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Ministry of Education, Science and Technology
Curriculum Development Centre
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Introduction to Meat Science

12

**Technical and Vocational Stream
Learning Resource Materials**

**Meat Science
(Grade 12)**

**Secondary Level
Animal Science**



Government of Nepal
Ministry of Education, Science and Technology
Curriculum Development Centre
Sanothimi, Bhaktapur

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Preface

The curriculum and curricular materials have been developed and revised on a regular basis with the aim of making education objective-oriented, practical, relevant and job oriented. It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in students and equip them with morality, discipline and self-reliance, creativity and thoughtfulness. It is essential to develop in them the linguistic and mathematical skills, knowledge of science, information and communication technology, environment, health and population and life skills. It is also necessary to bring in them the feeling of preserving and promoting arts and aesthetics, humanistic norms, values and ideals. It has become the need of the present time to make them aware of respect for ethnicity, gender, disabilities, languages, religions, cultures, regional diversity, human rights and social values so as to make them capable of playing the role of responsible citizens with applied technical and vocational knowledge and skills. This Learning Resource Material for Animal Science has been developed in line with the Secondary Level Animal Science Curriculum with an aim to facilitate the students in their study and learning on the subject by incorporating the recommendations and feedback obtained from various schools, workshops and seminars, interaction programs attended by teachers, students and parents.

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Dr. Lekhnath Poudel, Prof. Dr. D.K. Singh, Dr. Shambhu Sah, Dr. Yam Bahadur Gurung, Dr. Ganesh Gautam, Dr Kiran Pokharel, Dr. Navaraj Shrestha, Dr. Hari prasad panta, Dr. Asma Lamichhane, Dr. Bhumika Paudel, Dr. Garima Thapa is highly acknowledged. The book is written by Dr. Binod Kumar Yadav and the subject matter of the book was edited by Badrinath Timsina and Khilanath Dhamala. CDC extends sincere thanks to all those who have contributed in developing this book in this form.

This book is a supplementary learning resource material for students and teachers. In addition they have to make use of other relevant materials to ensure all the learning outcomes set in the curriculum. The teachers, students and all other stakeholders are expected to make constructive comments and suggestions to make it a more useful learning resource material.

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Unit: 1

Introduction

Objectives

- To know about the meat science.
- To know the situation, scope and problem of meat sector.

Introduction

Meat science is a broad field of study. An important part of which is the basic study of the unique characteristic of muscles and the other animal tissues that are used as a meat. It also includes all facets of the meat industry beginning with animal production and ending with final preparation for consumption.

Science is the development of new product and improvement of old one is a science. Meat is a flesh and organ of animals and fowls which are suitable for use as food. It is normally regarded as the edible part (muscles & offal) of the food animals. There are various legal definitions of meat in different countries designed to control the composition of products made with meat.

The flesh of cattle, buffaloes, pigs, and sheep is distinguished from that of poultry by the term red meat, while the flesh of poultry (chicken, turkey, duck, pigeon, guinea fowl, ostrich) is termed as white meat.

1.1 Situation of meat sector in Nepal

- Meat is highly income elastic product. Increasing population and urbanization (by 2021, urban population will be 26 % or 9 millions from nearly 5 million at present) led to high demand for meat.
- Annual consumption is increasing at about 3.87 percent (NLSS 1995/96 and 2003/04)
- 14 % of the total demand or nearly 17 % of the total national production is imported to meet the demand.
- Trade of live animals is on an average of NRs. 257 million per annum for last 12 years (1995 to 2007) period
- Tenth Plan targeted to raise per capita consumption from 8.5 kg to 9.94 kg.

Achievement is said to be 8.6 kg i.e 100 gram in 5 years.

- TYIP targeted to achieve 4.5 % growth per annum but estimate for 2008/09 by MoF is 3.3 %.
- The APP_ISR 2007 reported that production growth for poultry 5.37 %, Pig 3.08, Goats 4.23 % and buffalo meat 2.26 %.
- Production targets of the plans are usually unmet. Therefore, gap is widening.

Meat production by species 2010

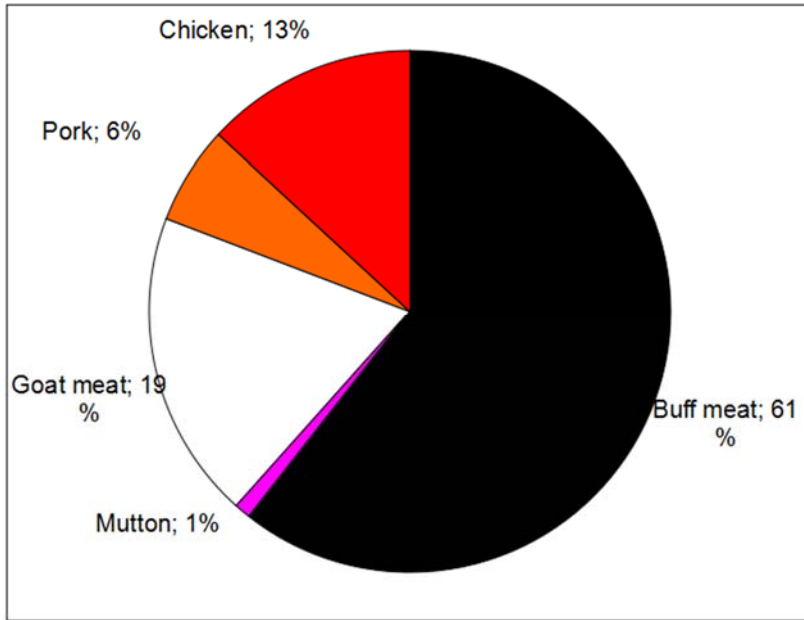


Fig1.1

Source: Statistical information of Nepalese agriculture MOAD

1.2 Per capita consumption and production

| Product | Consumption (per person per year) | Existing supply (per person per year) | Target to achieve self-sufficiency |
|---------|-----------------------------------|---------------------------------------|------------------------------------|
| Egg | 48 units | 48 units | Fiscal Year 2016/17 |
| Meat | 14 kg | 12.5 kg | Fiscal Year 2017/18 |
| Milk | 91 liters | 72 liters | Fiscal Year 2018/19 |

Source: Ministry of Livestock Development

Table 1.1

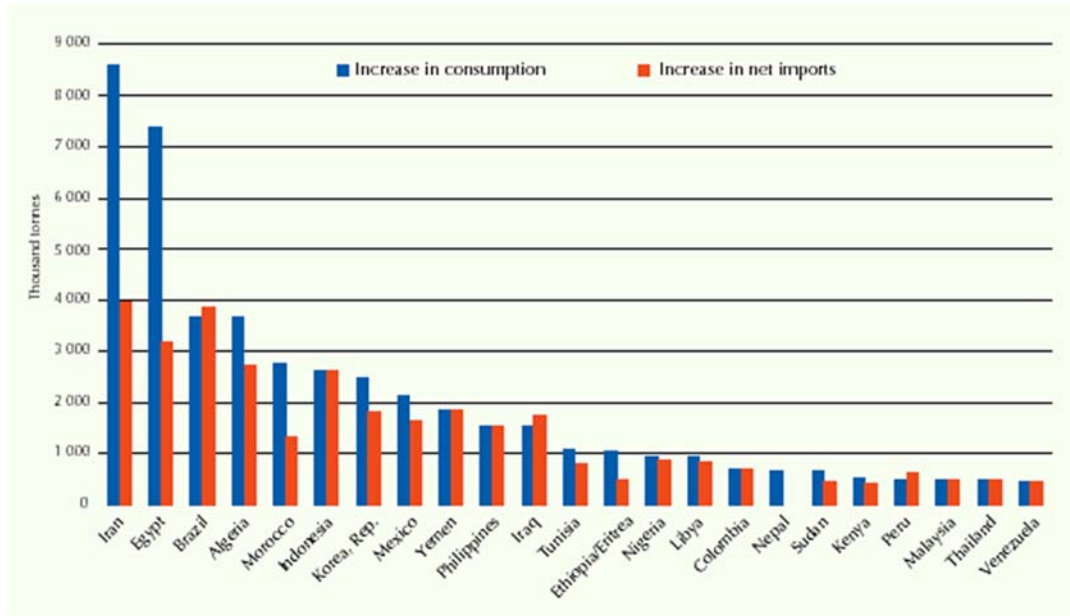


Fig1.2

Source- world agriculture towards 2015/20, <http://www.fao.org/docrep/005/y4252e/y4252e09>.

1.3 Meat and meat product processor in Nepal

1.4 History and definition of meat

The ancestors of sheep, cattle and pig were undifferentiated from those of human beings prior to 60 million year ago. When the first mammals appeared on earth by 2-3 million year ago, the species of human being to which they belong and the wild ancestor of our domesticated species of sheep, cattle and pigs were probably recognizable. Domestication started 10000-12000 years ago. According to zeuner (1963) the stage of domestication of animal by man involved first followed by the confinement of animals, with breeding in captivity. Domestication was closely linked with the development of agriculture. Sheep was domesticated before 7000 B.C. Cattle and pig did not come until 5000 B. C.

Domestication alters many of the physical characteristics of animals and some generalization can be made. Thus, the size of domesticated animals is usually, smaller than of their wild ancestors, their confirmation alters and there is a tendency

for the facial parts of the skull to be shortened relative to the cranial portion and the bones of the limbs tend to be shorter and thicker.

1.5. Scope and problem

Free raise livestock farming is popular in Nepal hygienic livestock are better for health products. An organic livestock farm provides economic, natural sustainability and generates farming jobs in rural areas of Nepal. Our sustainable livestock farming practice produce with respect for man, animal and environment. Animals and birds of livestock farms will be used to make plants grow better. Livestock farms practice sustainable meat production livestock farming in Nepal.

Natural livestock farm provides the training and information about livestock farming in Nepal for all interested peoples. Livestock farm is for meat, dairy and eggs as well as wool and leather organic livestock farm like goat, sheep, turkey organically grown feed and are not treated with any antibiotics drugs.

Major Issues/ problem relating to the safety of meat

1. Failure to enforce Animal Slaughterhouse & Meat Inspection Act
2. Lack of Infrastructure
3. Poor hygienic practices during slaughtering and marketing of meat
4. Lack of awareness among stakeholders

1. Failure to enforce Animal Slaughterhouse & Meat Inspection Act

The act has the provision that the government can enforce the act in designated area from designated date upon notification in Nepal gazette. The most frustrating fact about the law is that it hasn't been successfully enforced till now. The government has tried to enforce the act in some of the municipalities of the country by constructing slaughter houses but those slaughter houses were not utilized by the meat enterprisers. Turbulent political situation of the country for more than a decade and lack of adequate awareness among meat entrepreneurs, consumers and other stakeholders are suggested as the reasons behind the failure of enforcement of the law.

2. Lack of Infrastructure

The country is still not fully capacitated in terms of infrastructure and human resource development to implement food safety regulations. There are no adequate numbers of modern abattoirs in the country. Some slaughter houses made with the assistance of donor agencies are also not being operated satisfactorily. Lack of modern and hygienic abattoirs made people slaughter the animals in streets, open lands, pasturelands, riverside and courtyards. Meat animal traders collect the animals from farmers and keep them in certain designated places for sale. These animals are bought by the butchers who kill the animals to sell meat by themselves or by meat sellers nearby. Presently, there are some modern slaughter houses ready to use and a few more are being constructed. Awareness in meat entrepreneurs and consumers about the portance of good slaughtering facilities in the health of consumers is very important to operate these facilities smoothly.

3. Poor hygienic practices during slaughtering and marketing of meat

Poor hygienic practices during slaughtering and marketing of meat is one of the major contributing factors for unsafe meat in Nepal. Slaughtering animals in open and unhygienic places, use of dirty water during slaughtering process, and selling meat in open and non-refrigerated places are some of the unhygienic practices being used by the entrepreneurs. Slaughtering of animals in unhygienic place and use of polluted water contaminate the meat with different microorganism which can be harmful for the health of the consumers. Keeping quality of the meat processed in these facilities is also bad.

Due to continuous effort from the government and many other non-governmental development partners, there are some progress in practice of slaughtering and meat handling. Butchers started to use covered courtyard with concrete floor to slaughter the animals and meat seller started to keep meat covered and refrigerated.

4. Lack of awareness among stakeholders

Lack of information and knowledge about food safety among all stakeholders including producers, traders, consumers and even some government agencies has been regarded as one of the reasons preventing successful implementation of rules

and regulation regarding food safety. Most of the small entrepreneurs are not aware about Good Hygienic Practices (GHP) which directly impedes the safety of their products. Lack of awareness among different stakeholders has been stated as one of the major causes for the failure of enforcement of the slaughterhouse and meat inspection act.

Assignment

1. Define meat.
2. List out the major issues/problem relating to the safety of meat.
3. Describe the situation, scope and problem meat in the content of Nepal.

Unit: 2

Caring slaughter animal

Objectives

- To know care and management of slaughtering animals.
- To know idea about pre-slaughter and handling of animals.
- To know about the care, transportation, delivery and lairage of slaughtering animals.

2.1 Pre-slaughter care and handling

The optimum amount of rest required by meat animals before they are slaughtered depends on the climate, the distance they have travelled, their method of transport and their general health. In some countries, where animals are auctioned at stock yards before they are taken to an abattoir, the rest periods are sometimes inadequate. This creates a commercial problem that is difficult to evaluate. On one hand, animals lose weight during transport and in holding pens, and it is undesirable to use pens and labour to prolong a rest period that confers no immediately obvious commercial advantage. On the other hand, stressed or weary animals sometimes produce meat with an unacceptable appearance or water holding capacity, and this may create economic losses later on. Animals lose about 0.2% per hour of their live weight once feeding has ceased, but this is very variable. For beef cattle, losses in 48 hours of fasting may range from less than 1% to 8%. About half the live weight loss shows up as a loss in carcass weight. However, improvements may be gained by electrolyte therapy, allowing animals free access to drink electrolytes during lairage.

In some situations, a rest period of one day for cattle and two or three days for pigs is considered to be optimum. However, such rest periods may be counterproductive if the animals fight among themselves. Animals are not fed in the 24 hour period prior to slaughter

Important point of pre- slaughter care for food animal are

1. Animals are to be handled with the minimum of disturbance and as quietly as up to the point of slaughter to safeguard meat quality.

2. The meat of animals slaughtered while exhausted, appears dark fiery due to decreased oxygenation of the blood hemoglobin and muscle myoglobin. Allowances of molasses or sugar solution will reduce the incidence of PSE in pigs and also it helps to maintain glycogen level. This glycogen is useful for better acidification of the carcass for higher shelf life
3. It is necessary to rest fatigued and excited animals before slaughter-because of the complete development of acidity of the muscles and also the early invasion of the system by putrefaction bacteria from the intestinal tract. These bacteria are cause of bone taint in cattle and of ham taint in pigs.
4. A period of 6-24 hours with a maximum of 36 hours detention and rest in a lairage is essential for such animals before slaughter.
5. The actual duration of the resting period depends on many factors such as; species of animals, age, sex, class and condition, time of year, length of journey, method of transportation, etc.
6. Check to ensure that there are no defects, which could cause bruising or even death. V-race with catwalk arrangement should be provided for movement of food animals from lairage to slaughterhall to avoid obstruction of the passage and minimize stress.
7. Mixing of animals from different origins leads to fighting and injury.
8. The use of fine sprays of water on pigs awaiting slaughter in lairages has a beneficial effect in the prevention of fighting.
9. Only physiologically normal animals should be slaughtered thereby preventing any loss of body weight.
10. Electrical goads should be used for movement of stock.
11. Weight loss suffered during transit could be restored to some extent by providing adequate rest.

2.2 Transportation and delivery

The need to transport food animals occurs essentially in commercial agriculture and to a lesser extent in the rural or subsistence sector. These animals need to be moved for a number of reasons including marketing, slaughter, re-stocking, from drought areas to better grazing and change of ownership. Typically, methods used to move

animals are on hoof, by road motor vehicle, by rail, on ship and by air. Transport of livestock is undoubtedly the most stressful and injurious stage in the chain of operations between farm and slaughterhouse and contributes significantly to poor animal welfare and loss of production.

Effects of transport

Poor transportation can have serious deleterious effects on the welfare of livestock and can lead to significant loss of quality and production.

Effect of transport and movement include-

- | | | |
|------------------|--------------|----------------|
| a. Stress | b. Bruising | c. Suffocation |
| d. Heart failure | e. Trampling | f. Heat stroke |
| g. Sun burn | h. Blot | i. Poisoning |
| j. Dehydration | k. Injuries | l. Fighting |

Methods of transport

Cattle

The most appropriate methods of moving cattle are on hoof, by road motor vehicle or by rail wagon. Moving cattle on the hoof (trekking) is suitable only where road and rail infrastructure does not exist, or when distances from farm to destination are short. This method is slow and fraught with risks to the welfare and value of the animals. Rail transport is useful for short-haul journeys where loading ramps are available at railheads and communication is direct to destination. Road motor transport is by far the most versatile, the first method of choice and the most user friendly.

The most satisfactory method of transporting cattle is by road motor vehicle. Moving by rail truck requires more careful management and trekking is satisfactory for well-planned distances.

Sheep/goats

Of the food animals these are the easiest to transport and generally travel well on hoof, rail or road. Double-deck trucks are also suitable.

Pigs

Pigs are difficult animals to transport, and the only satisfactory method is by road, although rail can be used under careful circumstances.

Poultry

Broilers and other poultry such as turkeys or ducks are best transported by road. Flocks of birds should be subdivided in small numbers in crates. Recommended are plastic crates, which can be stacked on top of each other on a vehicle and which can easily be washed after use. The lid of the crates is for loading and the opening at the side for removal of the birds.

Ostriches

The skin and meat of ostriches is particularly valuable, so careful transport by road vehicle is the only suitable method of transport.

Having selected the preferred method of transport of slaughter animals, it is necessary to take into account numerous factors in order to ensure the health and welfare of the animals.

Characteristics of vehicles used for transport

Any vehicle used for the transport of slaughter livestock should have adequate ventilation, have a non-slip floor with proper drainage and provide protection from the sun and rain, particularly for pigs. The surfaces of the sides should be smooth and there should be no protrusions or sharp edges. No vehicle should be totally enclosed.

Ventilation- Transport vehicles should never be totally enclosed, as lack of ventilation will cause undue stress and even suffocation, particularly if the weather is hot. Poor ventilation may cause accumulation of exhaust fumes in road vehicles with subsequent poisoning. Pigs are particularly susceptible to excessive heat, poor air circulation, high humidity and respiratory stress. Well-ventilated vehicles are necessary. The free flow of air at floor level is important to facilitate removal of ammonia from the urine.

Floors- Non-slip floors in all vehicles are necessary to reduce the risk of animals falling. A grid of cross slating made from wood or metal is suitable. The grid can be removable, so the vehicle can be used for other purposes. Other forms of non-

slip surfaces such as grass or sawdust are not suitable. Additional balance for animals is provided by partitioning the interior of the vehicle with either wood or metal poles or solid boards. Broken floors will cause leg and other injuries. Vehicle floors should be level with off-loading platforms, otherwise animals will injure themselves climbing off or be manhandled in order to remove them.

