



PUBLIC HEALTH TRAINING OF TRAINERS MANUAL

Best hygiene practices in meat inspection and prevention of food borne diseases and zoonoses



This training manual was prepared by the Department of Public Health, Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Nairobi, Kenya for FAO Somalia.

Table of Contents

PREFACE	7
UNIT 1: TRAINING APPROACHES.....	8
1.1 Purpose of Training of Trainers.....	8
1.2 Training objectives	8
1.3 Pre-testing of participants	8
1.4 Principles and practices of adult learning	8
1.6 Elements of Adult Learning	9
1.7 Participatory training approaches	10
1.8 Training Methods	11
1.9 Community participation and education	14
UNIT 2: OVERVIEW OF PUBLIC HEALTH.....	15
2.1 Objectives of Public Health	15
2.2 Public health problems affecting developing countries	15
2.3 Public health activities that enhance the health of the community	15
2.4 Spread of diseases in the community.....	17
2.5 Prevention and control of diseases	18
UNIT 3: ZONOSSES, SURVEILLANCE AND MANAGEMENT	20
3.1 Learning objectives	20
3.2 Important zoonotic diseases.....	20
3.2.1 Anthrax.....	20
3.2.2 Tuberculosis	21
3.2.3 Brucellosis	23
3.2.4 Rabies.....	24
3.2.5 Rift valley fever.....	26
3.2.6 Echinococcosis/hydatidosis	27

3.2.7 Tapeworm infection (taeniasis).....	28
3.3 Surveillance, prevention and control of zoonoses	29
3.3.1 Disease surveillance.....	29
3.3.2 Reasons for surveillance	29
3.3.3 Population under surveillance	29
3.3.5 Surveillance data sources.....	30
3.4 Approaches to surveillance	31
3.4.1 Active surveillance.....	31
3.4.2 Passive surveillance	31
3.4.3 Notifiable disease reporting.....	32
3.4.4 Laboratory based surveillance	32
3.4.5 Volunteer providers.....	32
3.4.6 Surveys.....	32
3.5 Data analysis, interpretation and presentation	32
3.5.1 Data Analysis.....	32
3.5.2 Data Interpretation.....	32
3.5.3 Data presentation.....	33
UNIT 4: FOOD AND ENVIRONMENTAL HYGIENE	34
4.1 Learning objectives	34
1. Describe the various types of food hazards and how they contaminate food	34
4.2 Food Hazards	34
4.2.1. Biological hazards.....	34
4.2.2. Chemical hazards.....	35
4.3 Food hygiene	38
Impact of food contamination	38
4.5 Hygiene of Food Establishments	39
4.6 Slaughter facilities.....	40

4.7 Meat markets and butcheries	44
4.8 Slaughterhouse cleaning operations.....	46
4.9 Environmental hygiene of slaughterhouses.....	49
4.9.1 Fencing.....	49
4.9.2 Compound cleaning.....	49
4.9.3 Pest control	49
4.10 Personnel health status (medical fitness)	50
4.11 Personal Hygiene of slaughterhouse workers	51
4.12. Personnel Education/Training	51
4.13 Disposal of slaughterhouse waste.....	53
UNIT 5: FOOD BORNE DISEASES, CONTROL AND PREVENTION	55
5.1 Learning objectives	55
5.2 Food borne diseases.....	55
5.2.1 Bacterial Food borne Infections	55
5.2.2 Viral Zoonoses	60
5.2.3 Rickettsial foodborne infection	61
5.3 Food borne intoxications	61
5.3.1 Bacterial food borne intoxications	62
5.3.2 Fungal food borne intoxications.....	67
5.3.3 Chemical foodborne intoxication	67
5.4 Biotoxications:.....	68
5.4.1 Biotoxications of invertebrate origin.....	69
5.4.2 Biotoxications of fish	69
5.4.3 Prevention of poisoning due to poisonous animals	70
5.5 Factors that contribute to the occurrence of food borne intoxications	70
UNIT 6: BEST PRACTISES IN MEAT PRODUCTION	71
6.1 Meat value chain from farm to fork	71

6.2 Care of animals at the farm (Primary production)	71
6.3 Hygiene of feed and feed ingredients	71
6.4 Hygiene of slaughter animals	71
6.5 Meat hygiene and inspection.....	72
6.5.1 Objectives of meat inspection.....	72
6.6 Pre-slaughter handling of slaughter animals	72
6.6.1 Transportation of animals to slaughter points.....	72
6.6.2 Legislation related to transportation of animals.....	73
6.6.3 Animal identification and Traceability	73
6.6.4 Resting of animals at lairages.....	74
6.6.5 Pre-slaughter hygiene.....	74
6.7 Ante-mortem inspection	74
6.7.1 Reasons for antemortem inspection	74
6.7.2 Carrying out ante-mortem inspection	75
6.8 Slaughtering and dressing operations	75
6.9 Post-mortem meat inspection.....	76
6.10 Meat Inspectors	77
6.11 Legislation related to transportation of Meat.....	78
6.12 Meat by-products	79
6.13 Hides and skin curing.....	79
6.14 Meat traceability.....	79
6.15 Processing of Meat	81
UNIT 7: MILK HYGIENE.....	82
7.1 Introduction	82
7.2 Importance of milk hygiene	82
7.3 Sources of milk borne pathogens.....	82
7.4 Prevention of milkborne diseases	82
7.5 Composition of milk.....	83

7.6 Methods used to assess the quality of milk	83
7.7 Milk adulteration.....	85
7.8 Methods for determination of milk adulteration.....	85
7.9 Reduction of milk adulteration	86
UNIT 8: FOOD SPOILAGE AND PRESERVATION	87
8.1 Learning objectives	87
8.2 Food spoilage	87
8.2.1 Microbial spoilage of food	87
8.2.2 Factors affecting microbial growth in food.....	88
8.3 Spoilage of canned foods.....	90
8.4 Food preservation	91
UNIT 9: SURVEILLANCE OF FOOD IMPORT/EXPORTS	95
9.1 Learning objectives	95
9.2 Surveillance of food imports.....	95
UNIT 10: WATER AND SANITATION.....	97
10.2 Water pollution.....	97
10.3 Causes of water pollution	97
10.6 Control of excreta -related diseases.....	98
10.7 Management of water and sanitation services.....	99
10.8 Water borne diseases	99
10.8.2. Cholera	100
10.9 Pevention of waterborne diseases	102
10.10 Chemical hazards in water	103
10.11 Water treatment	103

PREFACE

This training manual is intended for use in training of the public health inspectors, health officers, veterinary public health officers, meat inspectors, and sanitary inspectors working in Somalia in order to enhance their capacity to effectively perform their public health service delivery roles.

The manual aims at imparting skills and knowledge in various public health issues on improved basic hygiene, best practices for meat inspection, zoonotic disease surveillance and application of sanitary measures to reduce zoonotic and food borne diseases.

The following topics are covered: training approaches, overview of public health, zoonoses surveillance and management, food and environmental hygiene, hygiene of food establishments, personnel hygiene and education, foodborne diseases and their prevention, best practices in meat hygiene and inspection, best milk hygiene practices, food spoilage and preservation principles, surveillance of food imports and export, application of sanitary and phytosanitary measures to control entry, establishment and spread of animal diseases into a country, importance of water hygiene and pollution control.



.....
Prof. Jackson N. Ombui
Chairman, Department of Public Health, Pharmacology and Toxicology

UNIT 1: TRAINING APPROACHES

Training is the process of acquiring knowledge, skills, and attitude that are needed to fill the gap between what people want to do, and what they are able to do now. Trainers are adults who impart knowledge to other people.

1.1 Purpose of Training of Trainers

The purpose is to pass knowledge and skills to adult trainers in order to strengthen their capacity to plan, organize and conduct effective training of the population on best practices in meat inspection, prevention of foodborne diseases and zoonoses. Training of Trainers (TOT) is based on the principle that everyone has something to share and should therefore be given an opportunity to share with other participants.

1.2 Training objectives

1. Introduce participants to principles and concepts of adult learning
2. Develop participant's capacity to plan, organize and conduct training
3. Develop participant's capacity to formulate achievement based objectives
4. Equip participants with knowledge of effective training methods.
5. Identify effective ways to monitor and evaluate training sessions

1.3 Pre-testing of participants

It is important to pretest participants at the beginning of the training program to enable the trainer to gauge the level of understanding of the issues they will be trained on. Pre-testing of participants has the following objectives

1. Assess participant's knowledge of key course contents
2. Identify participants strengths and weaknesses

Participant should be guided to complete self evaluation and pre-test competency forms

1.4 Principles and practices of adult learning

Adult learning is the process of adults acquiring the knowledge, skills, and attitude that are needed to enable them do what they are currently unable to do. The following are the characteristics of adult learners:

1. They are most interested in learning subjects that have immediate relevance to their job or personal life.
2. They have accumulated a foundation of *life experiences* and *knowledge* that may include work-related activities, family responsibilities, and previous education.
3. Adults are **goal-oriented**
4. Adults are **relevance-oriented**.
5. Adults are **practical**. They focus on the aspects of a lesson most useful to them in their work.
6. Adults need to be involved in the planning and evaluation of their instruction.
7. Only motivated adults are able to learn

1.5 Characteristics of adult learning

- Experience (including mistakes) provides the basis for learning activities. Experiential learning addresses the needs and wants of the learner. The qualities of experiential learning are: personal involvement, self-initiated, evaluated by learner, and has pervasive effects on learner. Experiential learning is integral to personal change and growth. Experiential learning is facilitated when:
 1. the student participates completely in the learning process and has control over its nature and direction;
 2. it is primarily based upon direct confrontation with practical, social, personal or research problems;
 3. self-evaluation is the principal method of assessing progress or success.
- Adult learning capitalise on the experience of participants.
- Adult learning is problem-centered rather than content-oriented.
- Significant learning takes place when the subject matter is relevant to the personal interests of the student.
- Learning is easily assimilated when external threats to the learner are at a minimum.
- Self-initiated learning is the most lasting and pervasive.
- Adults will commit to learning when the goals and objectives are considered realistic and important to them.
- Application of the information in the 'real world' is important and relevant to the adult learner's personal and professional needs
- Adults need to receive feedback on how they are doing and the results of their efforts.
- Opportunities must be built into professional development activities that allow the learner to practice the learning and receive structured, helpful feedback.
- Adults need to participate in small-group activities during the learning to move them beyond understanding to application, analysis, synthesis, and evaluation.
- Small-group activities provide an opportunity to share, reflect, and generalize their learning experiences.

1.6 Elements of Adult Learning

There are four critical elements of learning that must be addressed to ensure that adults learn. These elements are: (i). motivation (ii). reinforcement (iii). retention (iv). transference

Motivation

Facilitators must establish rapport with participants and prepare them for learning; this provides motivation. Learners need *feedback*. They must also see a *reward* for learning.

How to motivate adult learners

At least six factors serve as sources of motivation for adult learning:

1. **Social relationships-** opportunities to make new friends, to meet a need for associations and friendships.
2. **External expectations-** to comply with instructions from someone else; to fulfill the expectations or recommendations of someone with formal authority.
3. **Social welfare-** The need to improve ability to serve mankind, prepare to serve the community and improve ability to participate in community work.
4. **Personal advancement:** to achieve higher status in a job, secure professional advancement, and stay abreast of competitors.
5. **Escape/Stimulation:** to relieve boredom, provide a break in the routine of home or work, and provide a contrast to other exacting details of life.
6. **Cognitive interest:** to learn for the sake of learning, seek knowledge for its own sake, and to satisfy an inquiring mind.

Reinforcement. Reinforcement is a very necessary part of the teaching/learning process; through it, facilitators encourage correct modes of behavior and performance. When learners are trying to change behaviors (old practices), both positive and negative reinforcement are needed.

Retention. For learners to benefit from learning, they must retain information during the learning process. For them to retain information, they must see a meaning or purpose for that information. They must also understand and be able to interpret and apply the information.

If learners did not learn the material well initially, they will not retain it well either. Retention by the participants is directly affected by the amount of practice during the learning. Instructors should emphasize retention and application. After learners demonstrate correct (desired) performance, they should be urged to practice to maintain it.

Transference. The transfer of learning is the result of training. It is the ability to use the information taught in the course in a new setting.

Role of the trainer

The role of the trainer is facilitation by ensuring that learning occurs. This includes:

- setting a positive climate for learning;
- clarifying the purposes of learning;
- organizing and making learning resources available;
- balancing intellectual and emotional components of learning;
- sharing feelings and thoughts with learners but not dominating

1.7 Participatory training approaches

Participatory training is an interactive learning process enabling individuals and communities to develop skills, knowledge and attitudes and to share lessons learnt, so that they can contribute to the promotion of public health. Learning through hands-on-experiences facilitates the learning process, especially when the topics are every day practices. During participatory training, participants are encouraged to explore and discover for themselves.

Knowledge obtained this way is easily internalized and put into practice. Therefore in participatory training, discovery based learning and learning by doing plays a central role.

Participatory training requires a lot of time and energy from learners and trainers alike. However, after the training, season, participants will have gained knowledge and useful insights in a subject that is of very practical relevance to them. In order for participatory training to be successful;

1. There should be open communication between participants and facilitators
2. Participants must be able to pose questions to facilitators who are obliged to answer them
3. Participants must be involved in the whole process (curriculum development, execution and evaluation)
4. Participants must actively contribute to the topic under discussion
5. The training process should be developed according to the expectations of participants.

1.8 Training Methods

The following training methods are recommended for use by trainers: Brain storming, Interactive talk, illustrations, group discussions, panel discussions, role play exercise, work shop method, classroom/laboratory practice and field practicals.

Brain storming. This method is used as the first step to generate initial interest and essential involvement of the trainees in the training activity. For this, the trainers ask the trainees to think of any ideas without evaluation or judgement

Interactive talk. In this method, trainees are encouraged to be active and analytical in their learning approach. They are also motivated to be inquisitive and anxious to know new things by asking questions and exploring alternatives.

Illustrative talk. This is a lecture method supplemented by the use of proper illustrations using training material, including audio-visual aids. Presentations of success stories and case studies is also one of the essential elements of this method.

Group discussion. The use of this method is based on the principle of the trainer taking on the role of a group promoter. The method is a good instrument of participatory learning whereby the trainer acts as a group advisor or facilitator.

Panel discussion. In the use of this method, there is greater involvement of trainees in promoting participatory learning. The trainer's role is limited to that of the coordinator or moderator of the discussion, in which the trainees as panelists act as agents of the learning process.

Role play exercise. In method, trainees are provided an opportunity to put into action the skills learnt through the training. An artificial situation is created whereby every individual is assigned a role which he/she enacts to demonstrate the skills learnt through the process of training. The role of the facilitator of training is that of a 'guide' or director of the enacted play.

Workshop method. The use of this method promotes participatory learning and makes the best use of the mix of talent and skill of individual trainees. In this method, trainees are arranged into a number of groups, keeping in view their interests and areas of learning. Each group is assigned a theme of discussion relating to the topic being covered during the training session. Each group then identifies a leader to coordinate the discussions and present the decisions arrived at during the exercise. The method is used at an advanced stage of the training.

Classroom practical. The method is used to reinforce the learning experience through classroom practice. The method may be used to supplement the knowledge input given to the trainees through lecture method, to cover a particular topic of the training session, e.g. designing a disease control strategy, designing a sampling plan for disease investigation, sample preparation for staining and detection of disease agent, etc.

Field practical. This method has a special significance for providing the trainees an opportunity to use their skill in field situations. For example, physical examination of suspected cases to identify the disease, or carrying out a meat inspection exercise at the slaughterhouse.

Laboratory practical. In the method, the trainer can demonstrate to trainees in the laboratory how to determine the level of contamination of food, working tables, utensils, detection procedures for disease pathogens, how pathogens appear after culture and staining etc. Trainees can be given a chance to practice what has been demonstrated either alone or in a small group.

Audio visual aids. Audio and visual aids help to clarify concepts and ideas to save time and make learning more interesting and enhance retention rate. Learning takes place through all senses. It has been observed that people tend to remember 20% of what they hear, 40% of what they hear and see and 80% of what they hear, see and do. The following are the various kinds of visual aids:

- Non-projected – chalkboard, flipchart, printed material, models and handouts.
- Projected – overhead projector, slides, power point presentation
- Audio- tape recorder or deck, radio, loudspeaker
- Audio visual – television and video.
- A good visual aid should be simple, attractive, clear and concise in language.

General guidelines for the use of audio visual aids

1. Consider the size of the audience. Every one must be able to see and hear clearly.
2. Consider the level of the audience
3. Centrally display at one time the aid related to the topic.
4. Always practice before hand with your audio or visual aid in the room
5. Do not stand in front of the visual aid
6. Address the audience, not the visual aid when you speak.
7. Avoid overcrowding, visual aids or putting too many messages in the audio aid
8. Title and number handouts

Monitoring and evaluation of training. Learning and transfer of skills should be assessed during and after training to modify or maintain program strategy and improve outcomes.

Monitoring involves tracking the key elements of individual performance in terms of knowledge skills and attitudes during and after training. Evaluation is determining whether a training has achieved the course objectives, individual improvement and development of the training processes.

Characteristics of monitoring:

- Occurs on a regular basis during and after training
- Provides early indication of progress or lack of progress
- Provides periodic oversight of activity implementation
- Can be done by any staff not only specific evaluation staff
- Informs a program about strengths and weaknesses to decide whether and how to refine the strategy
- Determine whether activities are performed correctly
- Determines to what extent planned interventions are being implemented, what resources are provided to who, when, how often, how long and to what extent

Characteristics of evaluation

- Is time bound, systematic and objective.
- Assesses performance and impact
- If carried out selectively can be costly and time consuming
- Can focus on process (organization and management)
- Can focus on impact (effects on beneficiaries)
-

Types of evaluation for training

- Self- evaluation
- Pre-training assessment (Initial training)
- Evaluation of the process during training
- Peer evaluation
- Mood meter
- Post-training assessment or evaluation of the results

Trainers need to be given practice in monitoring and evaluation of the impact of training he or she has conducted. Such a practice can be arranged both in the classroom and in the field.

Trainers should:

- Share learning and experience with trainees rather than exclusively imparting knowledge to them
- Be creative and also encourage the trainees to be creative too
- Supplement talk with suitable illustrations such as pictures, drawings, flannel board, flash cards, models, samples etc to make presentations interesting.
- Start talk by inculcating in the trainees an interest in the subject matter to create curiosity of the trainees to learn more
- Make maximum use of two-way communication by inviting comments and questions from trainees and sharing their view with them
- Inspire and encourage trainees to be facilitators of training programs

- Constantly monitor the extent to which the trainees have been receptive and responsive to the information given to them
- Be equipped with knowledge of recent developments in the materials and methods of training skills.
- Inculcate a sense of confidence among the trainees by acknowledging their contributions during the training sessions.

1.9 Community participation and education

Community participation is defined as a process by which individuals and families assume responsibility for their own health and wellbeing, and in doing so enhance their capacity to contribute to their own as well as to the community's economic development. All sectors of society must have a role to eliminate zoonotic diseases. Specific educational materials should always be matched to the educational level of the particular target group to obtain the best results, and due attention should be paid to different religious beliefs, cultural customs and languages of inhabitants.

Appropriately prepared materials can be used to communicate information on diseases to local communities, and to engage them to adopt best practices and healthy lifestyles. Health education programs can be addressed to opinion leaders, parents/guardians livestock producers and rural communities. Indigenous knowledge should be respected and used when effective.

The dissemination of information through mass media is an essential element in preventing and controlling zoonotic diseases and in promotion of public health programs. Radio, television and video films are valuable means of disseminating health education, but the programs should be clear, concise and designed to appeal to the target audience in order to be effective.

School teachers are potential candidates for delivering health education lessons particularly in rural areas which are at high risk of zoonotic diseases. If trained teachers can teach their pupils about basic hygiene and the routes of transmission and measures to prevent zoonotic diseases. Health education can be organized in schools using materials such as slides, overhead transparencies, educational pamphlets, posters, colouring books, comic strips, games and puzzles.

Simple illustration pamphlets and posters are excellent media for teaching information on disease prevention. This can also be used to reach livestock producers as they are key elements in any program to control or eliminate zoonotic diseases.

Media should also emphasize on oral communication through songs, poems, games and jingle which can easily be learned even by school children.

Women, opinion leaders and individuals with influence among their peers should be identified and trained so that they can encourage lifestyles. They can then train others to multiply the benefits within the community. It is important to identify an appropriate team that is well aware of the social aspects of the health problems and has clear understanding of the objectives, strategies and tasks.

UNIT 2: OVERVIEW OF PUBLIC HEALTH

NOTES FOR TRAINERS

The trainer should draw attention of trainees and encourage their participation by starting this topic with the three questions listed below. The trainer will ask one question at a time and allow trainees to respond to the question. Encourage them to give which ever answer they wish to give and allow 3-4 responses for each question before embarking on the lecture.

1. What do you understand by the term “Public Health” and what are its main objectives?
2. What public health problems affect developing countries e.g. Somalia?
3. What public health activities are used to achieve the objectives of public health?

Public Health comprises of all analytical and organizational efforts that are aimed to promote and improve the health of the community.

2.1 Objectives of Public Health

1. Ensure adequate levels of nutrition of the community
2. Prevention and control of outbreaks/cases of human and zoonotic diseases
3. Prevention and control of food borne diseases
4. Reduce health risks related to poor basic hygiene and waste disposal & management practices
5. Prevent occurrence of natural disasters and accidents

2.2 Public health problems affecting developing countries

- Inadequate levels of nutrition
- Low standards of basic sanitation practices and infrastructure
- High prevalence of controllable infections
- Poor food hygiene and handling practices leading to food borne diseases
- Accumulation of waste in the environment
- Accidents (road air and rail)
- Fire outbreaks
- Natural disasters: floods, droughts, earthquakes.

2.3 Public health activities that enhance the health of the community

1. Proper nutrition of the population by provision of adequate quantity of safe quality food
2. Protection of water resources from contamination and provision of potable and adequate water supplies

3. Identification, prevent and control of diseases in the community
4. Proper design of houses and premises to provide for adequate space, natural lighting, ventilation, sanitary facilities and safety
5. Ensuring basic hygiene and sanitation in and around human habitation
6. Food protection and control to prevent contamination with disease agents and hazardous chemicals (pesticides, herbicides antibiotic residues, heavy metals, food additives, hormones, etc) in food
7. Environmental protection through prevention of environmental pollution with hazardous chemicals and infectious disease agents
8. Pest and vector Control: Design and implement strategies to deal with mosquitoes, tsetse flies, snails, other disease vectors and pests.
9. Radiation control: Limit use of radiation to essential services e.g. X-rays for medical diagnosis, promotion of proper use of radiation and disposal of radioactive materials

Veterinary Public Health (VPH) is a component of public health that is devoted to the application of professional veterinary knowledge, skills and resources to the protection and improvement of human health. VPH contributes to the physical and social well being of humans through an understanding and application of veterinary science. Many human diseases are transmitted through foods of animal origin especially meat, milk, eggs and fish, while others are transmitted through contact with infected animals or materials from infected animals. VPH is therefore devoted to the following specific aims:

1. Provision of sufficient hygienically safe and nutritionally adequate animal derived food for human consumption.
2. Prevention of zoonotic diseases and other occupational hazards to animal owners
3. Prevention of environmental contamination from agricultural and veterinary related activities.

The specific aims of Veterinary Public Health are achieved through the following activities:

- Prevention and control of Infectious/zoonotic diseases in animals
- Ensuring of proper design, siting, construction and hygiene of slaughter facilities
- Inspection of animals offered for slaughter to ensure that they are free from infectious and zoonotic diseases
- Inspection and quality assurance of meat to ensure its suitability for human consumption
- Inspection and quality assurance of fish to ensure its suitability for human consumption
- Ensure proper disposal of dead animals or condemned carcasses/organs after slaughter
- Ensure hygiene of milk and milk processing plants

- Prevention and control of chemical residues in food

2.3.1 Proper nutrition of the population

Man's food requirements are drawn from plant and animal sources. Different food substances provide man's nutrient requirements in varying amounts. A combination of both plant and animal derived foods ensures that human beings get all the nutrients the body requires. To ensure continuous access, food has to be collected, processed and stored for use during periods of the year in which food is not obtainable.

