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Course code: FST502

Course title: Meat Science & Fish Science & Technology

Course credit load: 3 units

List of Series:

1. **Science and Technology of Meat Production**
2. **Processing and Preservation of Meat Products**
3. **Quality Factors in Meat and Poultry**
4. **Fish Science and Product Technology**
5. **Egg and Poultry Product Utilisation**

1.1 Anatomy, Physiology and Histology of Domestic Animals

- 1.1.1 Anatomy of meat-type animals
- 1.1.2 Physiology relevant to meat production
- 1.1.3 Histological structure and its role in meat quality

1.2 Conversion of Meat-Type Animals to Human Food

1.2.1 Principles of slaughtering

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1.3 Slaughter and Dressing of Table Birds

1.3.1 Methods of poultry slaughter

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1.4 Introduction to Meat Processing Methods

1.4.1 Curing and preservation basics

1.4.2 Canning and drying of fresh meat

1.4.3 Intermediate moisture meat

Introduction

Meat has always been a central part of human diets, and its production involves a fascinating blend of science and technology. From the anatomy of domestic animals to the processes that convert

them into food, this Series provides the foundation for understanding how meat reaches our tables. By exploring the biological structures and physiological functions of animals, learners will gain insight into how these factors influence meat quality and processing. This knowledge is essential for anyone studying food science and technology, as it connects the science of animal biology with the practical aspects of food production.

The aim of this Series is to equip you with the scientific and technological principles underlying meat production, enabling you to analyse animal structures, evaluate slaughtering and dressing practices, and explain basic processing methods.

We shall commence this Series by examining the anatomy, physiology, and histology of domestic animals, which form the biological basis of meat science. Next, we will explore the conversion of meat-type animals into human food, focusing on slaughtering, dressing, and hygiene considerations. Following that, we will study the slaughter and dressing of table birds, highlighting methods and quality aspects. Finally, we will wrap up by introducing basic meat processing methods such as curing, canning, drying, and the concept of intermediate moisture meat. This sequential approach will provide you with a comprehensive understanding of the science and technology of meat production.

Series Learning Outcomes

Upon completing this Series, you should be able to:

SLO 1.1 define the anatomical structures of domestic animals relevant to meat production,

SLO 1.2 explain the physiological functions that influence meat yield and quality,

SLO 1.3 describe the histological features of muscle tissue and their role in meat science,

SLO 1.4 demonstrate the principles of slaughtering and dressing meat-type animals for human consumption,

SLO 1.5 apply hygienic practices in handling and preparing carcasses,

SLO 1.6 analyse the methods used in slaughtering and dressing table birds,

SLO 1.7 evaluate the quality and safety considerations in poultry processing, and

SLO 1.8 explain the basic processing methods of meat, including curing, canning, drying, and intermediate moisture meat.

1.1 Anatomy, Physiology and Histology of Domestic Animals

1.1.1 Anatomy of meat-type animals

Anatomy is the study of the physical structure of living organisms. In meat science, it focuses on the arrangement of bones, muscles, and organs in domestic animals such as cattle, sheep, goats, and poultry. This knowledge is vital because it determines the distribution of meat cuts and the efficiency of processing. For example, the hindquarters of cattle contain large muscles that provide high-value cuts such as sirloin and round. A clear understanding of anatomy also helps in

identifying edible and non-edible parts, which is essential for hygienic and economic meat production.

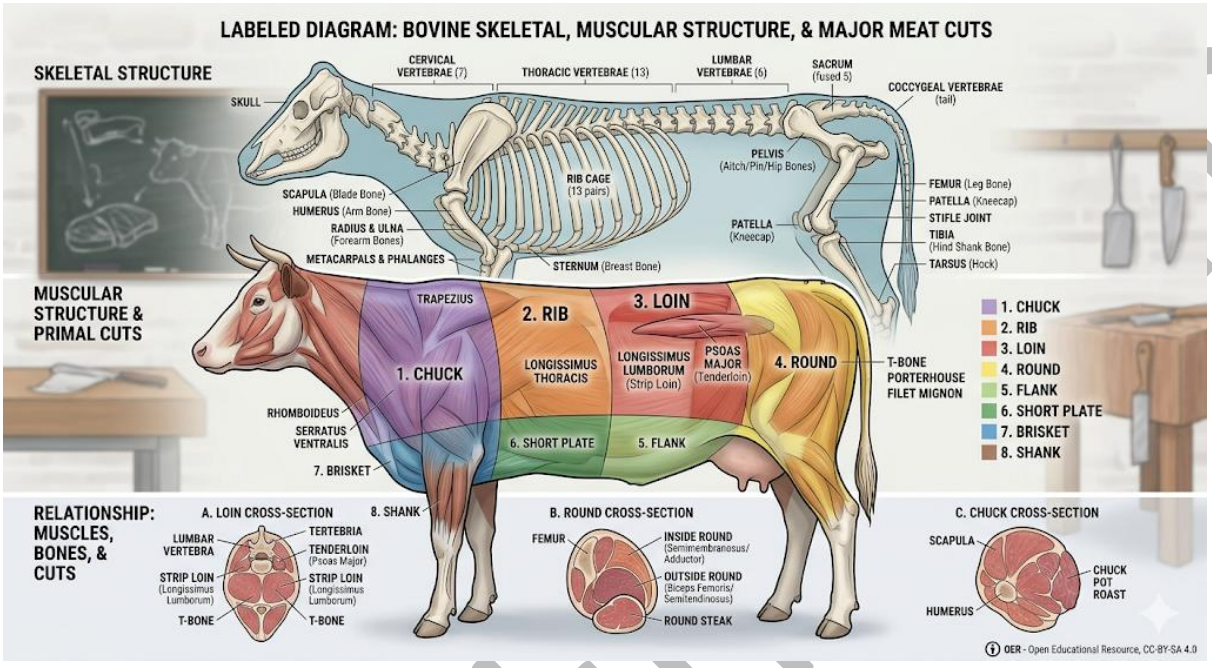


Diagram showing skeletal and muscular structure of a cow Figure 1.1: Basic anatomy of a meat-type animal.

Fill in the blank: The study of the physical structure of domestic animals is called _____.

1.1.2 Physiology relevant to meat production

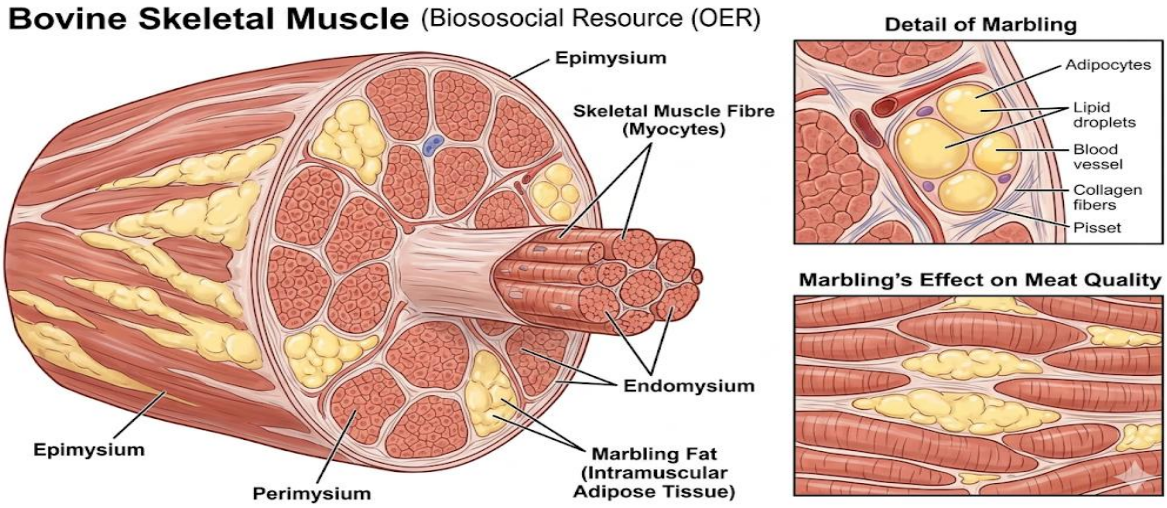
Physiology refers to the study of how the systems of the body function. In meat science, physiology is important because processes such as blood circulation, respiration, and metabolism directly influence meat quality. Muscle metabolism after slaughter affects tenderness and flavour, while stress before slaughter can lead to undesirable conditions. For instance, pigs may develop pale, soft, exudative (PSE) meat, while cattle may produce dark, firm, dry (DFD) meat. These conditions reduce consumer acceptability and market value.

Image showing cattle resting calmly in a holding pen Plate 1.1: Physiological condition of animals before slaughter.

Fill in the blank: Stress before slaughter can lead to _____ meat in pigs and _____ meat in cattle.

1.1.3 Histological structure and its role in meat quality

Histology is the microscopic study of tissues. In meat science, histology focuses on muscle fibres, connective tissue, and fat deposits. Muscle fibres determine texture, connective tissue influences toughness, and fat contributes to flavour and juiciness. A key histological feature is **marbling**, which refers to the distribution of fat within muscle tissue. Marbling enhances flavour and tenderness, and is often used as a grading criterion in beef production. The balance between muscle fibres and connective tissue also determines whether meat is tender or tough, which is an important consideration for both consumers and processors.



Microscopic view of muscle fibres with marbling Figure 1.2: Histological structure of muscle tissue.

Fill in the blank: The microscopic study of tissues is known as _____.

Pilot questions 1.1

1. What is the branch of science that studies the physical structure of domestic animals?
2. How does stress before slaughter affect meat quality in pigs and cattle?
3. What is marbling, and why is it important in beef grading?
4. Define physiology in the context of meat science.
5. Identify one histological feature that influences meat tenderness.

1.2 Conversion of Meat-Type Animals to Human Food

1.2.1 Principles of slaughtering

Slaughtering is the process of humanely killing animals for food. It is a critical stage in meat production because it directly influences the quality, safety, and acceptability of meat. Humane slaughtering practices are designed to minimise pain and stress, which is important not only for ethical reasons but also because stress alters muscle chemistry. When animals are stressed, glycogen reserves in the muscles are depleted, leading to poor post-mortem biochemical changes. This can result in meat that is either too pale and watery or excessively dark and dry.

The main stages of slaughtering include stunning, bleeding, and carcass preparation. Stunning renders the animal unconscious, preventing pain and distress. Bleeding ensures the removal of blood, which is essential for hygiene and shelf life, since retained blood can serve as a medium for microbial growth. Carcass preparation involves cleaning and positioning the body for dressing. Each of these stages must be carried out carefully, as errors can compromise both meat quality and consumer safety.

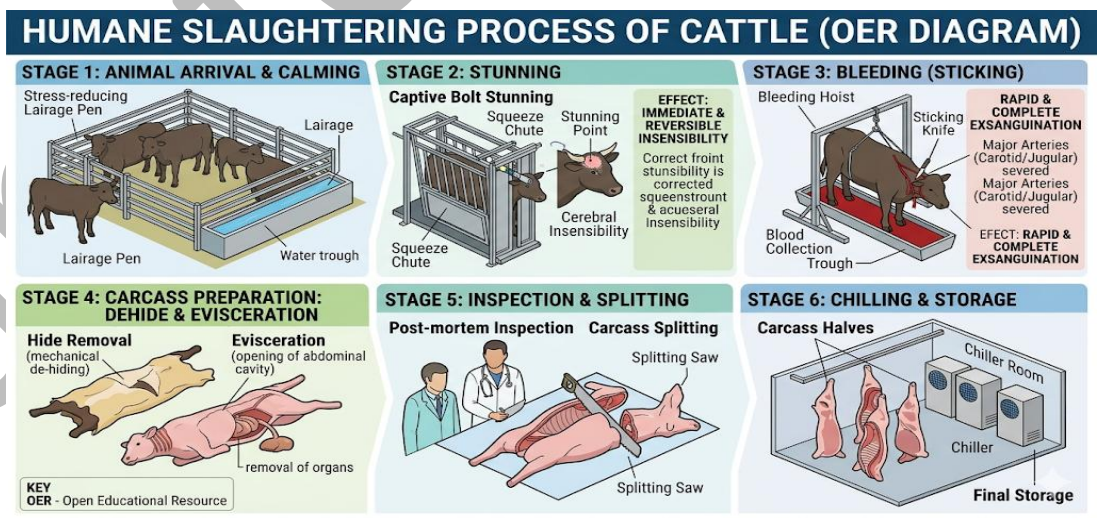


Diagram showing stages of humane slaughtering process
Figure 1.3: Stages in the slaughtering of meat-type animals

Fill in the blank: The process of humanely killing animals for food is called _____.

1.2.2 Dressing and preparation of carcasses

Dressing refers to the removal of non-edible parts of the animal after slaughter, including the head, hide, feet, and internal organs. This step is essential because it prepares the carcass for further processing and ensures hygienic handling. In cattle, dressing involves skinning and evisceration, while in poultry it includes plucking feathers and removing viscera. The process must be carried out with precision, since poor technique can lead to contamination or wastage of edible portions.

The efficiency of dressing also affects yield. For example, improper removal of the hide in cattle can damage underlying muscle, reducing the amount of saleable meat. Similarly, careless evisceration may rupture the intestines, contaminating the carcass with harmful bacteria. Therefore, dressing is not simply a mechanical task but a skill that requires knowledge of anatomy, careful handling, and strict hygiene.

Image showing workers dressing a carcass in a hygienic environment
Plate 1.2: Dressing and preparation of carcasses.

Fill in the blank: The removal of non-edible parts of the animal after slaughter is known as _____.

1.2.3 Handling and hygiene considerations

Hygiene refers to practices that maintain cleanliness and prevent contamination. In meat production, hygiene is critical at every stage, from slaughtering to dressing and storage.

Contamination can occur through dirty equipment, poor handling, or exposure to pathogens. Workers must wear protective clothing, equipment must be sanitised, and carcasses should be handled in clean environments.

Good hygiene practices not only protect consumers but also extend the shelf life of meat products. For instance, carcasses that are exposed to unsanitary conditions may quickly develop microbial growth, leading to spoilage and foodborne illness. On the other hand, strict hygiene ensures that meat remains safe, wholesome, and marketable. Hygiene is therefore both a scientific and managerial concern, requiring training, discipline, and constant monitoring.

Box 1.1: Key hygiene practices in meat conversion

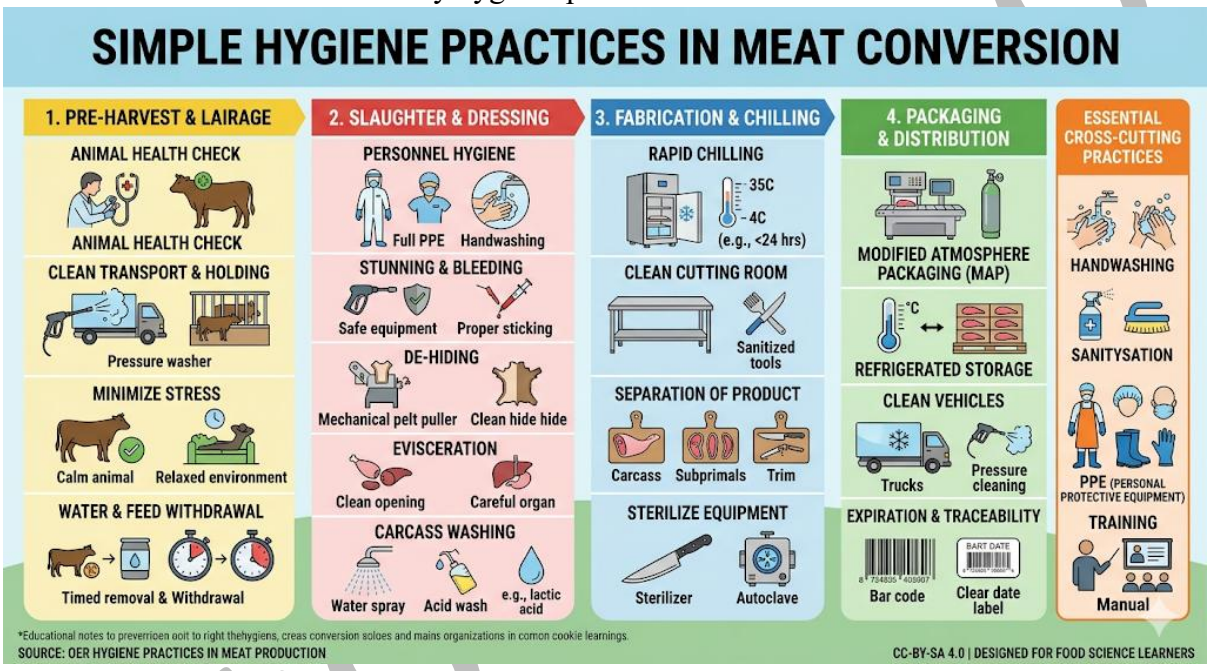


Table with single column listing hygiene practices
Caption: Box 1.1: Key hygiene practices in meat conversion.

Fill in the blank: Practices that maintain cleanliness and prevent contamination in meat production are referred to as _____.

Pilot questions 1.2

1. What is the process of humanely killing animals for food called?
2. Why is stunning important in the slaughtering process?
3. What does dressing involve in cattle compared to poultry?
4. Explain how poor hygiene affects the shelf life of meat products.
5. Describe one way in which improper dressing can lead to contamination.

1.3 Slaughter and Dressing of Table Birds

1.3.1 Methods of poultry slaughter

Poultry slaughter refers to the humane killing of birds such as chickens, turkeys, and ducks for food. Unlike large animals, poultry are usually slaughtered in large numbers, often using mechanised systems. The process begins with stunning, which may be electrical or mechanical, followed by bleeding. In some contexts, religious requirements such as halal or kosher practices influence the method of slaughter. The aim is always to ensure minimal suffering and effective bleeding, since poor bleeding can result in discoloured meat and reduced shelf life.

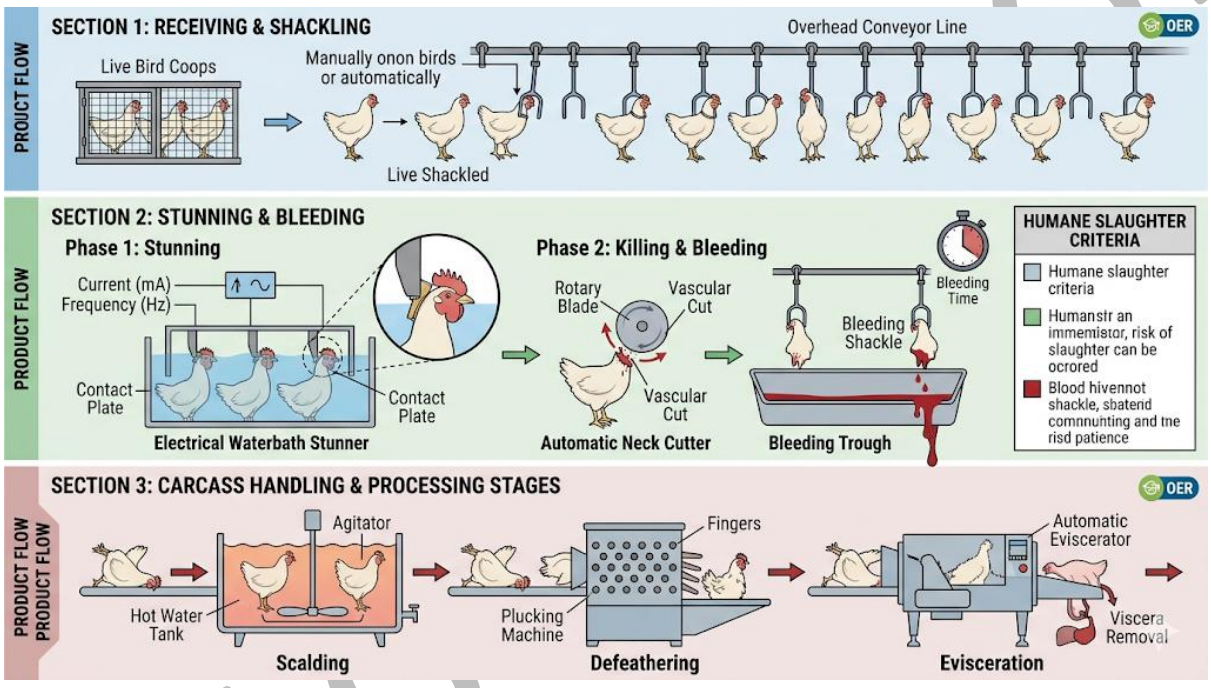


Diagram showing mechanised poultry slaughter line Figure 1.4: Mechanised poultry slaughter process.

Fill in the blank: The humane killing of birds for food is referred to as _____.

1.3.2 Dressing techniques for table birds

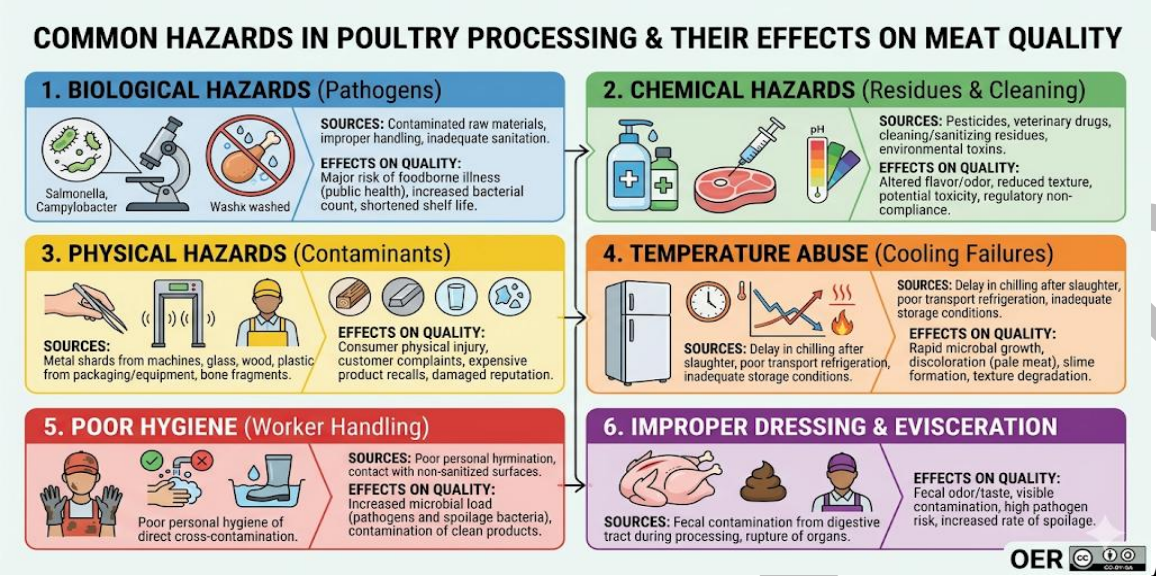
Dressing of poultry involves removing feathers, viscera, and other non-edible parts to prepare the bird for consumption. The process typically includes scalding, plucking, evisceration, and washing. Scalding loosens feathers, plucking removes them, and evisceration ensures that internal organs are taken out without contaminating the carcass. Washing is the final step, which improves appearance and reduces microbial load. Proper dressing is important because careless handling can rupture intestines, leading to contamination.

Image showing workers plucking and dressing poultry in a clean facility Plate 1.3: Dressing of table birds.

Fill in the blank: The removal of feathers, viscera, and other non-edible parts in poultry is known as _____.

1.3.3 Quality and safety aspects

Quality and safety in poultry slaughter and dressing are determined by both technique and hygiene. Birds that are not properly stunned or bled may produce meat with poor colour and texture. Similarly, contamination during dressing can introduce pathogens such as Salmonella or Campylobacter, which are major foodborne hazards. Maintaining strict hygiene, using clean equipment, and ensuring proper chilling after dressing are essential to preserve quality. Consumers expect poultry meat to be tender, safe, and visually appealing, and this is only possible when slaughter and dressing are carried out correctly.



OER *Box 1.2: Common hazards in poultry processing. Microbial contamination from intestines. Poor bleeding leading to discoloured meat. Inadequate chilling causing spoilage Caption: Box 1.2: Common hazards in poultry processing.*

Fill in the blank: Pathogens such as _____ and _____ are common hazards in poultry processing.

Pilot questions 1.3

1. What is the purpose of stunning in poultry slaughter?
2. Describe the main steps involved in dressing poultry.
3. How does poor bleeding affect poultry meat quality?
4. Identify two pathogens commonly associated with poultry contamination.
5. Why is chilling important after dressing poultry?

1.4 Introduction to Meat Processing Methods

1.4.1 Curing and preservation basics

Curing is a preservation method that involves adding salt, nitrates, or nitrites to meat. This process inhibits microbial growth, enhances flavour, and improves colour. Curing has been used for centuries and remains important in modern meat processing. Salt draws out moisture, reducing water activity, while nitrates and nitrites prevent the growth of harmful bacteria such as Clostridium botulinum. Cured meats include bacon, ham, and sausages.

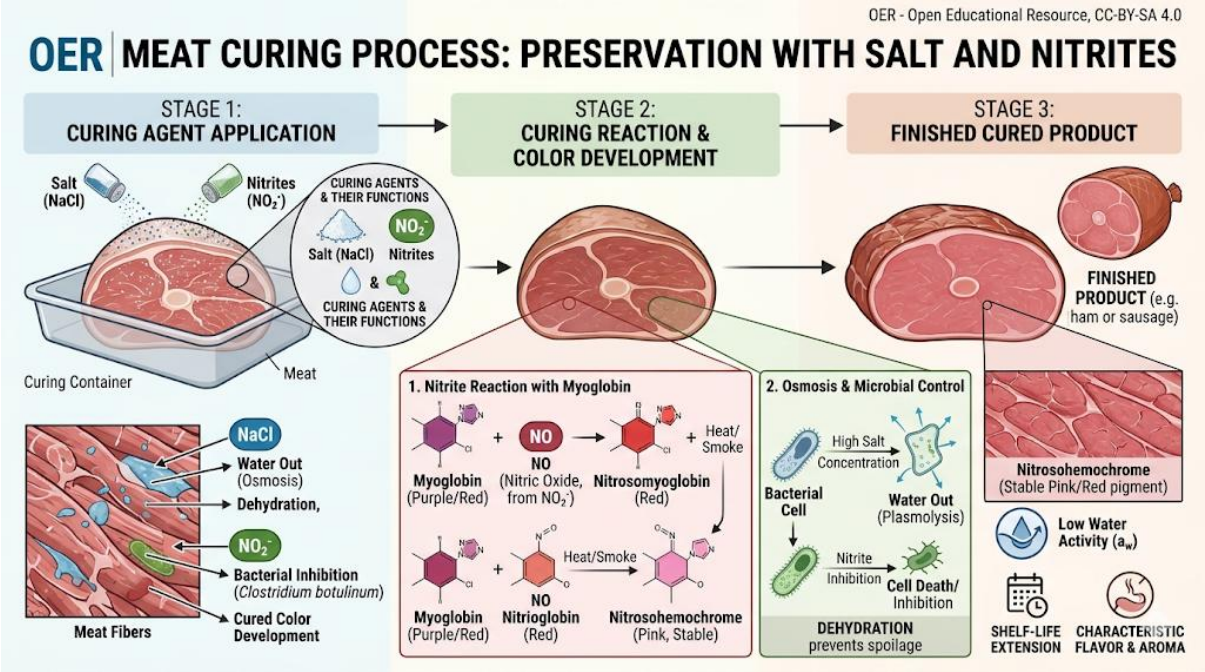


Diagram showing curing process with salt and nitrites Figure 1.5: Basic curing process in meat preservation.

Fill in the blank: The preservation method that uses salt and nitrites to inhibit microbial growth is called _____.

1.4.2 Canning and drying of fresh meat

Canning involves sealing meat in airtight containers and heating them to destroy microorganisms. This method provides long shelf life and convenience. **Drying**, on the other hand, reduces moisture content to prevent microbial growth. Traditional drying methods include sun-drying, while modern techniques use controlled environments. Both methods are effective, but they alter texture and flavour. Canned meat is often softer, while dried meat is chewy and concentrated in flavour.

