter is usually added to the milk about one hour prior to renneting. If the milk is very sweet, it should be warmed to the renneting temperature, the starter then added and allowed to work in the milk before the rennet is added. In the case of Cheddar cheese it is usual to add sufficient starter to enable the whole process of cheesemaking to be completed in six hours, and the quantity is gauged by the acidity of the milk at the commencement.

There are several kinds of starter used in cheesemaking such as pure culture starters, home-made starter, and whey. For most satisfactory results the pure culture or home-made starter is to be recommended. For if the whey from one cheesemaking is tainted it merely carries on the taint to the cheese produced from the next day's milk. On the other hand, it is a simple matter to prepare special cultures and keep these going independently, using them as required.

Where this is done it is necessary to renew the starter from fresh stock about once a month, as the intensive growth of lactic acid germs leads to the weakening of their action and in time they lose the power to coagulate milk readily.

Starter is in the best condition for cheesemaking when it contains ·65 to ·70 per cent. of lactic acid. It should have a clean acid smell and be of a smooth cream-like consistency.

It is always good practice to strain it through a fine sieve before putting it into the cheese vat. This prevents small specks of hard acid curd getting into the milk, which are apt to appear as white specks or patches in the finished cheese.

Colouring Cheese.—Certain makes of cheese are artificially coloured, the best-known type in this country being Cheddar cheese. Generally speaking, this cheese is given preference in the Northern Counties, whilst white cheese is preferred in the South.

The colour is produced artificially by adding to the milk annatto or some colouring matter prior to making it into cheese.

The safest and best colouring matter to use is a solution of annatto. This is a vegetable colouring matter prepared from the seed pods of a the plant called bixa orellana of South American and West Indies growth. Colouring matter is prepared as an alcoholic extract, and if required for colouring milk it is supplied as a water solution of a very concentrated nature. Colouring matter is added in proportion of 1 to $3\frac{1}{2}$ or 4 oz. to each 100 gallons of milk, and it is well diluted with water to enable it to be incorporated thoroughly with the milk by mixing. Generally speaking, about 1 dram of colour to 3 gallons of milk is the average used.

In spring and winter cheese is very white in colour, and needs the addition of more colouring matter than, say, in June, when it is naturally coloured to the greatest extent, and then has a faint golden yellow colour. Colouring matter should be mixed in with the milk and well stirred for 10 minutes prior to renneting. Other colouring preparations are sometimes used, but these and aniline dyes or similar chemical products are not to be recommended. The question of colouring cheese is entirely a matter of public taste, and it is done to suit different markets just in the same way that the public in many districts regard milk of inferior quality unless it is highly coloured. To suit their requirements in colouring the dairyman merely adds the necessary colouring though this brings about no improvement whatever in the actual quality of the milk.

CHAPTER XIII

RENNET : ITS PREPARATION AND USE

THE process of cheesemaking consists in eliminating to a large extent the water from the milk in order that the milk solids may be obtained. It is the large proportion of water present in milk that is partly responsible for its easily perishable nature, and if most of the water is eliminated the solid matter of the milk in a conserved form acquires increased keeping properties.

One of the best means of conserving the solids of milk is that of drying or desiccating it. In this process the water is almost entirely driven off, and practically the whole of the milk solids are obtained in the form of milk powder. In cheesemaking, however, the process of eliminating the water contents is not so complete, for a considerable proportion of water is retained in the cheese and unfortunately the method of separation adopted allows a considerable proportion of the milk solids to be lost in the bye-product whey.

The substance chiefly used for the separation of milk solids in cheesemaking is rennet, and the following table shows the solids present and the manner in which they are distributed in cheesemaking—

	Water.	*Fat.*	*Casein. and Albumin*	*Milk, Sugar and Ash.*
Lost in Whey . . .	83·84	·31	·76	5·02
Recovered in Cheese	3·70	3·39	2·68	·30
Milk employed . . .	87·54	3·70	3·44	5·32

Roughly speaking, half the solid matter of the milk is retained in the form of cheese, and half lost in the bye-product whey. Fortunately, it is the most valuable milk solids that are almost wholly retained in the cheese, and it is chiefly those of lesser value which are lost.

Rennet is a preparation made from the fourth stomach of a suckling ruminant. Commercially, rennet is prepared from the vells or fourth stomachs of young calves.

Naturally, rennet is secreted in the stomachs of young animals for the purpose of digesting milk foods, so that the proportion of the active principles of rennet is much greater in the case of suckling animals than in animals which are feeding on grass and other foods. Cheesemakers have almost from time immemorial made their own rennet, and the practice of thus preparing the rennet is still largely carried out by the Stilton cheesemaker, who prefers this class of rennet to any other. A great majority, however, employ Commercial Extract of Rennet, which is very much stronger and more uniform, and hence more reliable than any that can be home prepared. Home-made rennet is prepared by taking the dried skins (or vells, as they are sometimes called), cutting these into small strips, and soaking them in a strong solution of salt and water. This solution is prepared by first boiling the water, and when it is cold as much salt is dissolved in it as can be taken into solution. Several times daily the pieces of vells are rubbed together so as to assist the removal of the rennet from the skins into the solution. This process takes about five days, and at the end of this time the rennet, after being carefully strained, is ready for use. Its strength will vary considerably according to its preparation, and it does not keep well unless some preservative, such as boracic acid, is added. This, however, is not usually done, but if it is lime juice is the only substance generally employed by the cheesemaker who prepares home-made rennet. On the other hand, commercial rennets are supplied of definite known strength, and cheesemakers can use these with a certainty of invariably obtaining uniform results.

Commercial rennet may be obtained as a liquid extract, as a powder, or in the form of tablets. The Commercial Extract has generally a guaranteed strength of 1 to 8,000 or 10,000, while the powder form is very much stronger. The standard of strength taken in testing rennet is that 1 c.c. coagulates 10,000 parts of standard milk in 40 minutes at a temperature of 95° F.

As the manufacturer does not usually specify the strength of the liquid extract supplied, it is desirable that cheesemakers should test the supply when it is obtained. To do this 1 litre (1,000 c.c.'s) of perfectly sweet fresh milk is taken and the temperature raised to 95° F. Into this 1 c.c. of the extract is rapidly stirred for half a minute, and then the exact time at which coagulation takes place is noted. The time taken will be in proportion to the strength of the rennet, the longer the time the weaker the rennet, and *vice versâ*. Thus, for example, if 5 minutes is the time taken, the strength of the rennet would be 1 to 8,000. This results from the fact that the standard rennet, 1 to 10,000, has such a strength that 1 c.c. of it will coagulate the same amount of milk in 4 minutes.

