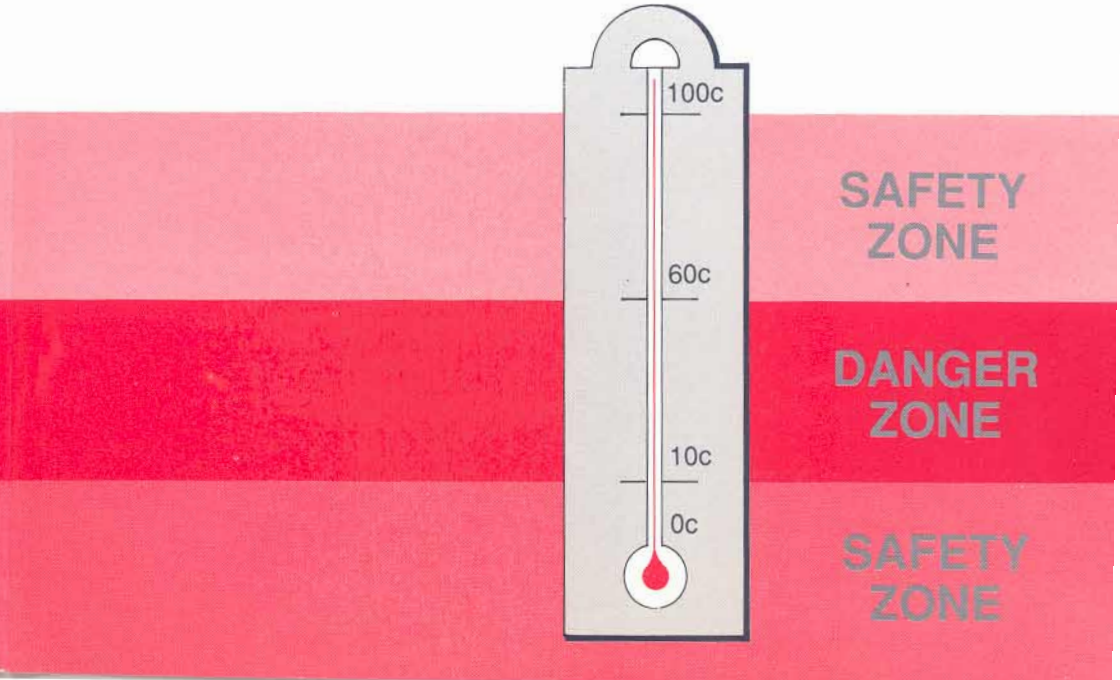
A HANDBOOK OF FOOD HYGIENE

DR. ABDULRAHMAN O. MUSAIGER



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Compiled and prepared by

DR. A.O. MUSAIGER
Assistant Professor of Nutrition
College of Medicine and Medical Sciences
Arabian Gulf University, Bahrain

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PREFACE

This handbook is intended for students in health inspection and catering programmes,other students taking short courses in food hygiene and food inspectors. Readers of this book are expected to have basic concepts of microbiology. Information presented here was extracted from several textbooks related to food hygiene and sanitation. The information provided is not exhaustive, but it serves as a concise reference on food hygiene .It can be of help in preparing seminar discussion leading the students further in the topics covered in the subjects of food hygiene.

The valuable comments made by Dr.J.W.T.Dickerson, former professor of nutrition , University of Surrey ,U.K.,is greatly appreciated.

CONTENTS

FOOD POISONING

DEFINITIONS

Food poisoning:

is a term used to describe an illness brought about by eating food or drink contaminated with harmful microbes. The symptoms are usually:

- Abdominal pains
- Vomiting
- Diarrhoea

Incubation period

This is the time that passes after the entry of the poisonous food into the body and the occurrence of the first symptoms. It ranges from two hours to about 2 days, and this depends on the kind and number of organisms.

Duration

The duration of the illness is the time between the appearance of the first symptoms of food poisoning and the clearing up of the last ones.

Vegetative state of bacteria

It is the normal state of bacteria when they are growing and multiplying.

Spores

When conditions become unfavourable for growth or multiplication, bacteria form spores inside their cells. The rest of the cells then gradually disintegrates leaving only the spores. The spore can resist very high temperatures and high concentrates of chemicals that would kill bacteria in the vegetative state.

Bacterial toxins

Exotoxin: Toxins produced outside bacteria bodies. If the bacteria growing in food produce exotoxin, then the food itself becomes poisonous. Examples of these bacteria are: Clostridium botulinum Staphylococcus aureus.

Endotoxin: Toxins produced inside bacteria bodies and these are not released until the bacteria die. When food contaminated with this type of bacteria is eaten, the bacteria become established in the digestive tract, but no ill effects occur, until a sufficient number of bacteria have died and released toxins. Examples of these bacteria are: Salmonella.

THE GROWTH REQUIREMENTS OF FOOD POISONING BACTERIA

1. Warmth
- Bacteria grow best at 37°C
- The majority will multiply between 15°C and 45°C except for C. perfringens, which grows at temperature upto 47°C.
- Above 63°C bacteria will be killed.
- Below 7°C reproduction of bacteria will slow down.

2. Food
- Bacteria causing food poisoning grow best on the food most palatable to human beings.
- Protein nature foods such as meat (especially pre-cooked and made-up dishes), poultry, milk, egg-products, gravy, cream and fish, are the most susceptible foods.

3. Moisture
- Like all living things bacteria require moisture for growth.
- Cold cooked meats contain sufficient moisture

to support growth, whereas dried food-stuffs such as dried milk powder, custard powder, bacteria will survive but remain until there is sufficient water added to revive them.

4. Time
- Bacteria need adequate time before their numbers are sufficient to cause illness.

5. Hydrogen Ion concentration (pH)
- Most bacteria favour a pH near neutrality or slightly on the alkaline side (6.8-7.5).
- Some prefer a lower pH(4-6), and usually this condition is created by the bacteria producing acids from carbohydrates.

TYPES OF FOOD POISONING

The types of food poisoning can be grouped on the basis of the causative agent.

Bacterial food poisoning

Most of food poisoning cases are caused by bacteria. However, it is important to distinguish between bacterial food poisoning and foodborne bacterial infection. Bacterial food poisoning is caused by pathogenic bacteria which by their heavy growth induces illness by one means or another after ingestion of the food. While in foodborne illness, the food merely acts a carrier for the causative organism which does not require to multiply in the food.

In bacterial foodborne illness, a minimum infective dose (MID) of bacteria or toxin is needed to cause illness. If a person consumes less than the minimum infective dose he or she may become a carrier.

Fungi food poisoning

This type of food poisoning is caused by the ingestion of poisonous metabolites (mycotoxins) which are produced by fungi

growing in food. There are several types of fungi which produce mycotoxins, and of these the aflatoxins are the most important. Aflatoxin is a poisonous substance produced by a mould Aspergillus flavus. There are four main components of aflatoxin designated B_1, B_2, G_1 and G_2. Many foods have been found to support the growth of aflatoxin such as nuts (especially peanuts), soyabeans, various ground spices, rice and maize.

Viral food poisoning

Viruses are smaller than bacteria, and some have capsules or outer coats to protect them. Viruses require living tissue for growth and therefore are unable to multiply in food. The food can only act as a vehicle for the transmission of viruses. They are destroyed by the normal heat treatment applied in routine cooking procedures. So their spread from human carriers, uncooked food, and from water to food is important. Viruses which infect by being ingested are termed 'enteroviruses'. They multiply in the intestines of the infected person and large number of them may be produced. Two viruses which are important agents of human infection and which are transmitted by food are hepatitis A and poliomyelitis.

Hepatitis A

The most common food-associated virus disease. The long incubation time (10-50 days) makes it difficult to investigate the cause of outbreak. The symptoms are fever, nausea, abdominal pain, followed by jaundice. Foods commonly involved in outbreaks are shellfish from polluted water, fruits and vegetables (contaminated by faeces) milk and various types of salad prepared under poor hygienic conditions.

Animal toxins and parasitic infections

Some fresh water and marine animals are toxic to humans even when consumed fresh (natural toxicity). Also, some marine foods may become toxic because in life they have consumed other forms of toxic marine life or as a result of microbial action after death (secondary toxicity). Among animals that are naturally are toxic to humans, Puffer fish, and Moray Eel.

Many foods such as pork, beef and marine foods may be infected with animal parasites. Contamination may occur from hand to food or directly from polluted water. Problems arise when people consuming raw meat or fish or drinking untreated water. The most common parasites are Entamoeba histolytica, Giardia lamblia and tapeworms.

Plant food poisoning

There are many plants which naturally contain substances which are toxic to man. Generally these plants are eaten by accident (mistaken for a similar variety). Examples of such plants are toadstools, hemlock, deadly nightshade, and rhubarb leaves. Certain fungi are extremely poisonous or produce toxic substances. The most common are those that act on the liver and kidney causing severe tissue damage.

It is worth mentioning that there are three plants which are commonly consumed by human and have poisonous parts to them; (1) the seeds of apples can be fatal if consumed in large numbers; (2) the tuber sprouts and peelings of potatoes contain an alkaloid called solanine and can also prove fatal, and (3) the leaves and stalks of rhubarb, which contain oxalic acid, may result in death.

Naturally occurring toxic substances in food are not removed by safe food handling practices.

Chemical food poisoning

The food is contaminated by chemicals which are poisonous. Chemical contamination of food is much less common than bacterial contamination. This kind of contamination is often caused due to careless storage of harmful chemicals (pesticides, detergents, etc.) leading to spillage or leakage. Many foods that consumed are contain chemicals that would prove harmful if consumed in substantially greater amounts. Therefore, there is a threshold level for these chemicals and provided that this level is not exceeded no harm is done as the chemicals are excreted or rendered innocuous in some other way.

Chemical food poisoning can be as a result of the containers or cooking utensils used to prepare foods such as zinc poisoning from galvanized iron containers used for stewing or storage of acid fruit. Other important metals that my contaminate food include cadmium, copper, arsenic lead and mercury.

THE GROWTH RATE OF BACTERIA

As stated earlier bacteria need time to multiply and grow. When bacteria are added to a fresh medium there is a period during which little, or no growth occurs. This is called the lag phase and during this period the cells increase in size and produce new materials but active division does not take place. The duration of this period is variable but the average is two hours.

The next phase of growth is called the logarithmic (log) phase, which is characterized by a constant and rapid growth. During this phase

each cell of bacteria is multiplicating itself in the same time and is constant in its size. When the surrounding environment was changed, mainly due to the growth of the bacteria causing depletion in nutrients and accumulation of waste products, the growth rate will decrease until the bacteria enter the stationery phase. The final phase of bacterial growth is called death phase, where the number of dead cells exceeds the number of live cells.