Floor space- Livestock require sufficient floor space so that they can stand comfortably without being overcrowded. Overloading results in injuries or even death of livestock.

Approximate floor space for transporting of different species of animals

| S.No | Species | Floor space/ animal (m2) |
|------|------------------------|--------------------------|
| 1 | Mature cattle/ buffalo | 1.0-1.4 |
| 2 | Small calves | 0.3 |
| 3 | Porker | 0.3 |
| 4 | Pigs | 0.4 |
| 5 | Sow/boar | 0.8 |
| 6 | Sheep/ goat | 0.4 |
| 7 | Ostriches | 0.8 |

Allowances should be made for breed and body size. If the floor area is too large for the number of animals, partitions should be used to avoid animals being thrown about.

Sides- The sides of vehicles should be high enough to prevent animals, particularly pigs, from jumping out and injuring themselves. Insides could also be padded at hip level with, for example, old tyres to reduce bruising of cattle and ostriches. Also there should be no gaps through which a leg might protrude and be broken. Narrow entry doors can lead to considerable bruising of hips. Rail trucks should be fitted with spring coupling to cushion jerky movement.

Roof- A roof is not necessary on a transport vehicle for bovines and small ruminants provided the animals are not exposed for hours in the hot sun. Vehicles for pigs should have roofs unless the pigs are to be transported in the early morning or late evening. Poultry should be protected from sun and rain. Transporting in cages or crates will protect them from physical injury. They should be large enough to allow

all the birds to sit down and move their heads freely. Ventilation should be adequate. At the small-scale level in more primitive conditions animals are often transported under very unsuitable conditions, which may cause a great deal of pain or even death through suffocating, heat stress, dehydration etc.

Pre-loading precautions

There are a number of simple procedures that can be implemented prior to the loading of livestock, which will considerably reduce the risk of injury and stress.

- a. Pre-mixing of cattle or pigs leads to greater familiarity and these animals travel better than animals that are strangers. Cattle should be mixed in a pen 24 hours before loading. Victimized or wild animals can be weeded out during this period. Fighting amongst pigs that are strangers is common, resulting in skin damage, wounds and stress. Mix pigs from different pens together before loading, smearing pigs with litter or excreta from the same pen so that they smell similar.
- b. Most animals can be fed and watered before transporting. This has a settling effect. However pigs should **not** be fed before transport as the feed ferments and the gas causes pressure on the heart in the thoracic cavity, leading to heart failure and death.
- c. Do not mix horned and hornless animals in the vehicles as these causes bruising and injury. Different species should also not be mixed - sheep, goats and calves less than 6 months can be mixed and individual animals can be transported in a loose sack tied at the animal's neck. Feet should not be tied, and animals should be turned every 30 minutes or so. Pigs should not travel with other species unless separated by a partition. Bulls should not be carried together with other stock unless separated by a strong partition.
- d. Animals that are diseased, injured, emaciated or heavily pregnant should not be transported, and unfit, heavy; pined animals should not travel far as they cannot stand up to the rigors of transport.
- e. Vehicles should be fitted with a portable ramp to facilitate emergency offloading in case of prolonged breakdowns.

Transport operations

A number of factors must be taken into account during the journey in order that the animals do not suffer, become injured or die.

1. **Trekking-** Only cattle, sheep and goats can be successfully moved on hoof, and here certain risks are involved. The journey should be planned, paying attention to the distance to be travelled, opportunities for grazing, watering and overnight rest. Animals should be walked during the cooler times of the day and, if moving some distance to a railhead, they should arrive with sufficient time to be rested and watered before loading. The maximum distances that these animals should be trekked depend on various factors such as weather, body condition, age etc., but the distance given in Table should not be exceeded when trekked.

Maximum distance for trekkin

| S.No. | Species | One day journey |
|-------|----------------|-----------------|
| 1 | Cattle/buffalo | 30km |
| 2 | Sheep/goat | 24km |

2. **Time of the day-** High environment temperatures will increase the risk of heat stress and mortality during transportation. It is important to transport animals in vehicles during the cooler mornings and evenings or even at night. This is particularly important for pigs. A combination of high humidity and high environment temperatures is especially deadly to pigs. Heat can rapidly build up to lethal levels in a stationary vehicle. Wetting pigs with water will help keep them cool.
3. **Duration of journey-** Where possible, journeys should be short and direct, without any stoppages. If the vehicle stops, pigs will tend to fight. Cattle and sheep/goats should not travel for more than 36 hours and should be offloaded after 24h for feed and water, if the journey is to take longer than that. Pigs should have access to frequent drinks of water during long journeys, particularly in hot and humid conditions.
4. **Wind chill-** Wind blowing on wet animals being transported in cold weather

causes a wind chill factor, where the body temperature is considerably reduced, resulting in severe stress or deaths.

5. **Driving-** Vehicles should be driven smoothly, without jerks or sudden stops. Corners should be taken slowly and gently. The second person should be in attendance to spot downer animals so that the vehicle can be stopped and the animal lifted. Train drivers should avoid “fly shunting” of trucks with livestock.

2.3 Care in lairage

Animals in lairages should be cared for in accordance with the following recommendations-

- As far as possible, established groups of animals should be kept together. Each animal should have enough space to stand up, lie down and turn around. Animals hostile to each other should be separated.
- Where tethers, ties or individual stalls are used, they should allow animals to stand up and lie down without causing injury or distress.
- Where bedding is provided, it should be maintained in a condition that minimises risks to the health and safety of the animals, and sufficient bedding should be used so that animals do not become soiled with manure.
- Animals should be kept securely in the lairage, and care should be taken to prevent them from escaping and from predators.
- Suitable drinking water should be available to the animals on their arrival and at all times to animals in lairages unless they are to be slaughtered without delay.
- If animals are not to be slaughtered as soon as possible, suitable feed should be available to the animals on arrival and at intervals appropriate to the species. Un weaned animals should be slaughtered as soon as possible.
- In order to prevent heat stress, animals subjected to high temperatures, particularly pigs and poultry, should be cooled by the use of water sprays, fans or other suitable means. However, the potential for water sprays to reduce the ability of animals to thermo regulate (especially poultry) should be considered in any decision to use water sprays. The risk of animals being

exposed to very cold temperatures or sudden extreme temperature changes should also be considered.

- The lairage area should be well lit in order to enable the animals to see clearly without being dazzled. During the night, the lights should be dimmed. Lighting should also be adequate to permit inspection of all animals. Subdued lighting, and for example blue light, may be useful in poultry lairages in helping to calm birds.
- The condition and state of health of the animals in a lairage should be inspected at least every morning and evening by a veterinarian or, under the veterinarian's responsibility, by another competent person, such as an animal handler. Animals which are sick, weak, injured or showing visible signs of distress should be separated, and veterinary advice should be sought immediately regarding treatment or the animals should be humanely killed immediately if necessary.
- Lactating dairy animals should be slaughtered as soon as possible. Dairy animals with obvious udder distension should be milked to minimize udder discomfort.
- Animals which have given birth during the journey or in the lairage should be slaughtered as soon as possible or provided with conditions which are appropriate for suckling for their welfare and the welfare of the newborn. Under normal circumstances, animals which are expected to give birth during a journey should not be transported.
- Animals with horns, antlers or tusks capable of injuring other animals, if aggressive, should be penned separately.

Assignment-

1. List out the important point of pre-slaughter care for food animals.
2. List out the effect of transport or movement of food animals.
3. Mention the approximate floor space for transporting of different species of animals.
4. Describe the management of transportation and delivery of food animals.
5. List out the important point of lairage of food animals.

Unit: 3

Meat inspection

Objectives

- To know the method of meat inspection.
- To know about the slaughterhouse and meat inspection Act-2055.
- To know the ante-mortem and postmortem inspection.

3.1 Slaughter house and Meat Inspection Act 2055

Preamble

To safeguard the health and welfare of public and to prohibit adulteration in meat and meat products, to prevent any frauds which lower the wholesomeness quality and adequacy of meat, it is imperative to establish slaughterhouse and arrangement for meat inspection.

1. Short title and commencement

- This Act shall be called "Slaughterhouse and Meat Inspection Act, 2054".
- This Act shall come into force in prescribed area on a prescribed date which Nepal Government may notify it in the Nepal Gazette, to specify it.

2. Definition

- "Animal" means castrated or uncastrated goat, sheep, pig, wild boar, chyangra goat, buffalo, bull, rabbit or the females above which are fit for meat other than cow and ox and this word also includes poultry, ducks, pigeon or other species kept for meat purpose.
- "Meat" means meat of the animals which is fit for human consumption.
- "Meat inspector" means person appointed or as prescribed under Article 6.
- "Meat supervisor" means person as prescribed under Article 7.
- "Slaughterhouse" means a person who sells the meat professionally.
- "Prescribed or as prescribed" means prescribed or as prescribed on the

regulation made under this Act.

3. Prohibit to established slaughterhouse and selling of meat without license

- Nobody shall established slaughterhouse or selling the meat without obtaining license under this Act.

4. Establishment of slaughterhouse

- His Majesty Government may establish the slaughterhouse in any area of the country by the notification in Nepal Gazette.
- What so ever is written in Sub-Article (1) His Majesty's Government may give permission to non-government sector as well to establish the slaughterhouse.
- The term and conditions and specification to establish the slaughter house under Article (1) or (2) shall be as prescribed.

5. Application for license

- Person interested to establish a slaughterhouse or selling of meat, shall obtain license as prescribed.
- To obtain the license under sub-article (1) a fee is to be paid as prescribed.

6. Appointment of meat inspector

- Nepal Government may nominate/appoint a person as a meat inspector to examine animals or meat, who is at least veterinary science graduate.
- Other rights and duties of meat inspector will be as prescribed, in addition to mention in this Act.

7. Nomination of meat supervisor

- Nepal Government may nominate a meat supervisor to any civil servant who is at least veterinary science graduate for supervision of slaughterhouse management and as meat supervisor.
- His Majesty's Government may nominate the meat supervisor as meat inspector in case if there is no meat inspector.
- Other functions, duties and rights of meat supervisor shall be as prescribed.

8. Inspection of animals before slaughtering (anti-mortem inspection)

- Animal to be slaughtered should be produced for inspection and anti-mortem examination before meat supervisor, at slaughterhouse, and in the area where slaughterhouse is not yet constructed such animal should be inspected at the site prescribed by the meat supervisor. Procedure for examination of animal will be as prescribed.
- After inspection under sub-article (1) animal found suitable for slaughter may be permitted for slaughter with marking the animal by meat inspector.
- Upon inspection under sub-article (1) if animal is found diseased, such animal should be prohibited for slaughter.

9. Slaughtering of animal in slaughterhouse

- Animal fit for slaughtering under article (8) shall be slaughtered in the slaughterhouse.
- Whatever is written in sub-article (1) if there is no slaughterhouse in those area, animal shall be slaughter at the place and time as prescribed by the meat supervisor.

10. Meat examination of slaughtered animal

- Meat inspector should inspect the meat of the slaughtered animal under Article 9, as prescribed.
- If meat inspector find any disease in meat of slaughtered animal upon inspection under sub-article (1) such meat may be prohibited for selling partially or completely by meat inspector.

11. Prohibition on sale of carcass

- Sale of meat of animal other than mentioned in section (A) of article 2 shall not be allowed.
- Meat of dead animal due to disease or any other cause shall not be allowed for sale.
- Sale of meat with skin shall not be allowed.
- But this article shall not be applied for selling the meat of birds, pigs,

wild pigs and in other species identifying organs or portions like head and legs with skins.

12. Marketing or stamping on carcass

- Meat inspector shall affix clearly visible marking or stamp as prescribed during the certification of meat for sale.
- No meat shall be sold without the marks or stamps retired under sub-article (1).

13. Adulterated meat shall not allowed to sale

- Adulteration of carcass with another species of animal or deceiving the species of animal while selling meat shall not be allowed.
- Adulteration of meat with any substance that alters the normal quality or taste or weight shall not be permitted for sale.

14. Fee to be paid

- Inspection of animal or meat under this Act fee shall be levied as prescribed.

15. Authority to enter

- Meat inspector or meat supervisor may enter in slaughterhouse or butcher's shop and may take sample of meat or inspection of animal or carcass. To help on this work will be the duty of all concerned.

16. No objection

- Whatever contains in this act, there will be no objection on slaughter of animal for household purposes the relevant articles of this act shall not be effective.

17. Penalty and punishment

- Person who contrivance sub-article (1) or (3) of article 8, article 9, sub-article (2) of article 10, sub-article (3) of article 11 or sub-article (2) of article 12 shall be punished with a fine of maximum of Rupees one thousand.
- Person who contrivance article 3, sub-article (1) or (2) of article 11 or article 13 shall be punished with a maximum fine of Rupees five

hundred.

18. Delegation of authority

- Authority vested on His Majesty's Government under this act may be delegated with limit to other bodies as required.

19. Nepal Government shall be plaintiff

- Nepal Government shall be plaintiff on case under this Act.

20 Investigation of crime and defense

- Meat inspector shall investigate the case under this act and register the case after completing the investigation he shall file the case to judiciary powered officer.
- During the registration of the case under sub-article (1) investigation personnel may take advise with government lawyer.

21. Judicial authority

- The judicial authority for cases and hearing appeal related to this act should be vested on prescribed officer.

22. Shall be according to the prevailing law

- Whatever mentioned in this act shall be decided accordingly, while in other matter it will be as per the prevailing law.

23. Authority to frame rules

3.2 Ante-mortem and Post-mortem inspection of Meat animals

Meat inspection is commonly perceived as the sanitary control of slaughter animals and meat. The aim of meat inspection is to safeguard the health and welfare of public and to prohibit adulteration in the meat and meat products, to prevent any frauds which lower the wholesomeness, quality and adequacy of meat.

The main objectives of meat inspection program are two fold;

- To ensure that apparently healthy, physiologically animals are slaughtered for human consumption that abnormal animals are separated and dealt with accordingly,
- To ensure that meat from animals is free from disease, wholesomeness and

no risk to human health

These objectives are achieved by Ante mortem and Post mortem procedure and by hygienic dressing with minimum contamination. Wherever appropriate, Hazard Analysis Critical Control Point (HACCP) principal should be applied.

Ante mortem and post mortem Examination of meat animals are two chief adjust of meat hygiene. The above methods assist to a great extend in detecting animals suffering from diseases communicable to human beings.

A. Ante-mortem Examination

Objective

- Detection of animals suffering from scheduled infections such as Anthrax, Rabies etc communicable to human beings
- Detection of certain toxic infection which is different to identify during post mortem examination e.g. Metritis, Tuberculosis, and Meningitis in young calves'
- Prevention of Food borne infections e.g. Febrile symptoms in case of acute Salmonellas,
- To check slaughter of pregnant animals,
- To safe guard the interest of insurance.

B. Post-mortem Examination

- Detection of any diseases on meat
- Determination of the significance of primary and systemic pathological lesions

Assignment

1. List out important point of Animals Slaughter house and Meat Inspection act 2055.
2. Meaning about ante-mortem and post-mortem inspection of food animals.
3. Importance or objectives of ante-mortem and post-mortem inspection of food animals.

Unit: 4

Edible and inedible meat of dressed carcass

Objectives

- To know the edible meat of dress carcass.
- To know the inedible meat of dressed carcass.

Enlist the edible meat of dressed carcass and their uses

Table 4.1. Edible By-products and their uses

| S.N. | Raw By-products | Processed By-products | Use |
|------|------------------|-----------------------------------------------------|----------------------------------------------------------------------------|
| 1 | Edible Fat | Edible Fat Oleo Oil Oleostearin Cracklings | Frying Purpose Shortening Candy, Chewing Gum Pet food, meat, meal |
| 2 | Liver and Kidney | | Edible-liver paste |
| 3 | Heart | | Edible |
| 4 | Tongues | | Edible |
| 5 | Edible Raw Blood | Plasma and red cells | Adhesive for sausages etc, blood sausages or pudding |
| 6 | Feet | Neat's-foot oil, Meal | Fine lubricants Glue & gelatin, Buttons, Jelly, Edible use |
| 7 | Tail | Brush Meal | Industrial use. Jelly |
| 8 | Trimming | | Sausages, Luncheon Meat etc |
| 9 | Raw Bone | Bone pieces | Bone, glue, Shortening, bone meal, soup, gelatin |
| 10 | Intestines | | Sausages casings |
| 11 | Head | | Soup, pet food |
| 12 | Stomach | Edible trip | Edible |

Enlist the inedible meat of dressed carcass and their uses

Table 2: Inedible By-products and some of their uses

| S.N. | Raw By-products | Processed By-products | Use |
|------|------------------------------|-----------------------|--------------------------------------------------------------------------------------------|
| 1 | Inedible Blood | Blood meal | Adhesive for livestock and poultry feed, pet food fertilizer glue, foam fire extinguishers |
| 2 | Feet | Meal | Pet food, fertilizer, animal feed |
| 3 | Head | Meal | Meat Meal. Pharmaceuticals |
| 4 | Ears | Meal | Meat Meal. Pharmaceuticals |
| 5 | Windpipes | Meal | Meat Meal. Pharmaceuticals |
| 6 | Lungs | Meal | Meat Meal. Pharmaceuticals |
| 7 | Spleen | Meal | Meat Meal. Pharmaceuticals |
| 8 | Udders | Meal | Meat Meal. Pharmaceuticals |
| 9 | Fetus | Meal | Meat Meal. Pharmaceuticals |
| 10 | Intestines | | Animals feed, Surgical sutures, heparin, casings, tennis racket string, music strings |
| 11 | Tails | Meal | Animal feed |
| 12 | Bone | | Glue, Shortening, bone meal, , gelatin, ornaments, fertilizer |
| 13 | Fat | Inedible fat | Adhesive for livestock and poultry feed, lubricants, soaps, candle, glycerin |
| 14 | Trimblings & Floor sweepings | | Animal feed, Pet food, glue, gelatin |
| 15 | Hides & Skins | | Leather goods, Collagen casings, Felt, upholstery, |
| 16 | Hairs and wool | | Felts, Carpets, Brush, Animal |

| | | | |
|----|--------------------------------|-----------|-------------------------------------------------------|
| | | | feed |
| 17 | Feathers | | Animal feed, Stuffing, Bedding |
| 18 | Horns and Hoofs | | `Buckles, Comb, ornaments, animal feed, fertilizer |
| 19 | Wool | | Clothing |
| 20 | Gland | | Pharmaceutical products |
| 21 | Stomach & Intestine content | | Fertilizer, Animal Feed |
| 22 | Condemned and dead stock | Rendering | Livestock and poultry feed |
| 23 | Waste water | | Fertilizer |

Assignment

1. Meaning about edible and inedible part of meat carcass.
2. List out the edible and inedible part of meat carcass.

Unit: 5

Stunning and slaughtering

Objectives

- To know the method of stunning of meat animals
- To know the method of slaughtering of meat animals

Introduction

Stunning: It is the process of rendering animals immobile or unconscious, with or without killing the animal, when or immediately prior to slaughtering them for food.