2.3.2 Prevention and control of infectious diseases

Disease is any impairment of the normal physiological function of plant and animal caused by inorganic or pathogenic agents. Disease is caused by the following agents:

- (i) **Non-living agents** which can be physical or chemical agents.
- (ii) **Living agents (microorganisms)** such as bacteria, viruses, fungi, protozoa, helminths, rickettsiae, chlamydia etc.

Environmental factors influencing occurrence of diseases

Environmental factors such as climate/weather, overcrowding, poor sanitation, poor nutrition can sometimes help living agents to cause disease in their host by weakening host resistance to infection.

Microorganisms can enter the body through the following routes:

- the respiratory system by inhalation of contaminated air with disease agents,
- orally through food and water,
- intact or damaged skin (wounds),
- genital organs (STDs),
- biting and sucking arthropods e.g mosquitoes.

2.4 Spread of diseases in the community

Diseases originate from an infected source and spread in the community. They are mainly passed from an infected person to another through contact, consumption of contaminated food and water, or through insect vectors such as mosquitoes, tsetse flies and sandflies. Others diseases are spread through contact with infected animals and /or their products.

NOTES FOR TRAINERS

Trainees can be asked to list diseases they think are of public health importance and identify the causative agents for each of the diseases listed. They can go further to give the environmental factor(s) that they think encourage the occurrence of specific diseases they listed.

2.5 Prevention and control of diseases

Prevention and control of diseases can be achieved through the following approaches:

i). Food protection and control

Food may get contaminated with physical, chemical and biological hazards during production, harvesting, processing, distribution/transportation and storage. Food protection and control aims at ensuring that food is not contaminated with the various hazards found in the environment. It involves safeguarding food sources(e.g fishing environments), , protecting food from contamination with various food hazard (e.g by control of animal diseases, protective packaging of food, hygienic transportation and storage), and elimination of biological hazards already in the food through various means (e.g. heating, processing).

ii). Environmental protection

Environment refers to the physical components of environment which include air, land and water from which living organisms derive their livelihoods. Environment can also refer to the combination of external physical conditions that affect and influence the growth, development and survival of living organisms, or external conditions or surroundings especially in which people live (living environment-housing and other basic facilities and needs), or work (work environment -the conditions in which an individual or staff works including amenities). Living environments focus primarily on living arrangements (and how they impact on health and wellbeing of people).

Environmental pollution can affect the survival and well being of human beings or living organisms. Pollution is any addition of chemical or form of energy to air, water, soil or food that threatens the health, survival or activities of human or living organisms. The environment can be polluted by an array of contaminants including, hazardous (poisonous, toxic, irritant, or corrosive) gases and particulates, poisonous chemicals (heavy metals, pesticides, herbicides etc), disease causing microorganisms and radiation. The presence of these substances in the environment constitute a health hazard to human beings. Prevention of environmental pollution with these substances constitute environmental protection.

iii). Environmental sanitation and hygiene

Environmental sanitation and hygiene is the process of taming the environment so that it no longer constitute a health hazard to man. Environmental sanitation and hygiene is important in the prevention of a number of important diseases in the community especially diseases that are transmitted by fecal-oral route like intestinal worms, food and water borne pathogens e.g. those causing cholera and typhoid fever. Prevention of such diseases consists of measures aimed at proper disposal of wastes and control of environmental hygiene, such as the use of latrines/ toilets that are properly constructed and maintained, provision of potable water, adequate preparation and cooking of food and personal hygiene. In addition, proper disposal of refuse help to keep the number of flies and cockroaches low as they play role in transmission of these diseases.

iv). Environmental management

This is part of an integrated approach in the control of diseases. Environmental management covers the following components:

(a). **Control of insect vectors and pests.** Manipulation of environment to produce temporary conditions that are unfavourable to vector or pathogen breeding, e.g. draining of stagnant water, bush clearing around homes for control of mosquitoes. The permanent or long-term modification of land, water and vegetation e.g clearing of vegetation, and or aconversion of forest to cropland will reduce occurrence of tsetseflies that transmit sleeping sickness

(b). **Provision of proper housing.** The modification or manipulation of human habitation proper construction of houses with adequate space, ventilation, lighting, sanitary facilities and easy to clean to avoid accumulation of dirt are key to control of diseases.

NOTES FOR TRAINERS

Trainers should ensure that trainees understand the relationship between disease and quality of the environment. For this, trainees can form groups to discuss the various environmental factors that influence the occurrence of specific diseases such as cholera, typhoid, malaria, trypanosomiasis and how environmental management can help in prevention and control of such diseases.

UNIT 3: ZONOSSES, SURVEILLANCE AND MANAGEMENT

3.1 Learning objectives

By the end of this unit, participants will be able to:

1. Describe the various zoonoses, their mode of transmission, control and preventive measures
2. Identify important zoonoses affecting their communities and risk factors associated with their occurrence

3.2 Important zoonotic diseases

Zoonoses are diseases and infections that are naturally transmitted from animals to humans or from human beings to animals.

Notes to trainers

Trainers should ask trainees to suggest examples of zoonotic diseases that they know and how such diseases are transmitted to human beings.

3.2.1 Anthrax

This is an acute bacterial infection caused by *Bacillus anthracis* that occurs frequently in herbivorous animals. However, all warm blooded animals are susceptible to varying degrees. Grazing animals are infected when foraging in areas contaminated with spores of *B. anthracis*. The disease is typified by sudden death in domestic and wild animals. Terminally ill animals bleed from the nose, mouth, and bowel thus contaminating soil or watering place with the bacteria. The disease has a worldwide distribution. Human infection occurs as a result of contact with animals that have anthrax through:

1. Butchering and skinning
2. Consumption of contaminated meat
3. contact with contaminated hides and skins, goats hair, wool or bones.

The following three forms of the disease occur in humans.

i). Cutaneous form

This is characterized by lesions found on exposed areas of skin that results from introduction of spores into the skin through cuts, abrasions, fly bites. The cutaneous lesion are described as a “malignant pustule” that is characterized by necrosis, vascular congestion, hemorrhage and gelatinous oedema. In most (80-90%) cases, the lesions heal spontaneously. In untreated cases 10 to 20% progress to a systemic infection characterized by high fever and death

ii). Pulmonary form

It results from inhalation of *B. anthracis* spores which are deposited directly into lungs. The spores then spread to regional lymph nodes and cause generalized infection is followed by and rapid death.

iii). Gastrointestinal form

This form results from consumption of contaminated meat. The symptoms are variable and include: fever, nausea, vomiting, abdominal pain, bloody diarrhea, sometimes rapidly development of fluid in the belly, with massive diarrhea in some cases and death if untreated.

Control measures

In man:

- 1) Control of infection in animals as described below
- 2) Prevention of contact with infected animals discharges and or products
- 3) Environmental and personal hygiene where animals products are handled
- 4) Prompt treatment of infected persons
- 5) Disinfections of fur and wool with hot formaldehyde
- 6) Vaccination of high risk groups

Animals

- 1) Prompt diagnosis
- 2) Vaccination in endemic areas - Animal with Blanthax
- 3) Deep (6 feet) burial or incineration for anthrax unopened cadavers. The grass and soil in the vicinity of the cadaver is buried and area covered with quicklime.
- 4) Affected herds should be quarantined for 2 weeks from last case with no animal or product allowed out of the farm.
- 5) In slaughterhouse – all operations must be halted until diagnosis is confirmed. If positive, all exposed carcasses must be destroyed and premises carefully disinfected with caustic soda within 8 hours.

3.2.2 Tuberculosis

Tuberculosis is a communicable disease of worldwide occurrence that presents itself with a respiratory problem in all animals including man. The disease is caused by organisms of the genus *Mycobacterium*. The main species are: *M. Tuberculosis* (human TB), *M. bovis* (Bovine TB) which is zoonotic .), *M. microti*, *M. avium* Two major types of tuberculosis syndromes are recognized: (1). Pulmonary tuberculosis (PTB) and (2) Extra-pulmonary TB. Epidemiology of human TB shows increasing incidence in both developing and developed world. This is due to Increasing population density in poor areas and HIV pandemic. TB in cattle leads to infection of various body organs including the mammary glands which makes infected milking cows to shed mycobacteria organisms in milk urine, uterine secretions, faeces and sputum. The figure 3.1 below shows multiple tubercles on the ribs and diaphragm of a bovine infected with tuberculosis.

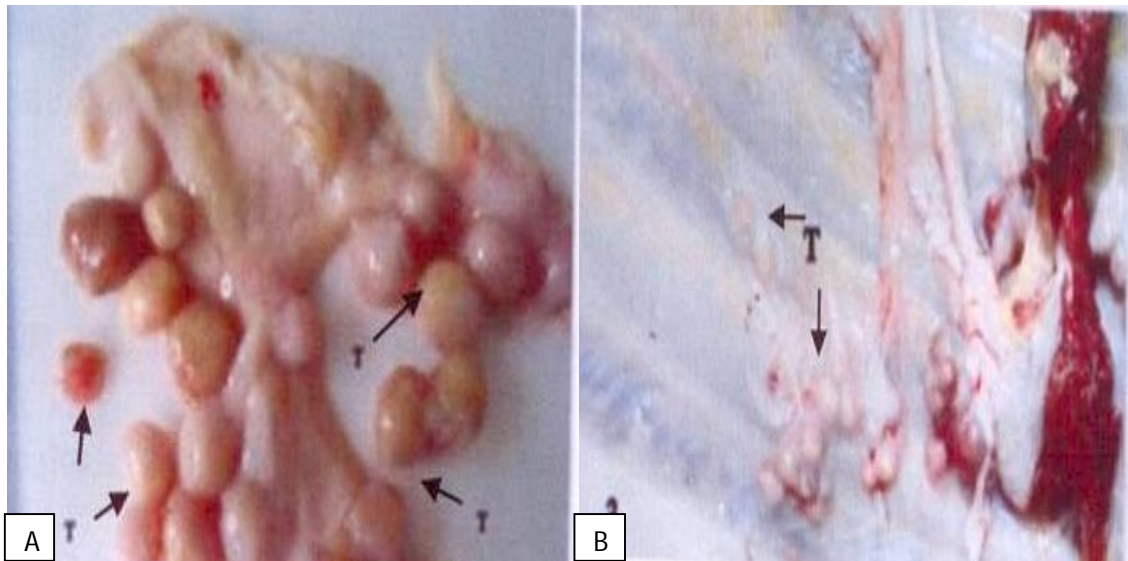


Figure 3.1: A. Multiple tubercles attached to the diaphragm of a bovine carcass; B. Multiple tubercles attached onto the ribs of a bovine carcass.

Transmission of zoonotic tuberculosis. Humans can acquire the disease from animal sources through:

1. Consumption of unpasteurized milk from infected milking animals
2. Ingestion of raw and undercooked meat from infected animals
3. Inhalation of contaminated aerosols
4. Direct contact with materials contaminated with nose and mouth secretions of infected animals
5. Postmortem examination of infected carcasses.

Human infection is characterized by chronic cough, weight loss, fatigue, profuse night sweating, fever, general discomfort, intermittent fever, paleness, swelling of glands and eventual death.

Control

In human:

- General health promotion
- Active immunization with BCG vaccine
- Chemoprophylaxis
- Control of animal reservoirs
- Early diagnosis/treatment
- Rehabilitation
- Surveillance

In animals

- Maintain TB free herds
- Test and slaughter positive reactors
- Pasteurization/boiling of milk before consumption

- Proper meat inspection to identify, isolate and condemn TB cases
- Proper cooking of meat before consumption.

3.2.3 Brucellosis

An infection caused by bacteria of the genus *Brucella*. Four species of *Brucella* cause infection in man. These are: *Br. Melitensis* (affecting mainly sheep and goats), *Br. suis* (affecting mainly pigs), *Br. Abortus* (affecting mainly cattle), and *Br. canis* (which mainly affects dogs). Animals acquire the disease by sexual transmission or ingestion of contaminated feed..

The disease causes abortion in cattle, sheep and pigs. Goats only develop lameness and mastitis. *Brucella* organisms are continuously shed in milk of lactating animals, uterine exudates, aborted fetuses and fetal membranes of aborting animals.

Disease in Human

The disease is occupational affecting human beings who work closely with animals such as butchers, herders, meat inspectors, and veterinarians. Other people may be infected through:

1. Consumption of raw or improperly pasteurized or unboiled milk from infected animals.
2. Consumption of dairy products such as cheese, and butter prepared from raw milk from infected animals.
3. Contact with infected animals, aborted fetuses, or infected tissues and products of abortion e.g. when assisting in difficulty calving.
4. Consumption of contaminated water and vegetables

Disease symptoms

The following three forms of the disease are recognized:

- 1) acute
- 2) localized and
- 3) chronic

Acute form. This is characterized by slow onset after an incubation period of between 7 and 21 days. Symptoms include headaches, fever alternating with chills (cold), severe night sweats, joint pains, general muscular pain, aches, general body weakness, chest pains and sometimes a non-productive cough. The signs of brucellosis can be confused with those diseases that present with flu-like symptoms such as malaria, typhoid fever, rheumatic fever, influenza and psittacosis. Most patients are anorexic and loose weight

Localized form. This may occur at any anatomic location. The most common signs are: osteomyelitis, splenic abscess, gastroenteritis, pneumonia and endocarditis. Endocarditis is the most common cause of mortality in brucellosis patients

Chronic form. The illness persists for more than 1 year following onset of brucellosis symptoms with varied and mixed manifestations including joint pains, undulating fever and night sweats among other symptoms..

Control in animals

1. Slaughtering of serologically positive animals and vaccination of young ones
2. Indiscriminate vaccination of all the animals in a region or country
3. Implementation of effective quarantine to restrict animal movement during outbreaks.
4. Hygienic disposal of aborted fetuses, placentae and uterine materials thereafter disinfection of contaminated areas.
5. All animals introduced in a farm should be isolated and tested before joining the rest of the herd.

Prevention of human infection

1. Pasteurization of milk and proper cooking of meat before consumption.
2. Observe personal hygiene and environmental sanitation during and after milking.
3. Preparation of ready-to-eat dairy products using pasteurized milk.
4. Ensure proper dressing and disinfection of wounds especially those on the hands that may come into contact with brucella organisms.
5. Veterinarians should take special care when handling vaccines and treating infected animals.
6. Rubber gloves and long sleeved gounlets should be worn especially when removing retained afterbirths or handling aborted fetuses.
7. Employees of the meat industry should wear protective clothing, treat and dress all wounds on hands and arms.

Treatment of human cases

A long course of upto 21 days of a mixture of antibiotics including: streptomycin/rifampicin and doxycycline. Dodexyclyline 100mg every 12 hrs or Tetracycline 30mg/kg per day plus Streptomycin 15mg/kg every 12 hrs for 3 weeks. Inadequate treatment frequently results in relapses /recurring illness. Relapse can be avoided by extending the treatment period.

3.2.4 Rabies

Rabies is a viral zoonosis that affects all warm-blooded animals including human beings. It is transmitted by the bites of infected animals and affects the brain and the spinal cord (CNS)..

How people get the infection

Human beings get the disease almost always by the bite of infected animals. The dog and sometimes the cat are the main animals that transmit the disease to human beings in Africa. Most human cases are caused by a bite from an infected dog. Other animals that can transmit the disease to human beings are foxes, wolves, mongoose, squirrels and jackals.

Domestic livestock (cattle, sheep, goats, horse etc.) may transmit the disease to human if they come into contact with the saliva of an infected animal – for example during treatment.

Symptoms of the disease in human beings

The early stages of the disease are marked by headache, malaise, slight elevation of temperature, nervousness and anxiety. The person feels an itchy sensation and pain around the site of the bite. Later, painful spasms of the pharyngeal muscles occur when fluids are swallowed. The person fears water and avoids swallowing even saliva. This causes foamy saliva in the mouth. The pupil of the eyes get dilated opening the eyes widely. The person becomes excited and enters a period of fits (convulsive seizures) which are later followed by relaxed periods. Most patients die at the height of excitation period, but sometimes those that do not die, become paralysed (general paralysis), loses all reflexes, eyes remain widely open with saliva dropping from the mouth and eventually the person dies.

Can rabies be treated?

There is no effective treatment for rabies. A person who has been bitten by the dog must ensure immediate washing and flushing of the bite wound with soap or detergent (dettol), then applying 70% ethanol, or iodine tincture. Such wound treatment is of great value if applied very early after a dog bite. This should be done even before going to hospital.

Vaccination against rabies following a dog bite

Five injections of the vaccine should be given, one each on day DO, D3, D7, D14 and D30 intramuscular or subcutaneously, for individuals not previously vaccinated. For previously vaccinated individuals with proven complete preventive vaccination, the following programme can be applied:

1. Those vaccinated within the last one year - one injection on DO
2. Those vaccinated more than one year ago but less than 3yrs- 3 injections on DO, D3 and D7.
3. Those vaccinated more than 3yrs ago -complete post-exposure vaccination (i.e D0,D3,D7,14 and D30)

Prevention and control of spread of rabies in the community

1. Dog owners should confine their dogs in their compounds and ensure that the dogs are regularly vaccinated. Dog vaccination should be done annually.
2. The public should report any dogs they see roaming around for the owners to confine them, or to the Veterinary Department to take the necessary action which will involve baiting them.
3. Dog population control (stray dog controls)
4. Public awareness and education on preventive measures

How will somebody know that the animal /dog has rabies?

1. A rabid animal can be identified by detecting unusual or abnormal behaviour.

- a. A usually aggressive dog suddenly becomes unusually docile and friendly, and may produce an abnormal voice.
 - b. A dog with a quiet temperament may look and behave as the most ferocious animal. Even a gentle dog can be rabid and therefore a threat to children particularly.
 - c. Refusal of food instead the dog may bite objects
2. In the later stages of the disease, the dog drools saliva excessively and foam at the mouth; walks in an incoordinated manner, may appear lame and paraplegia (paralysis of the lower part of the body) trembling of facial muscles.

3.2.5 Rift valley fever

RVF is a viral disease transmitted by mosquitoes. Mosquitoes are numerous during heavy rains and they transmit the infection among animals by biting. The disease has been confirmed in at least 24 African countries.

Source of infection. Little is known about circulation of virus in nature but it is thought that the virus resides in the mosquito eggs. It has been suggested that rodents could be natural reservoirs. The role of wild ruminants in the cycle has not been determined

Transmission. Principal mode of transmission among animals is by mosquito bites. Human beings get infected when they come into contact with infected animals during: slaughter, necropsy, food preparation and laboratory activities.

Disease in animals

- Disease has a short incubation period of 20-72hrs.
- There is 95% mortality in newborns
- Abortion In pregnant ewes is common in sheep,
- In cattle there is abortion, fever, anorexia, profuse salivation, abdominal pains and diarrhea. However, mortality in cattle is low.

Disease in Human

- The disease has an incubation period of 4-6 days
- Symptoms include fever, intense headache, muscle and joint pains, photophobia, vertigo, prostration, nausea, vomiting and vision changes
- Disease last few days but can progress to death especially with the hemorrhagic syndrome. The hemorrhagic syndrome includes yellowing of mucous membranes, blood in vomitus, blood in stool, bleeding of gums, petechia on the skin.
- Sometimes a nervous syndrome occurs.

Control

- In animals vaccination is the method of choice using inactivated vaccines
- Vaccination of pregnant females can cause abortion
- Should not be used in newborns or areas free of infection -could turn virulent
- Precautions in handling of sick/dead animals - use of protective clothing.
- Precautions in laboratories where work on virus is carried out.

- Care when conducting postmortem especially during outbreaks

3.2.6 Echinococcosis/hydatidosis

Echinococcosis/hydatidosis is a parasitic disease caused by *Echnococcus granulosus*. The disease occurs worldwide.

Life cycle: *E. granulosus* adult worm is found in the domestic dog and a wide range of wild carnivores who are the definitive hosts. The definitive hosts will pass out in their faeces eggs which are highly resistant to environmental conditions and which remain infective for a long time in favourable climates. However, desiccation and high temperatures affect the longevity of the eggs. The intermediate hosts which include domestic herbivores and a wide range of herbivores acquire infection by ingesting infective eggs. In the stomach and small intestines enzymes act on the eggs to release oncospheres from embryophored eggs.

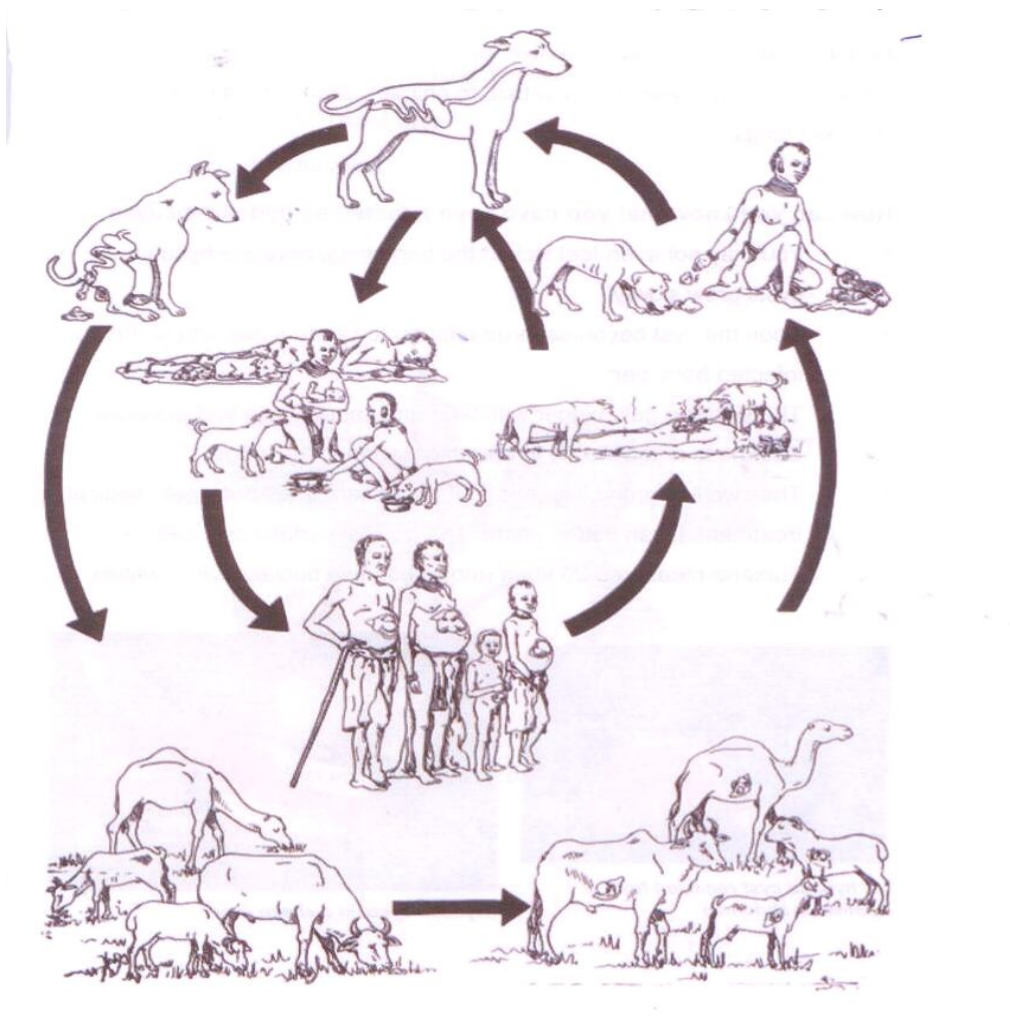


Figure 3.2: Life cycle of *Echnococcus granulosus* tapeworm

Disease in Human. The clinical signs depend on the site and size of the cyst. Abdominal swelling due to presence of cysts in the lungs, liver or any abdominal organ, swelling of one or both eyes when the cysts affects the eyes.

Preventive measures

- Creation of public awareness through health education,
- Meat inspection in farms and abattoirs,
- Dog treatment and control and
- Periodic diagnostic testing of dogs.
- Control of livestock slaughter by centralization of slaughtering,
- Efficient meat inspection and proper disposal of offal
- Dog owners to control movement of their dogs.
- Compulsory spaying of bitches (female dogs)
- Regular deworming of dogs with suitable anthelmintics e.g praziquantel
- Reduction of dog numbers by elimination of stray and surplus dogs

NOTES FOR TRAINERS

Trainers should ask trainees to suggest methods that can be used to reduce dog numbers (eliminate stray dogs) in the community

Community education

- People should not feed dogs with infected/condemned meat or organs
- Avoid contact with dog faeces
- Do not allow dogs to lick utensils used in the house
- Do not allow dogs to drink from wells or containers used by human
- Do not allow dogs to sleep in areas where people sleep
- Always wash hands before eating.
- Children should wash their hands thoroughly after playing with dogs and before eating.

