MATCOM

FOOD SPOILAGE AND PRESERVATION

a learning element for staff of consumer cooperatives

international labour office, geneva

by Karsten Lundsby

MATCOM
Material and techniques for cooperatives management training

The MATCOM Project was launched in 1978 by the International Labour Office, with the financial support of Sweden. In its third phase (1984-1986) MATCOM is financed by Denmark, Finland and Norway.

In collaboration with cooperative organizations and training institutes in all regions of the world, MATCOM designs and produces material for the training of managers of cooperatives and assists in the preparation of adapted versions for use in various countries. MATCOM also provides support for improving the methodology of cooperative training and for the training of trainers.

FOOD SPOILAGE AND PRESERVATION

Contents

MATCOM Element No: 15-03

Edition: Universal 1984

ISBN: 92-2-103693-6

PREREQUISITES

To benefit from this MATCOM Learning Element, you should:

- have studied the MATCOM Element "Shop Hygiene", or have the corresponding knowledge.

HOW TO LEARN

- Study the Element carefully.
- Give written answers to all the questions in the Element. This will help you not only to learn, but also to apply the knowledge you gain in your work later on.
- After studying the Element on your own, discuss it with your trainer and your colleagues, then take part in the practical exercises organised by your trainer.

TRAINER'S NOTES

are available for this Element. See the Trainer's Manual.

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Illustrations: Anja Längst

Printed in Vienna, Austria, 1984

INTRODUCTION

The Manager of South Side Consumer Co-operative welcomed his staff to the usual "Tuesday Morning Meeting". He had planned a programme of study for them, which he introduced as follows:

"You know that most of the food consumed by **people in this** area comes from our shop. We sell dry foodstuff, fresh food, frozen food and canned food. All of us here are more or less involved with food distribution. This certainly means a great responsibility: we must deliver high quality products which are clean and safe to eat. Now I have asked myself: do we know enough about these products to handle them and store them properly? Can we give our customers correct information and advice about all food products?

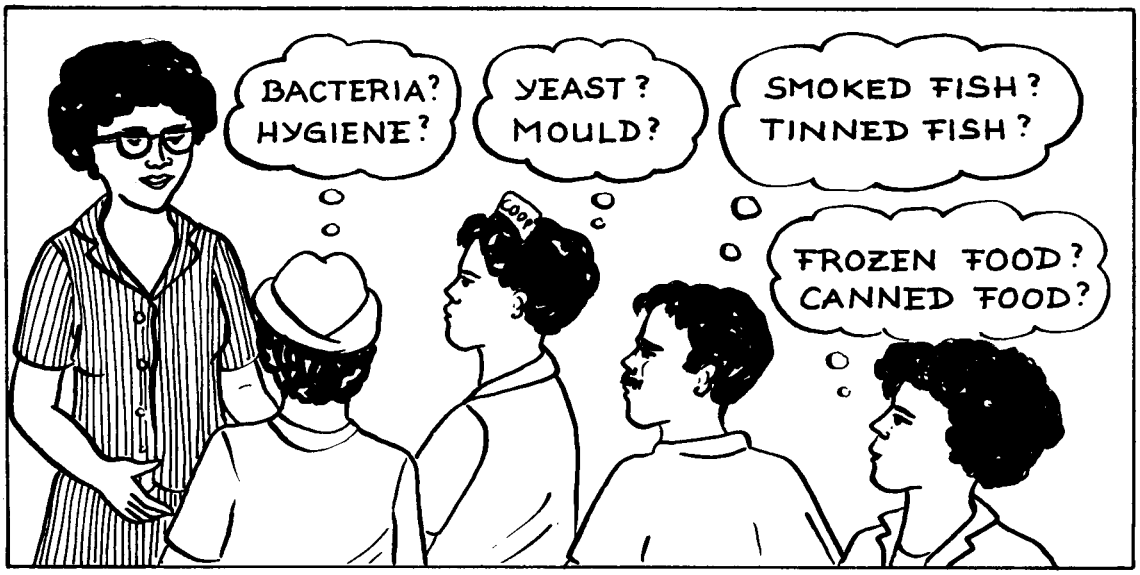
I think we all want to learn more, especially about perishable food and its preservation.

- What causes foodstuff to perish?
- What can be done to prevent it?
- How can food be preserved?

To find the answers to these questions, I have arranged a course of study.

Today, we begin with a lecture by Mrs. Ohene, our District Health Inspector. She will talk about what causes food to spoil. Next week, I have organised visits to some food processing plants, so that we can learn about food preservation.

Mrs. Ohene, we are very glad to welcome you here today. We are eager to hear what you have to tell us."



District Health Inspector Ohene began her lecture for the shop staff.

"I am delighted to be here. I am very pleased to learn of your interest in the proper management of food because you <u>are really key persons</u> in this connection. You have at least two major reasons to take good care of the food products in your shop:

- In the first place, you don't want to cause any 'health accidents' by selling contaminated foodstuff which could make people sick. This would be bad for the reputation of your shop, as well.
- Secondly, you don't want to waste money - your members' money! - by having to throw away fresh food that has gone bad in your shop.

The health factor

Not long ago, we had an outbreak of food poisoning. 250 people fell ill and some later died in the hospital. The sources of the poisoning were traced and, as a result, three food shops had to be closed down temporarily because of unsanitary conditions.

We have several links in the distribution chain, any one of which can cause a health accident; the processing factory, the transporter, the shop and the household.

It has been found that food shops and restaurants represent a larger health risk than households and food industries? What could be the reason?

Imagine what could happen if a strict standard of hygiene were not kept in the food industry. Take, for example, the dairy plant in Laloki. It produces 15000 cartons of milk every day. That is potential for a lot of accidents! But, fortunately, the food processing industry itself requires people properly trained, in both technique and hygiene. Even though we Health Inspectors keep a very strict eye on the food industry, we find very little to complain about. Health accidents caused by commercially-processed food are extremely rare. You must be equally careful to make sure that people do not get sick from food that has become contaminated in your shop.

The economic factor

While health accidents may be uncommon, there are common economic aspects to the food management problem which you are reminded of daily in your work. If you want to avoid unnecessary losses, you must know about correct handling and storage of food products. Carelessness and waste can be very expensive!

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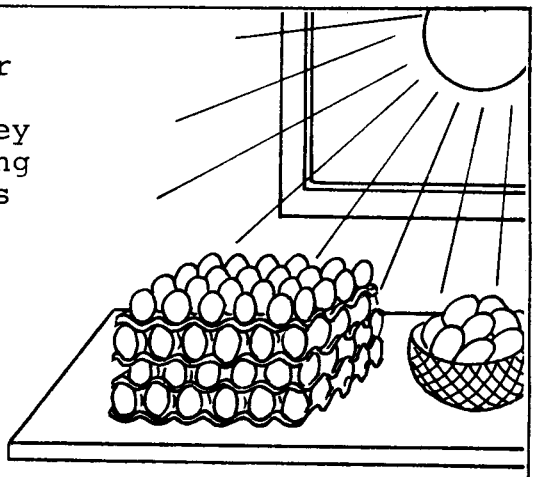
Suppose 100 eggs in your shop go bad and must be thrown away, because they had been placed in strong sunlight. How many eggs do you need to sell to cover this loss?