Image showing canned meat products and dried meat strips Plate 1.4: Examples of canned and dried meat products.

Fill in the blank: The method of sealing meat in airtight containers and heating them is known as _____.

1.4.3 Intermediate moisture meat

Intermediate moisture meat refers to meat products that have reduced water activity but still retain some moisture, making them soft and palatable. These products are shelf-stable without refrigeration because the reduced water activity prevents microbial growth. Examples include meat snacks and pet foods. The balance between moisture and preservation agents such as sugar or salt ensures safety while maintaining desirable texture.

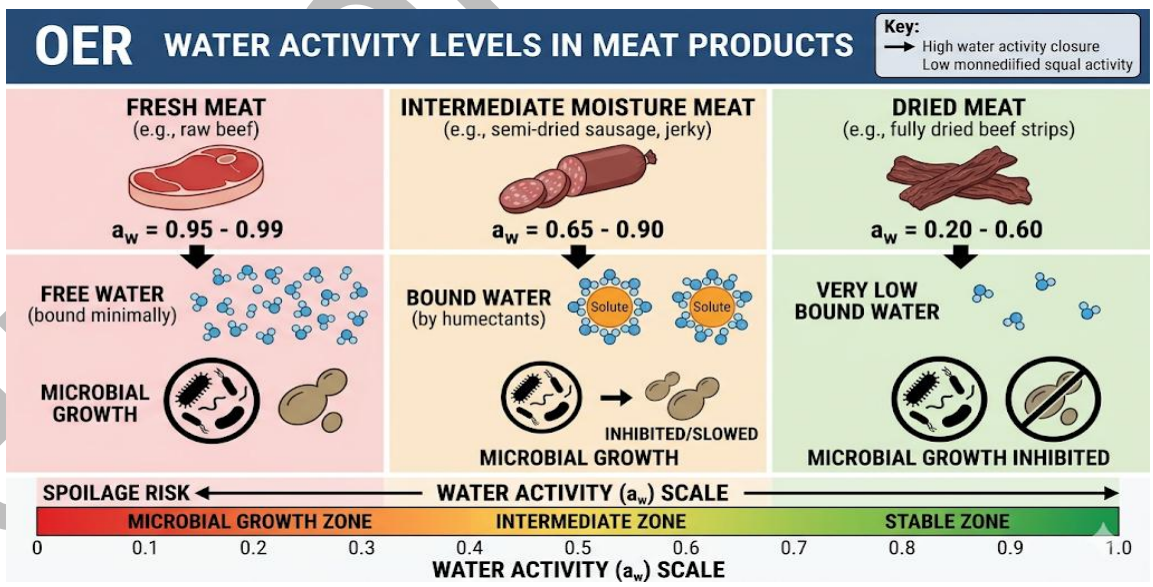


Diagram showing water activity levels in intermediate moisture meat Figure 1.6: Water activity in intermediate moisture meat.

Fill in the blank: Meat products that retain some moisture but are shelf-stable are called _____.

Pilot questions 1.4

1. What is the main purpose of curing meat?
2. Explain how canning preserves meat.
3. Compare the texture of canned meat with dried meat.
4. What is intermediate moisture meat, and why is it shelf-stable?
5. Identify one example of intermediate moisture meat.

Series Summary

This Series has introduced you to the scientific and technological foundations of meat production, highlighting its relevance to food science and human nutrition. We began by examining the anatomy, physiology, and histology of domestic animals, showing how biological structures and functions influence meat yield and quality. We then explored the conversion of meat-type animals to human food, focusing on humane slaughtering, dressing, and hygiene practices. Following that, we studied the slaughter and dressing of table birds, emphasising methods, techniques, and safety considerations. Finally, we concluded with an introduction to meat processing methods, including curing, canning, drying, and the concept of intermediate moisture meat.

By completing this Series, you should now be able to define anatomical features, explain physiological processes, describe histological structures, demonstrate slaughtering and dressing principles, apply hygienic practices, analyse poultry processing methods, evaluate quality and safety concerns, and explain basic meat preservation techniques. These abilities directly align with the Series Learning Outcomes and provide you with a strong foundation for further study in meat science and technology.

Glossary of Terms

Anatomy: The study of the physical structure of living organisms, including bones, muscles, and organs.

Canning: A preservation method that involves sealing meat in airtight containers and heating them to destroy microorganisms.

Curing: A preservation method using salt, nitrates, or nitrites to inhibit microbial growth, enhance flavour, and improve colour.

Dressing: The removal of non-edible parts of an animal after slaughter, such as the head, hide, feet, feathers, and internal organs.

Histology: The microscopic study of tissues, focusing on muscle fibres, connective tissue, and fat deposits in meat science.

Hygiene: Practices that maintain cleanliness and prevent contamination during meat production and processing.

Intermediate moisture meat: Meat products with reduced water activity but retaining some moisture, making them shelf-stable and palatable.

Marbling: The distribution of fat within muscle tissue, which enhances flavour and tenderness in meat.

Physiology: The study of how the systems of the body function, including processes such as circulation, respiration, and metabolism.

Slaughtering: The humane killing of animals for food, involving stunning, bleeding, and carcass preparation.

Concept Check Questions [Series 1]

Objective questions

1. What is the study of the physical structure of domestic animals called? (Linked to SLO 1.1)
2. Which preservation method uses salt and nitrites to inhibit microbial growth? (Linked to SLO 1.8)
3. What is the term for fat distribution within muscle tissue that enhances flavour and tenderness? (Linked to SLO 1.3)

Short-answer questions

4. Explain why stunning is important in the slaughtering process. (Linked to SLO 1.4)
5. Describe one difference between dressing cattle and dressing poultry. (Linked to SLO 1.6)
6. How does poor hygiene affect the shelf life of meat products? (Linked to SLO 1.5)

Long-answer questions

7. Analyse the role of physiology in determining meat quality, with examples of conditions such as PSE and DFD. (Linked to SLO 1.2)
8. Evaluate the importance of curing, canning, and drying in meat preservation, highlighting their advantages and limitations. (Linked to SLO 1.8)

Answers to Concept Check Questions [Series 1]

Objective questions

1. Anatomy
2. Curing
3. Marbling

Short-answer questions

4. Stunning prevents pain and distress, ensuring humane slaughter and effective bleeding.
5. Dressing cattle involves skinning and evisceration, while poultry dressing includes scalding, plucking, and evisceration.
6. Poor hygiene allows microbial growth, leading to spoilage and reduced shelf life.

Long-answer questions

7. *Basic response*: Physiology influences meat quality through processes such as muscle metabolism. Stress before slaughter depletes glycogen, leading to PSE meat in pigs or DFD meat in cattle. *Value-added response*: Beyond basic knowledge, physiology also affects post-mortem biochemical changes such as pH decline, which determines tenderness and colour. Understanding these processes helps in designing better handling practices to improve meat quality.
8. *Basic response*: Curing uses salt and nitrites to inhibit microbial growth, canning seals meat in airtight containers and heats them to destroy microorganisms, and drying reduces moisture to prevent spoilage. *Value-added response*: Each method has advantages and limitations. Curing enhances flavour but may raise health concerns about nitrites. Canning provides long shelf life but alters texture. Drying is cost-effective but changes flavour and chewiness. Combining methods can optimise preservation and consumer acceptability.

Answers to Pilot Questions [Series 1]

Part 1.1

1. Anatomy
2. Stress causes PSE meat in pigs and DFD meat in cattle
3. Marbling enhances flavour and tenderness in beef
4. Physiology is the study of body functions in animals
5. Connective tissue influences meat tenderness

Part 1.2

1. Slaughtering
2. Stunning ensures humane treatment and effective bleeding
3. Dressing cattle involves skinning and evisceration, while poultry involves plucking and evisceration
4. Poor hygiene reduces shelf life by allowing microbial growth
5. Improper dressing can contaminate carcasses

Part 1.3

1. Stunning ensures humane slaughter and proper bleeding
2. Dressing poultry involves scalding, plucking, evisceration, and washing
3. Poor bleeding causes discoloured meat and poor shelf life
4. Salmonella and Campylobacter
5. Chilling prevents spoilage and microbial growth

Part 1.4

1. Curing preserves meat by inhibiting microbial growth
2. Canning seals meat in airtight containers and heats them to destroy microorganisms
3. Canned meat is softer, dried meat is chewy
4. Intermediate moisture meat is shelf-stable due to reduced water activity
5. Meat snacks are examples of intermediate moisture meat

References and Attributions [Series 1]

- Figure 1.1: Basic anatomy of a meat-type animal. Suggested AI prompt: “Generate a labelled diagram of the skeletal and muscular structure of a cow, highlighting major meat cuts.” Search string: “OER cow anatomy diagram meat cuts.”
- Plate 1.1: Physiological condition of animals before slaughter. Suggested AI prompt: “Create a realistic image of cattle resting calmly in a holding pen before slaughter, emphasising stress-free conditions.” Search string: “OER cattle resting pre-slaughter physiology.”
- Figure 1.2: Histological structure of muscle tissue. Suggested AI prompt: “Generate a microscopic illustration of muscle fibres showing connective tissue and marbling fat deposits.” Search string: “OER histology muscle fibres marbling meat quality.”
- Figure 1.3: Stages in the slaughtering of meat-type animals. Suggested AI prompt: “Generate a labelled diagram showing the stages of humane slaughtering of cattle, including stunning, bleeding, and carcass preparation.” Search string: “OER humane slaughtering process diagram cattle.”
- Plate 1.2: Dressing and preparation of carcasses. Suggested AI prompt: “Create a realistic image of workers dressing a cattle carcass in a clean abattoir environment, highlighting hygiene practices.” Search string: “OER image carcass dressing abattoir hygiene.”
- Box 1.1: Key hygiene practices in meat conversion. Suggested AI prompt: “Generate a simple infographic listing hygiene practices in meat conversion, suitable for food science learners.” Search string: “OER hygiene practices meat production infographic.”

- Figure 1.4: Mechanised poultry slaughter process. Suggested AI prompt: “Generate a labelled diagram of a mechanised poultry slaughter line, showing stunning, bleeding, and carcass handling stages.” Search string: “OER poultry slaughter line diagram.”
- Plate 1.3: Dressing of table birds. Suggested AI prompt: “Create a realistic image of workers plucking and dressing poultry in a clean processing facility, highlighting hygiene practices.” Search string: “OER poultry dressing processing facility image.”
- Box 1.2: Common hazards in poultry processing. Suggested AI prompt: “Generate a simple infographic showing common hazards in poultry processing and their effects on meat quality.” Search string: “OER poultry processing hazards infographic.”
- Figure 1.5: Basic curing process in meat preservation. Suggested AI prompt: “Generate a labelled diagram showing the curing process of meat using salt and nitrites.” Search string: “OER curing process meat preservation diagram.”
- Plate 1.4: Examples of canned and dried meat products. Suggested AI prompt: “Create a realistic image showing canned meat products alongside dried meat strips.” Search string: “OER canned meat dried meat products image.”
- Figure 1.6: Water activity in intermediate moisture meat. Suggested AI prompt: “Generate a diagram showing water activity levels in intermediate moisture meat compared to fresh and dried meat.” Search string: “OER intermediate moisture meat diagram water activity.”

Course code: FST502

Course title: Meat Science & Fish Science & Technology

Course credit load: 3 units

List of Series:

6. **Science and Technology of Meat Production**
7. **Processing and Preservation of Meat Products**
8. **Quality Factors in Meat and Poultry**
9. **Fish Science and Product Technology**
10. **Egg and Poultry Product Utilisation**

2.1 Traditional and Scientific Principles of Meat Processing

- 2.1.1 Traditional methods of meat preservation
- 2.1.2 Scientific principles underlying modern meat processing

- 2.1.3 Comparative analysis of traditional and modern approaches

2.2 Processing Technology of Meat Products

- 2.2.1 Sausages: preparation and processing
- 2.2.2 Ham and bologna: curing and cooking methods
- 2.2.3 Frankfurters: formulation and processing techniques

2.3 Preservation Techniques in Meat Processing

- 2.3.1 Salting and boiling
- 2.3.2 Smoking and curing
- 2.3.3 Drying and canning

2.4 Quality Considerations in Meat Processing

- 2.4.1 Physical and chemical factors affecting processed meat
- 2.4.2 Microbiological safety in processed meat products
- 2.4.3 Management practices for ensuring product quality

Introduction

Meat processing and preservation are essential aspects of food science, ensuring that meat products remain safe, nutritious, and appealing to consumers. While fresh meat is highly perishable, processing and preservation techniques extend its shelf life, improve flavour, and create a wide variety of products such as sausages, ham, and frankfurters. This Series builds on the scientific foundation established in the previous Series by focusing on the technological methods that transform raw meat into diverse and stable products.

The aim of this Series is to equip you with the knowledge and skills to explain the principles of meat processing, demonstrate the preparation of processed products, and evaluate preservation techniques that maintain quality and safety.

We shall commence this Series by exploring traditional and scientific principles of meat processing, highlighting how methods have evolved over time. Next, we will examine the processing technology of specific meat products such as sausages, ham, bologna, and frankfurters. Following that, we will study preservation techniques including salting, boiling, smoking, curing, drying, and canning. Finally, we will wrap up by considering quality factors in meat processing, focusing on physical, chemical, and microbiological aspects as well as management practices that ensure consumer safety and satisfaction.

Series Learning Outcomes

Upon completing this Series, you should be able to:

SLO 2.1 describe traditional methods of meat preservation and explain the scientific principles underlying modern meat processing,

SLO 2.2 demonstrate the preparation and processing of sausages, ham, bologna, and frankfurters,

SLO 2.3 explain preservation techniques such as salting, boiling, smoking, curing, drying, and canning,

SLO 2.4 analyse physical and chemical factors that affect processed meat products,

SLO 2.5 evaluate microbiological safety concerns in processed meat, and

SLO 2.6 apply management practices to ensure quality in meat processing and preservation.

2.1 Traditional and Scientific Principles of Meat Processing

2.1.1 Traditional methods of meat preservation

Traditional preservation methods such as salting, smoking, drying, and fermenting were developed centuries ago to extend the shelf life of meat in the absence of refrigeration. Salting works by drawing moisture out of meat, thereby reducing water activity and inhibiting microbial growth. This technique was widely used in coastal regions where salt was abundant, and salted meat could be stored for months. Smoking, on the other hand, not only imparts flavour but also creates a protective surface that slows spoilage. The smoke contains compounds such as phenols and formaldehyde that inhibit microbial growth.

Drying is another ancient method, achieved by exposing meat to sun and air. By reducing moisture content, drying makes meat less hospitable to microorganisms. Although the texture becomes tougher, dried meat is lightweight and portable, making it ideal for long journeys. Fermentation, often used in sausages, relies on beneficial bacteria to produce acids that inhibit harmful microbes. This method not only preserves meat but also enhances flavour and digestibility.

Image showing smoked meat, salted meat, and dried strips Plate 2.1: Traditional methods of meat preservation.

Fill in the blank: The preservation method that reduces water activity by removing moisture is called _____.

2.1.2 Scientific principles underlying modern meat processing

Modern meat processing is guided by scientific principles that ensure safety, quality, and efficiency. One key principle is the control of **water activity**, which refers to the availability of water for microbial growth. Lowering water activity prevents spoilage and extends shelf life. Another principle is managing **pH**, which influences microbial survival and meat texture. For example, meat with a lower pH is less hospitable to bacteria, but excessively low pH can affect flavour.

Temperature control is also critical. Refrigeration slows microbial growth, while heat treatments such as pasteurisation and sterilisation destroy pathogens. Preservatives such as nitrates and nitrites are scientifically validated to prevent the growth of dangerous bacteria like Clostridium botulinum. These principles ensure that meat products are safe, consistent, and acceptable to consumers.

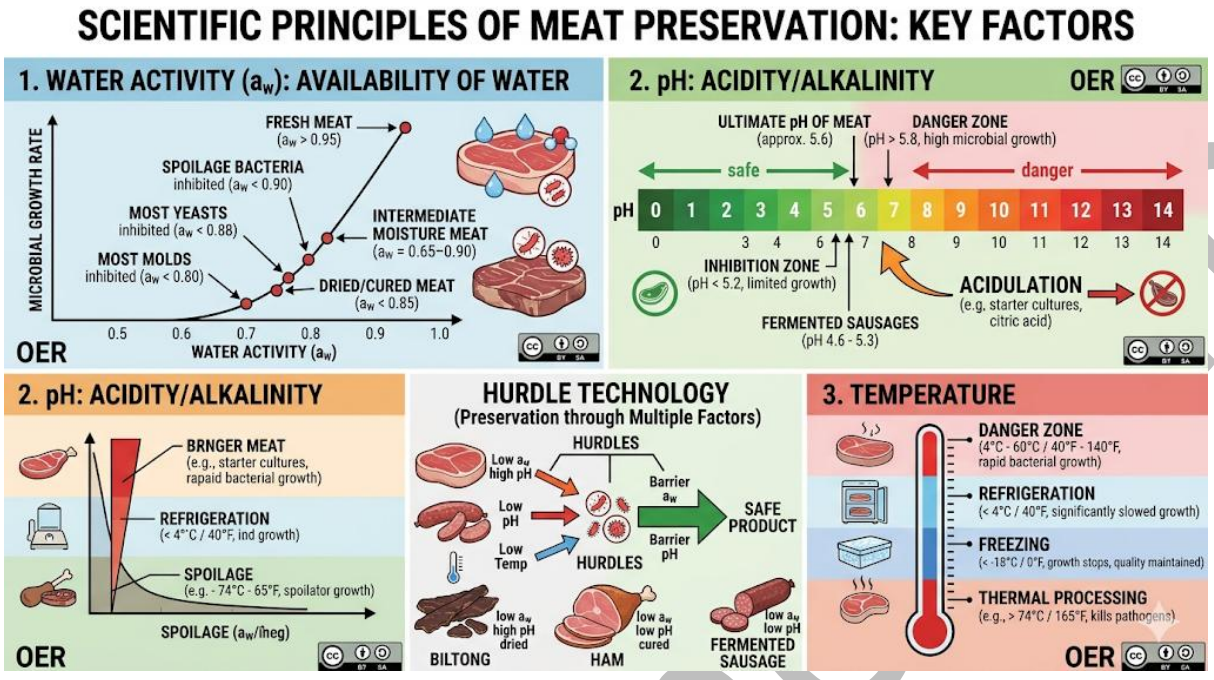


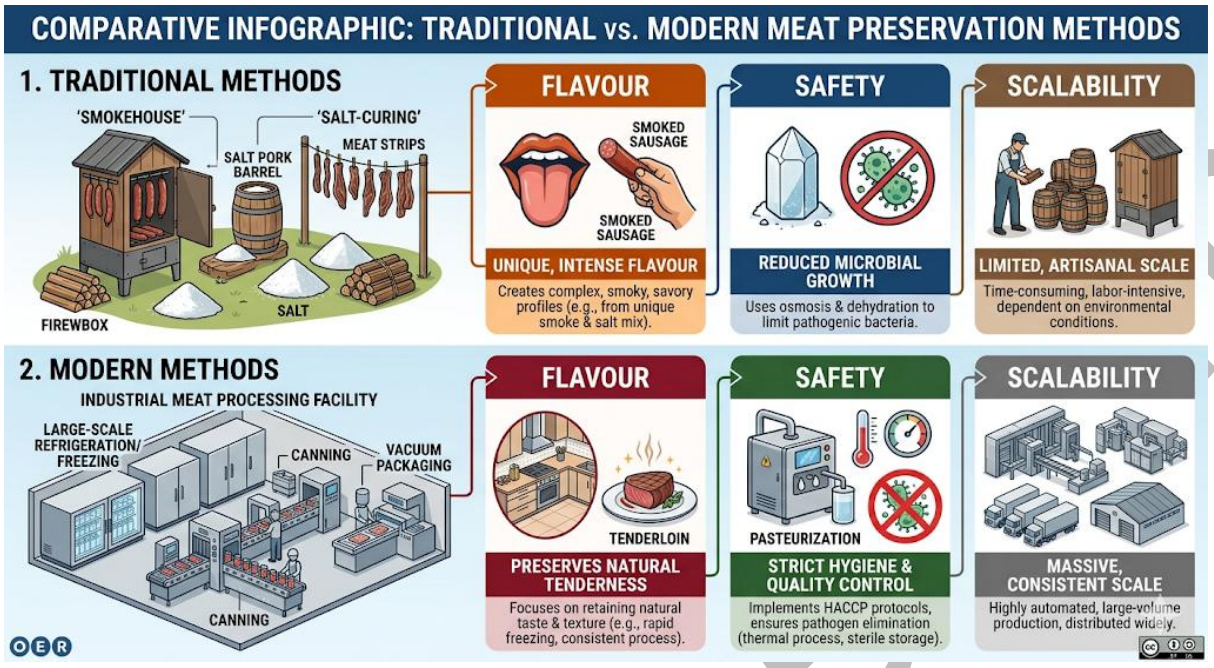
Diagram showing scientific factors influencing meat preservation (water activity, pH, temperature) Figure 2.1: Scientific principles in meat processing.

Fill in the blank: The scientific term for the availability of water for microbial growth is _____.

2.1.3 Comparative analysis of traditional and modern approaches

Traditional methods rely on natural processes, while modern approaches use controlled scientific techniques. Smoking provides flavour and preservation but may produce inconsistent results, whereas modern curing ensures uniformity and safety. Drying is effective but can alter texture significantly, while modern vacuum packaging maintains freshness without major changes in texture.

Both approaches have value. Traditional methods are culturally significant and often preferred for flavour, while modern methods guarantee safety and scalability. For example, artisanal smoked meats are prized for their unique taste, while industrially processed meats are valued for their consistency and safety. The integration of traditional and modern methods can produce products that are both safe and culturally authentic.



Box 2.1: Comparison of traditional and modern meat preservation methods Caption: Box 2.1: Comparison of traditional and modern meat preservation methods.

Fill in the blank: Traditional methods are valued for _____, while modern methods are valued for _____.

Pilot questions 2.1

1. What are two examples of traditional meat preservation methods?
2. Define water activity in the context of meat processing.
3. How does refrigeration contribute to meat preservation?
4. Compare smoking as a traditional method with curing as a modern method.
5. Why are nitrates and nitrites used in modern meat processing?

2.2 Processing Technology of Meat Products

2.2.1 Sausages: preparation and processing

Sausages are processed meat products made by grinding meat, mixing it with fat, salt, spices, and sometimes preservatives, then stuffing the mixture into casings. Preparation involves mincing, mixing, filling, and cooking or curing. Sausages can be fresh, cooked, or fermented. Fermented sausages rely on beneficial bacteria to produce acids that enhance flavour and safety. The variety of sausages reflects cultural preferences and technological advances, ranging from simple fresh sausages to complex fermented products.

Image showing different types of sausages (fresh, cooked, fermented) Plate 2.2: Types of sausages.

Fill in the blank: Sausages are made by grinding meat, mixing with fat and spices, and stuffing into _____.

2.2.2 Ham and bologna: curing and cooking methods

Ham is typically made from pork legs that are cured with salt, sugar, and nitrates, then smoked or cooked. **Bologna** is a finely ground, emulsified meat product that is seasoned and cooked in casings. Both products rely on curing to enhance flavour and ensure safety. Cooking stabilises the product and extends shelf life. These products illustrate how curing and cooking methods can transform raw meat into distinctive, safe, and appealing foods.

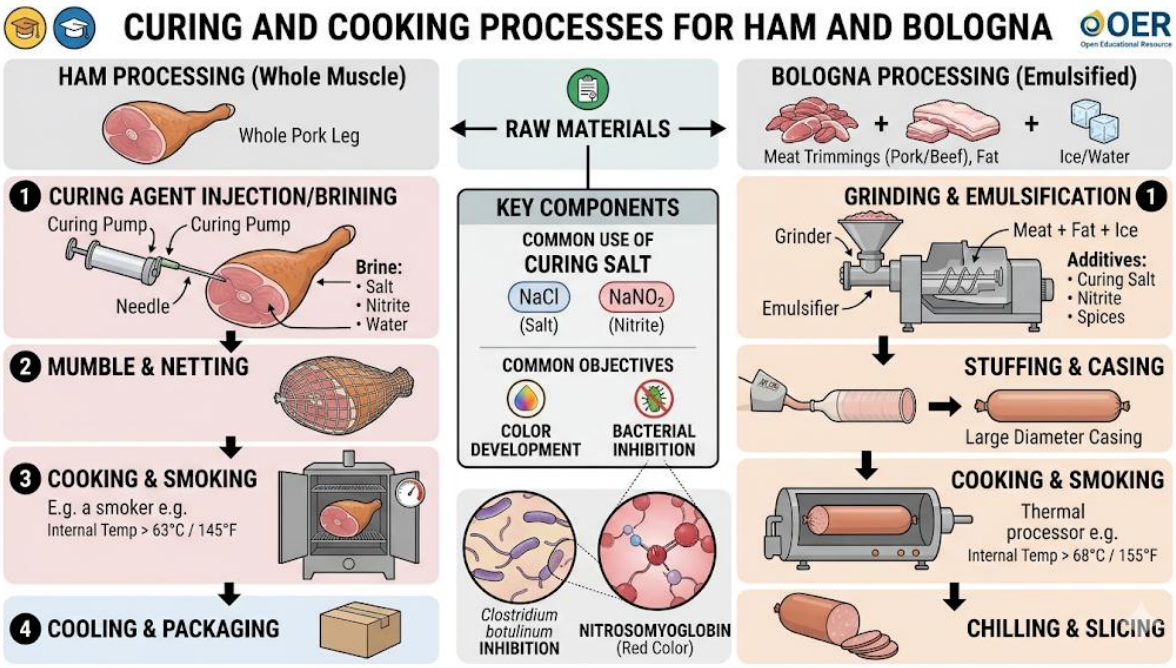


Diagram showing curing and cooking process for ham and bologna Figure 2.2: Curing and cooking of ham and bologna

Fill in the blank: Ham is usually made from the _____ of pigs.

2.2.3 Frankfurters: formulation and processing techniques

Frankfurters, also known as hot dogs, are emulsified meat products made from finely ground meat, fat, water, and seasonings. The mixture is stuffed into casings, cooked, and often smoked. The formulation must balance meat, fat, and water to achieve the desired texture. Processing techniques ensure uniformity, safety, and flavour.

Image showing frankfurters in casings and packaged form Plate 2.3: Frankfurters in processing and packaging.

Fill in the blank: Frankfurters are also commonly known as _____.

Pilot questions 2.2

1. What are the main ingredients in sausages?
2. How is ham typically cured?
3. What distinguishes bologna from other meat products?
4. What is the key balance required in frankfurter formulation?
5. Why is smoking often used in frankfurter processing?

2.3 Preservation Techniques in Meat Processing

2.3.1 Salting and boiling

Salting is one of the oldest and most widely used preservation methods. It works by drawing water out of meat tissues, thereby reducing **water activity**, which is the availability of water for microbial growth. Microorganisms require moisture to thrive, and by lowering water activity, salting creates an environment that is hostile to spoilage organisms. In addition to its preservative effect, salting enhances flavour and contributes to the characteristic taste of cured meats. Historically, salting was indispensable in regions without refrigeration, allowing meat to be stored for long periods and transported over long distances.

Boiling is another preservation technique that relies on heat to destroy microorganisms and inactivate enzymes that cause spoilage. When meat is boiled, the high temperature penetrates

tissues, ensuring that pathogens such as Salmonella and E. coli are eliminated. Boiling also softens meat fibres, making the product easier to chew and digest. However, prolonged boiling can alter texture and flavour, sometimes making meat less appealing. For this reason, boiling is often combined with other methods such as salting or curing to balance safety with sensory qualities.