Slaughter means kill (animals) for food or kill (people or animals) in a cruel or violent way, typically in large numbers.

1.1 Method of stunning

The most important factors that leads to the deterioration of fresh meat or meat products are the initial bacterial loads, Condition of slaughter, Bleeding of animals and dressing and cooling of carcass because these largely determine the load of spoilage organisms at the time of storage begins.

Different Methods of Stunning

1. Mechanical: – Hammer, Captive bolt (Handy and trigger, Hand held barrel which is tapped against skull which sets of cartridge explosion) of the cartridge expulsion.)
2. Chemical: - Carbon dioxide gas for pigs and poultry
3. Electrical: - Electrical Stunning for Pigs, Sheep, Goats, and Poultry.

| Species | M/amps | Amps | Volts | Time (Sec.) |
|----------------|---------|----------|----------|------------------------|
| Pig | Min 125 | Min.1.25 | Max. 125 | Max. 10. |
| Sheep and Goat | Min.125 | 1.0-1.25 | 75-125 | Max 10 or(Until EPS*.) |
| Boiler | 200 | 2 | 50-70 | 5 |
| Turkey | 200 | 2 | 90 | 10 |

* EPS: Electro plectic shock.

1.2 Method of slaughtering

Essential Approach

- a. Human Slaughter – without unnecessary suffering to the animals, safe and easy to handle for the operators.
- b. Adequate inspection Ante mortem and Post mortem Examinations
- c. Complete building of the animals.
- d. Hygienic evisceration and dressing to obtain with good keeping quality
- e. Full use of by-products.

I. Preparation for slaughter

- i. Remove feed on previous evening
- ii. Adequately rest
- iii. Provide enough water for drinking
- iv. Spraying of hooves, legs and undersides
- v. Do not excite the animals
- vi. Drive the animals to stunning areas in a quite and orderly manner without undue fuss and noise (Use canvas straps, rolled plastic or paper, prodder)

II. Different method of killing.

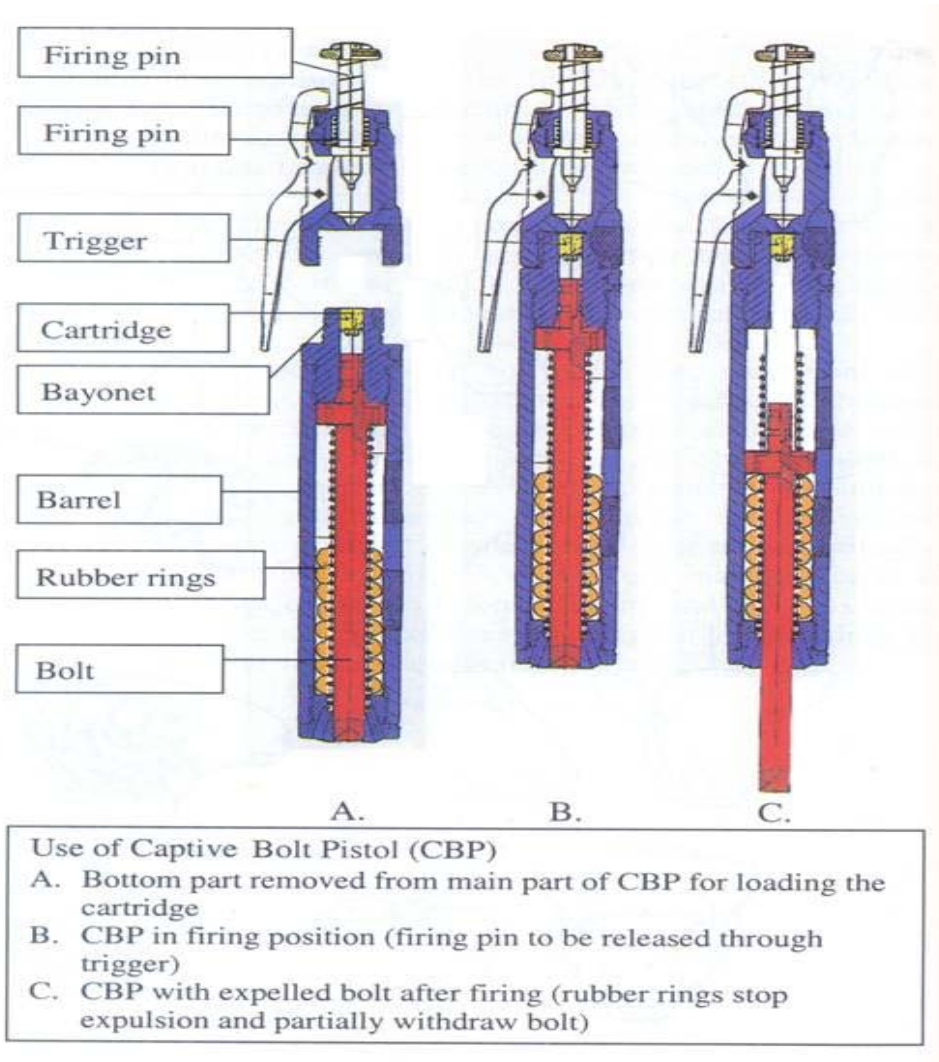
- i. **Jhatka** – cutting off neck of the animal with one stroke using a heavy and sharp knife or sword – Followed by Hindu and Sikh. (Humane Slaughter, Incomplete bleeding, Poor keeping quality)
- ii. **Halal** – Slitting the artery as well as vein of the neck but without disjuncting the neck from the body – Followed by Mohammad – Muslim. (Not humane Slaughter, Long time bleeding, good keeping quality)
- iii. **Sticking** – Killing by the double edged knife, Jugular vein, Continuation action of heart, complete bleeding
- iv. **Kosher method** - Similar to Halal, only religiously ordained person can do killing followed by Jews. Kosher means clean meat A strict follower can only eat this meat from the fore- half of carcass. Also the large

blood vessels are trimmed out. The portions that are forbidden to a strict Jews are called “Traphe” i.e. unclean.

III. Equipment

All equipment should be made of stainless steel or plastic, be rust resistant and easily cleaned and sanitized.

- a) Stunning equipments
 - Captive bolt / guns
 - Electrical head tongs
 - Stunning equipment for direct blow or
 - Air Stunner
- b) Dressing and evisceration knives.
- c) Hide removing equipment
 - Air knives
 - Hide puller mechanical operating devices.
- d) Splitting meat saw- Hand or Electrical.
- f) Chain hoist/ rails enough to hold the weight of animals to be slaughtered
- g) Working knives, sterilizer, scab board, and belt for holding the knives.
- h) Utility accessories.
- i) Services equipment – thermometers, hooks, singeing equipment
- j) Sanitation equipment – Hand wash, jet cleaners, sterilizers.



iv. Stunning

V. Skinning or pelting or hide pulling

- i. Separate the head at the last joint.
- ii. Open the skin along the back of the hind leg from hoof to rectum.
- iii. Separate the skin from udder or organ and also from the tail.
- iv. Separate the hide/skin from the body by twisting the fist between the skin and the body.
- v. Pull off the skin towards the neck.

VI. Evisceration

- i. A small cut in made above the breast bone.
- ii. Lift the muscular layer and extend the cut upwards up the hind legs .
- iii. Cut around the anus and loosen the bung and knot it.
- iv. Put two ligatures at the duodenums and cut between them.
- v. Separate and pull out the intestines.
- vi. Cut the breast bone and separate and remove thoracic viscera (pluck).
The identity of the head and viscera belonging to a particular carcass should be maintained to facilitate the post mortem examination till the carcass is passed by Veterinary inspection.
- vii. Weigh the carcass.
- viii. Wash thoroughly.
- ix. Transfer to chill room.

VII. Difference

- a. Scalding in the case of pig in hot water of temperature of 60°C to loosen the bristles.
- b. Scraping.
- c. Singeing.
- d. Shrouding in case of cattle.
- e. Splitting into two in case of large carcass.
- f. Horizontal/Vertical methods.

Assignment

1. Meaning about stunning and slaughter of food animals.
2. Mention the types of stunning and describe in details.
3. Mention the method of slaughtering of food animals and describe in details.
4. List out the essential approach of slaughtering.
5. Mention the types of killing of food animals and elaborate in briefly.

Unit: 6

Composition and physio-chemical properties of meat

Objectives

- To know about meat composition
- To know the physio-chemical properties of meat

6.1 Composition and physio-chemical properties of meat

Meat and Meat product make important nutritional contribution to the diet of people. Significant percentage of the recommended dietary allowance for Protein, Vitamin, Magnesium, Iron and Zinc are contributed by Red Meat, Poultry and Fish. Meat is also a highly desired food which frequently is the center of the meal. The annual per capita consumption in the developed country is estimated more than 85 Kg. whereas in Nepal per capita consumption of meat is 11 Kg. only.

Meat processing industry has made tremendous strides in the past ten years. The fresh meat industry has progressed from the sell of carcass complete with fat and the bone of the sale of trimmed cuts that are vacuum packaged and shipped in convenient sized cartoon to retail outlets. A great number of convenient pre-cooked forms of meat and ready to eat products are available in the market. Processing has progressed from an art handed down from generation to generation within a family to a science in which the recommended technology is backed by sound principle of chemistry, physics, statistics and microbiology.

This chapter deals with the red meat especially structure and chemistry of muscle and related tissues. The composition, characteristics, and structure of meat will be discussed.

Proximate composition

Meat muscle tissues contain approximately 75% water and 25% solid of which 19% are protein. Lipids constitute about 2.5 to 5% of muscle. Approximately percentage composition of mammalian skeletal muscle is presented in Table 1.

The variation is proximate composition of different cuts in different spices are given below Table 2

Table 6.1: Composition of edible portions of different meat

| | Beef Muscle | Buffalo Muscle | Goat Muscle | Mutton Muscle | Pork Muscle |
|----------------------|-------------|----------------|-------------|---------------|-------------|
| Moisture % | 74.5 | 78.7 | 77.2 | 71.5 | 77.4 |
| Protein %. | 22.6 | 19.4 | 21.4 | 18.5 | 18.7 |
| Fat % | 2.6 | 0.9 | 3.6 | 13.3 | 4.4 |
| Carbohydrate % | ----- | ----- | ----- | ----- | ----- |
| Mineral % | 1.0 | 1.0 | 1.0 | 1.3 | 1.0 |
| Calcium % (Mg/100g) | 10.0 | 3 | 12 | 150 | 30 |
| Phosphorus (Mg/100g) | 190 | 189 | 193 | 150 | 200 |
| Iron (Mg./100 gm) | 0.8 | 0.9 | 1.5 | 2.5 | 2.2 |

a. Water

Water represents the largest proportion of muscle with an average of 75% for raw muscle that is very low fat content (Table - 1). Water is present in the muscle to solubilize some of the components. Percentage water in muscle is inversely proportional to fat percentage and directly proportional to protein percentage. Due to polar behavior, water molecular is attached with electrically charged groups of muscle proteins. About 40% of the total water in muscle is so tightly bound that it is almost impossible to dislocate it. The attraction of molecules keeps on decreasing as the distance from the reactive groups increase. Thus most of water exists in immobilized and free form when pH of meat is more than iso-electric point, the enhanced negative charge increases in the inter filament space resulting in retention of excess water. It may be noted that almost 70% of water content in fresh meat is located within the myofibrils. Further increases water with juiciness and tenderness of the cooked meat.

b. Protein

Protein represent from 16 to 22% of the muscle mass (Table 1) and are principle solid component. Muscle proteins have been broadly classified into three categories.

- i. Myofibrillar Proteins – Soluble in dilute salt solution.

- ii. Sarcoplasmic Proteins – Soluble in water or very dilute salt solution.
- iii. Stroma or connective tissue Proteins – almost insoluble

i. Myofibrillar Protein (Actomyosin)

These proteins constitute approximately half of the protein of the skeletal muscles. They are insoluble under physiological condition that is that condition of living muscles. They are also highly charged and bind water. It has the characteristic of best emulsification and water binder capacity.

ii. Sarcoplasmic Proteins

These proteins make up about 30 – 35 % of the total proteins in the skeletal muscle. They include a large number of glycolytic and other enzymes for the normal functioning of muscle. They also include myoglobin and hemoglobin, two proteins that affect the color of meat and include cytochromes and flavoprotein. Myoglobin, Hemoglobin and cytochromes and involved in oxygen transport as living muscle. These proteins coagulate easily and have poor emulsification as stroma or connective tissues are poor water binding properties.

ii. Stroma

The stroma proteins represent a connective framework for muscle and include collagen, reticulum and elastin. Collagen is a fibrous appearing protein present through out the muscle. Reticulin is a finely structured material that closely resembles collagen. Elastin is a yellowish appearing fibrous materials. All of these are relative insoluble compared to the Saroplasmic and Myofibrillar Proteins

a. Lipid

The lipid content of muscle can range widely but usually is at least 1.5%. The major lipid components are natural lipid and phospholipids. Neutral lipids are mostly Triglyceride, which result from the combination of glycerol and free fatty acid, although some cholesterol can be associated with triglycerides.

The saturated and monosaturated fatty acid predominate in meat lipids. The principle saturated fatty acid are palmitic and stearic acid with little amount of fatty acid, whereas most common occurring unsaturated fatty acid are oleic, linoleic and linolenic acid. The composition and distribution of meat lipids depend on the diet

of meat animals.

Phospholipids are found in muscle tissue in small percentage (0.5–1%) and have a key role in the flavors and self stability of meat and meat products. Meat phospholipids are more susceptible to oxidation than triglycerides. They may cause discoloration and off flavor in meat products when exposed to air and heat.

Traditionally marbling or intra-muscular fat has been thought to be a contributor to muscle tenderness, to the point where it has received great emphasis in commercial marketing of red meat.

b. Carbohydrates

Muscle normally contains a very small amount (nearly 1%) of glycogen as it has been used during Glycolysis immediately after slaughter. It's a macro molecule of glucose residence which serves as a reserve polysaccharide of animal tissue.

The rate and amount of Glycolysis influence the color, tenderness, water holding capacity (WHC) of meat.

c. Minerals

Most of the total body inorganic materials consistency of 3.5% of total body weight is located in the skeletal tissue primarily as salts of calcium and phosphorous and some other minerals especially magnesium.

In conversion of muscle to meat inorganic elements play an important role. Their main function relates to development of Rigor mortis and alternative of fluid balance which cause a drop in pH and water holding capacity. Inorganic constituents also influence the meat color and tenderization. Several inorganic ions act as catalysts during oxidation of meat fat enhancing the process of rancidity development.

d. Vitamin

The main available vitamins in meat are B-complex vitamins. The availability and variability of vitamin content in meat are dependent on the species and age of animal, the degree of fatness and type of feed received by the animal.

Most of the vitamins in meat are relatively stable during processing or cooking.

However, the animal or to some extent vitamin B, are susceptible to heat treatment.

Assignment

1. Mention composition of edible portions of different meat.
2. Meaning about protein and mention the types protein in details.
3. Mention composition and physic-chemical properties of meat.

Unit: 7

Microbiology of meat

Objectives

- To know about the microbiology of meat.
- To know the microbes present on fresh meat and processed meat.
- To know the causes of microorganisms present in meat product.

Meat microbiology-

Meat is a highly perishable food. Maximum precautions must be taken to safeguard it right from the production site to consuming table. Microorganisms on meat are important for three reasons such as

- Some microbes are pathogenic
- Some may cause spoilage of meat and
- Some may be used as indicator organisms.

The growth of the bacteria in most cases depends upon some intrinsic (nutrients, pH, Oxygen content, water activity, structure of meat) and extrinsic factors during processing and storage conditions (temperature, relative humidity and gas-in the environment etc.) Mesophilic bacteria can grow at 5-15⁰ C (minimum) but Psychrotrophs grow even at -5⁰ Celsius (i.e below to the chilling temperature.)

7.1. Common microbes in fresh meat

The more common microorganisms occurring on fresh meats include both bacteria and molds bacteria such as *Bacillus*, *Clostridium*, *Escherichia*, *Pseudomonas*, *Lactobacillus*, *Micrococcus*, *streptococcus*, *Sarcina*, *Salmonella* occur most commonly.

Some pathogenic bacteria are

Pseudomonas aeruginosa- Produce yellow- green fluorescence pigments. Also produce pyocyanin.

Pseudo.fluorescens- Grow in contaminated blood and blood products in refrigerator. Produce yellow green fluorescence pigments

Pseudo.maltophilia- Free living and nasocomial pathogen.

Burkholderiapseudomallei- Cause melloidosis in animals and man.

Burkholderia mallei- Causes glanders in horse and man. Organism is non-motile.

Relative Humidity for microbial growth

- Highest humidity (almost saturation) required for Bacterial growth on the surface of meat.
- Yeast required 90 to 92 % RH for growth on the surface of meat.
- Mold required 85 to 90 % RH for growth on the surface of meat.
- Change on RH and temperature during storage may cause “**Sweating**” or **precipitation of moisture on food**. The moist favors slime formation on the meat surfaces.

Some Common microbes in fresh meat and meat products

Gram positive organisms

Micrococcus - Causes spoilage of salted and chilled meats

Staphylococcus - Causes spoilage and food poisoning

Streptococcus - Causes food poisoning

Clostridium - Proteolytic and putrefactive effect and causes intoxication.

Important members is

Clostridium botulinum

Gram negative organisms

Pseudomonas - Causes the production of slime, pigments and off odors

Flavobacterium - Causes discoloration of meat

Acinetobacter - Causes souring of meat as a result of oxidation of ethanol to acetic acid

Achromobacter - Causes to form slime

Echerichia - Causes spoilage of meat by fermentation of CHO's to acetic acid and gas causing off odors

Klebsiella- Causes food poisoning

7.2. Common microbes in meat product

Contamination and spoilage of meat and meat products is caused by various ways:

1. During handling, sticking, bleeding, skinning, cutting, processing.
2. From L/Nodes, bone marrow
3. From water, soil, feed, manure, air, hands, clothes, intestinal contents, equipments, etc

Invasion of tissue by microorganism

- Upon the death of the animal, invasion of the tissues by contaminating microorganism takes place.
- Factors affecting the invasion include the following:
 - The load in the gut of the animal
 - Physiological condition of the animal immediately before slaughter
 - The method of killing and bleeding
 - The rate of cooling

Spoilage under aerobic condition

Under aerobic condition bacteria may cause

- Surface slime

Surface slime causing bacteria are: **Pseudomonas**, *Acinetobacter*, *Moraxella*, *Alcaligenes*, **Streptococcus**, **Bacillus**, *Micrococcus* and some spp. of **Lactobacillus** etc. (At chilling temp. high moisture favor for *Pseudomonas*, *Alcaligenes*; Less moisture, for *Micrococci* and yeast; Still less moisture, for molds)

- Change in the colour of pigment
- Change in fat
- Phosphorescence
- Off-odor and tastes

Spoilage under anaerobic condition:

- Facultative and anaerobic bacteria grow within meat and cause spoilage.
- They cause souring, putrefaction and tainting (off taste / off-odor)of meat
- Putrefactive bacteria are: *Clostridium*spp, *Pseudomonas*, *Alcaligenes*,

Proteus

- Lactic acid bacteria may be responsible for three types of spoilage: - Slime formation, production of green discoloration, souring due to the excessive production of lactic acid.