If you neglect the rules for correct handling of foodstuff, or if you forget about cleanliness and personal hygiene, then you will create a paradise for bacteria and other organisms that can cause health problems and spoil the foodstuff in your shop. Bacteria cause most of our problems, so we will discuss them first.

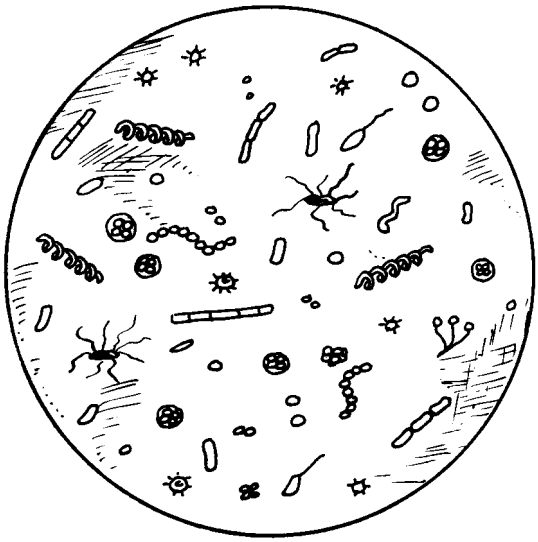
Since we must fight bacteria, in effect, go on a hunt for them, we must learn about them. As in any other hunt, the more you know about your quarry, the more successful you will be.

What do you know about bacteria?

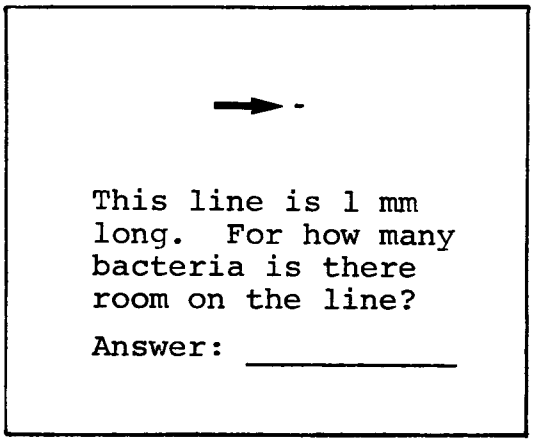
BACTERIA

What are bacteria?

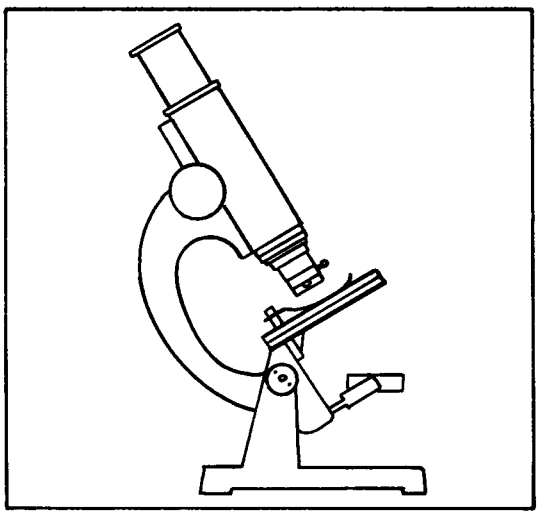
Bacteria are actually very tiny plants which like other plants require nutrients and moisture to live.

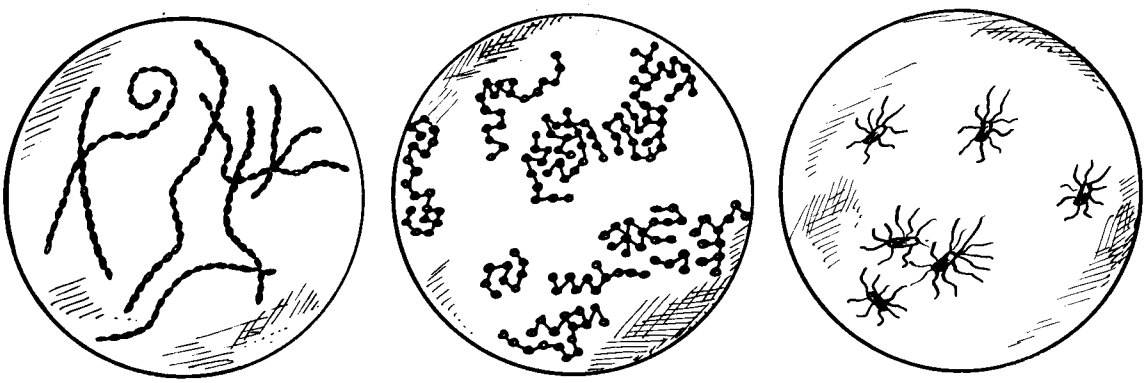


Bacteria are very small indeed. Only a few types will reach the size of 1/100 mm; the smallest bacteria reach only 2/100 of that size.



In order to see bacteria, we need a microscope. When we examine them, we realize that like the larger plants around us, bacteria are found in many different shapes. Like the more familiar plants and trees, bacteria can be divided into many different species, each with its own characteristics and name.





Different types of bacteria enlarged more than 1,000 times.

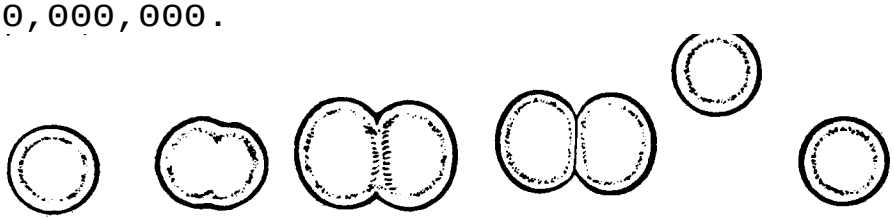
How do bacteria live?

Different types of bacteria require different diets but, generally speaking, there is no part of the body of any living thing - plant or animal - that cannot serve as food for some type of bacteria.

Bacteria can produce certain chemicals, called 'enzymes', which 'digest' or 'break down' food outside their bodies. The bacteria then absorb the digested nutrients or food almost the way the roots of a tree absorb 'food' from the soil.

When bacteria have adequate living conditions, they multiply. In that process, one individual simply splits into two more. When these, in turn, have grown a little, they each split again, resulting in four individuals.

If the living conditions are sufficient, this process can be repeated at amazing speed. A single bacterium can split into two bacteria in only 20 minutes; after an hour we will have 8 bacteria; an hour later, we will have 64; after 7 hours, 2,000,000; and after 10 hours, more than 1,000,000,000.



we can use this rapid growth of bacteria to our advantage in the laboratory. A large group of bacteria (called a colony') is easier to see than scattered individuals.

Therefore, in the laboratory we breed colonies of bacteria. First, we sterilize our equipment by boiling it. This kills any bacteria already there. Then we get a sample of the bacteria we want to look at onto a special sterile (boiled) 'jelly'. The bacteria will multiply there and form colonies which can be identified. For instance, a doctor can take a sample from a sick person's mouth or nose. In the laboratory the bacteria are identified and the doctor will know what steps to take to treat the illness.

Bacteria must have moisture - dampness - in order to live. Therefore you can see that dry conditions can kill them or at least slow down their rate of growth.

Temperature is also important. Different types of bacteria require different temperatures. Some need heat: 40 - 700C; others, low temperatures: 0 - 400C; but most bacteria (including those most interesting in our context) prefer the interval 30 - 40^0C. When the temperature becomes too low or too high for bacteria, they either die or multiply at a much slower rate.