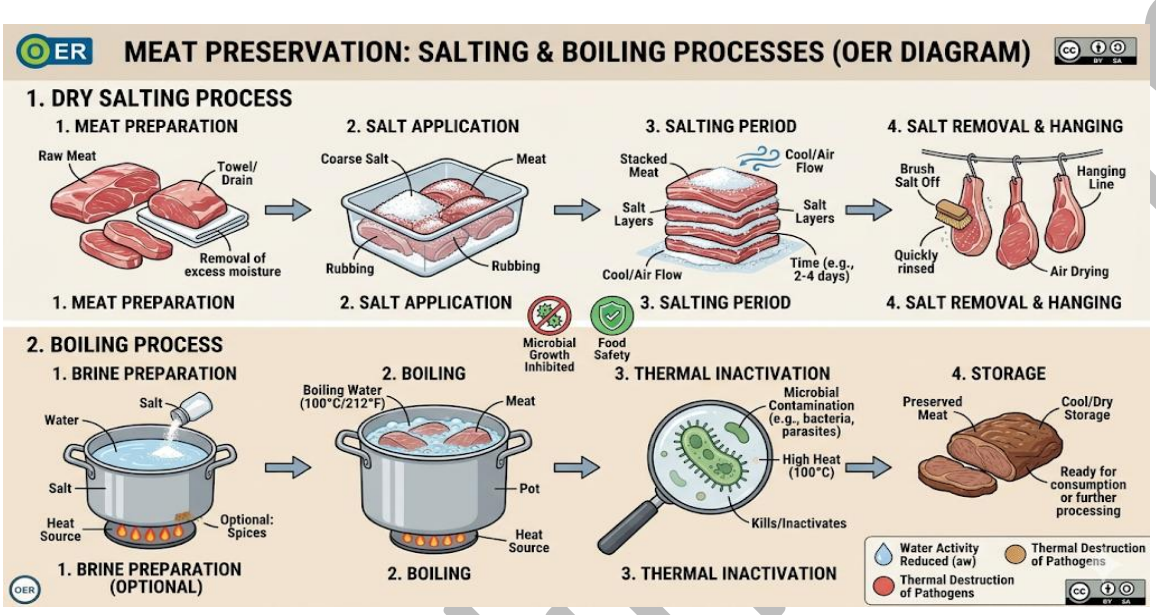


Diagram showing salting and boiling processes Figure 2.3: Salting and boiling in meat preservation.

Fill in the blank: The preservation method that reduces water activity by applying salt is called _____.

2.3.2 Smoking and curing

Smoking is a preservation technique that exposes meat to smoke generated from burning wood. The smoke contains compounds such as phenols, carbonyls, and organic acids, which inhibit microbial growth and impart a distinctive flavour. Smoking also creates a protective surface on meat, reducing moisture loss and slowing spoilage. The choice of wood influences flavour, with hardwoods such as oak and hickory being preferred for their aromatic qualities.

Curing involves the application of salt, sugar, and chemical preservatives such as nitrates and nitrites. These substances inhibit microbial growth, enhance colour, and stabilise flavour. Curing is often combined with smoking to produce products such as bacon and ham. While curing improves safety and shelf life, excessive use of nitrates and nitrites has raised health concerns, making it important to balance effectiveness with consumer safety.

Image showing smoked ham and cured bacon Plate 2.4: Examples of smoking and curing in meat preservation.

Fill in the blank: The preservation method that uses salt, sugar, and nitrates is called _____.

2.3.3 Drying and canning

Drying reduces the moisture content of meat, making it less hospitable to microorganisms. Traditional drying methods involve sun and air exposure, while modern techniques use controlled environments such as dehydrators. Drying alters texture, producing tough and chewy products like jerky, but it also concentrates flavour and makes meat lightweight and portable.

Canning is a more modern preservation method that involves sealing meat in airtight containers and heating them to destroy microorganisms. The heat treatment ensures safety, while the airtight seal prevents recontamination. Canned meat products are convenient, have long shelf lives, and are widely used in both household and military contexts. However, canning alters texture and flavour, often producing softer products compared to fresh meat.

Image showing dried meat strips and canned meat products Plate 2.5: Dried and canned meat products.

Fill in the blank: The preservation method that seals meat in airtight containers and heats them is called _____.

Pilot questions 2.3

1. How does salting preserve meat?
2. What is the main purpose of boiling in meat preservation?
3. What is the difference between smoking and curing?
4. How does drying prevent microbial growth?
5. Why does canning provide long shelf life?

2.4 Quality Considerations in Meat Processing

2.4.1 Physical and chemical factors affecting processed meat

Physical factors such as texture, colour, and water-holding capacity play a major role in consumer acceptance of processed meat. Texture determines whether meat is tender or tough, while colour influences perceptions of freshness and quality. Water-holding capacity affects juiciness, which is a key sensory attribute.

Chemical factors include pH, fat content, and the presence of preservatives. For example, a lower pH improves safety by inhibiting microbial growth, but excessively low pH can negatively affect flavour. Fat content contributes to juiciness and mouthfeel, but too much fat may reduce consumer

acceptability. Preservatives such as nitrates and nitrites enhance safety and colour but must be used carefully to avoid health risks.

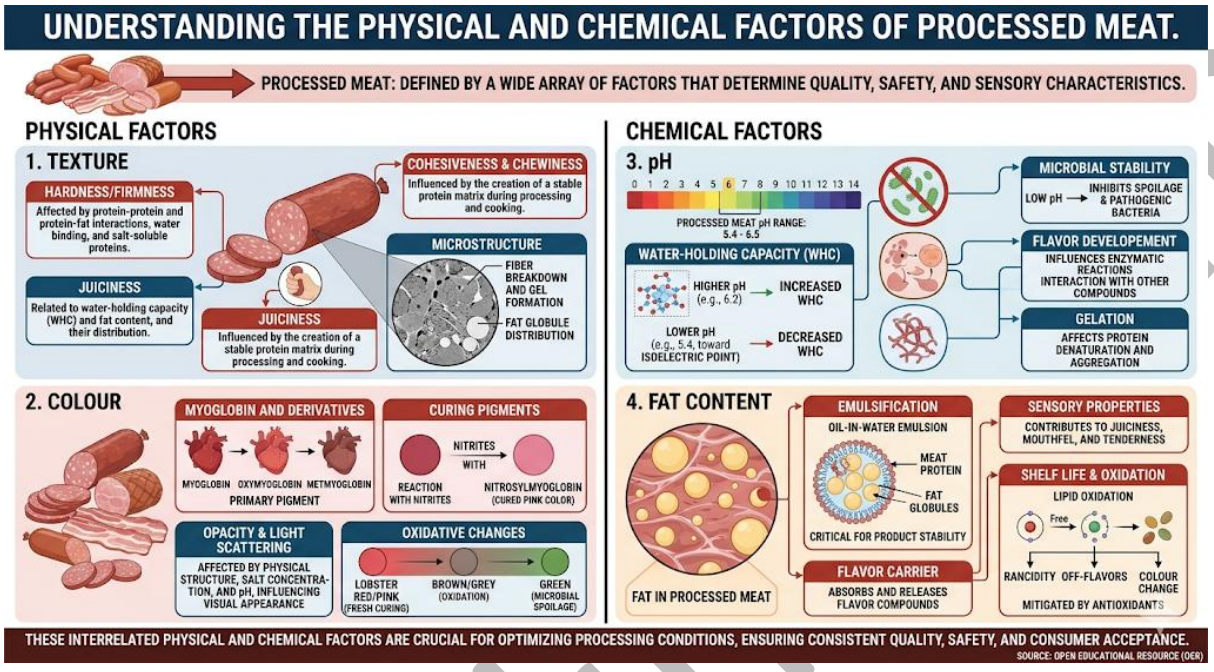


Diagram showing physical and chemical factors in processed meat Figure 2.6: Physical and chemical factors affecting processed meat.

Fill in the blank: The sensory attribute that depends on water-holding capacity is _____.

2.4.2 Microbiological safety in processed meat products

Microbiological safety refers to the control of harmful microorganisms in meat products. Pathogens such as Salmonella, Listeria, and E. coli can cause foodborne illness if not properly controlled. Processing methods such as curing, smoking, and canning reduce microbial risks, but hygiene during handling and storage is equally important.

Microbiological safety is ensured through hazard analysis and critical control points (HACCP), a systematic approach that identifies risks and establishes measures to control them. For example, monitoring temperature during cooking and storage prevents microbial growth. Consumers rely on microbiological safety to trust meat products, making it a central concern for producers.

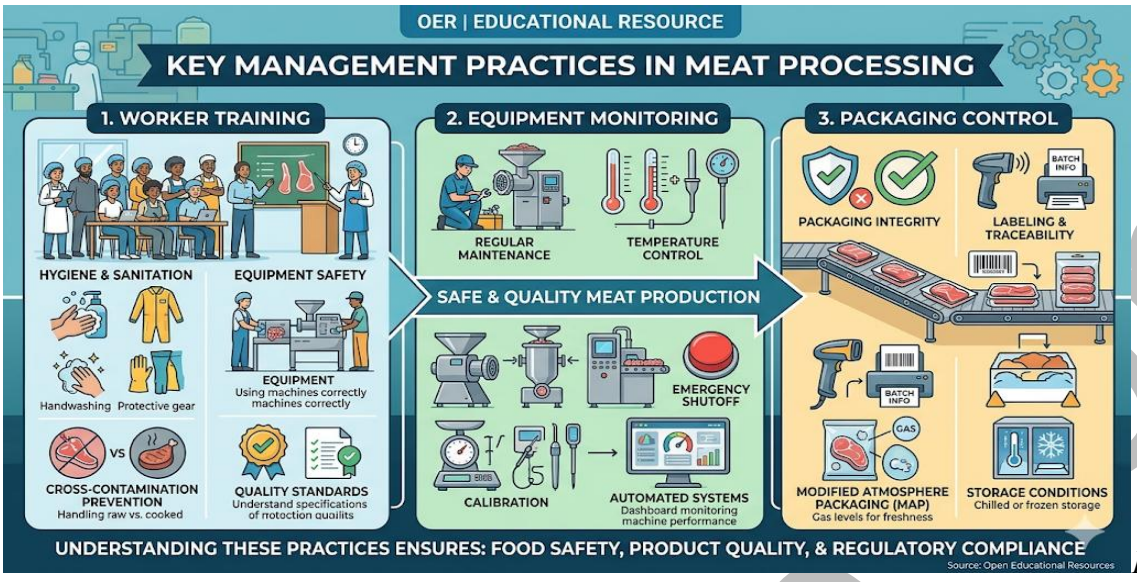
Image showing laboratory testing of meat samples for microbial safety Plate 2.6: Microbiological testing of processed meat.

Fill in the blank: The systematic approach to controlling microbial risks in food production is called _____.

2.4.3 Management practices for ensuring product quality

Management practices are essential to maintain quality in meat processing. These include training workers in hygiene, monitoring equipment, and implementing quality assurance systems. Regular inspections and audits ensure compliance with standards. Packaging and storage also play a role, as improper packaging can lead to contamination or spoilage.

Quality management systems such as ISO standards provide frameworks for producers to follow. By adhering to these systems, producers can ensure that meat products are safe, consistent, and acceptable to consumers. Effective management practices not only protect consumers but also enhance the reputation and profitability of meat processing businesses.



Box 2.2: Key management practices in meat processing Caption: Box 2.2: Key management practices in meat processing.

Fill in the blank: Quality assurance systems such as _____ provide frameworks for producers to maintain standards.

Pilot questions 2.4

1. What physical factors influence consumer acceptance of processed meat?
2. How does pH affect meat safety and flavour?
3. Name three pathogens that can contaminate processed meat.
4. What is HACCP, and why is it important in meat processing?
5. Explain how management practices contribute to meat product quality.

Series Summary

This Series has focused on the principles and practices of meat processing and preservation, building on the scientific foundation established earlier. We began by examining traditional methods such as salting, smoking, drying, and fermenting, before moving on to modern scientific principles like water activity, pH control, and temperature management. We then explored the processing technologies of specific meat products including sausages, ham, bologna, and frankfurters, highlighting preparation, curing, and formulation techniques. Following that, we studied preservation methods such as salting, boiling, smoking, curing, drying, and canning, showing how each contributes to safety and shelf life. Finally, we considered quality aspects, looking at physical and chemical factors, microbiological safety, and management practices that ensure consumer trust and product consistency.

By completing this Series, you should now be able to describe traditional and modern preservation methods, demonstrate the preparation of processed meat products, explain preservation techniques, analyse quality factors, evaluate microbiological safety, and apply management practices. These abilities align directly with the Series Learning Outcomes and provide you with practical and theoretical skills essential for meat science and technology.

Glossary of Terms

Boiling: A preservation method that uses heat to destroy microorganisms and enzymes in meat.

Canning: A preservation method that seals meat in airtight containers and heats them to destroy microorganisms.

Curing: The application of salt, sugar, and preservatives such as nitrates to inhibit microbial growth and enhance flavour and colour.

Fermentation: A preservation method that uses beneficial bacteria to produce acids, inhibiting harmful microbes and enhancing flavour.

Frankfurters: Emulsified meat products, also known as hot dogs, made from finely ground meat, fat, water, and seasonings.

Ham: A cured meat product typically made from pork legs, often smoked or cooked.

Microbiological safety: The control of harmful microorganisms in meat products to prevent foodborne illness.

Salting: The application of salt to meat to reduce water activity and inhibit microbial growth.

Sausages: Processed meat products made by grinding meat, mixing with fat and spices, and stuffing into casings.

Smoking: A preservation method that exposes meat to smoke, imparting flavour and inhibiting microbial growth.

Water activity: The scientific term for the availability of water for microbial growth in food.

Concept Check Questions [Series 2]

Objective questions

1. What preservation method reduces water activity by applying salt? (Linked to SLO 2.3)
2. Which meat product is made from finely ground, emulsified meat and cooked in casings? (Linked to SLO 2.2)
3. What is the scientific term for the availability of water for microbial growth? (Linked to SLO 2.1)

Short-answer questions

4. Explain why boiling is effective in meat preservation. (Linked to SLO 2.3)

5. Describe one difference between smoking and curing. (Linked to SLO 2.3)
6. How does pH influence meat safety and flavour? (Linked to SLO 2.4)

Long-answer questions

7. Analyse the role of microbiological safety in meat processing, with examples of pathogens controlled by preservation methods. (Linked to SLO 2.5)
8. Evaluate management practices that ensure product quality in meat processing, highlighting their importance for consumer trust. (Linked to SLO 2.6)

Answers to Concept Check Questions [Series 2]

Objective questions

1. Salting
2. Bologna or frankfurters
3. Water activity

Short-answer questions

4. Boiling destroys microorganisms and enzymes, making meat safe and extending shelf life.
5. Smoking imparts flavour and creates a protective surface, while curing uses salt and preservatives to inhibit microbial growth.
6. Lower pH inhibits microbial growth, improving safety, but excessively low pH can negatively affect flavour.

Long-answer questions

7. *Basic response*: Microbiological safety ensures meat products are free from harmful pathogens such as Salmonella, Listeria, and E. coli. Preservation methods like curing, smoking, and canning reduce microbial risks. *Value-added response*: Beyond basic control, microbiological safety involves systematic approaches such as HACCP, which identifies risks and establishes control measures. This ensures consistent safety and builds consumer confidence.
8. *Basic response*: Management practices such as worker training, equipment monitoring, and packaging control ensure product quality. *Value-added response*: Effective management also involves compliance with ISO standards and regular audits. These practices protect consumers, enhance reputation, and improve profitability in meat processing businesses.

Answers to Pilot Questions [Series 2]

Part 2.1

1. Salting and smoking

2. Water activity is the availability of water for microbial growth
3. Refrigeration slows microbial growth
4. Smoking provides flavour but is inconsistent, curing ensures uniformity and safety
5. Nitrates and nitrites prevent growth of Clostridium botulinum

Part 2.2

1. Meat, fat, salt, spices, and casings
2. Ham is cured with salt, sugar, and nitrates, then smoked or cooked
3. Bologna is finely ground and emulsified, cooked in casings
4. Balance of meat, fat, and water
5. Smoking enhances flavour and safety

Part 2.3

1. Salting reduces water activity
2. Boiling destroys microorganisms and enzymes
3. Smoking imparts flavour, curing uses salt and preservatives
4. Drying reduces moisture, preventing microbial growth
5. Canning seals meat and heats it to destroy microorganisms

Part 2.4

1. Texture, colour, and water-holding capacity
2. Lower pH improves safety but may affect flavour
3. Salmonella, Listeria, and E. coli
4. HACCP is a systematic approach to controlling microbial risks
5. Management practices ensure safety, consistency, and consumer trust

References and Attributions [Series 2]

- Plate 2.1: Traditional methods of meat preservation. Suggested AI prompt: “Create a realistic image showing smoked meat, salted meat, and dried meat strips displayed together.” Search string: “OER traditional meat preservation methods image.”
- Figure 2.1: Scientific principles in meat processing. Suggested AI prompt: “Generate a diagram showing water activity, pH, and temperature as key scientific factors in meat preservation.” Search string: “OER meat preservation scientific principles diagram.”

- Box 2.1: Comparison of traditional and modern meat preservation methods. Suggested AI prompt: “Generate a comparative infographic showing traditional vs modern meat preservation methods.” Search string: “OER comparison traditional modern meat preservation infographic.”
- Plate 2.2: Types of sausages. Suggested AI prompt: “Create a realistic image showing fresh, cooked, and fermented sausages.” Search string: “OER types of sausages image.”
- Figure 2.2: Curing and cooking of ham and bologna. Suggested AI prompt: “Generate a labelled diagram showing curing and cooking processes for ham and bologna.” Search string: “OER ham bologna curing cooking diagram.”
- Plate 2.3: Frankfurters in processing and packaging. Suggested AI prompt: “Create a realistic image showing frankfurters being processed in casings and packaged for sale.” Search string: “OER frankfurters processing packaging image.”
- Figure 2.3: Salting and boiling in meat preservation. Suggested AI prompt: “Generate a labelled diagram showing salting and boiling processes in meat preservation.” Search string: “OER salting boiling meat preservation diagram.”
- Plate 2.4: Examples of smoking and curing. Suggested AI prompt: “Create a realistic image showing smoked ham and cured bacon together.” Search string: “OER smoked ham cured bacon image.”
- Plate 2.5: Dried and canned meat products. Suggested AI prompt: “Create a realistic image showing dried meat strips alongside canned meat products.” Search string: “OER dried meat canned meat products image.”
- Figure 2.6: Physical and chemical factors affecting processed meat. Suggested AI prompt: “Generate a diagram showing texture, colour, pH, and fat content in processed meat.” Search string: “OER physical chemical factors processed meat diagram.”
- Plate 2.6: Microbiological testing of processed meat. Suggested AI prompt: “Create a realistic image showing laboratory testing of meat samples for microbial safety.” Search string: “OER microbiological testing meat safety image.”
- Box 2.2: Key management practices in meat processing. Suggested AI prompt: “Generate an infographic showing management practices such as worker training, equipment monitoring, and packaging control.” Search string: “OER management practices meat processing infographic.”

Course code: FST502

Course title: Meat Science & Fish Science & Technology

Course credit load: 3 units

List of Series:

11. **Science and Technology of Meat Production**
12. **Processing and Preservation of Meat Products**
13. **Quality Factors in Meat and Poultry**
14. **Fish Science and Product Technology**
15. **Egg and Poultry Product Utilisation**

3.1 Physical and Sensory Quality Factors

- 3.1.1 Colour, texture, and water-holding capacity
- 3.1.2 Tenderness, juiciness, and flavour
- 3.1.3 Consumer perception and sensory evaluation

3.2 Chemical and Nutritional Quality Factors

- 3.2.1 Protein, fat, and moisture composition
- 3.2.2 pH and biochemical changes post-mortem
- 3.2.3 Nutritional value of meat and poultry products

3.3 Microbiological and Safety Quality Factors

- 3.3.1 Common pathogens in meat and poultry
- 3.3.2 Spoilage organisms and shelf life
- 3.3.3 Food safety standards and HACCP application

3.4 Grading and Standards in Meat and Poultry

- 3.4.1 Principles of meat grading systems
- 3.4.2 Poultry grading and classification
- 3.4.3 International and national quality standards

3.5 Quality Assurance and Consumer Protection

- 3.5.1 Quality control practices in processing plants
- 3.5.2 Packaging, labelling, and traceability
- 3.5.3 Role of regulatory agencies and consumer rights

Introduction

In the last Series, we explored the principles of meat processing and preservation, focusing on how different techniques extend shelf life and ensure safety. Yet, beyond preservation and processing,

consumers ultimately judge meat and poultry by their quality. Quality is not only about safety but also about sensory appeal, nutritional value, and compliance with standards. This Series will guide you through the diverse factors that determine meat and poultry quality, helping you appreciate how science, technology, and management practices come together to meet consumer expectations.

The aim of this Series is to equip you with the knowledge and skills to evaluate meat and poultry quality based on physical, chemical, microbiological, and sensory attributes, and to understand grading systems and quality assurance practices that protect consumers.

We shall commence this Series by examining physical and sensory quality factors such as colour, texture, tenderness, juiciness, and flavour. Next, we will move on to chemical and nutritional aspects, including protein composition, fat content, pH, and post-mortem changes. Following that, we will study microbiological and safety factors, focusing on pathogens, spoilage organisms, and food safety standards. Afterwards, we will consider grading systems for meat and poultry, looking at both national and international standards. Finally, we will wrap up by exploring quality assurance and consumer protection, including packaging, labelling, and the role of regulatory agencies.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 3.1** describe physical and sensory quality factors such as colour, texture, tenderness, juiciness, and flavour in meat and poultry,
- **SLO 3.2** explain chemical and nutritional quality factors including protein composition, fat content, pH, and post-mortem biochemical changes,
- **SLO 3.3** analyse microbiological safety concerns in meat and poultry, identifying common pathogens and spoilage organisms,
- **SLO 3.4** evaluate grading systems and standards for meat and poultry at national and international levels, and
- **SLO 3.5** apply quality assurance practices including packaging, labelling, and consumer protection measures in meat and poultry processing.

3.1 Physical and Sensory Quality Factors

3.1.1 Colour, texture, and water-holding capacity

Colour is one of the most immediate indicators of meat quality. Consumers often associate bright red beef or pink poultry with freshness, while darker or pale colours may suggest spoilage or poor handling. Colour is influenced by **myoglobin**, a protein that binds oxygen in muscle tissue. The state of myoglobin determines whether meat appears red, brown, or grey. For example, oxymyoglobin gives meat a bright red colour when exposed to oxygen, while metmyoglobin produces a brownish hue when meat is stored for too long.

Texture refers to the structural feel of meat when chewed or handled. It is determined by muscle fibre arrangement, connective tissue content, and post-mortem changes. Tender meat is highly valued, while tough meat is less desirable. Texture is also influenced by cooking methods, with slow cooking often breaking down connective tissue to produce a softer product.

Water-holding capacity is the ability of meat to retain moisture during storage and cooking. Meat with poor water-holding capacity tends to lose juices, resulting in dry and less palatable products. This factor is closely linked to pH levels and post-mortem biochemical changes.

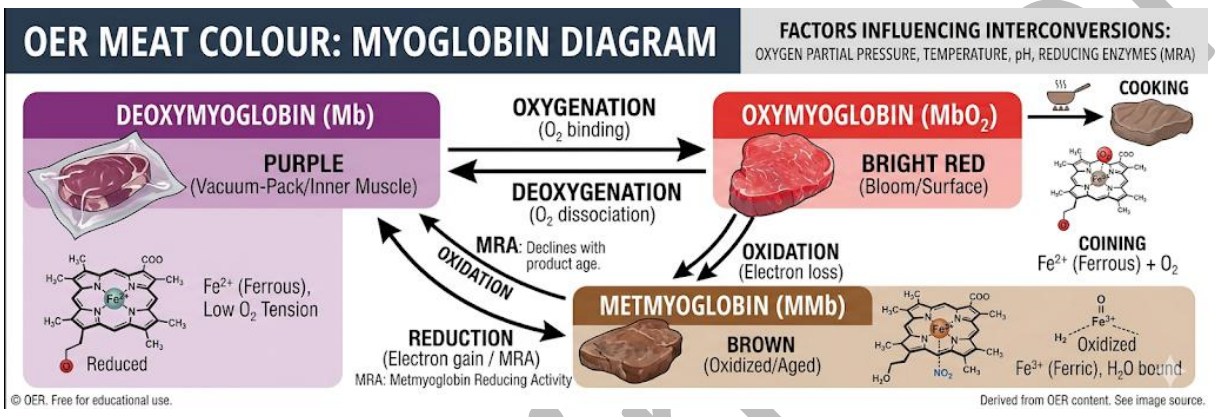


Diagram showing colour changes in meat due to myoglobin states Figure 3.1: Colour variations in meat linked to myoglobin states.

Fill in the blank: The protein responsible for meat colour is called _____.

3.1.2 Tenderness, juiciness, and flavour

Tenderness is often considered the most important sensory attribute of meat. It depends on muscle fibre structure, connective tissue, and post-mortem enzymatic activity. Ageing meat allows enzymes to break down muscle proteins, improving tenderness. Conversely, stress before slaughter can reduce tenderness by altering muscle chemistry.

Juiciness is influenced by water-holding capacity and fat content. Meat that retains moisture during cooking is perceived as juicy, while lean cuts may be drier. Fat contributes to juiciness by melting during cooking and distributing flavour throughout the meat.

Flavour arises from a combination of muscle proteins, fats, and cooking reactions such as the Maillard reaction. Seasoning and marinades can enhance flavour, but intrinsic qualities of the meat, such as fat composition, play a central role.

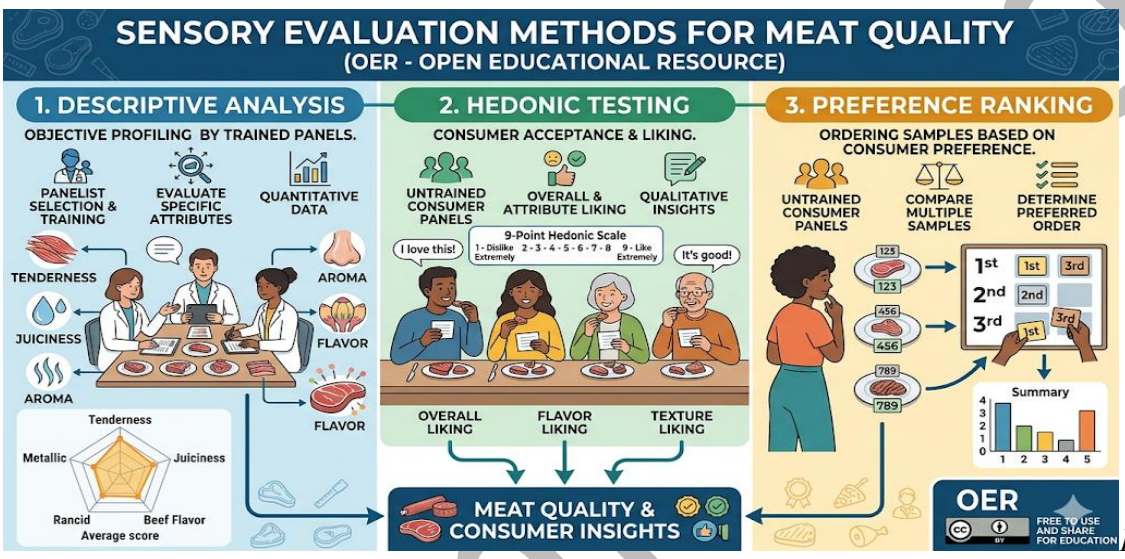
[Insert Plate here] Image showing grilled beef steak with visible marbling and juices *Plate 3.1: Tenderness, juiciness, and flavour in meat* AI prompt suggestion: “Create a realistic image of a grilled beef steak showing marbling, juices, and appealing flavour presentation.” Search string: “OER grilled beef steak tenderness juiciness flavour image”

Fill in the blank: The chemical reaction during cooking that enhances flavour is called the _____ reaction.

3.1.3 Consumer perception and sensory evaluation

Consumers judge meat quality based on sensory attributes such as colour, texture, tenderness, juiciness, and flavour. Sensory evaluation involves trained panels or consumer testing to assess these attributes systematically. While scientific measurements provide objective data, consumer perception ultimately determines market success. For example, consumers may reject meat that is safe but visually unappealing.