In summary:

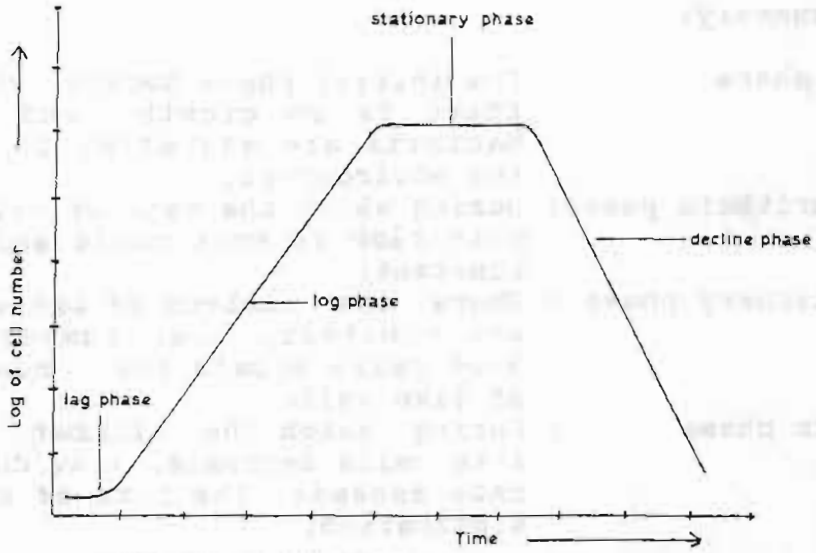
Lag phase	:	The initial phase during which there is no growth, and the bacteria are adjusting to the new environment.
Logarithmic phase	:	During which the rate of multiplication is most rapid and is constant.
Stationery phase	:	Where the numbers of bacteria are constant, i.e. number of dead cells equals the number of live cells.
Death phase	:	During which the number of live cells decrease, i.e. death rate exceeds the rate of multiplication.

Application of growth curve in food hygiene

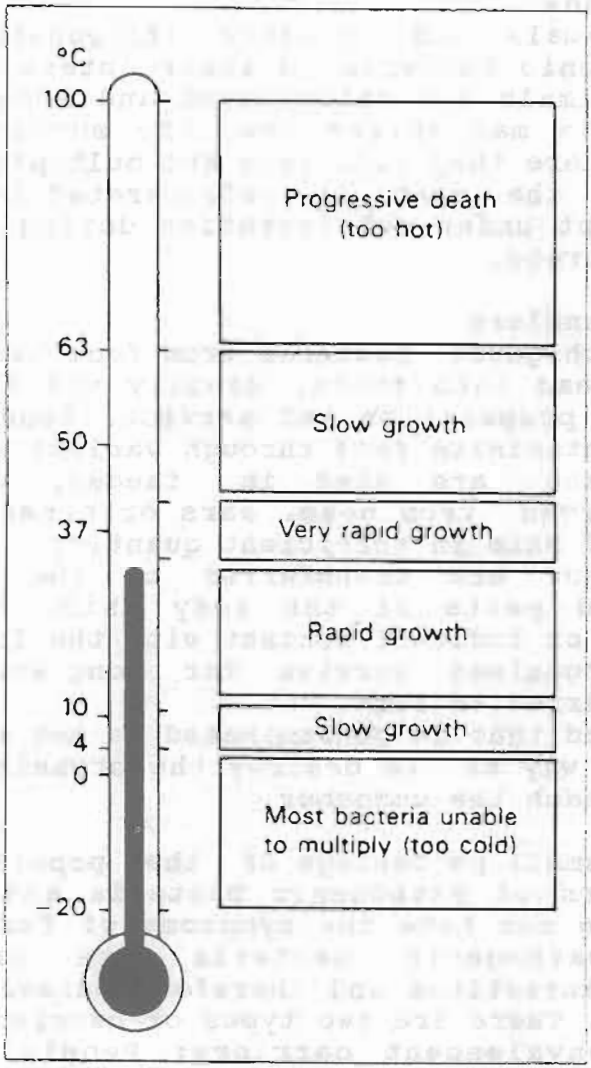
Especially important in Food Hygiene (i.e. prevention of spoilage) is the lengthening, as far as possible of the lag phase. This can be achieved in different ways:

- By reducing the amount of contamination, the fewer organisms there are present, the longer will be the lag phase.
- By avoiding the addition of actively growing organisms (from logarithmic phase of growth). Such organisms might be growing on unclean containers, equipment or utensils that come in contact with foods.

- By one or more unfavourable environmental conditions; unfavourable foods, moisture, temperature, pH or presence of inhibitors.



Growth curve of bacteria showing the four phases of growth, viz. lag, logarithmic or exponential, stationary, and decline or death.



Growth of Food Poisoning Bacteria at Different Temperatures

SOURCES AND TRANSMISSION OF FOOD CONTAMINANTS

1. Raw Foods

Animals and poultry frequently carry pathogenic bacteria in their intestines. When the animals are salughtered and dressed these bacteria may spread over the surface of the meat where they will grow and multiply rapidly, unless the meat is refrigerated immediately and kept under refrigeration during transport and storage.

2. Food Handlers

Pathogenic bacteria from food handlers can be spread into foods, usually via the hands, during preparation and service. Food handlers may contaminate food through various ways:

- Pathogens are shed in faeces, urine or discharged from nose, ears or other areas of exposed skin in sufficient quantity.
- Pathogens are transferred to the hands or exposed parts of the body which come into direct or indirect contact with the food.
- The organisms survive for long enough to be transferred to food.
- The food that is contaminated is not treated in such a way as to destroy the organisms before they reach the consumer.

A small percentage of the population are carriers of pathogenic bacteria and although they do not have the symptoms of food poisoning, pathogenic bacteria are present in their intestines and therefore passed in their faeces. There are two types of carrier:

(1) Convalescent carriers: People who have recently had food poisoning and although they are now perfectly fit again, they continue to pass small numbers of the pathogenic bacteria, which caused the illness, in their faeces.

(2) Healthy carriers: People who have not suffered the symptoms of food poisoning but nevertheless are carrying the pathogenic bacteria in their intestine.

3. Animals and Insects

Flies, rats, mice, birds, other insects and other animals frequently carry pathogenic bacteria in their intestines and on their feet and fur.

4. Dust

Soil contains spores of certain bacteria and additional bacteria will be present if the soil is contaminated with bacteria.

5. Cross-contamination

Cross-contamination is the transfer of bacteria from one contaminated source (usually raw foods) to another uncontaminated source (usually freshly cooked food).

Causes of Cross-contamination

- Using a chopping board, a working surface or other equipment without washing them thoroughly between each use.
- Using a knife or other utensils without washing them thoroughly between each use.
- The hands of the food handlers which are not washed in between preparing different types of foods.
- Incorrect positioning of foods in refrigerators.

Main causes of food poisoning

- Preparation of food too far in advance
- Storage at ambient temperature
- Inadequate cooling
- Reheating precooked food
- infected food handlers
- undercooking

- Contaminated process food (excluding canned food)
- Inadequate thawing
- Cross-contamination
- Improper warm holding
- Use of leftover foods
- Raw food consumed
- Extra large quantity prepared
- Contamination of canned food
- Unknown

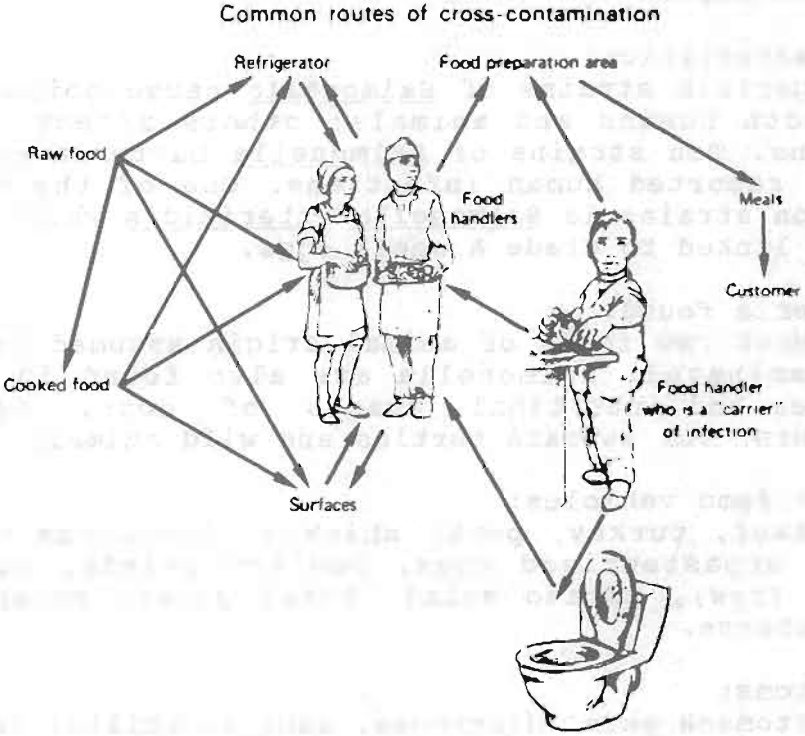
Reasons for the increase in the number of reported cases of food poisoning

- An increased tendency to 'eat-out'
- A much more varied menu (different kinds of dishes)
- An increasing number of shops selling 'take-away' meals
- Large scale factory production of food
- An increased tendency to shop and cook several days in advance of eating.
- Untrained staff
- Lack of health awareness

FOODS MOST LIKELY TO CAUSE FOOD POISONING

1. Foods which encourage the growth of bacteria:
- Raw and cooked meat and poultry including those with a meat-base e.g. soup, gravy and made-up dishes.
- Milk and milk products
- Eggs and egg products
- Fish and seafoods
- Cooked rice

2. Foods and liquids which are usually safe
- water (chlorinated)
- Milk (pasteurized or sterilized)
- Jams, syrup, honey (high sugar content)
- Pickles, soft drinks (an acidic pH)
- Flour, bread, fats (low water content)
- Most canned foods (heat processed)
- Frozen foods (held at very low temperatures and safe if kept frozen)



BACTERIA THAT CAUSE FOOD POISONING

A few types of bacteria are responsible for most cases of food poisoning. Some people are more vulnerable to food poisoning than others. Infants, young children and old people are generally most at risk. Others at risk include those with health problems and the malnourished. Genetic differences may make some persons more susceptible than others.

Salmonella

Salmonella bacteria continually cycle through the environment in the intestinal tracts of humans and animals.

Characteristics:

Certain strains of Salmonella cause poisoning in both humans and animals; others affect only humans. Ten strains of Salmonella bacteria cause most reported human infections. One of the most common strains is Salmonella enteritidis which has been linked to Grade A shell eggs.

Bacteria found:

Most raw foods of animal origin assumed to be contaminated. Salmonella are also found in the faeces and intestinal tracts of dogs, cats, rodents, and certain turtles and wild animals.

Major food vehicles:

Beef, turkey, pork, chicken, ice-cream made with unpasteurized eggs, poultry salads, eggs, milk (raw), potato salad, baked goods, macaroni and cheese.

Symptoms:

Stomach pain, diarrhoea, nausea, chills, fever or headache that normally appear within 6 to 48 hours after eating and may last 3 to 5 days.

Prevention and control:

Thoroughly cook all meat, poultry, fish and eggs. Avoid contaminating other foods with juices from raw meat or poultry via counters, utensils, hands or serving plates. Don't drink unpasteurized milk.

Staphylococcus aureus

Staphylococcus aureus intoxication is one of the most common cases of food poisoning and occurs when S. aureus bacteria multiply and form toxin in cooked food is usually high in protein.