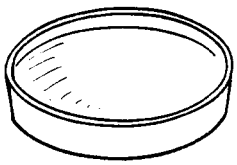
Under unfavourable conditions, several kinds of bacteria can protect themselves by forming a resistant shell. These bacterial capsules or spores are somewhat like seeds from a plant. They can survive for several years. Once conditions become favourable again, the dormant bacteria revive. Bacterial spores are extremely resistant, surviving boiling, freezing, long periods of drying, and even poisons (antibiotics and preservatives). As you will see, this fact is important for the shop management.

Where do bacteria live?

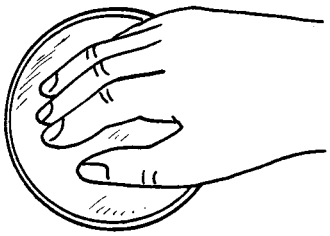
Bacteria exist almost everywhere. They live in the soil; in the water of seas, lakes, rivers, ponds and wells; on plants and trees; on insects, fish, birds, wild and domestic animals and humans.

Particularly high concentrations can be found in rotting carcasses, latrines, heaps of manure, etc. On the human body, the highest concentrations are found in the mouth and nose, in the large intestine, on hair, skin and under the nails.

In the laboratory

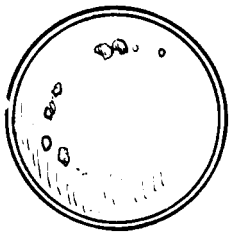


A glass-plate with a sterile 'jelly'.



Are there any bacteria on the fingers? We make a fingerprint on the plate ...

Soon we can see that bacteria from the fingers have formed large colonies on the plate.



This is another sample, taken after a handwash.

Particularly low concentrations of bacteria are found inside the living tissue of plants and animals. This is because living organisms are able to fight bacteria which penetrate their tissue.

Thus, if you cut a piece of fruit or fresh meat with an absolutely clean knife, you will get a surface virtually free of any bacteria. But it will not stay like that for long; bacteria will quickly collect even from the air. If you use a dirty knife, of course, you will immediately contaminate the fruit or the meat.

How do bacteria affect us?

Fortunately, most bacteria do not harm us at all. They are part of the natural processes of life, involved, for example, in the decomposition of dead plants and animals, breaking them down into soil.

A few types of bacteria are even useful in industry. Bacteria are used in the production of cheese and yoghurt, and in the manufacture of vinegar for example. Certain other bacteria like those found in human intestines, are even essential to us, aiding in the digestive process and synthesizing or manufacturing vitamins necessary to life.

But there are at least three ways in which bacteria can be harmful:

Certain bacteria can spoil the foodstuff we had intended to eat.

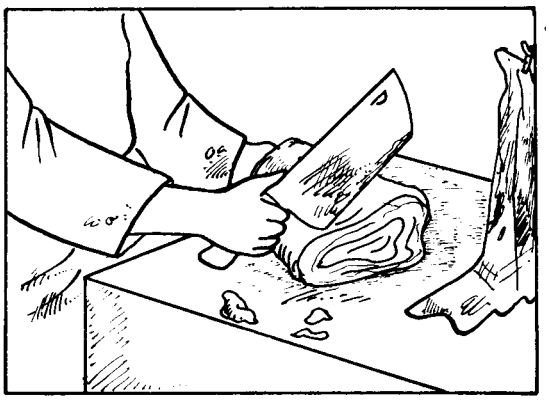
Other types can cause disease, often through our food. Cholera, typhoid fever and bacillary dysentery are all very serious diseases caused by bacteria and usually transmitted through food or water.

Some bacteria produce poisonous by-products: toxins. These toxins remain in the foodstuff even after the bacteria have been killed, and will cause food poisoning (and possible death) when eaten. One of the strongest poisons known is the toxin botulin produced by bacteria found in spoiled or improperly canned food. This specific bacterium is called Clostridium-Botulinum. The severe food poisoning - botulism - it causes is often fatal.

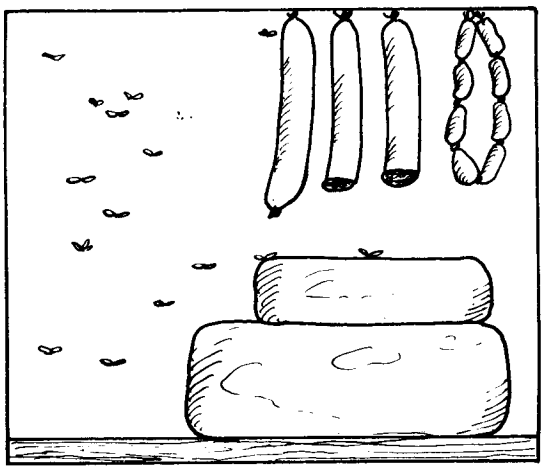
How do bacteria spread?

Most bacteria do not move around by themselves, but they get help to spread, often by direct contact.

We have already mentioned one such example: the dirty knife. We could add any dirty tools, brushes, handkerchiefs, towels, dish cloths, etc: And we must not forget dirty hands.



Bacteria often spread with the help of flies. As we know, flies are attracted to all kinds of dirty places - carrions and latrines among them - and their feet are full of bacteria.If the flies then come in contact with foodstuff, the bacteria are readily transferred.



Bacteria can also be spread through the air by our breath. High concentration of bacteria can be spread by coughing or sneezing. Dry air normally contains a lower concentration of bacteria, but spores are nevertheless carried along by the wind in rather large numbers.

How do we fight bacteria?

Shop-hygiene

First, we must try to prevent the spread of bacteria. This is possible in your shop only if you know where bacteria concentrate and how they get from one place to another. With this knowledge, you can develop a set of good habits and a good system for shop sanitation. Conscientious personnel can make life very difficult for bacteria.

Write a set of "Rules for good hygiene", corresponding to these pictures.

1

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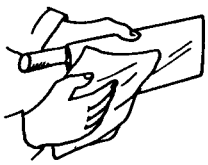

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5

Mention five places in your shop where the concentration of bacteria is particularly high.

Why should you not keep fresh meat and vegetables close together?

The bar of soap in the washstand is probably full of bacteria. Why?

In what part of your shop are there most flies?

Food preservation techniques

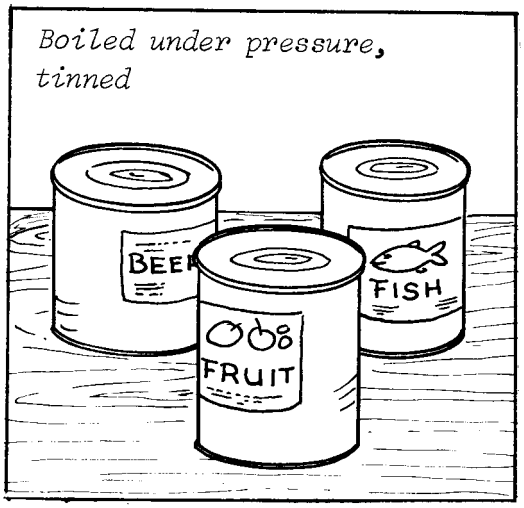
In addition to general sanitation, there are a number of techniques to either kill bacteria, or to retard their rate of growth. We can make their living conditions so unfavourable that they hardly multiply, and may even go dormant. These methods - called preservation techniques - enable us to maintain our products in good condition for a rather long period of time.

