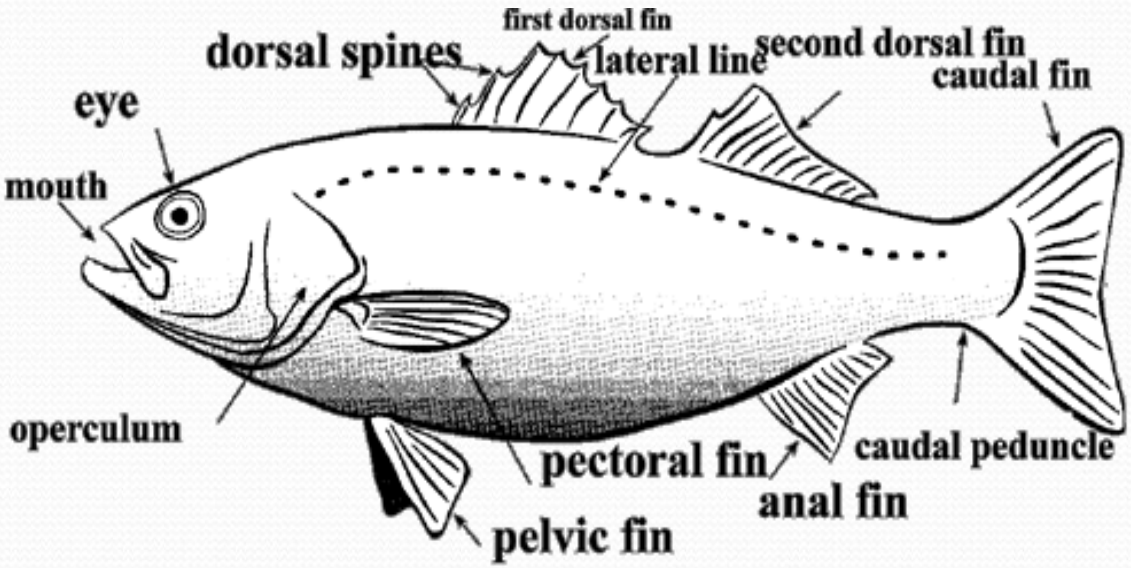
FISH

A fish is any aquatic vertebrate animal that is covered with scales and equipped with two sets of paired fins and several unpaired fins

Fish plays a significant role as part of a balanced healthy diet. Fish is a good source of many of the nutrients we need throughout life from infancy through to old age.

MAIN COMPONENTS OF FISH

- The body tissues include skin, flesh and bone.
- Skin consist of mainly of water ,about 80%,and about 16% protein.
- Bone contains much mineral matter, principally calcium phosphate, which amounts to about 14% of total bone material, the rest is mainly water,about75%,and protein ,about 9%.



- Chemical composition of a fish;
- 66-84% water
- 15-24% protein
- 0.1-0.22% fat
- 1-3% carbohydrates
- 0.8-2% minerals

Catching of the fish

FISH PROCESSING

- In the food industry , fish processing is the processing of fish and other seafoods delivered by fisheries, which are the supplier of the fish products industry.
- Fish processing may be subdivided into major categories;
  - fish handling
  - fish product manufacturing

A.FISH HANDLING

- Freezing
- Filleting of fresh fish for onward distribution to fresh fish retail and catering

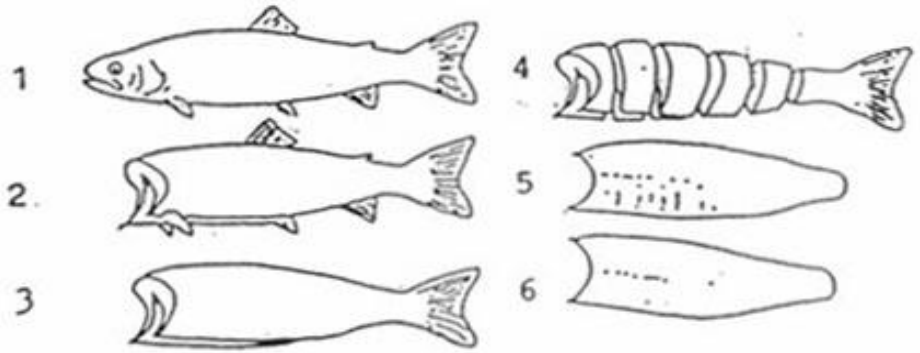


Figure 3.1 Major forms of preprocessed fish:

1 - whole fish,
2 - gutted fish without head,
3 - gutted fish without head and fins,
4 - sliced whole fish after deheading and evisceration,
5 - fillet with ribs, and
6 - fillet without ribs, with or without the skin.

B.FISH PRODUCT MANUFACTURING

- Chilled ,
- Frozen, and
- Canned products for the retail and catering trades

FISH HANDLING OPERATIONS

Sorting

Dressing

Cutting

Eviscerating

Skinnig

Precooking

Spicing

Blanching

Filleting

Salting

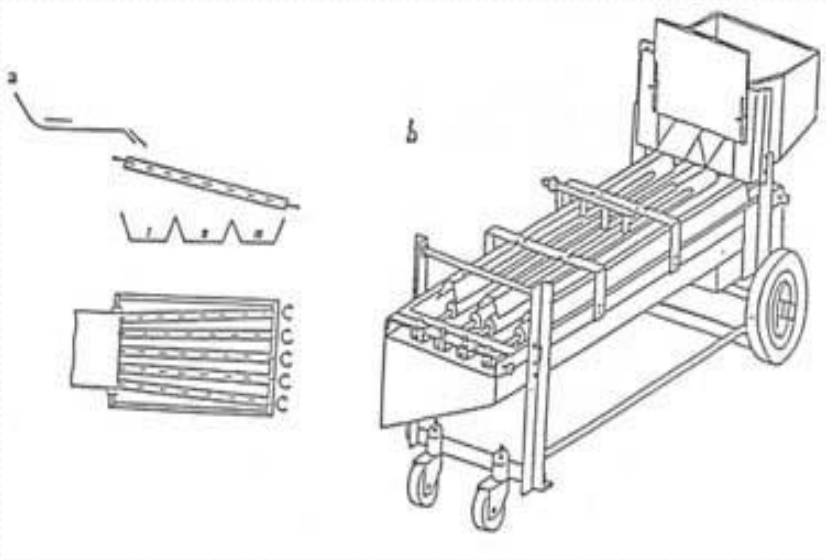
Packaging

Stunning of fish

- Stunning is critical for final product quality because prolonged agony of fish causes production of undesired substances in the tissue.
- Red spots appear on the surface of the skin and in the muscle tissue near the backbone; these reduce quality.
- Stunning is best done with an electric current. First, the fish are placed in a tank of water and an electric current is then passed through the water to stun or kill the fish.

Grading

- Size grading is very important for fish processing (i.e., smoking, freezing, heat treatment, salting, etc.) as well as for marketing.



Grading machine with a fan shaped arrangement of rollers:
a - scheme, b - general view

Washing

- Washing is intended primarily to clean the fish and to remove accumulated bacteria.
- The effectiveness of the washing procedure depends, inter alia, on the kinetic energy of the water stream,
- ratio of fish volume to water volume and on the water quality.

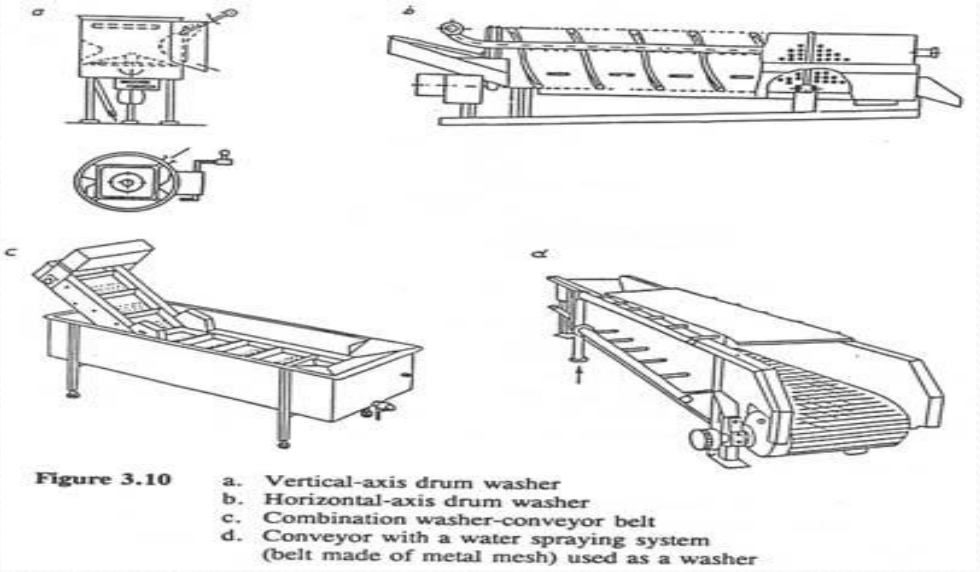


Figure 3.10 a. Vertical-axis drum washer
b. Horizontal-axis drum washer
c. Combination washer-conveyor belt
d. Conveyor with a water spraying system (belt made of metal mesh) used as a washer

Deheading

- The head constitutes 10-20% of the total fish weight and it is cut off as an inedible part. Although many mechanized deheading machines had been developed for processing marine fish, freshwater fish are usually deheaded manually

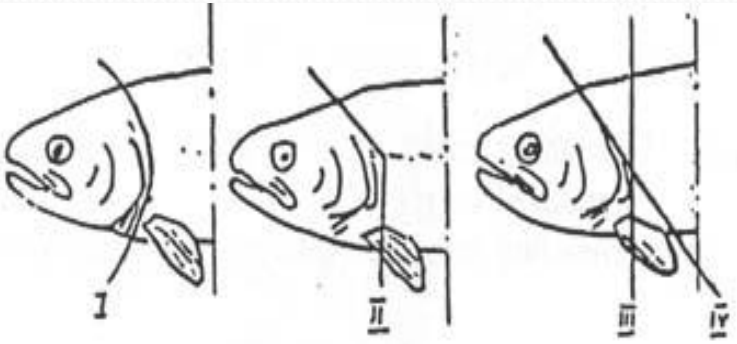


Figure 3.11 Cutting techniques used for deheading of freshwater fish:
I - round cut, II - contoured cut, III - straight cut, IV - slant cut

Gutting

- The purpose of gutting is to remove those fish body parts most likely to reduce product quality, as well as to remove gonads and sometimes the swim bladder.
- Evisceration of freshwater fish is labour-intensive and usually performed by hand.
- Gutting consists of cutting down the belly (fish may be deheaded or not), removal of internal organs, and, optionally, cleaning the body cavity of the peritoneum, kidney tissue and blood.

Figure 3.14 Gutting work station:
a. cutting down belly with a safe cutting element,
b. removal of guts with vacuum suction,
c. washing and rinsing of body cavity with rotational brush

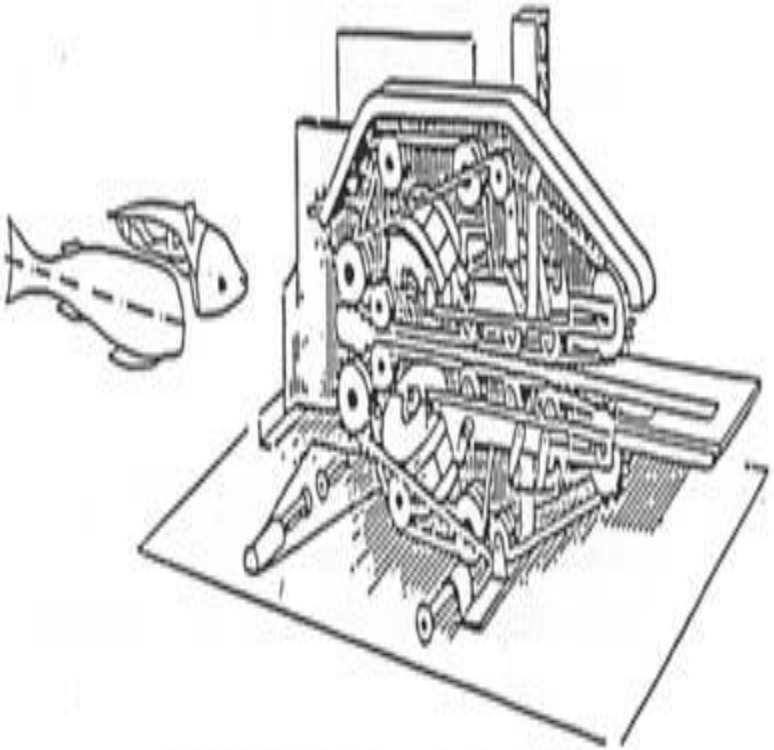


Figure 3.16 Deheading and gutting machine

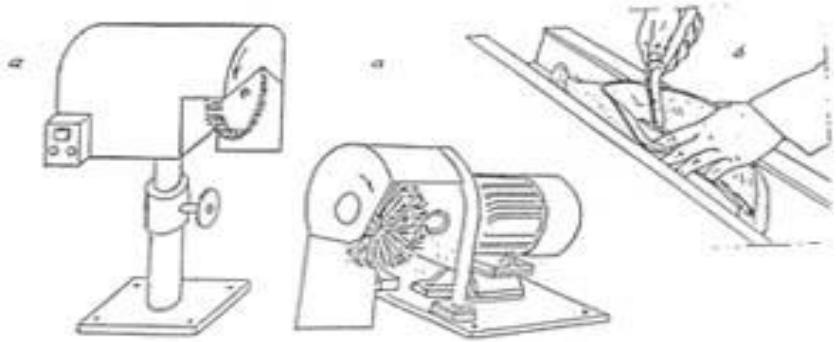


Figure 3.15 a. Rotating brushes used to clean body cavity and to remove kidney tissue (with and without adjustable height),
b. hand-held vacuum suction tool for kidney removal and cleaning of body cavity

FISH PRODUCTS

Fresh Fish

Canned Fish

Frozen Fish

Cured Fish

-salted and smoked fish

Dried Fish

Fish Fillets

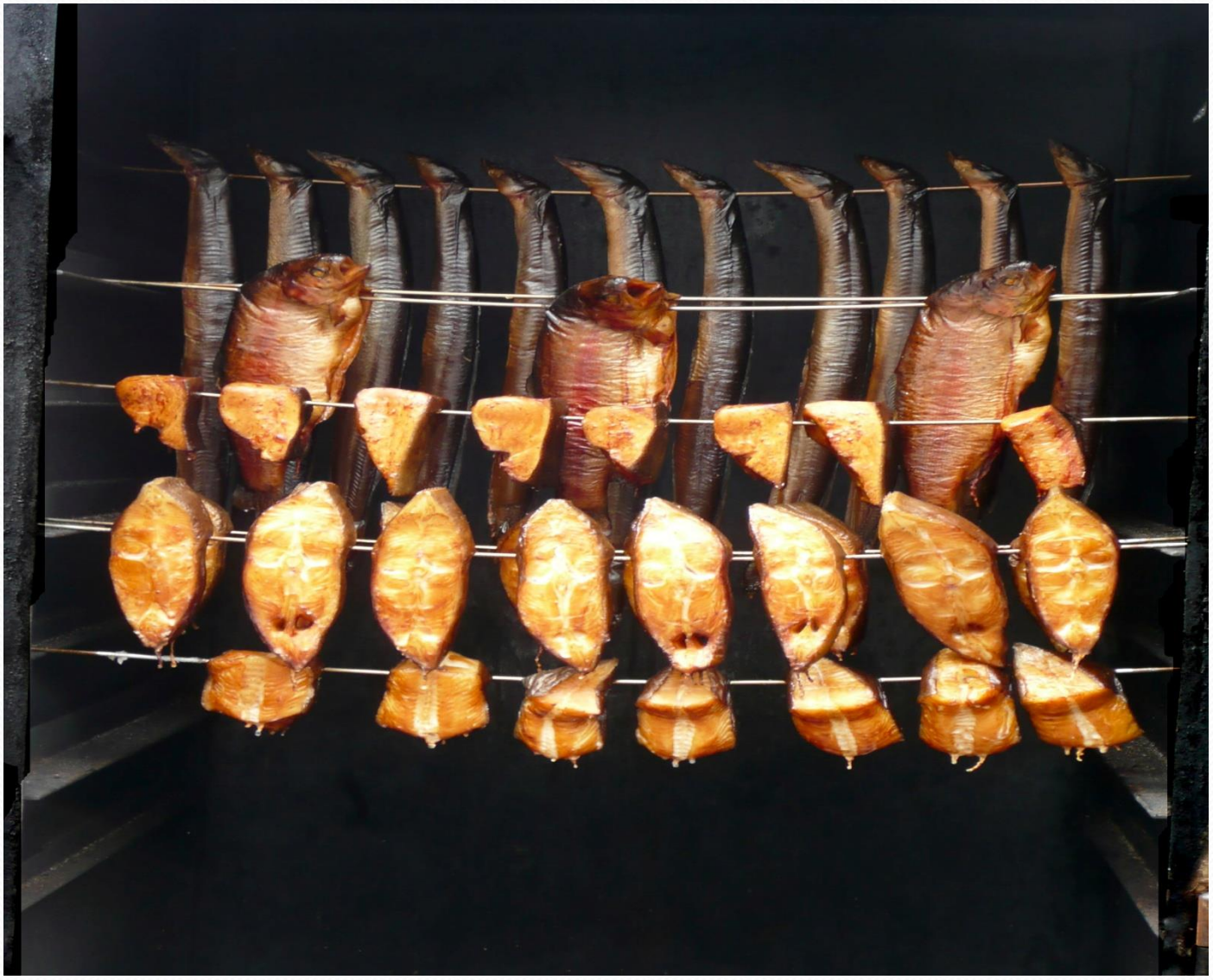
Fish Roe

Pre-cooked Fish

Fish Oil

Fish Meal

SMOKING



Smoking

- Although more frequently used for flavor than preservation , smoke is an antimicrobial and antioxidant. The smoke particles adhere to the surfaces of food , inhibitig bacterial growth and oxidant.

SALTING


8 888626 017624
甘文咸鱼
F9 SALTED FISH
NET WT: (170G)
INGREDIENT: FISH, SALT.
PRODUCT OF MALAYSIA
EXP DATE:02/09/2010
Packed By: CMM Marketing Management Pte. Ltd.
Marsiling Rd (S) 739108 T: 6269 0876 F: 6269 8265

salting

- Once properly salted ,the foods interior contains enough salt to exert osmotic pressures that prevent or retard the growth of many undesirable microbes.

DRYING

drying

- The drying of food is the world's oldest known preservation method , and dried fish has a storage life of several years.

- This method is cheap and effective in suitable climates.

FILLETING

filleting

- The fillet is made of fish that has been finely pulverized.It is made of the same surimi used to make fish balls .

CANNING

canning

- Canning is a method of preserving food in which the food is processed and sealed in an airtight container.The packaging prevents microorganisms from entering and proliferating inside.

CONTAMINATION AND PACKAGING METHODS

- Contamination depends on;

  habitat; seawater, fresh water, pelogic or at the bottom
- Perishability or stability of the food product

  -chemical

  -biological

  -physical nature of the food product
- And also initial quality.

- Internal factors;
  - -water activity
  - -pH
  - -redox potensials
  - -nutritive substance

Storage conditions and environmental factors;

_oxygen, light, temperature, humidity, storage time…

DECOMPOSITION OF FISH

- A. Enzymatic Spoilage
  - -lactic acid produced
  - -pH decrease
  - -muscle becomes rigid
  - -muscle becomes pliable
- B. Oxidative Deteriation
  - -rancid odors
  - -colour changes
- C. Bacterial Spoilage
  - -TMAO;TMA+formaldehyde
  - -decomposition of proteins

therefore,

- Preservation;
- -salted
- -smoked
- -heated
- -cooled
- -fermented
- -dried
- !!! Cooling or freezing provides a prolonged shelf-life

- Most spoilage of fish is due to bacterial breakdown.
- Chilling of fish immediately after harvest is very important part of preservation.