Characteristics:

Bacteria do not form spores. Prefer cooked food high in protein. Grow well in food high in sugar or salt, which inhibit growth of more sensitive organisms.

Bacteria found:

Skin, noses and throats of more than 50% of healthy people. Bacteria common in infected cuts, pimples, and acne; may be exhaled during talking, coughing and sneezing. Bacteria also common on animal hides.

Major food vehicles:

Ham, turkey, chicken, pork, roasted beef, chicken and turkey salads, potato salad, cream-filled pastry, other meats, other salads (crab, macaroni, tuna), eggs and egg salad, custard, luncheon meats and hot dogs.

Symptoms:

Abdominal pain, nausea, vomiting and often diarrhoea; occasionally, fever (or subnormal temperature), chills, headache, weakness and dizziness. Symptoms usually appear 30 minutes to 8 hours after eating and may last one or two days.

Prevention and control:

Wash hands and utensils before preparing and serving food. Prompt refrigeration of cooked food in shallow, covered containers, prevents the proliferation of bacteria and the formation of toxin. Thorough cooking destroys bacterial cells, but the toxin is resistant to heat, refrigeration, freezing, and chemicals such as nitrite. Avoid leaving cooked food at room temperature more than 2 hours.

Clostridium perfringens

Clostridium perfringens bacteria are anaerobic and may be present as either a vegetative cell or a spore. The vegetative cells produce the toxin that causes illness. The toxin is usually formed in the body, but evidence shows it may sometimes form in food. While thorough cooking will kill the vegetative cells, some of the spores may survive. At temperature 4 and 50°C the spores can become vegetative and produce toxin.

Characteristics:

Require anaerobic, or oxygen-free conditions for growth. Under the right conditions, they grow very rapidly. Vegetative bacterial cells are easily killed by normal cooking. Bacterial cells cannot reproduce at recommended refrigeration temperatures of 4°C or below.

Bacteria found:

Present in soil, sewage, dust, and the intestinal tracts of most animal and humans.

Major food vehicles:

Improperly prepared roast beef, turkey, other meat dishes, pork, chicken, and cooked ground meat.

Symptoms:

Diarrhoea and gas pain, rarely vomiting or fever that appear within 9 to 15 hours and usually last one day. Elderly people and ulcer patients can be affected more seriously.

Prevention and control:

Divide large portions of cooked foods such as beef, turkey, gravy, dressing, stews, and casseroles into smaller portions for serving and cooling. Keep cooked food above 60°C or cold at 4°C or below during serving. Thoroughly cooking, rapid and even cooling, and thoroughly heating are also necessary to destroy these bacteria or prevents their growth. Reheating leftovers thoroughly.

Clostridium botulinum

Botulinum poisoning is caused by ingestion of Clostridium botulinum neurotoxn in food. It is one of the most deadly causes of food poisoning. The neurotoxin is formed when heat-resistant, dormant spores of C. botulinum Type A, B, E, or F survive and germinate during storage.

Characteristics:

It is anaerobic and may be present either as a vegetative cell or a spore. The vegetative cells produce the toxin that cause poisoning. At temperatures above 3°C the spores can become vegetative and produce toxin. Types A, B, and F are a concern in low-acid canned foods. Types vary in intolerance to salt, water activity, and minimum temperature required for growth. In general, toxins are most likely to form in high-moisture, low-salt, low-acid foods devoid of oxygen and stored above 3°C.

Bacteria found:

Bacteria are present throughout the environment, including rotting vegetation, soil, forests, the bottoms of streams, lakes, and coastal waters, crabs and shellfish, faeces and carcasses of birds and animals.

Major food vehicles:

The risk of botulism has long been associated with canned foods that are not processed to a high enough temperature to kill all the spores. More recently, it has been associated with cooked foods held at room or warm temperature for an extended time under conditions where oxygen is limited. Foods commonly involved in botulism are peppers and pepper sauce, asparagus, beans (green, lima, salad, soy), salmon and fish eggs, tomatoes and tomato juice, beefs, improperly fermented fish, pickles/relish, and baked potatoes and potato salad. Meat loaves, pot pies and stew left at room temperature or in unheated ovens overnight.

Symptoms:

Botulism toxin affects the nervous system and can be fatal if not treated. Symptoms usually occur 12 to 18 hours after food consumption, but may start 8 days later, and last 1 to 10 days. Symptoms include dry mouth, double vision, difficulty in focusing on near point, trouble speaking and swallowing and difficult breathing. Many victims also suffer from nausea, vomiting, abdominal cramps, diarrhoea, sore throat, or dizziness. Later, constipation, weakness and muscle paralysis occur . Without treatment, a patient can die of suffocation because the nerves no longer stimulate breathing. There are antitoxins, which have reduced the number of deaths from botulism, but patients may suffer nerve damage, and recovery is often slow.

Prevention and control:

Divide large portions of cooked foods into smaller portions for serving and cooling. Keep cooked foods hot at 60^{o}C or above or cold at 4^{o}C or below. Reheat leftovers thoroughly to an internal temperature of at least 70^{o}C before serving. Outbreaks of botulism are rarely associated with commercial canned products. Thorough heat processing, nitrite and salt, acidification,

and proper drying are used to prevent botulism from processed products. Home canners should follow established guides for canning. Boil low-acid home-canned foods for 10 minutes. Do not taste from leaking, bulging or damaged cans; from cracked jars or jars with loose or bulging lids; from containers that spurt liquid when opened; or any canned food that has an abnormal odour or appearance. Refrigerate cooked foods in covered, shallow containers within 2 hours after serving. Ensure that steam tables keep cooked food above 60°C during serving.

Campylobacter jejuni

Campylobacteriosis occurs after live bacteria are ingested.

Characteristics:

Prefer low-oxygen environments, and will survive longer in foods at refrigeration temperature than at room temperatures. C. jejuni are fragile and do not grow well in the presence of harmless bacteria usually found on raw food.

Bacteria found:

Present in raw or undercooked meat, poultry and shellfish. Also common in intestinal tracts of chickens, turkeys, cattle, swine, sheep, dogs, cats, rodents, monkeys, some wild birds, and some asymptomatic humans, have been found in water, soil and sewage sludge.

Major food vehicles:

Raw milk, poultry, meat and eggs, untreated drinking water.

Symptoms:

Fever, headache, and muscle pain, followed by diarrhoea (sometimes bloody), abdominal pain, and nausea that appear 2 to 20 days after

food consumption and may last 1 to 10 days. Complications can include meningitis, urinary tract infection, and reactive arthritis.

Prevention and control:

Thoroughly cook all meat, poultry and fish. Thoroughly clean hands, utensils and surfaces that touch raw meats. Avoid drinking raw milk or untreated water. Practice good personal hygiene and kitchen sanitation to prevent possible recontamination of cooked food by bacteria in human faeces.

Escherichia coli

Several strains of E. coli bacteria, frequently associated with faeceally contaminated water, have long been known to cause diarrhoea in infants and travelers. A toxin of the serotype E. coli 015:H7 causes hemorrhagic colitis. Most often the toxin probably forms in the intestinal tract after an unknown number of the bacteria are ingested, but some speculate that the toxin may also form in food. Person-to-person transmission also appears to be possible.

Characteristics:

The bacteria are easily destroyed by heat, but grow slowly at temperature of 7°C and above.

Bacteria found:

Pork, poultry, raw ground beef and lamb, and unpasteurized milk.

Major food vehicles:

Ground beef and raw milk.

Symptoms:

Severe abdominal cramps, followed by diarrhoea (often bloody), nausea, vomiting and occasionally a low-grade fever. A possible complication is hemolytic uremic syndrome (HUS), a urinary tract infection that is a leading cause of acute kidney

failure in children. Symptoms generally begin 3 to 4 days after food is consumed and last up to 10 days.

Prevention and control:

Thorough cooking and reheating, good sanitation, and refrigeration at 4°C or below.

Listeria monocytogenes

Characteristics:

L. monocytogenes are relatively resistant to salt and heat, but post-processing contamination rather than failure of heating or pasteurizing processes is usually suspected when the bacteria are detected on processed products.

Bacteria found:

They are common in intestines of humans and animals, cow and human milk, improperly fermented silage, leafy vegetables, soil and food processing environments. Also they can be found in pasteurized cheese, ice-cream, raw meat and processed meat, raw and cooked seafood, and vegetables, including pre-cut and packaged vegetables.

Major food vehicles:

Cabbage, soft cheese, turkey frankfurter, raw processed and ready-to-eat products.

Symptoms:

Listerrosis is a rare potentially fatal disease. Symptoms in adults include the sudden onset of flu-like symptoms such as fever, chills, headache, backache and sometimes abdominal pain and diarrhoea. Symptoms in newborns include respiration distress, refusal to drink and vomiting. Possible complications include meningitis or meningo-encephalitis, which affects

tissues around the brain or spine, and septicemia, which is blood poisoning. Listerrosis can cause spontaneous abortions and stillbirths.

Prevention and control:

Avoid raw milk, and cheese made from unpasteurized milk. Pregnant women and other high-risk groups are advised to carefully observe "keep refrigerated" and "sell by" and "use by" dates on processed products, and to thoroughly reheat frozen or refrigerated processed meat and poultry products before consumption.

Yersinia enterocolitica

Poisoning due to yersiniosis infection is caused by ingestion of an unknown number of Y. enterocolitica bacteria. The bacteria are difficult to culture from human stools, so the disease is believed to be underreported.

Characteristics:

The bacteria form toxin, but the relationship of the toxin to the illness is still being studied. Yersinia bacteria can grow slowly at refrigerator temperatures.

Bacteria found:

The bacteria are common in swine and swine waste. They have been isolated from many wild and domesticated animals, seafood, milk, fruit and vegetables.

Major food vehicles:

Chocolate milk, milk, other dairy products, mussels, toffee, oysters, and contaminated water.

Symptoms:

Abdominal pain (in the lower right quadrant, mimicking appendicitis), fever, diarrhoea

(often bloody), and sometimes vomiting. Symptoms occur within 1 to 7 days after food consumption and last 1 to 2 days. Children are most at risk for contracting the illness. Elderly and those with weakened immune systems are most at risk for complications such as arthritic or anaemic conditions, heart problems,and occasionally meningitis.

Prevention and control:

Foods should be thoroughly cooked and reheated. Sanitation and personal hygiene are essential control measures.

Bacillus cereus

Bacillus cereus produces a toxin. When the food is consumed the toxin irritates the stomach lining causing the illness.

Characteristics:

B. cereus bacteria are anaerobic and can form spores when conditions are unfavourable for growth. The spores are not easily destroyed by heat and will survive most cooking processes. They do not multiply but if the food is cooled slowly or kept warm ($10^{\circ}C$-$63^{\circ}C$) for some time before serving, they will germinate producing vegetative bacteria which multiply rapidly at these temperatures and produce a very heat-resistant toxin.

Bacteria found:

Soil, dust, cereals and spices.

Major food vehicles:

Reheated rice is almost always the cause of B. cereus food poisoning.

Symptoms:

Vomiting, abdominal pains, and occasionally diarrhoea. Symptoms usually appear 1 to 5 hours after eating and last 6 to 24 hours.