7.3. Natures of microbes

Common causes of Food borne Infections

Many types of organisms are identified to cause food borne infections .Among them the most concerned organisms are *Salmonellaspp.*, *Campylobacter jejuni*, *Listeria*, *Hepatitis A virus*. But some unusual issues of HPAI, BSE/ TSE are also coming up in these days. The source and common symptoms of diseases caused by these organisms are briefed as below:

Campylobacter jejuni

Sources: raw poultry, unpasteurized milk

Symptoms: Diarrhea, nausea, vomiting and may last for 7-10 days

Listeria

Sources: raw milk, raw seafood, soft cheeses

Symptoms: 7-30 day onset; miscarriage, sepsis, meningitis

Salmonella

Sources: raw or undercooked poultry, eggs...

Symptoms: 6-48 hr onset; fever, chills, vomiting, abdominal cramps, diarrhea.

Hepatitis A virus

Sources: Undercooked or raw shellfish, human contact

Symptoms: 15-20 day onset; hepatitis, tiredness, nausea and vomiting

Highly Pathogenic Avian Influenza (HPAI)

HPAI Virus is considered to be circulating in Southeast Asia since 2003. In the globe it has killed 374 humans so far. Due to its outbreak more than 260 million birds are killed or forced for the culling and caused economic loss of about \$20 billion across the globe and devastated livelihoods at the family-farm level.

7.4. Microbes in processing

Meat inspector should be aware of the bacterial contamination during slaughtering and dressing. Because bacteria are introduced by the slaughter instrument and can spread to tissues or organs. Pig and poultry carcasses are scalded soon after sticking. This provides opportunity for microorganisms to enter body through the stick wound or mouth. Although water at 82⁰ C. is provided for decontamination of equipments but decontamination is not achieved because of short time frame of treatment. To eliminate salmonellae from contaminated instruments, an immersion period of at least 10 seconds is required. Major contaminating point is at the time of evisceration. Similarly most of the bacterial contamination of carcass of cattle, sheep occurs during removal of hide/skin/fleece. The first incision carries the microorganisms onto the underlying tissue. Hair can fall onto the exposed tissue. Salmonella can get transferred to carcass from the hide / skin / hooves during their removal. Contamination occurs during defeathering or debarring in poultry or pigs because **Salmonellae** are frequently isolated from carcasses. Bacteria already found in the blood of live animal dies short after death (about 1 hour after death). But if the bacterial load is too high in the blood/tissue they cannot be destroyed completely. *Salmonellae* and *Clostridiumperfringens* will survive and grow even if the load is as low as 20 cells/gram.

The effectiveness of washing varies with the time spent, volume, pressure and temperature of water and design of spray device. Washing removes some bacteria but often the reduction is small. Washing tends to redistribute organisms. Hence, efforts should be made to increase the effectiveness of washing in reducing the microbial load by-

- Treating water chlorine or lactic acid etc.
- By raising temperature of wash-water.

Microflora of chilled carcasses:

In poultry, after evisceration and washing, the carcasses are rapidly chilled. At the end of chilling it is estimated that following micro flora will be found at following numbers:

- | | | |
|----|---------------------------------------------------------------------------------------------------|-----------------------------|
| 1. | Aerobic mesophiles | $10^3 - 10^5 / \text{cm}^2$ |
| 2. | Psychrotrophs | $10^1 - 10^3 / \text{cm}^2$ |
| 3. | Enterobacteriaceae | $10^3 - 10^4 / \text{cm}^2$ |
| 4. | <i>E. coli</i> | $10^1 - 10^3 / \text{cm}^2$ |
| 5. | <i>Clostridium perfringens</i> | $10^2 / \text{cm}^2$ |
| 6. | <i>Staphylococcus aureus</i> up to | $10^3 / \text{cm}^2$ |
| 7. | <i>Compylobacter jejuni</i> , <i>Salmonella</i> and <i>Listeria</i> spp. are frequently detected. | |

Assignment

1. Meaning about microbiology in meat.
2. List out common microbes in fresh meat.
3. List out the microflora of chilled carcass.
4. Describes the nature of microbes in meat.
5. Describe the microbes in processing.

Unit: 8

Processing

Objectives

- To know the process of ripening and aging of meat
- To know the process of cutting
- To know the curing and tenderization of meat
- To know the smoking of meat quality

Introduction

The meat trade is made up of several distinct activities, which together transform a living animal into nutritious and wholesome food stuff. These activities requires slaughter house, cutting and packaging building, cold storage and distribution centers. Meat itself is not a living organism but it is subject to endogenic enzymatic activity or proteolysis which causes much muscle tissue to mature become tender and develops a typical taste. Long term storage without any control of temperature and humidity may tend to spoil the meat and meat products.

Due to its chemical composition which is rich in Proteins, Lipid and Water, Meat is particularly favorable substrate for the growth of micro-organism. The lipid content also makes it very sensitive to oxidation.

Healthy animals, hygienically slaughter after resting and fasting provide a practically aseptic meat. However following slaughter operation like the evisceration and dressing inevitably produce microbial contamination in depth and especially on the surface, though contact with all precaution.

8.1 Ripening/aging of meat

Quality of meat and meat products generally refers to the distinct traits or special features that contributies toward consumer's appeal. This consumers' appeal is dependent upon such factors as the appearance of meat and meat products and tenderness, juiciness, aroma and flavor of the meat food as finally prepared and served.

Within a few hours after an animal is slaughtered, rigor mortis sets in with, a

construction of muscle fibers and an increasing toughness of the meat. This is correlated with the loss of glycogen and disappearance of ATP from the muscle of newly slaughtered animals. If the meat is held cool, rigor mortis subsidizing about 2 days, the muscle become soft again. This is the process generally called as the ageing of meat or tenderization of meat. The tenderization is believed to be due to principally to natural proteolysis enzyme in meat which slowly breaks down the connective tissue muscle fibers as well as the muscle fibers themselves. This structural changes in the process of ageing as described generally by the term “Autolysis”

The action of proteolysis enzyme on the connective tissue in meat makes the shorter protein chain and reduced them a gelatinous consistency. This is the tenderizing action that transpires during the ripening process of meat.

a. Method of Ageing

Various techniques or methods have been adopted for ageing or ripening of meat in the commercial purpose. Some of them have been described briefly as follows.

b. Chilling or cold storage

Ageing or meat is generally done by hanging the carcass in a cold room by controlling the humidity and temperature for the specific period depending upon the type of carcass. During the storage condition, the activity of natural organic acid in meat will promote thereby partially hydrolyzing to breakdown the connective tissue and cellular structure.

Ripening and tendering meat by ageing in the cooler with controlled humidity and temperature not only improve the tenderness and texture but also inhibit the bacterial activity thereby increased the shelf life of the products. Ageing method by cold storage is generally carried by maintaining the temperature 0-2 °C with relative humidity between 85-90 % and air movement. 0.75 to 1.5 m/sec. generally the ageing period is about two to three weeks for the development of best flavor and tenderness and texture.

Low humidity increases the shrink of meat and hastens discoloration and drying of the surface. High humidity may produce a gray, watery appearance with increase

microbial growth. So humidity must be controlled as per specified and is suggested to cover the meat during storage by wrapping to minimize the drying and weight loss.

Excessive air movement may cause to a fiery-red colored surface of the carcass. High temperature increases the microbial growth and increase unfavorable enzymatic action.

The important points to remember in this ageing method are

- Prevent the shrinkage
- Preserve the bloom
- Control micro-organism.

c. Ageing by injecting the enzyme

There to five minutes before an animal is killed, the enzyme papain is injected in the jugular vein. This photolytic enzyme, which has the function of breaking brown the complex protein into simpler form, has the ability to tenderize meat tissue. The vascular system of the live animal affords an excellent distribution system throughout the body tissues. The heart of the live animal is an efficient pump and the blood stream itself acts as diluents for any introduction, thus providing more uniform distribution with less chance of undesirable concentration of the injected material commercially. The enzyme used in this process is Protein which is a patented process developed by Swift and company.

b. Ageing by mechanical means

Breaking down of connective tissue mechanically is widely used as method to improve the tenderness of meat. Many commercial machines have been developed for purpose including those, grinding crushes, pounding etc.

c. Use of enzyme

Another artificial tenderizing method involve the addition of proteolysis enzyme (chemical compound naturally present in plant or animal tissue) to meat such as bromating from pineapple, fichu from figs, tropism from pancreases or papain from papaya.

d. Electrical stimulation of carcass

This is the newest commercial method of tenderization. Electrical tenderization involves the application of sufficient voltage to cause rapid muscle contraction which produce both physical and biochemical effect in the muscle tissue. There are association with changes in level of glycogen ATP, lactic acid, pH and enzymatic activity. Through mechanism not yet well understood, impulses of about 100-600 volt over 1-2 min given within about 45 min of slaughter, not only increase meat tenderness but also reported to improve lean meat color, flavor, texture and to accelerate subsequent ageing. Either manual or automatic continuous electrical stimulation equipments have come into commercial use within the past decade.

e. Other methods

Heating and cooling generally described as tenderly method, uses of vinegar, lumen of low level of salt and spices, are another methods of tenderizing the meat adopted in the domestic purpose.

8.2. Smoking of meat

As one of the oldest method used for the meat preservation, smoking maintains flavour and colour of meat. Spreading of pea meal on the meat prior to smoking hastens the process. A special room is planned out where coal smoke is produced by burning wood or saw dust (oak, Chickory, maple, juniper or brichwood) as per the choice of flavors which depends on the liking of people of different countries and, this process lasts for 3 days at 29.5° C. Smoke has mainly formaldehyde whose action is bactericidal and bacteriostatic, however, it also causes coagulation of protein and dehydration of the meat.

Functions of smoking cured meat

i. Heating :

- a. Denaturation of proteins
- b. Inactivation of enzymes
- c. Destruction of a high percentage of micro – organisms, particularly on the surface.
- d. Development of fixation of color.

- e. Fixation of smoke constituents deposited on the surface.
- f. Improvement of texture and tenderness

ii. Application of smoke

- a. Impart desirable flavor
- b. Improve appearance of surface
- c. Impart antibacterial characteristics
- d. Impart antioxidative characteristics

iii. Drying

- a. Formation of a skin on the surface
- b. Improve appearance of surface

8.3. Curing of meat

Curing of meat started as method of preservation in olden times and is being practiced now with improvements as a specially product.

Major steps in the process: Slaughter and dressing – pumping of the curing pickle into the muscle – curing – maturing – smoking.

Different methods of curing: Wiltshiring curing – American method.

Ante and post-slaughter factors vs. quality- Pre-slaughter factors – breeding – feeding – growth – physiological status prior to slaughter – slaughter, dressing and handling factors, processing factors – injection of the pickle – tank pickle – maturation – drying and smoking.

Defects and their methods of preventions: Surface discoloration – browning, fading due to under cure, greening due to under cure, light fading- fading from rancid fat – chemical fading and bacteriological greening. Interior discoloration – due to under cure and over cure – green rings and cores – gassiness, slime and mold

Theory of Curing: Under optimum conditions of curing, NO₂ (added as well as bacteriologically produced) combines with myoglobin of the muscle to form nitrosomyoglobin. This compound when heated changes to nitroso-hemochromogen which is also a red pigment.

8.4. Tenderization of meat

Tenderness is a quality of meat gauging how easily it is chewed or cut. Tenderness is a desirable quality, as tender meat is softer, easier to chew, and generally more palatable than harder meat. Conversely, tender pieces of meat generally acquire higher price than harder ones. The tenderness depends on a number of factors including the meat grain, the amount of connective tissue, and the amount of fat. Tenderness can be increased by a number of processing techniques, generally referred to as tenderizing or tenderization.

Techniques for breaking down collagens in meat to make it more palatable and tender are referred to as tenderizing or tenderization.

There are a number of ways to tenderize meat;

- Mechanical tenderization, such as pounding, or piercing.
- The tenderization that occurs through cooking, such as braising.
- Tenderizers in the form of naturally occurring enzymes, which can be added to food before cooking.
- Examples of enzymes used for tenderizing like papain from papaya, bromelain from pineapple etc.
- Marinating the meat with vinegar, wine, lemon juice, buttermilk or yogurt.
- Brining the meat in a salt solution (brine).
- Dry aging of meat at 0 to 2 °C (32 to 36 °F).

Assignment

1. Meaning about ripening/aging of meat.
2. Mention the types of aging and describe in briefly.
3. Meaning about smoking and mention function of smoking.
4. Meaning about curing and tenderization of meat.
5. Describe chilling and cold storage of aging of meat.

Unit: 9

Sources of contaminants and methods of reducing contamination

Objectives

- To know the source of contamination of meat
- To know the method of reducing contamination of meat

Biological contaminations

Biological contamination is when bacteria or toxins contaminate food and is a common cause of food poisoning and food spoilage.

Food poisoning can happen when harmful bacteria, also called pathogens, spread to food, and are consumed. Bacteria are small microorganisms that split and multiply very quickly. In conditions ideal for bacterial growth, one single-cell bacteria can split so many times that in just seven hours; it has multiplied into two million.

Some bacteria such as salmonella, staphylococcus and listeria are extremely toxic by themselves. And, sometimes it's not the bacteria that are toxic to humans, but the process of the bacteria multiplying and producing waste. However, not all bacteria are harmful to humans; many are quite beneficial, such as those found in yoghurt.

As a food handler, it's your job to control the spread of harmful bacteria by maintaining food safety. Bacteria can be found everywhere and are impossible to see with the naked eye. Some of the most common places for bacteria to grow are:

- The human body
- Dust
- Raw meat
- Pets and pests
- The air
- Kitchen cloths
- Food handler's clothing

How Bacteria Survive

Food: Bacteria need a constant source of food to survive, especially protein. High protein foods such as meat are particularly vulnerable to biological contamination from bacteria, which means they're considered high-risk foods.

Water : Water is essential to bacterial growth and without it, most bacteria will die. Which is why drying foods as a way of preservation is so effective and has been performed for thousands of years?

Oxygen : Most bacteria require air to survive, these are called aerobic bacteria. Although some bacteria - called anaerobic bacteria - can survive without oxygen. This is why it's still possible to get food poisoning from canned food items.

PH Levels : PH refers to food acidity and is measured on a scale of 1 (acidic) to 14 (alkaline). Most fruits generally have a PH level of between 1 - 5.9, so are considered acidic. While many alkaline foods such as vegetables have a PH level at the other end of the scale. Bacteria thrive in neutral foods that are neither acidic nor alkaline and generally have a PH level of between 6 – 8.9. Foods such as meat and seafood are prime examples of neutral foods.

Time and temperature : Bacteria need both time and the right temperature to multiply to dangerous levels. A temperature of between 5°C and 60°C - also referred to as the 'danger zone' - allows for maximum bacterial growth, so it's important not to keep food at this temperature for too long.

High-risk foods are those that have ideal conditions for bacterial growth. This means they're usually:

- Neutral in acidity
- High in starch or protein
- Moist

Foods such as seafood, cooked rice or pasta, and dairy are all considered high-risk because they provide the perfect environment for bacteria to grow. This is why it's essential to practice proper food handling when dealing with these foods.

Low-risk foods are those that don't have particularly good bacterial growth

conditions. These foods are;

- High in acidity
- High in salt or sugar
- Dried
- Canned or vacuum packed

Some examples of low-risk foods would be pickles, uncooked rice or pasta and jams. Although these foods are not common sources of biological contamination, the appropriate care must still be taken when handling them.

Chemical Contamination

Chemical contamination occurs when food comes into contact with chemicals and can lead to chemical food poisoning.

Some common sources of chemical contamination can include;

Kitchen cleaning agents : Proper storing of kitchen cleaning chemicals is essential. Never keep food stored in the same place as your cleaning chemicals, and always use cleaning products designed especially for kitchen use.

Unwashed fruits and vegetables : The pesticides and fungicides often used on fruits and vegetables to help them grow free from diseases are harmful if consumed. This is why it's vital to properly wash all fruits and vegetables before eating them.

Food containers made from non-safe plastics : Single use items - such as plastic containers - are not designed to be reused again and again. Always store food in containers that are specially designed to safely be reused

Pest control products : Items like fly spray and rat poison are extremely hazardous if consumed. Always store these products away from food items.

Chemicals used in equipment maintenance : Some kitchen machines and equipment with moving parts - such as slicers and mixers- can need regular oiling. Always use food-safe oil to help make sure this doesn't contaminate the food you use them to prepare.

Physical Contamination

Physical contamination happens when actual objects contaminate foods.

Sometimes when a food is physically contaminated, it can also be biologically contaminated. This is because the physical contamination might harbor dangerous bacteria, for example a fingernail.

Common sources of physical contamination are;

Hair : Always wear hair neatly tied back and use a hair net if possible.

Glass or metal: This can occur when kitchen items are not maintained. Cracked or broken crockery and utensils should be thrown away, as well as any food that might have come into contact with it.

Pests: Pests - such as mice, rats and cockroaches - leave droppings that can contaminate food. Also, pests themselves - such as flies and insects - can also make their way into food.

Jewellery: Always keep jewellery to a minimum when preparing and handling food.

Dirt: Because dirt is so small, it's easy not to notice that it's contaminating your food. It usually gets into the food from unwashed food and vegetables.

Fingernails: Always keep nails short and clean to prevent contamination. Also, avoid wearing fake nails as these can fall off and may contaminate food.

Cross-Contamination

Cross-contamination occurs when bacteria or pathogens are transported from one object to another. This can happen in many different ways and some of the more common sources of cross-contamination include :

Clothing: Dirty clothes can transport bacteria from one place to another. If possible, clothing should be replaced when moving from one work area to another. You should also thoroughly wash your face and hands. This is especially important when working with allergens or high-risk foods.

Utensils: Separate utensils should always be used to prepare different types of foods. For example, never use the same chopping board or knife to prepare raw meat and ready-to-eat foods.

Personal hygiene: Coughing, sneezing or even touching your face and hair before handling food can also result in cross-contamination. Washing hands regularly when handling food is essential.

Pests: Flies, cockroaches, mice and rats carry harmful bacteria, which they can transport from one place to another. Pest control is vitally important in the workplace when it comes to preventing cross-contamination.

Raw food storage: One of the most common types of cross-contamination is when raw food comes into contact with cooked or ready-to-eat food. If this happens, it's a good idea to assume the raw food has been contaminated. Raw food should always be covered and stored below cooked foods to prevent this type of contamination.