Preservation Method	Proteins	Lipids
Salted	No effect	Might rancid
Smoked	No effect	Might rancid
Airdried	Might deteriote	rancid
Fermented	Bitter taste	Get rancid

FISH MARKETING

Fish markets are marketplace used for the trade in and sale of fish and other seafoods.

They can be dedicated to wholescale trade between fisherman and fish merchants

OR

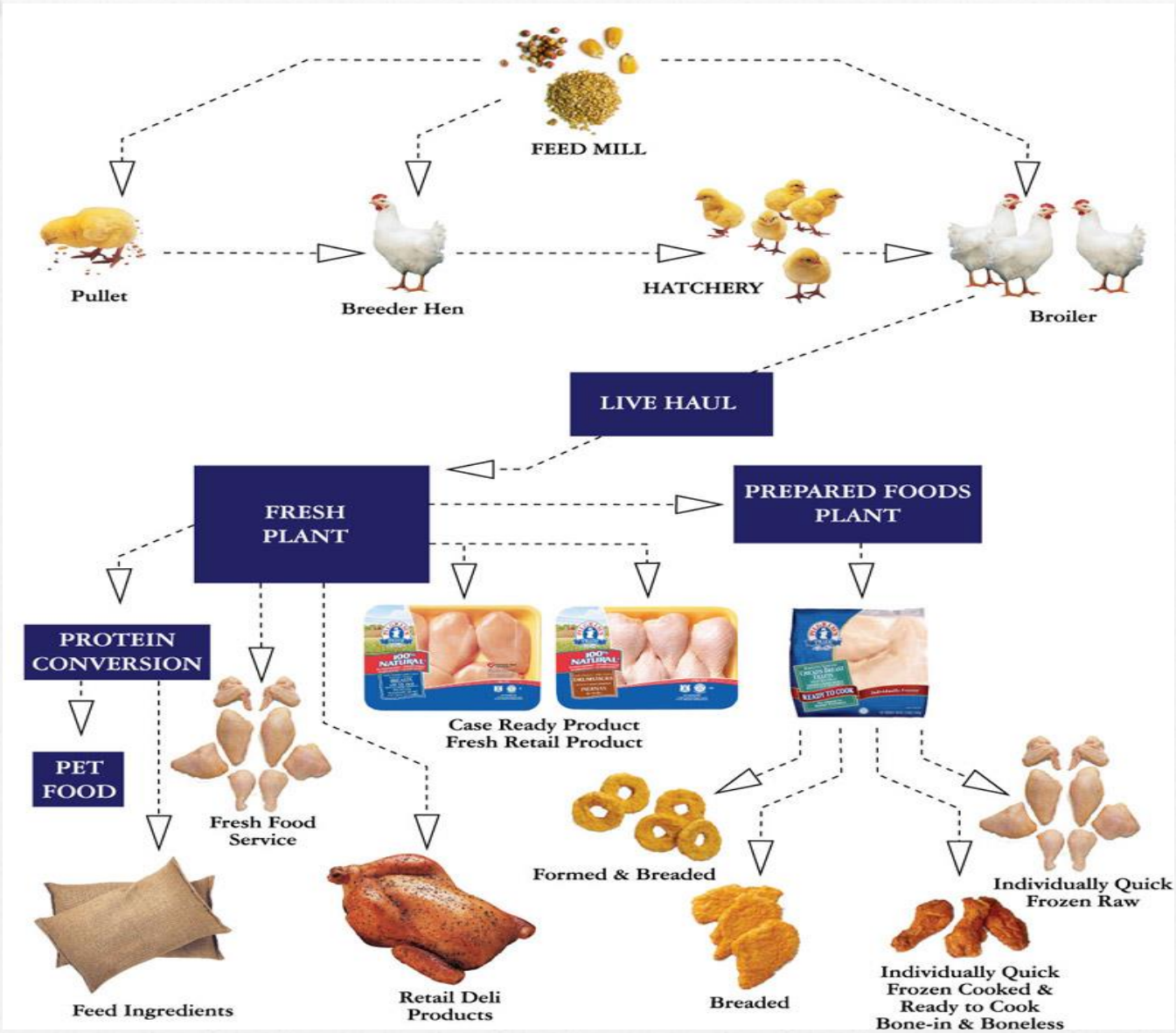
to the sale of seafood to individual consumers, or to both.


BAY
OAKERS
for
5 Lb.
for
10 Lb.
CARP
CATFISH
$1.49
LARGE
$1

UNIVERSITY OF GAZIANTEP

FE- 401
FOOD TECHNOLOGY

POULTRY


FEED MILL
Pullet
Breeder Hen
HATCHERY
Broiler
LIVE HAUL
FRESH PLANT
PREPARED FOODS PLANT
PROTEIN CONVERSION
PET FOOD
Case Ready Product
Fresh Retail Product
Fresh Food Service
Feed Ingredients
Retail Deli Products
Formed & Breaded
Breaded
Individually Quick Frozen Raw
Individually Quick Frozen Cooked & Ready to Cook Bone-in & Boneless

PROPERTIES OF RAW MATERIALS

BROILER

- Meat type chicken is known as broiler
- Consisted of young female chickens

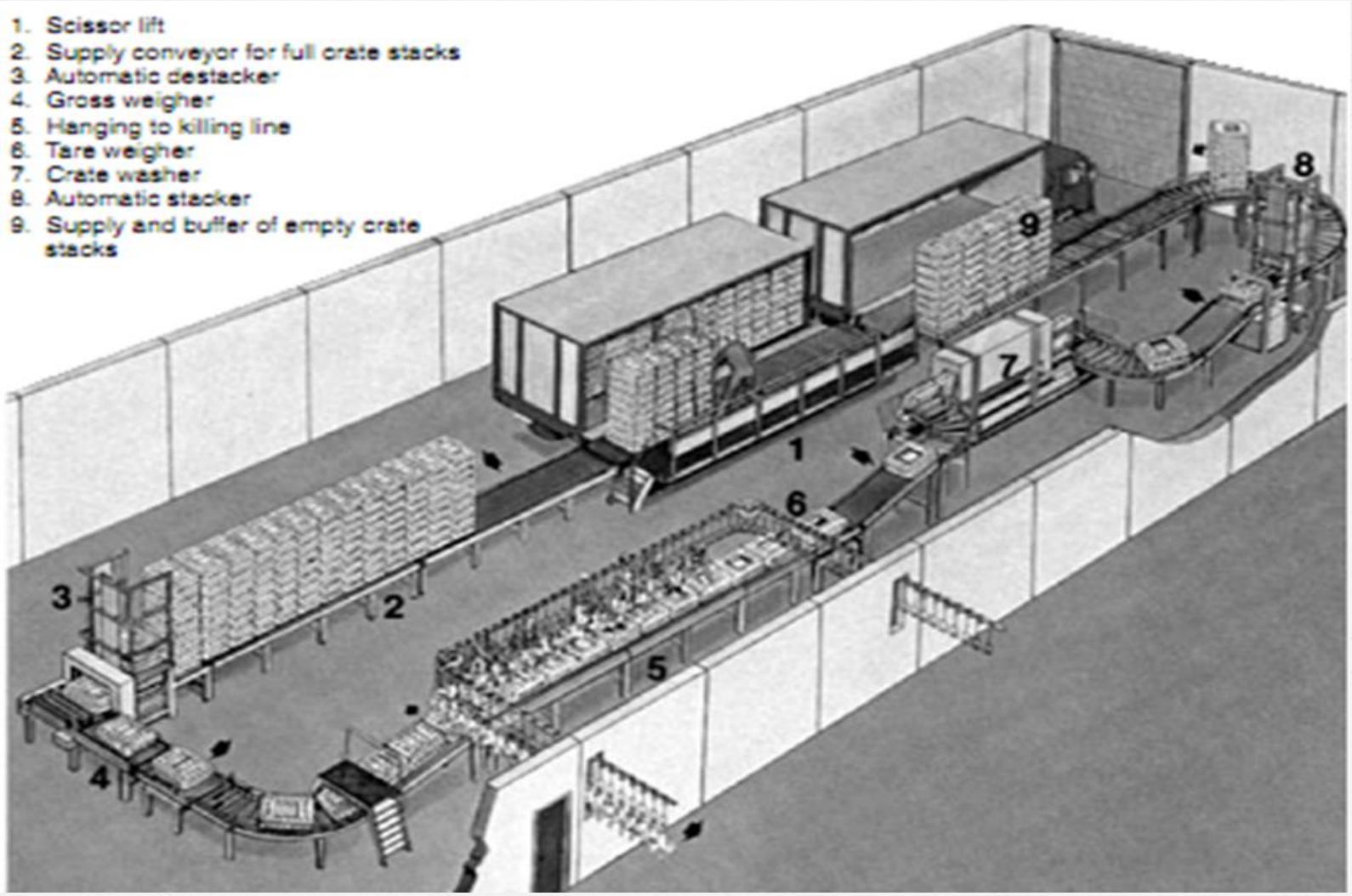
- Slaughtered when 6 or 7 week
- Weight range 1.13 to 2.04 kg
- High growth rate

- Have white feathers and yellowish skins

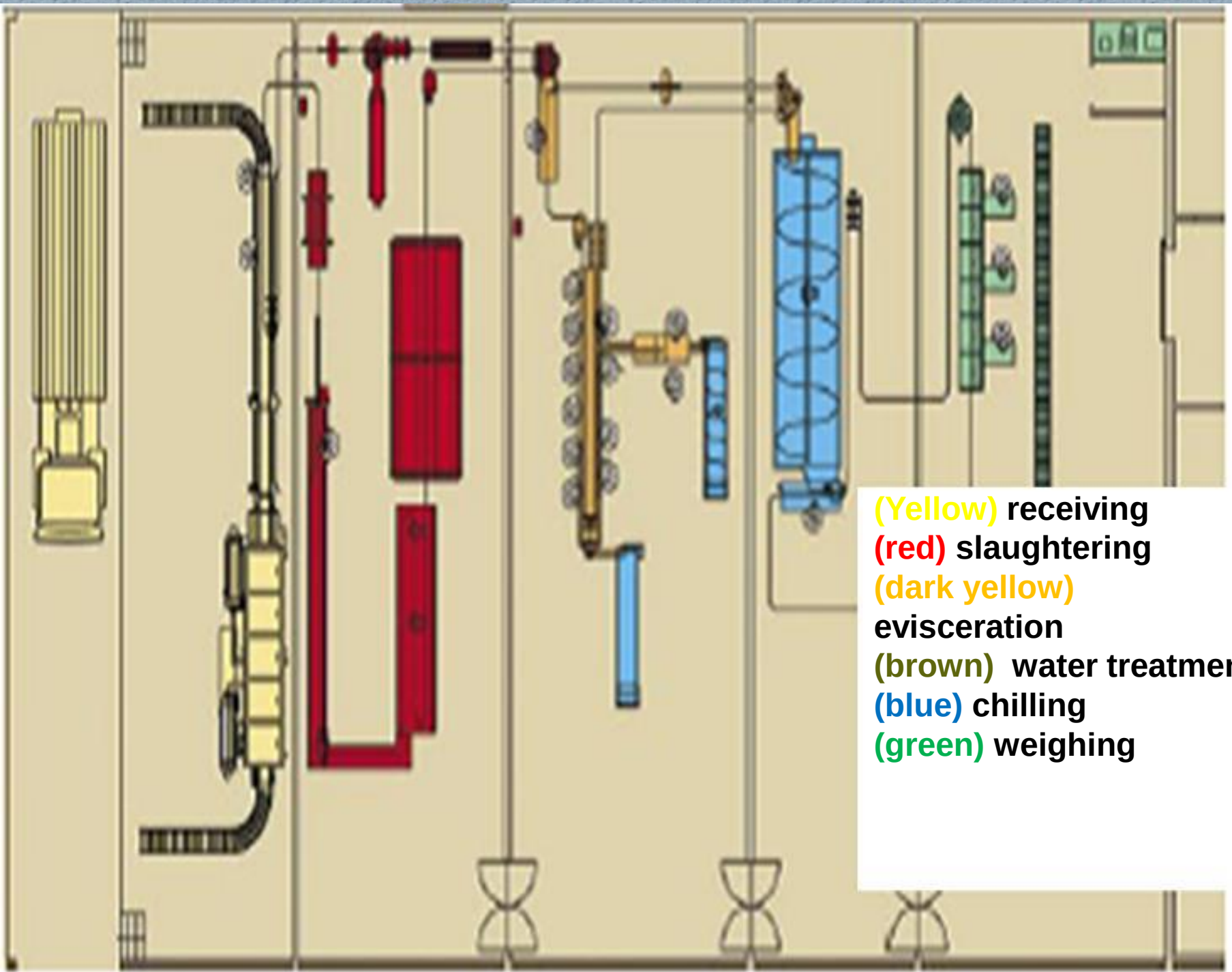
HOUSING

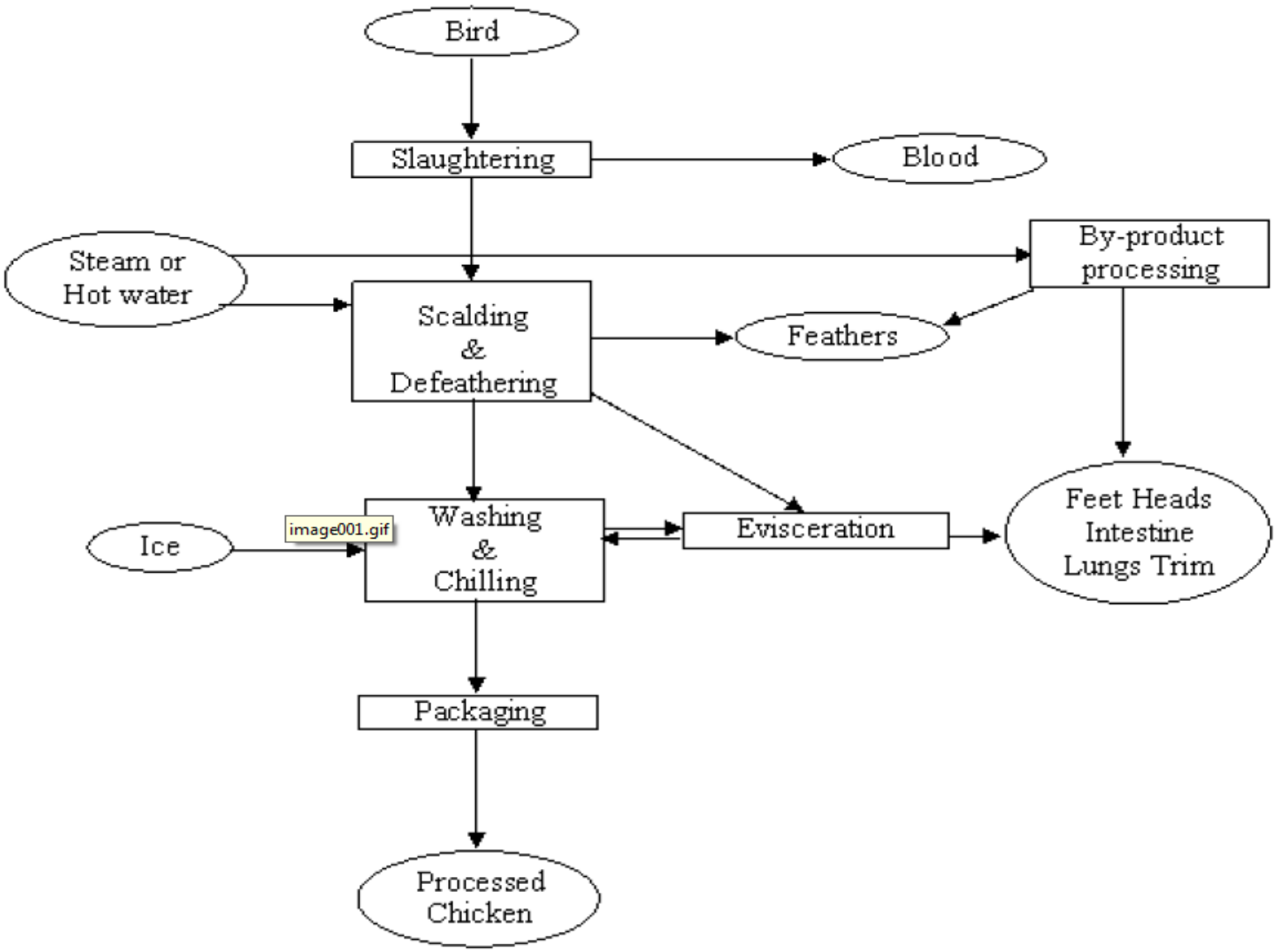
- 15-20 ˚C
- 20 % RH
- 24 hour lighting to 12 hours constant light
- White light to red light
- Energy sources cereals such maize and sorghum

POULTRY PRODUCTION TECHNOLOGY & EQUIPMENTS



CHICKEN UNLOADING SYSTEM


(Yellow) receiving
(red) slaughtering
(dark yellow)
evisceration
(brown) water treatment
(blue) chilling
(green) weighing


Bird
Slaughtering
Blood
Steam or
Hot water
By-product
processing
Scalding
&
Defeathering
Feathers
Feet Heads
Intestine
Lungs Trim
Ice
image001.gif
Washing
&
Chilling
Evisceration
Packaging
Processed
Chicken

Live Bird Supply

RECEIVING AND WEIHGING

UNLOADING

STUNNING

BLEEDING

SCALDING

RECEIVING AND WEIGHTING

- a bulk weighing of the birds
- used to determine the payment to the farmer.