Prevention and control:

Cool cooked food rapidly and refrigerate promptly. If reheating is necessary, reheat rapidly and thoroughly and then serve quickly. Never reheat rice more than once.

Limiting conditions for multiplication of some common foodborne pathogenic bacteria

Organism	Temperature (°C)			pH
	Minimum	Maximum	Optimum	Minimum
Bacillus cereus	5	49	30	4.4–4.9
Campylobacter jejuni	30	45	42–43	4.9
Clostridium botulinum				
Group I, A, B, F	10	48		4.6
Group II, B, E, F	3.3	45	--	5.0
C. perfringens	15	50	43–45	5.0
Escherichia coli	15		37–45	5.0
Listeria monocytogenes	0	45		4.0
Salmonella spp	5.2	45.6	43	4.1–4.5
Shigella spp	-		37	
Staphylococcus aureus	6.7	45	35–37	3.8–4.5
Vibrio cholerae	10–15	43	37	5.0
V. parahaemolyticus	5	43	37	5.0
Yersinia enterocolitica	0	-	32–34	6.8

EXAMPLES OF TYPICAL FOOD POISONING OUTBREAK

Food poisoning outbreak at home

On 15 May 1983, about 45 individuals were invited to a luncheon party at a private house. The meal consisted of chicken, rice and fruit. The chickens were purchased on 13 May from a local market, slaughtered, cleaned and brought to the house, and kept in the freezer. On 15 May, at 10.00 a.m. the frozen chickens were thawed and the meal prepared. At 1.30 p.m. on the same day the meal was served to the guests. From 10.00 p.m. onwards that day 26 guests (56%) had diarrhoea, abdominal pain and vomiting. Stool specimens were taken from 21 patients and it was found that 90% were positive for Salmonella infantis Group C. The incubation period ranged from 9 to 30 hours Inspection of the poultry shop showed that the hygienic conditions were very poor, indicating a high risk of contamination of the chickens during processing. Further investigations revealed to that the frozen chicken were not properly thawed, and that the cooking time was inadequate. Furthermore, the chickens were cooked in bulk which did not allow sufficient heat to penetrate the entire mass.

Food poisoning outbreak at school

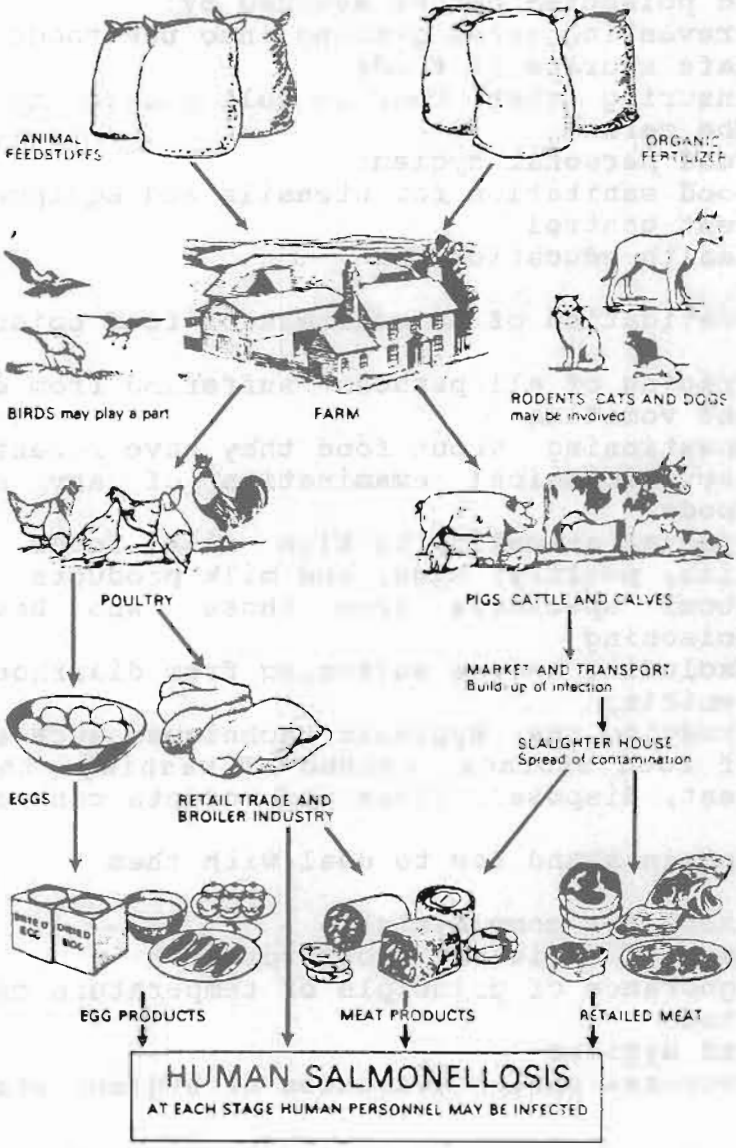
On 15 October 1985, an outbreak of food poisoning took place in a boys' school. A total of 24 pupils had symptoms of nausea, vomiting and abdominal pain after eating foods purchased from the school canteen. Investigation showed that the foods provided by the canteen were sandwiches of eggs, cheese, liver, minced meat, falafel (broad

beans with onions, spices and oil) and foul mediums (broad beans with oil). The food establishment which supplied the canteen was inspected and found to be deficient in hygienic standards. Moreover, the foods were prepared 4-6 hours before serving and kept at room temperature. Examination of the food handlers revealed that one of them had a coccus aureus which was isolated from the lesion. S. aureus was also isolated from the nasal swab of another food handler. Microbiological tests of foods showed a growth of S. aureus in eggs, falafel and liver sandwiches. Results of analysis of the food demonstrated that egg sandwiches had the highest attack rate (32%) followed by minced meat (27%), liver (18%) and chicken (14%) sandwiches.

Food poisoning outbreak at hotel

On 4 June 1986 an outbreak of food poisoning occurred at a wedding party in a five star hotel. Of the 200 persons who attended the party 105 (53%) developed symptoms of food poisoning pain, headache, high fever, nausea, and/or vomiting. The median incubation period was 11 hours About 75 patients sought medical care, 13 requiring an intravenous drip. Salmonella serotypes Norwich group C1 and Salmonella Paris group C3 were isolated from stools of the 13 patients. All the food handlers (14) were examined, and Salmonella was isolated from stool specimens of ten food handlers (71%). Analysis of the food histories showed that cold roast beef, chicken curry, grilled chicken, cold turkey, cold roast chicken and cold fish were the foods most likely to be responsible for the outbreak. It was found that cold foods were prepared at noon on the same day of the party. The food was then kept in chillers with temperature ranging from 8°C to 10°C, until the party began at 7.00 p.m.. Chickens were also prepared at noon and kept warm in water heated containers until served. Inspection revealed that raw and cooked food were processed on the same

table and using the same cutting equipment and utensils, providing ample opportunity for cross contamination.



Spread of salmonella contamination

PREVENTION OF FOOD POISONING

Food poisoning can be avoided by:
- Preventing germs getting into the foods
- Safe storage of foods
- Ensuring that food is well cooked (to destroy the germs)
- Good personal hygiene
- Good sanitation for utensils and equipment
- Pest control
- Health education

Investigation of an outbreak of food poisoning

- Tracing of all persons suffering from diarrhoea and vomiting
- Questioning about food they have recently eaten
- Bacteriological examination of any suspected foods
- Special attention to high risk foods such as fish, poultry, eggs, and milk products
- Stool specimens from those who have food poisoning
- Excluding anyone suffering from diarrhoea or/and vomiting
- Studying the hygienic techniques such as method of food storage, method of washing the equipment, disposal, flies and rodents control.

Complaints and how to deal with them

Reasons for complaints:
- Lack of efficient stock rotation
- Ignorance of principle of temperature control of food
- Bad hygiene
- Increase public awareness of hygiene standard

Main causes of complaints:
- Infestation: factory, retailer, consumer home
- Foreign matter manufacture, preparation
- Deterioration, mould, rancid
- Sub-standard, damage, parks, compositions
- Incorrect article - error
- Chemical contamination, cleaning liquid for bottling plant
- Metal from cans
- Stored disinfection

Food complaints - Action by Health Department
- Complaint received immediate investigation
- Visit shop or restaurant
- Interview manager, explain
- Check stock
- Seize or purchase similar stock
- Contact manufacture (if appropriate)
- Arrange with code or other indication of dates of manufacturers
- Obtain full statements for complaints
- Decision - reprosecution or warning letter
- Court hearing
- Revisit to check methods

Criteria used for decision
- Evidence of negligence (faulty stock rotation, infestation or faulty refrigeration).
- Degree of risk of food poisoning (extent of mould, decomposition type of food meal)
- Willful intention to deceive (food sold in bad quality)
- Previous convictions

Hazard analysis critical control point evaluation(HACCP)

The hazard analysis critical control point (HACCP) concept is a systematic approach to the identification, assessment and control of hazards.

This system offers a rational approach to the control of microbiological hazards in foods, avoids the many weaknesses inherent in the inspectional approach and circumvents the shortcomings of reliance on microbiological testing.

Main components of the HACCP system

The HACCP system comprises the following sequential steps:

1. Identification of hazards (unacceptable contamination) and assessment of the severity (magnitude) of these hazards, and their risks (probability of a hazard occurring), associated with growth, harvesting, processing, manufacture, distribution, marketing, preparation and/or use of a raw material food product.
2. Determination of critical control points (CCPs) at which the identified hazards can be controlled.

   Critical Control Points (CCPs) is an operation (practice, procedure, location or process) at which control can be exercised over one or more factors to eliminate, prevent or minimize a hazard.
3. Specification of criteria that indicate whether an operation is under control at a particular critical control point.

   Criteria are limits of characteristics of a physical (e.g. time or temperature), chemical (e.g. concentration of salt or acetic acid), biological or sensorial nature.
4. Establishment and implementation of procedures

to monitor each critical control point to check that it is under control.

Monitoring involves the systematic observation, measurement and/or recording of the significant factors for control of the hazard.

Application of the HACCP approach

The HACCP approach can be applied to food safety in homes, food industries, and food service establishments.

Unlike most traditional food-inspection activities, the HACCP approach is based on an understanding of the factors that contribute to outbreaks of foodborne disease and an applied research on the ecology, multiplication, and inactivation of foodborne pathogens.

PERSONAL HYGIENE

Hand washing:

Hand must be washed immediately after: visiting the toilet, blowing the nose, handling raw meat, poultry or vegetables, handling refuse or contaminated foods, smoking, handling pet animals or birds.

Nails:

Short unvarnished and clean. Nail brushes can be sterilized.

Towels:

Disposable paper towels is the best. Communal roller towels should never be used.

The skin:

Cuts, burns and other raw surfaces can harbour staphylococci and require to be covered by a water-proof dressing; to prevent the passage of bacteria and inwards from fluids, e.g. meat juices, washing water.

Personal habits:

The following practices should be avoided during preparation of foods:

- Sneezing or coughing
- Finger licking
- Nose picking or just fingering (use paper handkerchiefs).
- Smoking
- Spitting
- Hair should be covered (by hats)
- Protective clothing should be light, coloured and changed frequently.