As rennet varies considerably, it is necessary to alter the proportion added to the milk in the manufacture of cheese. Liquid extract of rennet when purchased should be of a clear brown colour, free from any objectionable smell, and should be enclosed in light-tight receptacles such as barrels or earthenware jars. It is very important that rennet should be kept free from the action of light, as light reduces its strength considerably.

The active principle of rennet is an organized ferment known as Lab or Chymosin, and although the purchased extracts contain bacteria of various descriptions, these bacteria are not essential to its effective action, but the manufacturer finds some difficulty in eliminating them since it is impossible to pasteurize or sterilize any solutions without destroying the unorganized ferment upon whose action the coagulation of milk depends.

Up to the present no substance has been found so reliable as rennet for the coagulation of milk, although Pepsin and other substitutes are used. The scarcity of rennet occasioned by the war has resulted in the putting on the market of two or three proprietary substitutes, and these, although apparently answering satisfactorily, have not up to the present been sufficiently tested for very definite conclusions to be drawn as to their reliability.

The enzyme or organized ferment contained in rennet is not only the efficient cause of the coagulation of the milk, but it plays some important part in the ripening of the cheese, and whether other ferments substituted might have the same action can only be proved by careful examination of the cheese when ripe. The amount of rennet employed in the manufacture of cheese varies considerably according to the variety of cheese manufactured, the temperature of the milk at which the rennet is added and also the acidity of the milk at the time of renneting. If milk is at a high temperature or contains a good deal of acid it coagulates rapidly. On the other hand, if the milk is at a low temperature, or if it is sweet it coagulates slowly. Where the curd is produced quickly it is of a much firmer character than that produced slowly, and it is the character of the curd produced that influences the cheesemaker in selecting the amount of rennet to be added to the milk. Thus it is found that the Stilton cheesemaker adds a smaller proportion of rennet and allows a longer period for coagulation.

The Cheddar cheesemaker, on the other hand, adds sufficient rennet to coagulate the milk in from 45 to 50 minutes. In the case of Coulommier, which is a soft cheese, the amount of rennet added is so small that the coagulation period is from 2½ to 3 hours.

The fermentation produced by rennet has, like other unorganized ferments, a spreading action, and even if only a small quantity is added to milk it will effect the desired coagulation in time, although this time may be lengthened, and this is an important factor which the cheesemaker relies upon.

The average quantity of Commercial Extract of Rennet used is 4 oz. per 100 gallons where the milk is set at a temperature of 82° to 86° F., but only half this quantity may be employed in some instances, and in others 25 per cent. more. Before adding extract of rennet to milk it is desirable to dilute it with ten times its bulk of cold water so as to cause it to be thoroughly incorporated with the milk during winter.

CHAPTER XIV

THE USE OF STARTER IN CHEESEMAKING

When scientific investigations were first made in cheesemaking it was soon realized that to obtain the necessary control of the manufacture it was essential that the fermentation of milk should be studied.

Whilst a knowledge of chemistry proved a valuable aid to the cheesemaker with regard to the changes taking place in cheesemaking, it did not provide sufficient explanations of the *modis operandi* of the various processes, and because of this insufficiency, investigations were also made of the bacteria present in milk.

It was then found that most of the chemical changes which take place in milk, butter, and cheese are brought about by bacteria, and that a knowledge of the nature and working of bacteria supplies the explanations necessary in order to control the production of cheese.

The bacteria found in milk may be either of a beneficial or an injurious character, whilst there are others which may be classed as indifferent since so far as it is known they are neither beneficial nor injurious. The aim of the cheesemaker, therefore, must be to utilize the beneficial organisms to the best advantage and eliminate or lessen the activities of the harmful ones.

As the result of investigation, explanations have been forthcoming of the why and wherefore of the various methods adopted in cheesemaking from early times, and the art has been placed on a scientific basis.

Despite all these advances, however, the majority of cheesemakers at the present time have no scientific knowledge of the principles underlying the work they perform, and this is equally true of those who manufacture the finest quality of cheese as of the ones whose article is of a moderate or inferior character.

The fact that many cheesemakers who possess practically no scientific knowledge produce cheese of the finest quality is sometimes used as an argument against the advantage of technical knowledge, but for the few who are able to do this there is an overwhelming number whose cheese is either mediocre or bad through lack of knowledge of the principles on which the various processes rest.

In order to get the best results and the greatest uniformity in cheese production, technical knowledge, as well as practical skill, is requisite.

CHAPTER XV

CHEESEMAKING APPARATUS

The apparatus required for cheesemaking whether on a large or small scale is of a comparatively simple character, and the following is an enumeration of the requirements—

Cheese vat or tub, with or without steam connections according to type.

Strainer for filtering the milk into the vat.

Curd cooler or drainer.

American curd-cutting knives.

Curd rake or stirrer.

Curd mill.

Moulds for putting the curd into to be pressed.

Cheese presses.

Cheese stool for placing cheese on for bandaging or moving from one place to another.

Curd pail for lifting the curd from the vat to the cooler.

Steam boiler, or copper, for providing means of heating milk.

Cream skimmer.

Pails.

Cheese iron for the hot-iron test.

Rennet measure.

Salt chest.

Weighing machine.

Floating and wall thermometers.

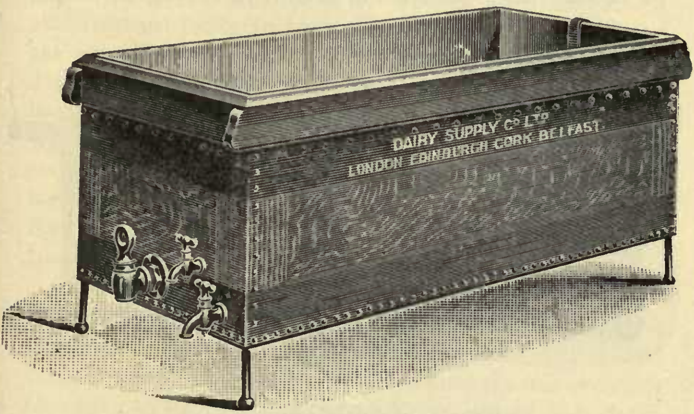
Hygrometer.

Acidimeter and chemicals.

Sundries, including rennet, salt, cheese cloth, bandages, brushes, etc.

In order to make the apparatus clear to the reader, it may be as well to describe each item separately.

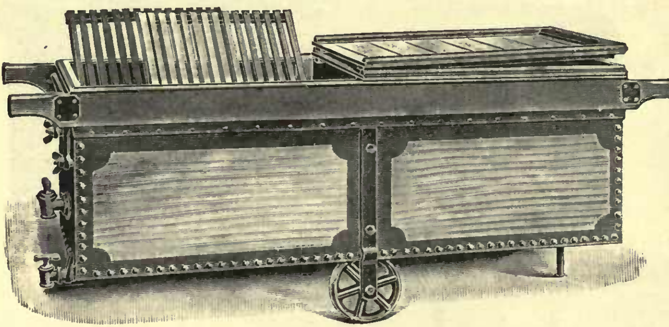
Cheese Vat.—The simplest form of vat used is a tin or wooden receptacle in which to coagulate the milk.