- Heat

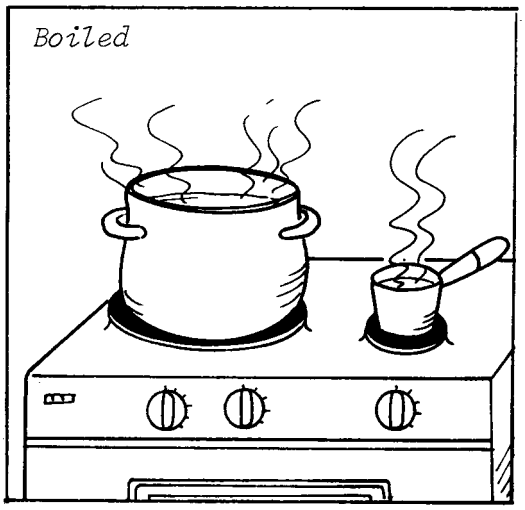
The most common way to kill bacteria in food is by means of high temperature. Most bacteria will be killed at a temperature of 800C.; none can survive boiling at 100^{0}C.

But such heat treatment will also have its effect on the foodstuff itself - cooking it, in a sense - in terms of texture, flavour and nutrition value. Therefore high temperature is not the only answer. It cannot be used with every kind of foodstuff.

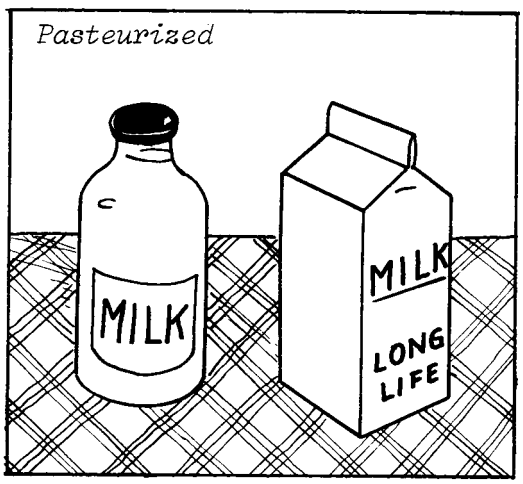
Canned meat, vegetables or fruit are boiled in the tins under pressure, at a temperature of 120^{0}C. Since this destroys all bacteria, the contents may keep safely for years. But once the tin is opened, the contents are subject to contamination and will perish just like any fresh food.



Cooking (boiling, baking, roasting or prolonged frying); as commonly done in households and restaurants will kill most bacteria, but this is not preservation. The food will only keep for a limited time afterwards, due to new contamination from the surroundings.



Dairy milk is pasteurized - given a very short heat treatment at 80^{0}C. This process kills disease-causing bacteria, but other types still survive. The milk must be kept cool in order to remain good for even a couple of days. Another method is also being used for milk, in which it is treated briefly at 130^{0}C. With this all bacteria are killed and the milk may be kept good for more than a month at room temperature. However, this method affects both the flavour and the nutrition value of the milk.

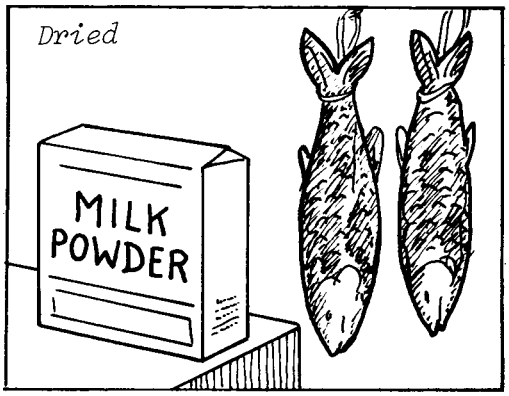


- Chemical additives

Still another way to kill bacteria is to add certain chemicals - called preservatives or additives - poisonous to the bacteria but not to humans. This technique is used in connection with preserves, pickles, ketchups, certain types of bread products, certain fish products and others. The foodstuff treated in this way may stay good for a rather long period, but the 'lifetime' very often depends on storage conditions. Preservatives are generally used in combination with moderate heat treatment.

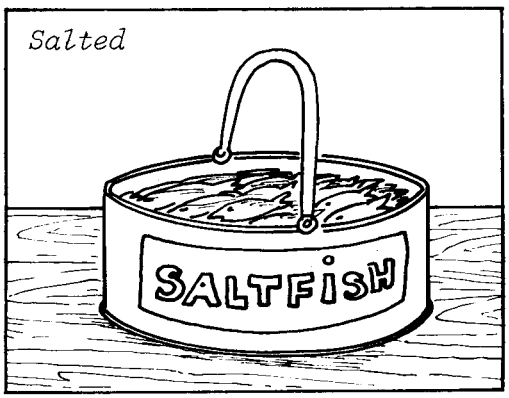
- Drying

If we take the moisture out of foodstuff, bacteria find it hard to survive. They die or form spores. Therefore, dried powdered milk, and dried fish, meat and fruit may be kept a long time.



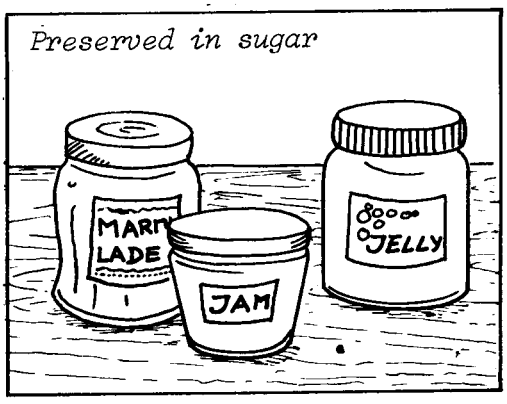
- Salting

A similar effect results from salting. The salt changes the balance of moisture in the bacteria, in effect, drying it out - thus destroying it or slowing down its rate of reproduction.



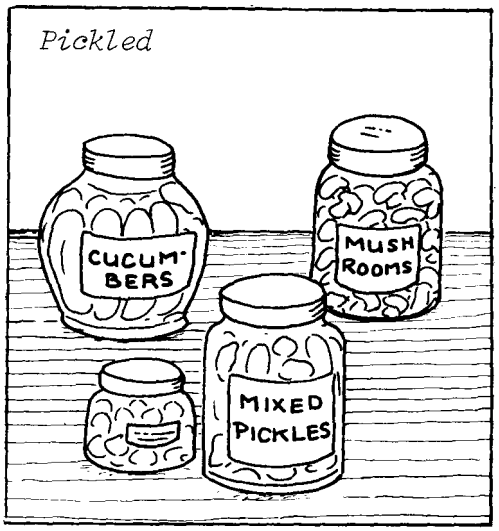
- Sugar

Preservation by means of sugar works somewhat like salting, in that it also affects the internal balance of the bacteria. It is commonly used with heat to preserve fruit.