UNLOADING

- Automated unloading systems
- the whole modulus is lifted

RECEIVING AND WEIHGING

UNLOADING

STUNNING

BLEEDING

SCALDING

STUNNING

- Contact a brine solution (approximately 1% NaCl)
- About 60 to 90 sec
- 10-20 mA per broiler

RECEIVING AND WEIHGING

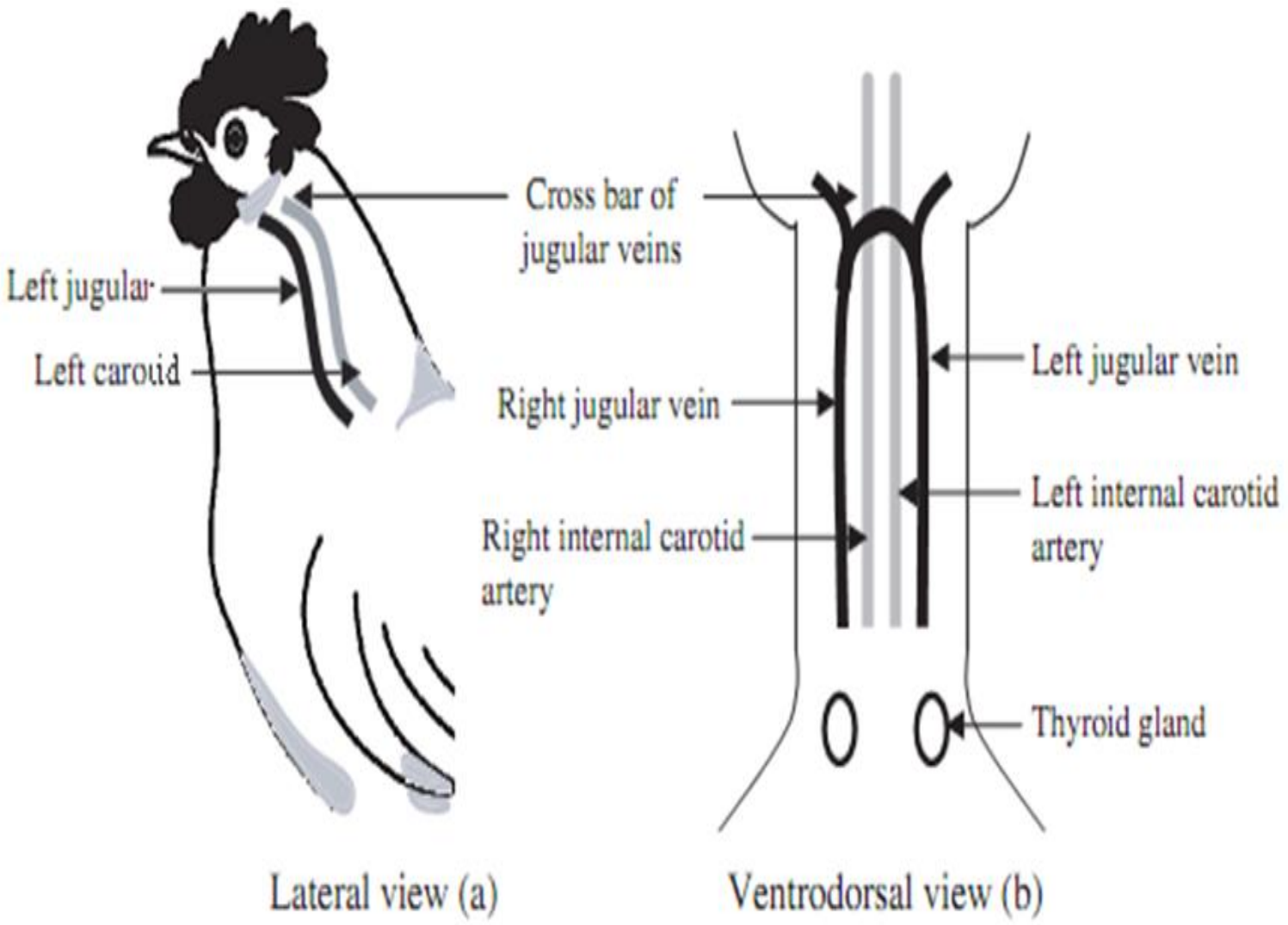
UNLOADING

STUNNING

BLEEDING

SCALDING

- Shocked
- Between 2–5 min
- About 35–50% of the total blood is lost


Cross bar of jugular veins
Left jugular
Left caroid
Right jugular vein
Right internal carotid artery
Left jugular vein
Left internal carotid artery
Thyroid gland
Lateral view (a)
Ventrodorsal view (b)

RECEIVING AND WEIHGING

UNLOADING

STUNNING

BLEEDING

SCALDING

- warm water to loosen the feathers
- performed manually
- single stage or multistage scalding bath
- Hard scalding
- Medium scalding or subscalding
- Soft/semi-scalding

RECEIVING AND WEIHGING

UNLOADING

STUNNING

BLEEDING

SCALDING

Soft/semi-scalding

- For young broilers
- Not damage the outer layer of the skin
- Easy removal of the feathers

Technique	Water Temperature (°C)	Time (sec.)	Used For
Hard scalding	59–61	45–90	Waterfowl
Medium/subscalding	54–58	60–120	Mature birds
Soft/semi-scalding	50–53	60–180	Broilers, roasters, young turkeys

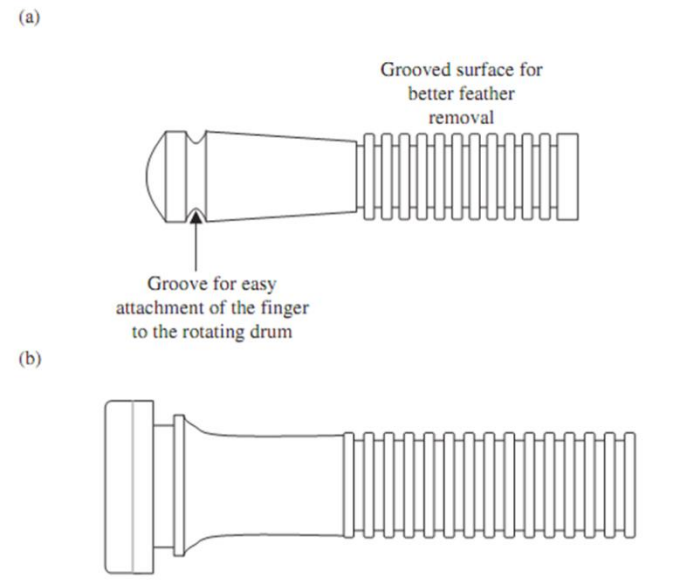
FEATHER REMOVAL

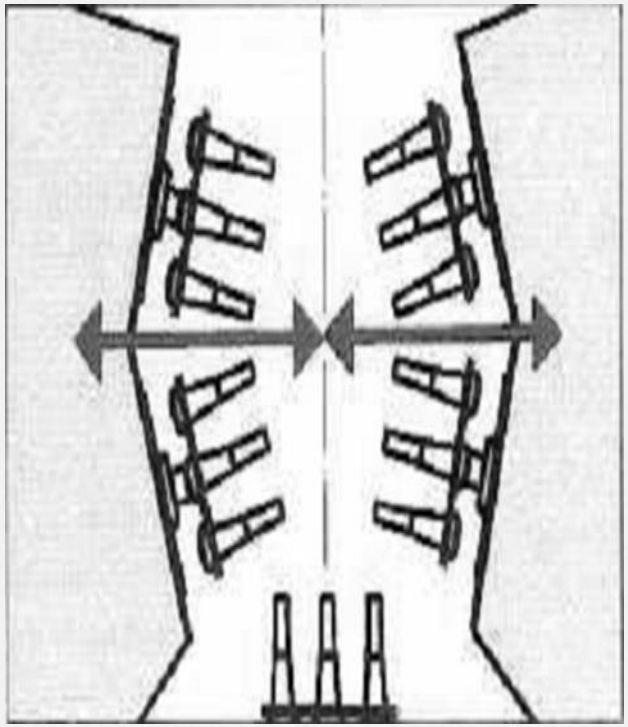
WASHING

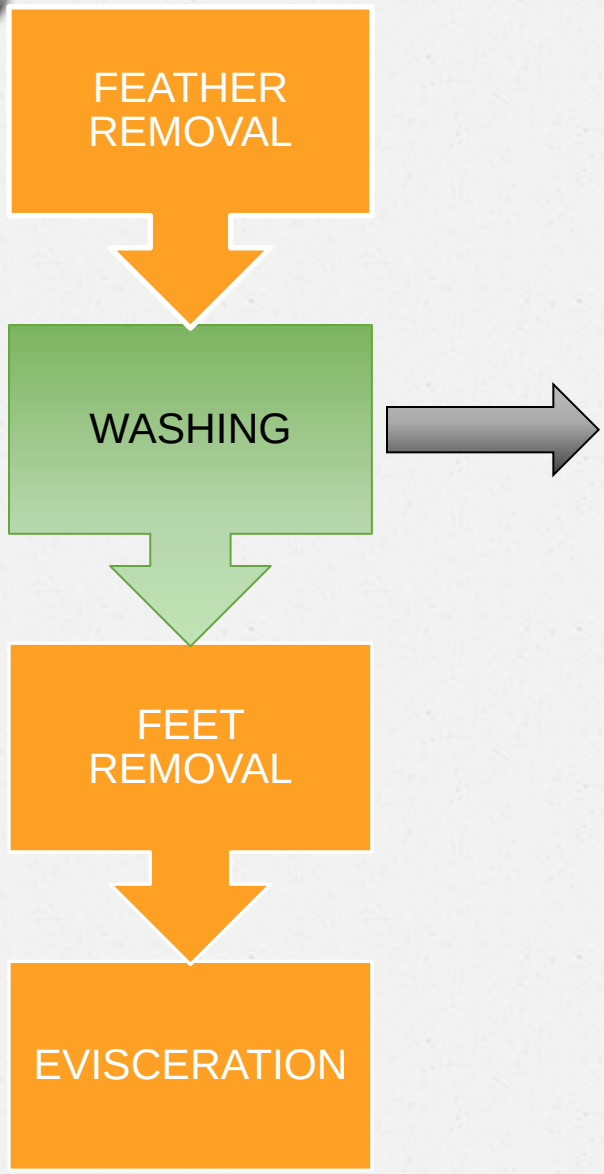
FEET REMOVAL

EVISCERATION

- Mechanical pickers/pluckers equipped
- Manually
- Between two/three sets of drums or disks covered with rubber fingers
- made out of rubber and contain different levels of a lubricating agent that controls their hardness, elasticity, etc
- the carcass is passed between the rotating disks


(a)
Grooved surface for
better feather
removal
Groove for easy
attachment of the finger
to the rotating drum
(b)




FEATHER REMOVAL
WASHING
FEET REMOVAL
EVISCERATION

FEATHER REMOVAL

WASHING

FEET REMOVAL

EVISCERATION

- Manually
- Automated equipment
- Cut be done between the bones and not through a bone

- manually as the carcasses fall onto a sorting table or
- automatically by transferring the birds to another line

Advantages

- labor savings,
- better hygiene
- a more even rigor mortis process

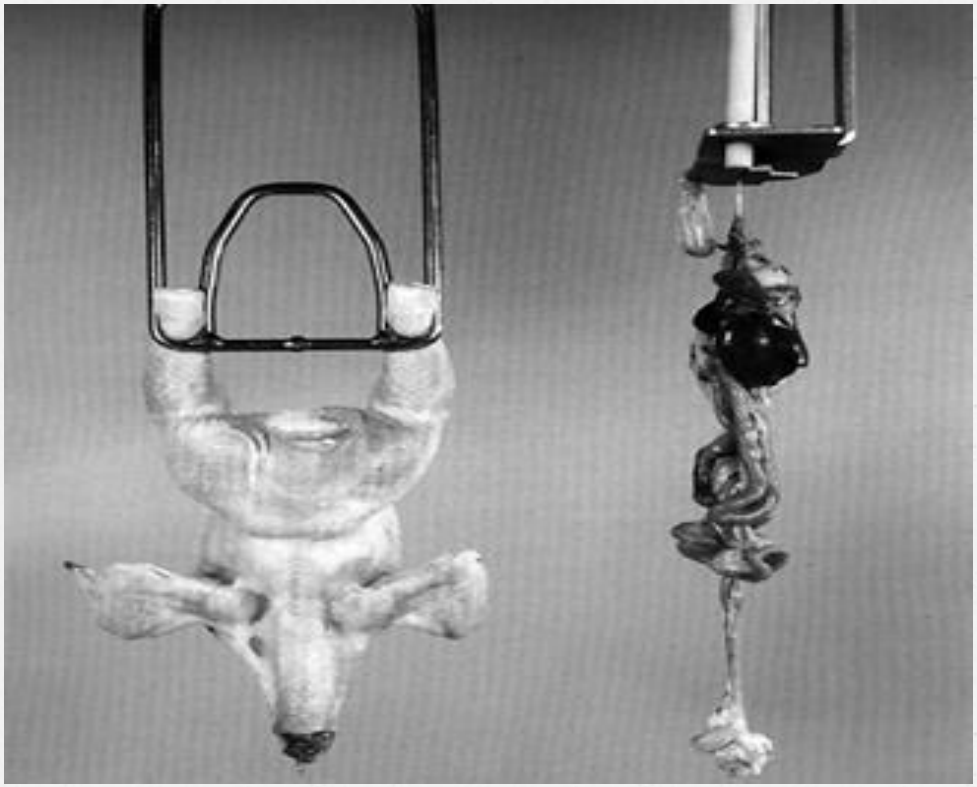
FEATHER REMOVAL

WASHING

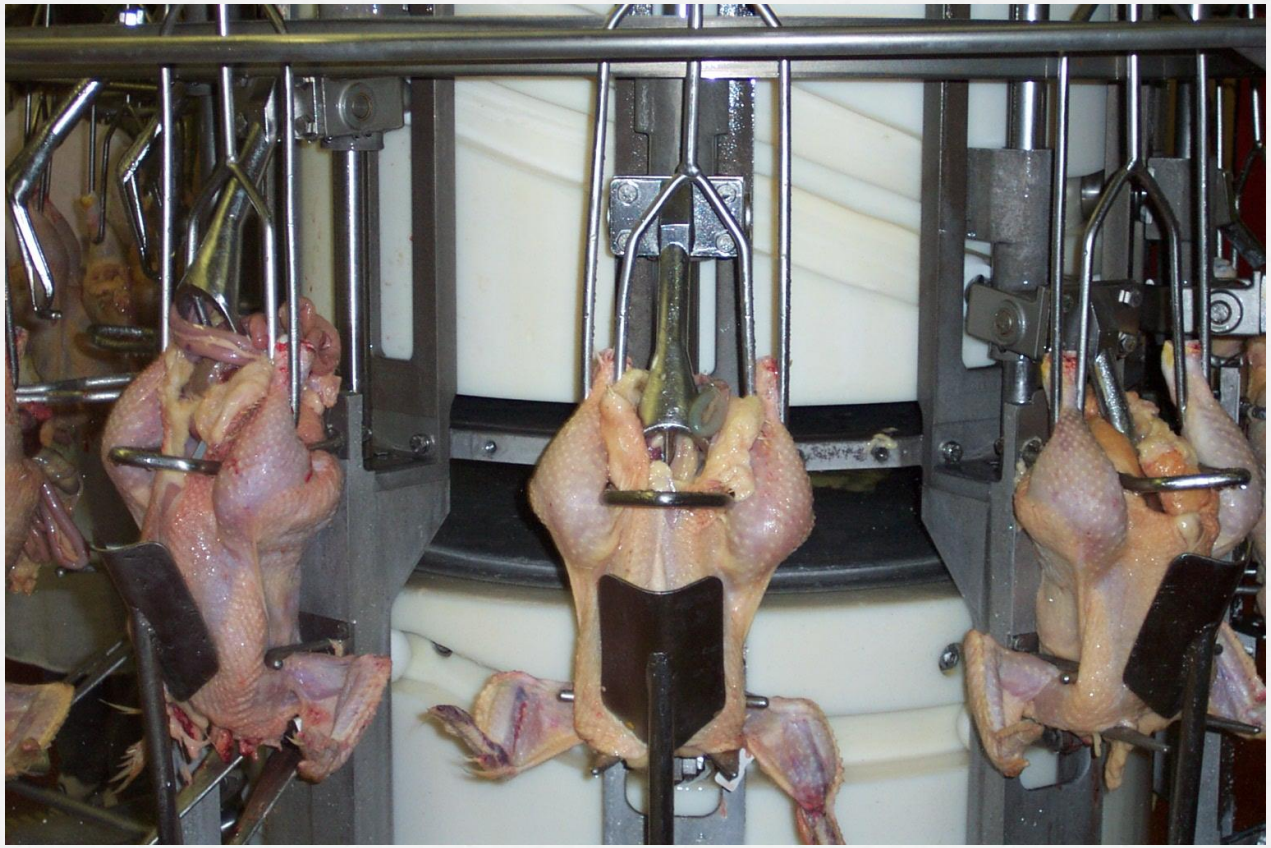
FEET REMOVAL

EVISCERATION

- removal of edible and inedible viscera
- manually
- semi-automatically
- fully automatically



Evisceration



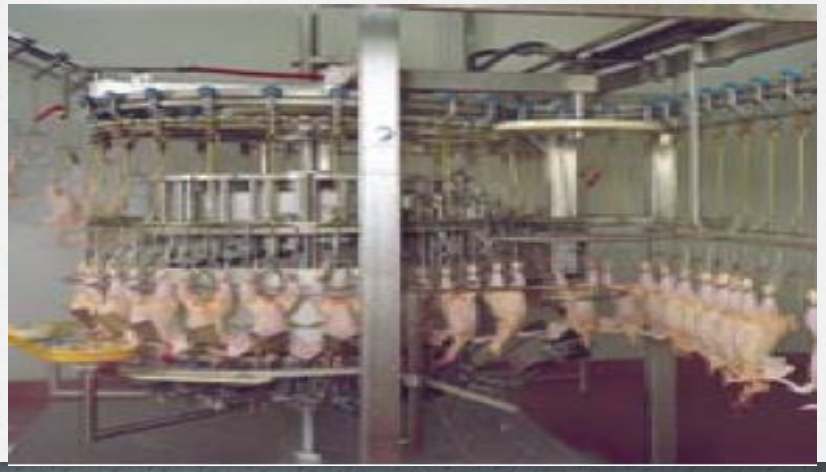
FEATHER REMOVAL

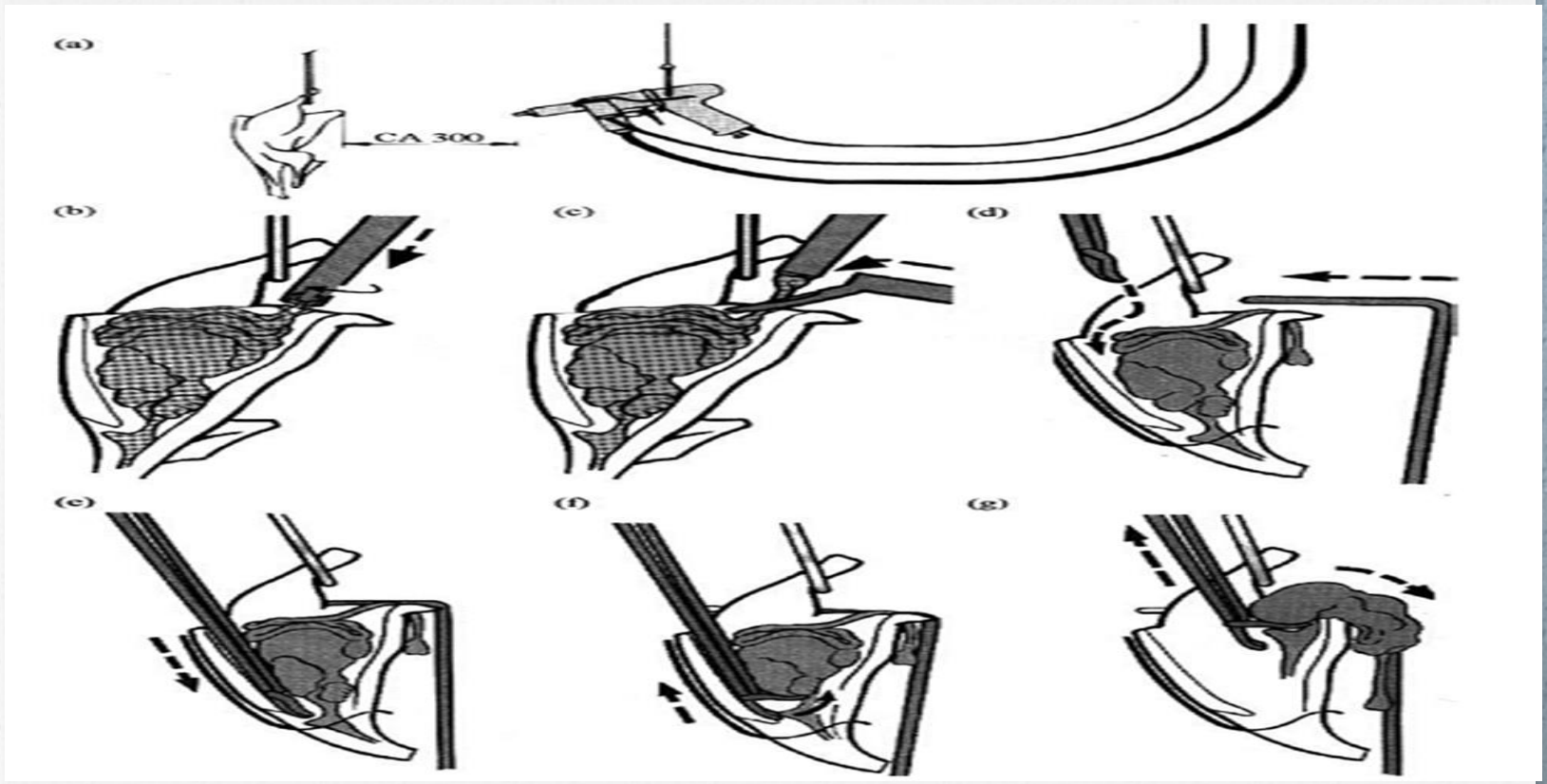
WASHING

FEET REMOVAL

EVISCERATION

- has three basic objectives;
- i) The body cavity is opened by making a cut from the posterior tip of the breastbone to the cloaca (anus)
- ii) The viscera (primarily the gastrointestinal tract and associated organs, reproductive track, heart, and lungs) is scooped out and;
- iii) The edible viscera or ‘giblets’ (heart, liver and gizzard) are harvested from the extracted viscera, trimmed of adhering tissues, and washed with water.