STEAM-JACKETED CHEESE VAT

In small dairies, or where only very small quantities of milk are made into cheese, the milk is warmed to renneting temperature (usually about 86° F.) by standing it in buckets in hot water, or in some cases the milk in the tub is heated by stirring it with a bucket full of hot water which is moved slowly round in it until the required temperature is reached.

This is the most primitive method of heating milk, and the first improvement was effected by the introduction of the milk warmer, or jacketed vessel, into which the milk was put before running it into the vat, or tub, the milk warmer being connected up with a small steam boiler. After this was developed, the jacketed vat which has a hollow jacket into which cold water and steam may be admitted. The jacketed vat, or tub, is made either oblong or round according to the likings of the cheesemaker. For making large quantities of cheese the jacketed vat is always oblong in shape,



STEAM-JACKETED CHEESE VAT
Showing wood racks and covers.

and in size it runs up from 20 to 600 gallons capacity. The great advantage of the jacketed vat is, that if milk is put in the vat overnight, cold water may be circulated in the vat and will prevent the milk from becoming too acid. As soon as the time arrives for cheesemaking, the steam may be admitted into the vat and the temperature of the milk raised quickly to the required degree of heating for renneting.

The vat is fitted with a large tap for running off the whey after the curd has been cut, and there are two water exit taps one above another, the top one of these is kept open in order to prevent excessive pressure of water injuring the inner jacket of the vat, while the lower tap is for the purpose of quickly removing all water from the jacket when the milk has reached the required temperature.

Small vats are usually placed on a wooden stand, but the larger vats are fitted on wheels, the commonest arrangement being to have two wheels in the middle of the vat with one leg at the back and two at the front. The front legs are made shorter than the one at the back, so that when the vat is to be used blocks of wood are put under the two front legs. When the time comes to remove the whey from the vat, by means of the tap, the blocks are removed so that the vat tilts forward and attains a sloping position, thus allowing the whey to drain freely out of the tap.

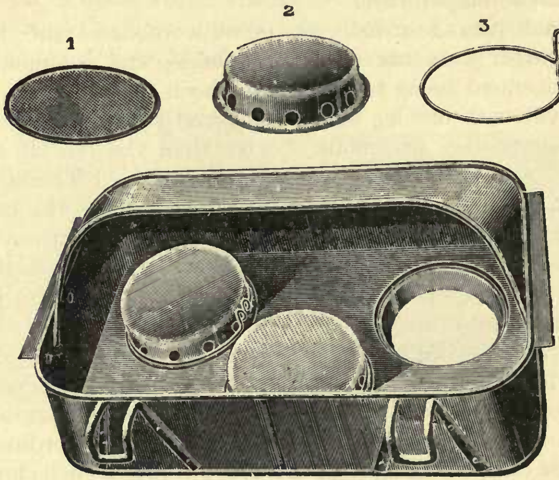
Strainer.—The best type of large strainer to use is one which fits right across the vat. In it there are several openings, each of which contains fine wire gauze and cotton wool. A great many cheesemakers use ordinary cheese cloth for straining purposes, but unless such cloths are kept thoroughly well sterilized by boiling, they are more likely to injure the milk by infecting it with undesirable bacteria than purify it by removing the sediment which it contains.

The **Curd Cooler** or **Drainer** is rectangular in shape of about the same length and breadth as its companion vat, but it is shallow and only about 8 in. deep. It rests on legs of sufficient height from the ground for convenient working.

Sometimes it is fitted with a water jacket so that on a cold day the temperature may be regulated by keeping warm water in the jacket. At one end of the cooler is fitted a plug through which whey may be drained off.

The bottom of the cooler is lined with removable wooden racks, and it is on these racks that coarse texture cheese cloths are placed before the curd is put on the cooler.

The use of the cooler is to allow of the removal of the curd from the vat so that it may be more easily and



FACTORY TYPE OF MILK STRAINER

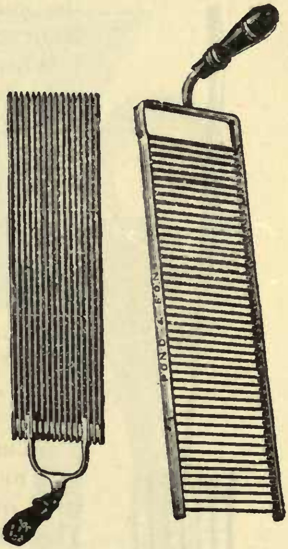
In which cotton-wool pads are used.

(1) Wire gauze discs (the cotton wool pad is placed between two of these).
(2) Strong metal cover with holes, through which milk flows into gauzes containing cotton wool.
(3) Wire clip to hold cover in groove of strainer.

expeditiously dealt with and the whey drained off. In many cases cheesemakers do not employ a cooler, and in this case the draining and maturing of the curd are carried out in the vat itself.

To do this, after the bulk of the whey has been drawn off, the curd is all removed to one end of the vat, and at the other is placed a wooden rack with a cloth on it and the curd is then put on to it.

Curd Knives.—Where only small quantities of milk are being converted into cheese, the cutting of the curd is a simple matter and can readily be performed with an ordinary knife. In the case of large quantities, however, it is necessary to work expeditiously in order to get the bulk of the whey drained off, otherwise the increase of acidity will take place so rapidly that it may get out of control and so the cheese be spoiled.



AMERICAN CURD KNIVES
The left is the vertical and the right the horizontal knife.

The most effective cutting of the curd is performed by the use of American curd knives, which are of two kinds. In one kind the blades run horizontally, and in the other vertically to the side stays. Thus it will be seen that if the curd is cut each way of the vat, first with one and then the other knife, the result will be curd in the form of cubes. The usual distance between the knife blades is $\frac{1}{2}$ in., so that cubes of $\frac{1}{2}$ in. in size will result from the use of the two knives. It is recognized generally that the smaller the curd is cut, the quicker the whey can be removed. In place of the two knives a diagonally-bladed knife, introduced by Messrs. Pond, is sometimes employed.

The **Curd Rake** or **Breaker**, as it is sometimes termed, is employed for stirring curd in the vat after cutting.

Where it is not used the hands and arms of the cheese-maker do this work, but the stirrer saves much back-aching labour. An automatic stirrer which can be used for the milk as well as for stirring the curd is sometimes fitted to the large factory vats.