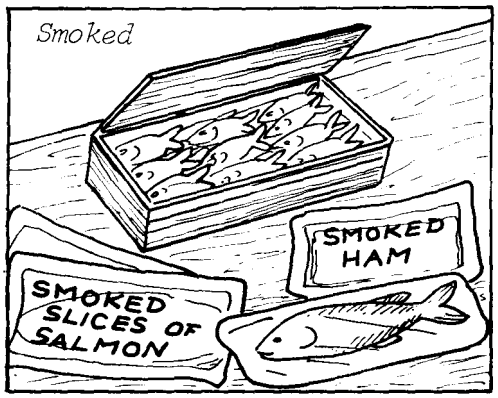
- Pickling

The preservation of vegetable; in brine (salt solution) or vinegar, called pickling, produces sour living conditions unfavourable to most bacteria. This process can also involve boiling in the pickling liquic As in the other processes, a sterile packing technique is important.



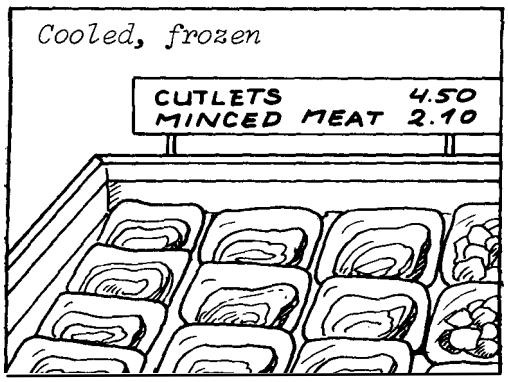
- Smoking

Curing or preserving meat or fish by smoking it, involves a prolonged process combining mild heat and drying with exposure to bacteria-inhibiting smoke.



- Refrigeration

Another way of making living conditions unfavourable for bacteria is to reduce temperature. We must here distinguisl between refrigerating at about +6 to +80C, and deep-freezing at -18 to -20^{0}C.



In the refrigerator, the temperature is so low that the multiplication of most bacteria either is stopped or considerably reduced. Foodstuff will keep several days longer than it would at room temperature. But this temperature does not kill the bacteria. (Some bacteria actually prefer this low temperature.) Eventually, the food will rot even in a refrigerator.

Of course, the 'life-time' of a food item in a refrigerator depends very much on the concentration of bacteria already on it when it was put in. Furthermore, the 'life-time' also depends on the proper use and maintenance of the refrigerator.

Every time the door is opened, cold air escapes and warm air is let in. The door should be opened for as short a time as possible.

The refrigerator's effectiveness is also reduced when there is ice on the cooling elements.

- Freezing

In the freezer, the temperature should be so low that all bacteria will either go dormant, become spores, or die. This requires a temperature of -18^{0}C, or below.

If the proper working temperature is observed and maintained all the time, foodstuff may be kept safely in the freezer up to a year (unless the expiration date on the package tells otherwise).

But we must remember that bacteria may start breeding again if the temperature goes up in the freezer. This happens if there is ice on the freezer elements, if too many goods are put in the freezer or if it is used for "freezing-in" fresh food. (Frozen food should normally be processed at a proper freezing plant at a temperature of -30^{0} or below.)

Cooling or freezing will not usually affect flavour or nutrition value, but freezing is not suitable for all products, as it may affect the texture.

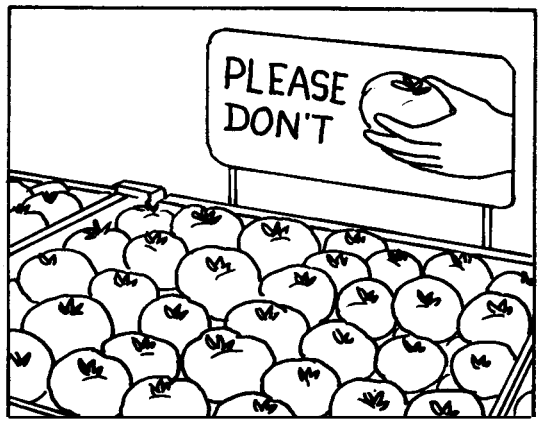
YEAST AND MOULD

Yeast and **mould** are two other kinds of tiny plants - fungi - that can grow on foodstuff and cause problems. Both require moist conditions to live, although they can survive dry periods. Neither can survive in dry heat - above 600C.

Yeast

Yeast feeds primarily on starch and sugar, multiplying through budding and causing fermentation. It is used to make bread rise and to brew beer or wine, but it can be harmful in fresh fruit. Yeast will not affect fresh fruit in good **c**ondition, but once the skin of the fruit is bruised or broken, it goes to work, starting a fermentation process inside.

Therefore, it is important **not** to drop, press or squeeze the fruit, but handle it with great: care. Fruit with broken skin or visible bruises should be separated from the rest immedi-- ately to prevent any fermentation from spreading.

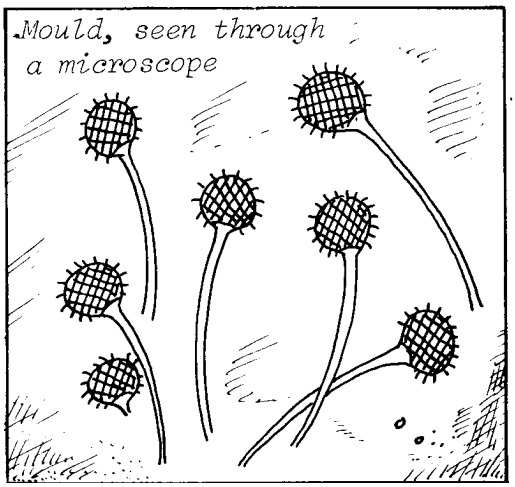


While yeast does not carry disease or cause food poisoning, it will give a bad flavour to the foodstuff and destroy it. Yeast can be killed at high temperature - for instance, when bread is baked or beer pasteurized - but this is obviously impractical for fresh fruit.

Mould

Mould can feed on many materials: bread, fruit, vegetables, leather, cloth, etc. It multiplies through formation. This process can be controlled and put to good use.

Edible mould is quite important in the cheese industry, used in the production of "blue cheese". It is also essential in modern medicine as the basis for production of penicillin.



Mould can also, of course, be a nuisance. It is damaging to foodstuff, producing an offensive taste and appearance. It is generally found on decaying food. As its spores spread easily, it does not help simply to scrape away the visible mould. In the household we might simply cut off the mouldy part of a loaf of bread and save the rest. This can hardly be done to bread sold in the shop, however. Nor can you give your goods some sort of heat treatment to kill the mould.

The only thing you can do is to keep the surroundings extremely clean, and to make sure there is a fast turnover of the fresh foodstuff. Any mouldy goods you find in the shop, must be thrown out immediately.

ENZYMES

Let me finish this talk with a brief discussion of enzymes. Like bacteria, yeast and mould, these can be both useful and harmful. Unlike the other three, however, enzymes are not organisms - not alive. Enzymes are complex organic substances produced by living cells. There are many different enzymes. Each one is able to 'break down' or produce a chemical change in some other organic substance. One may affect cellulose, another may work on sugar, and still another may 'break down' flesh.

It is important to understand enzyme action. Enzymes are very useful in the chemical, medical and food industries. Although they do not cause disease or food poisoning, they can affect food. For instance, if we let a piece of beef hang in a cooled storeroom for a while, the activity of enzymes will make the meat more tender.

But enzymes can. cause problems. For instance, if we squeeze a piece of fruit to test its ripeness, we damage some of. the tissue. It releases enzymes, which dissolve the neighbouring tissue. Gradually, a soft spot will develop, and probably some discolouration. This will reduce the sales value of the fruit. Even worse, the soft spot allows easy access for yeast and mould, which soon spoil the fruit entirely.