3.2.7 Tapeworm infection (taeniasis)

Taeniasis is a parasitic disease caused by *Taenia Saginata*. Adult tapeworm is found in human intestines from where eggs are shed to contaminate the environment such as pastures. Cattle come into contact with tapeworm eggs while grazing in these pastures and consume them with the pasture. The eggs develop into larvae, which then lodge in their muscles where they occur as cysts. When man ingests cattle meat having cysts, larvae are liberated from the cyst which then develop into adult worms.

Prevention and control measures

1. Proper meat inspection to identify infected meat
2. Proper disposal of sewage and other wastes to contamination of pastures
3. Construction and use of toilets/latrines
4. Regular deworming of humans
5. Regular deworming of cattle

6. Adequate cooking/roasting of meat

3.3 Surveillance, prevention and control of zoonoses

3.3.1 Disease surveillance

Disease surveillance refers to all regular activities aimed at ascertaining the health status of a given population with the aim of early detection and control of animal diseases of importance to national economies, food security and trade, as well as human diseases of public health importance.. Surveillance is always accompanied by an action plan to control spread of diseases. Disease surveillance is an important component of any effective disease prevention and control program in both human and animal populations. Unfortunately, and especially in developing countries, surveillance mechanisms for most diseases are inadequate leading to gross under-reporting of the diseases. Thus, the necessary epidemiologic and economic data necessary for the proper design, planning and implementation of sound disease control programs are lacking. In addition, such data are also required to convince policy makers on the importance of the diseases and therefore allocate adequate resources for their control. Some of these diseases other than having devastating socio-economic impacts wherever they occur, are zoonotic and of great public health importance. Indeed, over 70% of all animal infections are shared with man. A number of these zoonoses have been reported sometimes sporadically in the eastern African region as well as in the horn of Africa. However, because of inadequate surveillance, the prevalence and incidence of these diseases remains largely unknown. Zoonoses that have been reported include Anthrax, Tuberculosis, Brucellosis, Salmonellosis, Rift Valley Fever, Echinococcosis/Hydatidosis, Taeniosis/Cysticercosis, Hemorrhagic fevers, and Rabies.

Disease monitoring refer to all activities aimed at detecting changes in the epidemiological parameters of a specified disease. You do not necessarily have to make any action. These are routine activities like recording daily milk production. Identification of changes may trigger surveillance activities.

3.3.2 Reasons for surveillance

- 1). To detect diseases early in order to effectively manage them.
- 2) In a situation where a disease is under control, surveillance is important so as to determine the success of the programme. In this context proof of absence of disease rather than its presence.
- 3). Surveillance data is important in informing policy in order to allocate adequate resources for public health programmes

3.3.3 Population under surveillance

Surveillance targets specific populations, which may range from specific individuals (herds) communities and residents of a nation (national herd). The size of the population varies.

3.3.4 Cycle of surveillance

Is an information loop that allows information coming from the collecting organization and the information returned to those who need it, after collating, analysis and interpretation is done, including the participating population under surveillance.

Confidentiality of the information

Is an ethical consideration and ensures protection of surveillance data in order to gain the trust of the participants. This is achieved by limiting access of personnel to sensitive data, using locks for rooms and files where data is stored and use of passwords and other security measures in computer systems.

Incentives to participation

Provision of feedback information to participants is the best incentive to participation. Equally important is convincing participants that information they give or cases they report will be used to shape policy and this would support more effective design of prevention and control strategies and could also result in new resource allocations which would benefit them. Payments for cases reported is good during the last phase of a disease eradication programme where all cases need to be reported.

3.3.5 Surveillance data sources

Data may be obtained from a variety of sources which vary from country to country. The following list of organizations represents a possible data source for use in surveillance programmes but it is in no way exhaustive.

i) Government Veterinary Organizations

Government has organizations that conduct research on particular topics. Data from these institutions would be credible for use in surveillance. Such include for instance in Kenya, KARI and Veterinary Investigation Laboratories which are located in the regions.

ii) Veterinary Practices

In most African Countries, privatization of Government services has seen a growth of private Veterinary practices. These have varied clientele e.g small animal and large animal practices. Records kept by these practitioners would be invaluable sources of surveillance data.

iii) Abattoirs

Abattoirs deal with different species of animals (cattle, shoats, pigs, camels and poultry). The animals for slaughter come from different areas of the country. Inspection records (ante and post mortem) provide a kind of survey of various diseases distribution and frequency in a country.

iv) Registries

Registries exist in many government public health institutions that depict the frequencies of certain diseases and conditions of priority to the countries e.g tuberculosis. Such registries can be used as source of human disease data.

v) Pharmaceutical and agricultural sales

The data on the sales of pharmaceutical products e.g. antibiotics may be an indirect measure of the diseases caused by bacteria. However, such data may be misleading considering usage of antibiotics without isolation of the causative bacteria e.g prophylactically.

vi) Farm records

Most farmers/livestock owners, pastoralists and livestock traders should keep production and disease records. These records may be useful source of data that pertains to specific localities.

vii) Veterinary Schools

Universities conduct research on many topics of concern to the country and also see a large number of cases from small animal to large animal medicine, theriogenology and surgery. The data if combined with that from government organizations would be more accurate considering the methods of collection, diagnosis and analysis.

viii) Breeders' societies

Breeders' societies keep records of the breed numbers and distribution. Such records may be used in case of surveillance of certain conditions that are specific to certain breeds.

3.4 Approaches to surveillance

A wide array of methods can be used in carrying out surveillance, with the selection of a method depending on the information needs and resources. The methods include the following:

3.4.1 Active surveillance

This approach means that the organization conducting surveillance initiates procedures to obtain reports such as regular telephone calls or regular visits to clinics or research laboratories. It involves frequent and intensive activities with the objective of establishing the presence or absence of a disease e.g. outbreak investigations

3.4.2 Passive surveillance

In this approach the organization does not contact potential reporters but rather leaves the initiative for reporting to others who include farmers, livestock traders and private veterinarians.

3.4.3 Notifiable disease reporting

Health and veterinary agencies have authority by law to designate certain diseases as notifiable meaning that their occurrence must be reported. This approach is mainly for infectious diseases. Persons or organizations responsible for reporting these diseases may include individual physician, the laboratory where the diagnosis was made or the facility (clinic or hospital) where the case was reported.

3.4.4 Laboratory based surveillance

This is a very effective surveillance method. It identifies cases seen by different veterinarians or physicians from various regions, especially with centralized diagnosis of certain diseases. Where cases do not come from all regions therefore this approach may not be representative of all cases.

3.4.5 Volunteer providers

In some instances, special surveillance networks are developed especially in cases where the condition or disease may not fall within the legally reportable categories. The volunteer providers are therefore engaged to provide the specialized reporting of the condition or disease. In most cases, the volunteer providers are specialized professionals who encounter the population under surveillance.

3.4.6 Surveys

Periodic surveys are commonly used to look at the characteristic of a disease in a particular population. These surveys may include sero-surveillance aimed at detecting antibodies against the agent causing disease under investigation.

3.5 Data analysis, interpretation and presentation

3.5.1 Data Analysis

Data analysis involves using epidemiological techniques. The main objective is to detect unusual variation in disease trends from the baseline, which will alert authorities to take action. Analysis can be done using different computer software.

3.5.2 Data Interpretation

In addressing change detected by surveillance data, one needs to ask whether the change is real or an artifact that may arise from different sources. For instance, the community may lose interest in a disease and fail to report. This may seem like a drop in the trend while actually the disease still remains at the same level. In order to address this, one needs to have the knowledge of how the data was collected

3.5.3 Data presentation

Many methods may be used to present the data. Tables may be good but have more information but require time to identify the trends. Charts and maps are used to reveal the new trends and easier to retain the pictorial message. A combination of the presentation methods is often desirable.

NOTES FOR TRAINERS

Trainers can discuss with trainees some of the animal diseases which they know are transmitted to humans. The trainer can ask the trainees to name such diseases and give them time to describe what they know about them e.g Name of the disease (including local name), source of infection(i.e animals involved), how human beings get infected, symptoms in affected animals, and in human beings, and preventive measures, And whether the disease occurs in the country or not.

Trainees can brainstorm on the current system of disease reporting and the constraints associated with identification and management of zoonoses in the country, as well as the level of collaboration between medical and veterinary public health practitioners.

UNIT 4: FOOD AND ENVIRONMENTAL HYGIENE

4.1 Learning objectives

By the end of the lecture, participants should be able to:

1. Describe the various types of food hazards and how they contaminate food
2. Explain the best hygiene practices that are used to enhance safety of foods
3. Describe the basic hygiene requirements of slaughter facilities.
4. Explain the slaughter operations and identify potential sources of meat contamination.
5. Describe cleaning operations meant to enhance hygiene in slaughter facilities.

NOTES FOR TRAINERS

Trainers can create initial interest in the topic by allowing a few minutes for participant to brain storm on the food hazards they can think about, their sources and effect on human health. The following questions can form as a guide to initiate the brain storming session.

1. Are all foods safe for human consumption?
2. If not, what makes food unsafe for consumption?
3. How does the environment contribute to production of unsafe food?

4.2 Food Hazards

A hazard is a biological, chemical or physical agent in food with a potential to cause an adverse health effect. There are three types of food hazards:

- Biological hazards: especially microorganisms (bacteria, molds) and their toxins, viruses, yeast, etc.
- Chemical hazards e.g. cleaning chemicals, pesticides, drug residues, heavy metals, allergens etc.
- Physical hazards e.g. dirt, soil, stones, metals, glass, plastics and other foreign bodies

4.2.1. Biological hazards

Microorganisms in food render food unsafe for human consumption as it causes food spoilage and food poisoning. The primary sources of microorganisms in food include: Soil water, plant and plant products, food utensils, Intestinal tract of man and animals, food handlers, animal hides, air and dust.

Notes for trainers

Trainers should emphasize that the presence of microorganisms in food can cause food spoilage and foodborne diseases. This can make food unfit for human consumption. The trainer can ask learners to explain if they are able to identify spoiled food and whether food had ever caused them ill health and explain the circumstance that this took place.

Discussion questions

1. How do these microorganisms contaminate foods?
2. How can microorganisms be prevented from contaminating foods to make them safe for consumption?

Food can be contaminated with pathogenic microorganisms that result from poor production and storage environments, as well as unhygienic handling practices. Pathogenic microorganisms may reach food either directly at slaughter from animal or human excreta, or transferred to food through hands, utensils, equipments and by flies. Once in the food, microorganisms grow and multiply. Foods of animal origin including meat and meat products, milk and milk products, eggs and egg products, fish and fish product have especially high risk of infecting human with pathogenic microorganism especially bacteria. This is because they contain high level of nutrients that support growth and multiplication of these microorganisms.

Sources of microbial food contamination

- Environmental sources –contaminated soil and water where food is produced.
- Animal sources: - sick animals or animals carrying disease causing microorganisms, or animal products,
- Products of animal contaminated with microorganisms
- Fish contaminated with pathogens
- Plant sources - vegetables contaminated with pathogens
- Human sources - Food handlers carrying pathogenic microorganisms
- Contaminated raw materials used in the manufacture of food products
- Food processing and handling equipments and utensils
- Contaminated transport and storage facilities;
- Pests

Microbial toxins. These compounds are released by microorganisms while growing in food and are involved in causing food poisoning. Foods should be free of microorganism and they should be stored properly at refrigeration to avoid re-contamination and toxin production.

4.2.2. Chemical hazards

Various chemical residues can contaminate food meant for human consumption. They include antibiotics, pesticides and herbicides, mycotoxins, plant toxins, disinfectants, bacterial enzymes.

Antibiotic residues. These may be found in

1. Milk as a result of animal treatment or after intentionally being added as a preservative by unscrupulous farmers,
2. Beef, poultry, pork, meat as a result of animal treatment
3. Eggs following treatment of birds
4. Other foods where it has been added as a preservative

Effects of antibiotic residues

1. Cause anaphylactic shock , allergic reaction or death, e.g penicillin, when a person is allergic to it.
2. Can cause cancer
3. Presence of antibiotic residues in milk can destroy starter cultures especially when making cheese and fermented milk products including yoghurt.

Control of antibiotic residues in food

- Ensure that the recommended withdrawal periods after animal treatment are observed before use of milk or slaughtering animals meant for provision of meat. Withdrawal periods depends on the antimicrobial agent administered In addition, there is need for regular testing of meat, egg and milk for presence of antimicrobial residues.



Figure 4.1: Testing of meat for presence of antibiotic residues

Notes for trainers

Trainers can at this point enquire from learners the actual practice as regards withdrawal periods after animal treatment. For example, are farmers aware of the need for withdrawal period after animal treatment and do they adhere to the withdrawal periods? Who gives them the information?

Could provide labels of veterinary antibiotics (injectable, oral, intramammary, uterine pessaries) and ask trainees to describe and comment on relevant information on the label.

Pesticides and Herbicides

These may be found in milk following animal dipping or spraying to kill ticks, food crops e.g tomatoes, cabbage, kales etc, following spraying for pest and weed control. These chemicals may be found in fodder, forage and fish muscle after accumulation in fat tissues. Pesticides can be shed in mother's milk to contaminate infants.

Effects. Pesticides have carcinogenic effects i.e can cause cancer in human beings consuming food contaminated with these pesticides. Control will include observation of recommended withdrawal periods before consumption of milk, meat or food crops sprayed with the pesticides.

Mycotoxins. Mycotoxins are molecules produced by certain fungi when in favourable ecophysiological conditions. They can be toxic for humans and some animal species when a certain quantity is ingested. The main mycotoxin producing fungi are *Aspergillus flavus*, *Aspergillus parasiticus* produce aflatoxins, *Fusarium moniliforme* and *Fusarium proliferatum* produce Fumonisin, while *Fusarium graminearum* and *Fusarium culmorum* produce Zearalenone.

Mycotoxins are ingested by animals with contaminated feed that are improperly stored. The compounds may be shed in milk. High doses of these compounds can cause acute toxicity that is characterized by haemorrhages in various parts of the body. Low doses cause cancer of the liver. Cereals and cereal products have high risk of contamination with molds which grow and multiply in such foods to produce mycotoxins that cause human illness and death. Cereals and cereal products have high risk of contamination with molds which grow and multiply in such foods to produce mycotoxins that cause human illness and death.

Plant toxins. Some plants contain toxic alkaloids that cause toxic effects in animals and human beings when they are consumed. People can avoid plant poisoning by consumption of plants that are known to be non-toxic. Animals should not be fed with toxic plants

Disinfectants. These are compounds used for cleaning of food containers such as iodides and hypochlorides. Residues may be left in containers which can be avoided by rinsing containers thoroughly. Ensure correct use of disinfectants and properly label bottles containing disinfectants Avoid decanting disinfectants into unlabelled containers.

4.2.3. Physical Hazards

Physical hazards including foreign bodies such as glass, plastics and metal can cause physical injury to the consumer of the food

4.3 Food hygiene

Food hygiene refers to all efforts applied along the entire food production chain that are aimed at ensuring food safety e.g. eliminating or excluding physical, chemical and biological hazards from contaminated food

Impact of food contamination

1. Cause food borne diseases
2. Cause huge costs in consumer suffering and loss of life.
3. Considerable costs arise due to lost production, recalls and disposal of faulty products.
4. Incidents often result in bad publicity and loss of market for the product.
5. Legal costs related to illness or loss of life.
6. Costs to national/local health service
7. Food loss due to spoilage and unfit food.

NOTES FOR TRAINERS

Trainers can discuss with trainees the various hygiene practices that will exclude or eliminate the various hazards from food meant for human consumption.

It is important for trainees to note that hazards enter food at every stage of the production chain and different measures need to be instituted to eliminate or exclude the hazards from food.

The hygiene practices must be applied across the food chain from primary production to the final consumer. Primary production is the part of the food chain up to and including harvesting, slaughter, milking and fishing. The following measures can be put in place at primary production of livestock to ensure safety of meat:

- Avoiding the use of areas where the environment poses a threat to the safety of meat e.g grazing animals on pasture contaminated with pesticides or radioactive waste.
- Prevent contamination of animal feedstuffs with mycotoxins and other poisonous substances.
- Control of animals diseases through regular vaccination and prompt treatment
- Strict observation of withdrawal periods for veterinary drugs after animal treatment.

The following measures should be implemented to ensure hygienic handling, transportation and storage of meat.

- Ensure animals sent for slaughter are free of infectious and zoonotic diseases
- Ensure hygienic slaughter and processing of meat
- Decontamination of carcasses by washing with water containing 100 ppm of chlorine
- Protection of meat from contamination by pests or by chemical, physical or microbiological contaminants or other objectionable substances during handling, storage and transport, and
- Prevent deterioration and spoilage of meat through appropriate measures which may include controlling temperatures and humidity of storage
- Proper disposal of any condemned meat and other materials in a hygienic manner,

4.5 Hygiene of Food Establishments

A food establishment can be a slaughterhouse, a meat market or a food processing plant. Food establishments should be located away from:

- environmentally polluted areas and industrial activities which pose a serious threat of contaminating food;
- areas subject to flooding unless sufficient safeguards are provided;
- areas prone to infestations of pests;
- areas where wastes, either solid or liquid, cannot be removed effectively.

Potential sources of contamination need to be considered when deciding where to locate food establishments. Establishments should not be located anywhere where, after considering such protective measures, it is clear that there will remain a threat to food safety or suitability. Slaughterhouses and food processing plants siting and construction are normally approved by the veterinary or health authorities.

The internal design and layout of food establishments should permit good food hygiene practices, including protection against cross-contamination of food between and during operations. Internal structures and fittings within food establishments should be built of durable materials and be easy to clean, disinfect and maintain.

Temporary/mobile premises and vending machines that include market stalls, mobile sales and street vending vehicles in which food is handled should be sited, designed and constructed to avoid, as far as reasonably practicable, contaminating food and harbouring pests.

Ventilation. Adequate means of natural or mechanical ventilation should be provided, in a food establishment in order to:

- minimize air-borne contamination of food from aerosols and condensation droplets; ;
- control odours which might affect the suitability of food; and
- control ambient temperatures and humidity to ensure the safety and suitability of food.

Ventilation systems should be designed and constructed so that air does not flow from contaminated areas to clean areas

Lighting. Adequate natural or artificial lighting should be provided in a food establishment to enable operations to be done in a hygienic manner.

Equipment Equipment used in the slaughterhouse or food processing plant should be made of non-toxic materials and should appropriately be located to facilitate maintenance and good hygiene practices. Equipment and containers coming into contact with food, should be designed and constructed to ensure that they can be adequately cleaned, disinfected and maintained to avoid the contamination of food.

Storage facilities, Adequate facilities for the storage of food, ingredients and non-food chemicals (e.g. cleaning materials, lubricants, fuels) should be provided. Food storage facilities should be designed and constructed in a manner to enable food to be effectively protected from contamination during storage, and provide an environment which minimizes the deterioration of food (e.g. regulation of temperature and humidity).

Separate, secure and adequate storage facilities for cleaning materials and non-food or hazardous substances should be provided.

Water supply facilities. An adequate supply of potable water with appropriate facilities for its storage, distribution and temperature control, should be available to ensure the safety and suitability of food.

Drainage and waste disposal facilities. Adequate drainage and waste disposal systems and facilities should be provided. They should be designed and constructed to avoid the risk of contaminating food or the potable water supply.

Cleaning facilities. Adequate and suitably designed facilities should be provided for cleaning food utensils and equipment. Such facilities should have an adequate supply of hot and cold potable water for cleaning purposes.

Personnel hygiene facilities including toilets should be available to ensure that an appropriate degree of personal hygiene can be maintained to avoid food contamination. Such facilities include: hand washing and drying facilities, a supply of hot and cold water; lavatories of appropriate hygienic design; and adequate changing facilities.

Containers for waste and inedible substances should be provided. They should be suitably labeled for easy identification. Containers used to hold poisonous/toxic substances should be identified and be away to prevent malicious or accidental contamination of food.

4.6 Slaughter facilities

Slaughter facilities vary in size and manner of construction depending on the demand of slaughter activities, available resources and climatic conditions. Slaughter facilities may range in size from small **gantry** hoist with a metal or wooden bar to suspend carcasses. They may or may not have roofs. The floor may be made of grass or may be concreted with a rudimentary drain. They are ideal for slaughtering 5-10 animals per day.



Figure 4.5: Unhygienic slaughtering in a makeshift slaughter slab in Kenya.

Slaughter slabs are usually made of concrete floor with or without a roof, and some form of drainage. They are usually ideal for slaughter of 10-50 animals per day. An ideal slaughter slab should be equipped with facilities for hygienic and humane slaughter, proper bleeding, dressing, meat inspection, adequate cleaning of intestine, high standard of sanitation, facilities for sterilization of slaughter tools, hand washing facilities, hygienic disposal of effluents and safe treatment of condemned carcasses. A slaughter slab should be enclosed and protected by a wall and should have an entrance for livestock and an exit for meat, inedible and edible offals. The slab should have a roof and the entrance and exit from the slaughter slab may be closed if necessary with gates that can be locked. The slaughter slab should have provisions for separation of blood from water. They should have two side open drains and sometimes a central screened drain which are critical for maintenance of clean and hygienic conditions. The drains should slope outside towards the main drain.

The slaughter slab should be provided with inspection facilities and a laboratory with a microscope and related accessories. It should have a trippery equipped with a washing troughs, tripe draining racks, a cooking tank for *C. bovis* infected carcass and a water tank, a condemnation pits with a lockable manhole cover for condemned meat. It should have adequate pit latrines provided with water stand for hand washing.



Figure: Slaughter slabs at Burao and Gebiley in Somaliland

Slaughterhouse. A slaughterhouse should be located in an elevated area far from residential or industrial areas in a spacious area. The site should be free from industrial pollution: odours, smoke, dust and ash and of easy access the to meat markets. It should have impervious floor slopping towards a drain, one or two floor rings to secure the animal prior to stunning where stunning casting pens are not installed). One or more iron equipped with hoisting gear, adequate overhead rails, skinning cradles with wheels, viscera and inspection table equipped with hooks for heart, liver and lungs., sterilization containers and suitable transport containers for feet, skin and intestinal tracts. A slaughterhouse should have adequate hot and cold water supply, water storage tanks, adequate facilities for safe effluent disposal, sufficient lighting both natural and artificial be provided to facilitate meat inspection and processes, washing facilities for slaughterhouse staff as well as edible and inedible handling facilities. The layout of the slaughterhouse should be such that there is separation of clean (post-mortem inspection, grading, chilling, freezing, cutting), from unclean operations (stunning, bleeding, skinning/flaying, evisceration and washing). Lairages should be rough to avoid skidding. They should be build with a good gradient for easy of drainage and cleaning. They should be fitted with lighting facilities and watering troughs.



Figure 4.2: H-Foods export slaughterhouse at Burao in Somalia. Overhead rails are made of stainless steel, while the walls and floors are made of ceramic tiles for easy cleaning and hygiene.



Figure 4.3: Hargeisa local sheep and goat slaughterhouse. The slaughterhouse has a roof while the floors and working tables are made of ceramic tiles and rails are made of stainless steel.



Figure 4.4: Dirty water in a surface tank used to wash carcasses. The safety of meat from this slaughter slab cannot be guaranteed.

NOTES FOR TRAINERS

Trainers can engage trainees in a discussion where each of the trainees can give personal experiences regarding slaughterhouse hygiene, cleaning operations and waste disposal.

What challenges affect proper maintenance of slaughterhouse hygiene?

4.7 Meat markets and butcheries

These are establishments where meat is retailed. They should be designed and constructed to permit good meat hygiene practices, including protection against cross-contamination. Internal structures and fittings within meat markets and butcheries should be soundly built of durable materials and be easy to maintain, clean and disinfected. The establishments should be well ventilated with adequate lighting, water supplies, hand washing and cleaning facilities, well maintained drainage and waste disposal facilities. However, the design and hygiene conditions of many meat markets and butcheries in many African countries is poor.