(a) Vent-Cutter Gun Operated by Plant Personnel, (b to g) Automated Vent Cutting, Showing (b) Positioning of the Carcass, (c) Pulling the Cloaca, (d) Positioning the Carcass Prior to Evisceration, (e) Inserting the Drawing Arm, (f) Opening the Drawing Scoop, (g) Pulling Out the Viscera Pack

WASHING

CHILLING

GRADING

PACKAGING

WASHING

CHILLING

GRADING

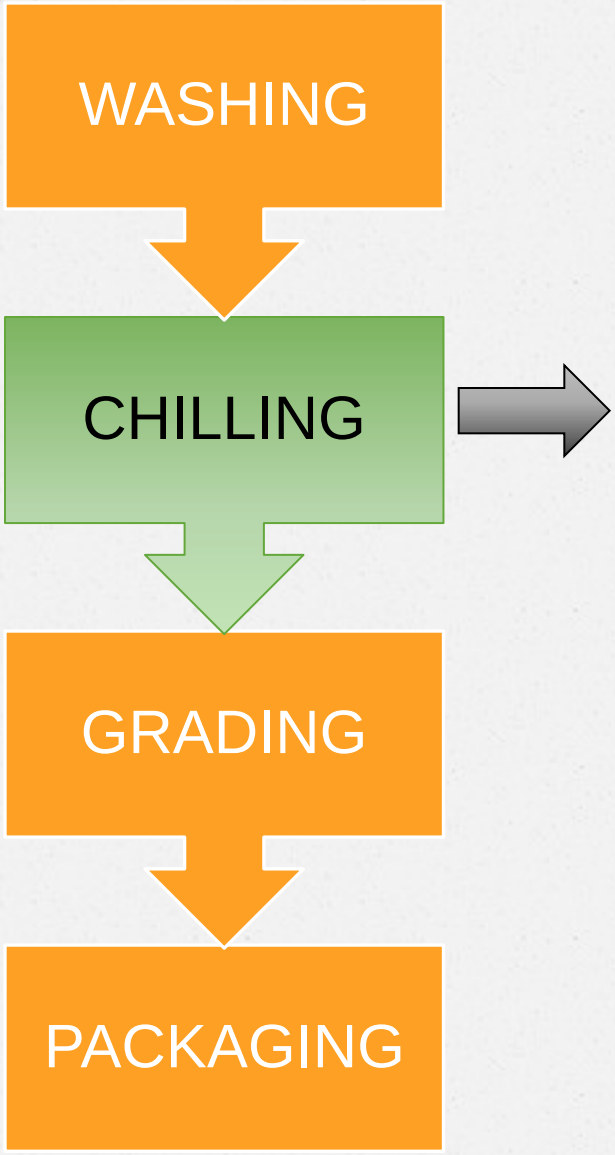
PACKAGING

- To minimize microbial growth
  - Temperature -6° - 1°
  - Takes longer: 2 hours
- More expensive equipment, space, utilities
- Less water
- The most common methods include;

1) water-immersion chilling,

2) air chilling and

3) spray chilling (which includes air and water).

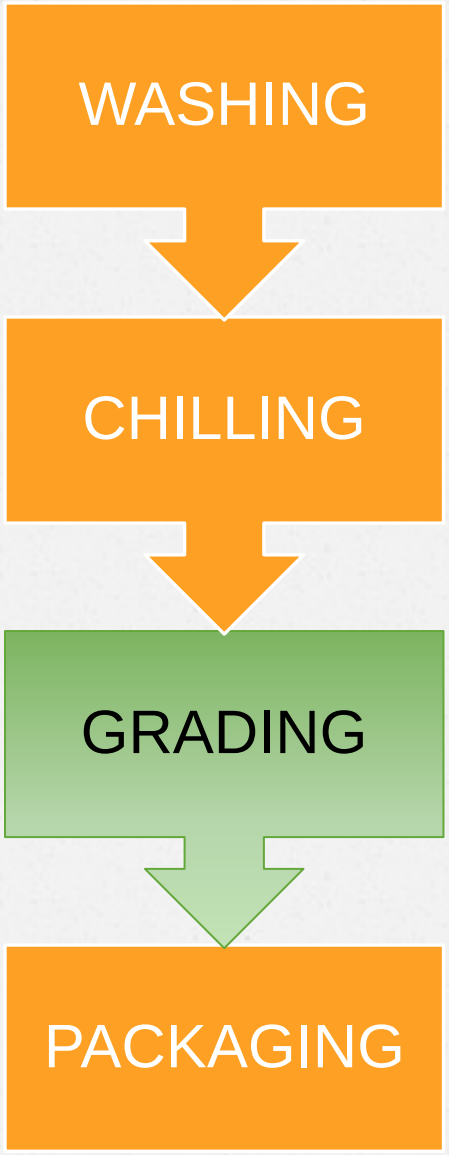


AIR CHILLING

- large rooms of circulating cold (-7 to 2°C) air for 1 to 3 hours.
- Cold air
- Depending on the chilling tunnel capacity and volume
- achieved within 60–150 minutes.
- the chilling time and improve the efficiency of the system.

Advantages of using air chilling are

- no moisture pickup and
- a drier final product.



- weighed, graded
- Grading
- before or after weighing
- not mandatory
- to facilitate sales
- by a qualified person or with the assistance of a computerized machine vision system.

WASHING

CHILLING

GRADING

PACKAGING

- different ways to cut up a poultry carcass.
- Depending on market demand
- be sold as a whole,
- ready-to-cook bird,
- split into two halves,
- separated into different parts (wings, legs) and
- sold with/without skin and bones (e.g., boneless breast).

Hand deboning

Mechanical Deboning

SPLINTER

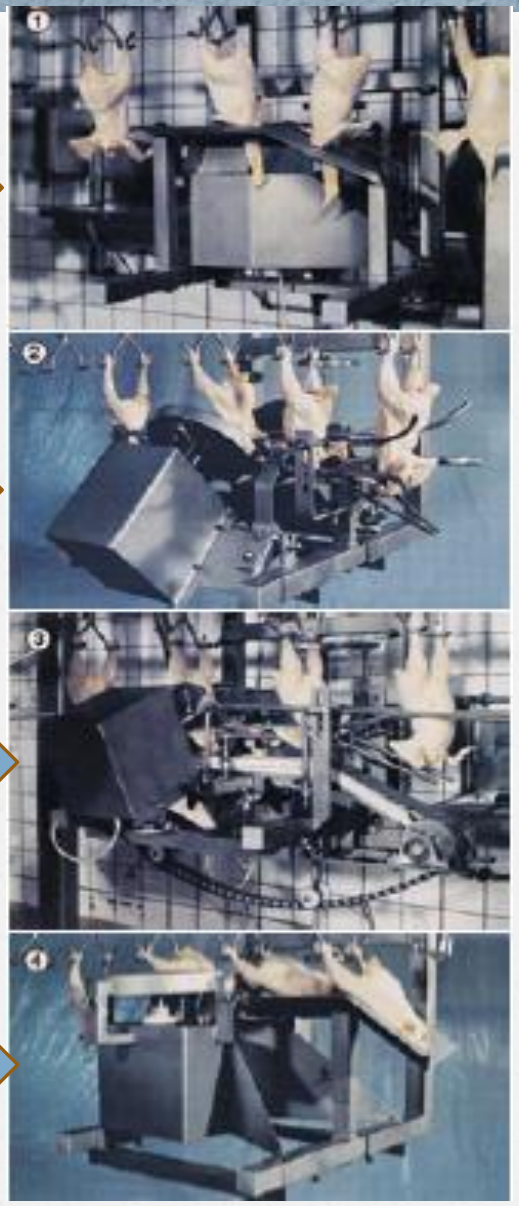
- FINAL PRODUCT CAN BE CUTTED INTO DESIRED SIZES WITH DIFFERENT EQUIPMENTS BEFORE PACKAGING.

Neck skin

Wings pole

Wings joint

Front chest



Vertical splinter

Horizon tal splinter

Tail and carcas

Saddle

Saddle middle

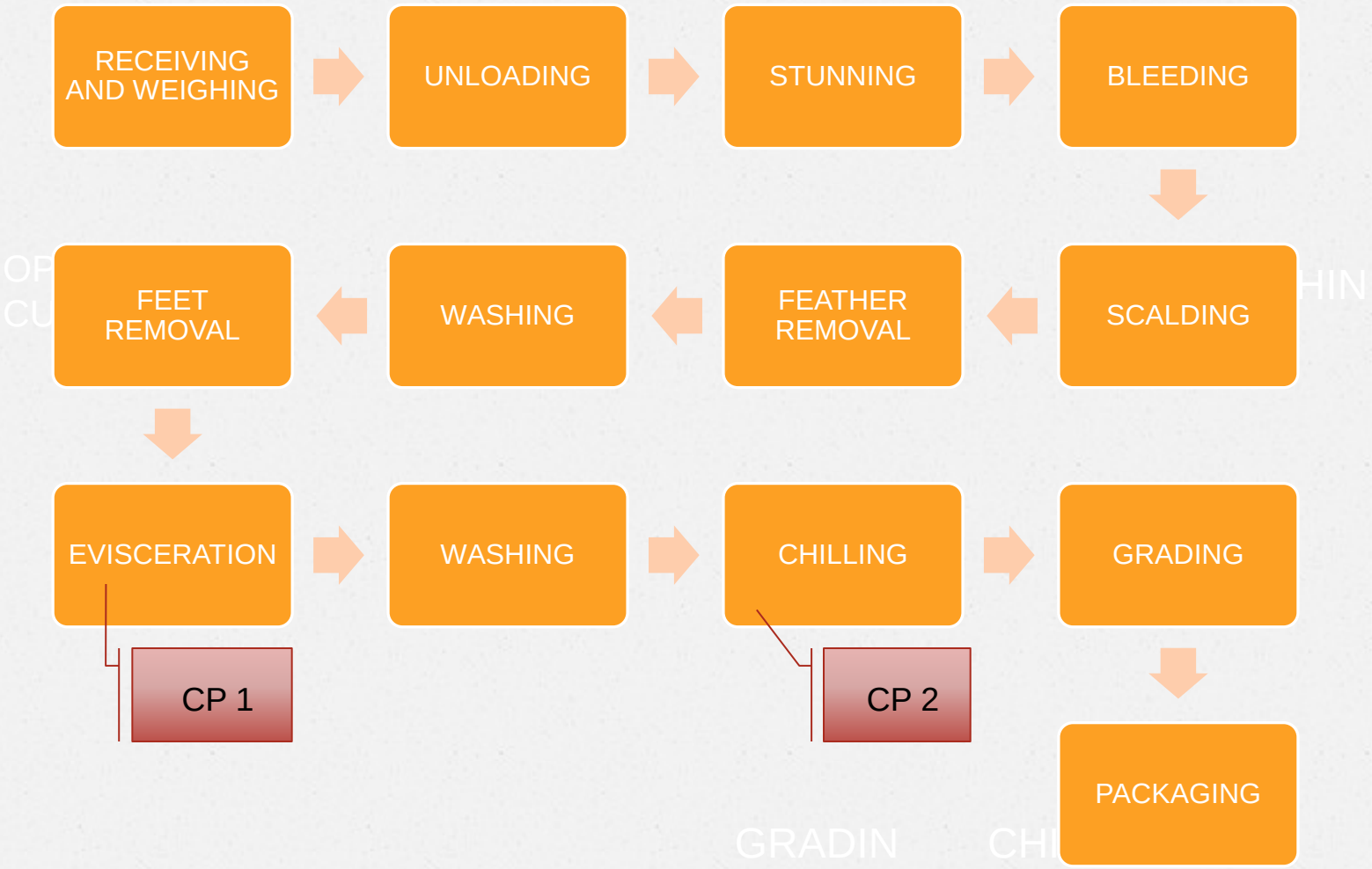
Huckle

Huckle releaser

POULTRY QUALITY

POULTRY CARCAS,LEG,BREAST,DEBONED

MICROBIOLOGICAL	CHEMICAL
Total Aerobic Mesophilic Count	pH
Staphylococcus aureus	Ammonia
Escherichia Coli	Thiobarbuturicacid (TBA)
Physchrophilic m/o count	
Clostridium perfingens	
Mold	
Salmonella	
Coliform count	


RECEIVING AND WEIGHING
UNLOADING
STUNNING
BLEEDING
SCALDING
FEATHER REMOVAL
WASHING
FEET REMOVAL
EVISCERATION
WASHING
CHILLING
GRADING
PACKAGING
CP 1
CP 2

PROPERTIES OF POULTRY PRODUCTS

- 1)POULTRY CARCASS

- 2)PROCESSED POULTRY CARCASS
  - 2.1)Breast
  - 2.2)Thigh
  - 2.3)Wing
  - 2.4)Boneless

CLASSIFICATION OF CHICKEN CARCASS

According to mass and age of the chicken;

- Broiler Chicken Carcass
- Boiled Chicken Carcass
- Adult Chicken Carcass

TYPES

According to cooling process;

- Chilled(fresh)
- Deep- frozen
- Quick - frozen

CLASSES

According to features of chicken carcass

- I.Class
- II.Class
- III.Class

CLASSIFICATION OF PROCESSED CHICKEN CARCASS

BREAST

GROUPS

- Chilled(fresh)
- Deep- frozen
- Quick - frozen

2.CATEGORIES

- With skin
- Without skin

3.CLASSES

- I. Class
- II. Class
- III. Class

THIGH

1.GROUPS

- Chilled(fresh)
- Deep- frozen
- Quick - frozen

2.CATEGORIES

- With skin
- Without skin

3.CLASSES

- I. Class
- II. Class
- III. Class

WINGS

1.GROUPS

- Chilled(fresh)
- Deep- frozen
- Quick - frozen

2.CATEGORIES

- With skin
- Without skin

3.CLASSES

- I. Class
- II. Class
- III. Class

BONELESS

1.GROUPS

- Chilled(fresh)
- Deep- frozen
- Quick – frozen

2.CATEGORIES

- Simple(with skin or no skin)
- Coated(with skin or no)

3.CLASSES

- I. Class
- II. Class
- III. Class

PROPERTIES OF CHICKEN MEAT

- Chicken meat is high in protein than other meats, less fat and calories low.
- It contains more than the fatty acid (oleic, linoleic, as palmitic acid).
- Breast meat is 114 kcal, but a thigh meat is 125 kcal .

- Chewable and digestible easly because of shortness of fibers
- Chicken meat is also a good source of B-group vitamins and iron

PROPERTIES OF BY CHICHEN PRODUCTS

CHICKEN BY PRODUCTS

- Chicken Liver
- Chicken Gizzard
- Chicken Meal
- Chicken Foot

PROPERTIES OF CHICKEN

NUTRITIONS	VALUES
Calories	196 kj
Proteins	9.2 g
Carbohydrates	0.4 g
Fats&Fatty Acids	1.5 g
Cholesterol	0.024 g
Ash	0.3 g
Water	18.8 g

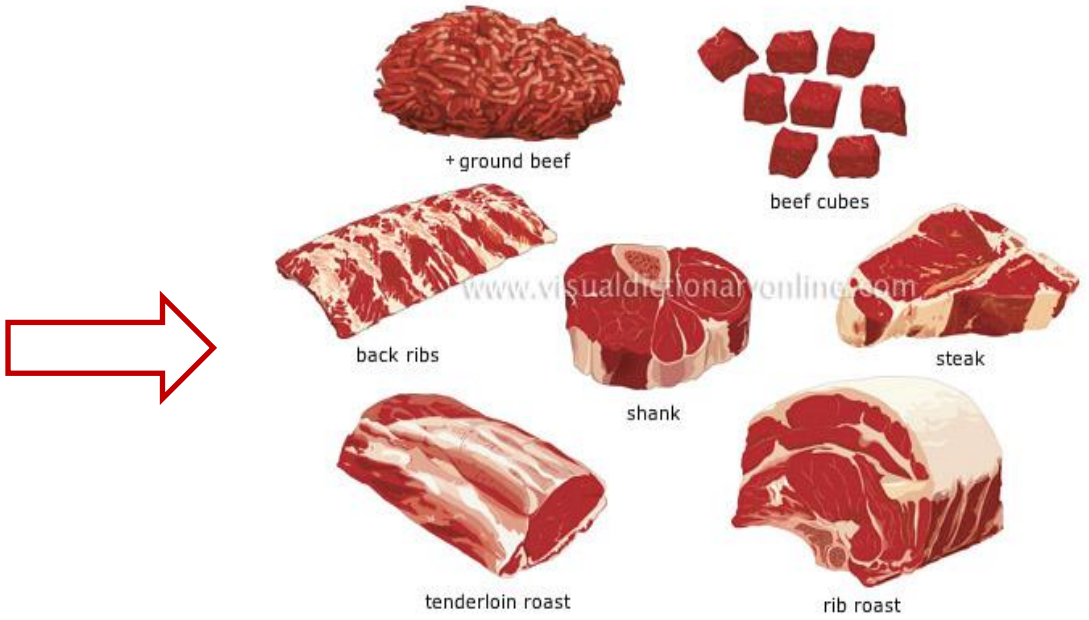
Chicken Meal

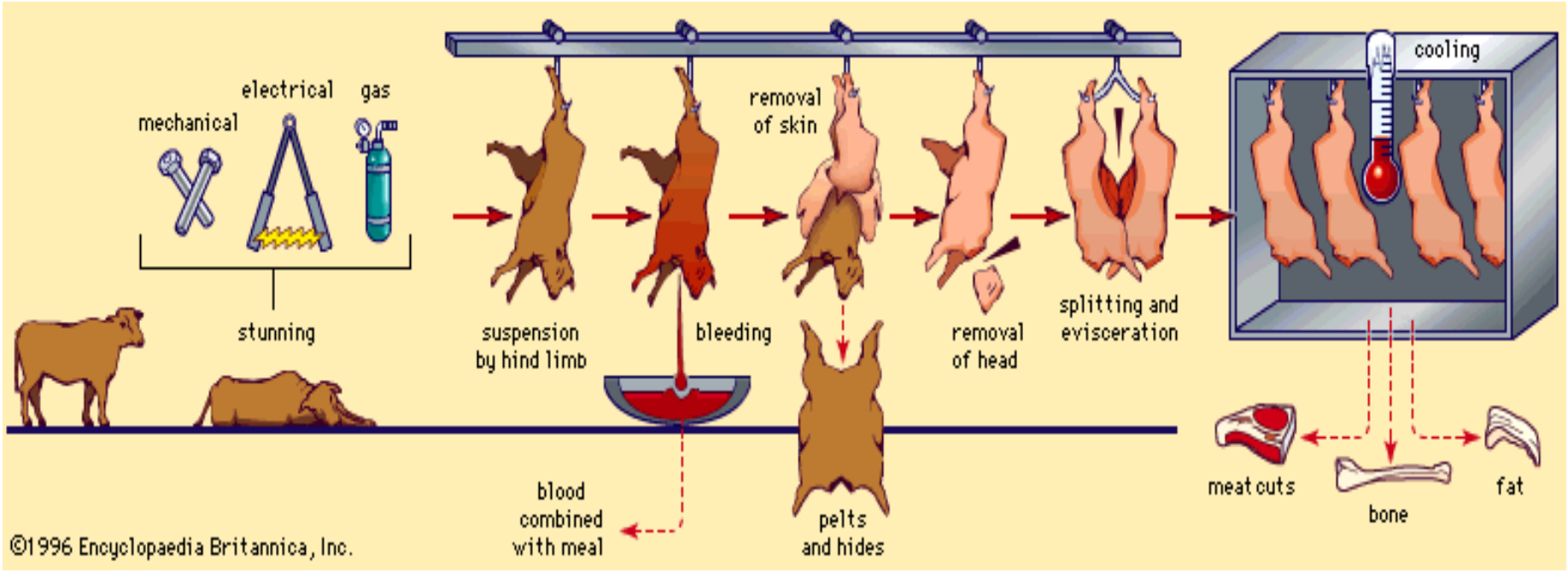
- Rendered product from poultry wastes such as;
- head, feet, intestines, blood and inedible tissues
- Hatchery wastes could be included.