Enzymes are also responsible for <u>rancidity</u>. This is a process that occurs in natural fat exposed to the oxygen in the air. The effect is often a slight change of colour, and always a change of smell and taste ('old', 'soap-like', 'rank'). Butter, margarine and certain fat-containing cosmetic creams are the items most commonly affected. But fatty meat and fish, even when stored in a freezer, can also go rancid.

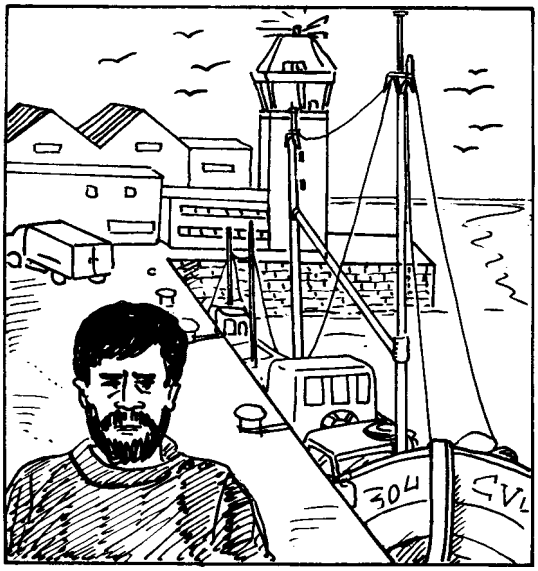
Enzymes can be destroyed through heat treatment (80^0C) but this is not very practical in the shop. Here,, little can really be done to prevent rancidity. The best prevention is cool storage and a fast turnover of the fatty foodstuff."

With this, Mrs. Ohene concluded her lecture. The first part of the programme arranged by the Shop Manager was now completed. From the Health Inspector's lecture, the staff had learned how bacteria and other organisms can affect foodstuff in the shop. Armed with their new knowledge, they were now better prepared for their fight against bacteria, mould,and other "food-spoilers".

What are the most common problems in your shop with regard to spoilage of foodstuff? Estimate the cost of all the goods spoiled in your shop during one year.

The shop personnel were looking forward to the rest of the programme, the study visits. They were eager to see food processing plants at work and to learn how food is actually preserved for long periods. This is described in the following chapters.

A FISH PROCESSING PLANT



"Welcome to Nautic Industries, Ltd. I am the chief of the Quality Control Department. I am most happy to tell you about our production.

Our main product is tuna, which is caught in rich quantities in our coastal waters. The majority of the tuna is tinned, mainly for export, but we also have a small export of whole frozen tuna. Another good export is prawns, which we only sell frozen. For local consumption, we produce fair quantities of smoked fish and salted fish. Both are very popular upland, because they keep much longer than fresh fish.

Our quality control starts when the fishing boats arrive at our wharf, and one of my assistants checks the freshness of the fish and prawns. We all know that fish go bad very quickly in our climate, especially the shellfish. Therefore, the quality of our processed products is determined largely by their freshness when raw.

Freezing

The prawns are caught near the coast, and usually delivered to the wharf 2-3 hours later. Immediately after the prawns have been weighed, we boil them in salted water and peel off the shells. Prawn meat is highly perishable, and even more so when still lukewarm after the boiling. We could cool it down with ice or water, but we cannot assume that the water is pure - and we would also wash out some of the flavour. We prefer to weigh the peeled prawns straight into polyethylene bags, seal the bags, put them one layer deep on trays, and get them into the freezing room immediately.

Freezing takes place much faster when the bags are placed in a single layer. It is essential to have the product pass the critical temperature zone (30 to 40^{0}C) as fast as possible.

Why is 30 to 40^{o}C described as "the critical temperature zone"?

Quality control consists of a check of the freshness of the raw fish, weighing of the finished product, a temperature check at various points of the process, and an overall time control of the process. I can assure you that the prawns will always be in the freezing room not later than 60 minutes after they arrive at the wharf. In addition to the control that we carry out ourselves, 3-5 bags of each day's production are taken out at random and sent to the Government Laboratories for bacteriological tests in order to obtain a certificate. This is because all export markets have very strict bacteriological standards for all kinds of shellfish.

The tuna is not quite as perishable as the prawns, but there is one particular problem that we have to be aware of. When tuna (or any such fish) start to perish in a hot climate, the bacteriological process will produce histamine, which can be described as a kind of toxin.

What is a toxin? (See page 11 if you don't remember.)

Once histamine is produced in the fish, it will not be destroyed by further processing. When the tinned fish is eaten, it will cause food poisoning.

Because of this we are very concerned with the freshness of the fish that we receive. Since the tuna is often caught far out at sea, we prefer to buy from fishing boats able to ice the fish. If this is not possible, we check the temperature, firmness and smell of the fish before accepting it.

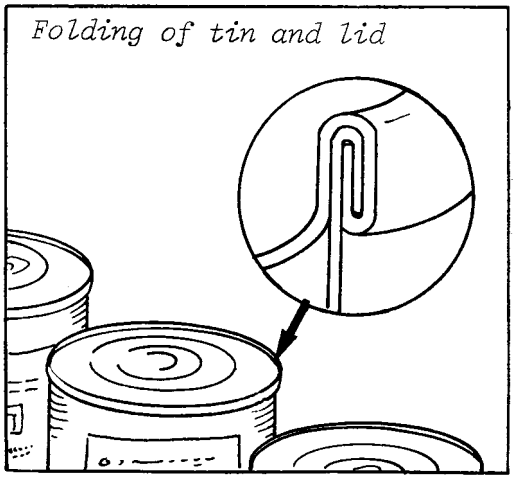
For the limited quantity we export as whole frozen tuna, we accept only absolutely fresh fish of under-average size. We wash this and take it straight into the freezing house. It is important that the fish not be too large, or it would take too long to freeze thoroughly. We would run the risk that the perishing process might continue for some time in the interior of the fish.

Canning

The majority of the tuna is tinned or canned, however. First, we cut up the fish into large chunks, we boil it and remove skins and bones. We then weigh the meat into tins and add brine (salted water) or cooking oil or tomato sauce. Once the tins are closed, they are boiled in a closed boiler (retort) under pressure. The time of the process varies depending on the size of the tin and type of liquid, but the general rule is that the temperature in the middle of the tin must reach 120^0C and be maintained for twenty minutes.

Quality control here consists of four parts; checking the fresh fish, checking the weight of the meat in the tins, ascertaining the proper closing of the tins, and establishing the sterility of the finished product.

To test the closing of the tins, we cut open a couple of tins, and in a microscope ascertain that the metal of the lid and the tin are folded into each other properly, ensuring an absolutely tight seal.



For sterility control, we use special paper test strips which are put into the retort with the tins. The paper changes colour according to the temperature to which it has been exposed. The next check involves opening a couple of tins from each batch in our own laboratories. We take samples from each and put them on a sterile 'jelly'. After 36 hours at 35^0C. there should still be no growth of bacteria on the jelly. If this is the case, we know that the product can keep good for years.

We do not process smoked or salted fish regularly. But when the fishermen run into periods of very big catches, and the supply of fresh fish exceeds the demand at the fishmarket, we offer to buy the excess fish which is suitable for such processing.