Sensory evaluation methods include descriptive analysis, hedonic testing, and preference ranking. These methods help producers understand consumer expectations and adjust processing techniques accordingly.



Box 3.1: Key sensory evaluation methods in meat quality Caption: Box 3.1: Key sensory evaluation methods in meat quality.

Fill in the blank: The systematic assessment of meat quality by trained panels is called _____ evaluation.

Pilot questions 3.1

1. What protein is responsible for meat colour?
2. How does ageing improve tenderness?
3. What factors influence juiciness in meat?
4. What chemical reaction enhances flavour during cooking?
5. Why is consumer perception important in meat quality evaluation?

3.2 Chemical and Nutritional Quality Factors

3.2.1 Protein, fat, and moisture composition

Protein is the primary nutrient in meat, contributing to growth and repair in the human body. The amount and quality of protein vary among species and cuts. Lean meats such as chicken breast are high in protein but low in fat, while fatty cuts of beef provide both protein and energy.

Fat contributes to flavour, juiciness, and mouthfeel. Intramuscular fat, or marbling, is particularly important in beef quality grading. While fat enhances sensory qualities, excessive fat intake has health implications, making balance essential.

Moisture content influences juiciness and weight. Meat with high moisture content is more palatable but may be prone to microbial spoilage if not properly preserved.

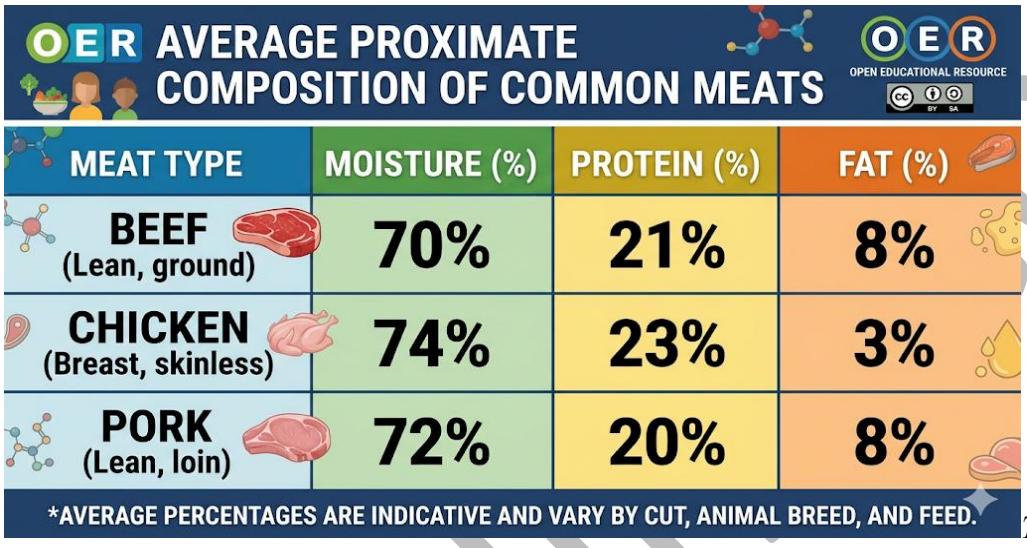


Table 3.1: Average protein, fat, and moisture composition in beef, chicken, and pork Caption: Table 3.1: Protein, fat, and moisture composition in common meats.

Fill in the blank: Intramuscular fat that enhances flavour and juiciness is called _____.

3.2.2 pH and biochemical changes post-mortem

pH is a measure of acidity or alkalinity in meat. After slaughter, muscle glycogen is converted to lactic acid, lowering pH. This decline is crucial for meat quality, as it influences colour, tenderness, and microbial stability. Normal meat has a final pH of around 5.5.

Biochemical changes post-mortem include rigor mortis, enzyme activity, and protein breakdown. Rigor mortis stiffens muscles, while enzymes gradually soften them during ageing. These changes determine whether meat is tender and palatable. Abnormal pH levels can lead to conditions such as pale, soft, exudative (PSE) meat in pigs or dark, firm, dry (DFD) meat in cattle.

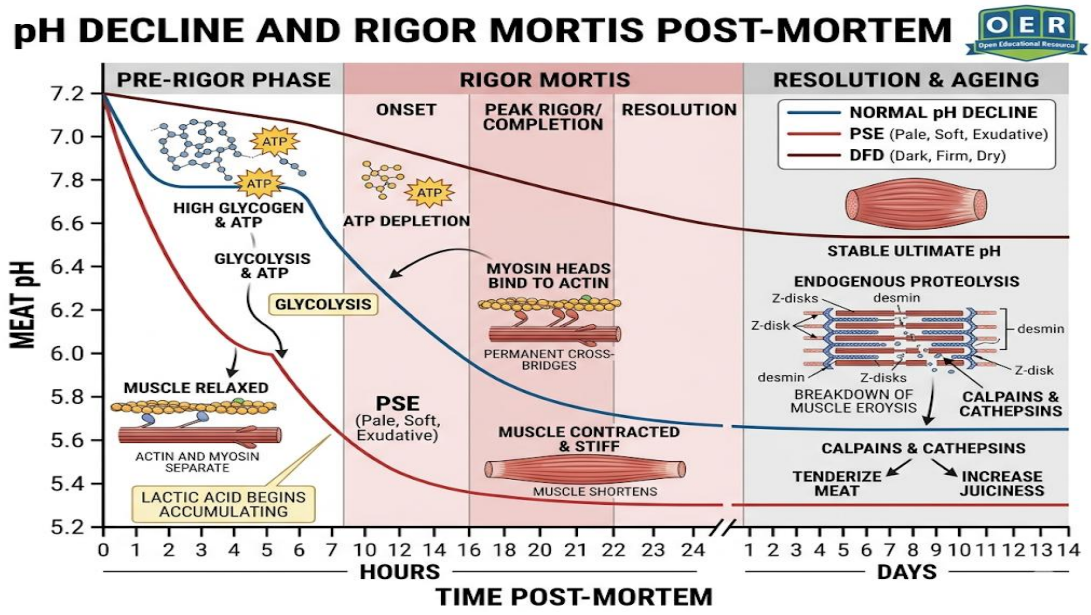


Diagram showing pH decline in meat post-mortem Figure 3.2: pH decline and biochemical changes in meat.

Fill in the blank: The condition in pigs caused by rapid pH decline is called _____ meat.

3.2.3 Nutritional value of meat and poultry products

Meat and poultry are rich sources of essential nutrients including protein, iron, zinc, and B vitamins. These nutrients support growth, immune function, and energy metabolism. Poultry is often considered a leaner option, providing high-quality protein with lower fat content compared to red meat.

The nutritional value of meat depends on species, cut, and processing method. For example, processed meats may contain added salt and preservatives, which affect health considerations. While meat is an excellent source of nutrients, moderation and balance are important in dietary planning.

Image showing a balanced meal with lean poultry, vegetables, and whole grains Plate 3.2: Nutritional value of meat and poultry in a balanced diet.

Fill in the blank: Meat is a rich source of essential nutrients such as protein, iron, zinc, and _____ vitamins.

Pilot questions 3.2

1. What is intramuscular fat called, and why is it important?
2. How does pH decline after slaughter affect meat quality?
3. What condition results from rapid pH decline in pigs?
4. Name three essential nutrients found in meat and poultry.
5. Why is moderation important in consuming processed meats?

3.3 Microbiological and Safety Quality Factors

3.3.1 Common pathogens in meat and poultry

Pathogens are microorganisms that cause disease in humans when present in food. In meat and poultry, common pathogens include *Salmonella*, *Listeria monocytogenes*, and *Escherichia coli* (E. coli). These organisms can contaminate meat during slaughter, processing, or handling. For example, Salmonella is often associated with poultry and can survive inadequate cooking, while E. coli O157:H7 is linked to undercooked beef and can cause severe illness.

Controlling pathogens requires strict hygiene, proper cooking, and effective preservation methods. Producers must ensure that meat is processed in clean environments, while consumers must cook meat thoroughly to eliminate microbial risks.

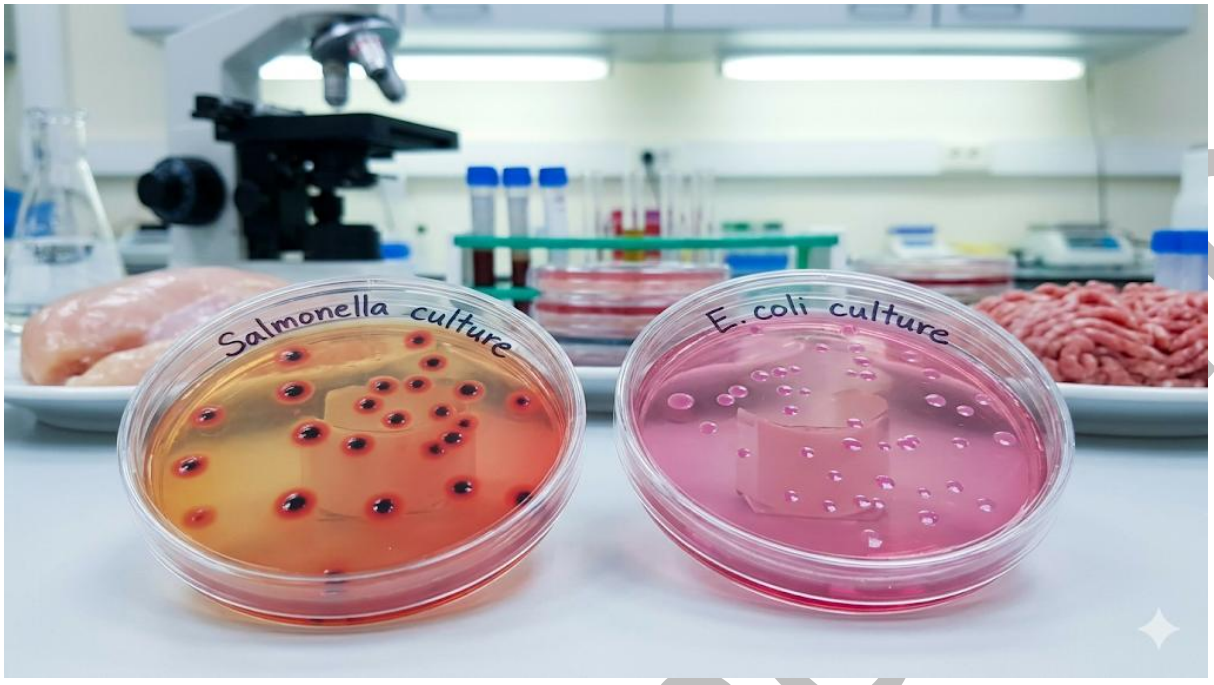


Image showing laboratory culture of Salmonella and E. coli Plate 3.3: Common pathogens in meat and poultry.

Fill in the blank: The pathogen commonly associated with undercooked beef is _____.

3.3.2 Spoilage organisms and shelf life

Spoilage organisms are microorganisms that do not necessarily cause illness but degrade meat quality. They include bacteria, yeasts, and moulds that produce off-odours, slime, and discolouration. Spoilage shortens shelf life and reduces consumer acceptability.

Shelf life is the period during which meat remains safe and acceptable for consumption. It depends on storage conditions, packaging, and preservation methods. Refrigeration slows microbial growth, while vacuum packaging reduces oxygen availability, extending shelf life. However, spoilage organisms eventually proliferate, making meat unsuitable for consumption.

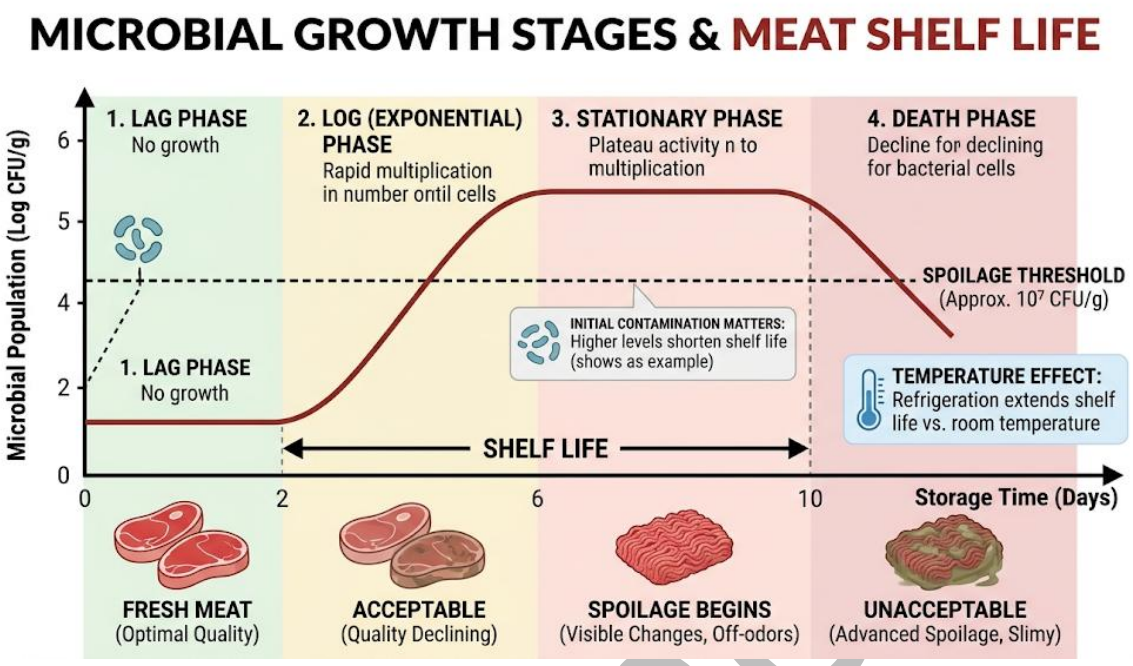


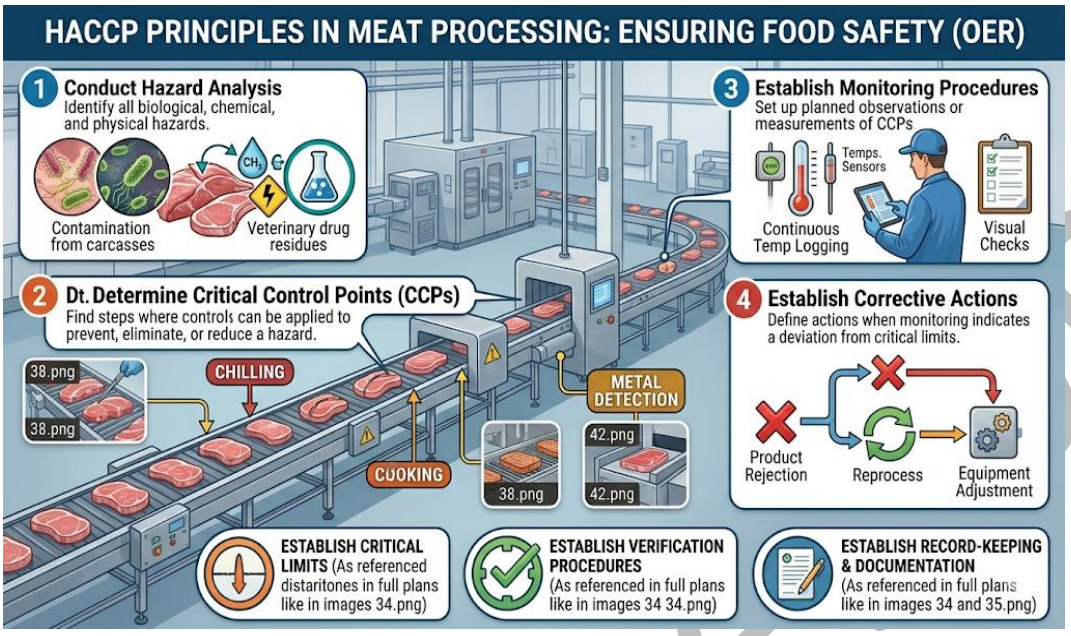
Diagram showing microbial growth and shelf life stages in meat Figure 3.3: Microbial growth and shelf life of meat products.

Fill in the blank: Microorganisms that degrade meat quality without causing illness are called _____ organisms.

3.3.3 Food safety standards and HACCP application

Food safety standards are regulations that ensure meat products are safe for consumers. These standards specify acceptable microbial limits, hygiene practices, and processing requirements. Compliance is mandatory for producers to protect public health.

HACCP (Hazard Analysis and Critical Control Points) is a systematic approach to food safety. It identifies potential hazards, establishes critical control points, and monitors processes to prevent contamination. For example, monitoring cooking temperatures ensures pathogens are destroyed, while checking packaging integrity prevents recontamination.



Box 3.2: Key principles of HACCP in meat processing Caption: Box 3.2: Key principles of HACCP in meat processing.

Fill in the blank: The systematic food safety approach that identifies hazards and control points is called _____.

Pilot questions 3.3

1. Name two common pathogens in meat and poultry.
2. What is the difference between pathogens and spoilage organisms?
3. How does refrigeration extend shelf life?
4. What does HACCP stand for?
5. Why are food safety standards important in meat processing?

3.4 Grading and Standards in Meat and Poultry

3.4.1 Principles of meat grading systems

Meat grading is the classification of meat based on quality attributes such as marbling, colour, and texture. Grading helps consumers and producers identify meat quality and value. For example, beef grading often considers marbling, which enhances flavour and tenderness. Higher grades indicate superior quality, while lower grades may be less tender or flavourful.

Grading systems vary by country but generally aim to provide consistency and transparency in the marketplace. They allow consumers to make informed choices and producers to receive fair prices.

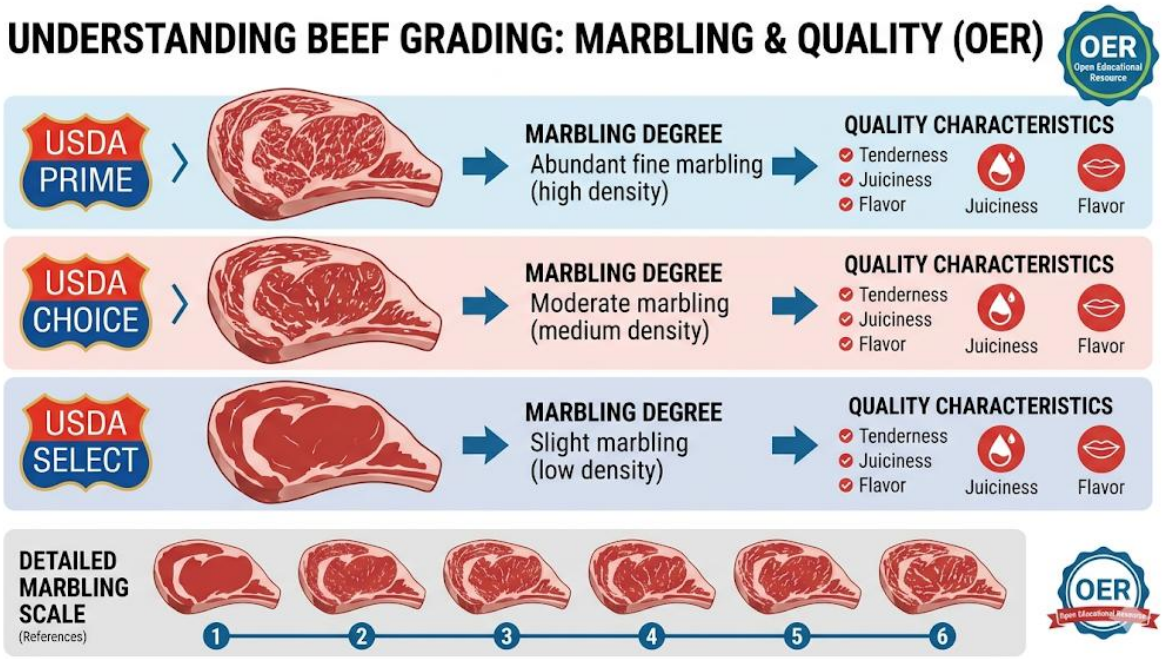


Diagram showing beef grading system based on marbling and quality Figure 3.4: Beef grading system based on marbling.

Fill in the blank: The visible fat within muscle tissue used in grading is called _____.

3.4.2 Poultry grading and classification

Poultry grading evaluates birds based on appearance, weight, and absence of defects. Grading considers factors such as skin colour, fat distribution, and freedom from bruises or broken bones. Poultry is often classified into grades such as Grade A, which indicates high quality with no defects, and lower grades, which may have minor issues.

Classification also includes size categories, such as broilers, fryers, and roasters, based on age and weight. These classifications help consumers select poultry suited to specific cooking methods.

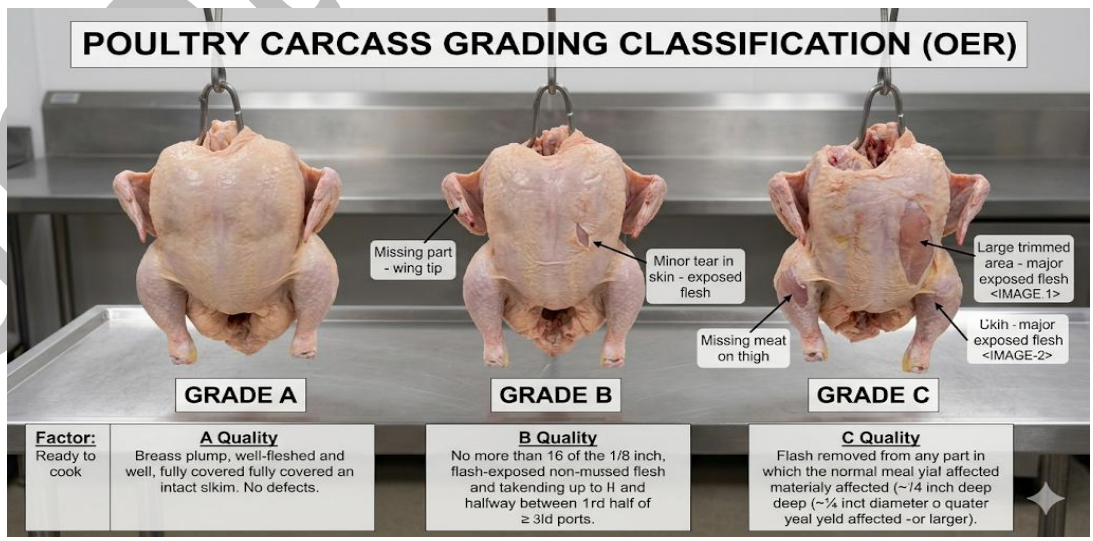


Image showing poultry grading examples (Grade A vs lower grades) Plate 3.4: Poultry grading and classification.

Fill in the blank: Poultry with no defects and high quality is classified as Grade _____.

3.4.3 International and national quality standards

Quality standards are established by national and international organisations to ensure meat and poultry products meet safety and quality requirements. Standards cover aspects such as microbial limits, chemical residues, and labelling requirements.

International standards, such as those set by the Codex Alimentarius, provide guidelines for global trade. National standards vary but often align with international frameworks to facilitate exports and imports. Compliance with standards ensures consumer safety and supports fair trade practices.

Box 3.3: Examples of international and national meat quality standards Caption: Box 3.3: Examples of international and national meat quality standards.

Fill in the blank: The international body that sets food quality standards is called _____.

Pilot questions 3.4

1. What factors are considered in meat grading?
2. How is poultry classified into grades?
3. What does Grade A poultry indicate?
4. Name one international organisation that sets meat quality standards.
5. Why are grading systems important for consumers and producers?

3.5 Quality Assurance and Consumer Protection

3.5.1 Quality control practices in processing plants

Quality control refers to systematic monitoring and testing of meat products to ensure they meet established standards of safety, consistency, and consumer acceptability. In processing plants, quality control begins at the slaughter stage and continues through dressing, packaging, and distribution. Visual inspection is often the first step, where trained personnel check carcasses for defects, contamination, or abnormalities. This is followed by **microbial testing**, which detects harmful pathogens such as *Salmonella* or *Listeria*. Chemical analysis is also conducted to ensure that preservatives, additives, and residues remain within safe limits.

Effective quality control prevents contamination, ensures uniformity, and builds consumer trust. For example, regular microbial testing can detect pathogens early, allowing corrective measures before products reach the market. Similarly, monitoring fat and moisture content ensures that products meet nutritional and sensory expectations. Quality control is therefore both a scientific and managerial responsibility, requiring skilled personnel, reliable equipment, and adherence to protocols.

Image showing workers conducting microbial and chemical tests in a meat processing plant

Plate 3.5: Quality control practices in meat processing plants.

Fill in the blank: Monitoring and testing meat products to ensure standards are met is called quality _____.

3.5.2 Packaging, labelling, and traceability

Packaging plays a vital role in protecting meat from contamination, extending shelf life, and enhancing presentation. Modern packaging methods include vacuum sealing, which removes air to slow microbial growth, and modified atmosphere packaging, which replaces oxygen with gases such as carbon dioxide or nitrogen. These methods not only preserve freshness but also maintain colour and flavour.

Labelling provides consumers with essential information such as product type, weight, nutritional content, storage instructions, and expiry date. Accurate labelling ensures transparency and helps consumers make informed choices. Misleading or incomplete labels can undermine trust and may even pose health risks.

Traceability refers to the ability to track meat products from farm to table. It ensures accountability and allows quick responses to food safety incidents. Traceability systems often use barcodes, QR codes, or digital records to monitor product movement. In the event of contamination, traceability enables rapid recalls, protecting consumers and minimising economic losses.