CURD-BREAKER AND STIRRER

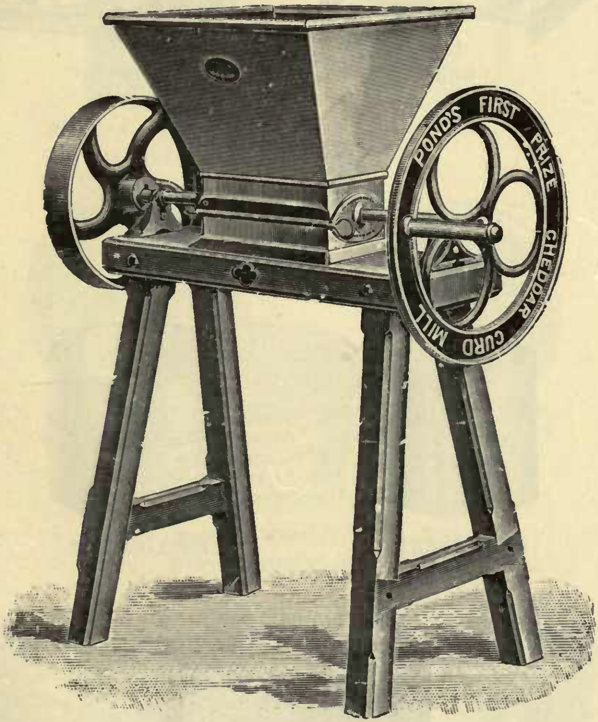
When the curd has attained the right degree of maturity, solidity, and texture, according to the variety of cheese being made, it is broken into small pieces so that it may be conveniently packed into the moulds, or chessets, as they are sometimes styled.

In the case where the curd is of a soft character the breaking may be done with the fingers, but the hard elastic curd of Cheddar cheese cannot be so broken.

A **Curd Mill** is necessary for dealing with most varieties of curd and where large quantities have to be broken. The mill may be complete in itself fixed on a stand, or it may be without a stand, in which case it fixes on to either the cooler or the vat.

The grinding is done either by two metal drums or rollers revolving in opposite directions on which are fixed a large number of interlocking teeth, or one drum only which has a number of teeth or cogs which work in a cast-iron grid to match the cogs. Thus curd is torn, ground, or shredded into small pieces, the size of which varies according to the construction of the particular mill used. It is usual to grind curd smaller when making Cheshire cheese than is the case in Cheddar and most other varieties.

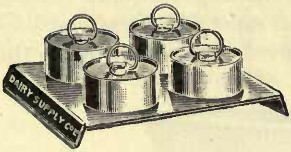
The moulds or chessets required vary according to the



CURD MILL

variety and size of the cheese made. Each variety of cheese is usually made of a certain size, and in some cases the same variety is made in two or more different

SOFT CHEESE MOULDS



CREAM

GERVAIS

PONT L'EVEQUE

CAMEMBERT

COULOMMIER

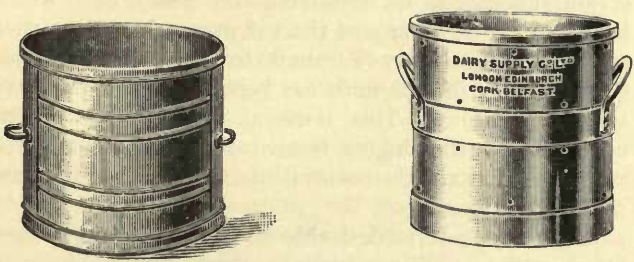
CAMBRIDGE OR YORK

CHEESE MOULDS

TRUCKLE CHEDDAR MOULD

STILTON MOULD

LEICESTER CHEESE MOULD WITH TIN (LEFT) AND WOOD (RIGHT) FOLLOWERS



CHEDDAR CHEESE MOULDS

sizes and weights according to custom. The number of moulds required depends upon the quantity of milk being converted into cheese and the time the moulds are in press.

In the case of cheese which are only pressed for a short time, of course, fewer moulds will do as they are soon emptied. In the case of large Cheddar or Cheshire cheese, however, the cheese are in press for three days, and as making goes on each day a fairly large number of moulds will be required.

Cheese Press.—A cheese press may be either of a simple or compound lever type, the latter being now most commonly employed. In the ordinary type of press pressure can be exerted running from 1 to 2 cwt. up to 30 to 35 cwt., the required pressure being obtained by altering the weights on the lever arm or chain. Where large quantities of cheese are dealt with the gang press is sometimes employed.

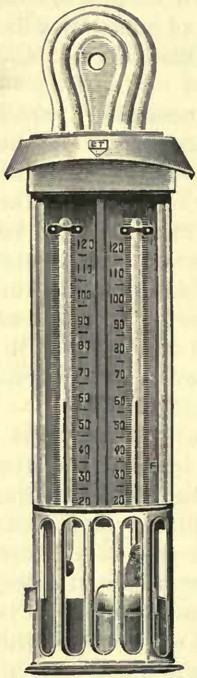
Steam Boiler.—In large dairies the steam boiler is essential, as only by this means can large quantities of milk be heated for cheesemaking. Small dairies, however, have a copper or other arrangement for heating water without producing steam pressure, which is sufficient to provide the means for warming the milk. A cream skimmer is for removing the cream, etc., which has risen to the surface of the vat overnight. It is then warmed up separately to from 90 to 100° F. and returned to the milk after the milk has been heated preparatory to cheesemaking. This removal and heating of the cream to a rather higher temperature than that of the milk, and remixing is essential to avoid loss in fat in the making of the cheese.

Salt Chest.—It is desirable to have a wooden chest fitted with a lid in which to store salt to keep it dry.

A **Weighing Machine** is very helpful to the cheesemaker. If small quantities of milk are made into cheese, then the curd may be weighed, and according to the weight fine salt may be added in proportion. Then again, the cheese as taken out of press may be weighed, and weighed subsequently when taken to the drying and ripening rooms, and again at the time of maturity. Such weighings give the cheesemaker useful figures in connection with the loss in ripening. In the cheese factory it is usual to employ the weighing machine for weighing the salt for the curd and for weighing the cheese at the time of sale. The bulk of curd would be so great that it would be difficult to weigh. Thus, the amount of salt is usually calculated according to the quantity of milk being made into cheese, and instead of adding 1 oz. of salt to so many lb. of curd, 2 to 3 lb. are added to the curd produced from every 100 gallons of milk.

Thermometers are very necessary in all dairy work, and in addition to wall thermometers for recording the temperature of the atmosphere, floating thermometers, which can be left floating in vats of milk, are employed. The floating thermometer is one made of a larger size than usual with an air space between the tube containing the mercury and the other glass encasement. If it is required to float upright, it is weighted with shot at the lower or mercury bulb end. The Fahrenheit scale is employed almost entirely in dairies, 32° F. being freezing and 212° F. the boiling point.