PROPERTIES OF CHICKEN MEAL

- Protein content is dependent on the rate of feature in the mixture 55-65%,
- 12-21% ash content, crude fat content varies between 14-30%.
- Calcium from mineral substances is found around 1.8-3.2% and phosphate 1.5-8.5%.
- Lysine content of about 2.6%, methionine content is around 1.1%.

SLAUGTERING PROCESS




mechanical
electrical
gas
stunning
suspension by hind limb
bleeding
removal of skin
removal of head
splitting and evisceration
cooling
meat cuts
bone
fat
blood combined with meal
pelts and hides
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What is the SLAUGTER?

- **Slaughter** is the term used to describe the killing and butchering of animals, usually for food.
- Commonly it refers to killing and butchering of domestic livestock (*tame animals*).

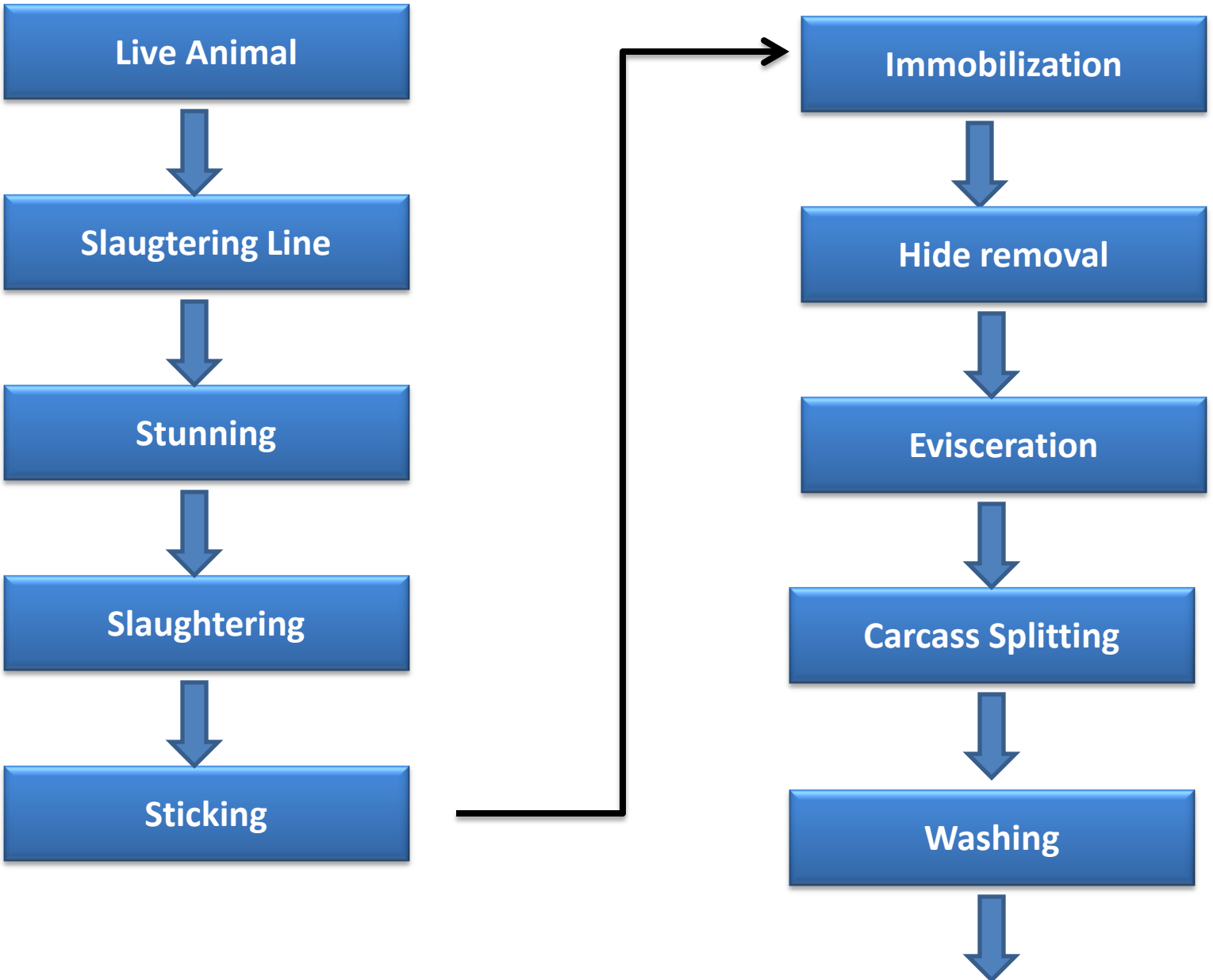
ANIMALS:

The animals most commonly slaughtered for food are

- Cattle(for beef and veal),
- Buffalo,
- Sheep (for lamb and mutton),
- Goats,
- Pigs (for pork),
- Horses (for horsemeat),
- Fowl, largely chickens, turkeys, and ducks.

Slaughtering

Process Flow Chart



Slaughtering

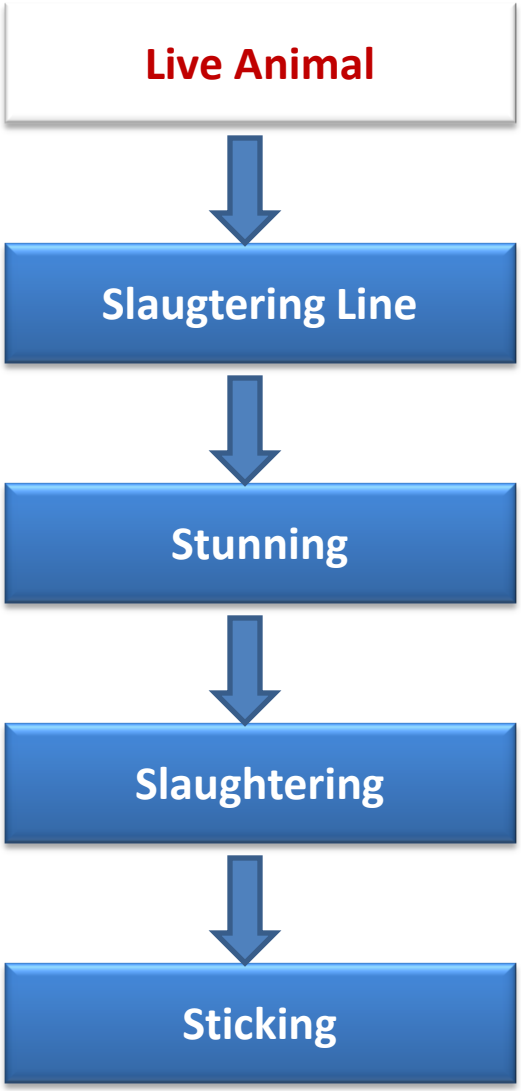
Process Flow Chart(go on)

Refrigeration

Boning

Distribution

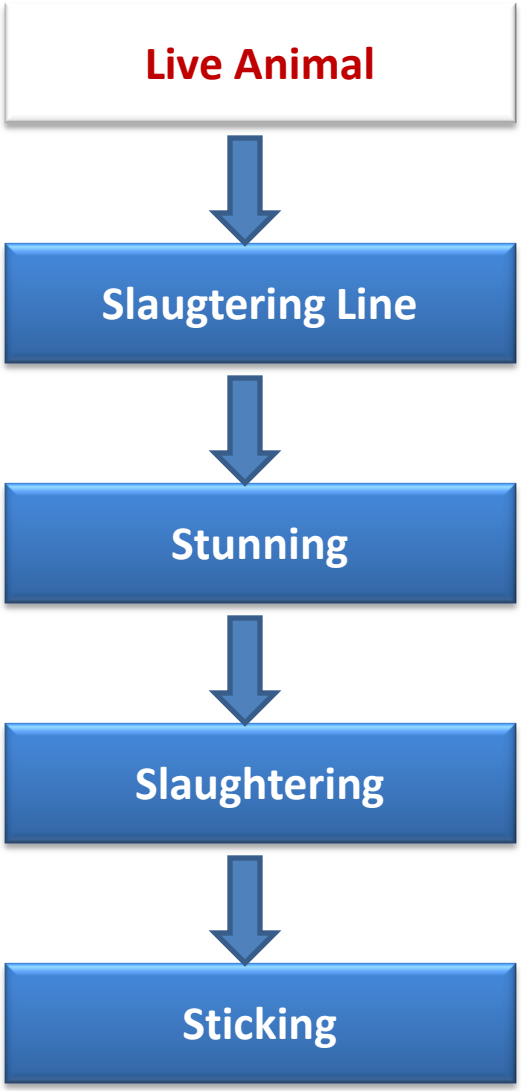
Slaughtering Process



Live animals must be:

- Healthy
- Physiologically normal
- Adequately rested
- Watered during holding
- Fed

Slaughtering Process



Effects of transport:

- Stress
- Bruising
- Heart failure
- Poisoning
- Dehydration
- Etc.

Slaughtering Process

Live Animal

↓

Slaugtering Line

↓

Stunning

↓

Slaughtering

↓

Sticking

Methods of transport

- Road motor vehicle for transporting cattle

Slaughtering Process

Live Animal

↓

Slaugtering Line

↓

Stunning

↓

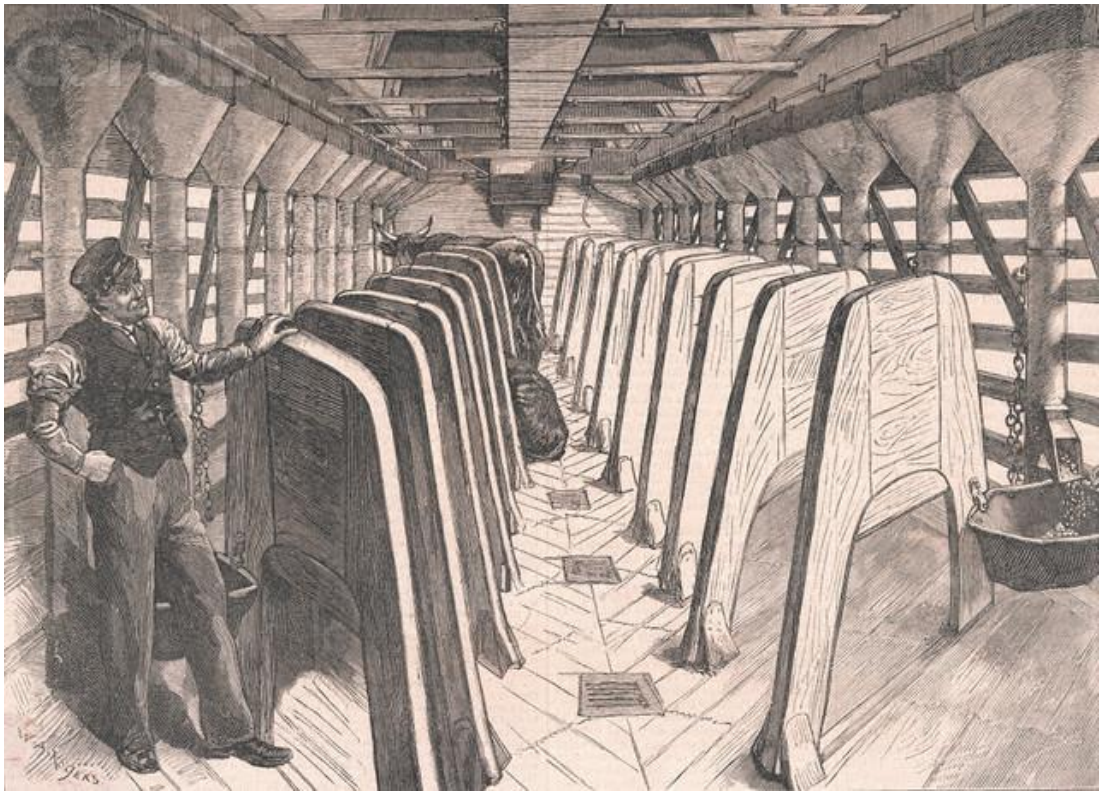
Slaughtering

↓

Sticking

Methods of transport

➢Large truck for cattle transport



Slaughtering Process

Live Animal

↓

Slaugtering Line

↓

Stunning

↓

Slaughtering

↓

Sticking

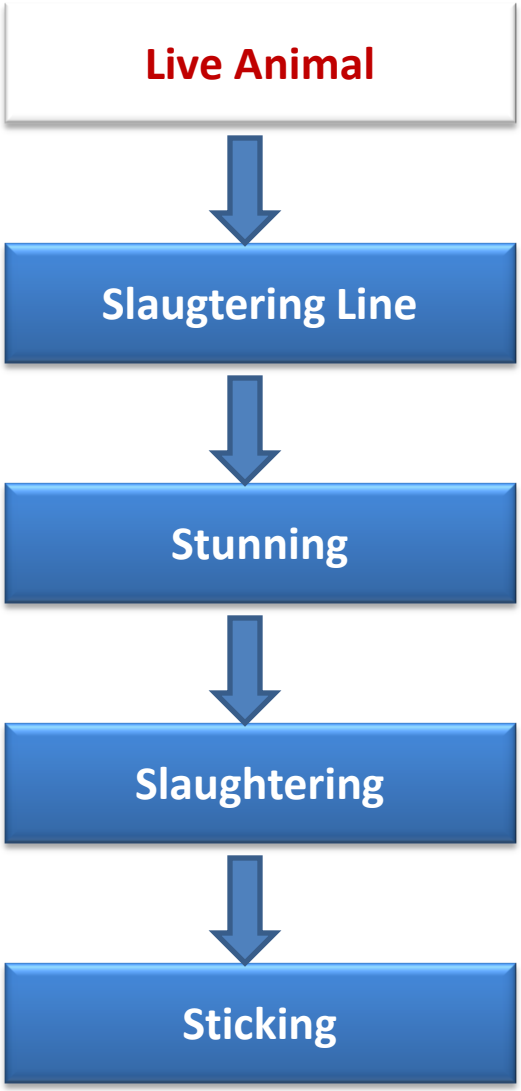
Methods of transport

➢ **Double-deck truck for transporting sheep/goats**

LIVE ANIMAL SHIPMENT

- **Cleaned and disinfected**
- **The floor coverings of the vehicle must be laid with straw, sawdust.**
- **Any behavior that may cause animals to overload the means of transport, injure them, and suffering**

Slaughtering Process



- **Approximate floor space for transporting different classes of animals**

Classes of stock		Floor area/animal (m^2)
Mature cattle		1.0 - 1.4*
Small calves		0.3
Pigs	porker	0.3
	baconer	0.4
	sow/boar	0.8
Sheep/goats		0.4
Ostriches		0.8

Slaughtering Process

Live Animal

↓

Slaugtering Line

↓

Stunning

↓

Slaughtering

↓

Sticking

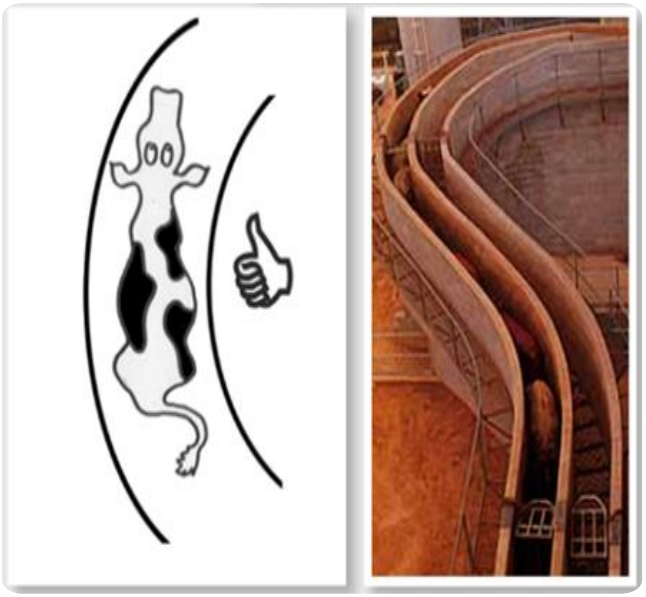
➢That is road between stable and slaughtering area

PADDOCKS

After the transport, live animals are brought to the pastures to rest. (At least 8 hours in winter and 12 hours in summer.)

Paddock structure and layout;

- ✓ must be suitable for the type of animal.
- ✓ The handrails in the passages should be of sufficient height.
- ✓ handrails must be resistant to animal movements.
- ✓ Floors should be in a way that prevents slipping and jamming.
- ✓ Lighting should be sufficient.



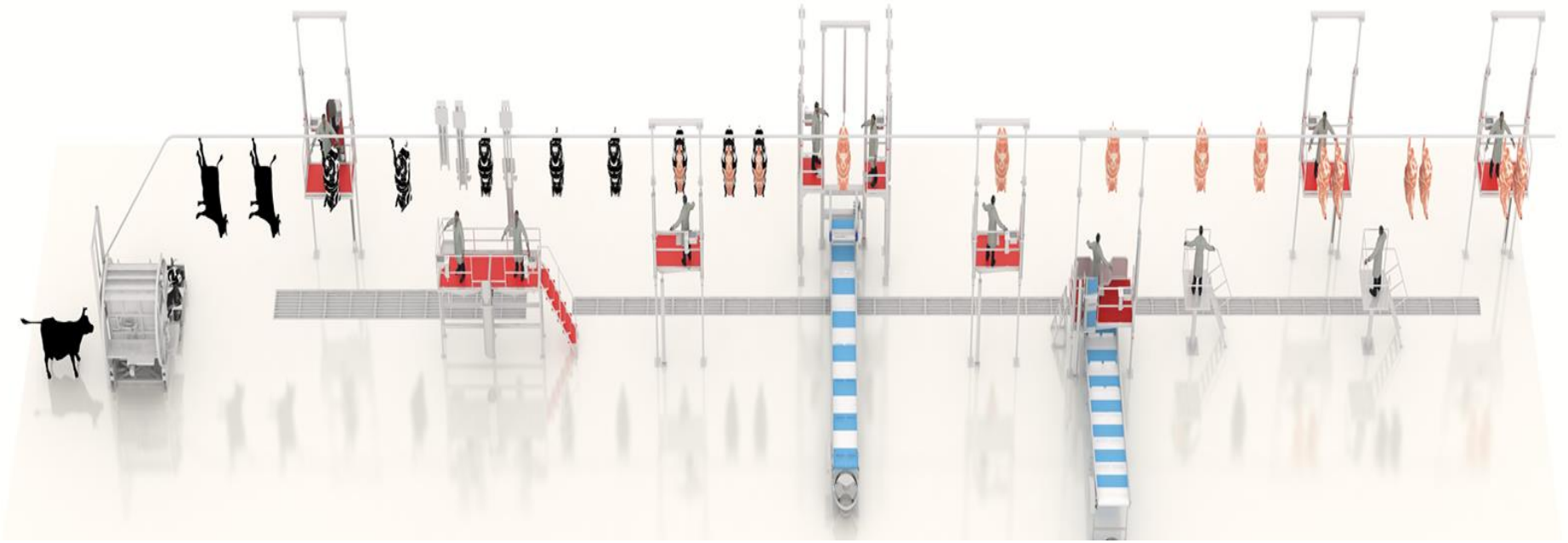
TRANSITION TO CUTTING

- This transport route must be wide and high enough for an animal to pass.
- there should be no noise, puddles or shadows.
- must go from dark to light.
- made with curved folds. (animals can move forward without fear and on their own.)