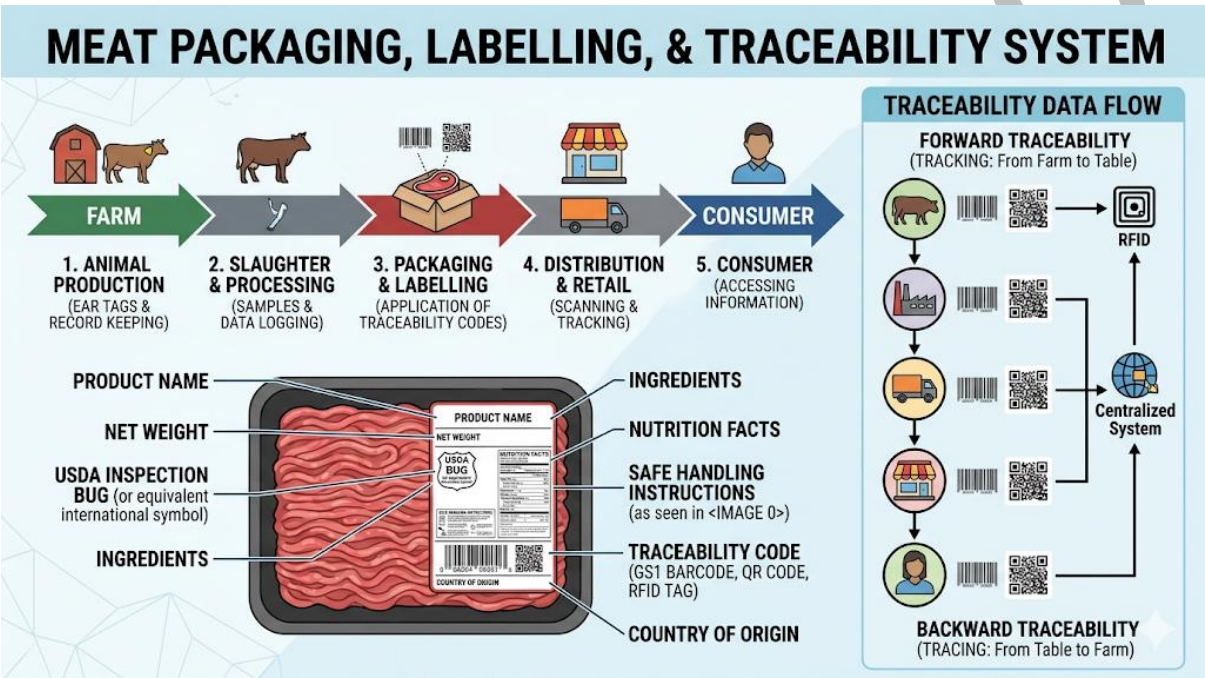


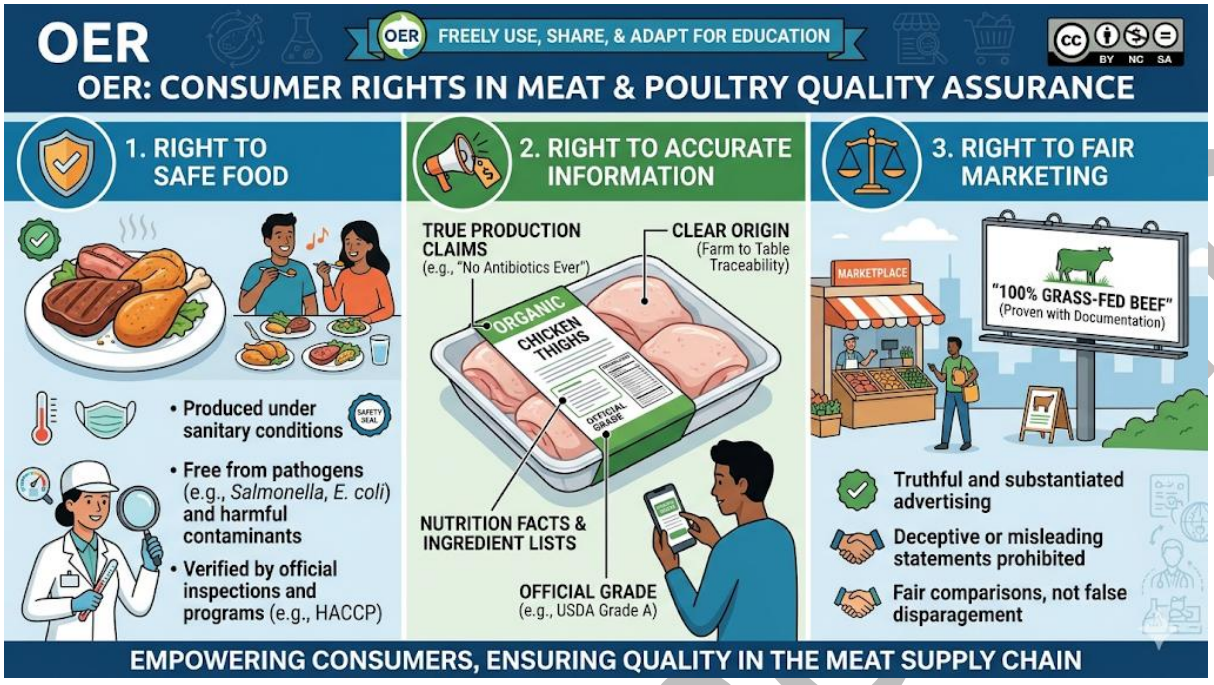
Diagram showing packaging, labelling, and traceability system Figure 3.6: Packaging, labelling, and traceability in meat products.

Fill in the blank: The ability to track meat products from farm to table is called _____.

3.5.3 Role of regulatory agencies and consumer rights

Regulatory agencies are organisations responsible for overseeing meat quality and safety. They establish standards, conduct inspections, and enforce compliance. Examples include national food safety authorities, ministries of agriculture, and international bodies such as the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). These agencies ensure that meat products are safe, correctly labelled, and fairly marketed.

Consumer rights are central to quality assurance. They include the right to safe food, the right to accurate information, and the right to protection from fraud. Quality assurance systems uphold these rights by ensuring products meet standards and by providing mechanisms for complaints and redress. For instance, labelling regulations protect consumers from misleading claims, while inspection systems safeguard against unsafe practices.



Box 3.4: Consumer rights in meat and poultry quality assurance Caption: Box 3.4: Consumer rights in meat and poultry quality assurance.

Fill in the blank: The international organisation that works with governments to ensure food safety and consumer protection is the _____.

Pilot questions 3.5

1. What is the purpose of quality control in meat processing plants?
2. How does vacuum packaging extend shelf life?
3. Why is accurate labelling important for consumers?
4. What is traceability, and why is it essential in meat production?
5. Name two consumer rights protected by quality assurance systems.

Series Summary

This Series has explored the diverse factors that determine the quality of meat and poultry, moving beyond processing and preservation to focus on consumer expectations and scientific evaluation. We began with physical and sensory attributes such as colour, texture, tenderness, juiciness, and flavour, which directly influence consumer perception. We then examined chemical and nutritional aspects, including protein composition, fat content, pH, and post-mortem biochemical changes. Following that, we studied microbiological and safety factors, highlighting pathogens, spoilage organisms, and the application of HACCP. We continued with grading systems, looking at meat and poultry classification and international standards, before concluding with quality assurance

and consumer protection, including packaging, labelling, traceability, and the role of regulatory agencies.

By completing this Series, you should now be able to describe sensory and chemical quality attributes, explain nutritional and biochemical factors, analyse microbiological risks, evaluate grading systems, and apply quality assurance practices. These skills align with the Series Learning Outcomes and provide you with a comprehensive understanding of how meat and poultry quality is assessed, maintained, and protected for consumers.

Glossary of Terms

Consumer rights: The entitlements of consumers to safe food, accurate information, and protection from fraud.

Grading: The classification of meat or poultry based on quality attributes such as marbling, colour, and absence of defects.

HACCP: Hazard Analysis and Critical Control Points, a systematic food safety approach that identifies hazards and establishes control measures.

Marbling: Intramuscular fat that enhances flavour, juiciness, and tenderness in meat.

Myoglobin: A protein in muscle tissue responsible for meat colour, influenced by oxygen exposure.

Packaging: Methods used to protect meat from contamination and extend shelf life, such as vacuum sealing.

Pathogens: Microorganisms that cause disease in humans when present in food.

pH: A measure of acidity or alkalinity in meat, which affects microbial growth, colour, and tenderness.

Sensory evaluation: The systematic assessment of meat quality attributes such as flavour, tenderness, and juiciness by trained panels or consumers.

Traceability: The ability to track meat products from farm to table, ensuring accountability and safety.

Concept Check Questions [Series 3]

Objective questions

1. What protein is responsible for meat colour? (Linked to SLO 3.1)
2. What is intramuscular fat called? (Linked to SLO 3.2)
3. What does HACCP stand for? (Linked to SLO 3.3)

Short-answer questions

4. Explain how ageing improves meat tenderness. (Linked to SLO 3.1)

5. How does pH decline after slaughter affect meat quality? (Linked to SLO 3.2)
6. Why is traceability important in meat production? (Linked to SLO 3.5)

Long-answer questions

7. Analyse the role of microbiological safety in meat and poultry, with examples of pathogens and spoilage organisms. (Linked to SLO 3.3)
8. Evaluate grading systems and quality assurance practices in meat and poultry, highlighting their importance for consumer protection. (Linked to SLO 3.4 & 3.5)

Answers to Concept Check Questions [Series 3]

Objective questions

1. Myoglobin
2. Marbling
3. Hazard Analysis and Critical Control Points

Short-answer questions

4. Ageing allows enzymes to break down muscle proteins, improving tenderness.
5. pH decline influences colour, tenderness, and microbial stability; abnormal decline can cause PSE or DFD meat.
6. Traceability ensures accountability, allows rapid recalls, and protects consumers in case of contamination.

Long-answer questions

7. *Basic response*: Microbiological safety ensures meat is free from harmful pathogens such as Salmonella, Listeria, and E. coli. Spoilage organisms reduce shelf life and consumer acceptability. *Value-added response*: Beyond basic control, microbiological safety involves HACCP systems, which identify hazards and establish control points. This systematic approach ensures consistent safety and builds consumer confidence.
8. *Basic response*: Grading systems classify meat and poultry based on quality attributes, while quality assurance practices such as packaging, labelling, and inspections protect consumers. *Value-added response*: International standards like Codex Alimentarius harmonise trade, while national agencies enforce compliance. Together, grading and assurance systems uphold consumer rights and support fair trade.

Answers to Pilot Questions [Series 3]

Part 3.1

1. Myoglobin

2. Enzymes break down muscle proteins during ageing
3. Water-holding capacity and fat content
4. The Maillard reaction
5. Consumer perception determines market success

Part 3.2

1. Marbling; enhances flavour and juiciness
2. pH decline affects colour, tenderness, and microbial stability
3. Pale, soft, exudative (PSE) meat
4. Protein, iron, zinc, and B vitamins
5. Processed meats may contain excess salt and preservatives

Part 3.3

1. Salmonella and E. coli
2. Pathogens cause illness, spoilage organisms reduce quality
3. Refrigeration slows microbial growth
4. Hazard Analysis and Critical Control Points
5. They protect public health and ensure compliance

Part 3.4

1. Marbling, colour, and texture
2. Appearance, weight, and absence of defects
3. Grade A
4. Codex Alimentarius
5. They provide consistency and transparency

Part 3.5

1. To ensure safety, consistency, and consumer trust
2. It removes air, slowing microbial growth
3. It ensures transparency and prevents misleading claims
4. Tracking products from farm to table
5. Safe food and accurate information

References and Attributions [Series 3]

- Figure 3.1: Colour variations in meat linked to myoglobin states. Suggested AI prompt: "Generate a labelled diagram showing oxymyoglobin (red), deoxymyoglobin (purple), and metmyoglobin (brown) in meat." Search string: "OER meat colour myoglobin diagram."
- Plate 3.1: Tenderness, juiciness, and flavour in meat. Suggested AI prompt: "Create a realistic image of a grilled beef steak showing marbling, juices, and appealing flavour presentation." Search string: "OER grilled beef steak tenderness juiciness flavour image."
- Box 3.1: Key sensory evaluation methods in meat quality. Suggested AI prompt: "Generate an infographic showing sensory evaluation methods such as descriptive analysis, hedonic testing, and preference ranking." Search string: "OER sensory evaluation meat quality infographic."
- Table 3.1: Protein, fat, and moisture composition in common meats. Suggested AI prompt: "Generate a table showing average protein, fat, and moisture percentages in beef, chicken, and pork." Search string: "OER meat composition protein fat moisture table."
- Figure 3.2: pH decline and biochemical changes in meat. Suggested AI prompt: "Generate a diagram showing pH decline in meat after slaughter, with stages of rigor mortis and ageing." Search string: "OER meat pH decline post-mortem diagram."
- Plate 3.2: Nutritional value of meat and poultry in a balanced diet. Suggested AI prompt: "Create a realistic image of a balanced meal with lean poultry, vegetables, and whole grains." Search string: "OER balanced diet poultry meat nutrition image."
- Plate 3.3: Common pathogens in meat and poultry. Suggested AI prompt: "Create a realistic image showing laboratory cultures of Salmonella and E. coli with labels." Search string: "OER pathogens in meat poultry Salmonella E. coli image."
- Figure 3.3: Microbial growth and shelf life of meat products. Suggested AI prompt: "Generate a diagram showing microbial growth stages and their impact on meat shelf life." Search string: "OER microbial growth shelf life meat diagram."
- Box 3.2: Key principles of HACCP in meat processing. Suggested AI prompt: "Generate an infographic showing HACCP principles such as hazard analysis, critical control points, monitoring, and corrective actions." Search string: "OER HACCP principles meat processing infographic."
- Figure 3.4: Beef grading system based on marbling. Suggested AI prompt: "Generate a diagram showing beef grading categories based on marbling and quality." Search string: "OER beef grading marbling diagram."
- Plate 3.4: Poultry grading and classification. Suggested AI prompt: "Create a realistic image showing poultry carcasses graded as Grade A and lower grades." Search string: "OER poultry grading classification image."

- Box 3.3: Examples of international and national meat quality standards. Suggested AI prompt: “Generate a table listing Codex Alimentarius standards and national meat quality standards.” Search string: “OER Codex Alimentarius meat quality standards table.”
- Plate 3.5: Quality control practices in meat processing plants. Suggested AI prompt: “Create a realistic image showing workers conducting microbial and chemical tests in a meat processing plant.” Search string: “OER meat processing plant quality control image.”
- Figure 3.6: Packaging, labelling, and traceability in meat products. Suggested AI prompt: “Generate a diagram showing packaging, labelling, and traceability system for meat products.” Search string: “OER packaging labelling traceability meat diagram.”
- Box 3.4: Consumer rights in meat and poultry quality assurance. AI prompt suggestion: “Generate an infographic showing consumer rights such as safe food, accurate information, and fair marketing.” Search string: “OER consumer rights meat poultry quality assurance infographic”

Course code: FST502

Course title: Meat Science & Fish Science & Technology

Course credit load: 3 units

List of Series:

16. **Science and Technology of Meat Production**
17. **Processing and Preservation of Meat Products**
18. **Quality Factors in Meat and Poultry**
19. **Fish Science and Product Technology**
20. **Egg and Poultry Product Utilisation**

4.1 Fundamentals of Fish Biology and Composition

- 4.1.1 Anatomy and physiology of fish
- 4.1.2 Chemical composition of fish muscle
- 4.1.3 Post-mortem changes in fish

4.2 Handling and Processing of Fresh Fish

- 4.2.1 Harvesting and handling practices

- 4.2.2 Storage and transportation methods
- 4.2.3 Quality assessment of fresh fish

4.3 Preservation Techniques in Fish Processing

- 4.3.1 Chilling and freezing
- 4.3.2 Salting, smoking, and drying
- 4.3.3 Canning and advanced preservation methods

4.4 Fish Product Technology and Value Addition

- 4.4.1 Fish fillets, surimi, and fish mince
- 4.4.2 Fish-based convenience foods (fish fingers, patties, nuggets)
- 4.4.3 By-product utilisation (fish oil, fish meal, collagen)

4.5 Quality Assurance and Standards in Fish Products

- 4.5.1 Microbiological safety and spoilage organisms
- 4.5.2 National and international standards for fish products
- 4.5.3 Consumer protection and traceability systems

Introduction

Fish and fishery products are among the most widely consumed sources of protein worldwide, valued for their nutritional richness and versatility. Unlike meat and poultry, fish are highly perishable, requiring careful handling and specialised processing techniques to maintain quality and safety. This Series introduces you to the science of fish biology and composition, as well as the technological methods used to process and preserve fish into diverse products. It highlights the importance of fish science not only for food security but also for value addition and international trade.

The aim of this Series is to equip you with the knowledge and skills to explain the biological and chemical characteristics of fish, demonstrate handling and preservation techniques, analyse fish product technologies, and apply quality assurance standards to ensure consumer protection.

We shall commence this Series by exploring the fundamentals of fish biology and composition, including anatomy, physiology, and post-mortem changes. Next, we will examine handling and processing practices for fresh fish, focusing on harvesting, storage, and quality assessment. Following that, we will study preservation techniques such as chilling, freezing, salting, smoking,

drying, and canning. Afterwards, we will move on to fish product technology and value addition, covering fillets, surimi, convenience foods, and by-products. Finally, we will conclude with quality assurance and standards in fish products, considering microbiological safety, national and international regulations, and consumer protection systems.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 4.1** describe the anatomy, physiology, and chemical composition of fish, including post-mortem changes,
- **SLO 4.2** explain handling, storage, and transportation practices for fresh fish,
- **SLO 4.3** demonstrate preservation techniques such as chilling, freezing, salting, smoking, drying, and canning,
- **SLO 4.4** analyse fish product technologies including fillets, surimi, convenience foods, and by-product utilisation, and
- **SLO 4.5** evaluate quality assurance systems and standards in fish products, including microbiological safety, consumer protection, and traceability.

4.1 Fundamentals of Fish Biology and Composition

4.1.1 Anatomy and physiology of fish

Fish anatomy is distinct from that of terrestrial animals, and understanding it is essential for processing and product development. The **muscle structure** of fish is composed of short fibres arranged in segments called myotomes, separated by connective tissue known as myosepta. This arrangement contributes to the flaky texture of cooked fish. Fish muscles are generally softer than those of mammals, making them more delicate during handling.

Physiologically, fish are cold-blooded, meaning their body temperature varies with the surrounding water. This influences metabolic activity and contributes to rapid spoilage after harvest. The gills, which are responsible for respiration, are highly vascularised and prone to microbial contamination once the fish is dead. The digestive system is relatively simple compared to mammals, and fat distribution varies widely among species, with some fish storing fat in the liver while others store it in muscle tissue.

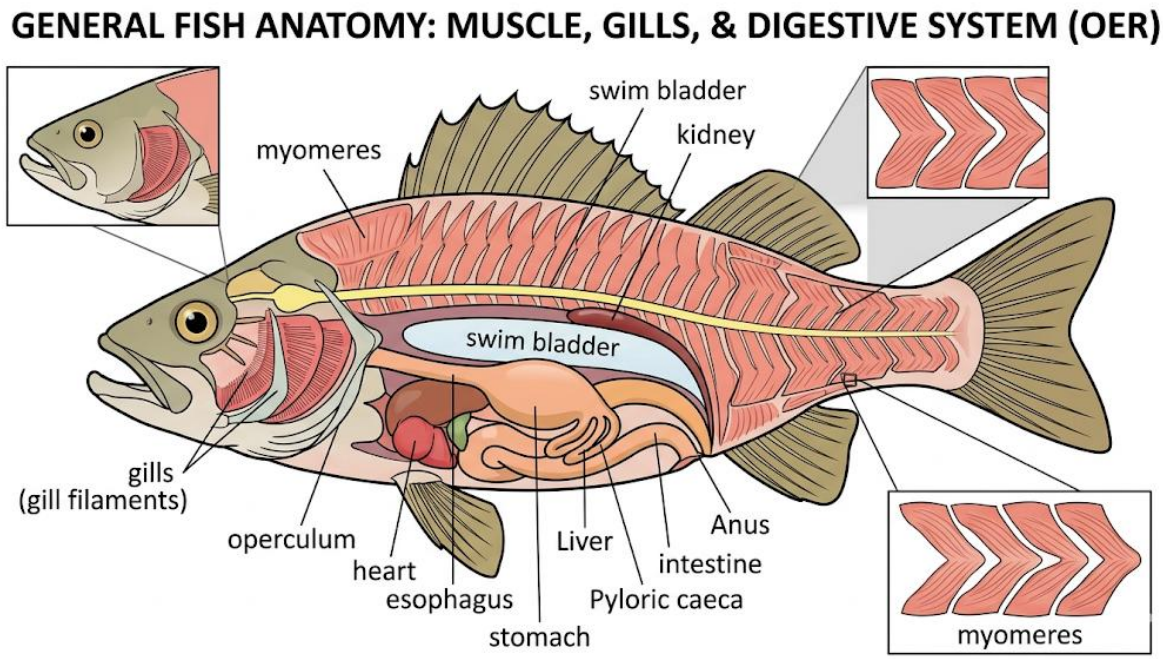


Diagram showing fish anatomy (muscle segments, gills, liver, digestive tract) Figure 4.1: Anatomy and physiology of fish.

Fill in the blank: The segmented muscle fibres in fish are called _____.

4.1.2 Chemical composition of fish muscle

The **chemical composition** of fish muscle determines its nutritional value and processing behaviour. Fish are rich in **protein**, typically ranging from 15 to 20 percent, which is easily digestible and of high biological value. Fat content varies widely among species, with lean fish such as cod containing less than 2 percent fat, while fatty fish like salmon may contain up to 20 percent.

Fish fat is notable for its high levels of **omega-3 fatty acids**, which are beneficial for cardiovascular health. Moisture content in fish muscle is generally high, often exceeding 70 percent, which contributes to its perishability. Minerals such as iodine, phosphorus, and selenium are also present, along with vitamins A, D, and B-complex.

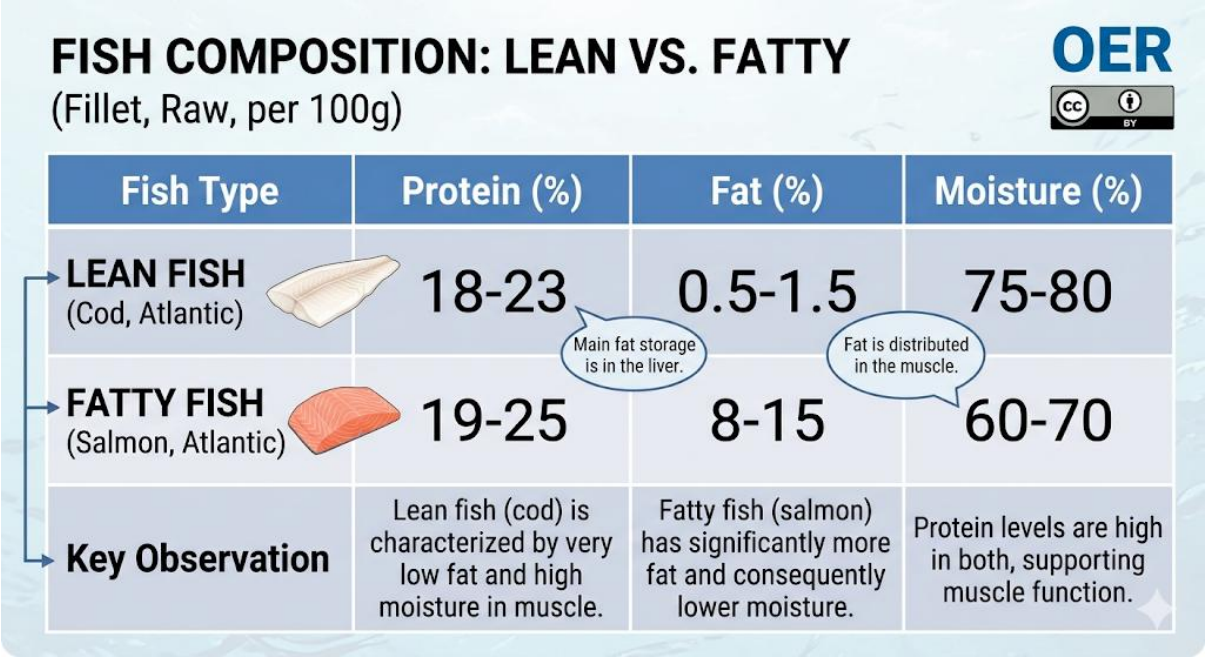


Table 4.1: Average protein, fat, and moisture composition in lean vs fatty fish Caption: Table 4.1: Protein, fat, and moisture composition in lean and fatty fish species

Fill in the blank: Fish fat is rich in _____ fatty acids, which are beneficial for cardiovascular health.

4.1.3 Post-mortem changes in fish

After harvest, fish undergo **post-mortem changes** that affect quality and shelf life. Rigor mortis sets in quickly, often within a few hours, due to the depletion of energy reserves. This stiffening of muscles is temporary, and as enzymes break down proteins, the flesh softens again.

Autolysis, the breakdown of tissue by endogenous enzymes, contributes to spoilage. Microbial activity accelerates deterioration, producing off-odours and slime. Lipid oxidation is another concern, particularly in fatty fish, leading to rancidity. These changes highlight the importance of rapid chilling and proper handling to maintain quality.

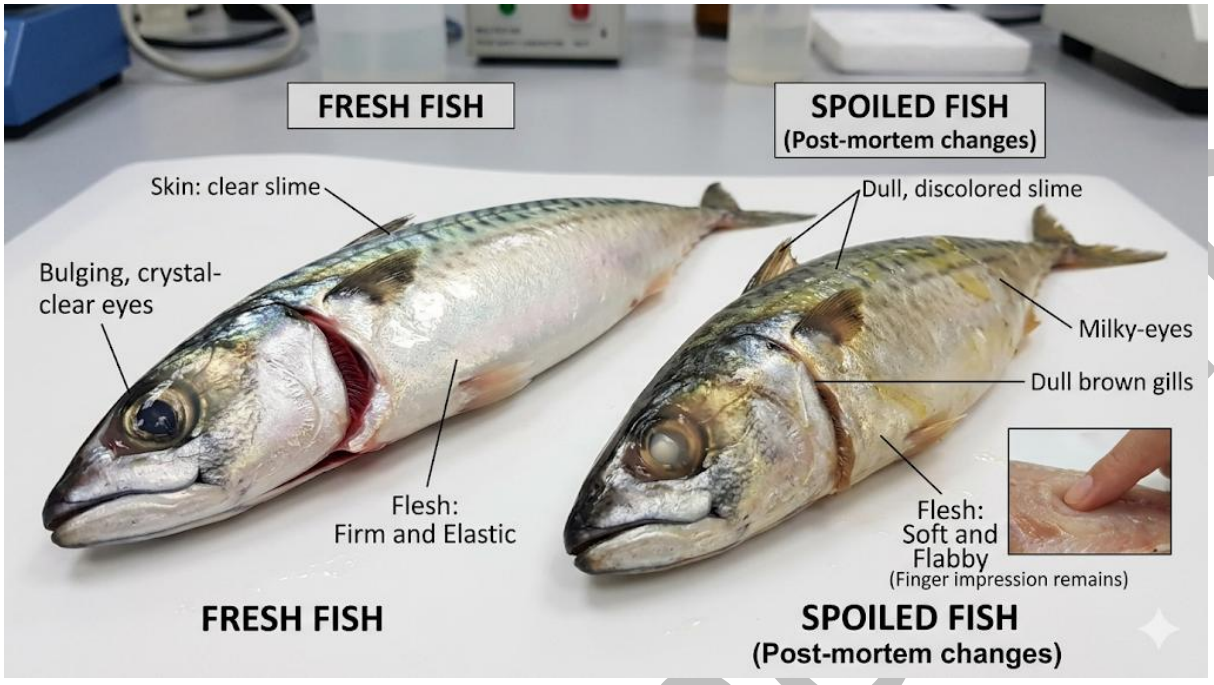


Image showing fresh fish vs spoiled fish (colour, texture differences) Plate 4.1: Post-mortem changes in fish quality.

Fill in the blank: The stiffening of fish muscles after harvest is called rigor _____.

Pilot questions 4.1

1. What are myotomes in fish muscle?
2. How does fat distribution differ among fish species?
3. Why is fish considered highly perishable compared to meat?
4. What nutrient makes fish fat particularly valuable for human health?
5. What post-mortem change leads to rancidity in fatty fish?

4.2 Handling and Processing of Fresh Fish

4.2.1 Harvesting and handling practices

Proper **harvesting practices** are critical to maintaining fish quality. Fish should be harvested quickly and humanely to minimise stress, which can accelerate spoilage. Once caught, fish must be handled carefully to avoid physical damage. Bruising or tearing of muscle tissue provides entry points for microorganisms, reducing shelf life.

Handling practices include immediate washing to remove slime, blood, and contaminants. Fish should be kept cool from the moment of harvest, ideally with ice, to slow microbial growth. Hygiene during handling is essential, as contamination at this stage can compromise product safety.

Image showing fishermen handling freshly caught fish with ice storage Plate 4.2: Proper handling of freshly harvested fish AI prompt suggestion:

Fill in the blank: Physical damage to fish muscle during handling provides entry points for _____.

4.2.2 Storage and transportation methods

Storage is vital to preserving fish quality. The most common method is icing, where fish are layered with crushed ice to maintain low temperatures. Freezing is used for longer storage, reducing microbial activity and enzymatic reactions. However, improper freezing can cause texture changes such as freezer burn.

Transportation requires maintaining the cold chain, ensuring fish remain at safe temperatures from harvest to market. Insulated containers, refrigerated trucks, and rapid distribution systems are used to prevent spoilage. Any break in the cold chain can lead to rapid deterioration, making strict monitoring essential.