Figure 4.6: Unhygienic meat market at Borama. The work tables are made of wood and iron sheets. Meat is placed on paper cartons that cannot be cleaned.



Figure 4.7: Concrete built dirty work table in Borama meat market are not easy to clean and disinfect. The work tables require ceramic tiles.



Figure 4.8: Ceramic tiles placed on meat display table by one of the meat trader at Borama meat market. The table looks neat and easy to clean.

4.8 Slaughterhouse cleaning operations

Slaughterhouse cleaning involves dry and wet cleaning operations.

4.8.1 Dry-cleaning: This does not involve use of water. It involves:

1. Placing of items removed from carcass into specially provided containers or put down in correctly positioned chutes e.g. heads, feet, hooves, horns, stomach, hides and skins, fetuses should not be placed on the floor during operations.
2. Condemned material and trimmings are kept in the condemnation room.
3. Dropped waste scraps of meat, fat and pieces of bones should be swept using a broom or a squeezer, and then collected using a dust pan and kept in special waste containers.
4. Removal of thick deposit on equipment such as knives, pangas, axes, splitting saw, cradle floor and wall surfaces etc by scraped off with a hand brush or scraper because some detergents will not be effective on areas which are heavily soiled. The scrapped material are then collected using a squeezer or broom and a dust pan and kept in waste containers.

Note: Racks and trolleys should be provided in the gut room (tripery/guttery) where offal can be placed to drain blood. Offals should not be placed on the floor.

4.8.2 Wet-cleaning: Continuous cleaning as slaughter operations are going on is important to remove accumulating blood and ingesta spilled on the floors and walls. Floors, walls, and platforms should be hosed down with water while care is taken not to splash onto any dressed carcasses as this would result into contamination of carcasses. Brooms and

squeezers can be used to scrap any blood, flesh or ingesta that is stuck on the surfaces being cleaned.

4.8.3 Cleaning during breaks

Breaks during slaughtering operations may occur:

1. When a certain mob of animals have been slaughtered and more animals are being awaited to arrive in the slaughterhouse
2. When there is congestion of carcasses inside the slaughterhouse and there is lack of rollers and hooks
3. When there is a technicality which necessitate temporary halting of slaughter operations
4. When slaughterhouse personnel are due to go for tea or lunch break.

4.8.4 Cleaning after slaughter operations

Cleaning is the removal of all foreign materials(dirt or organic matter) from the equipment and working surfaces(slaughterhouse walls, floors and tables). Thorough cleaning will remove most organisms from a surface and should always precede disinfection and sterilization procedures. Disinfection and sterilization cannot be effective if thorough cleaning has not been done. Cleaning involve two components: (i). friction to remove foreign matter, and (ii) fluids to remove or rinse away contamination. In the Slaughterhouse setting, cleaning is done on a daily basis when all animals have been slaughtered for the day and immediately after slaughter hall is clear of meat. It involves the following five steps:

Dry-cleaning: It involves:-

- a) Collection of dropped waste scraps of meat, fat and pieces of bones
- b) Removal of thick deposit on equipment, floor and walls.
- c) Use of squeezers to remove blood from the floor

Wet cleaning(washing): It involves brushing and scraping using clean potable water. Plain water without detergent is used. The cleaning starts from higher parts of the building, rails walls and tables, equipments and later the floor. The floor itself is washed last. Sufficient and efficient brushes, brooms, hoses, rubber squeezers, buckets, and plain potable water should be provided. Warm water at less than 100° F (41°C) should be used in order to soften residues. Hot water or steam will cause blood residue to hold firmly.

Application of detergent solution: Detergents are defined as cleansing agents, solvents, or any substances that will remove foreign or soiling materials from surfaces. Detergents are used to dissolve proteins and oil that can reside on equipments or surfaces after use. Detergents lower surface tension and lift dirt or oil away from the equipment or surface. Specific detergents commonly used are hot water, soap, soap powders and cleansers. The detergent solution should be made up to the recommended concentrations and applied to the surfaces being cleaned. It is not advisable to sprinkle neat detergents on surfaces to be cleaned. Detergents must not affect the colour, taste or odour of meat. Efficiency of the detergents usually increases with temperature up to 140°F (60°C). This process of cleaning removes fat, grease and film of dirt from the surface.

The three basic phases of detergent action and use are penetration, suspension and rinsing. The following are the actions and agents required for each phase.

Penetration. The cleaning agent must penetrate between the particles of soil and between the layers of the soil and surface to which it adheres. This action, known as *wetting*, reduces surface tension and makes penetration possible. Agents are: hot water, soaps and synthetic detergents, which are rather fragile suds formers.

Suspension. An agent is required to hold the loosened soil in the washing solution so it can be flushed away and not re-deposited. For fat particles, an emulsifying action is required to saponify the fat and carry it away. Soap, highly alkaline salts, and non-ionic synthetics may be used. For protein particles, colloidal solutions must be formed by peptizing (known also as sequestering or deflocculating). This action prevents curd formation in hard water.

Rinsing. The agent used must remove and flush away soils and cleaners so they are not re-deposited on the surfaces being washed. Clean, clear hot water is usually effective alone. The walls, equipment and floor should be rinsed well with cold or more potable water to remove the detergent before application of a suitable disinfectant.

Disinfection. This is the process of destroying pathogens on slaughterhouse equipment, containers and working surfaces to make them safe for intended use. Disinfection is achieved by use of disinfectants. Disinfectant is a chemical agent that destroys most pathogens but may not kill bacterial spores. Disinfectants are chemicals used to destroy microorganisms of equipment used. Most disinfectants do not kill all microorganisms that are present on equipment and working surfaces, but will reduce their numbers to a level that is not harmful to human health. Sodium hypochlorite is the commonly used disinfectant in food industries. Some bacteria may develop increased resistance after prolonged contact with some disinfectants. As a result disinfectants should be changed after every 3-4 months.

Antiseptics. These are chemicals used to kill microorganisms on the skin as in hands of slaughterhouse workers.

Sterilization. This is the process of removing or destroying all forms of microbial life including bacterial spores using physical or chemical means. Sterilization is accomplished commonly by steam under pressure, by dry heat and by chemical sterilants. The choice of the method for sterilization depends on a number of factors including:

1. the type of material that the object to be sterilized is made of,
2. the number and type of microorganisms involved, and
3. Availability of sterilization methods.

In many food industries, sterilization of equipments, meat containers and working surfaces is achieved by steam under pressure, or use of hot water at 90°C.

All surfaces and equipment should be rinsed off with potable water before starting work where chemicals had been applied and left overnight.

1.8.5 CLEANING SCHEDULE

Three levels of cleaning may be identified. These are:

(1) Ongoing 'clean as you go' . This is the cleaning that take place when slaughter opearions are going on. Both dry and wet cleaning are used to ensure hygiene of the slaughter facility. Containers /chutes should be used for feet, hides, offals , trimmings and waste scraps to make the cleaning easier. Cleaning operations must be frequent to prevent any buildup of bacteria especially trollies and hooks that come into contact with meat.

(2) Daily Cleaning . This is the type of cleaning done immediately after completion of the day's slaughter operations. A good system of dry cleaning will ensure operations ahat the daily cleaning operations after the slau ghtering is rendered more effective. Cleaning should commence immediately after operations have ceased, before fat has had time to harden. Detergent is first applied followed by sanitizer(disinfectant). Hot water of steam at 80°C is used as a sanitizing agent.

(3) Weekly cleaning. This involves thorough cleaning and disinfection and/or sterilization of the less accessible areas possible overlooked during daily clean-ups especially larger equipment which hide strippers and dehairers, behind scalding tanks, chill rooms and doors, loading bays, top walls and upper surfaces, dressing line, beams and lamps, lairages, windows, wash rooms offices stores-all must be cleaned and disinfected at least once a week.

Surplus water used for cleaning the chill room should be swept outside to minimize the risk of freezing and slipperiness.

4.9 Environmental hygiene of slaughterhouses

4.9.1 Fencing. The slaughterhouse compound must be fenced with chain link wires to prevent access of unauthorized persons and other animals and pests. This prevents contamination from outside. There should be one or two gates on the fence where strict control of incoming and outgoing should be maintained. A good and well maintained fence is beginning of proper hygiene in a slaughterhouse.

4.9.2 Compound cleaning

- Cutting of grass, clearing of bushes and filling of potholes
- Collection of papers, old ropes, cans, horn and tail switches and burning them
- Regular collection of manure from shed and subsequent clearing
- Proper disposal of condemned materials in lockable pits
- Proper washing and disinfection of the lairage and races,
- Pave the external surface of the slaughterhouse, including drive way and vehicle washing stands
- Top part of the condemnation pit and blood tank, grease trap and drains
- Meat containers/carriers
- Control of birds, insects, rodents cats and dogs
- Proper liquid waste disposal

Lairages, race, drains, loading bay, offices and wash rooms, top part of the grease trap, condemnation pit, blood tank, and manure shed; should be washed on daily basis and disinfected.

4.9.3 Pest control

Pests which include rodents (rats; mice, insects, cockroaches and ants) may be also be found in food. Their presence in food is important due to: (i) aesthetic aspect of their

presence, (ii) possible transmission of pathogenic agents, (iii) consumption of food thus compete with human beings. Therefore, it is essential for operators of food establishment to try to effect complete elimination of resident pest infestations and then to correct conditions within the establishments so that pests cannot gain entrance in the future.

Rodents and insects such as rats, mice, flies, cockroaches, grain insects, fruit flies and gnats all facilitate the transmission of communicable diseases; therefore, it is essential for any foodservice to try to effect complete control and eradication of pests and then to correct conditions within the establishments so that pests cannot gain entrance in the future..

Preventive measures: Use of screens to help keep out flies, covered trash and garbage cans closed cracks and crevices in walls and around equipments and areas around pipes and clean store rooms, removal of food sources, conditions that encourage infestation and harbourage/nesting of pest in premises. The use of certain residual insecticides is effective treatment when there is no danger of polluting food, whereas the use of less toxic insecticides is recommended for contact spraying.

Pest proofing the building to prevent access is the best preventive measure for making it free of the rodents. This means the closing of openings as small as one half inch diameter, placing rat guards on all wires on both inside and outside of pipes leading into the building, and careful joining of cement walls and foundations of the building. Trapping and the use of rodenticides are part of the rodent-control program and are used either inside or outside the building. Mention ongoing pest monitoring arrangements.

4.10 Personnel health status (medical fitness)

Slaughterhouse staff refers to anybody involved in all stages of slaughter, dressing, cleaning, inspection, loading and transportation of meat, washing and cleaning of equipment and all slaughterhouse premises.

- (a) A food handler must be healthy and free from communicable disease e.g. tuberculosis and salmonellosis.
- (b) They must go for medical check-ups after every 6 months

Personnel suffering from boils, nose or throat infections, intestinal disorder (diarrhea) should not handle meat. Their health status will have an impact on the level of bacterial contamination of meat and this can spread infection to the whole community. Cuts and wounds should be dressed up nicely. Dressings on hands must have a waterproof covering to prevent anything passing through the bandages from the wound.

In addition to medical screening, there is need to exclude people who are suffering from communicable diseases from working in food establishments until they are treated and healed. Slaughterhouse or food business managers should encourage prompt reporting of diarrhoea and vomiting by their workers. Anyone who has diarrhoea and vomiting should report to their line managers and leave the slaughterhouse or food handling facility immediately to seek medical attention. Workers can return to work if no vomiting and or diarrhoea occurs within 48 hrs once treatment has ceased. Anyone suffering from typhoid or paratyphoid fever must be excluded from slaughtering/food handling until stool tests indicate that the infecting organism is no longer being excreted. This will generally take at least three months. Ensuring that food handlers are free of communicable illnesses is an important part of the roles/duties of public health inspectors.

4.11 Personal Hygiene of slaughterhouse workers

- Workers must wash their bodies regularly and keep nails short
- Nail polish and dyes on nails and hands should be discouraged.
- Beards should be shaven or covered.
- The hair should be short, clean and tidy. The hair should either completely covered with a clean cap or hat or confined by a hairnet to prevent hair falling into products
- Ornaments such as rings watches, bangles should be removed.
- The following must be avoided: heavy perfumes, use of lipstick, false eyebrows and eye shadows.
- All meat handlers and persons in a room handling meat should wear CLEAN protective clothing's (overcoat, cap, plastic apron, and gumboots). They should be of light color, preferably white and be clean and tidy.
- Washing facilities should be provided where workers can wash before leaving and a canteen where they could take refreshment and rest during breaks.

Soiled (dirty) clothes in food premises are a sign of general slovenliness and indicate that hygiene is not of high standard.



Figure 4.9: Slaughterhouse workers dressed in their protective clothing. The cleanliness of personnel and the external environment of the slaughterhouse is satisfactory.

4.12. Personnel Education/Training

Slaughterhouse staff (food handlers) should be made fully aware of and conversant with the need for occupational hygiene, not only to avoid infection and food contamination but also from becoming carriers of infection to their families and communities. Education on good standards of health and hygiene and its importance is essential. Staff should be educated on:

- (a) Hygienic slaughter e.g using only properly washed and sterilized equipments e.g knives, pangas, axes, saws.
- (b) Maintaining cleanliness of the personnel, operation area and the environment.
- (c) Operations and equipments in use in the slaughterhouse
- (d) How and why unsanitary practices should be avoided.
- (e) Thorough washing of hands with soap after visiting toilet, smoking, coughing or sneezing, handling of money, garbage or soiled or infected material.
- (f) Knowledge that negligence may be detrimental to the whole community.

Personnel should be taught to avoid the following unsanitary practices (or bad habits)

- Walking aimlessly while operations are going on
- Unguarded coughing and sneezing can spread pathogenic and respiratory bacteria:
- Spitting on hands to enable firm gripping of an axe, panga e.g. while splitting carcass
- Licking of fingers to pick up items e.g. papers, utensils, paper towels or wrapping papers or to turn over the pages of a book
- Cutting of finger nails using teeth or by using slaughter or meat inspection knife
- Placing the pen, fingers in the mouth
- Any contact saliva will transfer salivary bacteria to the hands or fingers
- Blowing paper bags to open them
- Shaking of hands in the slaughterhouse
- Smoking of cigarettes, bhang or sniffing of tobacco
- Touching and placing of meat anyhow
- Chewing sweet-gum
- Blowing or wiping of nose using bare hands or protective clothing
- Scratching of head, use of mobile telephones
- Nose picking (removal of dried mucus from nostrils) placing fingers in or around the nose, mouth etc removal of ear wax using fingers, keys, pen, match stick and then rubbing it on the hands or protective clothing
- Eating, brushing of teeth, chewing miraa, Urinating near food
- Taking beer/drunkenness during operations
- Changing of clothes near food/meat
- Confrontations, fighting, playing in the slaughterhouse
- Stealing of meat
- Placing meat, knives, sharpening steel in the gumboots
- Washing the apron and protective clothing on the slaughterhouse floor.

NOTES TRAINERS

The trainer can request trainees to give an account of their experiences in their respective areas of work regarding:

1. Personnel hygiene practices
2. Medical check up of workers
3. Management of accidental injuries during working hours (e.g knife cuts)
4. Availability of facilities e.g. protective clothing, washrooms toilets etc.
5. Constraints they experience in maintaining appropriate standards of personnel hygiene.

4.13 Disposal of slaughterhouse waste

Disposal of slaughter waste is a problem in many African countries. It is not uncommon to find slaughterhouse wastes including carcass trimmings, horns, hooves, bones, and manure accumulating in the vicinity of the slaughter facility causing environmental contamination. Slaughterhouse wastes from slaughter facilities in Mogadishu are improperly disposed leading to environmental contamination(Figures 4.10 and 4.11)



Figure 4.10: Wastes from a slaughterhouse in Mogadishu that are improperly disposed



Figure 4.11: Bone wastes from a slaughterhouse in Mogadishu accumulate in the environment.

UNIT 5: FOOD BORNE DISEASES, CONTROL AND PREVENTION

5.1 Learning objectives

By the end of this unit, participants should be able to:

1. Identify and describe the various types of food borne diseases
2. Explain strategies required for control and prevention of foodborne diseases in the community.
3. Identify the various biotoxifications and their effect on human health.
4. Describe factors that contribute to occurrence of foodborne diseases in the community.

5.2 Food borne diseases

Food borne diseases are diseases that are transmitted to humans through consumption of a disease agent in the food. Food borne diseases are classified into two categories

1. Food borne infections
2. Food borne intoxications.

Foodborne infections/diseases are caused by consumption of food contaminated with pathogenic microorganisms. These can either be fungal, bacterial, viral or parasitic. Bacterial food borne infections are the most common. Food borne infections tend to have long incubation periods and are usually characterized by fever. They include bacterial (salmonellosis, cholera, typhoid fever, shigellosis, *Yersinia enterocolitica* infection, *E. coli* infections, campylobacteriosis, *Listeria monocytogenese*, mycotic (*Candida spp.*, *Sporothrix spp.*, *Wangiella spp.* etc), viral (hepatitis A and poliomyelitis),

5.2.1 Bacterial Food borne Infections

Salmonellosis

The salmonellae organisms are capable of causing disease in animals and man when taken into the body in sufficient numbers. The salmonella species involved in food poisoning include; *Salmonella typhimurium*, *Salmonella enteritidis*, *Salmonella dublin*, *Salmonella softenburg*, *Salmonella virchow*, *Salmonella montevideo*, *Salmonella infantis*, and *salmonella newport*. These species are also involved in causing diarrhea in animals. In some cases, they are nosocomially transmitted between people in hospitals.

Clinical signs in man

Salmonella food poisoning is characterized by symptoms which appear 12 hours after consumption of food. Symptoms include are abdominal pain diarrhea, chills, fever, vomiting, headache, prostration, and malaise.

Reservoir

The primary reservoir of salmonella bacteria is the vertebrate intestine, which means that almost all animals could excrete the organisms. Animals and human beings might harbor salmonella bacteria without showing any signs of the disease, thereby acting as carriers of the disease.

Factors affecting spread of salmonella infection

Species of salmonella: where some species such as *S. dublin* are more persistent in the environment compared to others (e.g. *S. typhimurium*). Increased persistence enhance the chances of spread of the disease.

Carrier state: The carrier animals in a herd will act as a source of infection for other animals

Intensive farming system: This concentrates salmonella in the environment which contribute to an increase in new salmonella infections. In range sheep, the commonest occurrence of salmonellosis is during drought time when sheep are concentrated in a small area of surviving grass which get heavily contaminated by faecal droppings.

Intensive grazing/pasture utilization: Ingestion of contaminated feed is the principal means of infection. Consumption of pasture is responsible for an increase in new infections. Temperature and wetness are important for multiplication of salmonella in the environment. The organisms can remain viable on pasture and in the soil, still water and in faeces for 7 months. Pastures contaminated by human sewage is a potential source of salmonella infection. Infected drinking water i stagnant ponds is also a significant source of infection.

Contaminated feedstuffs including meat and bone meal, and fish meal can spread salmonellosis. Such animal feeds need to be heated to 82°C for an hour to sterilize the feed. Stored feed especially grains are commonly contaminated by the droppings of rodents. Such grains may infect animals leading to outbreaks of salmonellosis.

Vectors such as free flying birds and infected nematodes/larvae can spread salmonellosis in in livestock farms.

The prevalence of salmonellosis estimated to be 4% in cattle

Transmission to food

Salmonellae reach food in many different ways; either directly at slaughter from animal or human excreta, from where they are transferred to food through hands, utensils, equipments, flies etc. Cross contamination from sick animals may occur during transportation and at the lairage of the slaughter facilities. Contamination of meat may occur at slaughter from hides/skins of dirty slaughter animals, during evisceration if there is puncturing of the stomach spilling its contents, meat handlers and from contaminated wash water. Animals may be infected by drinking from puddles of water contaminated by previous group of animals. In addition, soiling of meat may occur during preparation and during storage due to poor handling.

. Foods involved

Almost any food may be contaminated with salmonellae and under conditions of mishandling such food may become involved in the transmission of salmonella. The foods commonly involved are the various animal derived foods, like meat and meat products, milk and milk products, and egg and egg products especially from infected animals. Flies, rats, and mice may transfer salmonellae from fecal material to food.

Contaminated water can also act as a carrier by contaminating other foods, but is not directly the vehicle causing the disease since salmonella bacteria are found in very low numbers in water.

Control

1. Improvement of sanitation and to prevent mishandling of foods.
2. Control of Salmonella in primary production of domestic animals and
3. Good hygienic practices including control of contamination of meat/foods during animal slaughter and processing
4. Destruction of salmonella in raw products by thorough cooking and processing.
5. Use of feedstuffs that are free of salmonellae.
6. Hygienic standards of animal husbandry including proper control of slurry disposal,
7. Potable water supply and food protection from insects and rodents.
8. Proper design of the slaughter lines and the adoption of efficient hygienic methods of slaughter and carcass dressing which minimizes contamination.
9. Proper sewage treatment and disposal.
10. Bacteriological monitoring, which should include a presence /or absence tests for salmonellae.
11. Proper cooking of egg and milk products and keep them cool.

Typhoid/Paratyphoid fever (Enteric fevers)

Enteric fevers include typhoid and paratyphoid fevers caused by *Salmonella typhi* and *Salmonella paratyphi* A, B and C respectively. The typhoid and paratyphoid fevers are clinically and pathologically similar regardless of causal agent and only bacteriological examination can differentiate between them. The serotypes are similar to other salmonella bacteria, but unlike them, they only affect man. The bacteria can be transmitted through contaminated water, milk or food. Only a few organisms are needed to cause disease.

The disease symptoms

The incubation period is usually about 2 weeks, but might vary between 3 and 28 days for typhoid fever and between 1 and 15 days for the paratyphoid fevers. The abdominal symptoms are severe, while fever and illness may continue for 4-6 weeks. Generally the paratyphoid fevers have a short duration. The case fatality rate is approximately 10 %.

Control measures

1. Hygienic control of food and water supplies
2. Detection and treatment of chronic carriers and
3. Vaccination using TAB-vaccine. Protection by this vaccine is maintained for 5-7 yrs.

Campylobacteriosis

Campylobacteriosis is a foodborne disease caused by *Campylobacter jejuni* and *Campylobacter coli* which are associated with acute enterocolitis in man. The disease can be acquired from a variety of animals including poultry, pigs, wild animals and birds. The organisms are important causes of diarrhea illness in all age groups of persons throughout the world. *Campylobacter jejuni* occur in large numbers in cattle feces, and poultry as normal flora. Infection in humans is characterised by gastroenteritis and diarrhea.

Symptoms of the diseases: The disease causes diarrhea, abdominal pain, fever, nausea, vomiting, and abdominal complaints. Death only occurs due to other complications. The

condition is self-limiting lasting up to 10 days. The jejunum and ileum are primarily affected with extension to the colon resulting in acute inflammation and in occasions abscess formation.

Mode of infection

Infection occurs by ingestion of organisms in contaminated foodstuffs and water. Incriminated food includes meat or water, or from contact with infected animals, unpasteurized milk and possibly cross-contamination from these sources to foods eaten uncooked or unrefrigerated. Carelessness in the kitchens e.g. cutting chickens with the same knife used to cut other foods without prior cleaning. Pork is a major source of *C. coli*, which is mostly found as commensals in pig intestines, Contamination of pork occurs during slaughter. Red meat e.g. lamb and beef are not major causes.

Preventive measures

1. Thorough cooking of all foodstuffs derived from animal sources especially poultry.
2. Prevention of re-contamination after cooking.
3. Proper refrigeration of foods.
4. Recognition, control and prevention of campylobacter infections in animals, and
5. Maintenance of high standard of hygiene.

***Escherichia coli* food borne infection** *Escherichia coli* are potential food poisoning pathogens which are widely distributed in food environments in low numbers. *E. coli* strains involved in food borne gastroenteritis fall into the following groups :(i). Enteropathogenic *E. coli* (EPEC), (ii). Enterotoxigenic *E. Coli* (ETEC), (iii). Enteroinvasive *E. coli* (EIEC) and (iv). Enterohemorrhagic *E. coli* (EHEC). Each class is composed of various and often unique O:H serotypes and posses virulence characteristics of that class. The serotypes are characterized by using O-somatic and H-flagella antigens.