DESIGN AND CONSTRUCTION OF FOOD PREMISES

General principles
- Premises must be large enough.
- Separation of preparation of raw and cooked food
- All fittings and equipment should be simple as possible.
- The bottom shelves should be at least 30 cm from the ground.
- No space between tiles and walls to prevent harbourage for insects and vermin.
- No openings for rats and other vermin.
- Proper lighting and ventilation.
- Floor drainage must be of adequate size.

Ventilation
- Adequate ventilation to take out fumes
- Fixing hoods over stoves
- Using extractor fans
- Windows used for ventilation should be screened.

Lighting
- Good lighting to prevent strain of staff's eyes
- Natural light is preferable to artificial light
- Good lighting is necessary to enable the staff to see the dirt.

Water supply
- Hot and cold water
- Heater should meet the requirements.
- Toilets must not be in direct contact with food rooms.
- Hand washing facilities, depends on staff/ customers.
- Toilets must never be cleaned by food-handlers

Floors
- Easily cleaned
- Smooth but not slippery
- Even
- Without cracks or open joints
- Impervious
- Should be washed with very hot detergent water.

Ceilings
- Free from cracks and flaking
- Not able to harbour dirt and grease

Doors and windows
- Should fit correctly and be clean
- The glass should be clean inside and out
- Self closing doors
- Fly-proofed windows

Food storage
- A vermin-proof larder
- Solid impervious floor
- Smooth impervious walls
- Fly-proofed windows
- Impervious shelving

Cleaner's cupboard
- Cleaner's equipment must not be stored in food rooms.
- A separate storage cupboard should be provided.
- A separate slop sink may be necessary for disposal of waste water.

Staff room
- separate room for clothing.
- Use of heated clothes lockers.

THE DESIGN OF EQUIPMENT

General principle
- To be thoroughly clean.
- Shall not be absorbent.
- Shall not present any risk of contamination to the food.
- Must be made from materials that are smooth, impervious and capable of being readily cleaned
- Stainless steel.

Chopping blocks
- Made of denser, heavier type of wood, less absorbent.
- Heavy treatment of knives and cleaners creats potential harbours for dirt and bacteria.
- Cleaning the block; ensure the surface is as smooth as possible; clean away visible dirt with a scrapper and wire brush; apply a disinfectant solution (to destroy any bacteria found in the body of the wood, and where they might multiply and provide a reservoir of infection).

Cutting boards
- Last for years if properly used.
- Abusing the surface by food handlers may lead to scoring or breaking the board.
- Neither stainless steel nor laminated nor formica type surface are suitable for cutting or chopping.
- For chopping use chopping block.
- For cutting use cutting board.
- Rubber based boards are better because:
  - they do not crack.
  - Can be put into boiling water (sterilization)
- Scored boards should be discarded.
- Some boards do not withstand hot water so you should use disinfectant.

Food preparation surface
- Wood should not be used.
- Stainless steel or plastic laminate.

- No hidden gaps between the surface and the table, which might harbour dirt.
- Edges should be formed, so that water and food scraps cannot work underneath.
- Stainless steel tables are the best; they do not rust, and eliminate unwanted cracks or joints.
- Tables with open sides and without drawers are best.
- If drawers are necessary, use proof metal, easily removable, wooden drawers should not be encouraged.

Slicing machines
- Suitable size, according to the job.
- Safety features
- The blade and blade housing can be removed for easy cleaning.
- Good food practices for slicing machine:
  - Good washing before use raw meat after cooked meat.
  - The blade must be cleaned daily or between various foods.
  - Minimum amount of oil or grease, only oil recommended by the manufacture is used.

Cookers
- Simple in construction
- With large uncomplicated surface
- Easy to clean
- Stainless steel is the best
- Inside surface should be easily removable.
- Should be raised 10-15 cm off the ground.
- Sufficient distance away from the wall to allow cleaning.
- Island cookers have the advantage of being able to be cleaned "all-round".
- Gas ranges should be checked periodically.

Heating cabinets and ovens
- Metal construction
- Should permit one to reach every part with ease.
- Doors are either hinged or sliding should be raised and 10-15 cm off the ground.

- Regular cleaning

Microwave ovens
- They are able to cook, defrost and reheat food quickly safely and economically.
- Sealed metal-microwave energy cannot penetrate metal, the waves are reflected back towards the foods which absorbs them.
- Safety measurements
- Regularly serviced and checked for leaks.
- Ensure the door is tightly fitting.
- Ensure that the free passage of air to the oven cavity is not obstructed by dirty filters.
- Ensure that there are no loose or missing screws
- Metal or foil containers must not be used, neither should metal skewers.
- China with metal decorations should not be used.

Mincing machines
- They used for reducing the size of meat or vegetables.
- Demand special attention because of the danger of food particles becoming lodged.
- Easy cleaning should be facilitated by allowing the easy removal of the worm and mincing discs.
- All parts that come into contact with the food should be thoroughly cleaned and steeped in a disinfectant solution.
- Ensure all handles are well cleaned.
- Plastic handles or grips are preferable to wood.
- Handles should be steeped in a disinfectant solution.

Mixing machines
- Cleaning between different foods.
- They should be fitted with rollers to allow easy removal for cleaning.
- If placed on tables they should be slightly raised to permit effective cleaning underneath.
- Stainless steel paddles or aluminum.

Ice-cream (soft) machines
- Pipework and the main tank are usually stainless steel.
- All pipes, taps mad valves should be taken apart at the end of each day; washed and steeped in disinfectant solution, then rinsed with clean water.
- Ice-cream should not remain in the machine overnight.

Sinks
- Hot and cold water
- Hot water tank-sufficient supplies.
- Heater must be big enough to cope with demand.
- Stainless steel

Utensils
- Wooden handles are not preferable.
- Wooden spoons should be discouraged because they are absorbent and quickly become worn and cracked. They are difficult to clean effectively, and should be replaced by plastic or metal.
- Wooden trays and containers should not be used.
- Tin openers (particularly table-mounted models) require special care.
- Utensils plated with metal containing lead or other harmful metal or chemical should not be used.
- Any coated utensil where the covering has broken or worn should be replaced.
- Chipped or damaged plates, cups, or other crockery should be discarded.

THE STORAGE OF FOOD

General rules
- Keep it clean
- Keep it cool
- Keep it coverd

Rotation of stock
- Older stock is used first
  - By using code system
  - By using date system
  (This is particularly important with short life or perishable food)
- No food has an unlimited life and preserved foods require a degree of rotation.

The storage rooms
- Large enough, easy for delivery
- Close to the preparation or sales area
- Not exposed to the direct rays of the sun

Dry food store
- The larger the area the better (crowded store hampers cleaning, encourages pests and makes stock control more difficult).
- All parts should be easy to clean
- Walls and floors should be smooth and impervious
- Ceiling should be easy to clean
- All holes and openings should be sealed
- Effective measures against rodents and insects
- Air bricks should be covered with metal or nylon gauze.
- The cool temperature should be around 8°C. This could be achieved by natural ventilation, in summer. In the case of closed room mechanical fans should be used to exhaust the air and to create air movement.
- The positioning of the fan; not to pack crates and boxes tightly together because this obstructs the free flow of the air.
- Goods should be stored off the ground and away from walls.

Shelving

- Shelves should be smooth, impervious and easy to clean.
- Ensure that any strip on the edge of the shelf is well fixed (less chance of any insects being harboured).
- Rust-proof metal is preferable
- Avoid creating corners and voids when fixing the shelves.
- Shelves should be removable
- Shelves should not be so deep
- Cupboards within the store room should be avoided as possible. If they are required, remove the back and fit closely to the wall.
- The distance between shelves depends on the nature of the goods, but it should be not less than 75 cm (30 in) above the floor to permit the storage of bins below.

Storage containers

- Depend on the type of foods
- Tinned goods can be stored directly on the shelves.
- Sugar and flour are best kept in either metal or plastic bins with close-fitting lids and which stand on roller bases for easy movement.
- Aluminum containers have the advantage of being both rust-proof and light weight.
- Paper, polythene or plastic packages (for which turn-over is relatively quick), should be placed on a tray to prevent any spillage affecting food stored below.
- Vegetables will need to be kept in a well-ventilated container and should be stored at floor level in either plastic or metal trays with perforated sides.
- No container should be stored directly on the floor, unless they are containers with roller bases.

Chilling rooms
- The temperature at about 3 to 4°C.
- Same regulation for dry store except that the walls, ceiling and door should be insulated to maintain the lower temperature.
- Vegetables and milk should be kept in chilling room.
- Chilling room may be used as a preliminary store for foods which are being cooled prior to being placed in the refrigerator.
- The rule for danger foods e.g. gravy, meat, fish, milk and cooked foods is to place them in a chilling room as soon as possible where the temperature will be reduced quickly and as soon as chilling temperature has been reached they (foods) can be transferred to a refrigerator for longer storage periods.

Cold storage and refrigerator
- The temperature must be maintained at 1 to 5°C.
- The space depends on the load of work and size of premises.

Walk-in cold storage
- Allow easy cleaning
- Motors are best placed in weather-and noise-proofed housing.
- Motors generate considerable heat in hot weather and they should be well ventilated.
- Shelves should be of rust-proof metal on easily removable brackets.
- Floors should be tiled or granolithic and should be to the walls for easy cleaning.
- All steel enameled metal refrigerators are preferable.

Defrosting
- All refrigerators need to be serviced regularly
- When refrigerators are defrosted, all surfaces should be thoroughly cleaned at the same time.
- Remove shelves and clean
- Wash with detergent and warm water, rinse and dry thoroughly.

- If it is intended to close down the refrigerator, it should be defrosted, cleaned and thoroughly dried to prevent any mould formation.
- Doors should be left open slightly to encourage a constant circulation of air.
- When it is intended to defrost a refrigerator, the contents should be run down as far as possible.
- The remaining food should either, be placed in another refrigerator or be covered and stored in a cool place or wrapped with clean paper.

Using the refrigerator
- Do not overcrowed
- Foods with spillage should be placed in trays or in the lower down.
- Do not place hot food directly in the refrigerator.
- Moist or wet foods should be placed in containers to prevent dripping.
- Wrap food with cellophane or any suitable paper.
- Bring old stock to the front so that it will be used first.

Freezers
- The temperature at around -15 to -20°C.
- Deep freezers should be defrosted and cleaned regularly.
- The food should be examined periodically to check on damage to both itself and to wrappings.
- Stock rotation is essential as even frozen food has a "shelf life".
- Deliveries of frozen food should be transferred to the freezer immediately.
- It is essential for open-top freezers to ensure that food is not placed above the load line.
- Above the load line food becomes subject to a higher temperature which can seriously affect the quality.

Deep frozen food

- Frozen food should be used within the time recommended by the manufactures.
- As a rule, foods that have thawed should not be refrozen because of:
  - Damage of cell structure
  - Loss of colour
  - Effect on nutritional value and quality
- Refrozen food subsequently thoroughly cooked is quite safe, but the flavour and texture will be below the high quality.