Dairy thermometers usually have the important temperatures indicated by a red line such as 56° F. cooled milk, 58° F. churning, 85° F. cheese heat, 180° F. pasteurizing heat, etc., but these should only be regarded as rough approximate guides, as the conducting of dairy operations to get the best results require very considerable modifications of temperature to meet the varying circumstances constantly operating.



HYGROMETER

Or wet and dry bulb thermometer, used for indicating the moisture vapour in the atmosphere.

The Hygrometer is an instrument consisting of two ordinary thermometers, but on the mercury bulb of one a piece of cotton wick is wrapped. The end of the cotton wick dips into a small vessel containing water. Thus the instrument is sometimes termed the wet and dry bulb thermometer. One of the thermometers is kept constantly moist by the cotton wick. Owing to the evaporation of moisture from the cotton on the wet bulb, the reading of this thermometer will nearly always be lower than the other one. If not, the air is so saturated with moisture that both thermometers are acting as wet bulb thermometers. The object of the hygrometer is to ascertain the humidity of the air of the cheese-ripening rooms. In order to prevent an excessive loss of weight and drying of cheese during ripening, it is desirable to keep the air at the right degree of humidity. If the temperature of the dry bulb registers 55° F., and there is no difference between the two thermometers, the percentage of moisture is 100. With the dry bulb at 55° F. and the difference 1°, the percentage of moisture is 93 and 3° difference 81. There should not be a greater difference in the readings than 3° at any temperature, otherwise the air will be too dry. A table is supplied indicating the degree of humidity according to the thermometer readings. Different varieties of cheese require different degrees of humidity for ripening to the best advantage, and as all varieties increase in age, increased humidity of the air is necessary, otherwise the cheese may become hard and dry through excessive evaporation.

Bandaging Material.—In order to keep the coat of the cheese smooth and clean, cloth bandages are wound round so as to completely cover the coat. In some cases the bandage used is cut the exact size of the cheese and pasted on, whilst if desired to give a particularly fine smooth finish the bandaged cheese is put back into press for a short while and the bandage pressed into the cheese.

The bandaging of a cheese helps to a certain extent in keeping the coat from cracking and also in preventing the attack of cheese flies. These, however, are secondary considerations in bandaging, as no amount of bandaging will prevent badly-made cheese from cracking. The bandaging material usually consists of unbleached calico of varying thickness according to the size of the cheese, large-sized cheese require good substantial cloth.

Cheese is delivered to the retailers with the bandages which are often in a very dirty condition owing to the handling of the cheese in ripening and transit and the growth of moulds. When cheese is stripped of its bandage, however—if of the pressed variety—the coat will appear smooth and clean.

CHAPTER XVI

PROCESS OF CHEESEMAKING

CHEDDAR is the principal variety of hard-pressed cheese, and has therefore been selected to illustrate the process of cheesemaking.

The home of the Cheddar is a village of that name in Somerset, but it is now made in many parts of the United Kingdom as well as in the Colonies and America. It is, in fact, the most universally made variety of cheese.

There are many methods of making Cheddar, but the three principal systems are—

(1) Candy's ;
(2) Cannon's ;
(3) Canadian or Factory System.

The Scotch system is a modification of the third.

The process of manufacture begins with the treatment of the evening's milk. This is cooled as quickly as possible after milking to a temperature of not less than 70° F., by running it over a refrigerator, or where a jacketed vat is used, the milk may be strained directly into the vat and cold water circulated through the jacket.

The milk is stirred frequently especially during the first hour to prevent the cream from rising. In the morning, the cream is skimmed off, heated with some of the morning's milk to a temperature of 90° F., and then returned to the vat.

Ripening the Milk.—The next stage is ripening the milk. Starter is now almost always used for the purpose and gives more uniform results than the use of whey, etc.

The acidity and temperature of the evening's milk is noted and starter is added according to the degree of acidity present ; as a rule ¼ to 1 per cent. is required, but under some conditions as much as 2 per cent. may be necessary.

If the proper amount of starter is added, the process of making should occupy from 5½ to 6 hours from the time of renneting.

The starter is passed through the strainer to remove all lumps, and the warming of the milk commenced ; the morning's milk after straining is usually added as obtained.

When the milk is at a temperature of 84° F., it is left until the proper degree of acidity or ripeness has been attained. *i.e.*, from ·2 to ·22 per cent. when tested by the acidimeter. This will be in from one to one and a half hours from the time of adding the starter.

The rennet test is preferred by many makers and is considered a more reliable one at this stage than the acidimeter ; a test of 20 to 21 seconds indicates that the milk is ready for renneting. It is found in practice that the amount of acidity required at renneting varies on different farms and with milk produced on different soils. This is a point which must be left to the discretion of the individual maker.

Colouring.—Cheddar cheese may be made either coloured or uncoloured to suit the requirements of the market for which it is intended. If colouring is used, it should be added to the milk at least ten minutes before the rennet and be well stirred in to insure a uniform colour. From 1 to 2 oz. per 100 gallons of milk is the usual proportion, the latter may be considered the maximum amount for Cheddar.

Renneting.—The renneting temperature is usually 84° F., but in cold weather it may be 85° F. or even

86° F. Rennet is added at the rate of 1 dram to every 3 gallons of milk, or 4 oz. to 100 gallons of milk. It is diluted with at least four times its bulk of clean, cold water, and is then well stirred into the milk for from 3 to 5 minutes. After this the surface of the milk is gently stirred till coagulation commences. Great care is necessary at this stage, as if stirring is discontinued too soon a layer of cream forms on the surface and later on will be lost in the whey. If stirring is continued after the milk begins to coagulate this will also cause a loss of fat, and consequently the cheese will be hard and dry.

The vat is now covered with a cloth or a wooden lid till the curd is ready for cutting, usually in from 45 to 50 minutes after renneting.

Cutting the Curd.—The curd is ready for cutting when it breaks with a clean fracture over the finger or a thermometer. If cut too soon, or left until too firm, cutting is more difficult and much fat may be lost in the process.

The curd is cut into cubes with American knives, the vertical knife being used first, cutting lengthways, then across the vat, the horizontal knife is then employed in the same manner.

The sides and bottom of the vat are cleaned with the hands, or if the vat is a large one a rubber squeegee may be used instead. The tap is emptied of curd and returned to the vat, and the curd is carefully and gently stirred for 10 to 15 minutes, employing the hands while the curd is soft, and when it becomes firmer a wooden rake may be used instead.

Scalding.—Scalding may commence in about 10 minutes after the curd has been cut ; when a jacketed vat is used the temperature is raised by passing steam through the water in the jacket, stirring continuously to keep the particles of curd separate. The temperature is raised very gradually at the rate of about 1° in 3 or 4 minutes, taking not less than 45 minutes to reach the final scalding temperature. The temperature of the scald varies from 96° F. to 102° F., or even higher. When the acidity develops quickly, a higher scald is necessary and it may be done more rapidly. A higher scald is also necessary with milk from clay or other heavy soils. After the scalding temperature has been reached the curd is stirred till ready for pitching.