Smoking

For smoking, we select large, fat fish. We clean them, put them on long sticks and hang them in the chamber in the smoke house over a log fire. The fire is kept smoking by adding green leaves or sawdust or occasionally by sprinkling with water. We are careful to select only non-toxic and non-aromatic firewood and leaves. The temperature of

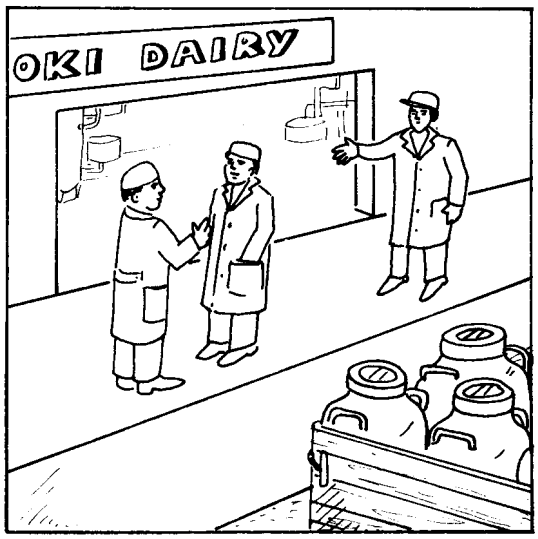
the smoke ranges between 80 and 100 ^{0}C. The process lasts 5-10 hours, depending on the size of the fish. After smoking, the fish is rubbed with salt. It will now keep good **for** about 14 days if kept under cool, dry conditions. Most of our smoked fish is offered **for** sale in th**e** interior, where the fish supply is poor.

Salting

For salting, the fish should not be too fat or too large. It is cleaned, rubbed with salt and stacked in alternating layers of fish and salt. It is left in a cold, dry storeroom for a couple of days, during which time the juice from the fish-meat will 'sweat out'. Then the fish is stacked again with fresh salt, and left in the storeroom for 2-3 weeks, depending on the size of the fish. By this time, the fish is saturated with salt. It will keep safely for about a month if kept in dry - and preferably cool - conditions. The keeping quality is not as good as that of imported salted cod because that produce is exposed after salting to a drying process under cold, dry air.

This is how we process fish at Nautic Industries. I hope you have found it interesting, and learned something which will enable you to handle fish products in your shop even better in future."

A DAIRY PLANT



"Welcome to the dairy plant of Laloki. I am the manager. Before I show you around the place, I must ask you to put on these white coats and caps.

You see, we are extremely fussy about hygiene here. All staff in our dairy wear white clothes, as you can see. That helps us to check on cleanliness. We have to be verv careful, because we know that contamination here would create big problems. For instance, if the milk should turn sour, we would lose a day's production. That would be bad enough, but it would be much worse if we contaminated the milk without noticing it, and then sold the milk to the consumers. They might then catch a disease or suffer food poisoning. Such things have happened. Unfortunately, people have even died from such 'accidents'.

The raw milk

You know that milk has excellent nutrion value for humans, but it also presents excellent living conditions for bacteria. A lukewarm liquid, full of fat, proteins, and mineral salts - what more could you wish from life if you were a bacterium?

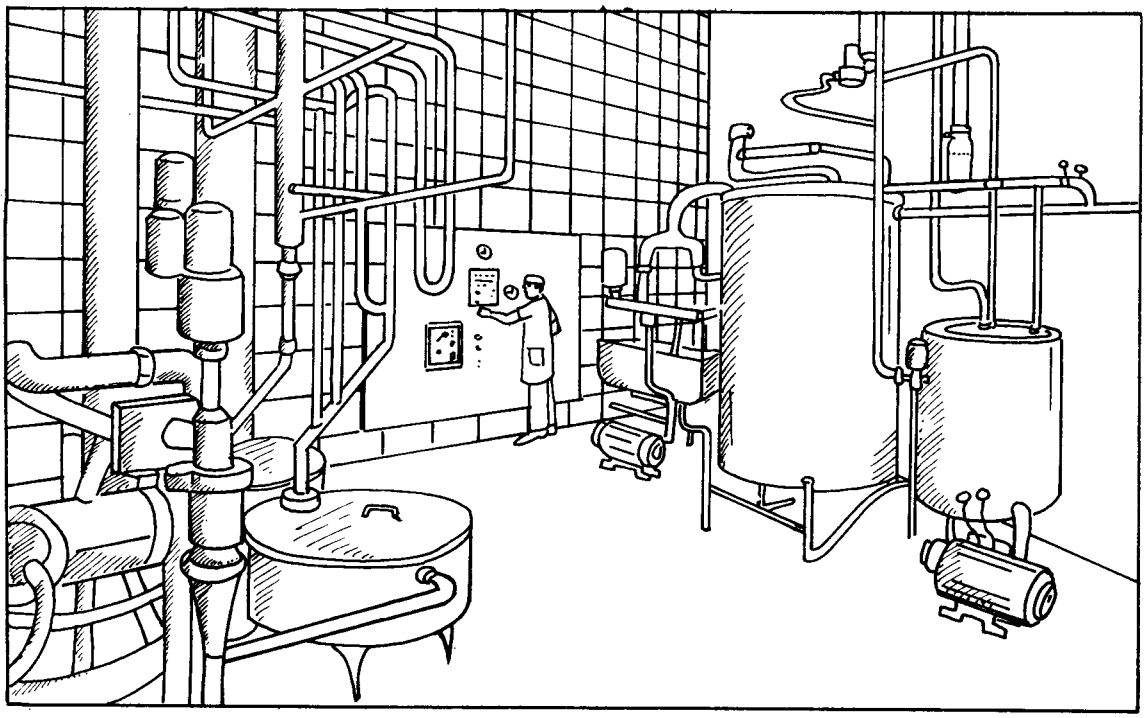
Hence, our battle against bacteria starts at the milk producers. Our main supplier is a Government Dairy Project. The project has modern milking and cooling facilities. The staff has been trained to produce a fine quality of raw milk for dairy production. We have also two co-operatives

as suppliers. To become a member, a cattle farmer must go through training in hygienic milk production; his herd must be under regular veterinary control; and he must accept that payment for the milk is based on bacteriological grading as well as quantity and percentage of milk fat.

This may appear somewhat strict, but it is certainly necessary. A reliable supply of raw milk of good bacteriological standard makes it possible for us to avoid excessive heat treatment, which would reduce the nutrition value of the milk and affect its flavour.

Processing of milk

When we receive the cooled raw milk we first centrifuge it to remove impurities - hair, straw, dust, etc. - before the heat treatment. We use a type of pasteurisation where the milk is pumped through thin tubes in a special heater. Here the milk is heated to 80^0C. for less than a second, then cooled to 65^0 C. and held at that temperature for 15 seconds, and finally cooled to 10^0C. This technique is a



compromise between the desire to kill all bacteria, and the desire not to spoil the natural flavour of the milk. What we obtain is a milk in which all bacteria which may cause disease have been killed, a milk that will keep good for a minimum of 3 days at refrigerator temperature, and a milk which has a flavour very close to that of raw milk.

After cooling, the pasteurised milk is tapped into cartons, put into cooled vans, and immediately distributed to the retailers. Here again, we are a bit fussy, only delivering milk to retailers with proper refrigeration facilities. We do not want our good product to be spoiled under a sun-shade in some market stall!