FOOT BATH

- The animal is directed to a foot bath to clean its feet. Its depth is approximately 80-150 mm and length is 2.5 m.

- It is cleaned in a water bath, then in a water solution (5-10% copper-sulphate) pool.



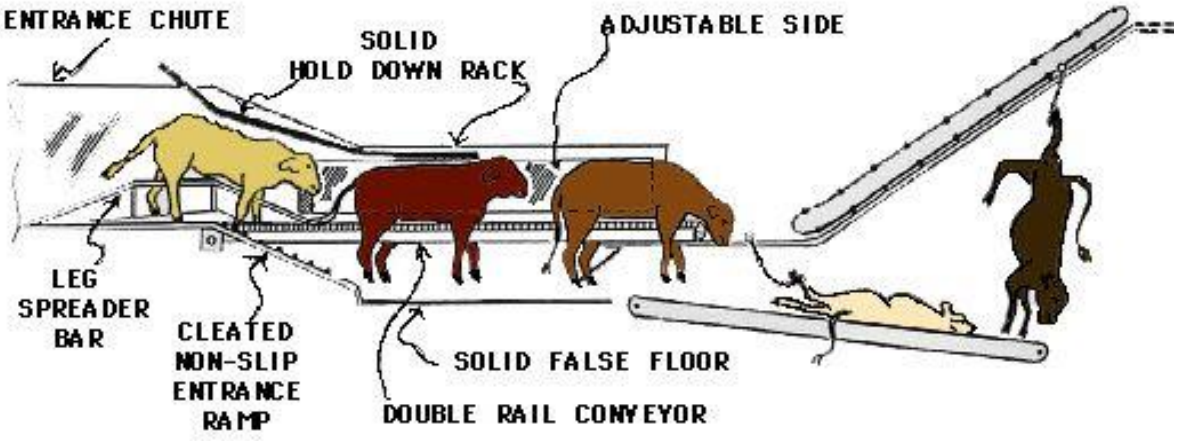
Live Animal

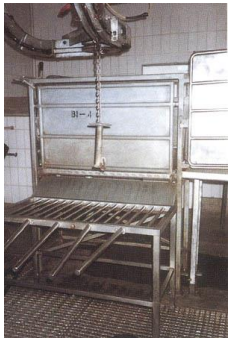
Slaugtering Line

Stunning

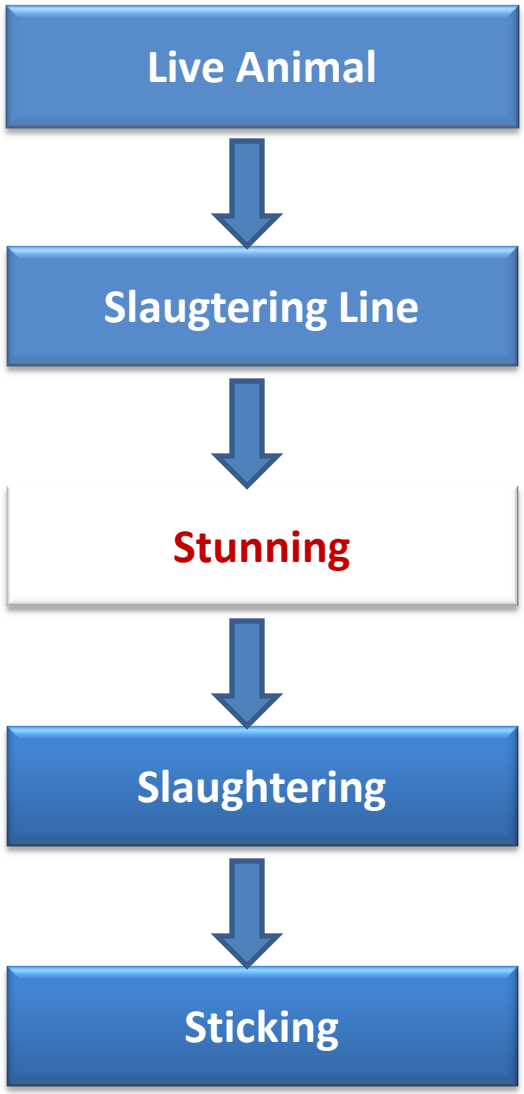
Slaughtering

Sticking





Slaughtering Process



- **Stunning** is the process of rendering animals immobile or unconscious prior to their being slaughtered for food.

Stunning methods:

- Mechanical stunning
- Electrical stunning
- Carbon dioxide gas stunning

Slaughtering Process

- Live Animal
- Slaugtering Line
- Stunning
- Slaughtering
- Sticking

Mechanical (captive bolt) stunning:

- This method is approved for,sheep,pig,goats, cattle,horses
- A captive bolt stunner is applied to the livestock so as to produce immediate unconsciousness in the animals before they are butchered

STUNNING

CIRCULAR CUTTING CELL

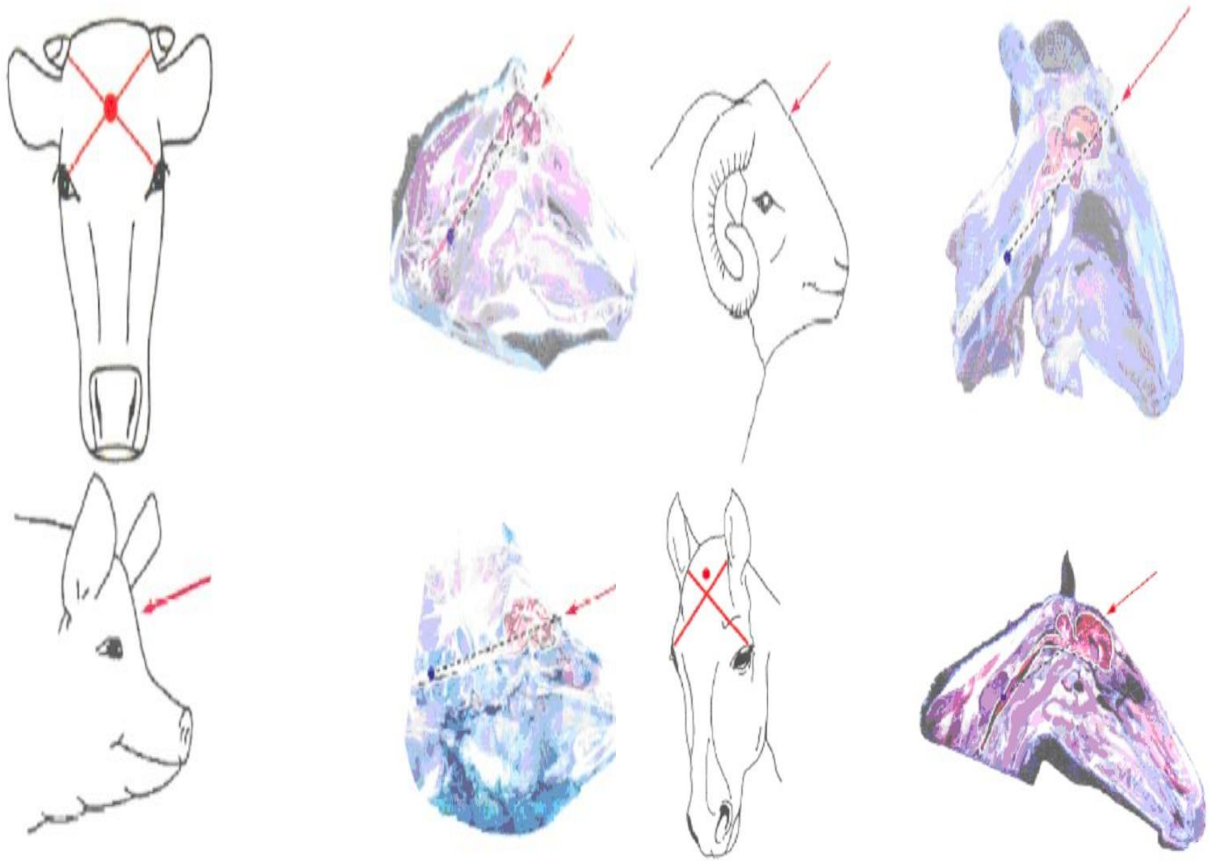
- For the slaughter of cattle.
- Suitable for halal slaughter.
- Prevents the animal from struggling by squeezing it.
- Designed to minimize butcher and animal accidents.

Slaughtering Process

- Live Animal
- Slaugtering Line
- Stunning
- Slaughtering
- Sticking

Mechanical (captive bolt) stunning:

➢Correct positioning of stunning gun for different species (horse, cattle, goat, sheep and pig)

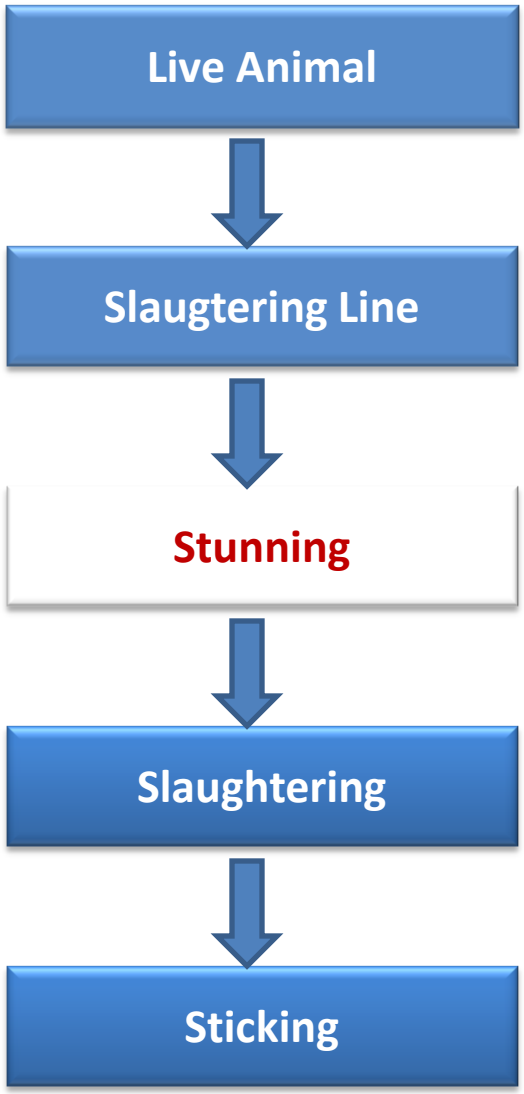


Slaughtering Process

- Live Animal
- Slaugtering Line
- Stunning
- Slaughtering
- Sticking

Application of mechanical stunning:

Slaughtering Process



Electrical stunning:

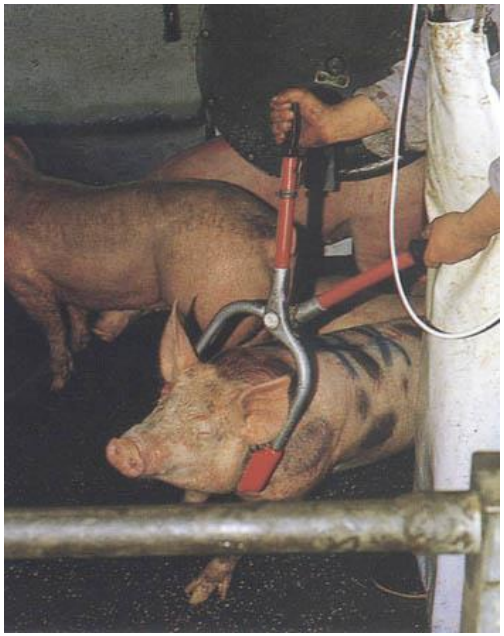
- This method is approved for pig, sheep, calves, cattle, and goats.
- Electrical shock must be applied adequately.

Species	Minimum current levels for head-only stunning
Cattle	1.5 amps
Calves (bovines of less than 6 month of age)	1.0 amps
Pigs	1.25 amps
Sheep and goats	1.0 amps
Lambs	0.7 amps
Ostriches	0.4 amps

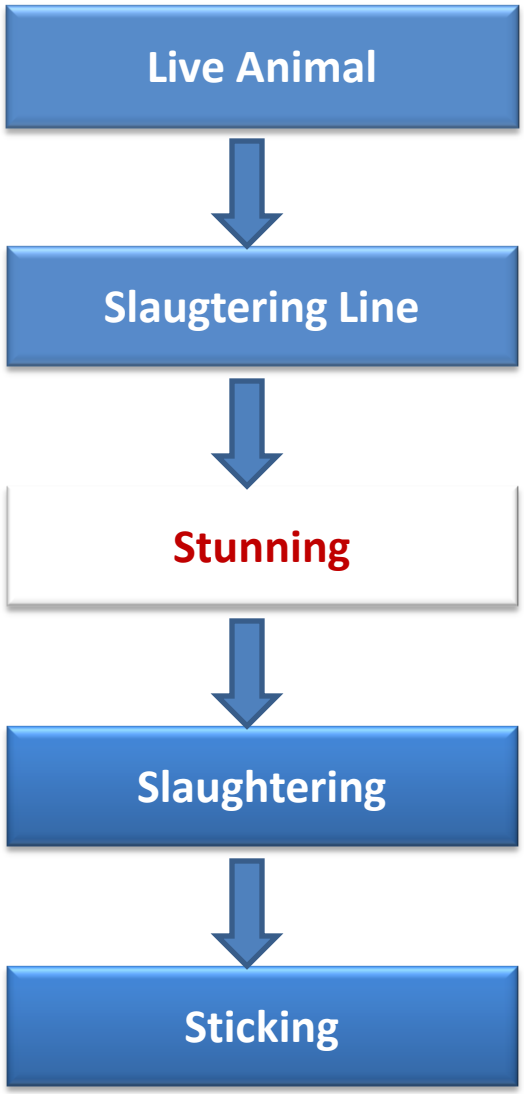
Slaughtering Process

- Live Animal
- Slaugtering Line
- Stunning
- Slaughtering
- Sticking

Application of Electrical stunning:

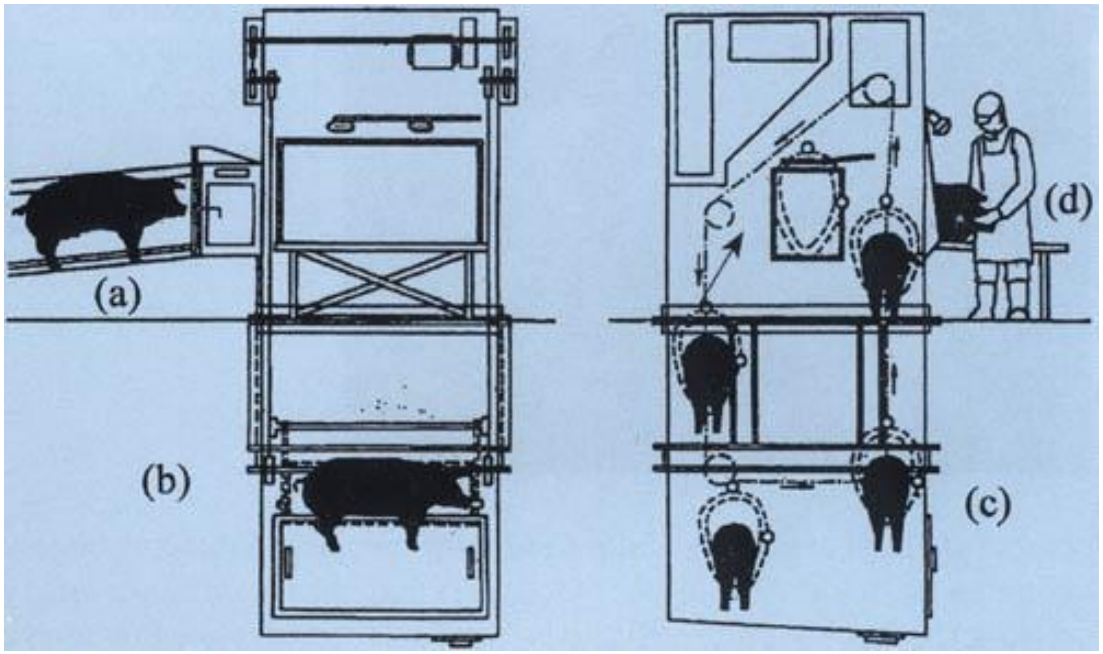


Slaughtering Process



Gas stunning:

- This method is approved for pigs and poultry
- Stunning of animal by exposure to carbon dioxide (CO_2)



Slaughtering Process

- Live Animal
- Slaugtering Line
- Stunning
- **Slaughtering**
- Sticking

Slaughtering:

- Cutting of the carotid arteries and esophagus
- The point of knife is inserted about 2 cm infront of the breast bone

Slaughtering Process

- Live Animal
- Slaugtering Line
- Stunning
- Slaughtering
- Sticking

Sticking: Removal of blood from the body.

Purpose of sticking:

- **Reduce the microbial content**
- **Prevent blood splash**
- **Economical importance**

Slaughtering Process

- Hide removal
- Evisceration
- Carcass Splitting
- Washing
- Refrigeration
- Boning

Hide removal:

PN-5323

Figure 23.—Siding.

TRANSFERRING STATION

- The cattle is transferred from the bleeding line to the processing line.

PRE-DEHIDING

- The skin of the animal is opened from the chest part and the skin is prepared completely for dehiding.

DEHIDING

- In this section, integrated dehiding machine, movable drum and movable platforms on both sides are used together.

Slaughtering Process

- Hide removal
- Evisceration
- Carcass Splitting
- Washing
- Refrigeration
- Boning

Evisceration:

➢Evisceration is a manual procedure of the viscera and gut from the carcass that requires careful handling to prevent any contamination from spillage.

EVISCERATION

BRISKET OPENING

- In this unit, a brisket opening saw is used and the chest part of the carcass is opened.

TRIPE EXTRACTING

- The tripe and intestine are extracted from the chest.

LIVER EXTRACTING

- The liver and internal organs of the animal are extracted and hanged to the liver conveyor. The parts are transferred to the internal organ room without manual interference.

CARCASS SPLITTING

- In this unit, the carcass separates the carcass from the center with the help of a saw on a pneumatic moving platform.

VETERINARY CONTROL

- carcass, liver, head and tripe are checked by the veterinarian. The animal diagnosed as being superior is directed to the suspect cold room.

Hide removal

Evisceration

Carcass Splitting

Washing

Refrigeration

Boning

Slaughtering Process

Splitting of Carcasses:

➢The whole carcass was cut into halves from center of the backbone.