Waste control: Garbage should be stored and sealed correctly to prevent cross-contamination. It should always be stored away from other items in the kitchen to ensure it never comes into contact with food preparation. Regular cleaning and sanitizing of waste bins should also be carried out to prevent the risk of pest infestation.

Methods of Reducing Contamination

- Read the “sell-by” dates on all packaged foods, and do not buy items at or beyond those dates. If you buy refrigerated foods, buy those that are truly cold, not just a little cool. Avoid foods that look off-color or have a funny odor. When you shop, bring your food directly home, instead of running other errands. Get all refrigerated goods promptly into your refrigerator.
- Before preparing foods, wash your hands thoroughly. Do not cough or sneeze into foods. When you have finished preparing meat, poultry or fish, wash ALL cutting boards, knives, plates and other utensils.
- Do not prepare vegetables or other foods with utensils used to prepare meat or fish until those utensils have been thoroughly cleaned with soap and water. Clean all utensils thoroughly, every time, after food preparation.
- Cook meats, poultry, fish and shellfish thoroughly at temperatures between 165 and 212 degrees fahrenheit. If you delay serving food after cooking, keep it at a minimum of 140 degrees until it is served.

- When you reheat food, cook it until it is hot.

Assignment

1. Mention source of contamination of meat and meat product.
2. List out the method of reducing contamination of food animals.
3. Meaning about the chemical contamination of food animals and mention briefly.

Unit: 10

Preservation of meat

Objectives

- To know the method of preservation of meat.
- To know the method of preservation like drying, chilling, freezing, chemical and irradiation etc.

Preservation

Meat products supply has to keep pace with the needs of the population. There is always a shortage of food in developing countries because of the demands of the increasing population. With Increasing meat and meat products production the surplus of products need to store but this storage results in wastage due to inadequate facilities available for storage (Cold Storage) and preservation. Preservation increases availability of meat and meat products, thus improving the nutrition of the people. Availability meat and meat products throughout the year also helps in stabilizing prices of such products.

10.1. Drying

Removal of water from meat concentrate, the water soluble nutrients making them unavailable to the microorganisms. The extent of unavailability of water to microbial cell is expressed as water activity. Dehydration lowers the water activity considerably to prevent the growth of spoilage causing microbes. Sun drying of meat chunks as a means of preservation was practiced in ancient days but rehydration of such meat chunks used to be limited. The mechanical drying process involves the passage of hot air with controlled humidity but here also there is difficulty in rehydration.

Freeze drying of meat is a satisfactory process of dehydration, preservation due to better reconstitution properties, nutritive quality and acceptability of the meat products. Freeze drying involves the removal of water from a food by sublimation from the frozen state to vapor state by keeping it under vacuum and giving a low heat treatment. Freeze drying of meat is carried out in three steps, namely pre-freezing, primary drying and secondary drying.

Meat is first frozen at -40°C , and then it is dried under vacuum for 9-12 h at low temperature in plate heat exchangers at 1-1.5 mm pressure of Hg. Ice crystals get sublimated to water vapors and there is no rise of temperature. In the 1st phase of drying, free and immobilized water of meat, which is freezable and constitutes about 90-95% of total moisture, is removed. Secondary drying is done at high temperature to remove remaining 4-8% bound water. Freeze dried products are packed under vacuum and have very good storage stability. The process has been largely used for the preparation of dehydrate meat soup mixtures.

10.2 Chilling

Micro-organism growth is a temperature dependent process. To avoid it, it is absolutely essential to reduce the temperature of the meat especially in the surface, immediately after dressing. Cooling must therefore be carried out the slaughterhouse itself. This operation is known as primary chilling.

To prevent or even to reduce the deterioration process, practically micro-organism development, chilling process has to be carried out quickly after carcass dousing at the end of slaughter process and the chilled state has to be maintaining until the meat is processed for consumption.

Chilling can be therefore defined as the fundamental operation in applying cold to meat to reduce its temperature quickly. This is done in a cold chamber with the intensive air movement. Rapid cooling of meat surface not only slows and nearly stops the development of surface micro-organism but also reduce the weight loss and the discoloration of the surface owing to hemoglobin oxidation. Different system of primary chilling are in use but air chilling is the most common.

The cold chamber, when the chilling process take place, must have a low air temperature, a high air speed, a high moderate relative humidity and high refrigerating capacity.

Air temperature must be in the region of 0°C with no decrease below -1°C which could be freeze in the meat surface and impair in appearance. Average temp $0-4^{\circ}\text{C}$ is recommended for chilling the carcass.

Air speed can range from 0.25 to 3 m/sec. however, for economical reason the most

common speed in use are from 0.75 to 1.5 m/ sec in the empty section of the cold chamber.

Relative humidity during the chilling operation should be kept high to prevent the excessive weight loss. The recommended rate is between 80 and 90 percent though this is most difficult factor to control.

Primary chilling is completed when the warmest point of carcass has reached to the temp of about 7 °C. With the current technology, these temperatures can be arrived at 16-24 hours in small carcass and in less than 48hrs in the large carcass.

Average surface temperatures are obviously much lower reaching 0 °C on the surface within 4hours. This is important to slow the microbial proliferation.

Stored chilled meat is mainly intended to carcass buffer stock between production and consumption. During the storage ageing of meat also occurs which will be dealt later. For hygienic reason, it is recommended the storage condition that 4 °C be used with relative humidity of 85- 95 %. In these condition, ageing also take place in a few hours for poultry, two to four days for pork, four days for mature and two weeks for buff.

Table gives the maximum storage time in which the product can be kept safe and keep their commercial quality during the subsequent marketing period even if this short and in favorable climatic condition.

However, there is wastage and some loss of quality and nutrition value when a meat carcass is stored for the whole period indicated in Table 1. It is therefore recommendation that the storage time should not exceed by much the ripening period required for the different types of meat.

Table: Storage condition for chilled meat and meat products (Animal products)

| Commodities | Temperature (°C) | Relative Humidity (%) | Practical Storage life |
|---------------------|-------------------------|------------------------------|-------------------------------|
| 1. Buff | -1.5 to 0 | 90 | 3-5 weeks |
| 2. Lamb/sheep/ goat | -1 to 0 | 90-95 | 10-15 days |

| | | | |
|------------|-----------|---------|------------|
| 3. Pork | -1.5 to 0 | 90 – 95 | 1- 2 weeks |
| 4. Veal | -1 to 0 | 90 | 1-3 weeks |
| 5. chicken | -1 to 0 | > 90 | 7- 10 days |

10.3 Freezing

Due to perishable nature of Meat products refrigeration is essential to extend the shelf – life. It was found that 4 hours slush ice chilled carcass held at 3⁰C (37.4⁰F) remains edible for more than 9 days. It was also observed that the carcass dipped in 10 p.p.m. of CTC or OTC, the shelf – life was extended by 5 to 8 days. Birds maintained quality for about one week by packing the fresh wrap carcass in ice where facilities for freezing are not available. Technological advances in poultry production and processing influencing quality has been discussed by many researchers. In Nepal, most of the dressed carcasses are transported, packed in crushed ice since refrigerated road transports are very limited. The birds on arrival are sold immediately for consumption due to lack of further handling and storage facilities at the receiving end. It was reported the storage problem of poultry and poultry products under our tropical climate.

Still air – freezing is mostly used for freezing meat products in most places of our country. Blast freezing is also available in few plants. For freezer storage, the preferred temperatures are -40⁰ C (-40⁰F) for the initial quick freeze and -23.8 to 17.8⁰ C (-10 to 0⁰F) in the holding room. These temperatures are low enough to store the frozen meat sufficiently long without affecting the quality. For quick freezing, blast freezing tunnels and individual freezer plates are employed and the carcasses are wrapped in close fitting polyethylene bags. Meat, Chickens and ducks are usually frozen at -40⁰ C (-40⁰F) in air blast at 300 meters /minute (or 1,000' min.). Packed turkeys, because of their greater size, are frozen by immersion in solution of sodium chloride or calcium chloride at -15 to -20⁰C (5 to -4⁰F.). New approaches envisages the conveyance of individual birds through the freezer on a moving belt and quick freezing of packaged material while stacked in standard holding room by means of low temperature.

10.4. Chemicals

Energy intensive freezing operations are the greatest way to preserve carcass, meat and meat products for a longer time, which inhibits bacterial growth, but not the psychrophiles and the spores. Most of these survive freezing and grow during thawing. Traditional methods for preservation of meat by salting and pickling are well accepted procedures. Other chemicals have been used as food additives for preservation of meat but every country has drawn its rules and regulations and established limits for the purpose of prevention of harmful effects to humans. Freeze storage cannot prevent oxidative spoilage and microbial/enzymatic spoilage. Thus, chemical preservation methods are quite beneficial in combination with refrigeration in order to optimize stability, product quality while maintain freshness and nutritional value. Antimicrobial preservatives are substances which are used to extend the shelf life of meat by reducing microbial proliferation during slaughtering, transportation, processing and storage. Growth of bacteria and spoilage of meat is depending on the species of bacteria, nutrients availability, pH, temperature, moisture and gaseous atmosphere. Antimicrobial compounds added during processing should not be used as a substitute for poor processing conditions or to cover up an already spoiled product. They offer a good protection for meat in combination with refrigeration. Common antimicrobial compounds include: chlorides, nitrites, sulfides and organic acids. Freeze storage cannot prevent oxidative spoilage and microbial/enzymatic spoilage.

Thus, chemical preservation methods are quite beneficial in combination with refrigeration in order to optimize stability, product quality while maintain freshness and nutritional value. Several organic acids have been generally recognized as safe. Benzoic acid, citric acid, propionic acid, sorbic acid and their salts are effective mold inhibitors. Acetic acid and lactic acid prevent the bacterial growth whereas sorbate and acetate are capable of arresting the growth of yeasts in food. Ascorbic acid (vitamin C), sodium ascorbate and D-isoascorbate (erythorbate) have been used as meat preservatives. Their antioxidant properties can oxidize reactive oxygen species producing water. Ascorbic acid has been shown to enhance antimicrobial activity of sulfites and nitrites. The enhanced activities include both

the antioxidant properties and the sequestering of iron. Benzoic acid and sodium benzoate are also used as preservatives in the meat industry. The un-dissociated molecule of benzoic acid is responsible for its antibacterial activity. The benzoic acid is generally used to inhibit yeasts and fungi rather than bacteria.

10.5. Irradiation

The chief handicap of irradiated food lies in the undesirable side reactions which occur as a result of the radiation. These include change of flavour, color, texture and destruction of some nutrients which has been observed by the researchers. The sources of radiation for food preservation are beta particles, cathode rays (or electrons), gamma rays, X-rays and neutrons. The cost of high energy radiation are very expensive and highly trained personal are required It is reported that both Gamma and electron beams destroy spoilage organisms.

Effect on nutritive value, production possibility of toxic substances, carcinogens and radio – active in irradiated food product are some of the general criteria use to measure the wholesomeness of irradiated food. Food can preserved by radiation does which kill organisms by sterilizing and by pasteurization. Radiation can also be used as a component in combination with other methods of preservation such as chemical additives or with heat to reduce microbial load or make microorganisms more sensitive to radiation. The shelf – life, safety, acceptability and costs are the factors to be considered for the radiation preservation of poultry meat. Products which show minimal odour and color change, and it is likely that application of irradiation to those may prove favorable.

Assignment

1. What do you mean by preservation of meat?
2. Meaning about the preservation of meat and mention its types.
3. Describe the preservation method of drying process by meat and meat product.
4. Describe the chilling and freezing method of preservation of meat and meat product.
5. Meaning abbot radiation and describe in briefly.

Unit: 11

Local delicacies of meat

Objectives

- To know the nutritive value of local delicacies meat.
- To know the process of Sekuwa, Choyla, Sukuti etc

Introduction and process

Sukuti

Sukuti is an indigenous dried meat product especially from buffalo lean meat. In the traditional method, lean meat is cut into strips and hung over the fireplace in the kitchen, and subjected to heat and smoke of the burning woods till the strips become adequately dry and hard. It can also be prepared by air drying or sun drying but drying and smoking over fireplace impacts more characteristic, pleasant taste and texture than sun-dried or air dried counterpart.

Most of the sukuti available in the local markets are air dry, sun dried or smoke-dried, which should be cooked prior to consumption steamed and dry sukuti is also available in the markets that need not be cooked before consumption. However it is very common in the market. There are several styles of eating sukuti but one of the more general styles is by roasting it in burning coal. The sukuti chips are then mixed with tomato chutney, ground spices, chilli, sauce, onion, garlic, salt etc. (a/c to local taste), and served while sukuti is still brittle. It is very delicious and goes well with jand, raksi or commercial beer.

In Nepal, buffalo meat is abundantly found in the market. It is also cheaper than any other meats. Most of the portion is lean and is therefore suitable for sukuti preparation. Sukuti preparation can be considered a traditional, low cost meat preservation method and is generally carried out in the home scale. It is a very popular food item and is within the reach of have not's also. Sukuti is mostly consumed in Eastern regions and Kathmandu valley of Nepal.

Sukuti can be processed and preserved easily at home. The moisture content of the final product is 10% (water activity, 0.5), where micro growth is impossible in a

package in an appropriate package i.e. else it should be kept over fireplace where it is frequently exposed to heat and smoke besides carting taste, smoking also has preservative effect.

Processing

Dried meat products have a history of more than 1000 years in china. During the lung dynasty (960-1279AD), about 200 types of dried meat products based on red meat , poultry and fish were known. In Nepal there is lack of such documented record. The general method of sukuti preparation is discussed in the following sections. The proximate composition of sukuti is given below

| Parameter | Value, % |
|-----------|----------|
| Moisture | 8-10 |
| Protein | 75-77 |
| Fat | 4-5 |
| Ash | 5-6 |

Slaughtering

Local butcher slaughter the buffaloes in an open ground by traditional method. In general the buffaloes are stunned by direct blow in the skull using a pole axe, then held by sticking the major arteries of the neck immediately. jhatka (deheading with heavy knife) method is rarely used. The most objectionable thing is that there is lack of slaughter hygiene and no provision of modern slaughtering. So, meat often becomes contaminated with dust, mud, etc. leading to entry of different types of spoilage and pathogenic microorganism in the meat. The buffaloes themselves may be suffering from zoonotic disease which are very dangerous for human health.

Cutting and trimming

In general hind quarter portion is taken for the preparation of sukuti. However, forequarter and sirloin parts can be used. Bones, fat and other undesirable portions are removed.

Strip preparation

There is no any fixed standard dimension for meat strips. In general they are

stripped in the dimensions of approximately (250mm. 20mm.20mm)

Smoking and drying

Traditionally these meat strips are hung over a fireplace of the kitchen where the strips dry due to the mild heat and smoke produced whilst the meal is cooked. Sometimes air and sun drying may be used. A typical sun dried product requires a drying time of 3-10days.

Packaging and storing

In the rural area, some people still used perunga (a bag prepared by weaving bamboo strips) as a packaging materials. Perungo (along with the product) is often hung in the andiron for storage however, perungo is less suitable than plastic packaging. There are some advantage as well disadvantage related to sukuti. Advantage includes simplicity of the process and shelf stable nature of the product. Disadvantage includes variable quality, poor hygienic practice and danger of carcinogens developed during smoking. The variability in meat quality is explicable because buffalo are seldom raised for meat purpose.

Sekuwa

Sekuwa in a strict sense is not a traditional products of Nepal. Normally, lean meat from goat, chicken or buffalo is used. Lean meat is cut into sizes suitable for skewering. It is then mixed with seasonings (garlic paste, ginger paste, chillipowder, mustard oil, and salt) and left for curing for 2-4 hrs. The meatpieces are then skewered and roasted over burning coal. Sekuwa goes well with alcoholic drinks and isbest when served hot.

Choyla

It is a buffalo lean meat delicacy prepared by the newar community of Nepal. These days, choyla prepared has taken a semi-commercial shape and is available in many restaurants and bars. Dependingon the method of preparation, there are two types of choyla, viz.

1. Prepared from boiled lean meat,
2. Prepared from scorched lean meat

The methods for the preparation of both the choyla types are given

In particular, choyla prepared by scorching deserves special mention because scorching is done in a very unique way. The meat strips are kept within the folds of paddy straw and then the latter is ignited. The fire scorches the meat strips and imparts a very characteristic sooty color and taste to the meat. In Newari dialect, scorched choyla is called Huku chhoyla, where Huku means black.

Kachila

Kachila is a special lean meat dish prepared on special occasions in the Newari community. The lean meat is obtained from different sources, such as buffalo, chicken, and goat. The term kachila is derived from kacho or kach which implies raw. An unusual feature of kachila preparation is that the final product is raw (neither boiled nor roasted). This practice of consuming raw meat immediately invites doubts regarding safety of kachila because the slaughtering practice as well as animal health is often far from satisfactory. However, there is no recorded incidence that substantiates this fear. The liberal amount of different spices used in the recipe may have a role in the safety of kachila.

Assignment

1. Describe the nutritive value of delicacies meat product.
2. Describe the nutritive value of sekuwa and making process.

Unit: 12

Nutritive values of meat and meat product

Objectives

- To know nutritive values of meat and meat product.
- To know values of protein, vitamin, minerals, fats etc

Nutritive values of meat and meat product

Nutrient Content of Meat

- High biological value protein
- Important micronutrients essential for good health
- Most healthy, balanced diets will include lean meat

Energy Content of Meat

- Energy provider of meat is variable.
- Meat contains:
 - virtually no carbohydrate
 - principally protein - 17kJ/4kcal per g.
 - variable fat - 37kJ/9kcal per g (↑ fat content= ↑energy)

Protein Content of Meat

- Dietary protein is required for growth, maintenance and repair of the body and can also provide energy
- Red meat contains on average
 - 20-24g of protein per 100g (raw)
 - 27-35g of protein per 100g (cooked)
- When meat is cooked water content decreased and nutrients become more concentrated so protein increased
- In most developed countries average protein intakes for all age groups are above requirements
- Reference nutrient intake for adults: 55g/day (men), 45g/day (women)
- Proteins from animal sources contain the full range of essential amino acids required for an adult's diet

- Meat & meat products (incl. poultry) contribute to 40% (men) and 35% (women) of average daily protein intake in adults (NDNS 2008/10 data).

Fat Content of Meat

Supplies rich source of energy and essential nutrients such as fat-soluble vitamins and essential fatty acids

Fat in meat is present as intramuscular fat (between the muscles), intramuscular fat (or marbling i.e. within the muscles) and subcutaneous fat (below the skin).