Enteropathogenic *E. coli* (EPEC)

Infection with EPEC strains occur through consumption of contaminated food and water. They produce moderate to severe watery, dehydrating diarrhea, which may be associated with fever, respiratory symptoms and abdominal distension. Duration of illness on average is about one week, but some patients may have a longer course. EPEC is one of the few known causes of chronic diarrhea in infants. Risk factors of death include: young age and virulence of associated EPEC strain. Case fatality can be 70 % in children less than 2 years.

Enterotoxigenic *E. Coli* (ETEC)

Infection with ETEC strains occur through consumption of contaminated food and water. The strains produce either heat stable enterotoxin (ST) or a heat labile enterotoxin (LT), or both, as well as colonizing factor antigens that mediate binding of cells to epithelial cells. These strains colonize the human small intestines and cause an influx of secretions mediated by the action of ST and/or LT enterotoxins.

Symptoms. The illness consists of watery non-bloody diarrhea, abdominal cramps, and little or no fever. The symptoms usually lasts for 4 to 5 days, and illness is mild in majority of patients, but a dehydrating cholera-like picture may occur. The disease is however self-limiting, and is common in children less than 5 years old. ETEC strains are the major

etiological agents of travelers' diarrhea. The illness is common among groups traveling from low risk areas to high risk areas (e.g. developing countries). A relatively large inoculum $>10^8$ cells/g is necessary to produce disease in adults. **Preventive measures:** Assurance of safe food and water.

Enteroinvasive *E. coli*

Infection with EIEC strains occur through consumption of contaminated food and water. The strains cause illness similar to shigellosis, as they have antigenic relatedness to shigella. EIEC strains usually produce watery diarrhea in most patients. In addition, there is fever, nausea, and abdominal cramps. Bloody diarrhea may occur in fewer than 10 % of patients. The presence of mucus and polymorphonuclear leucocytes in stool is typical of these strains.

Illness is usually self-limiting, lasting for 2 to 3 days. A relatively high dose (10^8 cells) is necessary to produce disease in volunteers. The median incubation period is 18 hours (range 2-48 hrs).

Enterohemorrhagic *E. coli*

Escherichia coli serotype O157:H7 causes hemorrhagic colitis in humans. The serotype does not ferment sorbitol or may do it slowly, but produce a verotoxin which is cytotoxic to vero culture cells. Infection involves all age groups and has been linked to ingestion of contaminated hamburger and beef in many outbreaks.

EHEC infection is characterized by diarrhea, abdominal pain which may be severe and vomiting. Few patients develop fever. Illness lasts for 4 to 8 days, although it may extend to 13 days for severe cases. Patients with complications have bloody diarrhea, acute ulcerative or ischemic colitis and sub-mucosal edema with severe colonic inflammation. Deaths due to *E. coli* O157:H7 infections have been reported only in elderly patients and in patients who develop the hemolytic uremic syndrome (HUS). HUS can be recognized by acute renal failure, microangiopathic hemolytic anemia and thrombocytopenia. Infection also precedes thrombotic thrombocytopenic purpura (TTP), an illness that shares many clinical features with HUS.

Control measures involve proper cooking of food and other meats, avoidance of cross-contamination of foods in the kitchen and good personal hygiene. Assurance of safe food and water is the best protection against diarrhea due to ETEC strains.

Listeriosis

Listeria monocytogenes is a gram positive bacterium that is pathogenic to both animals and human beings. In animals, it causes abortion and mastitis, while in man it can cause abortion in pregnant women as well as meningitis in newborn infants and immunocompromised adults. Pregnant women, infants and elderly people are at particular risk from listeriosis. The infection is fatal in susceptible individuals with a mortality of 25-30%.

Mode of infection: The disease is spread through consumption of food contaminated with *Listeria monocytogenes* type 1-4.

Vehicle foods

Outbreaks of listeriosis have been associated with the consumption of various foods including milk, ice cream, cheese, poultry, sauerkraut, salads, sea foods, meat and meat products contaminated by *Listeria*. Raw milk or cheese made of unpasteurized or insufficiently pasteurized milk play an important role in the epidemiology of the disease.

Preventive measures

Consumption of properly cooked or processed food.

5.2.2 Viral Zoonoses

Infectious hepatitis (Viral hepatitis A)

This is caused by hepatitis virus A. The incubation period is long, being an average of 30 days (range 15-50 days). It is a systemic infection characterized by gastrointestinal manifestations and liver injury, fever, malaise anorexia, lassitude, nausea, abdominal discomfort, bile in urine and jaundice. The duration of the disease could be from a few weeks to several months.

Hepatitis A may be acquired from fecal contaminated food or water, or from direct contact with infected individuals. Person-to-person transmission is particularly common between children and between sexual partners. Feces, urine, blood of infected human cases and persons incubating or convalescing from the disease are infectious materials. Foods mostly involved are shellfish, water, milk and fruit juices.

Control

1. Foods should be cooked thoroughly, virus survives 50 °C for 30 minutes but are destroyed at 63°C
2. Diluting juices using portable water
3. Shellfish should not be collected or produced in polluted waters
4. Personal hygiene
5. Vaccination of contacts, and
6. Serovaccination with immunoglobulin.

Viral hepatitis E

It is a waterborne infection that occurs as epidemics and/or sporadic cases. The virus has been isolated from hepatitis epidemics in many countries including Kenya. The disease primarily affects young adults, and is clinically similar to hepatitis A but does not lead to chronic disease. However, among women in the second or third trimester of pregnancy who contract the disease, about 15-20 % die of hepatitis.

Infection is acquired from fecal contaminated food or water.

Control

Proper cooking of food to eliminate the virus

Poliomyelitis

Poliomyelitis is an acute viral illness where the majority of infections remain inapparent. Manifested illnesses include paralytic and non-paralytic forms. This disease occurs commonly in older people when infected. Symptoms mostly seen are those of lower extremities, meningitis and general illness.

Reservoirs and epidemiology

Faeces and pharyngeal secretions contain the virus. The main route of transmission is oral-oral and fecal-oral routes. Foods involved include water and milk which get contamination with feces, and pharyngeal secretions of infected persons. The virus can be cultured from

stool, pharyngeal swabs and spinal fluids of diseased patients. Serology e.g. CFT is frequently used for diagnosis.

Control

Vaccination against the disease is the most important measure. Live and killed vaccines are available. Personal and food hygiene must be practiced.

5.2.3 Rickettsial foodborne infection

a). Q-Fever

Q-fever is caused by *Coxiella burnetii* and has an incubation period of between 2-4 weeks. Symptoms include a sudden onset of fever, dry cough and chest pain due to a pneumonitis. Hepatic disorders which include slight jaundice occur in severe cases. Mortality is low with complete recovery.

Reservoir and epidemiology

Q-fever is mostly an occupational disease among people who handle livestock and raw animal products (e.g. farm and slaughterhouse workers etc). Consumption of raw milk, contaminated butter and cheese, contact with infected placentas, contaminated straw beddings and animal carcasses or slaughterhouse offal are considered important.

Diagnosis

1. Serology including CFT micro-agglutination and FAT.
2. Isolation of agent (in well equipped laboratory due to the high risk of infection).

Control

1. Pasteurization of milk (heating at 66°C for 30 min or 75°C for 15 sec).
2. Safe disposal of offal

5.3 Food borne intoxications

Food borne intoxications are diseases caused by consumption of:

1. Toxins which are naturally produced by certain plants and animals.
2. Metabolic products (toxins) formed and excreted by microorganisms (such as bacteria, fungi and algae), while they multiply in food, or in gastrointestinal tract of man.
3. Food containing poisonous substances, which may be intentionally or unintentionally added to food as a result of producing, processing, transporting or storing.

Food borne intoxications have **short incubation** periods (minutes to hours) and are characterized by lack of fever. Food borne intoxications can be classified into:

- (1). Bacterial intoxications
- (2). Fungal intoxications
- (3). Chemical intoxication

- (4). Plant toxicants and
- (5). Poisonous animals.

5.3.1 Bacterial food borne intoxications

***Staphylococcus aureus* intoxication**

This is a type of food borne intoxication caused by consumption of food contaminated with staphylococcal enterotoxins produced by certain strains of *Staphylococcus aureus* while growing in food. The organism produces serologically different enterotoxins. Five staphylococcal enterotoxin A (SEA), Staphylococcal enterotoxin B (SEB), Staphylococcal enterotoxin C (SEC), Staphylococcal enterotoxin D (SED) and Staphylococcal enterotoxin E (SEE) have been involved in food poisoning. Individual strains of **S. aureus** may produce one or more enterotoxin types in food or in culture. The percentage of the strains that are enterotoxigenic differ widely depending on the source of the isolate.

Nature of enterotoxins

All the staphylococcal enterotoxins are heat stable (withstanding heating at 100°C for one hour) and ordinary cooking procedures, pasteurization and drying do not inactivate these enterotoxins. They are insensitive to pH changes (pH stable) and resistant to most proteolysis enzymes (trypsin, chymotrypsin, renin, papain and pepsin). The enterotoxins are also not affected by irradiation..

Vehicle foods. Majority of *S. aureus* food poisoning are due to foods in which the microbial flora is substantially reduced, where they grow well and produce high yields of enterotoxins. Such foods include boiled/cooked or processed milk and meat, cured meats and meat products which are later contaminated. Other foods include cream filled pastries, poultry, fish, shellfish, non meat salads, egg and egg products, vegetables and cereal products. Increased handling of foods increases contamination with enterotoxigenic *S. aureus*.

Reservoirs

Staphylococci are found in varying numbers in air, dust, water, food, feces and sewage. The primary habitat of *S. aureus* is the mucous membranes of the nasopharynx and skin of man, animals. Contamination of foods may be traced to food handlers with minor septic hand infections or severe nasal infections, with subsequent heavy growth of the organism on the food medium and production of sufficient enterotoxin to evoke gastrointestinal symptoms in man.

Mode of transmission

1. Contamination from food handlers, containers etc
2. Cross contamination from raw foods
3. Improper heat treatment of raw foods

Disease symptoms in man

Symptoms of staphylococcal food poisoning occurs 1-6 hrs after consumption of food contaminated with at least 1.0 microgram of enterotoxin. Clinical signs include salivation, nausea, vomiting, abdominal cramps, sometimes diarrhea with prostration. It has an attack

rate of 5-100%, but fatalities which occurs in children, the old and debilitated victims are rare. Duration of illness is 24-72 hrs. Dose of 1.0 µg or more is needed to cause disease.

Preventive measures

1. Practice good personal hygiene including good personal conduct in food establishment and when handling food.
2. Fast cooling of cooked food and keeping such foods at low temperatures.

***Bacillus cereus* food borne intoxication**

This is a food borne intoxication caused by consumption of enterotoxins produced by some strains of *Bacillus cereus* bacterium. The organism is facultative anaerobic, spore-forming, Gram-positive and motile by peritrichous flagella. Germination and growth of spores occur at temperatures between 4-55°C (optimum 28-38°C) and pH range 4.3-9.3. Spores are highly resistant to heat dehydration and other destructive factors.

Reservoirs

Bacillus cereus is widely distributed in nature and are normally present in soil, dust and water. Spores of this organism may contaminate food and especially of plant origin such as cereals, potatoes, and spices. Spores may also be found in milk, meat and meat products.

Cause of intoxication

Bacillus cereus food poisoning is caused by ingestion of any of the following enterotoxins produced by these organisms while growing in food:

1. **Diarrhea enterotoxins.** The diarrhea enterotoxins are heat labile, sensitive to enzymes trypsin, and pronase, and pH changes. They are most stable at pH range of 5.0 to 10.0, but losses activity rapidly outside this range. The toxin causes diarrhea syndrome when consumed in food
2. **Emetic toxin (cerulide).** The toxin is produced in food by some strains of *B. cereus* especially H-1 serovas. The toxin is a heat stable (withstand 126°C for 90 min) and resistant at pH range 2-11. It is resistant to trypsin and pepsin and remains active at 4°C for 7 days. The toxin causes emetic syndrome when consumed in food.

Vehicle foods

Bacillus cereus is a common soil saprophyte that is easily spread to many types of foods, including meat, eggs, dairy products. Cereal dishes such as rice, spice, mashed potatoes, herbs and vegetables. However, *Bacillus cereus* does not compete well with other microorganisms but spores can withstand heating at 100°C for 5 min. Spores of some strains can withstand even higher temperatures (135°C for 4 hours) and particularly if food has a high fat content, which seem to have a protective effect. Spores grow well after cooking and cooling to 48°C during storage. The heat treatment causes spore germination, and in the absence of competing flora, *B. cereus* grows well and produce enterotoxins. Some additives such as garlic extract have an inhibitory effect on bacterial growth.

Mode of transmission to foods

1. Contamination due to improper handling.
2. Insufficient heat treatment to destroy spores.

Symptoms of disease in man**1. Emetic syndrome**

The syndrome is characterized by nausea, vomiting, abdominal cramps and sometimes diarrhea that occur 1-6 hrs after consumption of contaminated food.

2. Diarrhea syndrome

In the diarrhea syndrome, patients experience profuse watery diarrhea, abdominal cramps and tenesmus, beginning 8 to 16 hours after ingestion of contaminated food. Fever is absent and symptoms resolve within approximately 12 hours.

Prevention

1. Good hygiene should be observed.
2. Low temperature and fast cooling of food.

***Clostridium perfringens* foodborne intoxication**

This is a food borne intoxication caused by *Clostridium perfringens* enterotoxin (CPE) produced in the gastrointestinal tract by enterotoxigenic strains of *C. perfringens*. This organism is a spore-forming, anaerobic, gram positive bacillus. The organism is found in the soil, dust, water, sewage marine sediments, decaying materials, intestinal tracts of humans and other animals. Food poisoning strains have a variety of origins including human and animal faeces, abattoirs, sewage and flies. Spores produced by these organisms can resist boiling for 4 or more hours. If the spores are present as contaminants on raw meat they may resist boiling or steaming, and on slow cooling the spores will germinate into rapidly multiplying bacterial cells which produce large amounts of toxin.

Cause of intoxication

Clostridium food borne intoxication is caused by the ingestion of food containing large numbers of vegetative cells of enterotoxigenic *C. perfringens* type A and some type C and D strains. These cells multiply in the intestine and sporulate releasing *Clostridium perfringens* enterotoxin (CPE). Sometimes CPE may be pre-formed in food, and once the food is consumed, symptoms may occur within 1-2 hours. The strains are heat resistant and survive heating at 100°C for 1 hr). CPE is heat labile (destroyed at 60°C for 10 min) and its activity is enhanced by trypsin.

Vehicle foods. The food involved are those that are prepared one day and served the next day. The heating of such foods is inadequate to destroy heat resistant endospores, and upon cooling and warming the endospores germinate and grow. Cooking kills the vegetative cells of *Cl. perfringens* but activates surviving spores which will germinate and multiply

Mode of transmission to foods

1. Directly from slaughter animals

2. Contamination of slaughter meat from containers, handlers dust, water etc.

Symptoms of disease

Symptoms appear 6-24 hours after ingestion of a large number of viable vegetative cells $\geq 5 \times 10^8$ /g of food, but not after ingestion of spores. The symptoms include nausea, intestinal cramps, pronounced diarrhea and fever. Vomiting is rare and the duration may be one to two days.

Diagnosis

1. Use of clinical signs. *Clostridium perfringens* is implicated as a cause of food poisoning outbreak by the appearance of typical symptoms (abdominal pain and profuse diarrhea), 12-24 hrs following consumption of food.

2. Confirmation of the outbreak requires (a). Enumeration of *C. perfringens* in foods and stool using selective media,

(b). Detection of enterotoxin in food and patient stool using serological methods e.g. ELISA, RPLA etc.

Prevention

1. Proper cooking of food and eating freshly prepared foods.
2. Thorough washing and sanitation of containers
3. Hygiene handling of cooked food
4. Fast cooling of cooked food and storage in refrigerator in small quantities.
5. Proper re-heating of cold cooked food before consumption
6. Storage of leftovers or unused foods in freezers

***Clostridium botulinum* foodborne intoxication**

Clostridium botulinum food borne intoxication (botulism) is a type of food poisoning caused by consumption of enterotoxins produced by strains of *Clostridium botulinum*. *C. botulinum* is an obligate, spore-forming anaerobe, Gram positive bacilli with terminal to sub-terminal spores. The strains are divided into proteolytic and non-proteolytic according to whether they hydrolyze proteins or not. The intoxication is caused by botulinum toxins A, B, E, F and G, produced by *C. Botulinum* type A, B, E, F and G, while the organism grows in food. Spores of *C. botulinum* type A can survive temperatures of 120°C.

Reservoirs

Clostridium botulinum is a saprophyte found in the soil, water, and decomposing manure. The organism is a natural inhabitant of the surface layers of the soil and thus may easily contaminate fruit vegetables or other cultivated produce.

Characteristics of botulinum toxins

Botulinum toxins are highly toxic, heat sensitive (inactivated by heating at 80°C for 10 min) neurotoxins. They are unstable at alkaline pH (but stable below pH 7.0). They are resistant to pepsin and acidic environment. Botulinum toxin is one of the most powerful poisons known. The calculated lethal dose for an adult man is in the region of 10 µg. The toxins can resist the action of the gastric and intestinal juices.

Types of foods implicated

Foods associated with anaerobic conditions and soil contamination such as home-canned foodstuffs, or hams and bacon stacked without air access, are particularly liable to be infected. Home made fermented foods have been incriminated, together with smoked, pickled and canned foods that are allowed to stand and then eaten without adequate cooking.

Botulism is associated in practically all outbreaks with consumption of smoked, pickled or canned foods, because they are foods most likely to be eaten straight out of the can, and without a further heating to destroy the any available toxin. Uncooked

For canned foods contaminated with *C. botulinum*, the can is often blown, and the food is soft and disintegrated, with an odor resembling butter or cheese, although meat foods so contaminated often show evidence of spoilage. Preserved foods such as beets, olives, spinach or string beans may contain potent *C. botulinum* toxin without the presence of obvious change in the appearance, taste or odor. Infant botulism occurs due to consumption of *C. botulinum* spores in honey and syrup. The spores germinate in intestines where they produce the potent toxin.

Role of preservatives in food

Preservatives such as salts especially nitrates/nitrites reduce chances of growth and inhibit toxin production. The danger of botulism has been the deciding factor in the formulation of food processing techniques, especially in meat canning.

Mode of transmission

1. Contamination due to improper handling.
2. Insufficient heating to destroy spores.
3. Spores present in animal tissues e.g. fish.

Symptoms of the disease in man

Symptoms of botulism are produced by the action of a powerful neurotoxin which possesses an affinity for nerve tissue. The period of incubation in man is usually under 24 hrs, but may be longer(range 12-72 hrs). Symptoms include nausea, vomiting, fatigue, dizziness, headache, dryness of skin, mouth and throat, constipation, lack of fever, nerve paralysis and great muscular weakness, double vision, respiratory failure and death. Duration of illness is 1-10 days and mortality is high up to 60-100% of affected persons. The earlier the appearance of symptoms, the higher the mortality rate.

Prevention

The following measures can help in the prevention of outbreaks:

1. Ensuring proper manufacturing practices.
2. Increasing sodium chloride concentration of food to 10% or more.
3. Preserved foods possessing rancid or other odors should be rejected.
4. Ensure proper hygiene of the cans, their transport, handling, storage
5. Proper heating of food before consumption to destroy heat labile enterotoxins. Food should be heated to $\geq 80^{\circ}\text{C}$ and temperature maintained for at least 10 min to destroy *C. botulinum* spores before eating.
6. Ensuring fast cooling of food. This will ensure that spores that may be remaining do not germinate in food grow and produce toxin.

5.3.2 Fungal food borne intoxications

Fungal intoxications are caused by consumption of metabolites produced by fungi, when growing in food. These metabolites are called mycotoxins. Grains, oilseeds, fruits and vegetables are mostly involved if they are stored at high humidity (> 0.75) or if they are not properly dried before storage. Poor dry storage practices of grains and other foods leads to mould growth and production of mycotoxins. Of significance to public health is aflatoxicosis.

Aflatoxicosis is caused by aflatoxins produced by the fungi *Aspergillus flavus*. Four types of aflatoxins have been described i.e. aflatoxin B₁, B₂, G₁ and G₂. In addition, M₁ and M₂ metabolites of B₁ may be secreted in milk.

Effects of aflatoxins

1. When consumed in large doses, they are lethal in causing acute hemorrhagic syndromes
2. Sub-lethal doses cause histotoxic changes
3. Long term consumption of small doses cause liver tumors as these are potent carcinogens, especially aflatoxin B₁.

Prevention of aflatoxicosis

1. Proper drying and storage of grains and other affected foods
2. Quality control of potentially hazardous foods to ensure that they do not contain above the allowable limits of 20 ppb before consumption by use of appropriate analytical tests.
3. use of fungicides as seed dressings to protect stored cereals and other foods like pulses and potatoes.
4. Avoid feeding mouldy cereals/grain to animals or as animal feed.

5.3.3 Chemical foodborne intoxication

This is a type of food borne intoxication arising from consumption of food containing poisonous chemicals, which may be intentionally or unintentionally added to foods as a result of producing, processing, transporting or storage. A number of substances can enter the food chain from the environment and through their use as growth promoters or veterinary therapeutics giving rise to chemical residues. Radionuclide may contaminate the environment, soil and pasture, and food/feed crops which can result in contamination of milk, meat as it happened following the Chernobyl nuclear disaster of 1986 in U.S.S.R which contaminated large areas of Russia and western Europe. Chemical food borne intoxication involve the following substances:

1. Heavy metals e.g. antimony, mercury, arsenic, fluoride, lead, cadmium, etc.
2. Pesticides and insecticides e.g. DDT, BHC Organochlorines and organophosphates.
3. Herbicides
4. Fungicides e.g. organomercurials
5. Preservatives e.g. nitrites, nicotinate, etc
6. Antibiotics e.g. Penicillin, tetracyclines, chloramphenicol

These compound usually enter foods through:-

- (a) Accidental contamination by (i). Heavy metals, (ii) Pesticides, and (iii) radionuclides.
- (b) Intentional addition e.g preservatives such as nitrite and sodium nicotinate for color preservation and fungicides used as dressing during storage.
- (c) Leaching from containers e.g zinc galvanized containers by acid foods, copper surfaces, lead pipes, asbestos roofs.
- (d) Presence of such chemicals in food as a result of their use in animal and crop husbandry
- (e). Maliciously added to cause harm (is rare).

Clinical signs and symptoms

Food borne intoxication due to poisonous chemicals exhibit a very short incubation period, usually a few minutes to a few hours, with an average of one hour. Symptoms are mainly due to effect on gastrointestinal tract and central nervous system and include nausea, headache, convulsions, gastrointestinal irritation, abdominal cramps, vomiting and diarrhea, pallor, cyanosis, blurred vision, sweating, flushing of skin and collapse. Other signs may be due to effects on circulatory system.

Symptoms of radionuclide toxicity depend on dose, time and organ affected. Toxicity causes (i) genetic effects including lethal mutations and reduction of the lifespan. (ii) somatic effects such as radiation sickness, leukemia, tumors, malformations and other physical ailments.

Measures to prevent spread by food

1. Discontinue use of utensils or containers that are able to leach chemicals such as antimony, cadmium, zinc, copper, etc.
2. Use of coloured pesticides and proper storage of the same.
3. Wash leafy vegetables thoroughly and prevent contamination by protecting food and utensils when using insecticides.
4. Prevent acid foods or carbonated liquids from contact with exposed copper.
5. Discontinue use of cyanide silver polishes or exercise care in their use.
6. Discontinue use in food establishments of pesticides containing fluorides.
7. Prevent misuse or avoid use of dangerous additives
8. Education of persons preparing food (e.g possibility of Zn poisoning).
9. Ensure that withdrawal periods are observed after use of these drugs and chemicals in animal and crop husbandry.

5.4 Biotoxifications: These are disorders resulting from ingestion of a poisonous substance (a biotoxin) present in the body of a plant or animal. Such substances are derived from plants or animals presumably as a result of metabolic activities. Only a small proportion of the species of fish and shellfish taken for human consumption throughout the world contain biotoxins.

5.4.1 Biotoxications of invertebrate origin

These toxins occur in many invertebrates including cephalopods, crabs, lobsters, etc, but few incidents have a wide epidemiological significance. Of major significance is the paralytic shellfish poisoning.