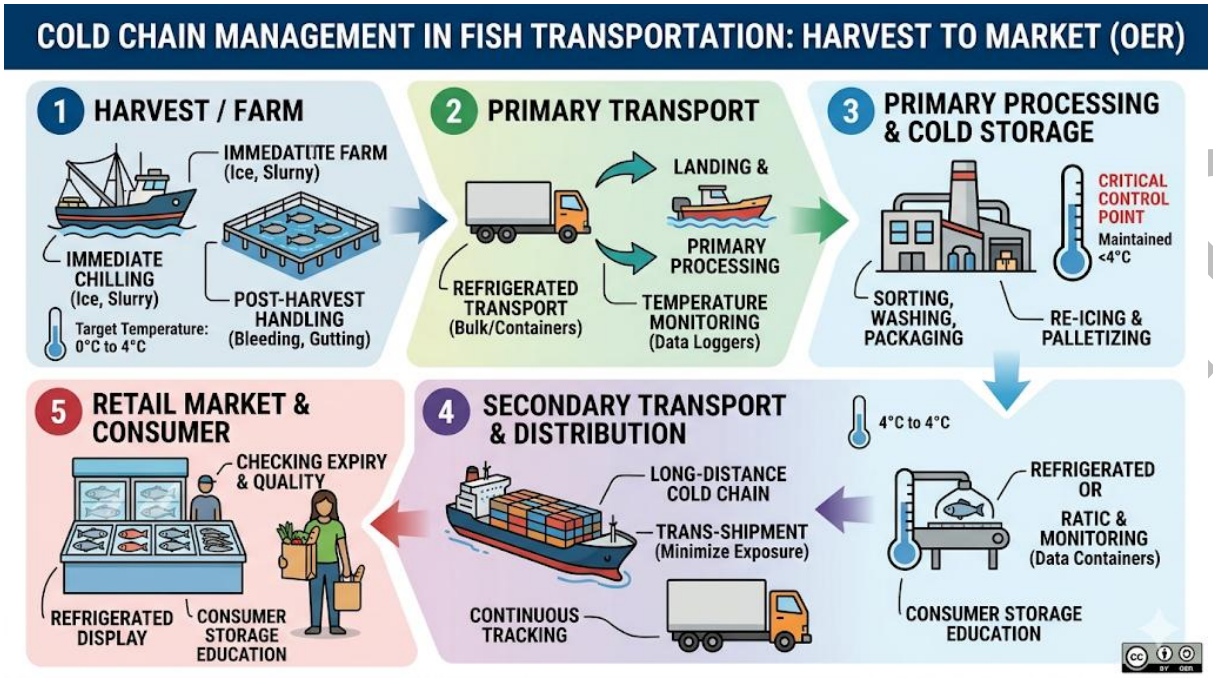


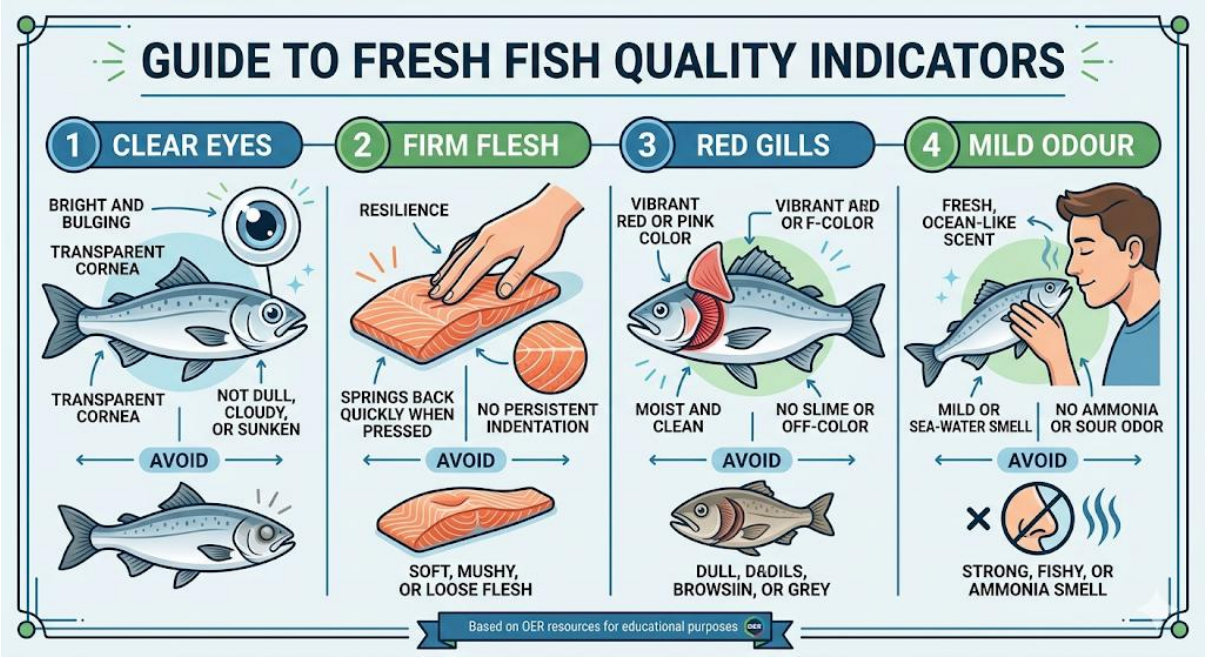
Diagram showing cold chain management in fish transportation Figure 4.2: Cold chain management in fish storage and transport.

Fill in the blank: The system that ensures fish remain at safe temperatures during transport is called the cold _____.

4.2.3 Quality assessment of fresh fish

Quality assessment involves evaluating sensory and physical attributes of fish. Fresh fish should have bright, clear eyes, firm flesh, and a mild odour. Spoiled fish exhibit cloudy eyes, soft flesh, and strong off-odours. Gills should be bright red in fresh fish, turning brown or grey as spoilage progresses.

Physical tests include measuring pH, checking microbial counts, and assessing water-holding capacity. These tests provide objective data to complement sensory evaluation. Quality assessment ensures that only safe and acceptable fish reach consumers, protecting public health and market reputation.



Box 4.1: Key indicators of fresh fish quality Caption: Box 4.1: Key indicators of fresh fish quality

Fill in the blank: Fresh fish should have bright, clear _____ and firm flesh.

Pilot questions 4.2

1. Why is immediate washing important after fish harvest?
2. What is the most common storage method for fresh fish?
3. What is the cold chain, and why is it important?
4. Name three sensory indicators of fresh fish quality.
5. How do microbial counts contribute to quality assessment?

4.3 Preservation Techniques in Fish Processing

4.3.1 Chilling and freezing

Chilling is the most immediate preservation method applied to fish after harvest. It involves storing fish at temperatures close to 0°C using ice or refrigerated systems. Chilling slows microbial growth and enzymatic activity, thereby extending shelf life for a few days. However, chilling does not stop spoilage entirely, and fish must be consumed or processed quickly.

Freezing preserves fish for longer periods by reducing temperature below -18°C, which halts microbial activity and slows enzymatic reactions. Freezing maintains nutritional value but may alter texture if not done properly. Rapid freezing methods such as blast freezing or plate freezing minimise ice crystal formation, preserving the delicate structure of fish muscle.

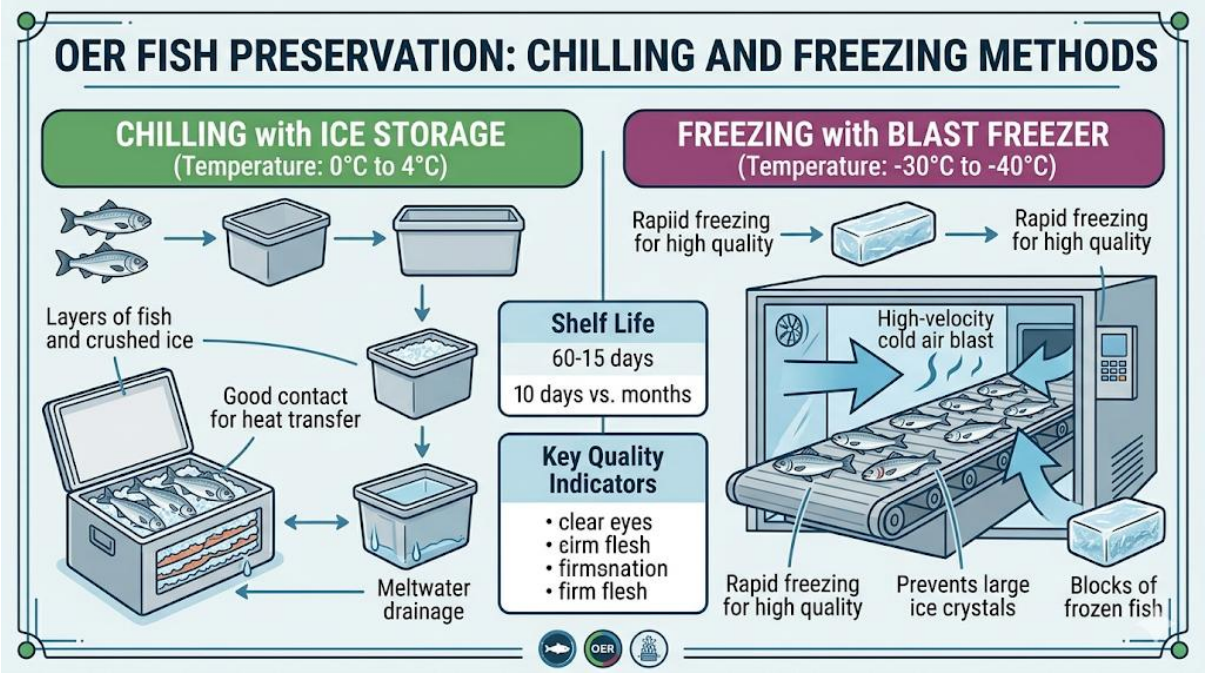


Diagram showing chilling and freezing processes in fish preservation Figure 4.3: Chilling and freezing methods in fish preservation.

Fill in the blank: The preservation method that stores fish close to 0°C using ice is called _____.

4.3.2 Salting, smoking, and drying

Salting reduces water activity by drawing moisture out of fish tissue, inhibiting microbial growth. It also enhances flavour and is often combined with drying or smoking.

Smoking exposes fish to smoke from burning wood, which imparts flavour and creates a protective surface. The smoke contains compounds such as phenols and organic acids that inhibit microbial growth. Smoking can be hot or cold, with hot smoking cooking the fish and cold smoking preserving it without cooking.

Drying reduces moisture content, making fish less hospitable to microorganisms. Traditional sun-drying is still widely used, while modern methods employ mechanical dryers for consistency. Dried fish is lightweight, portable, and has a long shelf life, though texture becomes tougher.

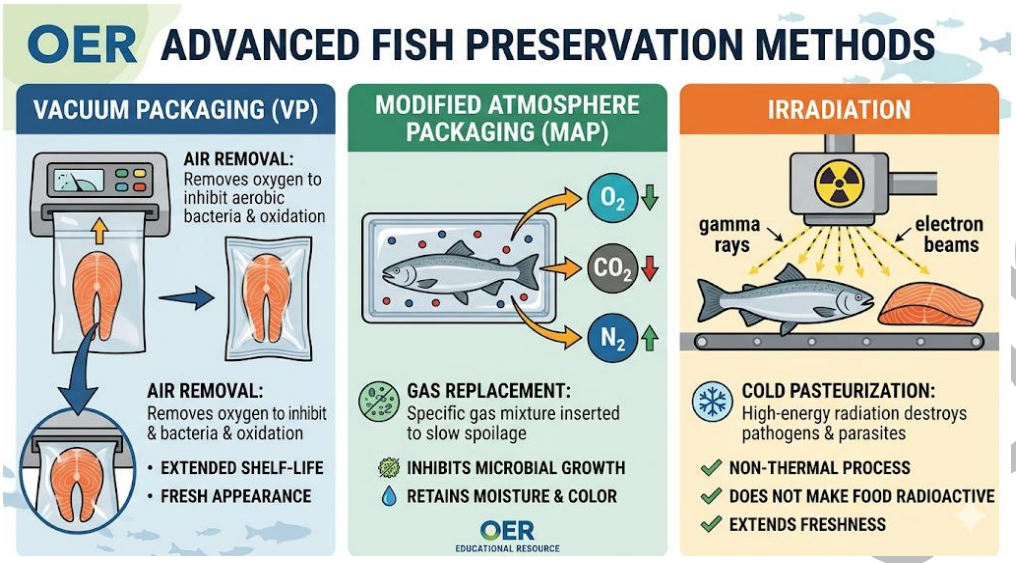
Image showing salted fish, smoked fish, and dried fish strips Plate 4.3: Salting, smoking, and drying in fish preservation.

Fill in the blank: The preservation method that reduces water activity by drawing moisture out of fish tissue is called _____.

4.3.3 Canning and advanced preservation methods

Canning involves sealing fish in airtight containers and heating them to destroy microorganisms. This method provides long shelf life and convenience, though it alters texture and flavour. Canned fish products include tuna, sardines, and mackerel.

Advanced preservation methods include vacuum packaging, modified atmosphere packaging (MAP), and irradiation. Vacuum packaging removes air, slowing microbial growth. MAP replaces oxygen with gases such as carbon dioxide or nitrogen, extending shelf life while maintaining colour and flavour. Irradiation uses controlled doses of radiation to destroy pathogens without significantly affecting nutritional value.



Box 4.2: Advanced preservation methods in fish processing Caption: Box 4.2: Advanced preservation methods in fish processing.

Fill in the blank: The preservation method that seals fish in airtight containers and heats them is called _____.

Pilot questions 4.3

1. What is the difference between chilling and freezing?
2. How does salting preserve fish?
3. What compounds in smoke inhibit microbial growth?
4. Why is drying effective in fish preservation?
5. Name two advanced preservation methods besides canning.

4.4 Fish Product Technology and Value Addition

4.4.1 Fish fillets, surimi, and fish mince

Fish fillets are boneless pieces of fish obtained by cutting along the backbone. They are convenient, versatile, and widely used in households and restaurants. Filleting requires skill to minimise waste and maintain product quality.

Surimi is a processed fish product made by washing minced fish to remove fat and soluble proteins, leaving myofibrillar proteins. Surimi is then mixed with stabilisers and flavourings to create products such as imitation crab sticks. It is valued for its versatility and ability to mimic other seafood.

Fish mince is produced by mechanically deboning fish, resulting in finely ground flesh. It is used in products such as fish balls, patties, and sausages. Mince must be handled carefully to prevent microbial contamination due to its high surface area.

Image showing fish fillets, surimi sticks, and fish mince products Plate 4.4: Fish fillets, surimi, and fish mince.

Fill in the blank: The processed fish product used to make imitation crab sticks is called _____.

4.4.2 Fish-based convenience foods (fish fingers, patties, nuggets)

Fish fingers are breaded strips of fish fillet or mince, designed for easy cooking and consumption. They are popular among children and in fast food outlets.

Fish patties are formed from minced fish mixed with seasonings and binders, then fried or baked. They provide a convenient protein source and can be customised with different flavours.

Fish nuggets are small, breaded pieces of fish, often made from mince or surimi. They are bite-sized and widely consumed as snacks or fast food items. Convenience foods add value by increasing consumer appeal and marketability.

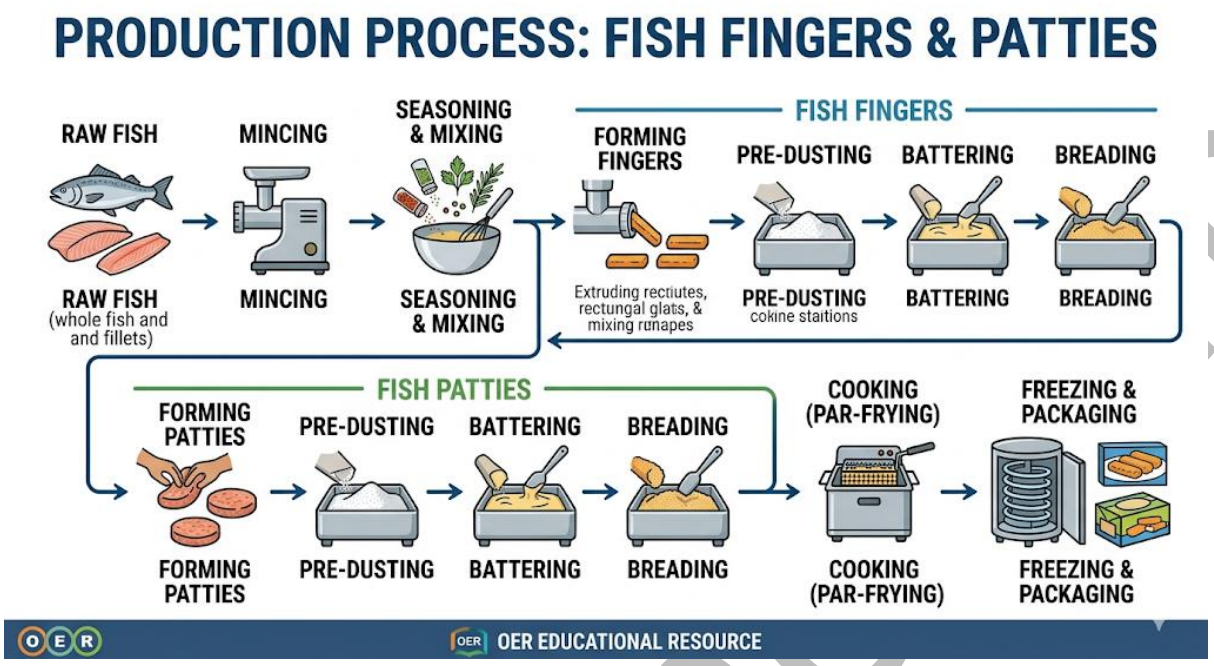


Diagram showing production steps for fish fingers and patties Figure 4.4: Production steps for fish-based convenience foods.

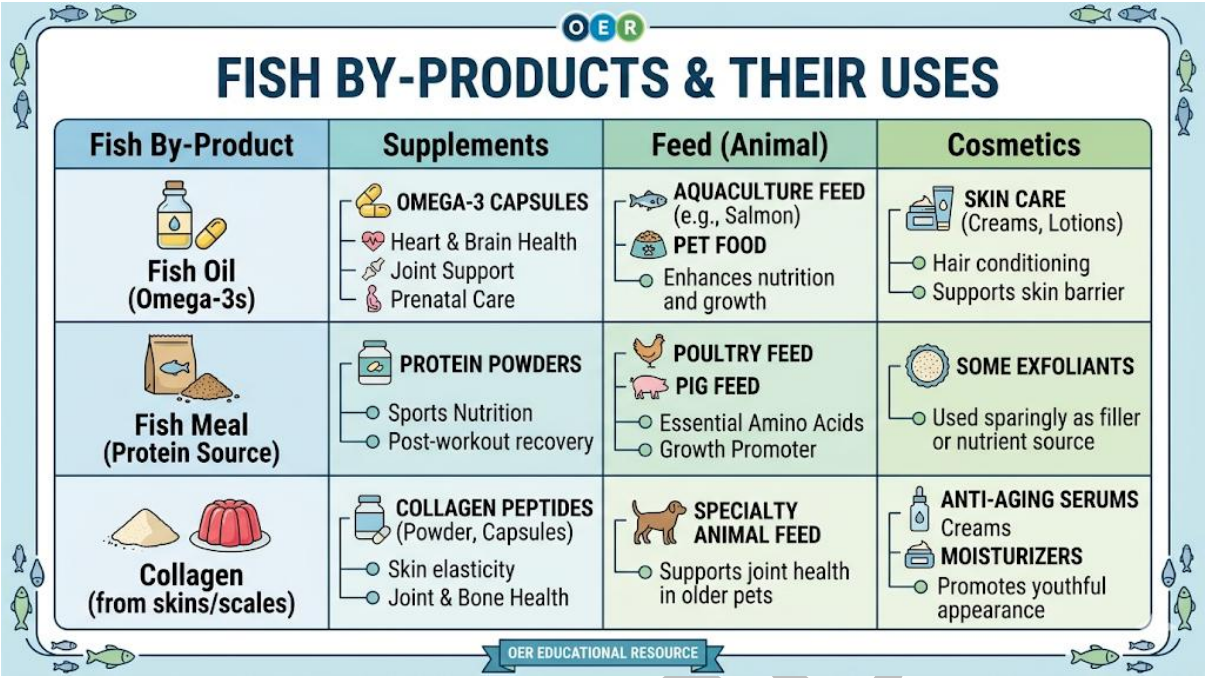
Fill in the blank: Breaded strips of fish fillet designed for easy cooking are called fish _____.

4.4.3 By-product utilisation (fish oil, fish meal, collagen)

Fish oil is extracted from fatty fish and is rich in omega-3 fatty acids. It is used in dietary supplements and pharmaceuticals.

Fish meal is produced by drying and grinding fish or fish waste. It is a high-protein feed ingredient for livestock and aquaculture.

Collagen is extracted from fish skin and scales. It is used in cosmetics, pharmaceuticals, and food products. By-product utilisation reduces waste and adds economic value to fish processing.



Box 4.3: Common by-products of fish processing and their uses Caption: Box 4.3: Common by-products of fish processing and their uses.

Fill in the blank: The high-protein feed ingredient produced from fish waste is called fish _____.

Pilot questions 4.4

1. What is surimi, and how is it used in product development?
2. How are fish fillets different from fish mince?
3. Name three examples of fish-based convenience foods.
4. What nutrient makes fish oil valuable in human diets?
5. How does by-product utilisation add value to fish processing?

4.5 Quality Assurance and Standards in Fish Products

4.5.1 Microbiological safety and spoilage organisms

Fish are highly perishable due to their high moisture content and neutral pH, which provide an ideal environment for microbial growth. **Microbiological safety** refers to the control of harmful microorganisms such as *Salmonella*, *Listeria monocytogenes*, and *Vibrio* species that can cause foodborne illness. These pathogens may contaminate fish during harvesting, handling, or processing if hygiene standards are not maintained.

Spoilage organisms, including bacteria, yeasts, and moulds, do not necessarily cause illness but degrade fish quality. They produce off-odours, slime, and discolouration, reducing consumer acceptability. Controlling spoilage requires rapid chilling, proper storage, and strict hygiene

practices. Microbiological testing is routinely performed in processing plants to ensure fish products meet safety standards before reaching consumers.

Image showing laboratory testing of fish samples for microbial safety Plate 4.5: Microbiological testing of fish products.

Fill in the blank: Microorganisms that degrade fish quality without causing illness are called _____ organisms.

4.5.2 National and international standards for fish products

Quality standards are established to ensure fish products are safe, nutritious, and acceptable to consumers. National standards are set by food safety authorities within each country, while international standards are developed by organisations such as the Codex Alimentarius Commission. These standards cover aspects such as microbial limits, chemical residues, labelling requirements, and processing practices.

Compliance with standards is essential for both domestic markets and international trade. For example, exporters must meet the requirements of importing countries, which often align with Codex guidelines. Standards also protect consumers by ensuring consistency and transparency in product quality. Producers who fail to comply may face penalties, recalls, or loss of market access.

Box 4.4: Examples of national and international fish product standards Caption: Box 4.4: Examples of national and international fish product standards.

Fill in the blank: The international body that sets food quality standards is called the Codex _____ Commission.

4.5.3 Consumer protection and traceability systems

Consumer protection ensures that fish products are safe, correctly labelled, and fairly marketed. Consumers have the right to safe food, accurate information, and protection from fraud. Labelling regulations require producers to provide details such as species name, weight, nutritional content, and expiry date. Misleading labels undermine trust and may pose health risks.

Traceability systems allow fish products to be tracked from harvest to consumer. These systems use barcodes, QR codes, or digital records to monitor product movement. Traceability ensures accountability and enables rapid recalls in case of contamination. It also supports sustainability by verifying that fish are sourced responsibly.

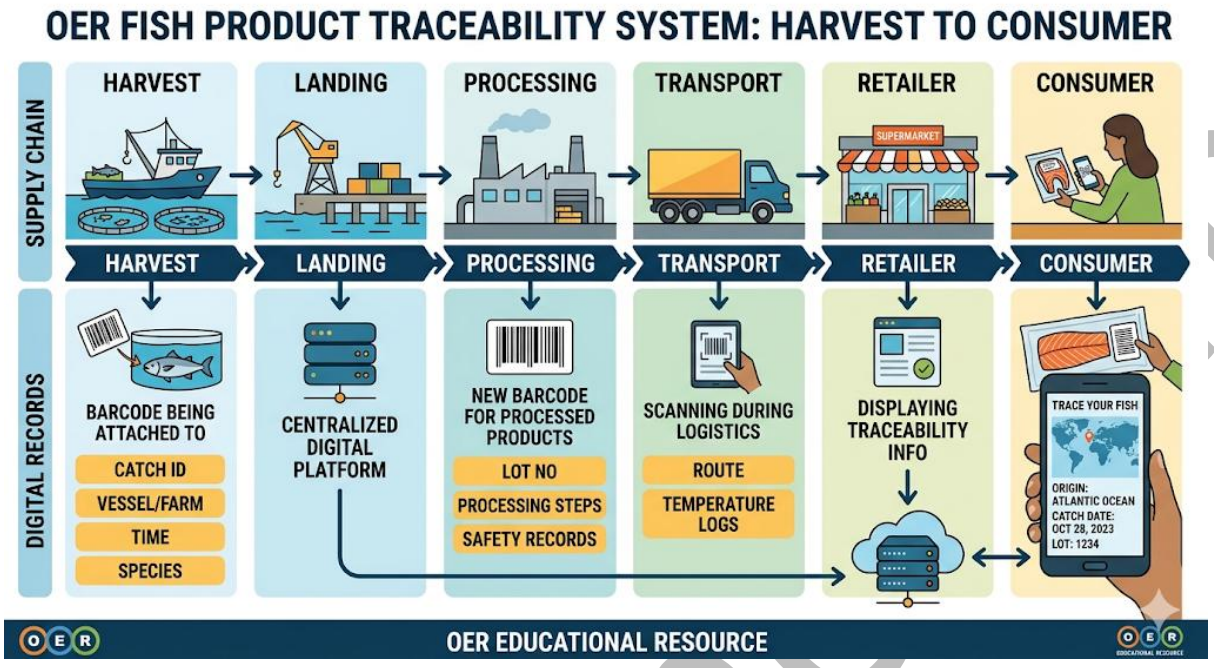


Diagram showing traceability system for fish products from harvest to consumer Figure 4.5: Traceability in fish product supply chain.

Fill in the blank: The ability to track fish products from harvest to consumer is called _____.

Pilot questions 4.5

1. What is the difference between pathogens and spoilage organisms in fish products?
2. Why are national and international standards important for fish trade?
3. What information must be included on fish product labels?
4. How do traceability systems protect consumers?
5. Name one international organisation that sets fish product standards.

Series Summary

This Series has focused on the science and technology of fish processing, highlighting the unique biological characteristics of fish and the specialised methods required to maintain quality. We began by examining the fundamentals of fish biology and composition, including anatomy, physiology, chemical composition, and post-mortem changes. We then explored handling and processing practices for fresh fish, emphasising harvesting, storage, and quality assessment. Following that, we studied preservation techniques such as chilling, freezing, salting, smoking, drying, and canning, alongside advanced methods like vacuum packaging and irradiation. We continued with fish product technology and value addition, covering fillets, surimi, convenience foods, and by-product utilisation. Finally, we concluded with quality assurance and standards, focusing on microbiological safety, national and international regulations, and consumer protection systems.

By completing this Series, you should now be able to describe fish biology and composition, explain handling and preservation methods, analyse product technologies, and evaluate quality assurance systems. These skills align with the Series Learning Outcomes and provide you with a comprehensive understanding of fish science and product technology, preparing you for both academic study and practical application in the fisheries sector.

Glossary of Terms

Autolysis: Breakdown of fish tissue by enzymes after harvest, contributing to spoilage.

Chilling: Preservation method that stores fish close to 0°C using ice or refrigeration.

Codex Alimentarius: International body that sets food quality and safety standards.

Fish fillets: Boneless pieces of fish obtained by cutting along the backbone.

Fish meal: High-protein feed ingredient produced by drying and grinding fish or fish waste.

Fish oil: Oil extracted from fatty fish, rich in omega-3 fatty acids.

Microbiological safety: Control of harmful microorganisms in fish products to prevent foodborne illness.

Myotomes: Segmented muscle fibres in fish, separated by connective tissue.

Rigor mortis: Temporary stiffening of fish muscles after harvest due to energy depletion.

Surimi: Processed fish product made from washed minced fish, used to create imitation seafood.

Traceability: Ability to track fish products from harvest to consumer, ensuring accountability and safety.