B vitamins

- Function: B vitamins work as co-factors in different enzyme systems in the body
- Meat and animal derived foods are naturally a rich source of B12
- Meat and animal derived foods make an important contribution to B12 intakes
- It has been shown consistently that vegetarians and esp. vegans have low dietary intakes of B12
- Meat also contains thiamin (B1), riboflavin (B2), niacin (B3), folate and B6

Vitamin D

- Function: essential for the development and maintenance of bone
- Many individuals have low vitamin D status
- Dermal synthesis is the best source and therefore dietary supply of vitamin D is important for housebound people and individuals who wear concealing clothing
- Meat and liver can provide substantial quantities of 25 (OH)D3 (vitamin D metabolite) which is thought to have high biological activity and be readily absorbable

Vitamin A

- Function : Normal structure and function of the skin and body linings e.g. in lungs, normal growth and development, vision and the immune system
- Source: offal, in particular liver can be an excellent source (retinol) but content can be variable (age of animal, composition of feed)
- Note: very high doses many have adverse health effects

Vitamin E

Function: As an antioxidant protecting the body's cells against damage

- Small amounts of vitamin E in meat
- Due to the fat soluble nature of vitamin E, fatter cuts of meat will have a higher content of this vitamin
- Introduction of seed oils in animals diets ↑ vitamin E content of the meat

Iron

Function: Important as an oxygen carrier in haemoglobin in blood, or myoglobin in muscle, and is also required for many metabolic processes

- Meat is a rich source of bio-available iron (heme iron)
- Non-heme iron is susceptible to factors affecting its bioavailability (e.g. phytate)
- Meat and meat products provide 19% (men) and 15% (women) to average daily intake of iron (NDNS)
- Vulnerable groups – infants, girls/women of reproductive age.

Zinc

Function: Is essential for cell division and therefore for growth and tissue repair. Also necessary for normal reproductive development, immune system and healing of wounds.

- Meat is a source of bio-available zinc
- In the UK, meat and meat products provide ~ 34%
- Some concerns regarding low intakes of zinc among sub-groups of UK population(adolescent girls).

Selenium

Function: Acts as an antioxidant, necessary for the use of iodine in thyroid hormone production, immune system function

- Meat is a useful source of selenium, esp. red meat (dependent on diet of livestock and soil)

Processed meats and meat products

- In general processed meats and meat products are more likely to contain a

higher content of sodium than lean meat

- However they can provide extra nutrients not typically found in meat (carbohydrate, fibre)
- The addition of sodium enhances and modifies the flavour, physical properties and contributes to the preservation of the product
- The food industry is constantly working to reduce the amount of salt in processed meat products

Assignment

Describe the nutritive value of meat and meat product.

Unit: 13

Handling Carcass

Objectives

- To know the handling of meat carcass
- To know the handling of cooling, freezing and preservation of meat carcass
- To know the handling on packing, storage and distribution of meat carcass

Handling of meat carcass

The main principle of animal handling is to avoid getting the animal excited. Physically fit animals that are to be slaughtered within 24 hours must be conveyed direct to Lairage for rest. During the resting period any excitement must be avoid. Feed must be kept away from the animals at least during eight hours before slaughter. However, fresh clean water may be provided throughout the resting time. Ante-mortem inspection should be made during this period or about 12 hours before the animals are delivered to the killing floor. Rest is important because when animals are overworked or fatigued carcasses of lower quality result from slaughter. Time must therefore be allowed for the gut to empty itself of bulk at which time fewer nutrient as possible will be present in the blood stream and the cells of the body. With this, spoilage bacteria act less on the carcass, thus reducing the incidence of off-taste and souring. It should be noted further that when a great deal of food is present in the gut, it makes evisceration difficult. Conversely, an empty gut reduces viscera size and makes its removal easier. It also lessens the possibility of spilling the contents of the gut on to the carcass, thus facilitating its cleaning, while eliminating contamination.

13.1 Preservation

Meat products supply has to keep pace with the needs of the population. There is always a shortage of food in developing countries because of the demands of the increasing population. With Increasing meat and meat products production the surplus of products need to store but this storage results in wastage due to inadequate facilities available for storage (Cold Storage) and preservation. Preservation increases availability of meat and meat products, thus improving the

nutrition of the people. Availability meat and meat products throughout the year also helps in stabilizing prices of such products.

Thermal processing for preservation of meat products

The potential source of marketing canned product can be expected from the Armed Forces, consumers demand in cosmopolitan cities and places where refrigeration facilities are not available. In future, canned poultry products may be exported to neighboring countries at competitive price.

Well – fleshed and finished carcass are suitable for canning. Clean meat cuts, after chilling, should preferably be used for canning and the carcass should not be held for long periods under conditions that facilitate bacterial development. Whole-bird or cut-up-parts are suitable for canning. In brief, the process consists of preparing meat, whole or cut-pieces or joints, filling in the sterilized cans with gravy, raw meat or semi-cooked meat curry, thermal exhausting, sealing, processing, cooling and incubation of representative samples of fully processed product. Care should be taken to prevent under-processing. Optimum time and temperature of processing, kind and maturity of birds' formulations to suit different sections of consumers are to be standardized. The cans were processed at 15 psi. for 75 minutes and cooled.

Preservation by curing and Smoking of Meat

Cured and smoked meat products are well known for its delicacy. Curing and smoking extend the shelf life of the products, improve the flavor and tastes, and transport is easy. The ingredients used in curing solutions are salt, sugar, salt peter, spices and condiments. Phenolic compounds are one of the principle constituents of smoke flavor of meat. Time, temperature and quantity of smoke are important factors. It is reported that smoke generated from hard-wood increases the shelf life and acceptability of the poultry products.

The methods used for curing are:

1. The carcass may be cured in sugar and salt brine and then smoked using hard wood
2. Processed in brine in which salt has been smoked (Liquid Smoking)

3. Stitching or pumping curing materials not more than 10 % of body weight

Dry curing.

The salt is astringent and bactericidal. Sugar counter acts dehydrating and toughening action of salt and help fixation of color. Salt acts as preservative and help retention of natural color of meat (Potassium nitrite). Spices and condiments are added to enhance the flavor and taste. Nitrates are responsible for the pink color of the meat. The nitrite reacts with hemoglobin found in the meat to form nitrosohaemoglobin (Color Fixation) by smoking.

13.2 Cooling and freezing

Due to perishable nature of Meat products refrigeration is essential to extend the shelf – life. It was found that 4 hours slush ice chilled carcass held at 3⁰C (37.4⁰F) remains edible for more than 9 days. It was also observed that the carcass dipped in 10 p.p.m. of CTC or OTC, the shelf-life was extended by 5 to 8 days. Birds maintained quality for about one week by packing the fresh wrap carcass in ice where facilities for freezing are not available. Technological advances in poultry production and processing influencing quality has been discussed by many researchers. In Nepal, most of the dressed carcasses are transported, packed in crushed ice since refrigerated road transports are very limited. The birds on arrival are sold immediately for consumption due to lack of further handling and storage facilities at the receiving end. It was reported the storage problem of poultry and poultry products under our tropical climate.

Still air – freezing is mostly used for freezing meat products in most places of our country. Blast freezing is also available in few plants. For freezer storage, the preferred temperatures are -40⁰ C (-40⁰F) for the initial quick freeze and -23.8 to 17.8⁰ C (-10 to 0⁰F) in the holding room. These temperatures are low enough to store the frozen meat sufficiently long without affecting the quality. For quick freezing, blast freezing tunnels and individual freezer plates are employed and the carcasses are wrapped in close fitting polyethylene bags. Meat, Chickens and ducks are usually frozen at -40⁰ C (-40⁰F) in air blast at 300 meters/minute (or 1,000' min.). Packed turkeys, because of their greater size, are frozen by immersion in solution of sodium chloride or calcium chloride at -15 to -20⁰C (5 to -4⁰F.). New approaches

envisages the conveyance of individual birds through the freezer on a moving belt and quick freezing of packaged material while stacked in standard holding room by means of low temperature .

13.3 Packaging, storage and distribution of meat carcass

Slaughtering Procedure for livestock animal (Packaging, storage and distribution of meat carcass)

| | |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 1: Reception Area | |
| Animal in Lairage | Details |
| Cleaning | Lairage should be cleaned daily |
| Watering | Animals should have water but be fasted for 24 hours |
| Resting | Give resting time as per following schedule Transportation from farm to slaughterhouse: 2 hr Transportation by truck from few hours up to one day allow 2 days Walked/driven for a few days: allow several days. |
| A/M Inspection | Ante mortem inspection within 24 hr of slaughter |
| | Select only healthy animals for slaughter |
| Treatment | Avoid beating or any other kind of stressful treatment when holding in lairage or during driving to slaughter hall. Beating bruises the meat and damages the hide. |
| Step 2 : Stunning and Bleeding | |
| Stun | Use a captive bolt stunner |
| Bleeding | Bleed for 3 min, bleeding should be complete |
| Step 3 : Dressing | |
| Hoisting | Hang in the Dressing Rail |
| Skinning | Skinning is done by Skinning knife |
| Care | Exercise extreme care not to contaminate carcass with head and feet. |
| Cleanliness | Ensure outside of skin does not touch carcass |

| | |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Step 4 : Evisceration | |
| Cleanliness | Exercise extreme care not to puncture gut and contaminate carcass with faecal matter and urine. |
| | Repeatedly sterilise knives with steam |
| | Wash carcass after evisceration, free carcass from blood and dirt and any visceral content adhered on the carcass. |
| Step 5 : Meat Hygiene | |
| Post mortem inspection | Inspect both carcass and viscera |
| | Pass only inspected carcass and viscera which is free from disease |
| | Withhold suspected carcass or parts of carcass for detailed investigation |
| | Condemn and dispose of rejected carcass and viscera |
| | Necessary trimming of carcass |
| Grading and Stamping of Carcass | Inspected and passed carcass only |
| Step 6 : Cutting and Packing | |
| Cleanliness | Carcass should be thoroughly washed and free from microbes Total plate count $<10^4$ /gm or cm^2 |
| Weighing | Take weight of each part |
| Preparation of retail cuts, boned meat, minced meat | Meat cutting room temp. 12-15°C |
| Cleanliness | Total plate count $<5 \times 10^6$ /gm or cm^2 |
| Packaging of meat ordinary and vacuum packaging | Packaging room temp. 15°C |
| Step 7 : Chilling/Cold Storage | |
| Chilling | Air temp. 1 to 1°C |
| | Air Speed 1-4m/s |
| | Air RH 85-90% |

| | |
|----------------|----------------------------------------------------------------------------------------------------------------------------|
| | Lighting: dark room |
| | Core temp (around femur) <math> < 4^{\circ}\text{C}</math> |
| | Core temp should be <math> < 5^{\circ}\text{C}</math> in 48 h |
| Cold storage | Air Temperature 1 to 2 ⁰ C |
| | Air speed 0.1 to 0.3m/s |
| | Air RH 90-95% |
| Freezing | Air temp. -25 ⁰ C |
| | Air speed 2-4m/s or higher |
| | Product core temp-10 ⁰ C |
| Frozen storage | Maintain temp. or 10 ⁰ C invariably during frozen storage in freezer storage or transportation or distribution. |
| | Store under conditions of light air movement and darkness |

- Maximum storage period of two weeks at 0 to 2⁰C, 90 to 95%RH and air speed of 0.1 to 0.3m/s
- Vacuum packed met chilled at 2⁰C and held at 2⁰C keeps well for up to 3 weeks. Hence it depends upon marketing process whether to chill or freeze the meat carcass temperature <math> < 14^{\circ}\text{C}</math> (and pH >6.8).

Assessment

1. What do you understand by handling of meat carcass.
2. What do you mean by preservation of meat and meat product and elaborate the process of preservation.
3. Mention the packaging, storage and distribution of meat and meat product in slaughtering process.

Unit: 14

Meat by-product and their uses

Objectives

- To know about the edible by-product and their uses of meat
- To know about the inedible by-product and their uses of meat

Introduction

By-products may be divided into two categorizes

1. Edible By-product
2. Inedible By-product

The more important types of by-products belonging to these groups and some of the uses of these by-products are summarized in Table III and Table IV as below;

Enlist the edible meat of dressed carcass and their uses

Table III. Edible By-products and their uses

| S.N. | Raw By-products | Processed products | By- Use |
|------|------------------|-----------------------------------------------------|----------------------------------------------------------------------------|
| 1 | Edible Fat | Edible Fat Oleo Oil Oleostearin Cracklings | Frying Purpose Shortening Candy, Chewing Gum Pet food, meat, meal |
| 2 | Liver and Kidney | | Edible-liver paste |
| 3 | Heart | | Edible |
| 4 | Tongues | | Edible |
| 5 | Edible Raw Blood | Plasma and red cells | Adhesive for sausages etc, blood sausages or pudding |
| 6 | Feet | Neat's-foot oil, Meal | Fine lubricants Glue & gelatin, Buttons, Jelly, Edible use |
| 7 | Tail | Brush Meal | Industrial use. Jelly |
| 8 | Trimming | | Sausages, Luncheon Meat etc |

| | | | |
|----|------------|-------------|---------------------------------------------------|
| 9 | Raw Bone | Bone pieces | Bone, glue, Shortening, bone meal, soup, gelatine |
| 10 | Intestines | | Sausages casings |
| 11 | Head | | Soup, pet food |
| 12 | Stomach | Edible trip | Edible |

Enlist the inedible meat of dressed carcass and their uses

Table IV : Inedible By-products and some of their uses

| S.N. | Raw By-products | Processed By-products | Use |
|------|-----------------|-----------------------|--------------------------------------------------------------------------------------------|
| 1 | Inedible Blood | Blood meal | Adhesive for livestock and poultry feed, pet food fertilizer glue, foam fire extinguishers |
| 2 | Feet | Meal | Pet food, fertilizer, animal feed |
| 3 | Head | Meal | Meat Meal. Pharmaceuticals |
| 4 | Ears | Meal | Meat Meal. Pharmaceuticals |
| 5 | Windpipes | Meal | Meat Meal. Pharmaceuticals |
| 6 | Lungs | Meal | Meat Meal. Pharmaceuticals |
| 7 | Spleen | Meal | Meat Meal. Pharmaceuticals |
| 8 | Udders | Meal | Meat Meal. Pharmaceuticals |
| 9 | Fetus | Meal | Meat Meal. Pharmaceuticals |
| 10 | Intestines | | Animals feed, Surgical sutures, heparin, casings, tennis racket string, music strings |
| 11 | Tails | Meal | Animal feed |
| 12 | Bone | | Glue, Shortening, bone meal, gelatin, ornaments, fertilizer |

| | | | |
|----|-----------------------------|--------------|------------------------------------------------------------------------------|
| 13 | Fat | Inedible fat | Adhesive for livestock and poultry feed, lubricants, soaps, candle, glycerin |
| 14 | Trimming & Floor sweepings | | Animal feed, Pet food, glue, gelatin |
| 15 | Hides & Skins | | Leather goods, Collagen casings, Felt, upholstery, |
| 16 | Hairs and wool | | Felts, Carpets, Brush, Animal feed |
| 17 | Feathers | | Animal feed, Stuffing, Bedding |
| 18 | Horns and Hoofs | | Buckles, Comb, ornaments, animal feed, fertilizer |
| 19 | Wool | | Clothing |
| 20 | Gland | | Pharmaceutical products |
| 21 | Stomach & Intestine content | | Fertilizer, Animal Feed |
| 22 | Condemned and dead stock | Rendering | Livestock and poultry feed |
| 23 | Waste water | | Fertilizer |

Assignment

1. What do you mean by edible and inedible by product ?
2. List out the edible by product of meat and its uses.
3. List out the inedible by product meat and its uses against potential danger of infections from the waste materials reaching the public or contaminating the environment. In process of slaughtering large quantities of slaughterhouse wastage and produced which need to be properly handled to avoid pollution?

Location/Site for the Slaughterhouse

With increasing industrialization and population growth in the urban areas, it is better to locate the abattoir nearer to producing area. This holds training even for

the municipal area. An abattoir should be located outside or on the periphery of a city or town. Care should be taken to see that the site has:

- Sufficient land area for the abattoir to be well laid out
- Easy access for the patrons and in-coming animals
- Availability of water discharge channel
- Neighbors (Zoning)- Agricultural/Industrial, Non residential/commercial, Adaptability, Health hazard, Source of contamination
- Good road access for the transport of meat to the market place.
- Key services such as sufficient potable water, electricity, drainage
- Disposal facilities for waste so that the environment is not affected and neighbours are not offended.

Layout plan

The organized slaughterhouse should have the following facilities:-

- Animal reception area or resting ground
- Lairages or pens where animals are held just prior to slaughter
- Slaughter hall
- Meat holding area
- Ancillary areas
- Administration, and staff amenities
- Refrigeration room (optional)
- By-product utilization area
- Effluent treatment (waste disposal area)

Area requirements of different purpose of working

Holding area:

Buffalo- 3 sq m per head (32.27 sq. ft)

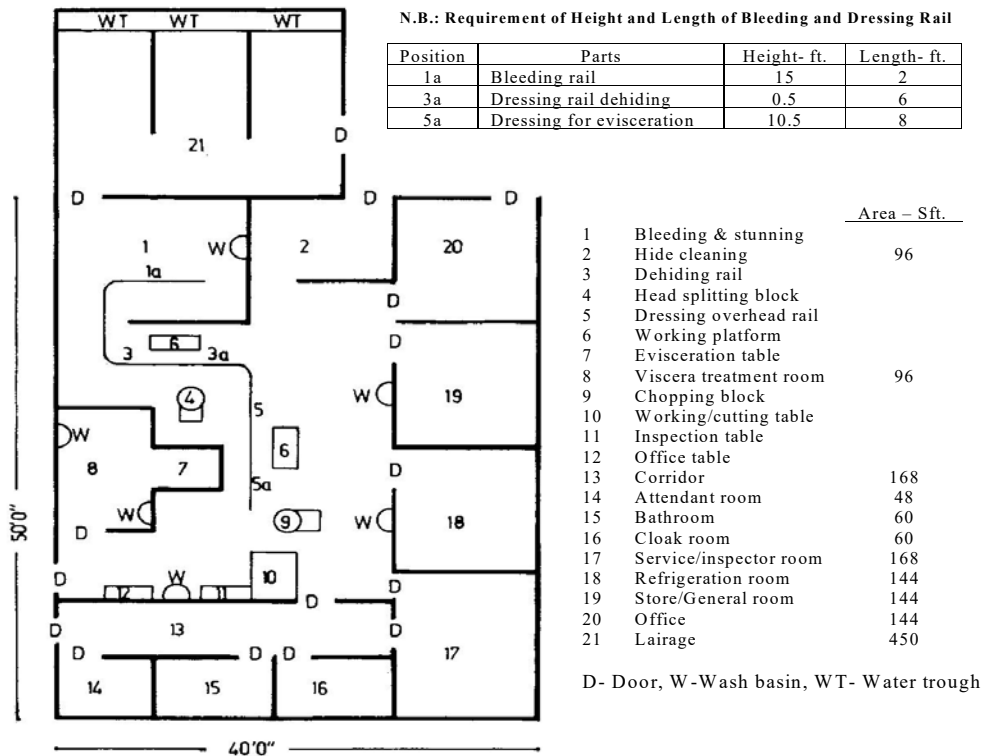
Pig- 2 sq. m per head (21.51 sq.ft)

Goat- 1 sq.m per head (10.76 sq.ft)

Kill floor

Buffalo

A typical layout plan for slaughtering the buffalo is shown in Fig. The size of the layout plan can be adjusted as the capacity to be installed.