Paralytic shellfish poisoning. This results from consumption of shellfish such as oysters, mussels and clams that have become toxic after consumption of toxic dinoflagellate protozoa, which pre-dominantly feed on planktons containing *saxitoxin* and accumulating the toxin in their tissues. **Saxitoxin** is the biotoxin responsible for paralytic shell fish poisoning. It is heat stable, highly toxic. The toxin acts by blocking the propagation of nerve impulses without depolarization. Small doses lead to tingling of mouth and lips, while higher doses lead to paralysis, collapse and death. Mortality is about 1-22 %. There is no known antidote.

Prevention

- i) Avoiding sea foods from waters laden with toxic dinoflagellates.
- ii) Reduce toxin activity by heating above 100°C. Thorough cooking may reduce 70 % of the toxin activity in muscles.

5.4.2 Biotoxications of fish

Only a relatively small proportion of the species of fish taken for human consumption contain biotoxins of significance to man that lead to the various biotoxications including:

i) Ciguatera poisoning (ciguaterotoxicity)

Almost all fishes involved in ciguatera poisoning are reef or shore species that become toxic by feeding on herbivorous fish, which in turn feed on toxic algae or other toxophoric matter present in coralline reefs or from related areas. Over 400 species of fishes are involved including sharks, eels, jacks and groupers. The illness is caused by a heat stable **ciguatoxin**. Symptoms include mild paralysis and gastrointestinal disturbances.

ii) Tetraodon poisoning

This type of poisoning is associated with puffer fish mainly of the genus *fugu* from the Pacific, Atlantic and Indian oceans. Puffers contain **tetraodotoxin**, the most lethal poison from fish that can kill 60-70 % of human victims. The toxin is heat stable, concentrates in liver and gonads of puffer fish. One must ensure that the toxic organs are removed before the fish is eaten.

iii) Scombroid toxicity

This type of poisoning involves consumption of tuna, bonitos, mackerel and related fish, which become toxic due to bacterial decomposition arising from improper preservation. The toxic principle is the heat stable histamine or histamine-like substances e.g. *saurine*. Symptoms of this type of poisoning resemble those of allergy. Initially, there is a sharp or peppery taste, followed by headache, dizziness, abdominal pain, burning of throat, difficulty in swallowing, thirst and gastrointestinal upsets. A severe urticaria eruption may develop covering the entire body which may be accompanied by severe itching. Death may occur due to suffocation and shock. However, the acute symptoms are generally transient, rarely lasting more than 12 hours. Treatment involves use of anti-histamines which give effective relief. Control of illness is through hygienic handling of fish to prevent bacterial decomposition.

5.4.3 Prevention of poisoning due to poisonous animals

Eating of unknown meats from vertebrates or invertebrates sources is always a threat to the consumer. Local eating customs should be followed and local quarantine regulations strictly adhered to in order to reduce the risk. Always heat foods to above 100°C to denature the inherent heat labile toxins that may be present in animal tissues.

5.5 Factors that contribute to the occurrence of food borne intoxications

1. Preparation of food several hours or days before intended use, and allowing such food to remain warm at bacterial incubating temperatures(15-45°C).
2. Infected food handlers (employees) who may have or may not have disease or wound who practice poor hygiene.
3. Failure to thoroughly cook or heat process contaminated foods
4. Inadequate cooling or failure to refrigerate potentially hazardous foods
5. Use of leftovers with inadequate storage after preparation.
6. Undercooking (insufficient heating to destroy spores)
7. Inadequate reheating to destroy toxins.
8. Preparation of extra large quantities of food.
9. Establishing environmental conditions that selectively permit pathogens to grow but inhibit competing organisms e.g Cooking or canning followed by contamination.
10. Cross contamination of raw and cooked foods.
11. Consumption of contaminated raw food
12. Use of contaminated raw ingredients in a food which is to be served uncooked e.g salads.
13. Failure to clean and disinfect kitchen utensils and equipments.
14. Obtaining foods from unsafe sources
15. Poor dry storage practices e.g for grains leading to mould growth and aflatoxicosis.
16. Using utensils or water pipes that contain toxic materials.
17. Incidental or intentional addition of toxic chemicals to foods.
18. Poor hygiene practices leading to contamination and cross-contamination

NOTES FOR TRAINERS

Trainees should be able to give an account of any food poisoning episodes they have ever experienced in their lives. They should describe what happened, foods eaten, symptoms they experiences and for how long. They should also reflect on how they managed such episodes. In addition, they should describe some of the outbreaks cases they may have been involved in investigating and managing and the outcome. This will help them internalize what foodborne diseases are and how they present.

UNIT 6: BEST PRACTISES IN MEAT PRODUCTION

6.1 Meat value chain from farm to fork

The health of animals and food safety is affected by a number of events that occur along the chain. This chain encompasses stakeholders from primary production, processing, distribution and final consumption. Value chain approach refers to the responsibilities or full range of activities by the stakeholders along the food chain that are required to deliver the food that is safe, nutritious and healthy through different phases of production, processing, distribution and delivery to final consumer and disposal. In meat production, the stakeholders include input suppliers, livestock farmers, slaughter operators, processors, transporters, traders' government regulatory agencies and consumers. The attention is placed on the activities that are carried out at each stage of the food chain by the stakeholders and their contribution to the vision of presenting a safe, healthy and nutritious animal food product. Evaluation and control of weak points or activities at certain stages of the food chain that are likely to endanger the safety of the food ensures that safe food is delivered to the consumer.

6.2 Care of animals at the farm (Primary production)

Theoretically, hundreds of animals could supply meat for human consumption. However, in practice, a relatively small number of species are used to date. Food animals include cattle, camels, sheep, goats, chicken and fish. The producers should endeavor to document all the aspects of health of the animals as it may affect safety of the meat. Production areas should not present situations where hazards may enter the health animals and result in residues in meat. Such include areas where chemical contamination may be in plants that can cause presence of unacceptable levels of residues in meat- such as lead, mercury and cadmium. These are more likely to apply to dumpsite environments of urban production systems.

6.3 Hygiene of feed and feed ingredients

Feeds used for feeding animals in the primary production could be a source of hazards- *Salmonella*, antibiotic and mycotoxin residues –aflatoxin etc which could affect the safety of the meat. It is important therefore that proper records at farm level be kept of the feed sources. Equally feed manufacturers should keep records of the feed ingredients suppliers for trace back reasons. Regulatory agencies working with the manufacturers should provide guidelines for production and sale of quality feeds

6.4 Hygiene of slaughter animals

A number of hazards are present in populations of slaughter animals. These include tuberculosis, *E. coli* O157, *Salmonella*, Cysticercosis, *Campylobacter*, Anthrax, Echnococcosis etc that present a challenge of control at the primary production. Producers working together with regulatory agents need to put in place management strategies that aim at pathogen reduction. Information on hygienic status of animals intended for slaughter will enable slaughter inspectorate to put in place target procedures to deal with spectrum of pathogens anticipated (risk based inspection). Slaughter establishments should also endeavor to feedback to producers the inspection data as relates to their animals.

Regulatory agencies should put in place programmes that aim at reducing the presence of the zoonotic agents in the slaughter populations or subpopulations, reduce introduction of new zoonotic agents, control of movements especially through areas under quarantine and

establish a monitoring and surveillance programme that helps to institute a risk based inspection of slaughter animals.

6.5 Meat hygiene and inspection

The aim of meat hygiene and inspection is to ensure the fitness and safety of meat for human consumption. The meat and meat products should not carry pathogenic microorganisms that might cause disease in man, nor shall they contain microbial toxins or chemical residues that might affect public health.

Adequate meat hygiene measures covers the time period animals are on the farms before they are transported to the abattoirs, through its journey to and from the abattoir until the consumption of the final meat products. It involves hygienic production of food animals, antemortem inspection of slaughter animals, handling and slaughter of animals, post-mortem inspection of carcass, design and hygiene of slaughterhouses and meat industries, design and hygiene of meat carriers, hygiene of slaughterhouse and meat industry personnel and equipment, management of waste from slaughterhouses and meat industries.

A proper meat inspection consists of a veterinary examination of a live animal or bird, carcass and offal, and where necessary carrying out laboratory tests (pathological, microbiological and chemical) of body tissues and fluids.

6.5.1 Objectives of meat inspection

1. Protect consumers against zoonotic diseases
2. Avoid unaesthetic products
3. Ensure hygienic processing, storing and marketing of meat
4. Avoid harmful products like antibiotics and pesticide residues
5. Help to identify and control infectious diseases especially notifiable diseases
6. Protect the economy of the country
7. Avoid cruelty against animals by ensuring humane animal handling and slaughter practices
8. Ensure sanitary conditions in slaughterhouses
9. Ensure hygienic disposal of waste products.

6.6 Pre-slaughter handling of slaughter animals

6.6.1 Transportation of animals to slaughter points. While transporting animals to the slaughterhouse, one should always be conscious of the welfare of the animals. They should as much as possible be transported in a humane manner. In this regard, care should be taken to:

- Maintain the nutritional value and health status of the animal. They should be provided with adequate and suitable feed and water every 12 hrs during the journey except when the journey is completed within 15 hrs.
- Reduce fatigue, injuries, stress, infections. Efforts should be made to avoid all forms of stress as stress affects the keeping quality of meat. This is mainly associated with low glycogen and lactic acid giving less than expected pH fall after slaughter. For example, beef from stressed animals is dark, firm and dry. To reduce injury, separate

horned from polled animals, aggressive and females in estrus from calm animals, and animals from different origins to prevent fighting.

Modes of transportation Animals may be trekked on hoof, or be moved by use of vehicles(trucks), by train, ship or aeroplane. Whatever mode is used, the principle is to have humane transport that does not have any adverse effects on the animals that may compromise the suitability of meat.

- **By hoof/trekking:** When trekking animals, provide grazing enroute and avoid long walks/treks. Animals should not be trekked for more than 30 miles per day. Trekking animals for over 30 miles may cause fatigue to animals.
- **By vehicles, train and ship:** Vehicles and wagons used for transport of animals should be well ventilated and large enough to avoid overcrowding. Different species and age groups should be transported in separate compartments. Mixing different species of animals will lead to injury. Vehicles and wagons should be fitted with rigid sides and protective overhead coverings to protect animals from adverse weather. There should be no sharp projections in transport vehicles and wagons as they could result in injury and unnecessary suffering of animals. Vehicles should be large enough to provide adequate space between roof and floor and rail gaps should not allow the head of animals to pass through to avoid them getting strangled. In addition, the journey should be made in a careful manner avoiding sudden stops or starts.

Transporting animals (especially chicken) inside or while hanging on top of public transport vehicles is inhumane and discouraged.

6.6.2 Legislation related to transportation of animals

Movement Permit which is a legal document given by a duly authorized officer by the DVS such as a veterinary officer in charge of the District where animals originate. The permit is only issued after the Veterinary officer receives a no objection permit from the Veterinary officer in charge of the area where the animals are moving to for slaughter (or the veterinarian in-charge of the slaughterhouse). It allows movement of live animals from one area to another. The purpose of such movement may be for slaughter, sale, farming or research etc. It has the following details: transporter's name; address, date of transporting, species, sex and number being transported, special identification features, route, duration and mode of transport, origin and destination.. In order to have the legal basis, the signature of the issuing officer and stamp are appended. The role is to assist in disease control as well as traceability of animals. To control animals on arrival, the meat inspector checks for movement permit and the health condition of the animals.

6.6.3 Animal identification and Traceability

Traceability is defined by codex as the ability to follow up the movement of a food through specified stage(s) of production, processing and distribution. In Livestock, an animal identification and meat traceability system should offer information on the origin, animal breed, age, sex, movement, treatment regimes. Animal identification and meat traceability

systems play a vital role in providing information useful in public health and animal health interventions. Methods of animal identification at primary production include: - paint/spray markings, hot/Cold branding, tattooing, Collar tag (neck band), plastic/metal ear tags, ear notching and microchip (RFID-Radio frequency identification device).

6.6.4 Resting of animals at lairages

Fatigued and excited animals should be rested before slaughter to enhance the keeping quality of meat. Animals should rest for between 12-24 hrs (maximum 36hrs) before they are slaughtered. During rest, animals should receive ample drinking water. This will serve to lower the bacterial load in the GIT and facilitate removal of the hide during dressing. .

Animals need to be fasted for at least 6hrs before slaughter to reduce stomach contents. This requirement serves to prevent carcass contamination if the stomach is accidentally punctured.

6.6.5 Pre-slaughter hygiene

During the rest period in the lairages, animals must be kept under conditions which prevent any further contamination of feet, hides and skin by using clean straw beddings or regular washing of solid floor that has good drainage.

The use of slats or grid in the area near the landing area will keep will keep animals as clean and as dry as possible.

6.7 Ante-mortem inspection

Antemortem inspection is the inspection of live animals to ascertain their health condition and fitness for slaughter. Antemortem inspection takes place at the farm, as animals enter the slaughterhouse and when in the lairage just before slaughter.

6.7.1 Reasons for antemortem inspection

1. Examine animals for evidence of infectious and zoonotic disease especially those that cannot be detected after slaughter e.g. rabies
2. Identify and separate sick from normal animals
3. Remove animals dying on transit
4. Check for movement permit
5. Prevent animals with dangerous and notifiable diseases e.g. anthrax, FMD from reaching the killing floor
6. To avoid unnecessary suffering of animals especially those with acute pain e.g. animals with fractures, uterine prolapse, post-partum uterine hemorrhage by carrying out emergency slaughter
7. Postpone slaughter of fevered/excited animals
8. Check for conditions of transport vehicles
9. Identify excessively soiled animals and take appropriate action – e.g. scheduling them last for slaughter to avoid contamination of SH.

6.7.2 Carrying out ante-mortem inspection

1. Check for movement permit before animals are offloaded
2. Observe the animals as they off load
3. Inspect animals at the lairages while at rest and in motion for general behaviour, level of nutrition, obvious signs of disease and any other abnormalities e.g starring coat, tacked abdomen, arched back, circling, ataxia, salivation, lachrimation etc.
4. For animals found to be sick or in poor condition, record species, age, condition, colour and identification marks, their place of origin and travel routes for easy of follow-up. Then send them for emergency slaughter.
5. Dead animals are removed and sent to the post-mortem room for autopsy examination to determine the cause of death. After the autopsy. The cadava is incinerated or buried.
6. Animals found fit for human consumption are taken for slaughter
7. Ante-mortem inspection should be carried out under adequate natural or artificial lighting.
8. The inspection should be repeated if 24 hrs have elapsed since the last inspection or/and at any time if required by the veterinary surgeon in-charge of the slaughterhouse.

6.8 Slaughtering and dressing operations

This is the process of putting the animal to death. It involves, stunning, bleeding, flaying, evisceration, carcase splitting (cattle/large stock), trimming and washing, chilling and freezing.

Stunning: Is a method of rendering an animal insensible to pain. It is done to avoid unnecessary suffering of the animals (humane slaughter) and avoid risks of hurting slaughter personnel. The following methods are commonly used to stun animals.

(i). Mechanical stunning: Cattle, camel, sheep and goats: Stunning is done by use of a captive bolt stunner/pistol.

ii). Electrical stunning: Used to stun poultry. The heads are dipped in an electrolyte that produces an electric shock making the bird unconscious.

In Halal /Jewish slaughter, there is no stunning of animal animals. Instead the throat is cut transversely by one stroke of a sharp sword.

Bleeding: Bleeding is effected by severing the neck at the level of the jugular and hanging the animal upside down on the rails. Bleeding is hastened by hanging the animal upside down on the rails for some time. It is expected that as much blood as possible (upto ½ of total amount) is removed from the stunned animal after the bleeding process. It is important that the heart continue beating after stunning to ensure complete bleeding.

The efficiency of bleeding has a bearing to the keeping quality of meat. Blood is a good medium for growth of microorganisms and hence its presence in the carcass will accelerate (hasten) spoilage/deterioration of meat. A carcass that is not well bled looks dark and muscles ooze (produces) blood when cut. Blood vessels (especially subcutaneous and

intercostal vessels appear injected with blood while visceral organs (lungs, heart, liver and lymphnodes) contain excessive blood, are flaky and watery. Carcasses that are not properly bled are condemned during meat inspection.

Flaying is the removal of the hides and skin. It should be done carefully to preserve the wholeness of the hides and skins. They should not be punctured during flaying. Intact hides and skin fetch high prices as they produce quality leather and leather products. Proper flaying is done using special knives or pneumatic flaying machines. These yield hides and skins with minimum puncturing.

Evisceration is the removal of internal organs such as stomach, liver, spleen, intestines and lungs. Should be done carefully to avoid puncturing of the stomach and spillage of its contents which can contaminate the carcass. Stomach contents contain a lot of disease agents that cause food poisoning to consumers.

Carcass splitting: Carcasses are split carefully through the backbone into two equal portions. The splitting can be accomplished manually using a panga and or an axe or by use of an electrical power saw.

Washing – After evisceration, the carcass is washed to remove any surface contamination with blood and intestinal contents. It is important to use potable water to wash carcasses as any other water can introduce pathogens on to the carcass. Both hot and cold water should be provided in the slaughterhouse. Carcasses should not be wiped with any type of cloth.

Trimming: This is meant to remove contaminated and unaesthetic parts of the carcass. The aim is to enhance the aesthetic value of the carcass.

Sources of contamination in the slaughterhouse

1. Cross contamination due to unhygienic practices including contaminated hands and clothing, as well as slaughter equipment/tools (knives, pangas, axes etc). Slaughterhouse personnel should frequently wash and disinfect their hands and tools during the slaughter operations. They should wear clean gumboots and dust coats as well as frequently sterilize the knives.
2. Hides and skin contain high microbial load. Care should be taken to ensure clean flaying operations take place
3. Intestinal and stomach content during evisceration. Care should be taken to avoid puncturing and spilling stomach and intestinal contents during evisceration. In case a puncture occurs, the spilled contents should be washed off immediately and knife and hands washed and disinfected before proceeding with the operations.

6.9 Post-mortem meat inspection

Post-mortem meat Inspection is a systematic process of examination of the dressed carcass, pluck (liver, heart, lungs & lymphnodes), and head aimed at identification of known and unknown diseases or conditions. Routine post-mortem inspection should be carried out as soon as possible after carcass dressing is completed. Beef carcasses set rapidly and if inspection is delayed particularly in cold weather, the examination of the carcass becomes

more difficult. Post-mortem inspection aims to protect consumers against zoonoses and unwholesome meat. The reasons for post-mortem inspection are to:

1. Check the efficiency of slaughter and carcass dressing techniques
2. Identify diseased carcasses and organs and remove them from the food chain
3. Detect visible contamination to avoid harmful and unaesthetic products from reaching the consumer
4. Ensure hygienic processing of meat

There are three cardinal principles used in meat inspection. They include:

i). Visual examination of animal carcass and organs:: This is important for purposes of animal identification (species, sex, age), to determine the nutritional state of the animal and state of bleeding, detect bruises, deformities, edema, peritonitis, discolourations and general contamination. Examination of gums reveal vesicles or erosions arising from FMD, rinderpest, MCF and mucosal disease. Examination of lungs may reveal pneumonia, abscesses and TB lesions.

ii). Palpation: Identify abscesses, abnormal growths (tumors), deformities, abnormal consistency of fat and various body organs, hydatid cysts and TB lesions in the lungs.

iii). Incisions: These are made with sharp knives to show clean undistorted surfaces. Standard incision are made to identify cyticercosis in beef and pork muscles (tongue, masseters, triceps brachii), liverflukes in livers, aspiration pneumonia in lungs, abscesses and congestion in lymphnodes etc.

6.10 Meat Inspectors

Meat inspection is done by trained and suitably qualified meat inspectors. The inspector must be present during the arrival of animals to the slaughterhouse for antemortem inspection, supervision of slaughter, post-mortem inspection, grading and dispatch of meat to butcheries. Inspected carcass are stamped for the purpose of identification. Meat inspectors work under the general supervision of a qualified and registered veterinarian. Inspectors ensure that all condemned meat products are removed from the slaughterhouse and destroyed appropriately. They also oversee the general cleaning and hygiene of slaughterhouses and environmental control as well as general hygiene of personnel working in slaughterhouses. In addition, they ensure that slaughterhouse facilities have ample supply of water for cleaning purposes.

Importance of this exercise

1. Ensure hygienic storing and marketing of meat
2. Protect honest butchers against unauthorized competition
3. Helps in traceability and in disease control
4. Prevents entry of harmful products into the market
5. Protect the economy of the country
6. Ensure that marketing and sale of meat is done at designated outlets, e.g meat markets, butcheries and supermarkets.

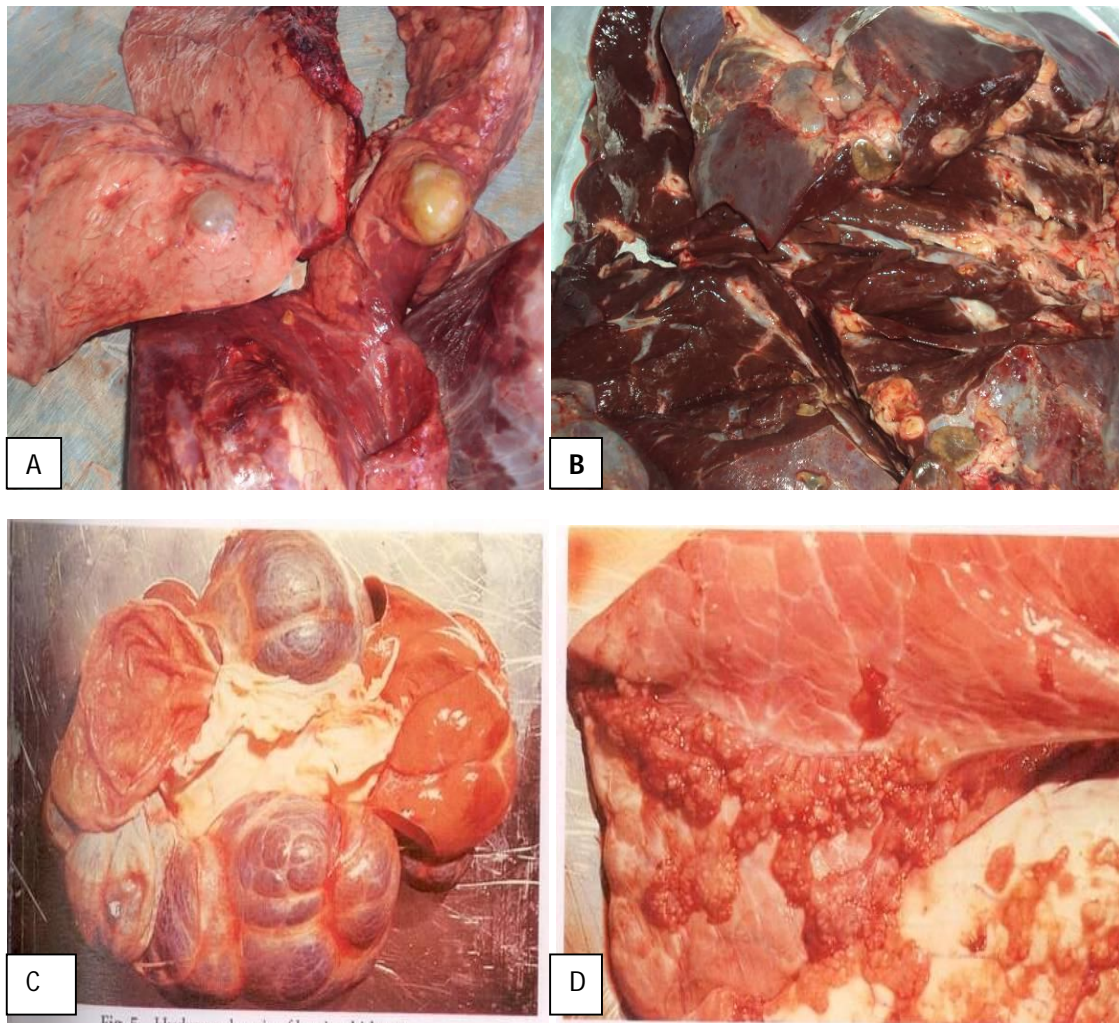


Figure 6.2: Some conditions at postmortem meat inspection A. Hydatid cyst in bovine lung; B. Liver cirrhosis in cattle C. Hydronephrosis D. Bovine tuberculous pleuritis

6.11 Legislation related to transportation of Meat

Carrier permit is given a legal document given to an owner of vehicle/container used for transporting meat from a slaughterhouse. Transport containers are made up of seamless stainless steel, with lockable lids. They are inspected to ascertain that they comply with meat transport regulations and are licensed annually with identification numbers for traceability. The number given to the carrier identifies the area of operation.