Pitching.—The curd is allowed to pitch or settle when it feels springy and fairly firm and when the particles of curd do not adhere together when pressed in the hand. The acidity at this stage should be ·16 to ·17 per cent., and the curd is left till sufficient acidity has developed for the removal of the whey. This may be anything from 15 minutes to 1 hour.

Drawing the Whey.—The whey is drawn when it shows an acidity of ·18 to ·19 per cent. In dealing with small quantities of milk the curd is usually ripened in the vat, a rack and weight is placed on the curd for a few minutes then the whey is removed.

Where a large quantity of milk is made up, the curd is more conveniently ripened on a cooler. In this case a rack covered with cloths is placed on the cooler, and when part of the whey has been run off the curd is lifted on to the cooler with a curd bucket ; all the small particles of curd are brushed up and placed on the pile of curd, which is then covered and left for about 15 minutes.

Ripening the Curd.—The curd is now cut into 9-in. squares, turned, and piled up two deep and again covered. This process is repeated at intervals of 15 imnutes till the curd is ready for milling. If the curd is soft, a rack and weights should be put on it, and if the acidity is developing very quickly the curd is cut into smaller pieces and turned more frequently. If the acidity develops slowly the curd should be opened out and turned at longer intervals, say 20 to 30 minutes.

Grinding.—When ready for milling the curd should be tough and pliable and should pull apart into thin leafy strips. The acidity of the whey draining from the curd should now be ·8 to ·9 per cent. Grinding reduces the curd into small pieces, and thus the salt may be more uniformly distributed, while it also facilitates the removal of moisture.

After grinding, the curd is well stirred with the hands for 10 to 15 mintues before salting, and unless the acidity is developing quickly it may be covered with a cloth and left for a time to mellow and mature.

Salting.—Salt is used at the rate of 1 oz. to 3 lb. of curd or about 2 per cent., and after being well stirred in, the curd may be left for 10 minutes or so to allow the salt to be thoroughly dissolved.

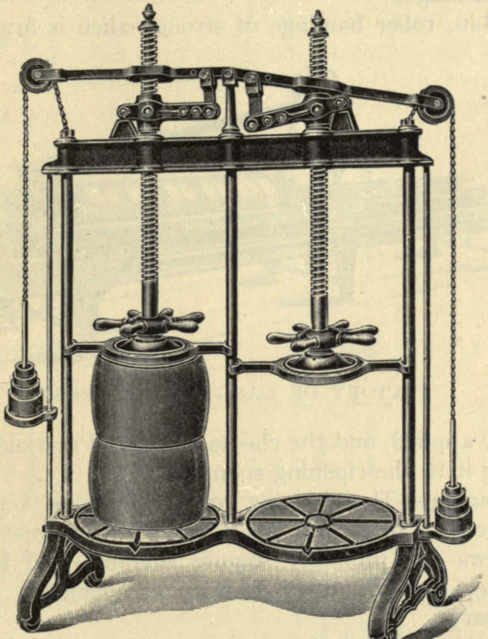
Vatting.—The temperature of the curd at vatting should not be above 70° F. or a loss of fat will result, but if the curd is too cold at this stage it will not go together properly in the press. The mould is lined with a coarse cloth and the curd well pressed in. One corner of the cloth is turned over the curd when the mould is full and the followers put on.

Pressing.—Pressing is necessary to form the curd into a compact mass and to get rid of the superfluous moisture.

In order to get a good-shaped cheese it is necessary to be very careful when putting it to press and later on in turning, and the presses should not stand in a draughty or overheated place, the former causes the cheese to crack and the latter will result in a loss of fat.

When the cheese is put to press the weight of the screw is applied, and the pressure is gradually increased till it reaches about 10 cwt. in two hours' time. The whey drainings from the press should contain ·95 to 1 per cent. of acid.

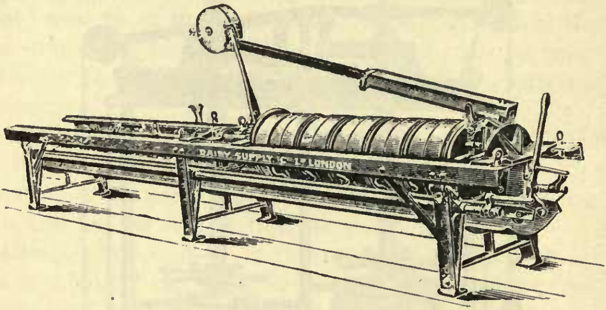
In the evening the cheese is turned and the pressure



DOUBLE-LEVER TWIN CHEESE PRESS

increased to 15 cwt. Next morning the cheese may be bathed in water at a temperature of 140° F. for a few minutes, the object of this is to seal the coat and to produce a smooth even rind, but the process is not essential and may be omitted. When returned to press the cheese should be placed in a smooth cloth, and the following morning the cheese is well greased with a small quantity of lard and a cap of thin calico placed on each end. The pressure is now increased to 20 to 30 cwt., and in the morning the cheese is taken from press and bandaged.

A 3-in. roller bandage of strong calico is firmly and



FACTORY OR GANG CHEESE PRESS

evenly applied, and the cheese dated and marked before taking it to the ripening room.

Ripening.—The ripening room should be kept at a temperature of 60° to 65° F., and in hot weather the windows will probably require shading, and for cold weather some kind of heating arrangement will be necessary.

The cheeses are placed on shelves and turned daily for the first two or three weeks, after that every other day is sufficient. Where a large number of cheese are made, self-turning shelves are very useful, as they save a lot of lifting. Ripening will occupy from four to six months, though many Cheddars are sold at three months old.

Size of Cheddar Cheese.—A full-sized Cheddar cheese weighs 80 lb. ; a truckle Cheddar from 8 lb. to 14 lb.

Left-hand Side.

CHEESEMAKERS DAILY RECORD BOOK.

Date.	*Quantity of Milk.*	*Quantity of Starter.*	*Acidity of Milk.*	*Rennet Test.*	*Quantity of Colour.*	*Quantity of Rennet.*	*Temperature Rennet added.*	*Time Rennet added.*	*Time Curd Cut.*	*Acidity at Cutting.*	*Temperature of Scald.*	*Time Pitched.*

Binding Margin.

Right-hand Side.

Time Whey drawn.	*Acidity when Whey drawn.*	*Time on Cooler or Vat.*	*Acidity at Grinding.*	*Time of Grinding.*	*Quantity of Salt.*	*Weight of Cheese.*	*Number on Cheese.*	*REMARKS.*

Binding Margin.