Layout Plan for Buff Slaughter Unit

General Principles of Abattoir Design

It has earlier stated that the slaughterhouse is concerned with the processing of one or several classes of livestock into meat for human consumption. Hence, care should be taken while designing the slaughterhouse so that the adverse effects should be occur or numerous disease and contaminated from human beings or environment. Therefore essential factor such as production economics, utility or aesthetics the design of the slaughterhouse must always satisfy hygienic requirement as prescribed by meat regulation (slaughterhouse and meat inspection regulation 057). The following parameters should be met while designing the slaughter house.

- Humane considerations in animal slaughter
- Hygienic processing and storage of meat and edible by product
- Reclamation (recycle) of inedible by-products
- Amenities for employees
- Livestock facilities

An abattoir comprises several distinct units and there is a need for adequate separation between clean and unclean areas. For example, there must be no direct access between the lairage and the slaughter hall and meat holding areas.

The following separate areas are required in an abattoir:

- Holding place for animals prior to slaughter
- Adequate facilities for ante-mortem, examination
- Stunning pen for humane slaughtering
- Equipment and hoist for dehiding, dressing and washing of the carcasses off the floor
- Places for hanging carcasses and edible offal
- Place for handling by-products
- Provision for post-mortem inspection of meat
- Place for disposal of meat unfit for human consumption and wastes (gut contents, heads, legs etc)
- Separate toilet block and wash room for workers
- An office and administration room
- Adequate utilities (water, electricity, drainage and sewage)

Reception area or resting ground

The abattoir should have a reception area of adequate size, where animals are subjected to veterinary ante mortem inspection. The reception area should have facilities for adequate supply of drinking water for animals, and have overhead shelter from the sun and rain.

Lairage (pre-slaughter holding area)

The lairage shall be adequate in size for the number of animals to be laired. The space provided in the pen shall not be less than 3.3 m² per buffalo. The lairage shall

be so constructed as to protect the animals from heat, cold and rain and have adequate facilities for watering and ante-mortem examination.

Slaughter hall

A separate space with crush pen for restraint shall be provided for stunning and bleeding the animal. Dressing of carcass should not be done on the floor. This is hard on workers and is the first major point of contamination of the meat. The slaughter hall should have sufficient height and building strength to allow the use of a hoist so that the animal can be hoisted by its hind legs off the floor for dehiding. Adequate means of access (ladders and platforms) and hand tools for dressing of the animal should be provided.

Rails for the hooks made of suitable rust-proof metal or mild steel with sufficient strength for hanging the carcass. The height and length of rails provided for bleeding and dressing shall be in accordance with as follow.

Requirement of height and length of bleeding and dressing rails (based on 10-12 animals per hrs.)

| S.N. | Animals | Bleeding Rail (Ft.) | Dressing Rail for Legging & Dehiding/ Singeing | Dressing for Evisceration and Further Processing |
|-------------|-------------------------------------------|----------------------------|-----------------------------------------------------------|---------------------------------------------------------|
| 1 | Buff (more than 450 kg.) Ht. Length | 15 2 | 10.5 6.0 | 10.5 8.0 |
| 2 | Young buff (> 450 kg.) Ht. Length | 13 2 | 9.5 5.0 | 9.5 7.5 |
| 3 | Pig Ht. Length | 10.5 2 | 7.8 4.0 | 7.8 6.0 |
| 4 | Sheep/Goat Ht. Length | 6.5 1.5 | 5.3 3.5 | 5.3 4.5 |

Construction Materials Specification

The specification of the materials that has to be considered for construction of

slaughter house is listed below:

1. Floors

The floor should be durable, smooth but not slippery, non-absorbent, and easy to clean and to maintain. Brick, tiles, concrete or other imperviously waterproof materials are suitable base for floors. The best surface is made from well laid concrete of good strength and quality. There should be drainage to gully traps and floor drains to carry the liquid wastes to an outside disposal point.

2. Walls

The inner walls and pillars should be covered with materials which facilitate easy washing, cleaning and good upkeep. Walls should be light colored to aid in the distribution of light to facilitate through cleaning. Glazed tiles, smooth cement plaster, rust proof metal panels or smooth plastic panels are all acceptable. They can all be effectively cleaned and sanitized.

3. Roof/Ceiling

Roof/Ceiling should also be light colored to aid in the distribution of light. Materials used should be either G.I. Sheet or transparent plastic/fiber glass roofing. The ceiling should have panels that let through light, be smooth, free from any scaling or moisture that may fall into the meat product. They should also be made of moisture resistant material that is easy to clean.

4. Windows - Light and Ventilation

There should be sufficient windows to provide light even on dull days. All windows must be fitted with fly-proof screens and arrangements made for them to be pest proof. Windows must be so designed that the sufficient ventilation is available to reduce smells, reduce temperatures in warmer weather, and to improve the easiness of working.

5. Premises Yard

The premises yard should be kept neat and clean and efforts made to improve appearance. Boundary planting with trees or a wall with interior planting is advisable. The intention is to provide an attractive working environment but also because settlement invariably comes to surround an abattoir and an attractive

surrounding reduces the risk of objections from neighbors.

Assignment

1. What do you mean by slaughterhouse?
2. Mention the need of slaughterhouse.
3. Describe the design and construction of slaughter house.

Unit: 16

Meat quality

Objectives

- To know quality meat and meat product
- To know the kind and class meat and meat product
- To know the color and structure of lean meat
- To know the maturity and marbling of meat

Meat quality

The energy required for muscle activity in live animal is obtained from sugars (Glycogen) in the Muscle. In the healthy animal, the glycogen content of muscle is high. After the animal has been slaughtered, the glycogen in the muscle is converted into lactic acid and the muscle and carcass becomes firm. The process is called Rigor Mortis. Rigor mortis process depends on glycogen content and creatine phosphate. This lactic acid is necessary to produce meat which is tasteful and tender, of good keeping quality and good meat color. If the animal is stressed before and during slaughter, the glycogen is used up and the lactic acid level that develops in the meat after is reduced. This will have serious adverse effects on meat quality.

16.1 kind and class of meat

Meat quality is normally defined by the compositional quality (lean to fat ratio) and the palatability factors such as visual appearance, smell, firmness, juiciness, tenderness, and flavour. The nutritional quality of meat is objective yet "eating" quality, as perceived by the consumer, is highly subjective.

Visual Identification

The visual identification of quality meat is based on colour, marbling and waterholding capacity. Marbling is small streaks of fat that are found within the muscle and can be seen in the meat cut. Marbling has a beneficial effect on juiciness and flavour of meat. Meat should have a normal colour that is uniform throughout the entire cut. Beef, lamb, and pork should also have marbling throughout the meat.

Smell

Another quality factor is smell. The product should have a normal smell. This will be different for each of the species (i.e. beef, pork, chicken), but should vary only slightly within the species. Any rancid or strange smelling meat should be avoided.

Firmness

Meat should appear firm rather than soft. When handling the retail package, it should be firm, but not tough. It should give under pressure, but not actually be soft.

Juiciness

Juiciness depends on the amount of water retained in a cooked meat product. Juiciness increases flavour, helps soften meat - making it easier to chew, and stimulates saliva production in the mouth. Water retention and lipid content determine juiciness. Marbling and fat around edges helps hold in water. Water losses are from evaporation and drip losses. Meat aging can increase water retention and therefore increases juiciness.

Tenderness

Has been linked to several factors, such as the animal's age, sex or the muscle location. One important way to tenderize meat is by aging. Carcasses are aged by holding them at refrigeration temperatures for extended periods of time after slaughter and initial chilling.

Flavour

Flavour and aroma are intertwined to create the sensation the consumer has during eating. These perceptions rely on the smell through the nose and on the sensations of salty, sweet, sour and bitter on the tongue. Meat flavour is affected by type of species, diet, cooking method and method of preservation (e.g. smoked or cured).

16.2. Maturity

Maturity refers to the physiological age of the animal rather than the chronological age. Because the chronological age is virtually never known, physiological maturity is used; and the indicators are bone characteristics, ossification of cartilage, color and texture of ribeye muscle. Cartilage becomes bone, lean color darkens and

texture becomes coarser with increasing age. Cartilage and bone maturity receives more emphasis because lean color and texture can be affected by other postmortem factors.

Cartilage evaluated in determining beef carcass physiological maturity are those associated with the vertebrae of the backbone, except the cervical (neck). Thus the cartilage between and on the dorsal edges of the individual sacral and lumbar vertebrae as well as the cartilage located on the dorsal surface of the spinous processes of the thoracic vertebrae (buttons). Cartilage in all these areas are considered in arriving at the maturity group. The buttons are the most prominent, softest and least ossified in the younger carcasses. As maturity proceeds from A to E, progressively more and more ossification becomes evident. Ribs are quite round and red in A maturity carcasses, whereas E maturity carcasses have wide and flat ribs. Redness of the ribs gradually decreases with advancing age in maturity, and they generally become white in color because they no longer manufacture red blood cells and remain white thereafter. Color and texture of the longissimus muscle are used to determine carcass maturity when these characteristics differ sufficiently from normal.

There is a posterior-anterior progression in maturity. Thus, ossification begins in the sacral region and with advancing age proceeds to the lumbar region and then even later it begins in the thoracic region (buttons) of the carcass. Because of this posterior-anterior progression of ossification, even young a maturity carcasses will have some ossification in the sacral cartilage.

16.3. Marbling

Marbling is the visible unsaturated (healthy) intramuscular fat that accumulates within the muscle and between the muscle fibre bundles. Visually, marbling is soft intramuscular (between the muscle fibre) fat made up of polyunsaturated, monounsaturated and saturated fats.

At chiller temperatures, marbled fat appears white and will become less obvious as the meat comes up to room temperature with unsaturated fats beginning to melt.

How does it happen?

Marbling is determined by both genetics and nutrition. Generally, Wagyu will develop considerably more marbling than other breeds. Most are feedlot fed on carefully designed rations of straw for roughage, and grain for protein and carbohydrates.

Cow meat

The presence of marbling has an extremely positive effect on the eating quality of beef, in terms of tenderness, juiciness/moisture and flavour.

The fat makes the meat softer and easier to chew, as there is simply less muscle fibre and collagen per unit volume of meat. This decreases the amount of chewing required, leading to a more rapid breakdown of the food, and greater flavour release.

A small study also found that when specifically Wagyu and Angus steaks had more than 10 per cent intramuscular fat, the steak had significantly higher Flavour Volatiles – a measure of the taste intensity.

Change the flavour

What's that old anecdote? No fat, no flavour. With a higher fat content, perceived sweetness will increase, a higher oily mouth-coating will become more obvious, and the sour/acidity or acidic aftertaste and lingering aftertaste decreases.

When eating meat with a higher marble score, a more noticeable amount of meat juice (liquid fat and saliva) is produced, compared when eating lower marble score grade meats.

With a more rapid breakdown of the food, we experience a greater flavour release, and are more likely to get a higher peak flavour concentration.

16.3. Color and structure of lean meat

| Meat | Meat color | Consistency | Fat color | Fat quality |
|-------------|-----------------------------------|----------------|------------|---------------------------------------------------|
| Chevon | Light pink to red, goaty odor | Very firm | Pure white | -Particularly no marbling fat -very firm |
| Mutton/lamb | Light to dark red, ammonical odor | Firm and dense | White | -Abundant marbling fat -Very firm and flakier. |

| | | | | |
|------------|------------------------------------------------------------|-----------|------------------------------|-----------------------------------------------------|
| Buff | Dark red | Firm | Pure white, dry, less sticky | Fairly firm |
| Pork | Young: Whitish grey to Light red Old: dark red in color | Very soft | white | Subcutaneous fat deposition, presence of marble fat |
| Poultry | White to pale white | Firm | Yellow | Mostly subcutaneous fat |
| Horse meat | Dark red and sticky, sweet and repulsing odor | Firm | Yellowish white | Soft and smears |
| Dog meat | Red soft and smeary, doggy odor | Firm | White to whitish gray | Oily and greasy |

Structure of Muscle Tissue

Animal musculature is mostly of mesoderm organ. There is more than 300 animal's body. Their muscle constitute about 30 – 45% of live wt. or 35 – 60% of the carcass wt. of meat animals.

In general skeletal muscles are directly attached to the bone, although bone attach indirectly via ligament, cartilage, fascia and skin. Each muscle surrounded by a sheath of connective tissues known as epimysium. From the inner surface of epimysium, spectrums of connection tissue penetrate into muscle and surround the bundle of muscle fibers. The connection tissue is called perimysium. It contains major blood vessels and nerves. Each muscle fiber is surrounded by a connective tissue layer called endomysium beneath which is delicate sarcolemma or muscle cell membrane. It transmits nervous signals along the surface of muscle fiber.

Skeletal muscle fibers are long, narrow, almost tabular multinucleated cells which may extend from an end to the other end of the muscle. The nuclei are distributed peripherally close to the sarcolemma muscle fiber are usually 10 – 100 in. diameter with conical or tapering ends and their length range from 1 – 40 mm. The individual fiber may also be classified as red, intermediate and white. Most animals muscle contains a mixture of these three types.

When viewed under the light microscope, skeletal muscle appears striated, with alternate dark and light areas. Because the light band is singly refractile or isotropic when viewed with polarized light is called I band. The dark band is doubly refractile or anti isotropic and is called A - band. These bands differ in density of protein, Close observation shows the I – band to be bisected by a thin dark line called Z-

line. The A –Band has region in the center with a lighter color termed the H – Zone and a dense narrow band its center called the M – line.

Size of A – band are approximate 14 – 16 μm in diameter and 1.5 μm in length. I – band contains thin filament and extend about 1 μm to either side of Z- line. These thick and their filaments consist of contractile protein myosin and actin respectively. The muscle fiber in an intricate and well designed mechanic for converting chemical energy into mechanical energy.

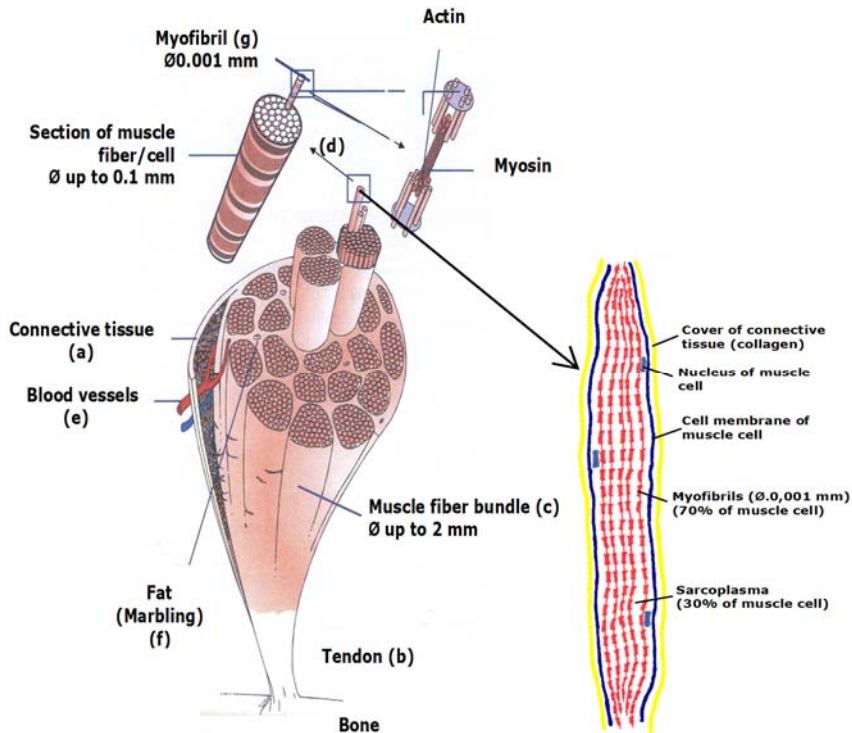


Fig. 1: Muscle structure (skeletal muscle)

Fig. 2: Entire muscle fibre or muscle cell. 0.01-0.1 mm

Fig:16.1

Assessment

1. What do you mean by meat quality?
2. Meaning about marbling and also mention the benefit of marbling meat.
3. Describe the color and different structure of meat.

Unit: 17

Methods of preparation of meat product

Objectives

- To know the preparation of meat ball and rolls.
- To know the idea about the preparation of meat product.
- To know the preparation of corned beef, sausage, becon and ham

Introduction

Most of the meat processed in Nepal is sold by the retail butcher shops to the consumers as fresh hot meat (unchilled). This meat is then cooked in the households in many different ways depending on their taste and preferences. A very small proportion is sold as processed meat.

In fact processing refers to any treatment including salting which brings about a substantial chemical and physical change in the natural state of meat. It imparts comparatively shelf stability to meat. These processed meat products are also consumed by large number of non- vegetarian population of the country.

Basic processing procedure

1. Comminution

All processed meat can be classified as either non-comminuted or comminuted. Non-comminuted products are generally processed from intact cuts and cured, smoked and cooked eg ham and bacon. Comminution refers to reduction of raw meat into meat pieces and particles. Comminution is done with the help of meat mincer for coarse ground product.

2. Emulsification

A mixture of two immiscible liquids where one is dispersed as droplets in another liquid is called emulsion. The emulsion remains unstable if interfacial tension is very high. The emulsion can be stabilized by reducing the interfacial tension with help of emulsifying agent. For preparation of good meat emulsion, lean meat is first chopped with salt to extract salt soluble proteins and then fat and other ingredients are added. Once good meat emulsion is formed, it has to be protected during

cooking so that emulsion breakdown can occur because of coalescence of finely dispersed fat particles into larger ones. The encased emulsion is first exposed to heat at 55⁰C so as to coagulate the coating proteins and stabilize the emulsion.

3. Meat extension

The lot of non-meat items can be incorporated in meat products. These are generally termed as extenders, although these may be referred as fillers, binders, emulsifier or stabilizers depending on purpose of its incorporation. In developing country, potato, soy products and flours are used as fillers, skim milk powder dried whey, sodium caseinate as binders, some gums like sodium alginate, gum arabic as stabilizer.

4. Preblending

It refers to mixing of part or all the curing ingredients (salt,nitrate,nitrites) with ground meat in a specified proportion. It allows better extraction of proteins which help in formulation of stable emulsion.

5. Hot processing

It refers to processing of carcass as soon after slaughter (1-2 hrs) without chilling. It accelerates the processing steps and entire processing time is reduced. There is improvement in cooking yield and sensory quality of product.

6. Cooking

Meat and meat products are cooked by any or combination of three method, ie dry heat ,moistheat and microwave cooking.

Dry heat cooking is accepted for tender cuts of meat such pork chops. It involves broiling (grilling), roasting, or frying.

Moist heat cooking involves hot water or steam is continuously kept in contact with meat for cooking, so that moisture loss does not take place.