Certificate of transport is a legal document issued by the meat inspecting officer to an authorized carrier to transport meat from certain slaughterhouse/slab to butchery. It indicates the number of carcasses or quarters being carried, species and the destination. It also indicates the time of departure from the slaughterhouse and the approximate time the journey should take. The certificate is given every time a carrier transports meat. It is valid only for one journey.

6.12 Meat by-products

By-products of a meat may be everything from the abattoir or butchers shop that is not sold directly as food. Products other than carcass meat may be considered as byproducts. By-products can be divided into two:

- a) **Edible byproducts/offals:** Are parts of an animal not considered as good as carcass flesh. They include edible livers, kidney, thymus gland, stomachs and intestines, pancreas, edible blood, edible fat as well as edible trimmings.
- b) **Inedible byproducts:** Include hide/skin, feet, raw bone, horns, inedible raw blood, inedible fat, condemned livers, condemned, kidneys, condemned carcasses, lungs, trachea and heart, trimming from various parts of the carcass etc.

Efficient methods of handling by-products will result in a larger amount of edible products of high quality. The need for efficient treatment of these products is based on the necessity for their rapid hygienic disposal to avoid contamination of fresh meat, decomposition and formation of abnoxious odours. In addition, efficient processing of abattoir by-products secures an economic return on materials which would otherwise be wasted.

The by-products that must undergo some form of processing before use are: Edible and inedible fat, edible and inedible blood, bone, hooves, horns, hair, hides and skins. The best and most economical method of processing byproducts is by heat treatment in a jacketed cylinder as it gives maximum returns from the rendered material.

6.13 Hides and skin curing

Hides and skins have the highest yield and value of all products of livestock other than the carcass, and in some livestock-rich developing countries such as Somalia and the Sudan, they account for substantial portions of export revenue.

Hides and skins are processed into leather by tanneries. Thus, it is necessary for them to be preserved for storage and shipment after removal from the animal (flaying). The method of preservation is curing, either in free air or by use of salt or both. In each of these methods the preservation principle is the same, namely, removal of moisture from the product to enhance keeping quality (lowering of water activity). In this method air acts by facilitating evaporation of moisture from the skin, and salt by osmotic withdrawal of water, thus making the moisture unavailable for growth of microorganisms (inhibition principle).

6.14 Meat traceability

Traceability is tracking the movement of identifiable products through the marketing chain. Traceability can be used to convey information about a product, such as what it contains, how it was produced and every place it has been. Meat traceability is ability to follow the movement of a meat product through specified stage(s) of animal production, slaughter, processing and distribution of meat products. An extensive form of traceability is the ability to follow meat products forward from their source animal (at birth) through growth, slaughter, processing and distribution to the point of sale or consumption, (or backward from the consumer to the source animal). Animal identification is one component of meat traceability. It is the marking of individual animals or group of animals so that they can be tracked from place of birth/origin to slaughter. Producers keep records on identities of each animal. A well

designed traceability system provides accurate data on the origin, sex, age, breed, movements, and records of treatments that an animal received.

Functions of animal identification and traceability

Commercial production and marketing. Traceability can help to identify and exploit desirable production characteristics e.g better yields, fast growth etc. Traceability helps to coordinate shipments, manage inventories and monitor customer behaviour. Some customers prefer milk, meat or eggs from animals raised according to specified organic, humane treatment or environmental standards. Traceability can help firms separate and keep records on these unique products to verify production methods. Improved traceability is viewed as important for maintaining foreign market access as animal identification systems are being used as technical barriers to trade. Functioning traceability systems are often a pre-condition for meat producing countries to enter export markets. Universal bar codes on processed food and meat products are widely used for tracking.

Animal health. Traceability systems are important tools to prevent the spread of animal diseases and to enhance biosecurity in general. Animal identification can help track down more quickly the source of diseases in flock/herds in order to determine origin of the animals, cause of the disease, control and prevent their spread. When used in animal health programs, Animal identification and tracing systems are likely to have both commercial and regulatory functions.

Food safety. In slaughterhouses, meat traceability requires the clear identification of the live animals through to meat products. A rigorous animal identification and traceback can prevent potentially serious food safety problems. Traceability system can facilitate recalls of meat products, enhance process controls, testing and other science based food safety measures. In addition, it will possibly facilitate identification of the source of the disease, timely application of control measures to contain its spread, as well as help authorities prevent future disease incidents. Improved traceability may enable firms to limit their legal and financial liabilities.

Country of origin labelling. Traceability systems will facilitate country of origin labelling that is required for animals or products exported to foreign countries.

Meat identification methods include:

- Paper/plastic Tags;
- Ink stamping;
- Bar code labels (Figure 3.1); and
- Microchip (Radio Frequency Identification Device (RFID)).

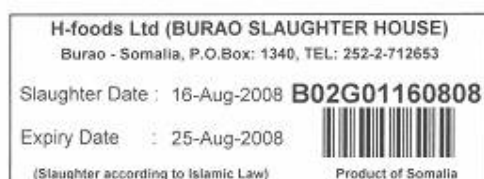


Figure 3.1: A bar code label

Costs of the identification and traceability systems vary widely, depending on the options applied and the level of detail required. An animal identification system will incur a variety of

costs incurred for acquisition of identification devices, data systems and administration expenses.

6.15 Processing of Meat

This involves cutting of meat to make special cuts for the market, packing of the special cuts, canning, smoking, mincing and cooking of meat to make other products. Products of processing include canned products (corned meat), smoked beef, sausages (beef sausages), bacon, ham salamis, steak, meat loaf etc. Meat processing plays a prominent role in the utilization of meat resources, including all edible livestock parts for human food consumption. Meat processing can create different types of product composition that maximizes the use of edible livestock parts that are tasty, attractive and nourishing such as sausages, ham, salami etc. In addition, processing extends the shelf life of the products thus allowing market diversification and access of target (niche) markets.

NOTES FOR TRAINERS

Discuss with the participants the status of meat processing in Somalia and the benefits that can accrue from establishment of meat processing factories. What do they think are the perceived limitations to development of meat processing business enterprises.

UNIT 7: MILK HYGIENE

7.1 Introduction

Milk as drawn from the normal udder of a healthy animal is not sterile. Under normal conditions, the bacteria found are non-pathogenic, although some may be pathogenic. Immediately after drawing the milk will be contaminated from the air, milking utensils, hands of the milkers or from milking machines. Unhygienic conditions can result in fecal contamination, and dust as from hay and other sources can contribute a number of various bacteria to the milk. Bacteria commonly found in milk are *Corynebacteria bovis*, *streptococci*, *coliforms*, *sarcinae*, *staphylococci* and *micrococci*.

7.2 Importance of milk hygiene

- To prevent transmission of zoonotic diseases from animals to man
- To prevent consumption of chemical residues and other toxic substances
- Prevents malnutrition and improve the nutritional status of consumers.

7.3 Sources of milk borne pathogens

- **Animals acting as a source of disease agent (pathogen).** These are infections of animals that can be transmitted to man through shedding of infectious agents in the milk. Such infectious diseases include: tuberculosis, brucellosis, *staphylococcus aureus*, Q-fever (*coxiella burnetti*), salmonellosis, campylobacter, *E coli*, *bacillus anthracis*, *Bacillus cereus*, *Listeria monocytogenes*, *Clostridium perfringens*, *streptococcal infections*, *leptospirosis* and *listeriosis*, *Aspergillus flavus*.
- **Milk acting as a vehicle for transmission of pathogens** In this case, milk acts as a vehicle for transmission of pathogens following contamination from milker's hands, dust, fecal materials, dirty water, containers, rats, insects, mice and flies. Infection arising from consumption of milk contaminated with disease pathogens including *Salmonella typhi*, *Salmonella paratyphi*, *shigella spp*, *vibrio cholera*, *pathogenic E. coli*, *Staphylococcal aureus*, *streptococcus pyogenes*, *Infectious hepatitis virus* and *corynebacterium diphtheriae*.

7.4 Prevention of milkborne diseases

1. Control of animal diseases through prompt diagnosis and treatment, vaccination, screening and culling of positive reactors.
2. Prevent contamination of milk through udder health and milking hygiene practices
3. Improved milk handling hygiene by use of potable water for washing/clean equipments, and containers,
4. Medical check up of milkers and milk handlers, and ensuring their personal hygiene,
5. Pest control and environmental hygiene.
6. Prevent multiplication of harmful bacteria by prompt cooling of milk, and maintaining the cold chain during collection, transportation, distribution, retail and storage.

7. Heat treatment (pasteurization) to destroy pathogens.

7.5 Composition of milk

The composition of milk for various animal species is given in table 7.1. The composition vary from one species to another. Water forms the main constituent of milk in all species constituting over 87% of the milk constituents.

Table 7.1: A comparison of milk constituents and characteristics among various species

<u>Constituents (%)</u>	<u>Camel</u>	<u>Goat</u>	<u>Sheep</u>	<u>Cow</u>
Protein	1.80-3.20	1.10-3.18	5.32-7.74	4.46-5.75
Lactose	2.91-4.12	4.0-5.5	3.0-4.2	3.0-4.6
Fat	1.80-5.0	3.9-5.7	8.0-9.6	4.0-5.0
Ash	0.85-1.0	0.20-0.39	0.50-0.65	0.29-0.48
pH	6.5-6.7	6.5-6.9	6.4-6.8	6.6-6.8
Lactic acid	0.03-0.14	0.11-0.17	0.16-0.19	0.12-0.19
Specific gravity	1.014 -1.017	1.028-1.032	1.027-1.029	1.028-1.034

7.6 Methods used to assess the quality of milk

Platform tests

Organoleptic tests: This uses the senses of sight and smell to check for the gross appearance and odours of milk. With this one can detect the various contaminants in milk and detect abnormal odours.

Sediment test.

Use to assess the amount of dirt in the milk. Milk is filtered through a cotton filter and the amount of dirt remaining after filtration is assessed. Alternatively, milk is centrifuges in a test tube of special shape and amount and appearance of the sediment judged.

Alcohol test

This will detect spoiled milk. Spoiled milk will have high acid content and may produce off-flavours. Fresh milk has acidity below 0.13%. The acidity of fresh milk is due to casein and albumen that react like weak acids as well as its content of citric acid, carbonic acid and various acid salts. Microbial activity breaks down lactose to produce lactic acid thus increasing the ultimate acidity of the milk. When levels of acid reaches 0.17%, milk will clot when mixed with alcohol. A 68% or more alcohol will dehydrate the proteins and clot the milk in the presence of an acid greater than 0.17%.

In this test, equal volumes (2 ml each) of ethanol and test milk are mixed and observed for signs of clots or flakes within 1-2 minutes. The test becomes even more sensitive if two parts of alcohol is mixed with one part of milk. Milk of above normal acidity is not fit for processing or production of high quality milk products.

Clot -on-boiling test

Milk with acid levels above 0.24% will clot on boiling and therefore not fit for pasteurization or sterilization. In this test, a small amount of milk (1-2ml) is boiled. If the milk curdles, it shows the acid level in milk has gone beyond 0.24% and therefore not withstand the pasteurization or sterilization processes.

Dye reduction tests

These tests include Resazurin and methylene blue reduction tests. Both resazurin and methylene blue reduction tests measure the intensity of the metabolic activity of microbes present in milk. Dicolouration or change of colour of a given quantity of indicator substance in a given volume of milk depends on the intensity of microbial production of reductase (an enzyme that lowers the redox potential in milk) and this depends mainly on the bacterial counts and types of bacteria in milk, plus their growth phase at the time of testing.

Resazurin test (10 minutes) is good for testing milk for its suitability for pasteurization. The test is more sensitive to leucocytes and other reducing substances in milk than methylene blue test.

Both resazurin and methylene blue tests(30 minutes) are suitable for testing for quality of pasteurized milk.

Titration acidity

Milk gets sour because of the conversion of lactose into lactic acid by microorganisms. Fresh milk contains no lactic acid. Titration of the acidity is therefore a way of assessing the keeping quality of milk. The principle of the method is to calculate/measure the amount of sodium hydroxide used to neutralize the acid in a given volume of milk. A 2% phenolphthalein in alcoholic solution is used as indicator.

Total bacterial counts

This method gives the extent of contamination of milk. It is intended to count the number of bacteria in milk. The bacterial load is low in fresh milk. The levels do not exceed 10^5 , but this increases as milk deteriorates. Bacterial counts higher than 10^7 indicates that milk is of low quality and will not be used to produce high quality milk products. Both total viable counts and coliform counts are routinely done to assess the quality of milk. High coliform counts indicates that milk is drawn and handled under poor hygienic conditions.

7.7 Milk adulteration

- Adulteration is the addition of any substance to milk or removal of its natural constituents.
- Adulteration of milk reduces the quality of milk.

7.7.1 Substances that may be added to milk

1. **Water** - to increase milk volume. Water added to milk represent an additional hygiene risk.
2. **Solutes** - usually added to spoiled milk to mask the level of spoilage Solutes include:
 - i. Sweeteners, e.g. sugar and other substances
 - ii. Thickeners, e.g. flour
3. **Preservatives**. Unauthorized preservatives may be added to milk including formaldehyde, antibiotics and peroxides (e.g. hydrogen peroxide).

7.7.2 Removal of milk constituents

- **Skimming** is removal of milk fat. Fat may be removed from milk for sale of butter alone. Fat may be removed from milk during processing to standardize milk fat.
- **Removal of protein** during the process of cheese manufacture.

Milk adulteration can be intentional or accidental.

Intentional milk adulteration. Is usually done by unscrupulous people for their own benefit. They do so for monetary gains

Accidental adulteration. Unwanted substances may be found in milk as a result of processing of cleaning and disinfection of milk equipments. For example, hypochlorides and other substances be found in water used to wash milk equipments.

7.8 Methods for determination of milk adulteration

(a). Specific gravity

Specific gravity = Density of milk at 20°C/ Density of water at 20°C. The specific gravity is determined by taking weight of a known volume of milk. The specific gravity has no units. It is determined by use of a lactodensimeter. Addition of water causes reduction of specific gravity of milk, while skimming increases the specific gravity.

Specific gravity of normal milk for various animal species is given in table 7.1 above.

The specific gravity of camel milk is less than that of cow, goat, sheep and buffalo. The specific gravity of goat milk is similar to that of cows milk.

(b). Determination of butterfat content

- Addition of water and skimming lowers the butterfat content of milk. Whole unadulterated milk has a butterfat content of more than 3.5%. Butterfat content values of less than 3.0% indicates addition of water or skimming.

(c). Total Solids (TS) and Solid-not-Fat (SNF)

Usually the determination of fat content is considered to be a satisfactory measure for estimating the overall quality of fresh milk. However, the overall quality of fresh milk where skimming, addition of water or dried milk powder is suspected, estimation of total solids in the representative sample of milk may also be necessary. Milk adulteration affects the level of TS and SNF. Addition of solutes raises the total solids and solids-not-fat.

Table 7.2: Comparison of Total Solids and Solids-not-Fat of milk among various species

Parameter	camel	goat	sheep	cow
Total solids	7.7-12.13	12.60-15.17	17.48-19.5	13.45-14.34
Fat	1-8-5.0	3.9-5.7	8.0-9.6	4.0-5.0
Solids-not- fat	5.56-8.39	8.53-9.47	0.48-10.1	8.43-10.14

7.9 Reduction of milk adulteration

1. Education of farmers and milkers in hygiene of milk
2. Regular checking of milking equipments on accidental adulteration
3. Checking of milk for the following physical properties at reception, i.e specific gravity and freezing point.

UNIT 8: FOOD SPOILAGE AND PRESERVATION

8.1 Learning objectives

By the end of this unit, participants should be able to:

1. Explain the causes and effects of food spoilage especially meat, milk and fish.
2. Describe the two food preservation principles and the methods used to achieve each of them
3. Identify and explain methods used to preserve meat, milk and fish and compare with those used in their communities.

8.2 Food spoilage

Food spoilage is the decomposition of food components resulting in change in quality, appearance, colour, flavour, texture and odor. Food spoilage result from:

1. Growth and activity of spoilage microorganisms which produce various enzymes that decompose the various constituents of food.
2. Action of enzymes of plant or animal tissues which start the decomposition of various food components. These enzymes if present in the food must be inactivated in order to preserve the food.
3. Chemical reactions of non-enzymatic nature. These include reactions between product and packaging material, oxidation of fat, Maillard reaction in milk and a reaction between proteins and lactose.

8.2.1 Microbial spoilage of food

Bacteria, yeasts and molds are the major causes of food spoilage. They produce various enzymes that decompose the various constituents of food. Molds are the major causes of spoilage of foods with reduced water activity such as dry cereals and cereal products, while bacteria spoil foods with relatively high water activity such as milk and milk products.

Bacterial growth in and on food often makes the food unattractive in appearance or objectionable. Bacteria grow rapidly in many food products with high nutrient content and available water such as milk, meat, fish, eggs that are not preserved. Pigmented bacteria cause discolourations on the surface of foods, while, surface growth make food slimy. Bacterial growth throughout the liquid may result in undesirable cloudiness or sediment, while, films may cover the surface of liquids.

Bacterial genera usually found to cause food spoilage include: *Acinetobacter*, *Aeromonas*, *Alkaligenes*, *Leuconostoc*, *Citrobacter*, *Bacillus*, *Clostridium*, *Moraxiella*, *Escherichia*, *Lactobacillus*, *Proteus*, *Pseudomonas*, *Micrococcus*, *Flavobacterium*.

Molds are involved in the spoilage of foods with relatively low available water, especially dry foods kept under humid conditions. The minimum available water in food that encourage mold growth is 0.80. An estimated 14-15% total moisture in flour or some dried fruits will prevent or delay mold growth. The following are some of the genera involved in food spoilage; *Mucor spp.*, and *Rhizopus nigricans* (bread mold) spoil many foods including berries, fruits, vegetable and bread., *Aspergillus niger* and *Aspergillus flavus* produce

aflatoxin in many foods especially cereals and pulses. Penicillin spp, e.g *P. digitatum* cause blue-green soft rot on fruits.

8.2.2 Factors affecting microbial growth in food

i). Intrinsic factors: These are factors that are inherent in the food which affect microbial growth. They include nutrient content of the food, pH, moisture content, oxidation reduction potential, antimicrobial substances and biological structures.

(a). Nutrients content of the food. Microorganisms require proteins, carbohydrates, lipids, water, energy, nitrogen, sulphur, phosphorus, vitamins, and minerals for growth. Various foods have specific nutrients that help in microbial growth. Foods like milk, meat and eggs have many nutrients required by microorganisms hence are susceptible to microbial spoilage.

(b). pH of the food. The pH of the food product influence the kind of microorganisms to be found there. Most bacteria grow best in a neutral or weakly alkaline pH usually between 6.8 and 7.5 but are killed in strong acid or alkaline environment. Some bacteria such as salmonella grow between 4.5 and 9.0. Salmonella and many other bacteria do not grow at pH values below 4.5. Molds grow between 1.5 to 11.0 while yeasts grow between 1.5 and 8.5. Other microorganisms such as *vibrio cholerae* are sensitive to acids and prefer alkaline conditions.

In neutral products, spoilage bacteria (*Pseudomonas spp.*, *Aeromonas spp.*, *Bacillus spp.*, *Clostridium spp.*, will dominate, while in acid products, *Lactobacillus spp.*, certain *streptococcus spp.*, yeasts and molds and *Streptococcus spp.*, are being used for production of fermented milk and other milk products. Table 2 shows pH values of some food products, while table 3 shows the minimum and maximum pH for growth of some specific microorganisms. Table 2 shows pH values of some food products, while table 3 shows the minimum and maximum pH for growth of some specific microorganisms.

Table 2: pH values of some food products

Food type	Range of pH values
Beef	5.1 - 6.2
Chicken	6.2 – 6.4
Milk	6.3 – 6.8
Cheese	4.9 - 5.9
Fish	6.6 - 6.8

Table 3: Minimum and Maximum pH for growth of some specific microorganism

Microorganism	Minimum	Maximum
E. coli	4.4	9.0
Salmonella typhi	4.5	8.8
All bacteria	4.0	9.0
Molds	1.5	11.0
Yeast	1.5	8.5

c). Available water in foods (water activity)

Growth of microorganisms is greatly affected by the available water in the food. They do not grow in foods with available water that is below their minimum requirement for growth. However, in foods that have available water within their growth range, they grow and cause food spoilage. Table 4 shows the available water of some food products, while table 5 shows the minimum water activity that supports growth of some microorganisms.

Table 4: Available water of some food products

Food Product	Available water
Raw meat and milk	0.99- 1.0
Luncheon meat	0.95
Boiled ham, sliced bacon	0.90
Dried grains	0.80

Table 5: Minimum available water that supports growth of various microorganisms

Microorganism	Water activity
<i>Aspergillus spp.</i>	0.70
Most spoilage bacteria	0.90
Most spoilage yeast	0.88
Most spoilage molds	0.80

ii). Extrinsic factors

These are factors external to the food that affect microbial growth. They include temperature of storage, humidity of storage environment, presence and concentration of gases.

Most bacteria are killed in strong acid or strong alkaline environment except Mycobacteria

(a).Temperature. The growth of microorganisms is affected in the environmental temperatures. Various microorganisms are able to grow at certain temperatures and not others. Psychrophilic microorganisms grow at -10°C in unfrozen media and can cause food

spoilage at low temperatures. Mesophilic bacteria grow at temperatures between 25°C and 40°C and spoil food kept at room temperature. Most pathogenic bacteria belong to this group. Thermophilic bacteria grow at temperatures of between 50°C and 70°C. Growth of some bacteria occur at 80°C. Bacteria in this group are mainly spore formers such as *Bacillus spp* which are of importance in the food industry especially in processed foods.

(b). Oxygen requirements. Microorganisms require either high oxygen tension (aerobic), low oxygen tension (micro-aerobic) or absence of oxygen (anaerobic) for growth. Anaerobic or facultatively anaerobic sporeformers are the microorganisms most likely to grow and spoil canned food products. Microaerophilic bacteria are most likely to grow and spoil vacuum packed foods, while aerobic bacteria are likely to grow on the surface of raw meat.

(c). Relative humidity. Relative humidity is the amount of moisture in the atmosphere or food environment. Dried foods placed at high humidity environment take up water, increase their available water and get spoiled by molds. For example, dry grains stored in an environment with high humidity will take up water and undergo mold spoilage. Foods must always be stored in a dry and cool conditions.

8.3 Spoilage of canned foods

Canning involves cooking food, sealing it in sterile cans and boiling the containers to kill or weaken any remaining bacteria as a form of sterilization.

Spoilage of canned food can be due to microorganisms, chemical or physical changes. Spoilage often results in swelling, but not always. Under processed cans permit the survival of microorganisms which grow and cause spoilage after the process. The growth may produce gas and acid alone. All cans spoiling from the survival and growth of microorganisms are under processed. This may come about by having an extremely large load of bacteria. Unless grossly understerilized, spoiled cans will contain one type of organism with high heat resistance.

This spoilage may be due to cocci, non-spore forming rods and non-heat resistant rods. *Clostridium botulinum* and other spore formers may also enter this way. Yeast and molds may be present.

Food spoilage leads to: (i). Wastage of large quantities of food (ii). Economic losses

NOTES FOR TRAINERS

Form three groups of trainees and let each group discuss the causes of meat, milk or fish spoilage. They should identify the chairperson to lead the discussions and a secretary to write down the causes they come up with. The trainer should only guide the discussions by moving from one group to the next. After each group makes their presentation, members of other groups should be allowed to comment or add to what they have presented. The trainer can then guide on the right causes of meat, milk and fish spoilage.

8.4 Food preservation

Food preservation is a process of treating and handling food to stop or slow down spoilage and thus allow for longer period of storage. Food preservation aims at:

1. Preventing growth of bacteria, yeast and molds and other microorganisms
2. Preventing oxidation of fats which cause rancidity
3. Arresting enzymatic deterioration of food
4. Preserving the nutritional value, texture and flavour of food.
5. Protecting food against attack by pests during storage.