CHAPTER XVII

THE RIPENING AND YIELD OF CHEESE

THE curd of all firm or pressed cheese when placed in the moulds is of an insoluble elastic character and is quite indigestible. During the ripening process its character gradually changes until it becomes mellow or ripe and easily digestible. One writer has likened the ripening of cheese to the maturing of a hard pear which when plucked is hard and unpalatable, but when kept a few days under suitable conditions becomes beautifully mellow and ripe.

After cheese are removed from the press, bandaged, and kept a few days to a week in a room with plenty of fresh air circulating so as to dry the coats, they are removed to the ripening room, which is a room where the temperature can be controlled and the air regulated to contain the right degree of humidity.

The ripening process may take anything from three weeks to four months for completion, the time being largely dependent upon the type of cheese and the methods employed in manufacture. Thus, for example, Cheshire cheese is made on three systems, the early ripening, medium, and long ripening.

The early ripened cheese is marketed in three weeks to a month, the medium in about two months, and the long ripening in three to four months. Cheese ripened quickly must be consumed when ready as they do not keep well afterwards. On the other hand, cheese made on the long-ripening system after ripe should keep in sound condition for nine to twelve months. The quick-ripening cheese is made by adding a larger quantity of rennet and developing more acidity in the curd, the latter being the main factor.

As acidity is produced by the growth of bacteria it follows that bacteria are to a great extent responsible for the ripening of cheese. As a result of the ripening process the casein is rendered soluble, and, in addition, characteristic flavours are developed, which changes are all brought about by a series of fermentations, enzymes as well as bacteria taking an important part in bringing about the ripening.

The different fermentations which produce ripening are as yet not fully understood. The amount of a particular product needed to produce a particular flavour is so minute that it is a very difficult matter to isolate it—hence the study of cheese flavours is wrought with difficulties. In practice it is found that the best-flavoured cheese is that which takes a comparatively long time to ripen and in which the fermentations take place gradually and continuously. The temperature at which ripening takes place to best advantage is 60° F., and 65° F. should be regarded as the maximum. Above this temperature cheese develops a sharp, pungent flavour as well as deteriorating in mellowness owing to the loss of fat which occurs owing to the cheese sweating. The lactic acid bacteria undoubtedly play an important part in the ripening, particularly in the early stages, but later on in the ripening process the numbers present diminish very considerably even so much so as to become a negligent factor.

The fact that cheese ripens best at the temperature named does not preclude the possibility of ripening taking place at other temperatures. At a low temperature cheese will ripen even though the conditions are such as to preclude the possibility of the growth of bacteria. Cheese freshly made and put into cold storage at a temperature of 40° F., will ripen in due course, though several months longer are required for it to become quite mature.

Such cheese does not possess so fine or full a flavour, but is nevertheless good and ripe and the loss in weight that occurs is appreciably less, and it is often convenient to store cheese in this way. The enzyme galactase, which is normally present in milk, probably works freely when cheese is ripened under cold storage conditions, and the enzyme of rennet, lab or chymosin, added during the manufacture, continues its work, helping to produce maturity in the cheese.

The growth of moulds such as penicillium glaucum also contributes to the ripening process more particularly however, in blue moulded varieties of cheese such as Stilton. Many moulds grown under certain conditions produce enzymes and these act upon the curd. Yeasts, again, act to a certain extent, but more particularly in some of the varieties of soft cheese.

From these remarks on ripening it will be seen that it is most important to have present in the milk only such bacteria as are favourable to the production of good flavour in cheese.

Many bacteria produce undesirable flavours and thus we may get as a result cheese possessing respectively a putrid flavour, bitterness, fishy flavour, vinegary flavour, etc. Even the lactic acid bacteria, to which so much is owing, may get out of control, and if allowed to develop to too great an extent will produce an acid-flavoured cheese which will also be hard and dry in texture, and this is a case of a friend becoming an enemy.

It is important to regulate the amount of moisture present in the air of the ripening in order to prevent the cheese losing too much weight and becoming dry in texture. This can be done by the use of an hygrometer, and damping the floors if the air is becoming too dry. Without the presence of suitable proportions of fat and moisture cheese cannot become mellow.

The amount of fat present in cheese depends upon the quality of the milk used in manufacture, and the treatment adopted in the making so as to conserve the fat, the amount of moisture present is regulated also in the making process and subsequently in the ripening. The average period occupied in the ripening of a good class of cheese is three months. The quick-ripening process, however, has become popular amongst makers, as it enables them to market the cheese quickly and realize their money, but the best cheese is not produced in this way.

The composition of Cheddar curd as compared with the ripe cheese is shown by Lloyd in the following figures—

	Water.	*Solids.*
Curd	41·25	58·75
Ripe Cheese	35·58	64·42

Yield of Cheese.—During ripening there is a gradual loss in weight due to the loss of moisture from the cheese.

At first the loss occurs in much higher proportion than later on, and when the maximum is reached very little further loss takes place if the cheese is stored under suitable conditions as to temperature and humidity of the surrounding air. Generally speaking, the richer the milk the greater will be the yield of finished cheese, provided no unnecessary loss of fat takes place during the manufacturing process or subsequent ripening.

In speaking of richness of milk this should apply to both the fat and casein contents. The former it should be remembered is only mechanically entangled in the curd, but the latter actually forms the coagulum or curd. The fat assists in conserving the moisture in the cheese, thus, milk rich in fat produces moist and mellow cheese. Generally there is about two-thirds of a pound of casein present in milk for each pound of fat, but when the fat increases very much there is a slightly less proportion of casein.

The yield of cheese varies in the case of different varieties, but in the case of Cheddar cheese the average of a season's output should be approximately 1 lb. of ripe cheese for each gallon of milk. The yield varies at different periods of the year with the normal season's fluctuating quality of the milk. Thus, in spring, less than 1 lb. of cheese will be yielded ; whilst in autumn the proportion will be greater than 1 lb.

Month.	*Average yield of milk per cow per day.*	*Vol. of milk.*	*Curd taken from press.*	*Cheese when sold.*	*Shrinkage in ripening.*	*Cheese from one gall. of milk.*
	Galls.	Galls.	lb.	lb.	lb.	lb.
April	2·02	81	73	69	4	·85
May	2·59	119	117	111	6	·93
June	2·64	132	132	123	9	·93
July	2·24	112	114	107	7	·96
August	1·82	91	99	91	8	1·00
Sept.	1·58	79	87½	82	5½	1·04
October	1·04	52	64	59½	4½	1·14
Average	1·99	95	98	92	6	·98

The above results by Lloyd in his experiments in Cheddar cheesemaking show the average yield of milk, curd, and cheese from herd of cows for each month during the years 1891 to 1898.