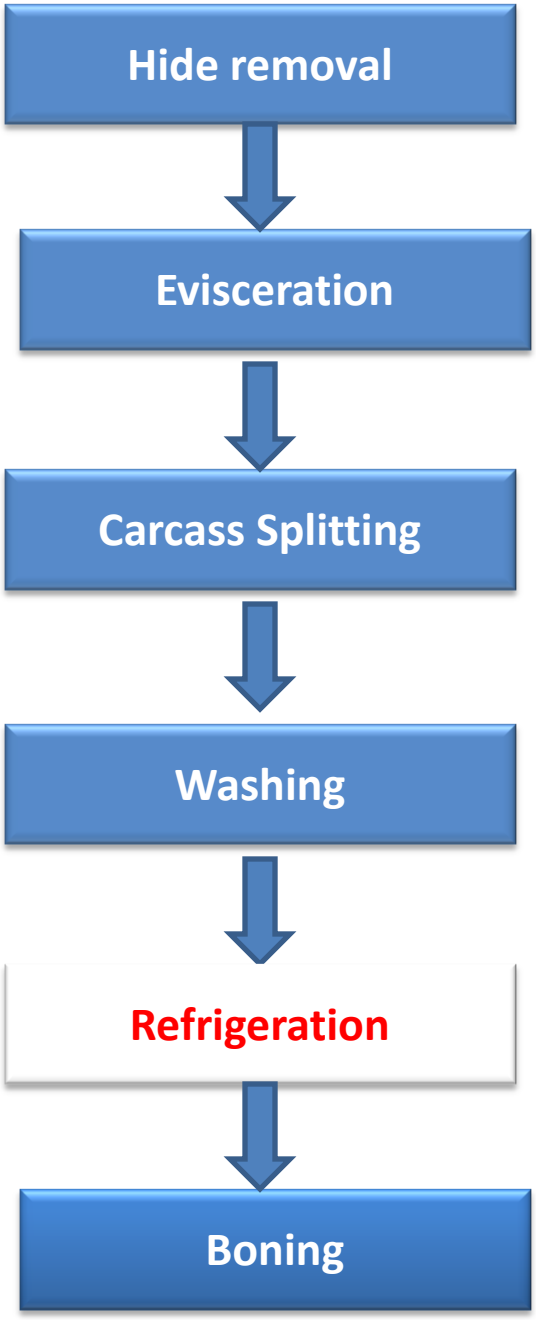
Slaughtering Process

- Hide removal
- Evisceration
- Carcass Splitting
- Washing
- Refrigeration
- Boning

Washing of Carcasses:
(with spraying hot water about 40-50^{0}C)

- **Carcass washing is to remove visible soiling and blood stains and to improve appearance after chilling**
- **Good hygienic practices**

Slaughtering Process



Refrigeration of carcasses:

- Delay bacterial growth
- Extend the shelf-life

Type of meat	*Expected storage life at - 1°C*
Beef	up to 3 weeks (4–5 with strict hygiene)
Veal	1–3 weeks
Lamb	10–15 days
Pork	1–2 weeks
Edible offal	7 days
Rabbit	5 days
Bacon	4 weeks (at - 3°C)

Slaughtering Process

- Hide removal
- Evisceration
- Carcass Splitting
- Washing
- Refrigeration
- Boning

Boning: Separation of bone

- Hot boning or
- Cold boning

CARCASS CHILLING

Air temperature must be in the region of 0°C, with no decrease below -1°C, which could freeze the meat surface and impair its appearance.
Air speed can range from 0.75 to 1.5 m/s.
The relative humidity is between 90 and 95 percent.

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

CHILLED STORAGE

- Aging (maturation) of meat also occurs during storage.
- For chilled meat, normally 0 ° C is a reasonable choice.
- The relative humidity is between 80 and 90 percent, and this is a compromise between weight loss and microbial growth.

FERMENTED – DRY SAUSAGE *(SUCUK)*

Dr. Hüseyin BOZKURT
University of Gaziantep

Sausages are usually defined as comminuted seasoned meats, stuffed into casings; they may be smoked, cured, fermented and heated.

INGREDIENTS

- MEAT: Meats used for sausages must be
  - fresh,
  - completed rigor-mortis phase
  - high quality,
  - with very low microbial counts,
  - good color,

Composition of Meat

- Water 65-80 %
- Protein 16-22 %
  - Myofibrillic protein (9.5 %)
    - Actin
    - Myosin
  - Sarcoplasmic protein (6.0 %)
    - Myoglobin
    - Hemoglobin
  - Stroma proteins (3.0 %)
    - Collogen, elastine
- Fat 1.5- 13.0 %
  - Phospholipids, cholesterol
- Carbohydrate 0.5-1.5 %
  - Glycogen and glucose

SALT (*SODIUM CHLORIDE*):

Salt provides

- flavors,
- essential in solubilizing muscle proteins,
- decrease the moisture,
- improve yield,
- influence textural characteristics.

NITRITE

Nitrite has several functions on meat products;

1. forms a bright red-pink color,
2. gains flavor and aroma,
3. prevents rancidity,
4. prevents growth of pathogenic microorganism,

ASCORBATE AND ERYTHORBATE

- These reductants react with nitrite to give nitric oxide, thus
  - fastening development of the pink-red color in cured sausages.
- Prevent formation of nitrosamines

SUGAR

- Sugar is added to meat as an adjunct
  - to counteract the salty taste,
  - to give flavor
  - to serve as a substrate for bacterial acid production in dry and semidry sausages.

SPICES

- Spices are aromatic vegetable substances in whole, broken or ground form.
- Spices may be added as natural spices or spices exracts.
- They are used to
  - give flavor (allspice, garlic)
  - give color (red pepper)

PHOSPHATES

- Phosphates are used to
  - give a phosphate source to microorganisms
  - increase the fermentation rate
  - buffering activity

- Some examples: sodium tripolyphosphate, tetrasodium pyrophosphate, sodium hexametaphosphate, sodium acid pyrophosphate, dissodium phosphate etc..

FERMENTED SAUSAGE TYPES

- 1. SEMIDRY SAUSAGES:

Semidry sausages differ greatly from dry sausages;

- By their high moisture content
- By their pronounced “tangy” flavor of forced fermentation resulting in lactic acid accumulation

2. DRY SAUSAGES

- The organoleptic and other properties of dry sausages depend upon;
  - The products of sugar bacterial fermentation
  - And strongly influenced by biochemical and physical changes occurring during the long drying or ripening process.

EXAMPLES OF FERMENTED SAUSAGES

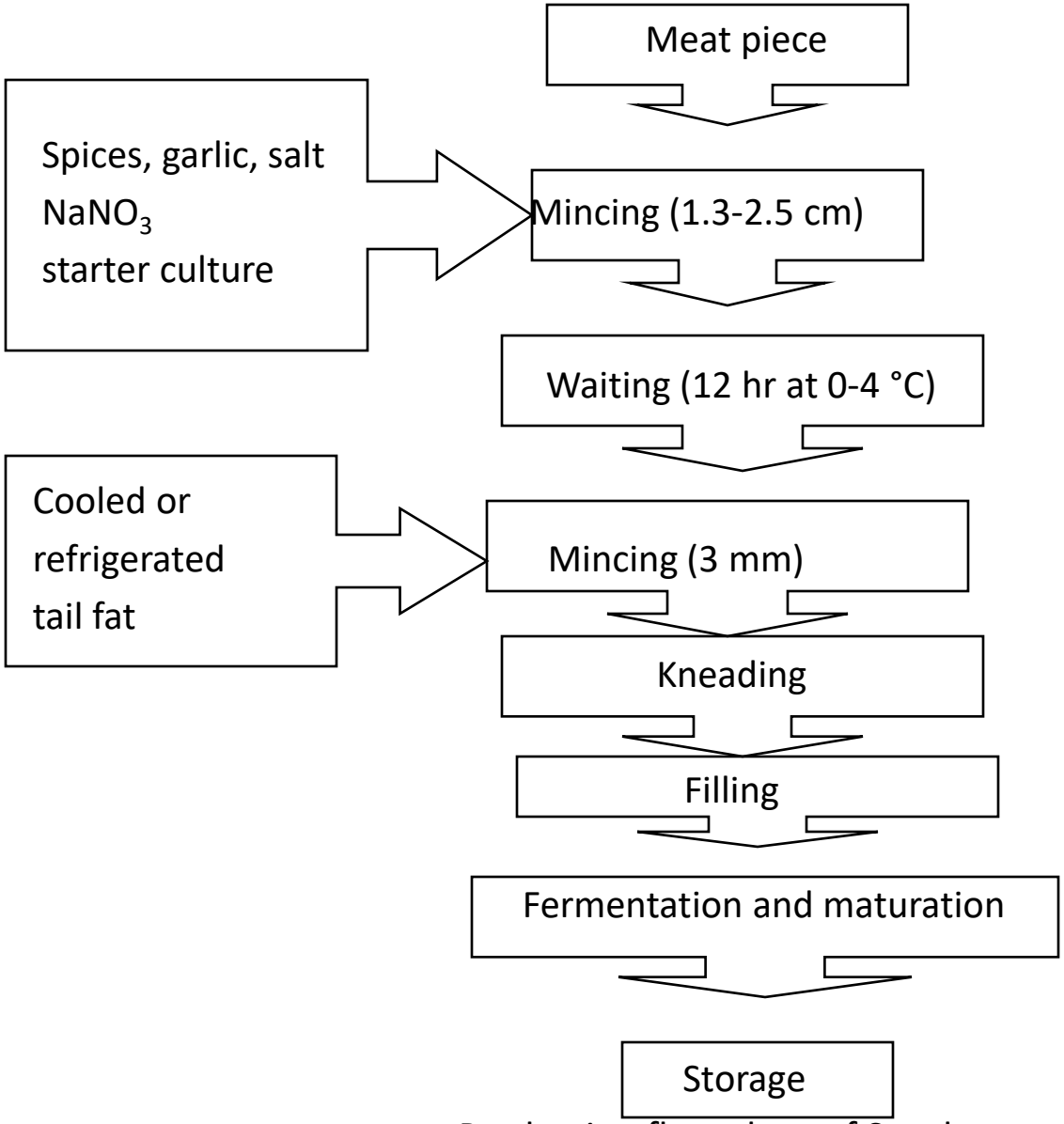
- SUMMER SAUSAGES
- AIR-DRIED SAUSAGES
- PEPPERONI
- PORK AND BEEF CHORIZOS
- BEEF SALAMIS
- TURKISH AND ORIENTAL STYLE RAW BEEF SAUSAGES
- LANDJAEGERS

Sucuk

- Sucuk is a fermented dry meat product.
- Minced meat and fat are mixed with salt, sugar, spices, and little amount of other additional substances.
- These are filled into natural or artificial casing.
- Then, at specific temperature and moisture content they are ripened and dried.

Some Examples of Sucuk

Sucuk: DRY-FERMENTED SAUSAGE



Production flow-chart of Sucuk

PRODUCTION OF SUCUK

- Selection of raw materials
- Grinding, chopping and mixing
- Stuffing
- Ripening
  - Fermentation
  - Drying
- Storage

Selection of Meat

- The meat of adult and well fed animals is preferred.
- Dark-firm-dry (DFD) meat must not be used.
- High pH value of meats has high water holding capacity so causes some problems during ripening.
- Pale-soft-exudative (PSE) meat is not preferred for sausage manufacturing.
- The use of chilled meat with a low pH is most suitable.

Selection of Other Ingredients

- Tail fat should be frozen.
- Spices should have dry and free from microorganisms, toxin and etc.
- Spices should be fresh.

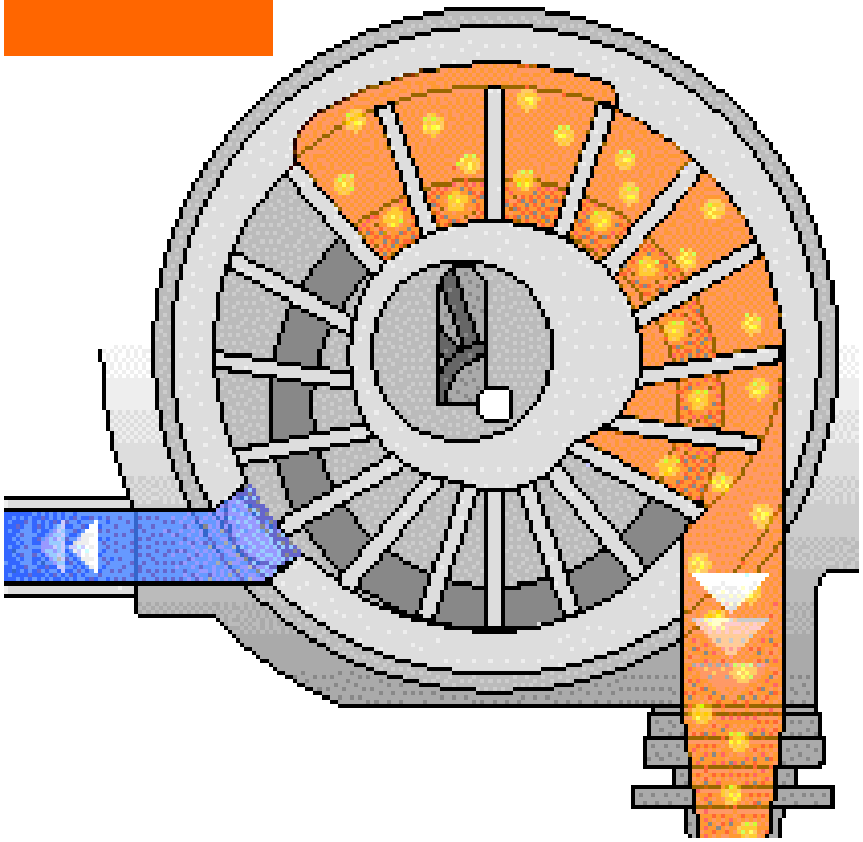
Grinding, chopping and mixing

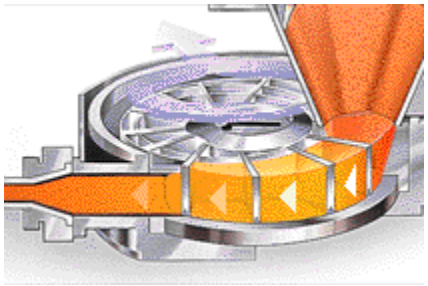
- The extraction of protein while the spreading properties of the finished product will be improved.
- Meat is normally chopped first, and than other ingredients are added.
- Salt is added at the latest stage of chopping.

Stuffing

- Stuffing into casing should also be done firmly and carefully to exclude air.

- Air inside the casing will discolor meat and reduce self life.



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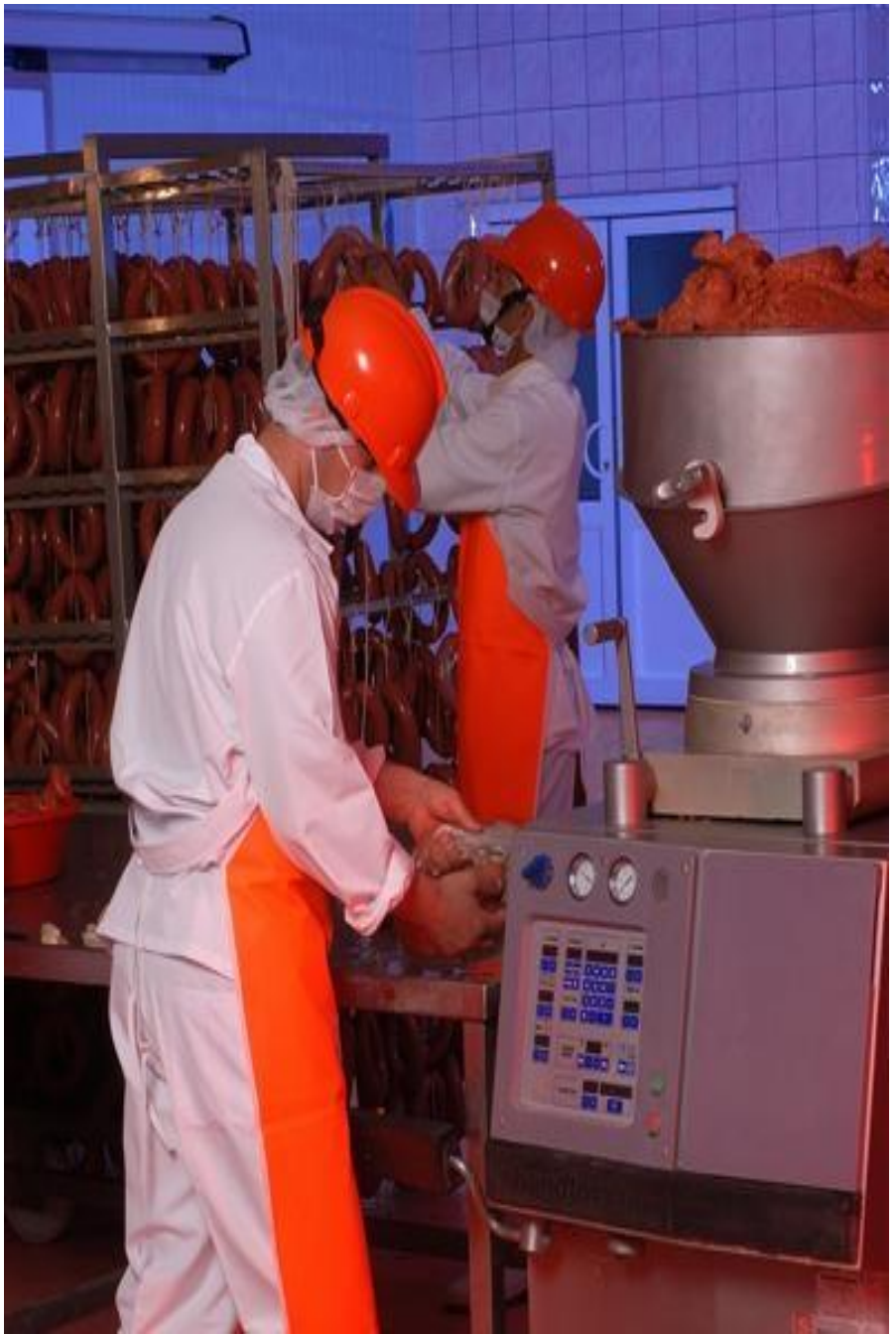


Drying

- The drying rate should be as low as possible.
- The most critical point in drying is to avoid the formation of case-hardening.

Ripening (Fermentation and Drying)

- During the ripening;
  - pH reduced
  - Desired color formation (nitrosomyoglobin) observed
  - Nitrite level decreased
  - Desired flavor formed
  - Biogenic amines could be formed
  - Microorganism count decreased
  - Desired texture attained

Storage

- If stored in a warm room, sucuks shrink excessively and become firm.
- If left in too humid or too cool room, they soon lose their color.
- Optimum storage conditions: 50-65 % relative humidity, and 18-22°C.

Factors Affecting Ripening and Storage of the Sucuk

1. External Factors
   - Temperature
   - Relative Humidity
   - Air-condition

2. Internal Factors
   - Raw Material
   - Salt and sugar
   - Water activity
   - Initial Number of Starter Culture.
   - pH
   - Additives

Microbial Activity in Ripening and Storage Periods

- Two basic microbial activities proceed during the fermentation period.
    - Reduction of pH by lactic acid bacteria,
    - Formation nitric oxide by nitrate and nitrite reductase activity of microorganisms

1. Lactic Acid Bacteria (LAB)

- LAB has a number of beneficial effects on the manufacturing process, quality and shelf-life.
  - inhibits undesirable microorganisms.
  - helps to develop texture
  - accelerates gelatinization.
  - controls enzymic activities that contribute to aroma.
  - favors color formation

2. Micrococcus and *Staphylococcus*

- Bacteria of *Micrococacceae* family,
  - Microflora or
  - Added as starter culture,

  an essential role in the reduction of nitrate to nitrite by means of their nitrate reductase activity.

- The catalase of *Micrococacceae* which breaks down peroxides, including hydrogen peroxide produced by Lactobacilli and rancidity is inhibited.