Concept Check Questions [Series 4]

Objective questions

1. What are the segmented muscle fibres in fish called? (Linked to SLO 4.1)
2. Which fatty acid makes fish oil valuable for human health? (Linked to SLO 4.4)
3. What does Codex Alimentarius set? (Linked to SLO 4.5)

Short-answer questions

4. Explain why fish are more perishable than meat. (Linked to SLO 4.1)
5. How does chilling differ from freezing in fish preservation? (Linked to SLO 4.3)
6. What is surimi, and how is it used in product development? (Linked to SLO 4.4)

Long-answer questions

7. Analyse the importance of handling and storage practices in maintaining fresh fish quality. (Linked to SLO 4.2)

8. Evaluate quality assurance and traceability systems in fish products, highlighting their role in consumer protection and international trade. (Linked to SLO 4.5)

Answers to Concept Check Questions [Series 4]

Objective questions

1. Myotomes
2. Omega-3 fatty acids
3. Food quality and safety standards

Short-answer questions

4. Fish are highly perishable due to high moisture content, neutral pH, and rapid post-mortem changes.
5. Chilling slows microbial growth at 0°C, while freezing halts microbial activity below -18°C.
6. Surimi is a processed fish product made from washed mince, used to create imitation seafood such as crab sticks.

Long-answer questions

7. *Basic response*: Proper handling and storage prevent physical damage, microbial contamination, and spoilage. Immediate washing, icing, and maintaining the cold chain are essential. *Value-added response*: Beyond basic preservation, handling and storage practices influence consumer trust, market reputation, and compliance with food safety standards. Effective systems ensure fish reach consumers in safe and acceptable condition.
8. *Basic response*: Quality assurance and traceability systems ensure fish products are safe, correctly labelled, and accountable. They protect consumers and support fair trade. *Value-added response*: International standards such as Codex Alimentarius harmonise trade, while national agencies enforce compliance. Traceability systems enable rapid recalls and verify sustainability, strengthening consumer confidence and market access.

Answers to Pilot Questions [Series 4]

Part 4.1

1. Myotomes
2. Some fish store fat in the liver, others in muscle tissue
3. High moisture content and rapid post-mortem changes
4. Omega-3 fatty acids
5. Lipid oxidation

Part 4.2

1. To remove slime, blood, and contaminants
2. Icing
3. The cold chain; it ensures safe temperatures during transport
4. Clear eyes, firm flesh, red gills
5. They provide objective data on safety and quality

Part 4.3

1. Chilling slows microbial growth, freezing halts it completely
2. By reducing water activity
3. Phenols and organic acids
4. It reduces moisture content, preventing microbial growth
5. Vacuum packaging and irradiation

Part 4.4

1. Surimi is washed minced fish used to make imitation seafood
2. Fillets are boneless cuts, mince is mechanically deboned ground flesh
3. Fish fingers, patties, nuggets
4. Omega-3 fatty acids
5. It reduces waste and adds economic value

Part 4.5

1. Pathogens cause illness, spoilage organisms reduce quality
2. They ensure compliance and facilitate trade
3. Species name, weight, nutritional content, expiry date
4. They allow rapid recalls and accountability
5. Codex Alimentarius

References and Attributions [Series 4]

- Figure 4.1: Anatomy and physiology of fish. Suggested AI prompt: “Generate a labelled diagram of fish anatomy showing muscle segments, gills, liver, and digestive tract.” Search string: “OER fish anatomy diagram muscle gills liver digestive tract.”

- Table 4.1: Protein, fat, and moisture composition in lean and fatty fish species. Suggested AI prompt: “Generate a table comparing protein, fat, and moisture percentages in cod and salmon.” Search string: “OER fish composition protein fat moisture table.”
- Plate 4.1: Post-mortem changes in fish quality. Suggested AI prompt: “Create a realistic image showing fresh fish alongside spoiled fish, highlighting colour and texture differences.” Search string: “OER fresh vs spoiled fish image post-mortem changes.”
- Plate 4.2: Proper handling of freshly harvested fish. Suggested AI prompt: “Create a realistic image showing fishermen handling freshly caught fish and storing them in ice.” Search string: “OER fish handling harvesting ice storage image.”
- Figure 4.2: Cold chain management in fish storage and transport. Suggested AI prompt: “Generate a diagram showing cold chain management from harvest to market in fish transportation.” Search string: “OER cold chain fish transportation diagram.”
- Box 4.1: Key indicators of fresh fish quality. Suggested AI prompt: “Generate an infographic showing indicators of fresh fish quality such as clear eyes, firm flesh, red gills, and mild odour.” Search string: “OER fresh fish quality indicators infographic.”
- Figure 4.3: Chilling and freezing methods in fish preservation. Suggested AI prompt: “Generate a diagram showing chilling with ice storage and freezing with blast freezer for fish preservation.” Search string: “OER chilling freezing fish preservation diagram.”
- Plate 4.3: Salting, smoking, and drying in fish preservation. Suggested AI prompt: “Create a realistic image showing salted fish, smoked fish, and dried fish strips displayed together.” Search string: “OER salted smoked dried fish preservation image.”
- Box 4.2: Advanced preservation methods in fish processing. Suggested AI prompt: “Generate an infographic showing advanced fish preservation methods such as vacuum packaging, MAP, and irradiation.” Search string: “OER advanced fish preservation methods infographic.”
- Plate 4.4: Fish fillets, surimi, and fish mince. Suggested AI prompt: “Create a realistic image showing fish fillets, surimi sticks, and fish mince products side by side.” Search string: “OER fish fillets surimi mince products image.”
- Figure 4.4: Production steps for fish-based convenience foods. Suggested AI prompt: “Generate a diagram showing production steps for fish fingers and patties, including mincing, seasoning, breading, and cooking.” Search string: “OER fish fingers patties production diagram.”
- Box 4.3: Common by-products of fish processing and their uses. Suggested AI prompt: “Generate a table listing fish oil, fish meal, and collagen with their uses in supplements, feed, and cosmetics.” Search string: “OER fish by-products oil meal collagen table.”

- Plate 4.5: Microbiological testing of fish products. Suggested AI prompt: “Create a realistic image showing laboratory technicians testing fish samples for microbial safety.” Search string: “OER microbiological testing fish products image.”
- Box 4.4: Examples of national and international fish product standards. Suggested AI prompt: “Generate a table listing Codex Alimentarius standards and national fish product standards with examples.” Search string: “OER Codex Alimentarius fish product standards table”

Course code: FST502

Course title: Meat Science & Fish Science & Technology

Course credit load: 3 units

List of Series:

21. **Science and Technology of Meat Production**
22. **Processing and Preservation of Meat Products**
23. **Quality Factors in Meat and Poultry**
24. **Fish Science and Product Technology**
25. **Egg and Poultry Product Utilisation**

5.1 Composition and Functional Properties of Eggs

- 5.1.1 Structure and chemical composition of eggs
- 5.1.2 Functional properties of egg components (foaming, emulsification, coagulation)
- 5.1.3 Nutritional value of eggs

5.2 Egg Processing and Product Development

- 5.2.1 Preservation methods for eggs (refrigeration, pasteurisation, drying)
- 5.2.2 Processed egg products (liquid eggs, powdered eggs, frozen eggs)
- 5.2.3 Industrial applications of eggs in food production

5.3 Poultry Meat Products and Utilisation

- 5.3.1 Composition and nutritional value of poultry meat
- 5.3.2 Processing of poultry meat (cut-up parts, deboning, marination)
- 5.3.3 Poultry-based convenience foods (sausages, nuggets, patties)

5.4 Preservation and Quality Assurance in Eggs and Poultry Products

- 5.4.1 Microbiological safety and spoilage organisms
- 5.4.2 Packaging, storage, and shelf life
- 5.4.3 National and international standards for eggs and poultry products

5.5 Value Addition and Consumer Protection

- 5.5.1 By-product utilisation (egg shells, poultry feathers, offal)
- 5.5.2 Labelling, traceability, and consumer rights
- 5.5.3 Role of regulatory agencies in safeguarding quality

Introduction

Eggs and poultry products are among the most versatile and widely consumed foods globally, valued for their nutritional richness, functional properties, and adaptability in diverse culinary and industrial applications. Unlike other animal products, eggs possess unique characteristics such as foaming, emulsification, and coagulation, which make them indispensable in food processing. Poultry meat, on the other hand, is a lean source of protein that lends itself to a wide range of processed and convenience products. This Series introduces you to the science and technology behind the utilisation of eggs and poultry, highlighting their composition, processing, preservation, and value addition.

The aim of this Series is to equip you with the knowledge and skills to describe the composition and functional properties of eggs, explain methods of processing and product development, analyse poultry meat utilisation, and evaluate preservation, quality assurance, and consumer protection practices.

We shall commence this Series by examining the composition and functional properties of eggs, including their structure, chemical composition, and nutritional value. Next, we will explore egg processing and product development, focusing on preservation methods and industrial applications. Following that, we will study poultry meat products and utilisation, considering composition, processing, and convenience foods. Afterwards, we will move on to preservation and quality assurance in eggs and poultry products, highlighting microbiological safety, packaging, and standards. Finally, we will conclude with value addition and consumer protection, including by-product utilisation, labelling, and the role of regulatory agencies.

Series Learning Outcomes

Upon completing this Series, you should be able to:

- **SLO 5.1** describe the structure, chemical composition, and functional properties of eggs,
- **SLO 5.2** explain methods of egg processing and product development, including preservation and industrial applications,
- **SLO 5.3** analyse poultry meat composition, processing techniques, and convenience product development,
- **SLO 5.4** evaluate preservation methods and quality assurance systems in eggs and poultry products, and
- **SLO 5.5** apply knowledge of value addition, by-product utilisation, and consumer protection measures in egg and poultry product utilisation.

5.1 Composition and Functional Properties of Eggs

5.1.1 Structure and chemical composition of eggs

Eggs are composed of three main parts: the **shell**, the **albumen** (egg white), and the **yolk**. The shell, made primarily of calcium carbonate, provides protection and allows gas exchange through its pores. The albumen is rich in proteins such as ovalbumin and conalbumin, which contribute to foaming and coagulation properties. The yolk contains lipids, proteins, vitamins, and minerals, making it the most nutrient-dense part of the egg.

Chemically, eggs are approximately 12 percent protein, 11 percent fat, and 74 percent water, with small amounts of carbohydrates and minerals. The balance of these components makes eggs highly versatile in food systems.

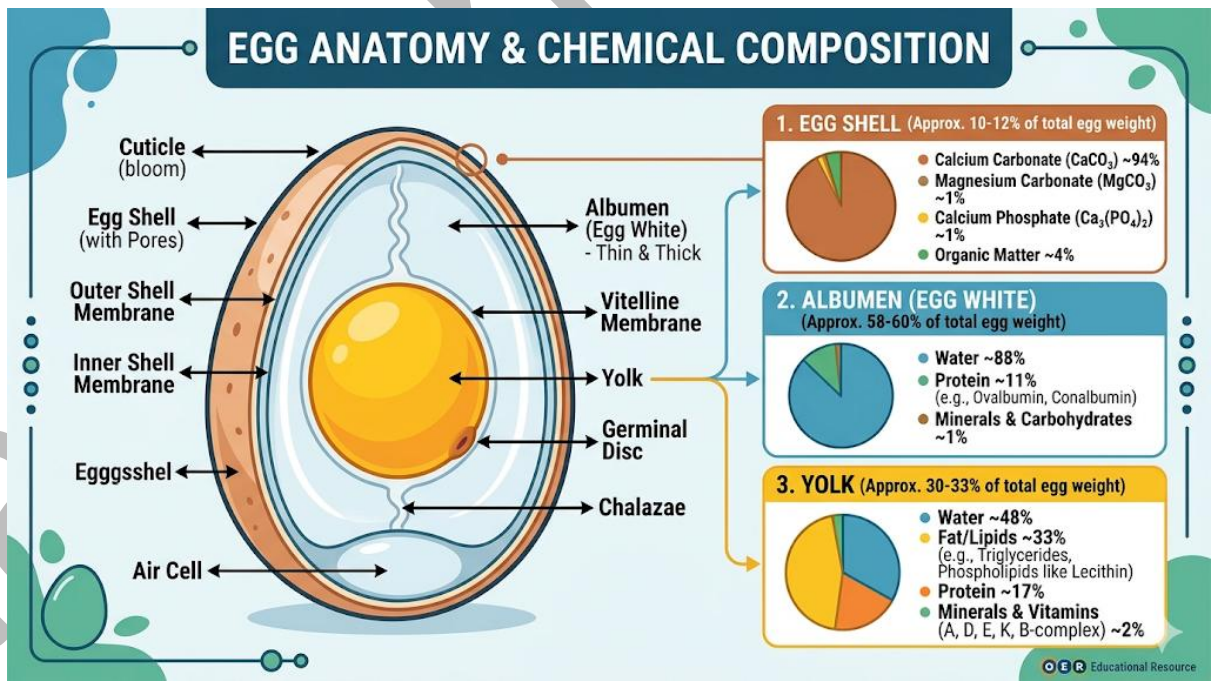


Diagram showing the structure of an egg (shell, albumen, yolk) Figure 5.1: Structure and chemical composition of an egg.

Fill in the blank: The nutrient-dense part of the egg that contains lipids and proteins is the _____.

5.1.2 Functional properties of egg components (foaming, emulsification, coagulation)

Eggs possess unique **functional properties** that make them indispensable in food preparation and processing. **Foaming** occurs when egg whites are beaten, incorporating air and forming a stable foam used in products like meringues and soufflés. Proteins in the albumen stabilise the foam by forming a network around air bubbles.

Emulsification is the ability of egg yolk to stabilise mixtures of oil and water. This is due to lecithin, a phospholipid present in yolk, which acts as an emulsifier. Mayonnaise and salad dressings rely on this property.

Coagulation refers to the thickening or solidifying of egg proteins when heated. This property is essential in custards, cakes, and other baked goods, where eggs provide structure and stability.

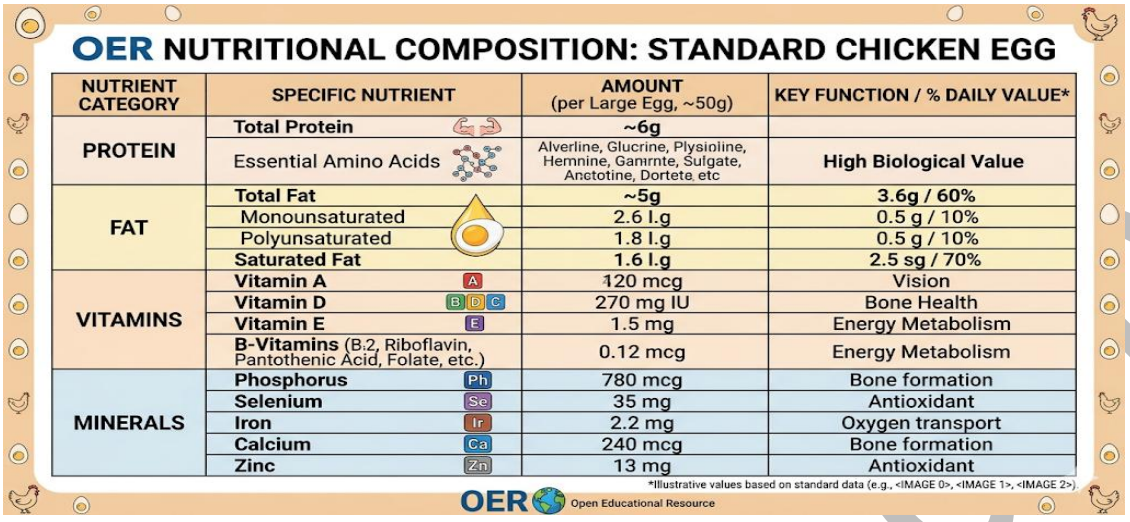
Image showing examples of egg foaming (meringue), emulsification (mayonnaise), and coagulation (custard) Plate 5.1: Functional properties of eggs in food preparation.

Fill in the blank: The phospholipid in egg yolk responsible for emulsification is called _____.

5.1.3 Nutritional value of eggs

Eggs are considered a complete protein source, containing all essential amino acids required by the human body. They are rich in vitamins such as A, D, E, and B-complex, and minerals including iron, phosphorus, and selenium. The yolk provides fat-soluble vitamins and essential fatty acids, while the albumen contributes high-quality protein with minimal fat.

Eggs are also affordable and widely available, making them an important food for combating malnutrition. Their nutritional profile supports growth, immune function, and energy metabolism.



OER NUTRITIONAL COMPOSITION: STANDARD CHICKEN EGG

NUTRIENT CATEGORY	SPECIFIC NUTRIENT	AMOUNT (per Large Egg, ~50g)	KEY FUNCTION / % DAILY VALUE*
PROTEIN	Total Protein	~6g	
	Essential Amino Acids	Alverline, Glucrine, Plysioline, Hemnine, Ganrrnte, Sulgate, Anctotine, Dortete etc	High Biological Value
FAT	Total Fat	~5g	3.6g / 60%
	Monounsaturated	2.6 l.g	0.5 g / 10%
	Polyunsaturated	1.8 l.g	0.5 g / 10%
	Saturated Fat	1.6 l.g	2.5 sg / 70%
VITAMINS	Vitamin A	120 mcg	Vision
	Vitamin D	270 mg IU	Bone Health
	Vitamin E	1.5 mg	Energy Metabolism
	B-Vitamins (B_12, Riboflavin, Pantothenic Acid, Folate, etc.)	0.12 mcg	Energy Metabolism
MINERALS	Phosphorus	780 mcg	Bone formation
	Selenium	35 mg	Antioxidant
	Iron	2.2 mg	Oxygen transport
	Calcium	240 mcg	Bone formation
	Zinc	13 mg	Antioxidant

*Illustrative values based on standard data (e.g., <IMAGE 0>, <IMAGE 1>, <IMAGE 2>)

OER Open Educational Resource

Table 5.1: Nutritional composition of a standard chicken egg Caption: Table 5.1: Nutritional composition of a standard chicken egg.

Fill in the blank: Eggs are considered a complete source of _____ because they contain all essential amino acids.

Pilot questions 5.1

1. What are the three main parts of an egg?
2. Which protein in egg white stabilises foam?
3. What phospholipid in egg yolk acts as an emulsifier?
4. Why are eggs considered a complete protein source?
5. Name two vitamins found in egg yolk.

5.2 Egg Processing and Product Development

5.2.1 Preservation methods for eggs (refrigeration, pasteurisation, drying)

Eggs are highly perishable and require preservation to extend shelf life. **Refrigeration** slows microbial growth and enzymatic activity, keeping eggs fresh for several weeks.

Pasteurisation involves heating eggs to destroy pathogens such as *Salmonella* without cooking them. Pasteurised eggs are used in products where raw eggs are required, such as mayonnaise.

Drying converts eggs into powdered form, reducing moisture and preventing microbial growth. Dried eggs are lightweight, easy to transport, and have a long shelf life, making them useful in industrial food production.

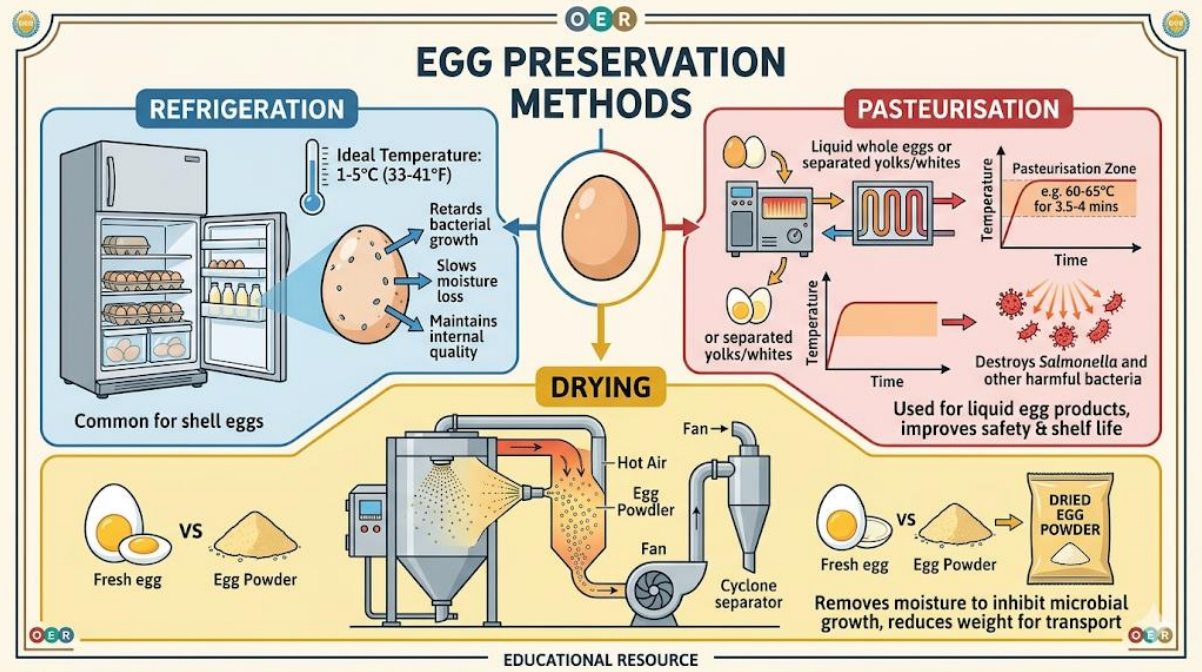


Diagram showing preservation methods for eggs (refrigeration, pasteurisation, drying) Figure 5.2: Preservation methods for eggs.

Fill in the blank: The preservation method that heats eggs to destroy pathogens without cooking them is called _____.

5.2.2 Processed egg products (liquid eggs, powdered eggs, frozen eggs)

Liquid eggs are pasteurised and packaged for use in bakeries, restaurants, and food industries. They save time and reduce contamination risks.

Powdered eggs are produced by spray-drying liquid eggs. They are convenient, have a long shelf life, and are widely used in baking and confectionery.

Frozen eggs are stored at sub-zero temperatures, maintaining quality for extended periods. They are often used in large-scale food production where fresh eggs are impractical.

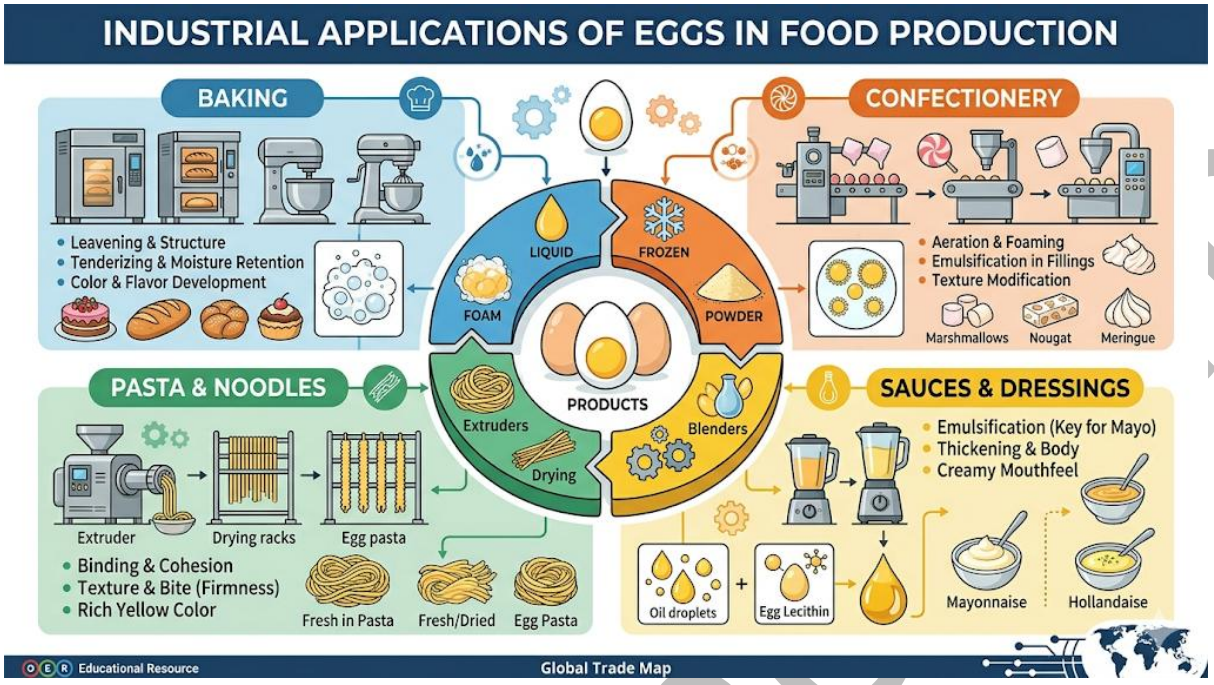
Image showing liquid eggs in cartons, powdered eggs in packets, and frozen eggs in containers
Plate 5.2: Processed egg products.

Fill in the blank: Eggs converted into powdered form by spray-drying are called _____ eggs.

5.2.3 Industrial applications of eggs in food production

Eggs are widely used in the food industry due to their functional properties. In baking, eggs provide structure, moisture, and flavour. In confectionery, they contribute to aeration and texture. In processed foods, eggs act as binders, emulsifiers, and stabilisers.

Industrial applications also include pasta production, where eggs improve texture and colour, and sauces, where they stabilise emulsions. The versatility of eggs makes them indispensable in both traditional and modern food systems.



Box 5.1: Industrial applications of eggs in food production Caption: Box 5.1: Industrial applications of eggs in food production.

Fill in the blank: In pasta production, eggs improve both texture and _____.

Pilot questions 5.2

1. What preservation method is used to destroy pathogens in eggs without cooking them?
2. How are powdered eggs produced?
3. Name three types of processed egg products.
4. Why are eggs important in baking?
5. Give one industrial application of eggs outside baking.

5.3 Poultry Meat Products and Utilisation

5.3.1 Composition and nutritional value of poultry meat

Poultry meat is widely consumed due to its affordability, versatility, and nutritional benefits. The **composition** of poultry meat includes approximately 20 percent protein, 5–10 percent fat (depending on the cut and species), and 70–75 percent water. It is considered a lean source of protein compared to red meat, particularly when skin is removed.

Nutritionally, poultry meat provides essential amino acids, B vitamins (especially niacin and B6), and minerals such as phosphorus, selenium, and zinc. Its relatively low fat content makes it suitable for health-conscious diets, while its high protein supports growth and tissue repair.

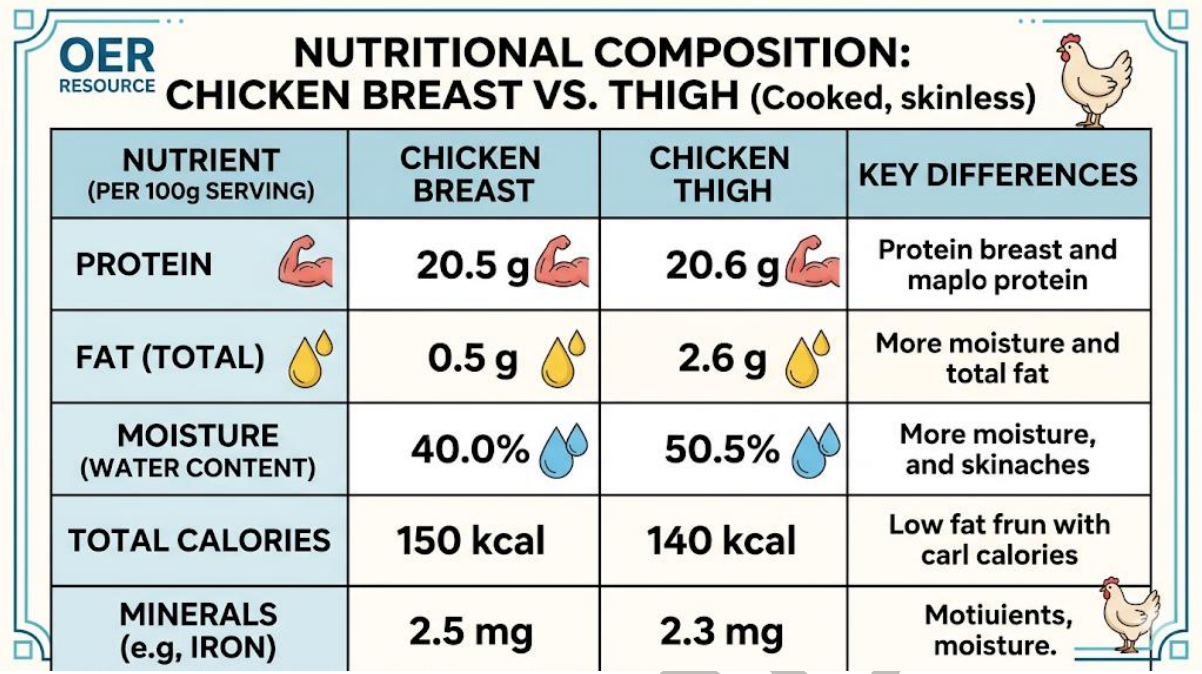


Table 5.2: Nutritional composition of chicken breast vs chicken thigh Caption: Table 5.2: Nutritional composition of chicken breast and thigh meat.