An unpressed cheese like Stilton loses considerably more in weight during the ripening, the yield of curd from milk in the first instance being considerably more than in the curd of firm or pressed cheeses. For example: 16 gallons of milk converted into Stilton will produce from 20 to 38 lb. of curd when ready for moulding, which in turn produces about 14 lb. of ripe cheese.

CHAPTER XVIII

JUDGING AND MARKETING

THERE are various points to be taken into consideration in judging the quality of cheese when ready for consumption. Flavour is, of course, the all-important point, and each variety of cheese has its characteristic flavour, which depends upon the method adopted in making and the fermentations that go on in the ripening. Commencing with good milk, it is possible to make at any dairy practically all varieties of cheese and to develop their characteristic flavours. Thus, Cheddar cheese, which has its home in the county of Somerset, is now a universal type and is made in very many different parts of the world. Again, Cheshire cheese, which is of an entirely different flavour and type, may be made successfully elsewhere than in Cheshire, though it is an acknowledged fact that the best-flavoured cheese of its type is that produced in its native locality in dairies where it has been made for generations. This is due to the dairy itself having become the seat or breeding-ground of the bacteria which are most suitable to producing the particular flavour of the variety of cheese always there manufactured. In investigating the particular types of bacteria present in the air of dairies it will be found that even the lactic acid bacteria (present in all dairies) vary considerably in size, form, and activity at different dairies where different cheeses are produced. Thus, to judge cheese, its particular type or variety is the first thing to consider, and this must be in accordance with the recognized fine flavour of the variety in question. The flavour should be clean and fully developed, and the aroma nutty and agreeable, there should be an entire absence of a hot, acrid bitter, or acid or other foreign aroma or taste. The texture should be in accordance with the variety. Thus, in Cheddar it should be solid, or compact, whilst in Cheshire a granular condition is desired. In any case, the cheese must be mellow and readily break down when rubbed in the fingers, so as to show that it contains a sufficiency of moisture and fat. On the other hand, there should be no excess of moisture present, and the texture should neither be pasty nor leathery, as such conditions indicate defective control of the manufacture. Cheese of a leathery or gutta-percha type of texture is usually got where too much fat is lost in the manufacture, and, owing to the presence of insufficient acid, the digestive process that takes place in the ripening has not properly developed. Other points of some importance in judging cheese are the colour and uniformity of salting and the general appearance and finish. Good cheese may sometimes present a poor and unattractive appearance, but, generally speaking, this is not the case. Cheese that are out of shape and badly bandaged or dirty looking, through insufficient attention having been devoted to their appearance do not market to best advantage even if the flavour, texture, etc., are good. The colour of cheese made from milk that has not been artificially coloured varies according to the time of year, being palest in spring. When cows are getting practically nothing but grass as a food, the colour is best, as the green colouring matter of plants or chlorophyll, as it is termed, undoubtedly goes to make lactochrome, which is the primrose yellow colouring matter of the milk fat. Milk from which the fat has been removed is quite white in colour. A certain section of the public demand coloured cheese—hence artificial colouring matter is added to produce coloured cheese.

In judging the colour of cheese this should be uniform and free from streaks whether the colour is natural or artificial. Up to a certain point the deeper the yellow tinge of cheese the richer it looks—hence some makers always add just a small amount of artificial colouring matter at the seasons of the year when milk is very pale in colour. Streakiness or white patches is a fault often observed in coloured cheese, and is commonly caused by bacteria which have the power of producing a bleaching action upon the colouring matter.

The uniform distribution of salt throughout the cheese is important, and there should be no cause for fault in this direction if the matter of salting has been properly attended to in the manufacture and the salt used is pure. There should be no excess of salt flavour, sufficient salt only being necessary to blend with and bring out the fine flavour of the cheese.

The following points serve as a useful standard for the judging of cheese, and at many shows now the points scored by each exhibit (as compared with the maximum procurable) are shown.

This is of considerable educational value to the exhibitor, indicating to him where his cheese, in the opinion of the judge, has failed.

Flavour and aroma	50
Texture, condition, and evenness of salting	30
Colour	10
General appearance and finish	10
	100

Marketing.—The marketing of cheese made on the farms in this country is chiefly done through cheese factors. The cheese factors, or merchants, commonly buy the entire make of the farm for the season, agreeing to take delivery as the cheese is ready or at set times, chiefly at the end of the season, and allowance is claimed for any cheese of inferior quality. It is not uncommon for the factor, after agreeing as to the price to be paid, to advance money to the farmers so that the latter will not have to wait until the cheese is ripe before being able to realize some of the capital, which is locked up for the time being in the form of cheese.

In other cases the cheese is sold at cheese fairs, which are held at different places, whilst often the farmers supply the grocer retailer direct on much the same lines as he supplies butter. Factors usually take the cheese only when it is ripe and ready for sale, and thus act as middleman, merely instructing the maker as to the destination to which the cheese is to be sent.

On the other hand, many factors have large stores or warehouses where cheese can be stored and ripened, and where the purchaser can pick and choose his wares. Cheese factories where the collected milk from many farms is converted into cheese also sometimes dispose of their make through factors, but in most cases supply the retailer direct. Unfortunately, there is in this country no official grading for cheese as abroad—hence the commonly-varying character of different lots of cheese marketed, which is very noticeable to the consumer. In many countries there are official grading stations where all cheese is graded by Government officials before it is shipped—hence the generally-uniform quality of imported cheese as compared with the home produced. Undoubtedly what the market requires is cheese of uniform quality as well as quantity, and such secures the best trade.

Thus it is that the New Zealand makes of cheese have come into such favour during the past few years. Cheese which is not fit to pass the graders is not allowed to be exported, hence the reputation of the cheese we import into this country is enhanced. All the cheese exported is stamped with the Government grading mark. It is generally the case that a country which specializes in food production and which desires to secure the best British market, retains at home all inferior goods. This is well instanced by Denmark, which keeps back all inferior butter and bacon for its home consumption. Markets, of course, vary considerably in their requirements and these must be studied by the suppliers. Thus, in the matter of colour, London and the South generally require pale or uncoloured cheese, whilst in the North coloured cheese is mostly in demand. Some districts demand cheese of a soft character others of a firm type, so that not only has the variety of cheese to be considered but the make of that variety modified to suit local requirements. Many varieties of cheese which sell well in their own district would hardly sell at all outside. Furthermore, very many varieties of foreign cheese sold in London meet with no demand in the provinces. The makes of British blue moulded cheese such as prime Stilton and Wensleydale are chiefly bought up and served in clubs and high-class hotels and restaurants and are not appreciated at all and even disliked by the average public. Thus it will be seen, that however good a class of cheese is produced, its particular market has to be found in order to realize it and sell to the best advantage.

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v—(1461c)

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