The star-rating system for frozen foods

Rating	Maximum Temperature	Period for which food can be kept frozen
* One	-6°C	Up to 1 week
** Two	-12°C	Up to 1 month
*** Three	-18°C	Up to 3 months
**** Four	-25°C to -30°C	At least 3 months

DETERGENTS AND DISINFECTION

DETERGENTS

Detergents are cleaning agents, solvents or any substance that will remove grease,or soil and dirt from a surface. There are several types of detergents and each type is designed for a different purpose.

1. Anionic (alkaline): Used for removing fat, grease and heavy acid;these require an alkaline type detergent to neutralize and dissolve the food deposit. This type is usually used in the dishwashing machine.
2. Nonionic (neutral): Particularly useful in hard water areas; less tendency to foam, dissolve mineral oils efficiently. It is usually used to clean some floors.
3. Cationic (acid): Complex chemicals which are capable of removing mineral (lime) deposits from the dishwashing machine, steam table, or any other places where the white, chalky deposit builds up. If the water is very hard it would be wise to use an acid-type detergent.
4. Combinations: Detergents that contain a chemical sanitizer to help in preventing bacterial growth.

Soap
- Made from animal and vegetable oils
- It frequently forms a scum when used in hard water supply
- It is not very efficient at removing bacteria
- It is mainly used for personal hygiene

Washing cream
- Made from pure vegetable oils
- Very efficient, even in hard water areas
- Cheap
- Mainly used for personal hygiene

Characteristics of good detergents

- Thoroughly wet the surface to be cleaned
- Remove the dirt from the surface
- Hold the dirt removed in suspension
- Have good rinsability
- Bacterial properties
- Prevention of corrosion
- Prevention of scale formation
- Economy in use

DISINFECTION

- Disinfection reduces the numbers of living micro-organisms, but does not usually kill bacterial spores. Disinfection can be more effective if preceded by thorough cleaning.

Disinfection by Heat

- The application of moist heat to raise the temperature to at least 70°C is one of the commonest and most useful method of disinfection.
- There are two types of heat disinfection.

Hot-water disinfection

- This is the method most commonly used by food industry
- Removable parts of machinery and smaller items of equipment can be submerged in a sink or tank containing water at disinfecion temperature (80°C) for a suitable time (2 minutes)

Steam disinfection

- Where steam is used, the surface to be disinfected must be raised to a disinfecting temperature for a suitable time.

Chemical disinfection

- Chemical disinfectants are chemicals which have germ-destroying properties of a proven standard.
- Chemical disinfectants can only be used when it

is impossible to apply heat.

- Hypochlorites are a good disinfectant for use in food premises, leaving little taint or smell at the correct concentration.
- They are anionic and therefore must not be used with cationic detergents.
- Some metals, especially aluminum alloys, will be corroded by a bleach solution.
- Mixing of bleach with an acid water closet cleaner will cause a chemical reaction and give off poisonous fumes of chlorine gas.

Iodophors
- These incorporate iodine with a detergent
- Tend to be inactivated by organic material
- They are less effective against spores than are hypochlorites.
- They are more expensive
- They leave little taste or smell

Quaternary ammonium compounds (QACs)
- They are less effective against bacteria than hypochlorites or iodophors.
- They are colourless and are relatively non-corrosive to metals and non-toxic but may have a bitter taste.
- They are not compatible with soaps or anionic detergents.

Amphoteric surfactans
- They consist of active agents with detergent as well as bactericidal properties.
- They are of low toxicity, relatively non-corrosive, tasteless, and adourless.
- They are efficient when used according to the manufacturer's recommendations.
- They are inactivated by organic matter

Checks on the effectiveness of procedure

- The effectiveness of cleaning and disinfection procedures should be verified by microbiological monitoring of the product and food contact surfaces.

- When sampling for microbiological monitoring of equipment and food contact surfaces, the use of a quenching (neutralizing) agent is required to eliminate any residual disinfectant.

FOOD PRESERVATION

Food preservation depends on type of bacteria, there are three main types of bacteria based on temperature for growth:

- Thermophilic: bacteria, usually live at 40°C to 75°C
- Mesophilic: bacteria, usually live at 5°C to 45°C (pathogenic)
- Pschrophilic: bacteria, usually live at 5°C to 20°C

Reasons for food preservation

- Make the food edible
- Prevention or delay of microbial decomposition
- Preserve the food

METHODS OF FOOD PRESERVATION

DEHYDRATION (DRYING)

- Removal of the water in foods, this reduces the volume of foods
- Deprives bacteria of the necessary available water
- This technique is most suitable for high moisture content foods, mainly fruit, vegetables and meat.

Public health aspects

- Stops the growth of pathogens but does not kill them
- Enzymes do not act
- Toxins do remain
- Spores survive

Pretreatment:

- Depend on the kind of food
- Fruit and vegetables are washed and graded, and usually blanched to deactivate the enzymes
- Meat usually cooked before drying

Methods of drying

1. Sundrying (Solar)

- Most effective in hot and dry climate
- Limited to certain foods; dates, grapes, figs, fish and meat.
- The fruit are spread out on trays and may be turned during drying.
- In case of fish and meat sun-drying, generally salt is added.
- The air exposure of the drying fruit and vegetables increases the access to animal, bird and insect infestation.

2. Fluidized Bed

- Warmed air circulated around the food, which is continually agitated to prevent sticking. This method is particularly useful with vegetables.

3. Spray drying

- Most effective with liquid or semi-liquid foods
- The product is sprayed through fine nozzles into a rapidly circulated current of hot air.
- This causes moisture to evaporate quickly and particles of the dried foods are deposited and removed.
- Spray drying is not effective at destroying pathogens, and milk and eggs are often heat treated before processing to reduce the bacterial population.

4. Roller drying

- For breakfast cereal, potatoes flakes, and foods in emulsion form.
- Applying the paste to the heated surface of a roller and scraping off the thin layer of powder as it forms.

5. Freeze drying

- Freezing of the food, followed by gradual heating under reduced pressure.
- This causes the ice formed to sublime, that is, to pass from solid phase to drying phase without passing through the liquid phase.
- The process does not cause shrinkage or distortion in the food.
- Only 2% moisture remain
- The freeze dried foods are stable at room temperature, but they require careful packaging to prevent condensation and refrigeration should be used for long term storage.
- Advantage: allow retention of flavour
- Disadvantage: expensive

HEAT STERILIZATION

CANNING

Pretreatment of food
- Soften the tissue to facilitate close packing
- Deactivate the enzymes
- In vegetables cause shrinking which facilitates can filling.
- The food is then placed in the can, which is then filled with liquor.
- Syrup for fruit
- Brine for vegetables and meat
- Heating the can to 95°C without the lid being fixed firmly.
- Sealing the can which is then ready for sterilization

Thermal destruction of microbes

- Temperature higher than 100°C to ensure that resting spores are destroyed.

Impractical because of:
- Undesirable changes in flavour, colour and texture.

- Therefore, most canning practices are aimed at eliminating specific bacteria that are potentially hazardous.
- The most dangerous pathogen in canned food is Clostridium botulinum.
- Acid or high acid foods have a less severe heat treatment.
- Medium and low acid foods require considerable heat treatment.

Method of canning

High acid foods

Normally treated for a few minutes at 100°C since the pH being below 4.5 is sufficient to destroy dangerous pathogens.

Low acid foods
- Normally 115°C for several minutes is sufficient to destroy pathogens.

HIST (high temperature short time)
- Most effective, if carried out before canning
- The food is heated to 120°C for a short time, then transferred to sterilized containers, and sealed.
- This process is called aseptic canning and is suitable for liquid or semisolid foods.

Spoilage of canned foods

Canned foods may be spoiled due to:
- Imperfect heat sterilization
- Inadequate evacuation of the air
- Improper sealing, this lead to water as well as air to enter the can.
- Storage at an improper temperature may lead to multiplication of spores.
- Storage in a moist atmosphere produces rust and corrosion, and holes may be formed in the can.

PRESERVATION USING LOW TEMPERATURE

Chilling (1 - 5°C)

- Chilling inhibits the growth of both pathogenic and spoilage organisms, but not for long-term preservation.
- Chilling of food, especially that which has not been processed is not usually effective for long periods (several weeks).
- Good chilling depends on humidity, low humidity is better.

Public health aspects

- Little or no growth of pathogenic organisms but pathogens survive
- Toxins remain
- Spores survive
- Enzymes remain active
- Spoilage by Pschrophilic bacteria

Quick freezing

- At -10°C most of the water in food is frozen
- In general the more quickly food is frozen the better is the quality achieved on thawing. This is largely due to the rate of formation of ice crystals in the foods:
  - Slow freezing rates favour formation of large ice crystals which cause cellular disruption and initiate chemical break down.
  - Rapid freezing prevents large ice crystals and does not disrupt cellular structure.

Plate freezing

Food is packed between metal surfaces which are cooled by the refrigeration and direct contact with the plates allows rapid cooling by conduction.

Blast freezing

The food is exposed to cooled air in a specially designed Tunnel (mostly used for fruit and vegetables).

Cryogenic freezing

By using liquid nitrogen (-200^{o}C),a very highly freezing rate, is achieved with little loss;method expensive.

Public health aspect of freezing

- No growth of pathogens
- Toxin is unaffected by freezing
- Enzymes remain active
- Spores survive
- A proportion of vegetable cells are killed, but some survive

FOOD IRRADIATION

Food is irradiated for the same reasons that it is processed by heat or refrigeration or freezing or treated with chemicals - to kill insects, fungi, and bacteria that cause food to spoil and can cause disease, and to make it possible to keep it longer and in better condition in warehouses stores, and homes.

The food is exposed to a form of energy called ionizing radiation, the same kind of energy used to make X-ray pictures, sterilize up to 50% of all disposable medical and hygienic products, treat certain kinds of cancer, and for many other purposes. The treatment does not alter the food in any way that could harm people, and food irradiated under approved conditions does not become radioactive.

Because of the small amount of energy involved in food irradiation, usually no significant difference in terms of appearance, smell, or taste can be detected if the process has been carried out properly. It is even difficult to detect any change by means of analysis in a laboratory. It is worth remembering that food processors want their products to appeal to consumers, not put them off. If an irradiated food product were very different from what consumers expect, there would be no market for it. This

technique is used only when needed and only when it is economically advantageous. Some examples of foods that have been approved for radiation treatment in a number of countries are listed below:

- potatoes and onions - to control sprouting when climatic conditions make storage difficult;
- spices, herbs dehydrated vegetables, and condiments - to control microorganisms and get rid of insects;
- poultry shrimps, frogs legs, and fish - to control microorganisms (in particular pathogens) and prolong shelf-life;
- mangoes, papayas, strawberries, and mushrooms - to control insects and to extend shelf-life;
- rice, cocoa beans and wheat - to control insects and microorganisms.

PEST CONTROL

The pests of primary concern are insects and rodents that spread disease through foods, together with stored-food insects that damage and waste foods. These include the rats, house-flies, the cockroaches, small moths and beetles. In addition to rodents and insects, birds sometimes become both a nuisance and a potential public health hazard and should be prevented from entering food plant and storage areas.

Effective insect control consists of:

- The elimination of places where the insects can breed and hide (e.g., manure and waste should be kept well away from the slaughterhouse and other food establishments)
- The protection of all openings in buildings by well-fitted screens
- The destruction of insects by the use of insecticides (of which there are two types: those with a knock-down effect, containing pyrethrum; and those with delayed or residual effect such as DDT, lindane, etc.).