Fill in the blank: Poultry meat is considered a lean source of _____ compared to red meat.

5.3.2 Processing of poultry meat (cut-up parts, deboning, marination)

Processing poultry meat involves several steps to prepare it for consumption and product development. **Cut-up parts** include whole chicken, drumsticks, wings, thighs, and breasts, which are packaged and sold separately to meet consumer preferences.

Deboning removes bones from meat, producing boneless cuts that are convenient for cooking and widely used in processed products. Mechanical deboning is often employed in large-scale operations, though manual deboning ensures higher precision.

Marination enhances flavour, tenderness, and juiciness. Marinades typically include salt, spices, acids (such as lemon juice), and sometimes enzymes. Marination also improves shelf life by reducing microbial growth.

Image showing poultry cut-up parts, deboned chicken fillets, and marinated chicken pieces Plate 5.3: Processing of poultry meat.

Fill in the blank: The process of removing bones from poultry meat is called _____.

5.3.3 Poultry-based convenience foods (sausages, nuggets, patties)

Poultry meat is widely used in the production of **convenience foods**, which are ready-to-cook or ready-to-eat products. **Sausages** are made from ground poultry meat mixed with spices and fillers, then encased and cooked.

Nuggets are small, breaded pieces of poultry, often made from minced meat or mechanically deboned meat. They are popular in fast food outlets and among children.

Patties are formed from ground poultry meat mixed with seasonings and binders, then shaped and cooked. They are used in burgers and sandwiches. Convenience foods add value by increasing consumer appeal and marketability.

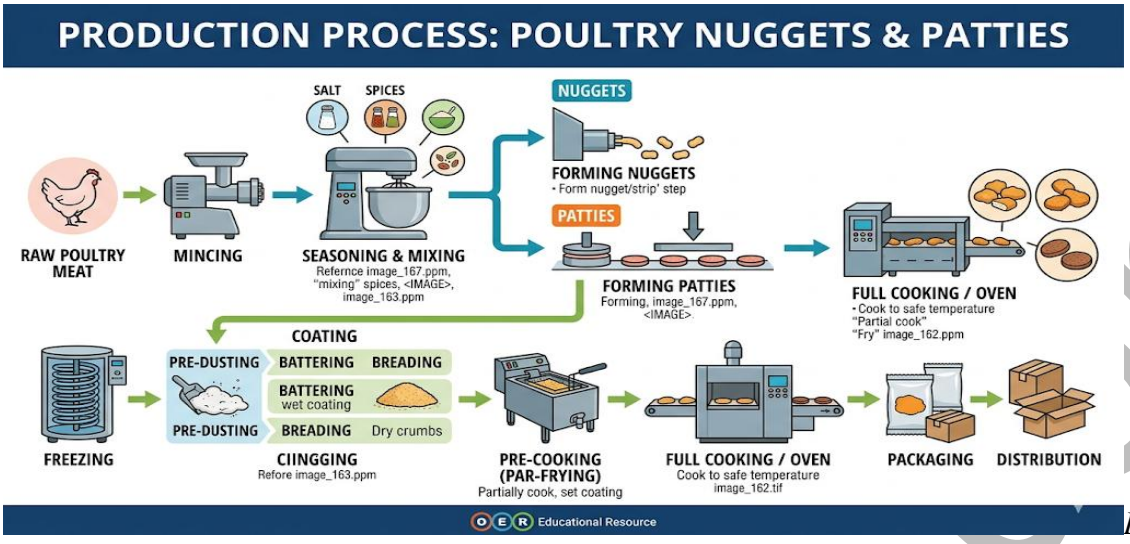


Diagram showing production steps for poultry nuggets and patties Figure 5.3: Production steps for poultry-based convenience foods.

Fill in the blank: Breaded pieces of poultry meat shaped into small portions are called _____.

Pilot questions 5.3

1. What makes poultry meat a lean protein source?
2. Name three common cut-up parts of poultry.
3. What is marination, and why is it important?
4. Give two examples of poultry-based convenience foods.
5. What nutrients are abundant in poultry meat?

5.4 Preservation and Quality Assurance in Eggs and Poultry Products

5.4.1 Microbiological safety and spoilage organisms

Eggs and poultry products are highly perishable and prone to contamination by **pathogens** such as *Salmonella*, *Campylobacter*, and *Listeria monocytogenes*. These microorganisms can cause foodborne illness if products are not handled or cooked properly.

Spoilage organisms, including bacteria and moulds, degrade product quality by producing off-odours, slime, and discolouration. Controlling spoilage requires refrigeration, hygienic handling, and proper packaging. Microbiological testing is essential to ensure products meet safety standards before reaching consumers.

Image showing laboratory testing of eggs and poultry samples for microbial safety Plate 5.4: Microbiological testing of eggs and poultry products.

Fill in the blank: The microorganism commonly associated with foodborne illness in eggs is _____.

5.4.2 Packaging, storage, and shelf life

Packaging protects eggs and poultry products from contamination and physical damage. For eggs, cartons made of paper or plastic provide cushioning and prevent breakage. Poultry products are often vacuum-packed or stored in modified atmosphere packaging to extend shelf life.

Storage involves maintaining products at low temperatures. Eggs are best stored at 4–7°C, while poultry meat requires refrigeration or freezing to prevent microbial growth. Shelf life varies depending on storage conditions, with fresh eggs lasting several weeks under refrigeration and poultry meat lasting only a few days unless frozen.

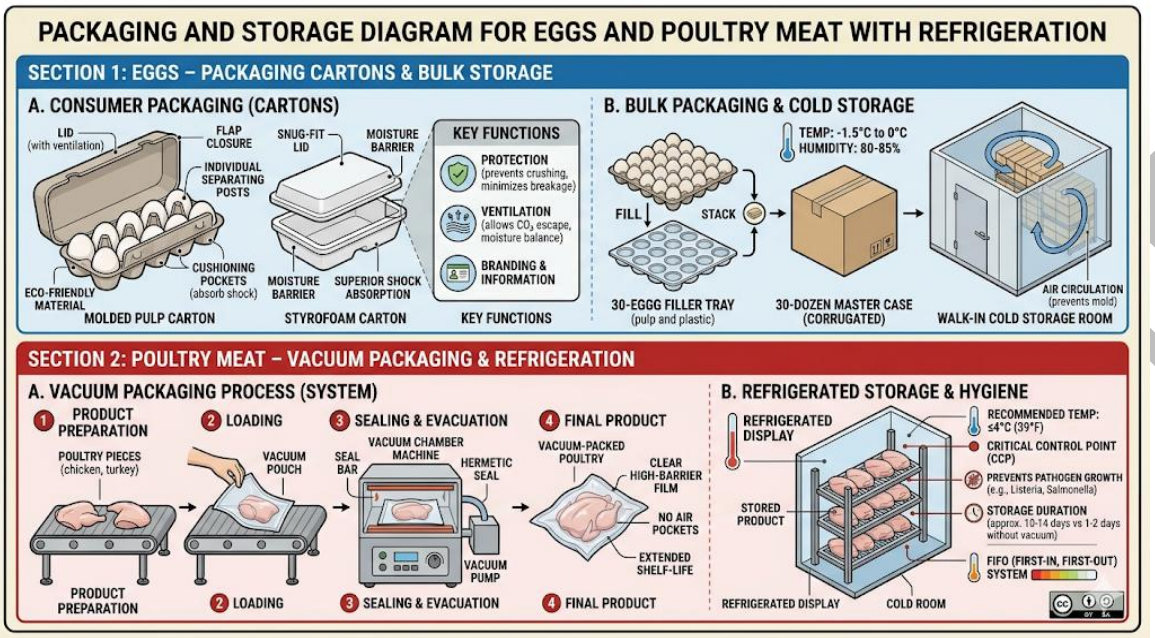


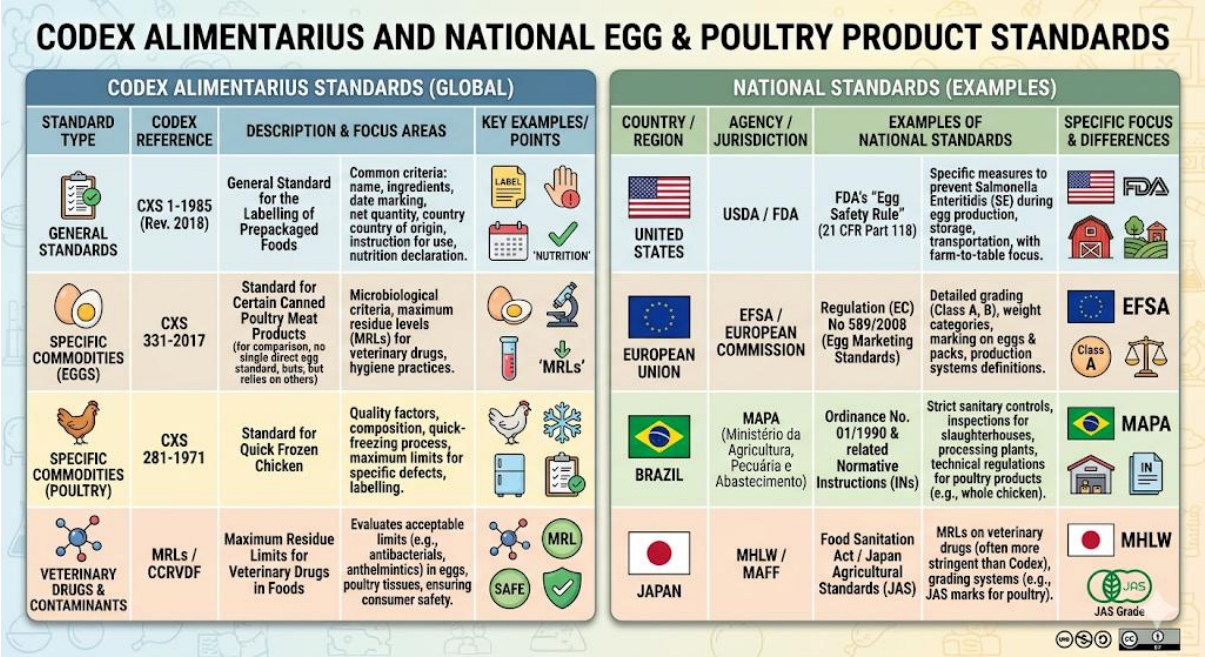
Diagram showing packaging and storage methods for eggs and poultry products Figure 5.4: Packaging and storage methods for eggs and poultry products.

Fill in the blank: Poultry meat stored at low temperatures has a shelf life of only a few _____ unless frozen.

5.4.3 National and international standards for eggs and poultry products

Quality standards are established by national food safety authorities and international organisations such as the Codex Alimentarius Commission. These standards specify acceptable microbial limits, hygiene practices, labelling requirements, and processing methods.

Compliance with standards ensures consumer safety and facilitates international trade. For example, exporters must meet importing countries' requirements, which often align with Codex guidelines. Producers who fail to comply may face penalties, recalls, or loss of market access.



Box 5.2: Examples of national and international standards for eggs and poultry products
Caption: Box 5.2: Examples of national and international standards for eggs and poultry products.

Fill in the blank: The international body that sets food quality standards is called the Codex _____ Commission.

Pilot questions 5.4

1. Name two pathogens commonly associated with eggs and poultry products.
2. Why is packaging important for eggs and poultry?
3. What is the recommended storage temperature for eggs?
4. How long can fresh poultry meat last under refrigeration?
5. Which international organisation sets food quality standards?

5.5 Value Addition and Consumer Protection

5.5.1 By-product utilisation (egg shells, poultry feathers, offal)

By-products from eggs and poultry processing can be transformed into valuable resources rather than discarded as waste. **Egg shells**, composed mainly of calcium carbonate, are used in animal feed supplements, fertilisers, and even biomedical applications such as bone graft substitutes.

Poultry feathers are rich in keratin, a tough protein that can be processed into animal feed, biodegradable plastics, and insulation materials. They are also used in the textile industry for feather-based products.

Offal, which includes internal organs and other non-meat parts, can be processed into pet food, animal feed, or rendered into valuable products such as poultry meal. By-product utilisation reduces waste, adds economic value, and supports sustainability in the poultry industry.

Image showing egg shells, poultry feathers, and offal being processed into useful products Plate 5.5: By-product utilisation in eggs and poultry.

Fill in the blank: Poultry feathers are rich in the tough protein called _____.

5.5.2 Labelling, traceability, and consumer rights

Labelling provides consumers with essential information such as product type, nutritional content, expiry date, and storage instructions. Accurate labelling ensures transparency and helps consumers make informed choices. Misleading or incomplete labels undermine trust and may pose health risks.

Traceability refers to the ability to track eggs and poultry products from farm to table. This system ensures accountability and allows rapid recalls in case of contamination. Traceability often uses barcodes, QR codes, or digital records to monitor product movement.

Consumer rights include the right to safe food, accurate information, and protection from fraud. Upholding these rights is central to consumer protection, and producers must comply with regulations to safeguard public health.

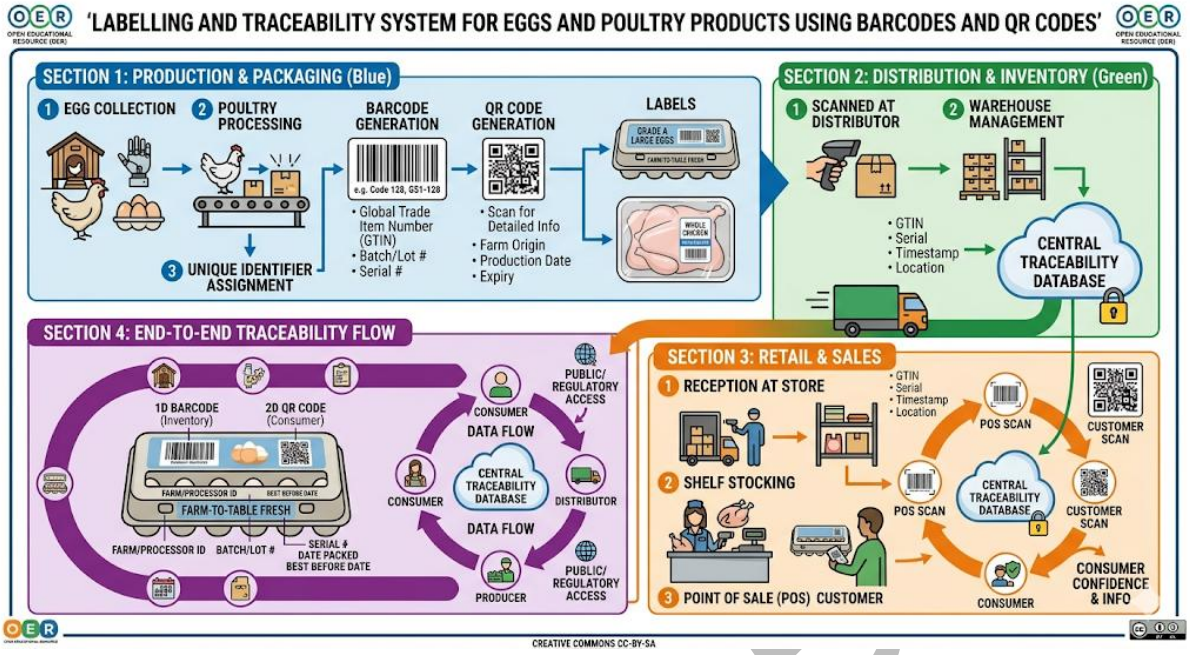


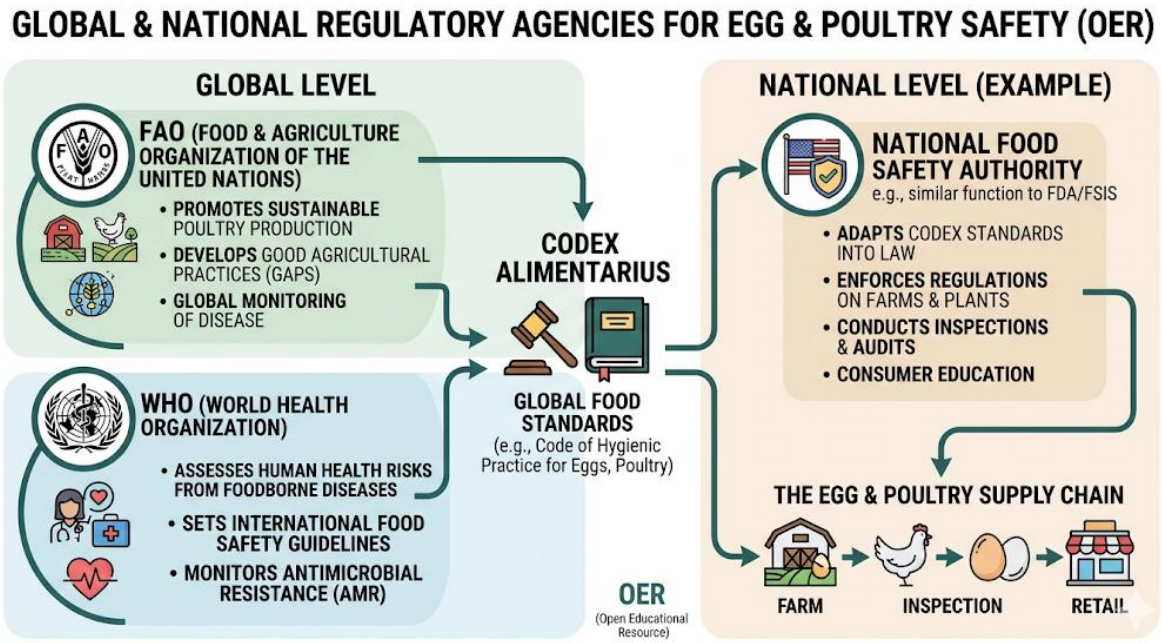
Diagram showing labelling and traceability system for eggs and poultry products Figure 5.5: Labelling and traceability in eggs and poultry products.

Fill in the blank: The ability to track eggs and poultry products from farm to consumer is called _____.

5.5.3 Role of regulatory agencies in safeguarding quality

Regulatory agencies oversee the safety and quality of eggs and poultry products. They establish standards, conduct inspections, and enforce compliance. Examples include national food safety authorities and international organisations such as the Food and Agriculture Organization (FAO) and the World Health Organization (WHO).

These agencies ensure that eggs and poultry products are safe, correctly labelled, and fairly marketed. They also protect consumers by responding to food safety incidents, issuing recalls, and penalising non-compliant producers. Their role is critical in maintaining public trust and supporting international trade.



Box 5.3: Regulatory agencies and their role in egg and poultry product safety Caption: Box 5.3: Regulatory agencies and their role in egg and poultry product safety.

Fill in the blank: The international organisation that works with governments to ensure food safety and consumer protection is the _____.

Pilot questions 5.5

1. Name three by-products of eggs and poultry and their uses.
2. Why is labelling important for consumer protection?
3. What is traceability, and how does it benefit consumers?
4. Which consumer rights are protected by food regulations?
5. Name one international regulatory agency involved in food safety.

Series Summary

This Series has explored the utilisation of eggs and poultry products, focusing on their composition, processing, preservation, and value addition. We began by examining the structure, chemical composition, and functional properties of eggs, highlighting their unique roles in foaming, emulsification, and coagulation. We then studied egg processing and product development, including preservation methods such as refrigeration, pasteurisation, and drying, as well as processed products like liquid, powdered, and frozen eggs. Following that, we analysed poultry meat products and utilisation, covering composition, processing techniques, and convenience foods such as sausages, nuggets, and patties. We continued with preservation and quality assurance, emphasising microbiological safety, packaging, storage, and compliance with

national and international standards. Finally, we concluded with value addition and consumer protection, focusing on by-product utilisation, labelling, traceability, and the role of regulatory agencies.

By completing this Series, you should now be able to describe egg composition and functional properties, explain egg processing methods, analyse poultry meat utilisation, evaluate preservation and quality assurance systems, and apply knowledge of value addition and consumer protection. These skills align with the Series Learning Outcomes and provide a comprehensive understanding of egg and poultry product utilisation.

Glossary of Terms

Albumen: The egg white, rich in proteins such as ovalbumin, responsible for foaming and coagulation.

By-product utilisation: The process of converting waste materials such as egg shells, feathers, and offal into valuable products.

Coagulation: The thickening or solidifying of egg proteins when heated, providing structure in food systems.

Consumer rights: The entitlements of consumers to safe food, accurate information, and protection from fraud.

Deboning: The process of removing bones from poultry meat to produce boneless cuts.

Emulsification: The ability of egg yolk, due to lecithin, to stabilise mixtures of oil and water.

Foaming: The incorporation of air into egg whites during beating, forming a stable foam.

Marination: The process of soaking poultry meat in a mixture of salt, spices, and acids to enhance flavour and tenderness.

Pasteurisation: Heating eggs to destroy pathogens without cooking them.

Traceability: The ability to track eggs and poultry products from farm to consumer, ensuring accountability and safety.

Concept Check Questions [Series 5]

Objective questions

1. What protein in egg white stabilises foam? (Linked to SLO 5.1)
2. What phospholipid in egg yolk acts as an emulsifier? (Linked to SLO 5.1)
3. What preservation method heats eggs to destroy pathogens without cooking them? (Linked to SLO 5.2)

Short-answer questions

4. Explain why poultry meat is considered a lean protein source. (Linked to SLO 5.3)

5. What is marination, and how does it improve poultry meat quality? (Linked to SLO 5.3)
6. Why is labelling important for consumer protection in eggs and poultry products? (Linked to SLO 5.5)

Long-answer questions

7. Analyse the importance of egg functional properties in food processing, with examples of foaming, emulsification, and coagulation. (Linked to SLO 5.1 & 5.2)
8. Evaluate preservation and quality assurance systems in eggs and poultry products, highlighting microbiological safety, packaging, and international standards. (Linked to SLO 5.4 & 5.5)

Answers to Concept Check Questions [Series 5]

Objective questions

1. Ovalbumin
2. Lecithin
3. Pasteurisation

Short-answer questions

4. Poultry meat has lower fat content compared to red meat, especially when skin is removed, making it a lean protein source.
5. Marination involves soaking poultry meat in salt, spices, and acids, which enhances flavour, tenderness, and juiciness while reducing microbial growth.
6. Labelling provides consumers with accurate information about product type, nutritional content, and expiry date, ensuring transparency and protecting consumer rights.

Long-answer questions

7. *Basic response*: Egg functional properties such as foaming, emulsification, and coagulation are essential in food processing. Foaming stabilises air bubbles in meringues, emulsification stabilises oil-water mixtures in mayonnaise, and coagulation provides structure in custards. *Value-added response*: These properties make eggs indispensable in industrial applications, supporting product development in baking, confectionery, sauces, and pasta production. Their multifunctional role enhances both sensory qualities and product stability.
8. *Basic response*: Preservation and quality assurance systems ensure eggs and poultry products remain safe and acceptable. Refrigeration, packaging, and microbiological testing are key practices. *Value-added response*: International standards such as Codex Alimentarius harmonise trade, while national agencies enforce compliance. Together, these systems protect consumers, support sustainability, and maintain market access.

Answers to Pilot Questions [Series 5]

Part 5.1

1. Shell, albumen, yolk
2. Ovalbumin
3. Lecithin
4. They contain all essential amino acids
5. Vitamins A and D

Part 5.2

1. Pasteurisation
2. Spray-drying
3. Liquid eggs, powdered eggs, frozen eggs
4. They provide structure, moisture, and flavour
5. Pasta production

Part 5.3

1. Lower fat content compared to red meat
2. Drumsticks, wings, thighs
3. Soaking meat in salt, spices, and acids to enhance flavour and tenderness
4. Sausages, nuggets
5. B vitamins and selenium

Part 5.4

1. Salmonella and Campylobacter
2. It protects products from contamination and damage
3. 4–7°C
4. A few days
5. Codex Alimentarius

Part 5.5

1. Egg shells (fertiliser), feathers (biodegradable plastics), offal (pet food)
2. It ensures transparency and accurate information

3. Tracking products from farm to consumer, enabling recalls
4. Safe food, accurate information
5. FAO or WHO

References and Attributions [Series 5]

- Figure 5.1: Structure and chemical composition of an egg. Suggested AI prompt: "Generate a labelled diagram showing egg shell, albumen, and yolk with their chemical composition." Search string: "OER egg structure diagram shell albumen yolk composition."
- Plate 5.1: Functional properties of eggs in food preparation. Suggested AI prompt: "Create a realistic image showing meringue, mayonnaise, and custard as examples of egg foaming, emulsification, and coagulation." Search string: "OER egg foaming emulsification coagulation food examples image."
- Table 5.1: Nutritional composition of a standard chicken egg. Suggested AI prompt: "Generate a table showing protein, fat, vitamins, and minerals in a standard chicken egg." Search string: "OER nutritional composition chicken egg table."
- Figure 5.2: Preservation methods for eggs. Suggested AI prompt: "Generate a diagram showing refrigeration, pasteurisation, and drying as egg preservation methods." Search string: "OER egg preservation methods diagram refrigeration pasteurisation drying."
- Plate 5.2: Processed egg products. Suggested AI prompt: "Create a realistic image showing liquid eggs in cartons, powdered eggs in packets, and frozen eggs in containers." Search string: "OER processed egg products liquid powdered frozen image."
- Box 5.1: Industrial applications of eggs in food production. Suggested AI prompt: "Generate an infographic showing industrial applications of eggs in baking, confectionery, pasta, and sauces." Search string: "OER industrial applications eggs food production infographic."
- Table 5.2: Nutritional composition of chicken breast and thigh meat. Suggested AI prompt: "Generate a table comparing protein, fat, and moisture content in chicken breast and chicken thigh." Search string: "OER chicken breast thigh nutritional composition table."
- Plate 5.3: Processing of poultry meat. Suggested AI prompt: "Create a realistic image showing poultry cut-up parts, deboned fillets, and marinated chicken pieces." Search string: "OER poultry meat processing cut-up deboning marination image."
- Figure 5.3: Production steps for poultry-based convenience foods. Suggested AI prompt: "Generate a diagram showing production steps for poultry nuggets and patties, including mincing, seasoning, breading, and cooking." Search string: "OER poultry nuggets patties production diagram."
- Plate 5.4: Microbiological testing of eggs and poultry products. Suggested AI prompt: "Create a realistic image showing laboratory technicians testing eggs and poultry samples

for microbial safety." Search string: "OER microbiological testing eggs poultry products image."

- Figure 5.4: Packaging and storage methods for eggs and poultry products. Suggested AI prompt: "Generate a diagram showing packaging cartons for eggs and vacuum packaging for poultry meat with refrigeration." Search string: "OER packaging storage eggs poultry diagram."
- Box 5.2: Examples of national and international standards for eggs and poultry products. Suggested AI prompt: "Generate a table listing Codex Alimentarius standards and national egg and poultry product standards with examples." Search string: "OER Codex Alimentarius egg poultry product standards table."
- Plate 5.5: By-product utilisation in eggs and poultry. Suggested AI prompt: "Create a realistic image showing egg shells processed into fertiliser, poultry feathers into insulation, and offal into pet food." Search string: "OER egg poultry by-product utilisation image"