Microwave cooking is relatively a recent development, they are high frequency non-ionsing electromagnetic waves.

Some of the popular meat products are as follow

- **Hams:** It is processed in three steps, curing, smoking and cooking. A typical

curing solution consists of

| Ingredients | Quantity |
|--------------------|-----------|
| Table salt | 850g |
| Phosphate | 225g |
| Sucrose | 175g |
| Sodium erythrodate | 15g |
| Sodium nitrate | 8 g |
| Water | 40 liters |

Curing is done by artery pumping or stitch pumping to 10% weight at 4°C for 5 days, ham is then sifted to smoke chamber at 75-85°C and 30-40% relative humidity for 5-6 hours.



Fig:17.1



Fig:17.2

- **Bacon:** pork bellies are first cleared and stitch pumped with a curing pickle, these are then transferred to smoke chamber at 60-65°C and 30-40% for smoking as well as cooking. After smoking and cooking, bacon is chilled to 0°C and facilitates slicing at 5-7 mm.



Fig 17.3

- **Luncheon meat:** It is a canned product usually prepared from pork along with some cereal component. The product contains not less than 80% pork

including pork fat which should not exceed 30% in the final product. Besides, added water is limited to 3% and the cereal ingredients should not exceed 7% of the total formulation.



fig 17.4

- **Meat patties:** Meat patties are generally used as filling for burger roll or sandwich. Patties are partially or completely emulsion based product, contain less than 30% fat and are moulded manually or mechanically.



Fig 17.5

- **Meat loaves:** This meat product can be made either from coarse ground meat or meat emulsion or a combination of both. The formulation of pork meat loaf is given below:

| Ingredients | Percentage |
|--------------------|------------|
| Lean pork | 65 |
| Pork backfat | 15 |
| Iceflakes | 5 |
| Table salt | 2 |
| Refined wheat four | 7.5 |
| Skin milk powder | 4 |
| Dry spices | 1.5 |
| Sodium nitrite | 150 ppm |

The meat mix or batter is tightly filled in aluminium or steel loaf pans which may be rectangular, cubical or cylindrical in shape depending on the requirement of slices for making the sandwiches. The pan-in mix is cooked in hot water maintained at 80°C or steam without pressure or boiled in hot air oven at 165°C for 2.5 to 3 hours. The internal temperature of 70°C must be achieved. It is then given a cold shower and chilled at 4°C. The chilled loaves are either packed as such or cut into slices of desired thickness and packed.



Fig 17.6

Meat nuggets: It is ready-to-eat convenient product which is obtained by cutting cooked and cooled rectangular or cubical shape meat loaves into approximately 4 cm × 1.5 cm × 1.5 cm pieces. The product is packed in unit pouches and can be stored at 4°C for a week.



Fig 17.7

Meat balls: The products, stored raw or cooked offers a great convenience to restaurants and hotels. The product is prepared from ground meat which is mixed with fat, bread powder, salt and spices in an electrically operated mixer. The dough portions of 15-20 gm are rolled into balls manually or mechanically. These are either stored raw or deep fat fried in refined vegetable oil at 135°C for three minutes to get brown color and fried flavor. Alternatively, these are cooked in hot water maintained at 80°C for 10 minutes to get an internal temperature of 65-70°C. Water cooked balls may be subjected to light frying to get golden brown color. These are packed in polythene pouches and can be kept at 4°C for a week.

Materials required

- Lean chicken
- Meat masala
- Mixer
- Salt
- Baking powder
- Sunflower oil



Fig 17.8

Procedure

- Lean meat of chicken is minced.
- The minced meat is subjected to mixer after adding salt, meat masala and baking powder in the minced meat.
- About 15-20 gm of doughed portion is rolled manually to make balls.
- Oil is kept in a pan and is heated.
- The balls are deep fried in a heated pan containing oil.

17.2. Sausage

Food product prepared from chopped and seasoned meat containing salt, curing ingredients, spices, flavorings and fillers of proteineous or farinaceous nature and formed into regular symmetrical shape, either in natural or artificial casings or in rectangular molds. Those formed in casings are called sausage and those formed in molds are called meat loaves.

a. Classification

- i. Fresh – fresh pork sausages
- ii. Cooked
- iii. Smoked
- iv. Semidry
- v. Dry
- vi. Fermented

b. Sausage emulsion

- i. Fibril proteins
- ii. Stroma
- iii. Salt
- iv. Fat
- v. Spices

c. Type of meat

- a. Good binding quality: i. Bull beef ii. Chucks iii. Trimming
- b. Intermediate binding quality

- i. Head meat
- ii. Shank meat
- c. Poor binding quality**
 - i. Fatty tissue
 - ii. Smooth muscle
 - iii. Tripe
- d. Processing**
 - i. Grinding
 - ii. Chopping
 - iii. Vecuumising
 - iv. Stuffing
 - v. Linking
 - vi. Cooking
 - vii. Showering
 - viii. Smoking
 - ix. Peeling
 - x. Packing
- e. Regulations**
 - i. Fresh
 - ii. Cooked
 - iii. Additives
 - iv. Temperature of processing.

17.3. Corned beef, Becon and Ham

Raw cured meats

- Cured meat represents a large group of products with great many varieties. The pork, beef and
- other meats including chicken are cured, pork being mostly used. Pork ham (whole ham or
- individual muscles), shoulder, belly, coin, etc. are cured.

Processing

Meat



Curing



Salt equalization and maturing



Drying or smoking



Storage or further ripening

Raw materials

- Since, the product is eaten raw; the quality of the raw material is of utmost importance. Pork
- Products such as ham whole or individual muscle), loin, belly, shoulder, beef meat as well as
- Chicken breast etc. can be used for curing.

Quality of raw material

1. Microbiological quality

- Free from pathogens- *Cl. botulinum*, *Cl. Perfringens*, *Staph. aureus*, *Salmonella*, *listeriamonocytogenes*.
- Free from spoilage organisms- when production time is long (several weeks to months), the TPC 102/g, maximum TPC =103/g and surface TPC=5x10⁴/cm² should not be exceeded.

2. pH 5.8

- Higher pH = higher WHC and pH higher than 5.8 is not desirable since the product is to be dried.
- Higher pH =high microbial growth.
- DFD meat is unsuitable due to the following reasons:
 - High pH (approx 6.2) -has good WHC and favorable for bacterial growth.

- Closed structure of muscles -poor diffusion of the cure.
- Dark color -unattractive to the consumer.
- PSE meat is also unsuitable- (pH 6.0 can be allowed for smaller cuts because of shorter production time)
 - Cure diffusion in meat is not uniform
 - Salty (over □ salty product results because of open structure.
 - Pale in color and appearance- no appreciable cure color.
 - Sour taste due to low pH

3. Maturing of animal

>7 months (pig) for long -cured meats.

Preparation of meat

- Meat-cutting and trimming , deboning , skinning
- The temperature during preparation =10-120C in cutting room
- RH during preparation =55-70%
- The temperature of meat during preparation =2-40C
- Meat can be fresh or frozen and thawed meat.

Ingredients

Salt: Salt has substance specific antimicrobial effect. Therefore, its effect on microorganisms is

concentration dependent. It retards microbial growth by lowering water activity. Secondly, it

extracts water from microbial cells and causes death of cell by plasmolysis. In the third possible

mechanism, salt ionizes and the ions diffuse into microbial cells and interfere with the metabolism.

Death of microorganisms does not occur immediately. It will take some time before the cells die.

Hence salting is not suitable for the products, which are consumed immediately after processing.

Nitrite and nitrate: Nitrite and nitrate are regularly used as curing agents in meat. Nitrate doesn't have anti-microbial activity, instead used as a reservoir of nitrite. Nitrite exhibits antimicrobial effect by the following modes of action;

- Inhibition of metabolic enzymes viz. dehydrogenase.
- Bacterial reduction of nitrite or its reduction by SH-groups produces a bactericide, hydroxylamine (NH₂OH).
- Heating of cured meat (T>90°C) results in the production through reaction of nitrite and chemical constituents of meat of a substance called perigo substance or perigo factor. It is found to be inhibitory to *C. botulinum*.

Permitted levels of Nitrite and nitrate

- Maximum dose NaNO₃ = 500mg/kg
- KNO₃ = 600mg/kg
- Nitrate may be used only in meat containing 2 or more muscles.
- Residual nitrate (total nitrite and nitrate) 600mg as KNO₃.
- NO₃ + salt can be added = 600 ppm of nitrate.
- NO₃ + NCS = 300 ppm of nitrate

Nitrite is effective against bacteria but not yeast & mold. Against bacteria it shows both bacteriostatic & bactericidal effect. Nitrite is effective against gram negative bacteria: Salmonella, E. coli, pseudomonas, Coliform, bacillus & clostridium spp. Micrococcus, which is important for reduction of nitrate to nitrite show high resistance to nitrite. Lactobacilli, important for covering of pH & Enterococci are also resistant to nitrite of concentration usually found in cured meats, *Streptococcus aureus* also relatively resistant to nitrite.

Ascorbic acid & ascorbates

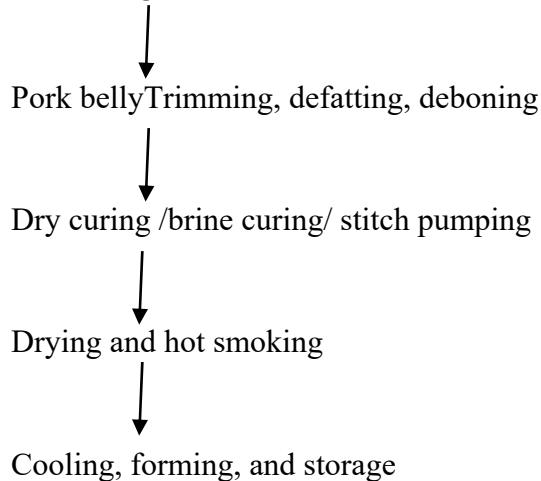
- For dry curing, it has no effect.
- Rapid reaction of NO₂ & ascorbic acid, so ascorbates are preferred due to slow reaction.
- Dose: 0.5g/kg
- See also cooked sausage (ingredients)

Sugar products: Sugars (sucrose), monosaccharide- glucose honey, corn syrup

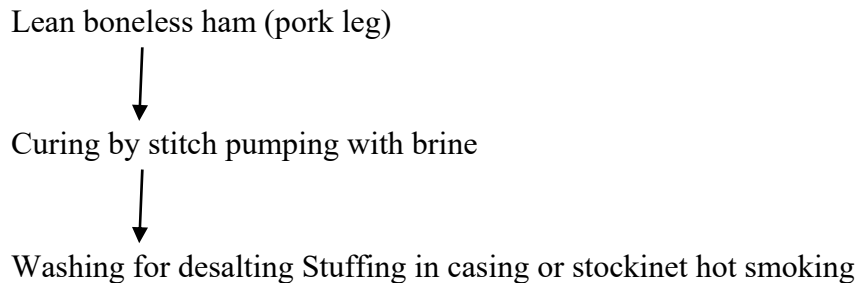
Function: see also [only sausage]

Some raw cured products

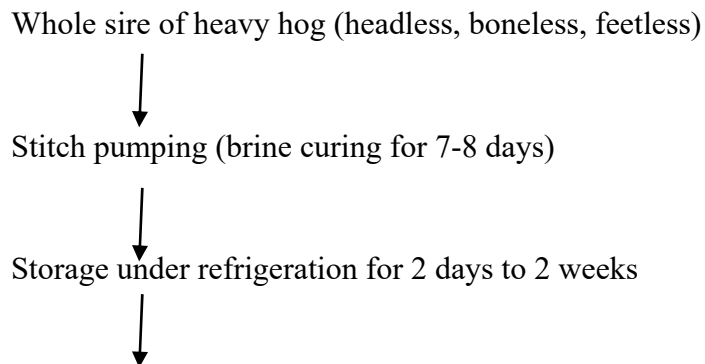
Bacon (regular bacon)



Canadian Ham



Wiltshire bacon



Smoking (optional)

Corned beef

Beef round / brisket



Stitch pumping or brine curing (with required spices and herbs)



Cooking (optional)

(If stitch pumping, no desalting required)

Assessment-

1. Meaning about sausage and describe the protocol of sausage making.
2. List out the ingredients of meat ball and rolls and elaborate the process of meat ball making.
3. Mention the method and preparation of bacon and ham.

Unit: 18

Properties of fresh meat

Objectives

- To know the water and fat holding capacity of fresh meat.
- To know the pigment and chemical state of fresh meat.
- To know the discoloration of fresh meat.

18.1. Water holding capacity

Approximately three-quarters of meat is water. In the living muscle about 10% is bound to the muscle proteins and another 5–10% is located in the extracellular space – the small channels between parts of adjacent muscle fibres. However, most of the muscle water is probably held in the spaces between the thick and thin filaments of the myofibrils. Lateral expansion or contraction of the filament lattice caused by differences in the state of interaction between the myosin and actin will therefore lead to uptake or expulsion of this water. During the development of rigor mortis the lattice shrinks and the water which is expelled will eventually be lost from the muscle fibres into the extracellular space. If a muscle is cut post-rigor this extracellular water will tend to be at least partially lost and contributes to drip. Drip is a dilute solution of the sarcoplasmic proteins. Drip loss leads to lower meat yield and is unsightly if it collects in the tray or pack containing the meat.

Water holding capacity is important technological quality parameter of meat which is directly related to sensory quality viz. fineness of meat. This is of great importance in meat products containing added water such as sausage products, other processed meats, such as cooked ham, etc.

WHC can be defined as the capacity of meat to hold or retain its native water and under certain circumstances the water added to meat.

Types of water in meat

- Filament bound water = loosely associated with filaments and bound between myosin molecules.
- Protein bound water

- Water in sarcoplasmic space =free moving water
- Fibril bound water: water immobilized between myofilament (actins and myosin filaments).
- Extra cellular water: water found outside muscle cell, ad between muscle cells held bycapillary forces.

Factors affecting WHC: pH, Temperature, ATP content, Salt and salts of organic acids, chopping.

1. pH: pH is directly proportional to WHC; higher the pH , high will be the WHC. pH of meatinitially is 7.0-7.2 which later on lowers to 5.5- 5.3.This reduces the WHC of meat. Thelowering of pH nearer to its isoelectric point decreases the net charge (electrostatic attraction)
2. Temperature: Negative relation
At higher temperatures- denaturation of protein causes the shrinkage of meat which squeezesout moisture and hence water is released from meat as drip. The shrinkage and denaturationcauses reduced WHC.
3. ATP content: phosphate increases WHC by
 - Increasing the pH,
 - Increasing ionic strength,
 - Dissociating actomyosin into actin and myosin
4. **Salt and salts of organic acids:**
 - Salt: NaCl, KCl, Salts of organic acids □citric, lactic, tartaric, acetic, etc. These also have agood impart on WHC.
 - They increase ionic strength of meat-product
 - They complex with calcium and magnesium ions which are bound to protein resulting inincrease in interspaced for holding water.
 - Maximum= 5-6%, otherwise higher concentration will lead to salting out effect.
5. **Chopping**
 - Chopping liberates proteins by chopping and cutting the fibers.
 - Muscles are chopped; fibers and proteins are exposed free and hence

can bind more water,i.e. increased WHC.

Fat binding capacity (FBC)

Proteins are natural emulsifiers as they contain both the lipophilic and hydrophilic sites .thisproperty is of great importance in comminuted meat products such as sausage products.

FBC depends on protein content in meat, particularly actin and myosin (myofibrillar proteins).Connective tissues proteins do not contribute. Long cooking results in lowered FBC as incanned products.

18.2 Pigmentation:

A meat inspector may encounter with the following conditions related to the pigmentation of meat or musculature.

Melanosis (Black Pith)

Melanosis means accumulation of melanin pigment in various organs including lungs, heart, kidneys, liver, brain, and spinal cord. In old cattle, melanosis of kidneys is very common. Melanosis is found due to increased secretion of melanin in hyper-adrenalism and *Anthracesisnigrican*. Multifocal deposition of melanin in calves is called "**Melanosismaculosa**" AM and PM findings are finding of black coloured affected tissue or organs.

Judgment:

1. Extensive melanosis ----- Total condemnation.
2. Localized melanosis ----- Local condemnation.

Differential diagnosis: Melanoma, Haemorrhage, and liver fluke infection.

Brown atrophy (Xanthosis)/Myocardiallipofuscinosis

Brown atrophy is caused by senile atrophy, wasting disease and emaciation. This condition is generally found in the skeletal and cardiac muscles of old dairy animals.

Judgment:

Carcass with extensive xanthosis and emaciation should be condemned.

18.3. Chemical state

| ● Component | % weight |
|---------------------------------------------------------------------------------------------------------------|----------|
| ● Water | 75 |
| ● Protein | 19 |
| ● Lipid | 2.5 |
| ● Carbohydrate | 1.2 |
| ● Miscellaneous Soluble Non-Protein Substances | 2.3 |
| ■ Nitrogenous | 1.65 |
| ■ creatinine, inosine monophosphate, di- and triphosphopyridine nucleotides, amino acids, carnosine, anserine | |
| ● Inorganic | 0.65 |
| ● Total soluble phosphorus, potassium, sodium, magnesium, calcium, zinc, trace metals | |
| ● Vitamins | qm |
| (quantitatively minute)various fat- and water-soluble vitamins | |

18.4 Discoloration

The discoloration of fresh meat is an important process, which is determined by the relative concentration of the three redox of myoglobin like deoxymyoglobin, oxymyoglobin, and metmyoglobin. Loss of the desirable cherry red appearance with subsequent replacement by reddish brown and browns in a natural process affected by a variety of intrinsic and extrinsic parameters. Because consumers often use meat color as a basis for product selection or rejection, the loss in economic value that accompanies fresh meat discoloration can be substantial. In general the approaches for measuring fresh meat discoloration are relatively straight forward and simple. Fresh meat may be merchandised in either minced or whole forms. While principles involved in objectively measuring changes in color are the same for both product types, sample preparation and instrumentation are different. Minced products are often homogenized and the pigment-containing extract is analyzed by transmission or absorbance spectrophotometry. Although this is the method of choice for myoglobin and hemoglobin quantification, it does not offer an accurate representation of surface color as observed by the consumer. Whole-

muscle products are analyzed with reflectance techniques or colorimetry. With these rapid methods, repeated measurements may be recorded from the same sample over time. Fresh meat discoloration projects are generally carried out for 3 to 7 days, with color analysis being performed either every day or every other day. The time course for frozen samples is longer with color analysis being performed much less often. It is imperative to establish sampling parameters based on specific research objectives prior to the beginning of a study. Finally, many investigators find it necessary to utilize a model approach for studying the biochemistry of myoglobin in vitro. These experiments often require the isolation and redox manipulation of myoglobin.

Assessment

1. What do you mean by water holding capacity of meat?
2. Mention the chemical state of fresh meat.
3. Meaning about pigmentation and judgment.

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