Flies

The best way to control house-flies is to provide wire-gauze doors and ventilators and to remove materials in which the larvae develop; such doors should be self-closing and, when appropriate, designed to keep out flies while permitting the entry of personnel and material. The principal sources of flies are frequently improperly stored garbage, and animal excreta. The use of standard garbage cans with tight-fitting lids will help considerably in fly control. Commercially prepared fly sprays, cords, and baits incorporating chemicals should be used in strict accordance with instructions. Continuous insecticide vaporizers must not be used where food is stored, prepared or served. It should always be

borne in mind that insecticides are a supplement to, never a substitute for, clean food establishments and adequate screening.

Moths, beetles and cockroaches: These can be the cause of wasted food and nuisance. Good sanitation, including frequent cleaning of shelves and floors, helps to check them in stored foods and discourages infestation. These pests thrive on flour, meal and cereal products.

Rodent control

Rodent control is facilitated by everything that increases the general hygiene of the compound. In particular:

- the elimination of rodent harbourages in surrounding areas, as well as in buildings;
- the elimination of food supply for rodents;
- rodent-proofing of buildings
- the destruction of rodents

Traps are useful around food establishments where rodenticides are not permitted or are hazardous, and also where only slight infestation is encountered. There are two main types of traps:

- live or cage traps, used for catching rats or mice alive, whether one at a time or severally;
- killer or snap traps, used for both rats and mice.

In general, all traps must be maintained; they should be checked frequently, never less than once every 24 hours.

Poison can also be used to control rodents. Some of the more toxic poisons, that should never be used in food establishments and must only be used by specially trained persons, are: sodium monofluoroacetate (1080), a white, odourless and tasteless compound; fluoroacetamide (1081), almost as hazardous to handle as 1080; gophacide, an organophosphate; strychnine; zinc phosphide; elemental phosphorus; and arsenic. A less

toxic poison is antu (alpha-naphthyl thiourea), specifically developed for the house or Norway rat (Rattus norvegicus), but since it is carcinogens it should not be used in food establishments.

Precautions in using insecticides and rodenticides

An inspector should thoroughly understand the hazards associated with the use of insecticides and rodenticides and communicate this information to the general public as well as to the food industry. Some of the most important precautions to be observed in pesticide handling are:

- to read and understand the instructions on container labels for preparing and applying the pesticide;
- to know the material being used;
- to avoid prolonged exposure and to wear protective clothing;
- not to use the poison in any way that will result in contamination of food or drinking water;
- to store pesticides in properly labelled containers, away from food and in a secure place;
- to dispose of empty containers safely;
- to know emergency measures for treating accidental poisoning.
- rodenticides containing Salmonella or other live bacteria should never be used in or near food establishments.

WASTE DISPOSAL

Disposal of garbage and waste is an important operation in foods service sanitation because waste products attract pests and can contaminate food, equipment and utensils.

Waste containers
- Waste containers should be leakproof, pestproof, easily cleaned and durable.
- Plastic bags and wet-strength paper bags are effectively used to line waste containers.
- Tight-fitting lids for waste containers are essential.

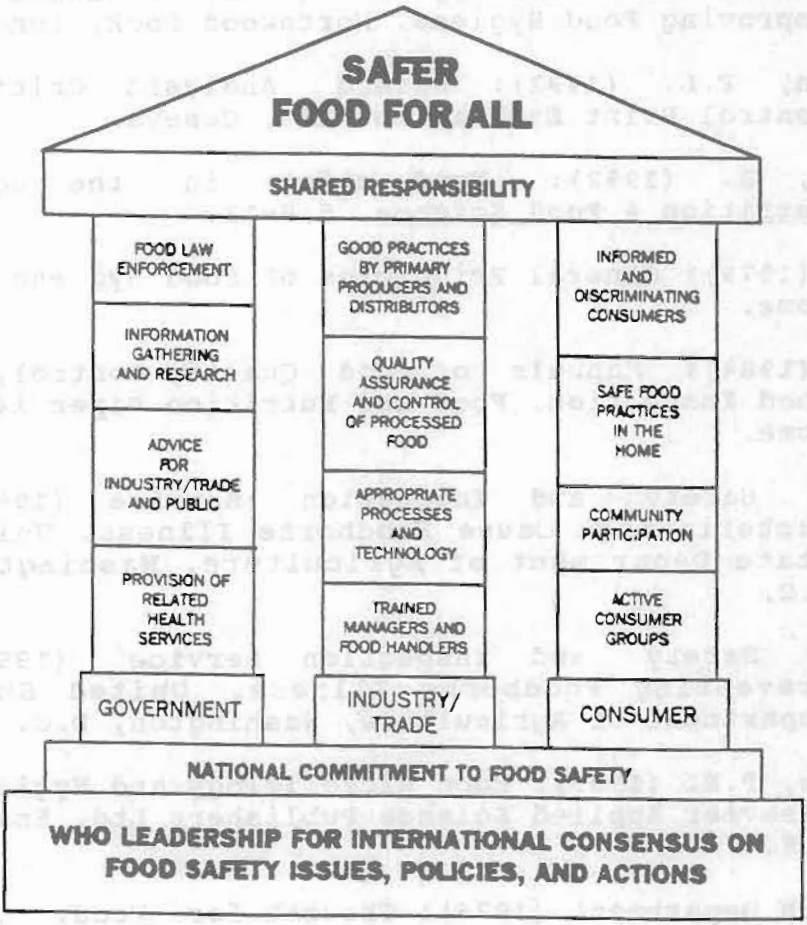
Waste Removal
- Waste should be removed from food preparation areas as well as possible and disposed of often enough to prevent the formation of odour and the attraction of pests.
- Accumulation of waste materials should be permitted only in waste containers.

Waste storage areas
- Waste storage areas should be easily cleaned and pestproof.
- If a long holding time is required, refrigerated indoor storage should be provided.
- Inside storage area should be easily cleaned and pestproof.
- Large waste containers such as dumpsters and compactor systems located on the outside should be stored on or above smooth surface of nonabsorbent material like concrete or machinelaid asphalt.

Cleaning of waste containers
- An area equipped with hot and cold water and a drain should be provided for cleaning waste containers.
- Location should be such that food in preparation

or storage will not be contaminated when containers are washed.

To ensure the safety of food, a concerted effort is required by the three sectors mainly concerned, i.e. governments, industry and trade, and consumers



BIBLIOGRAPHY

Ali, A.A., Dudani, R. and Abdulrahim I.Y. (1986): Salmonellosis outbreak linked to improper handling of food in a hotel in Bahrain. Bahrain Med.Bull 8,119-123.

Alock, P.A. (1980): Food Hygiene Manual. H. K. Lewis & Co. Ltd., London.

Aston, G. and Tiffney, J. (1981): A Guide to Improving Food Hygiene. Northwood Book, London.

Bryan, F.L. (1992): Hazard Analysis Critical Control Point Evaluation. WHO, Geneva.

Eley, A. (1992): Food safety in the home. Nutrition & Food Science, 5,8-13.

FAO (1979): General Principles of Food Hygiene, Rome.

FAO (1984): Manuals of Food Quality Control, 5. Food Inspection, Food and Nutrition Paper 14/5, Rome.

Food Safety and Inspection Service (1990): Bacteria that Cause Foodborne Illness. United State Department of Agriculture, Washington, D.C.

Food Safety and Inspection Service (1990): Preventing Foodborne Illness. United State Department of Agriculture, Washington, D.C.

Hayes, P.R. (1985): Food Microbiology and Hygiene. Elsevier Applied Science Publishers Ltd. Essex, U.K.

Health Department (1976): Thought for Food. City of Canterbury, U.K.

Jacob, M. (1989): Safe Food Handling. WHO, Geneva.

Jay, J. (1986): Modern Food Microbiology. 3rd edition, Van Norstrand, N.Y.

Marriott, N.G. (1985): Principles of Food Sanitation. AVI Publishing Company Inc. Westport, Connecticut.

Musaiger, A.O. (1989):Food poisoning outbreaks in Bahrain. Health & Hygiene, 10, 21-24.

Nield, A. and Hesmondhalgh, Z. (1984): Revise Home Economics. Letts study aids, Charles Letts & Co. Ltd., London.

Public Health Directorate (1984): Annual Report, 1983. Ministry of Health, Bahrain.

Public Health Directorate (1986): Annual Report, 1985. Ministry of Health, Bahrain.

Public Health Directorate (1987): Annual Report, 1986. Ministry of Health, Bahrain.

Robins, G.V. (1982): Food Science in Catering. Heinemann, London.

Royal Institute of Public Health & Hygiene (1980): Certificate Course in Food Hygiene and the Handling of Food, Lecture Notes, third edition, London.

Trickett, J. (1991): The prevention of Food Poisoning, 2nd edition, Stanely Thornes (Publishers) Ltd., Chettenham, U.K.

WHO (1988): Food Irradiation. WHO Features, No. 130. Geneva.

WHO (1989): Health Surveillance and management procedures for food-handling personnel. Technical Report Series 785, Geneva.

WHO (1991): Food Safety. In point of Fact, June 1991, No. 75.

Appendix(1)

FOOD SAFETY FOR TRAVELLERS

Travellers who are obliged to eat in restaurants and/or hotels, or have to buy their meals from street vendors, or who prepare their food on camp sites, are exposed to a high risk of being affected by foodborne diseases. In the majority of cases, foodborne diseases affecting travellers are of biological origin,. and manifest themselves in the form of diarrhoea.

To prevent and control foodborne diseases during travelling- vendors on the street to expensive hotel restaurants:

- Cooked food that has been held at room temperature for several hours constitutes one of the greatest risks of foodborne illness. Make sure your food has been thoroughly cooked and is still hot when served.

- Avoid any uncooked food, apart from fruits and vegetables that can be peeled or shelled. Avoid fruits with damaged skin. Remember the dictum "Cook it, peel it or leave it".

- Ice-cream from unreliable sources is frequently contaminated and can cause illness. If in doubt, avoid it.

- In some countries, certain species of fish and shellfish may contain poisonous biotoxins even when they are well cooked. Local people can advise you about this.

- Unpasteurized milk should be boiled before consumption.

- When the safety of drinking-water is doubtful, have it boiled or disinfect it with reliable, slow-release, disinfectant tablets. These are generally available in pharmacies.

- Avoid ice unless you are sure that it is made from safe water.

- Beverages such as hot tea or coffee, wine, beer, and carbonated soft drinks or fruit juices which are either bottled or otherwise packaged are usually safe to drink.

If you get diarrhoea do the following

- Most diarrhoeal attacks are self-limiting and clear up in a few days. The important thing is to avoid becoming dehydrated.

- As soon as diarrhoea starts, drink more fluids, such as bottled, boiled or treated water, or weak tea. Fruit juice (diluted with safe water) or soup may also be taken. If diarrhoea continues for more than one day, prepare and drink ORS solution' and continue to eat normally.