Preservation principles and methods

Two general principles are employed in food preservation. (1). Inhibition principle (2). Killing principle,

(1). Inhibition principle. In this principle, food preservation is achieved by inhibition of growth and multiplication of microorganisms. The inhibition principle can be achieved by any of the following methods:

- (a). Reduction in available water e.g. by drying and salting
- (b). Reduction in pH e.g by fermentation and addition of acids.
- (c). Use of preservatives, e.g sodium benzoate
- (d). Use of low temperatures (chilling or freezing)
- (e). Smoking – which has a drying and preservative effect

Preservation by these methods does not necessarily imply the destruction of microorganisms. This is because, on removal of the inhibiting influence, the food will undergo spoilage.

NOTES FOR TRAINERS

1. Trainers can ask participants to give examples of foods preserved by different methods: drying, salting, fermentation, smoking, use of preservatives, chilling and freezing.
2. It is important to emphasize that sometimes a combination of these methods are used to preserve foods. Ask participants to name foods that are preserved by a combination of two or more of the listed methods e.g salting and drying, smoking and chilling etc.

Food preservation by lowering pH. Many food products can be preserved by lowering pH so that the growth of spoilage and pathogenic bacteria is prevented. The lowering of pH can be achieved by addition of acids and fermentation. The inhibitory effect of acids are exerted whether the acid is added directly to food, is a constituent of the food, or is produced in the food by fermentation.

Food preservation by lowering of available water. Preservation of food by lowering water activity has been practiced for centuries. On harvesting, most foods contain enough moisture to permit action by their own enzymes and by microorganisms. In order to preserve such foods, it is necessary to remove the free water (moisture) necessary for enzyme and microbial activity. Lowering of water activity can be achieved by:

- a. Addition of salt
- b. Drying

NOTES FOR TRAINERS

Trainees should be asked to give some typical pH and water activity values for preserved foods.

Food preservation by salting. Salting is commonly employed in the meat industry in the curing of meat and production of cured meat products. Sodium chloride and small amounts of nitrates and nitrites is commonly used for this purpose. The salting procedure can be performed in four ways:

1. Dry cure in which the meat or fish is rubbed with salt and stacked between salt layers.
2. The products are immersed in pickle or brine, usually containing about 15% salt. The brine can be used over again if carefully handled.
3. The injection cure, in which a concentrated solution of the ingredients is injected by needle into the muscular tissue in various parts of the meat by using a pickle injector machine. The advantage here is that the salt enters into the inner of the product more rapidly, thus greatly shortening the curing time
4. Direct addition method in which the salt or curing agents are added directly to finely ground meats such as sausage.

The preservative effect of salt is often supported by drying, chilling, chemical preservatives and/or heating.

Food preservation by drying. Drying is the most widely used method of food preservation. Some foods e.g grains are sufficiently dry as harvested, or with little drying can remain unspoiled for long periods under proper storage conditions. Dry foods store for a long time at room temperature under low humidity. Properly dried foods stored in moisture proof containers can stay for over one year. Moisture may be removed from foods by means of the sun's rays or the modern artificial methods. Microorganisms and parasites present in the product before drying will survive the drying process.

Methods of drying foods

1. Sun drying. Food is spread in the sun to dry. Sun drying is commonly used to dry grains, certain fruits such as raisins, prunes, figs, apricots; meat and fish. Sun drying requires large land area and has problems of contamination from dust, insects, birds and rodents. To sun dry fish, the fish scales and offals have to be removed before the fish are spread out in the sun to dry on a raised rack or clean sacks or mats. On the other hand meat is cut into thin long strips or slices and then hang outdoors to dry.

2. Mechanical driers. Mechanical driers are used to produce dehydrated or desiccated food product. A dehydrated or desiccated food has been dried by artificially produced heat under controlled conditions of temperature, relative humidity and air flow.

Food preservation by use of low temperatures. Two methods are employed to arrest microbial growth and multiplication. These are chilling (cold storage) and freezing. Chilling is keeping food at temperatures between 0-15°C. The common chilling temperatures range between 4-5°C. Temperatures that are just above freezing point maintain foods near their original condition for a limited time (2-4 days). Chilling alone is not considered as a method of food preservation, but a method to prolong the shelf-life of fresh products.

Freezing is keeping food at temperatures between 0°C and -35°C. However, because of the content of electrolyte, most foods will start to freeze at -2°C to -5°C. Low temperatures are used to retard chemical reactions and actions of food enzymes and to slow down or stop the growth and activity of microorganisms in the food. A low enough temperature will prevent the growth of any microorganisms.

Food preservation by smoking. Smoking is commonly employed in the meat industry to preserve and give flavour to meat. Smoking has three main purposes, (1) aids in preservation (2) adds the desired flavour, and (3). improve colour of the food. Smoking preserves by:

- impregnation of preservative chemicals from the smoke on the surface of food,
- drying effect of smoke reduces the water activity of the food,
- heat of smoking may also destroy microorganisms.

The smoke can be produced in certain smoke generators and the smoke conducted into the smoking room or cabinets. Wood smoke contains a large number of volatile compounds that differ in their microbiocidal or microbiostatic activities.

Use of preservatives

Preservatives are physical or chemical substances used to prolong the shelf-life of a food by protecting against deterioration caused by microorganisms. Chemical preservatives for use in food preservation must be (i) non-toxic and non-carcinogenic to mammals, (ii) should not react with other substances to produce toxic substances and (iii) Should not restore a bright colour or freshness of already spoiled food product. A good preservative should have a good inhibitory power against a wide range of microorganisms. The use of preservatives should embrace the principle of good manufacturing practices, where only a minimum level to achieve the desired keeping quality is used. Preservatives can be grouped into:

1. Antimicrobials e.g. Calcium propionate, sodium nitrate, Sodium nitrite, sulfites (Sulfur dioxide, sodium bisulfite, potassium hydrogen sulfite), Disodium EDTA. These inhibit growth of microorganisms in food
2. Antioxidants e.g. Butylated hydroxyanisole (BHA), and Butylated hydroxytoluene (BHT). They inhibit oxidation of food constituents.
3. Other preservatives: e.g. glutaraldehyde that is used to kill insects.

ii). Killing principle In this principle, spoilage microorganisms are destroyed in the food and thereafter the food is protected against subsequent contamination by being enclosed in an

air tight container. This principle is achieved by heating: Two methods are used to preserve food by heat treatment. These are: (i). Pasteurization, and (ii) sterilization.

Pasteurization. Is a process of heat treatment of a food substance at specific temperatures and times, aimed at destroying all pathogenic microorganisms except spores, without affecting the nutritive quality of the food. Pasteurization leads to destruction of 99% of all vegetative organisms and all pathogenic microorganisms. Pasteurization is commonly employed in the milk industry. Three methods are usually employed:

- (1). Low temperature, long time (63°C for 30 minutes)
- (2). High temperature, short time (72°C for 15 seconds)
- (3). Flash method at 80°C for 1-2 seconds/or continuously

Sterilization. Is a physical or chemical process which destroys or eliminates all forms of life especially microorganisms from a given substance such as food. Sterilization can be achieved by heating food at temperatures above 140°C. Some of the foods preserved by sterilization include ultra heat treated milk and canned meat. During sterilization, some food nutrients are destroyed such as vitamin C. However, sterile foods store for a long time. Such foods only spoil through occurrence of chemical reactions in the stored food leading to fat rancidity and off-flavours.

NOTES FOR TRAINERS

The trainer can engage the trainees to discuss:

1. The methods used to preserve various foods in their communities.
2. The problems that are associated with preservation of foods in their communities
3. How such problems can be alleviated
4. How can preservation of meat, milk and fish be improved in their communities

UNIT 9: SURVEILLANCE OF FOOD IMPORT/EXPORTS

9.1 Learning objectives

By the end of this unit, participants will be able to:

1. Explain the role of food surveillance in ensuring safety of foods, and in prevention of introduction of disease pathogens and pests from other countries
2. Describe circumstance under which food imports should be granted or rejected

9.2 Surveillance of food imports

Surveillance of food imports is an important activity that aims to;

1. Protect consumers and the domestic foods and food sources from exotic pathogens, pests and diseases from imported food or animals;
2. Ensure compliance of food and live animal exports with health, safety and quality standards stipulated in national regulations or demanded by the importing country.

The jurisdiction for such activity lies with the Veterinary Department, the competent authority of any country. All exports of foods and products of animal origin must be accompanied by a 'certificate of veterinary inspection' from the Veterinary Department who are recognized as the competent authority, or an authorized veterinarian. The 'certificate' confirms that an animal or a group of animals were apparently healthy and showed no signs of contagious or communicable diseases on the date the inspection took place, or in the case of products of animal origin, that the product originates from an establishment that is officially approved for export. The competent authority shall in particular ensure that:

- Establishments that are authorised to export comply and continue to comply with the requirements, and
- That the list of such approved establishments is kept up-to-date and communicated to the importing country(ies).
- The certification requirements are satisfied
- There is collection of information with regard to residues of veterinary medicinal products and other pharmacologically active substances used to treat animals,
- There is collection and reporting of notifiable and zoonotic diseases in accordance with national and international requirements and obligations.
- There is collection and submission of information on the following, if required.
- Contaminants and other chemical residues (pesticides, heavy metals, dioxin, methyl mercury, etc)
- Use of substances having hormonal effects

- Materials and articles in contact with foodstuffs
- Radioactivity
- Genetically modified organisms (GMOs).

For any facility to export, importers normally require that they inspect the facility before they agree to import from such a facility. Once they approve, the responsibility to ensure establishments maintain the hygiene status of the facility lies with the Veterinary Department who carry out regulatory inspection and licensing of export facilities.

To get such licenses from the veterinary authorities, the management of the export slaughterhouse or processing facility have to meet their obligations which include:

1. Providing for general hygiene of primary production
2. Ensuring that all hygiene requirements after primary production are followed
3. Monitoring food production processes and safety of food products they produce
4. Ensuring microbiological control requirements for specific products are followed
5. Implementing hygiene procedures in food production and processing based on the HACCP principles
6. Ensuring registration and approval by veterinary authorities of their food processing establishments.

UNIT 10: WATER AND SANITATION

10.1 Learning objectives

At the end of this lecture participants should be able to:

1. Identify the causes and effects of water pollution
2. Identify water borne and water related diseases and factors contributing to their spread in the community.
3. Explain how poor sanitation affects public health and wellbeing.
4. Identify facilities and practices that can enhance the level of sanitation in the community

10.2 Water pollution

Water is an important commodity that is used for drinking and in food production and processing. Water is also important for proper maintenance of hygiene and sanitation. Potable water is required for drinking, production of safe food for human consumption and maintain hygiene of the food establishments. Pollution of water is one of the major problems confronting public health and water supplies authorities all over the world. Water pollution is any chemical, biological or physical change in water quality that makes water unsuitable for desired uses.

10.3 Causes of water pollution

The main causes of water pollution is the discharge of solid or liquid wastes or effluents containing pollutants into surface, underground or coastal waters. Wastes that contribute to water pollution are broadly grouped into (i) sewage wastes (ii) industrial wastes (trade wastes), and (iii) agricultural wastes (iv) storm water/rain water runoff. These wastes originate from domestic and commercial premises, land drains, some industrial plants and agricultural sites. Other industrial wastes are discharged directly into rivers, canals and the sea and not into the sewage system. Poor sanitation in the community causes water pollution. One of the most common sources of contamination of water is inadequate disposal of excreta and effluents from human waste. Unavailability, inadequate or dilapidated waste treatment facilities will lead to disposal of excreta and discharge of effluent into the environment without treatment. This leads to contamination of surface or ground water sources especially during the rainy season when the environment is prone to flooding.

10.4 Effects of water pollution

Worldwide, it is estimated that 60-80% of all diseases are linked directly or indirectly to water pollution, whereby the highest incidence is in crowded low income urban settlements. In many African countries, hospitals are full with patients suffering from water and excreta related diseases with diarrhoea diseases killing more children compared to many other diseases. Contamination of water resources has a direct and devastating implication on public health. Insufficient access to sanitation facilities and hygiene education increases the incidence of diarrhoea and the prevalence of worm infestations in the community.

Water pollution has a tremendous effect on spending on health. Funds which otherwise could be used to reduce poverty. Unavailability of separate and hygienic sanitation facilities at schools and public places is directly linked to low education and insufficient participation in public life of girls and women. This combined with loss of working days due to illness and caring for the sick leads to low productivity and poses serious limitation to the economic development of the country. Protection and prevention of contamination of water resources is important in improving public health and quality of life of the people.

10.5 Health and sanitation

The goal of improved sanitation is to prevent disease causing organisms which are present in the excreta from being transmitted to other people. Excreta related organisms include:

1. Bacterial diseases- cholera, typhoid and bacillary dysentery
2. Viral diseases- infectious hepatitis, and viral diarrhoea
3. Protozoal diseases – Amoebic dysentery, giardiasis
4. Helminths infections- hookworms, tapeworms and schistosomiasis

These diseases occur where::

1. There are no latrines and the soil is polluted
2. Latrines are not sanitary or where they are not used (e.g by children)
3. Fresh untreated waste are used as fertilizer
4. People do not wash hands before eating
5. People walk on bare feet (without shoes)

10.6 Control of excreta -related diseases

1. Isolate excreta from surface water by providing and using latrines
2. Provide clean water for washing, cooking and drinking, and for recreation
3. Control or Kill disease vectors such as flies and cockroaches
4. Treat infected people to prevent the shedding of pathogens to the environment
5. Educate the community about diseases, their transmission and control measures.

Treatment and disposal of excreta can involve use of latrines or toilets. Latrines are used for disposal of excreta into the soil. They are common in rural areas and in urban areas where there is no piped water. Excreta is either retained on the earth or remain in latrines. There are various types of latrines, namely:

1. Pit latrines, -single or multiple latrines
2. Ventilated improved pit (VIP) latrines, with single, double or multiple pits
3. Pour flush latrines with a vault and soak away pit
4. Composting latrines
5. Bucket latrines.

Poorly designed and constructed onsite facilities (with questionable privacy and cultural appropriateness, produce foul smell or which are structurally insecure) will hamper utilization by potential users and increase tremendously the rise of disease pandemics during rainy seasons. The results of poor facilities is that many onsite sanitation installations are not used

or maintained making people to resort to such habits as relieving themselves on public grounds, on roadsides or in bushes.

Access to improved sanitation facilities is important for human dignity, increasing self esteem gender equality and poverty reduction. Outbreaks of waterborne diseases mainly occurs during the rainy season and in crowded urban areas. Safe sanitation infrastructure guarantees good disposal of human excreta through adequate facilities. Adequate water and sanitation facilities will reduce diarrhoea by 51% and when combined with hand washing compaigns by 87%. Access to water and sanitation facilities for safe disposal of excreta combined with large scale hygiene education is key to improving public health. National and individual health costs could be significantly reduced with the improvement of waste treatment facilities and by the use of environmentally sound onsite sanitation facilities.

10.7 Management of water and sanitation services

A number of sectors including health, water, education, housing and local government are normally involved in provision of water and sanitation services. Significant progress to improving access to sanitation can only be achieved if contributions of each sector are considered. Due to the multi-disciplinary nature of sanitation, coordination and joint decision making between ministries at national level is critical. Coordination needs to create an enabling environment where contributions of all the involved sectors are taken into account.

Water and sanitation projects should be implemented concurrently and never de-linked. In addition, the link between environment and sanitation (a clean environment) helps to break the cycle of diseases and therefore is as important as the link between sanitation and health.

The high population density in urban areas often makes it impossible to place a sanitation facility at each household and therefore ablution blocks may be needed. Lacking or inappropriate sanitation facilities make living conditions much worse in urban than in rural areas. Pollution of water resources due to insufficient sanitation is high in urban areas, hence investment in sanitation is important. Solutions may include construction of ablution blocks, decentralized waste treatment with bio-digestors. In rural areas, communities have to play a key role in sanitation development and promotion of technologies.

10.8 Water borne diseases

10.8.1 Shigellosis (Bacillary dysentery)

Shigellosis is caused by members of the genus *Shigella*. They are *Shigella dysenteriae*, *Shigella flexneri*, *Shigella boydii* and *Shigella sonnei*. All strains of shigella possess potent exotoxins which are responsible for causing diarrhoea

Mode of infection and spread

Human beings get infection through consumption of untreated water, water that is not boiled, or consumption of contaminated food. Spread is by fecal-oral route. *Shigella* organisms leave the body in stool of an infected person and contaminate water or food. Flies can spread *shigella* organisms when they have had contact with stool from an infected person and then contaminate food.

Symptoms

The illness begins 1 to 4 days after ingestion of bacteria and may last 4 to 7 days. Symptoms include diarrhea, (may be watery or bloody), fever, stomach cramps, nausea or vomiting, dehydration (in severe cases) and convulsions in young children. The diarrhea which starts as a thin watery discharge quickly loses its fecal character to be composed of nothing but pus, mucus threads and blood. Death from bacillary dysentery may occur if efficient treatment is not provided.

Prevention. Supply of adequate potable drinking water and environmental sanitation

10.8.2. Cholera

Cholera is caused by *Vibrio cholera* bacterium. *Vibrio cholera* are gram negative motile rods, usually curved and with one single polar flagellum. Vibrios are aerobic, motile organisms with a high alkaline tolerance.

Mode of infection and spread

Cholera vibrios are ingested in drink or food. Outbreaks occur either as explosive epidemics usually in non-endemic areas or as protracted epidemic waves in endemic areas. Man is the only natural host of the cholera vibrios and the spread of infection is from person-to-person through contaminated water or uncooked foods, washed or made up with contaminated water. Cholera is an infection of crowded poor class communities and it tends to persist in such areas.

Symptoms of the disease

Cholera is typically characterized by the sudden onset of effortless vomiting and profuse watery diarrhea. Vomiting is seen frequently, but very rapid dehydration that can lead to hypovolemic shock. Patients may have up to 20-30 stools per day, losing many litres of water. Death may occur in 12 to 24 hrs if treatment is not provided.

Prevention: Supply of adequate potable drinking water and enhanced environmental sanitation

Health education

Health education on prevention of cholera is important in cholera endemic countries so that people in or near areas already affected by cholera take proper measures to minimize the risk to themselves and to others. Health education message should be designed and for deliver to the general public through various media.

Provision of sanitary facilities and safe drinking water to poor communities will reduce the incidence of cholera outbreaks.

10.8.3 Amoebiasis (Amoebic dysentery). Amoebiasis is caused by the parasite *E. histolytica*. Infections occur through contaminated hands of food handlers, flies and contaminated water sources. Ingestion of food and drink contaminated with *E. histolytica* cysts from human faeces and direct faecal oral contact can lead to amoebiasis.

Source of infection

The most common sources of infection are: Infected food handlers, faulty plumbing, raw vegetables or fruit from farms fertilized with human feces or washed in polluted water. The risk increases with crowded or unsanitary living conditions.

Cysts are highly resistant to dessication and certain chemicals including chlorine. They are therefore not inactivated by chlorination of water. However, the parasite may be destroyed by iodination.

Amoebiasis signs and symptoms

- Sometimes no symptoms are present.
- Intermittent diarrhea with bad-smelling stools. Diarrhea is often preceded by constipation in the early stages.
- Abdominal cramps and bloating due to gas accumulation.
- Fever and muscle aches.
- Mucus and blood in the stool (sometimes).
- Fatigue.

When the liver is involved there is:

- Tenderness over the liver and right side of the abdomen.
- Yellow skin or eyes (sometimes).
- Shaking chills.
- Weight loss.

10.8.4 Giardiasis

Giardiasis is caused by the parasite *Giardia lamblia* which inhabits the duodenum and jejunum of man. Outbreaks of giardiasis has been linked to consumption of untreated surface water contaminated by human sewage.

Signs and Symptoms

More than two thirds of people who are infected may have no signs or symptoms of illness, even though they are infected. When the parasite does cause symptoms, the illness usually begins with severe watery diarrhea, without blood or mucus. Giardiasis affects the body's ability to absorb fats from the diet, so the diarrhea contains unabsorbed fats. That means that the diarrhea floats, is shiny and foul smells. Other symptoms include: abdominal cramps, large amounts of intestinal gas, an enlarged belly from the gas, loss of appetite, nausea and vomiting and sometimes a low-grade fever. These symptoms may last for 5 to 7 days or longer. If they last longer, a child may lose weight or show other signs of poor nutrition.

Sometimes, after acute) symptoms of giardiasis pass, the disease begins a chronic (or more prolonged) phase. Symptoms of chronic giardiasis include periods of intestinal gas and abdominal pain in the area above the navel.

10.8.5 Bilharzia

Bilharzia is caused by a parasite known as schistosome. The parasites live in the blood vessels of the abdomen of an infected person. The female parasite lays fertilized eggs in the blood vessels. The eggs work through the blood vessels into the bladder and bowel. They are then passed out in urine or stool and contaminate the environment. In the water environment, the eggs hatch into young schistosomes which enter the snails and undergo development before emerging as free swimming parasites in water that are ready to infect man. A person who gets into contact with the contaminated water is at risk of infection with the free swimming schistosomes which readily penetrate intact skin of man and find their way into the bloodstream and settle in the blood vessels in the abdomen.

Signs and symptoms

1. The most common sign is blood in urine, especially when passing the last drops.
2. Pain in the lower abdomen between the legs, usually at the end of urination
3. Low fever and itching
4. Kidney damage that may lead to death.

10.9 Prevention of waterborne diseases

The following measures can be used to prevent the spread of waterborne diseases:

Proper treatment of water. Large quantities of water is made safe for use through chemical treatment to kill disease causing microorganisms. Water treatment is done at a water treatment plant. Smaller quantities of water can also be treated using chemicals that are readily available from chemists.

Boiling water. Boiling water kills disease causing microorganisms. Boiled water should be stored in clean containers. The containers should be covered to keep off dust and flies that will contaminate the water again.

Proper sanitation. Sanitation involves protection of personal and public health. This can be done by:

1. Maintaining general cleanliness of the body and environment
2. Using clean safe water for drinking and preparation of food
3. Using toilets and latrines to dispose of human waste. Improper disposal of human waste can lead to contamination of water sources and food thereby spreading diseases
4. Proper disposal of domestic and industrial solid wastes. Solid waste from homes and industries should not be dumped into sources of water but in designated areas away from water bodies.
5. Proper treatment of sewage and industrial liquid waste before disposal.

Proper hygiene. Water borne diseases can be prevented by observing the following basic hygiene rules:

1. Washing hands before handling and eating food
2. Washing hands after visiting the latrine or toilet

3. Washing fruits and vegetables before eating or cooking.
4. Covering food and water to keep off dust and flies.

Wearing protective clothing when handling stagnant water: People who get into contact with stagnant water can easily be infected with bilharzia germs. This can happen when people:

1. Play or swim in stagnant water
2. Work in rice fields
3. Wade through flooded areas or contaminated rivers.

To prevent contracting bilharzia, people should wear protective clothing such as waterproof gumboots and gloves, as well as avoid swimming in stagnant water.

10.10 Chemical hazards in water

Water may contain chemical hazards that affect public health. Such chemicals include heavy metals(mercury, lead arsenic cadmium etc), fluorides, nitrites and nitrates. Sources of these chemicals include industrial effluents that are discarded onto the land, or rivers thus increasing the chances of chemical build-up in various water sources.

Health effects of chemical hazards

Nitrites/Nitrates. The ingested nitrate in water can be reduced to nitrite in the stomach before it is absorbed into the blood stream. Nitrite readily oxidizes iron of hemoglobin to methemoglobin that is ineffective in oxygen transport.

Fluoride. Fluoride in drinking water can cause dental fluorosis in children. The use of drinking water containing 1-1.2 mg/litre fluoride may cause dental fluorosis. More than 5-8 mg/litre can cause skeletal fluorosis with symptoms of chronic fluorosis.

Heavy metals. They cause various toxic effects depending on the metal involved.

The safety of water used for drinking and food processing is of major importance. Safe water must be free of pathogenic microorganisms and hazardous chemicals.

10.11 Water treatment

Ample supply of potable water and adequate sanitation facilities is a prerequisite for good health. Provision of adequate supplies of safe water result in reduction of the incidence of infectious diseases.

Methods of water treatment

1. Boiling
2. Chlorination
3. Iodination