Cheese production

In cheese production, we benefit even more from the strict hygiene which we impose upon our suppliers. The raw milk for cheese production can only be subjected to a mild heat treatment, so we depend entirely on a low number of bacteria in the raw milk, and the high hygienic standards of our staff. I must say that to our staff, hygiene is not an abstract idea - it is an attitude and a way of life!

The chemistry of cheese production is simple. We add an enzyme called rennet to the milk. This causes one of the components in the milk to curdle or stiffen, retaining most of the fat and some minerals. This stiff 'jelly' separates from the liquid (the whey). The rest of the process is a matter of mechanics: getting rid of the whey, salting the raw cheese, pressing it, etc.

We use a mild pasteurisation - just below 70^{0}C· - which kills most disease-causing bacteria, but does not ruin the ability of the milk to curdle. We then add the rennet at 30°C. - a very dangerous temperature. When the whey has separated, we wash it out of the raw cheese. If certain

unintended bacteria are present at this stage, the milk will not curdle at all; if others are present, they will produce gases in the cheese later, during storage. So you see the importance of good hygiene.

We cut the raw cheese into small bits a couple of times, and heat it, as well (to 40^0C. - another dangerous temperature) in order to extract as much whey as possible. Next, we work salt into the raw cheese and put it into forms. Here, it is pressed, forcing it to stick together. The young cheese is cooled in brine and left to mature in a storeroom at a moderate temperature. It is here that the flavour of the cheese develops. Afterward, it is stored under cool conditions for a month or more, until it is ready for sale.

I hope that this has given you the impression that hygiene is an essential part of the work in a dairy plant, because that really is the case. And I also hope that you will treat our good products accordingly in the shop!

Now let's walk through the plant to see what it all looks like!"

"CHECK-OUT"

To prove to yourself that you have fully understood this Element, you should now go through the following questions. Mark what you think is the right answer to each question. If you have problems with a particular auestion, go back and read the corresponding chapter again. Your teacher will later check your answers.

1 Bacteria are:

a animals;
b plants;
c eggs.

2 Bacteria can be found:

a only in water;
b only in plants;
c almost everywhere.

3 Bacteria multiply by:

a dividing themselves;
b laying eggs;
c growing sprouts.

4 Most bacteria multiply very quickly in a temperature of

a 0^0C.;
b 30 to 40^oC.;
c 100^0C.

5 Most bacteria multiply fastest in a place which is:

a cool and dry;
b hot and humid;
c clean and cold.

6 If conditions are not suitable for bacteria, they can protect themselves and- survive for a long time by turning themselves into:

a spores (capsules);
b gas;
c enzymes.

7 Bacteria spread mainly through:

a the wind;
b their own movements;
c direct contact.

8 Cholera and typhoid fever are spread by:

a viruses;
b bacteria;
c toxins.

9 All bacteria will die in:

a boiling water;
b cool water;
c dirty water.

10 All bacteria will be killed by:

a boiling;
b deep-freezing;
c smoking.

11 The temperature in a refrigerator should be:

a o^{o} C.;
b $+6^{o}$C.;
c $+16^{0}$C.

12 The temperature in a freezer should be:

a 00C.;
b -80C.;
c -180C.

13 Yeast and mould will grow mainly in:

a humid conditions;
b very dry conditions;
c very cold conditions.

14 A piece of meat which is kept in a cold storeroom for some time will become more tender because of the effects of the

a toxins;
b vitamins;
c enzymes.

15 Tinned fish is:

a boiled under pressure in the closed cans;
b boiled quickly in open tins;
c not boiled.

16 To "pasteurise" means:

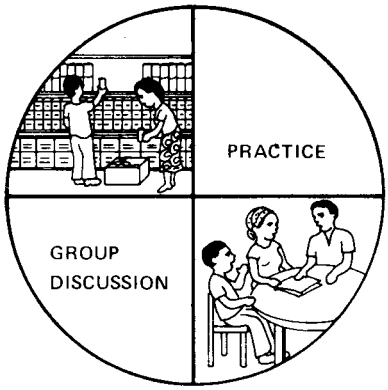
a to boil something for 80 minutes;
b to take away 80% of the licuid;
c to heat something to 80oC.

17 Pasteurisation of milk will:

a not kill any bacteria;
b kill disease-causing bacteria;
c kill all bacteria.

COMPLEMENTARY EXERCISES

To complete your studies of this topic you should take part in some of the following exercises which will be organ-ised by your teacher.

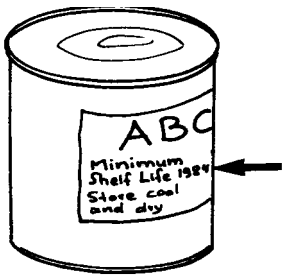


Group Exercise and Discussions:

1 Canned food

Canned food can be kept for a very long time, but only if the proper technique has been used for canning (pressure boiling). Sometimes other methods are used for canning. It is then necessary to keep the cans in a cool place and only for a limited time.

Check your stock of canned food. Read all the text on the labels carefully. Identify which products have limited shelf-life. Make a list of these, state the latest selling dates, and see to it that they are stored properly.



2 Information about expiry dates

Customers in a co-operative shop have a right to know the age of certain food products. Various methods are used to provide this information, for instance:

- the expiry date is printed on the package (which means that the contents can safely be consumed before that date),

- the date of manufacture or packing is stated on the package,
- the shop personnel inform the customers orally about the freshness of the products, when asked.

Discuss which method is safest and most satisfactory from the customers' point of view, what information you can possibly provide in your shop, and how you can improve your present information in your shop.

3 Care of fresh vegetables and fruits

Fruits and vegetables must be stored properly so that they stay fresh until sold. Different products need different treatment: some products can be kept in plastic bags, others cannot; some products should be sprayed with water, others must not. Your entire staff must learn the proper treatment of all products. Therefore, you should make a list of all the fresh vegetables and fruit you sell. Fill in the information and instructions for each product, as in the example below. Consult an expert if necessary.

Product	Common problem	Usual causes	Care/protection/ remedy
Onions	Mouldy Rotten Overgrown	Humidity and temperature too high.	Do not pack in plastic bags.
Lettuce	Drooping Rotten	Too old. Not dry when packed. Packed in tight bags.	Lettuce can be packed in airy bags.
etc.			

4 Care of fresh meat and dairy products

Make up a similar list, as in exercise 3 above, for your fresh meat and dairy products.

5 Rescue operations

Good planning and ordering systems help to keep a high rate of stock-turn for fresh food. (That means that the goods are sold soon after their arrival in the shop.) However, it is difficult to avoid having some food items remain in the shop too long. It is in everybody's interest that goods be consumed before they begin to deteriorate. Discuss what you should do in the following cases:

- You have some old containers of milk still in stock which will turn sour the day after tomorrow.
- You have, by mistake, ordered too many carrots. While probably enough for three weeks' sale, they will not keep good that long.
- At the end of the day, you have still a stock of 3 kg of minced meat. It will definitely be bad tomorrow if you don't do anything about it immediately.
- The first signs of mould have appeared on some onions. There is still about 1 kg left in stock.
- (Add some other examples, reflecting typical problems in your area and your shop.)

6 Shop study

Assess the handling of perishables in your own shop. What should be done better? How could it be done? What practical circumstances prevent you from doing it properly? Could any of these circumstances be overcome? How?