Amounts of fluid or ORS to drink

Children less than 2 years: 1/4-1/2 cup (50-100ml) after each loose stool

2 years to 10 years : 1/2-1 cup (100-200ml) after each loose stool

Older children and adults : Unlimited amount

Seek medical help if:

Diarrhoea lasts for more than 3 days and/or there are very frequent watery bowel movements, blood in the stools, repeated vomiting or fever.

- When there is no medical help available and there is blood in the stools, a course (5 days) of contrimoxazole may be taken.
- Prophylactic use of antibiotics is not recommended. antidiarrhoeals (e.g. loperamide) are not recommended but may be used, in addition to fluids, by adults only, for symptomatic relief. They should never be used for children.

- If there are often symptoms, seek medical advice.

Source: WHO (1991): A Guide on Safe Food for Travellers leaflet) Geneva.
Kaferstein, F. and Motarjemi, Y (1991): Foodborne diseases as related to travellers. Catering and Health, 2, 41-52.

Appendix(2)

HAZARDS, CRITICAL CONTROL POINTS AND MONITORING PROCEDURES FOR COMMON FOOD SERVICE OPERATION

Operation/ critical control point	Hazards	Control measures	Monitoring procedures
Purchase/receipt	Pathogens on raw foods, foods obtained from unsafe sources	Obtain foods from safe source	Set purchase specifications and check for compliance on receipt
Frozen storage	Microbial growth in thawed goods	Maintain frozen until use	Observe whether foods are frozen, measure temperature of freezer
Refrigerated storage	Microbial growth if temperatures too high or duration of storage too long, cross-contamination	Maintain cold temperature, rotate stock	Observe condition of food; measure food and unit temperature, observe storage practices; measure duration of storage, look for potential routes of contamination
Dry storage	Break in package, high moisture, poisons stored near foods, sewage backflow or droppage from pipes; vectors	Maintain low temperature and humidity; store poisons elsewhere; protect foods from contamination	Observe storage practices
Thawing	Bacterial growth, contamination of area by thaw water, incomplete thawing	Thaw at temperatures and within times that do not permit multiplication of common pathogenic bacteria	Observe thawing practice, feel whether product completely thawed
Reconstitution (rehydration)	Contamination during rehydration, bacterial growth	Use safe water and clean utensils and containers, use food promptly or refrigerate in small volumes	Observe practices

Operation/ critical control point	Hazards	Control measures	Monitoring procedures
Preparation	Cross-contamination from raw products, contamination from food handlers and dirty equipment and utensils	Avoid handling raw foods and then cooked foods; avoid touching foods that are not to be heated subsequently	Observe practices
Cooking	Pathogens survive inadequate time–temperature exposure, spores survive	Adequate time–temperature exposure	Measure temperature at geometric centre of food
Handling of foods that are not subsequently heated	Cross-contamination from raw products, contamination from hands, equipment, or utensils	Avoid handling raw foods and then cooked foods, avoid touching foods that are not to be heated subsequently; exclude ill persons from working with food, ensure personal hygiene of food service workers	Observe practices; observe personnel for signs of illness, receive reports of illness or significant symptoms
Holding at room or warm outside temperatures	Bacterial growth	Limit time of such holding, hold hot or cool	Observe practices; measure time of holding
Hot-holding	Bacterial growth	Hold foods at temperatures at which pathogenic bacteria do not multiply	Measure temperature of foods at intervals
Cooling	Pathogenic bacteria multiply	Cool foods rapidly in shallow containers or use other method of rapid cooling, store as close to freezing as feasible	Measure depth of food, measure temperature of food after cooling; observe storage practices
Reheating	Microbial pathogens may survive, heat-stable toxins will survive	Adequate time–temperature exposure	Measure temperature at completion of reheating
Cleaning of equipment and utensils	Failure to remove pathogens from surfaces	Wash, rinse, disinfect	Observe practices, measure concentration of disinfectant solution and contact time

Appendix(3)

WHO GOLDEN RULES FOR SAFE FOOD PREPARATION

The following rules have been drawn up by the World Health Organization, to provide guidance to members of the community on safe food preparation in the home. They should be adapted, as appropriate, to local conditions.

1. Choose foods processed for safety

While many foods, such as fruits and vegetables, are best in their natural state, others simply are not safe unless they have been processed. For example, always buy pasteurized as opposed to raw milk and, if you have the choice, select fresh or frozen poultry treated with ionizing radiation. When shopping, keep in mind that food processing was invented to improve safety as well as to prolong shelf-life. Certain foods eaten raw, such as lettuce, need thorough washing.

2. Cook food thoroughly

Many raw foods, most notably poultry, meats, and unpasteurized milk, are very often contaminated with disease-causing pathogens. Thorough cooking will kill the pathogens, but remember that the temperature of *all parts of the food* must reach at least 70 C. If cooked chicken is still raw near the bone, put it back in the oven until it is done—all the way through. Frozen meat, fish, and poultry must be thoroughly thawed *before* cooking.

3. Eat cooked foods immediately

When cooked foods cool to room temperature, microbes begin to proliferate. The longer the wait, the greater the risk. To be on the safe side, eat cooked foods as soon as they come off the heat.

4. Store cooked foods carefully

If you must prepare foods in advance or want to keep leftovers, be sure to store them under either hot (near or above 60 C) or cool

(near or below 10 °C) conditions. This rule is of vital importance if you plan to store foods for more than four or five hours. *Foods for infants should preferably not be stored at all.* A common error, responsible for countless cases of foodborne disease, is to put too large a quantity of warm food in the refrigerator. In an overburdened refrigerator, cooked foods cannot cool to the core as quickly as they must. When the centre of food remains warm (above 10 °C) too long, microbes thrive, quickly proliferating to disease-producing levels.

5. Reheat cooked foods thoroughly

This is your best protection against microbes that may have developed during storage (proper storage slows down microbial growth but does not kill the organisms). Once again, thorough reheating means that *all parts of the food* must reach at least 70 °C.

6. Avoid contact between raw foods and cooked foods

Safely cooked food can become contaminated through even the slightest contact with raw food. This cross-contamination can be direct, as when raw poultry meat comes into contact with cooked foods. It can also be more subtle. For example, do not prepare a raw chicken and then use the same unwashed cutting board and knife to carve the cooked bird. Doing so can reintroduce all the potential risks for microbial growth and subsequent illness present prior to cooking.

7. Wash hands repeatedly

Wash hands thoroughly before you start preparing food and after every interruption—especially if you have to change the baby or have been to the toilet. After preparing raw foods such as fish, meat, or poultry, wash again before you start handling other foods. And if you have an infection on your hand, be sure to bandage or cover it before preparing food. Remember, too, that household pets—dogs, birds, and especially turtles—often harbour dangerous pathogens that can pass from your hands into food.

8. Keep all kitchen surfaces meticulously clean

Since foods are easily contaminated, any surface used for food preparation must be kept absolutely clean. Think of every food scrap, crumb or spot as a potential reservoir of germs. Cloths that come into contact with dishes and utensils should be changed every day and boiled before reuse. Separate cloths for cleaning the floors also require frequent washing.

9. Protect foods from insects, rodents, and other animals

Animals frequently carry pathogenic microorganisms which cause foodborne disease. Storing foods in tightly sealed containers is your best protection.

10. Use pure water

Pure water is just as important for food preparation as for drinking. If you have any doubts about the water supply, boil water before adding it to food or making ice for drinks. Be especially careful with any water used to prepare an infant's meal.

Source:WHO (1989): Health Surveillance and management procedures for food-handling presonnel.Geneva.

Appendix(4)

MODEL FORM FOR USE IN PRE-EMPLOYMENT HEALTH INTERVIEWS

Name of employee .....

Address .....

Telephone no. .....

1. Have you ever had typhoid or paratyphoid fever? YES/NO

2. Are you suffering from:

   (*a*) Skin rash YES/NO
   (*b*) Boils YES/NO
   (*c*) Diarrhoea and/or vomiting now or within the last seven days YES/NO
   (*d*) Discharge from the eye YES/NO
   (*e*) Discharge from the ear YES/NO
   (*f*) Discharge from the nose YES/NO

3. Have you ever lived abroad? YES/NO

   If yes: where .....

   when .....

   Have you travelled abroad recently (in the last 3 weeks) YES/NO

   If yes: where .....

   when .....

Name, address and telephone no. of your doctor:

Name .....

Address .....

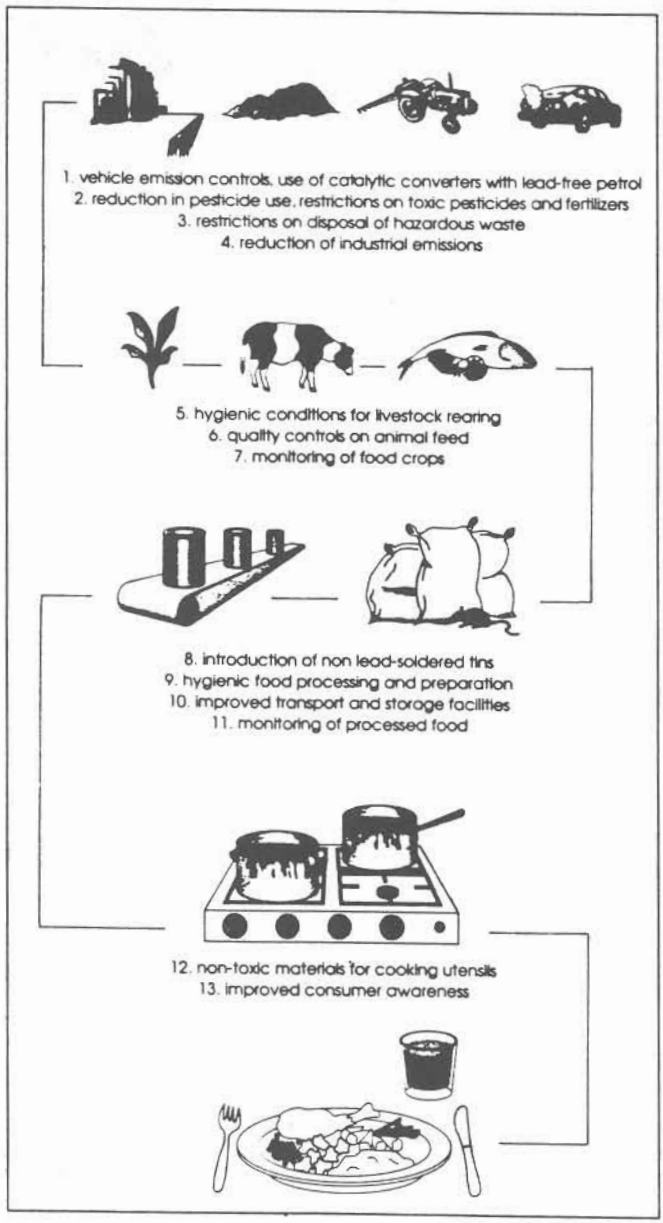
.....

Telephone no .....

[1] Adapted from. LONDON BOROUGH OF HOUNSLOW. *Health monitoring arrangements for fod handlers.* Environmental Health Codes of Practice. No. 1.

Appendix(5)

STEPS TO REDUCE FOOD CONTAMINATION



Source:UNEP(1992): The Contamination of Food. UNEP/ GEMS Environment Library N0 5.Nairobi,Kenya.

Awal Press Bahrain