•*Micrococacceae* have an ability to break down

• fat (lipolysis) and

• protein (proteolysis)

which have great importance in the development of flavor, also stabilize the color in dry sausage

3. Molds and Yeasts

The surface flora of dry sausages, mainly the genus *Penicillum*,

•protects from harmful effects of air, and light,

•makes drying the sausages easier and

•gives them their typical aroma

Starter Cultures and Their Effects

•*Lactobacillus*, *Micrococcus*, *Pediococcus*, *Staphylococcus*, *Debaryomyces*, and *Penicillium*

•Mixed cultures of lactobacilli and micrococci have given much better results for

- •reducing ripening period,
- •development of flavor,
- •development of color,
- •development of texture
- •development of firmness and
- •prolonging the shelf-life.

- *Debaryomyces hansenii*
  - for unique and more aromatic flavor
  - better and homogeneous color development
  - inhibit surface flora.

Species used as starters	Useful metabolic activity	Benefits to sucuk fermentation
L. plantarum, *L.pentosus*, *L.sake*, *L. curvatus*, *P.pentosaceus*, *P. acidilactici*	Formation of lactic acid and bacteriocins	Inhibition of pathogenic and spoilage bacteria Acceleration of color formation and drying
S. carnosus, *S. xylosus* *M. varians*	Nitrate reduction and oxygen consumption Peroxide destruction Lipolysis	Color formation and stabilization Removal excess nitrite Delay of rancidity Aroma formation
Debaryomyces hansenii	Oxygen consumption Lipolysis	Delay rancidity Aroma formation
Penicillium nalgiovense biotype 2, 3, 6	Oxygen consumption Peroxide destruction Lactate oxidation Peoteolysis Lipolysis	Color stability Delay of rancidity Aroma formation Aroma formation Aroma formation

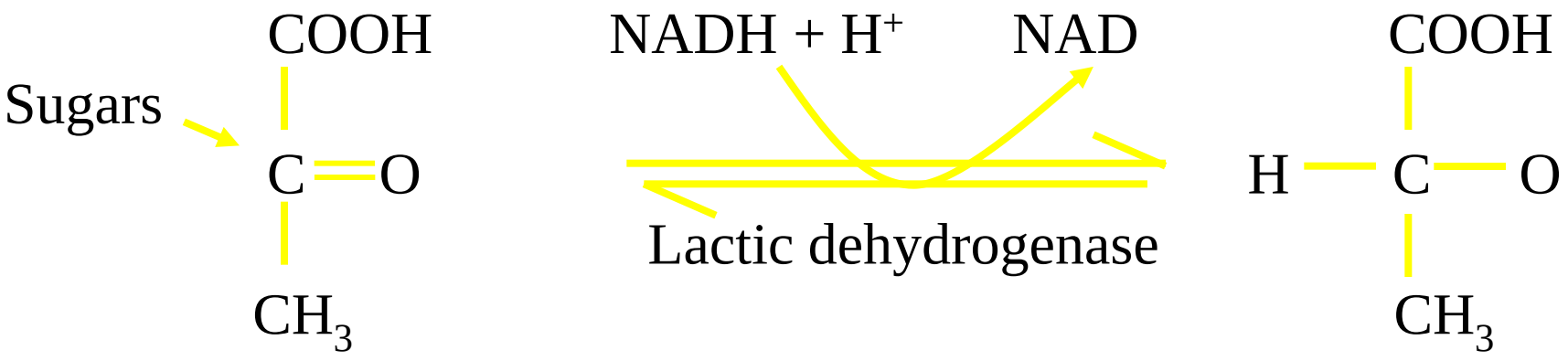
Chemical Changes in Sucuks during the Ripening

1. **Acid Formation (pH Reduction)**
2. **Lipid Oxidation (2-Thiobarbituric Acid Formation)**
3. **Color Formation (Nitrosomyoglobin Conversion)**
4. **Formation of Biogenic Amines**

1. Acid Formation (pH Reduction)

- The rate and extent of acid formation must be adjusted carefully to achieve both
  - favorable sensory quality and
  - safety from pathogens.

- Acid formation rate depends on
- the activity of lactic acid bacteria,
- ripening temperature,
- ability of lactic acid bacteria to ferment sugars and
- the rate of drying.



Glycolitic pathway for lactic acid formation

2. Lipid Oxidation

- Lipid oxidation may have significant problems on the quality
  - color,
  - flavor,
  - texture and
  - nutritional value changed

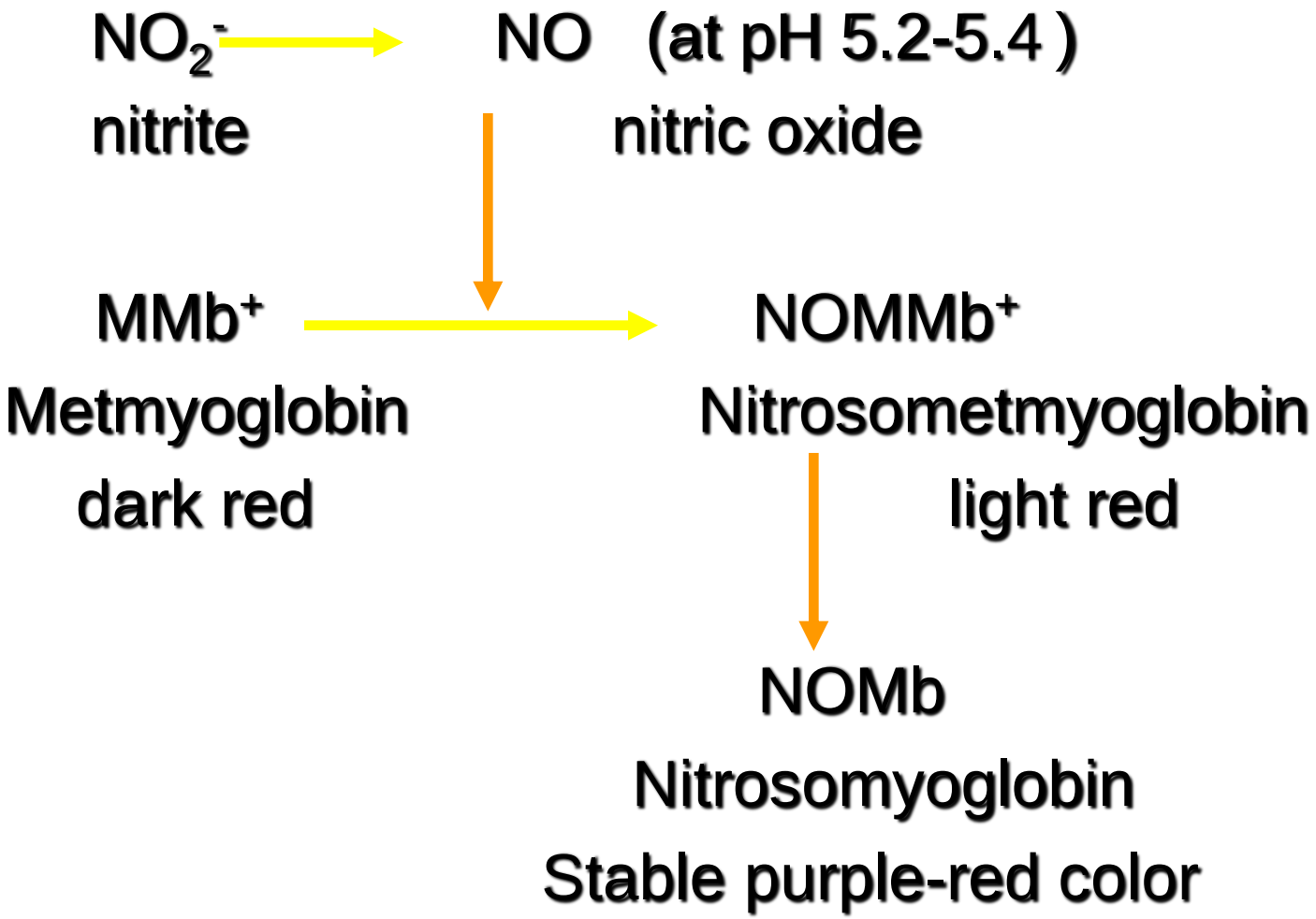
- As a result of oxidation malonaldehyde is formed.
  - causes cancer and mutation.

3. Color (Nitrosomyoglobin) Formation

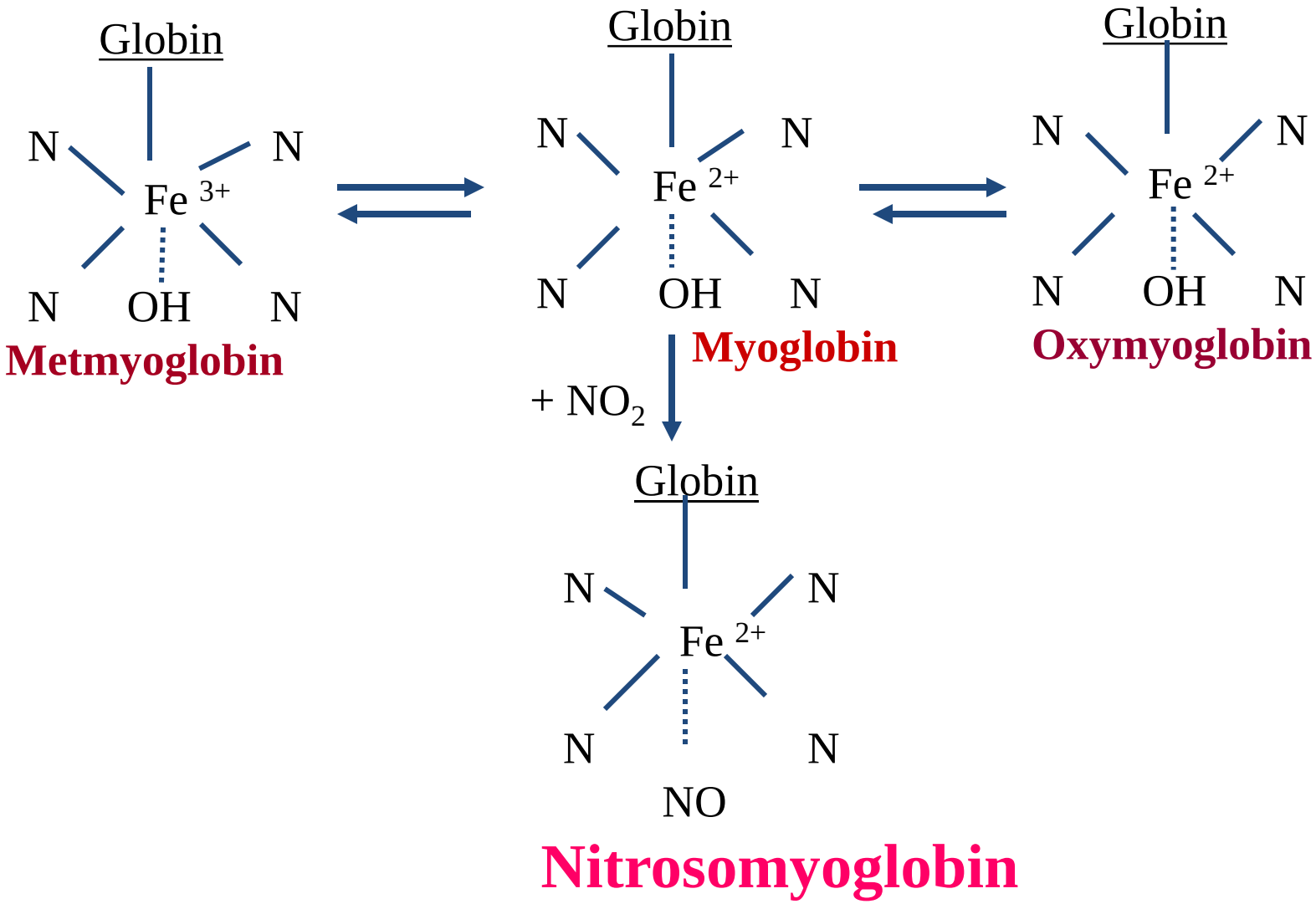
- The characteristic color (nitrosomyoglobin) of dry-fermented sausage is produced by interaction between the meat pigments (myoglobin) and nitrite and nitrate.

- *Micrococcaceae* are responsible for the production of nitrosomyoglobin.

Formation of Color



If iron molecule in the heme is oxidized to Fe^{+3}, meat color is changed to brown-red color



4. Formation of Biogenic Amines

- Biogenic amines could be found in meat, sausages, milk, chocolate, cheese, fishes and some beverages.

- Biogenic amines are toxic substances; can cause nausea, respiratory distress, hot flushes, sweating, heart palpitation, bright red rash, oral burning, gastric, intestinal problems, and hyper– or hypotension.

- Histamine intake of 8-40 mg, 40-100 mg and higher than 100 mg, may cause slight, intermediate and intensive poisoning, respectively.

4. Formation of Biogenic Amines

- The allowable maximum level of tyramine in foods is 100-800 mg/kg and 1080 mg/kg of tyramine is toxic.

- Spermine, spermidine and cadaverine have not adverse health effect, but

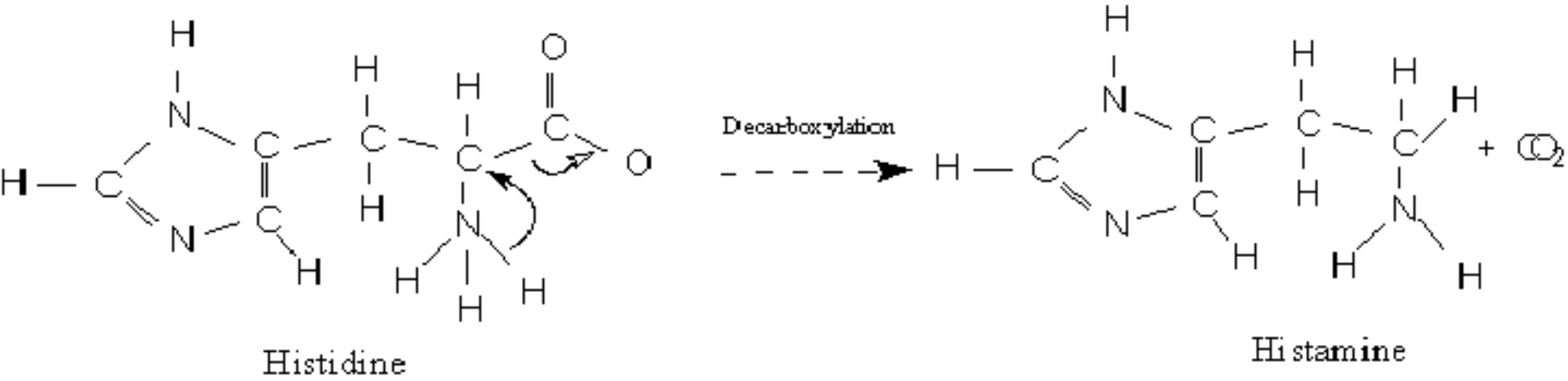
  – they may react with nitrite to form carcinogenic nitrosamines and

  – also can be proposed as indicators of spoilage.

Major biogenic amine and precursors

Amine	Precursor	Pharmacological effects
Histamine	Histidine	Liberates adrenaline and noradrenaline Excites the smooth muscles of the uterus, the intestine and the respiratory tract Stimulates both sensory and motor neurons Controls gastric acid secretion
Tyramine	Tyrosine	Peripheral vasoconstriction Increases the cardiac output Causes lacrimation and salvation Increases blood sugar level Releases noradrenaline from the sympathetic nervous system Causes migraine
Putrescine and cadaverine	Ornithine and lysine	Hypotension Bradycardia Lockjaw Paresis of the extremities Potentiate the toxicity of other amines
β–Phenylethylamine	Phenylalanine	Releases noradrenaline from the sympathetic nervous system Increases the blood pressure Causes migraine
Tryptamine	Tryptophane	Increases the blood pressure

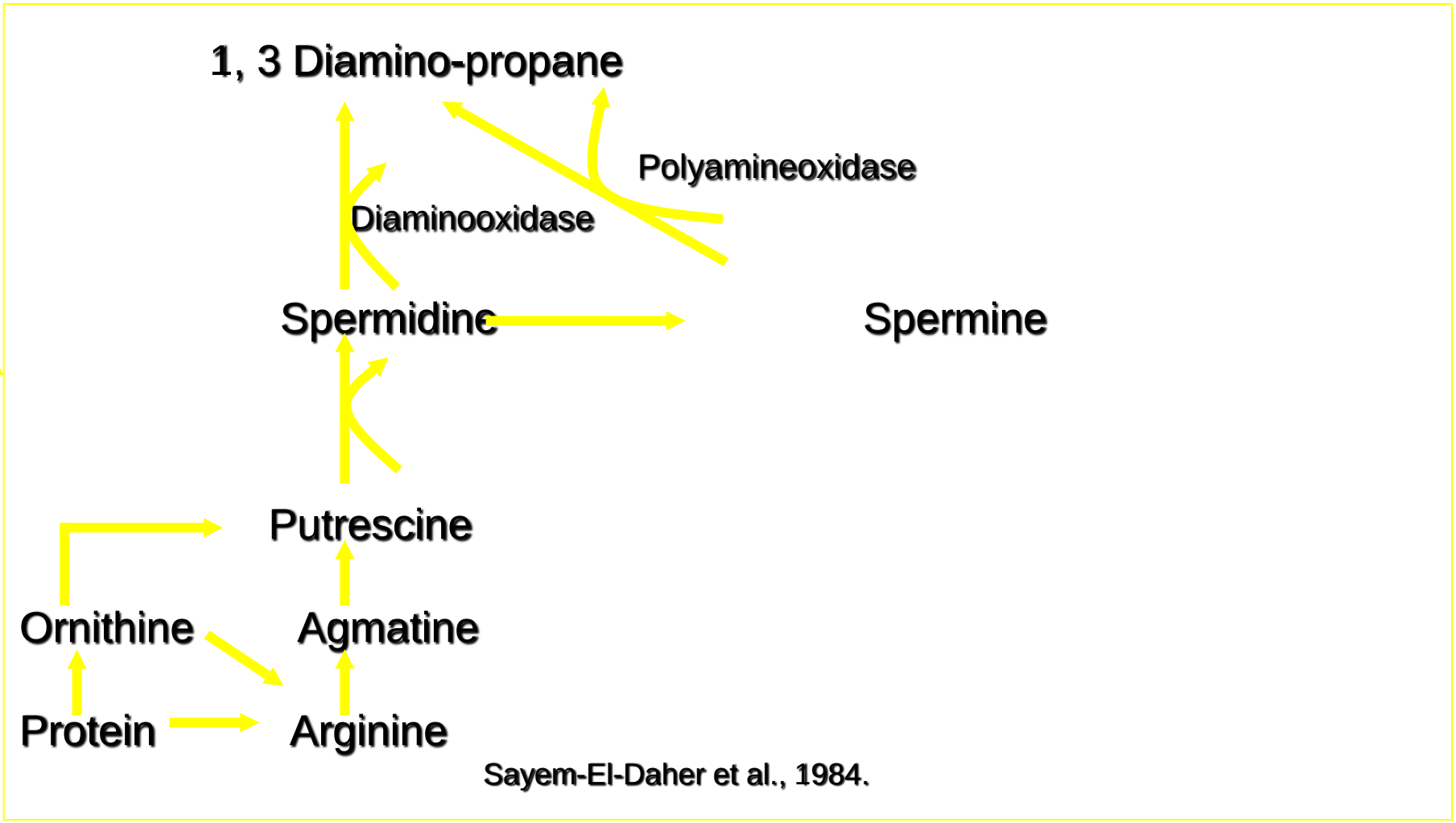
Formation of Histamine



Histidine

Histamine

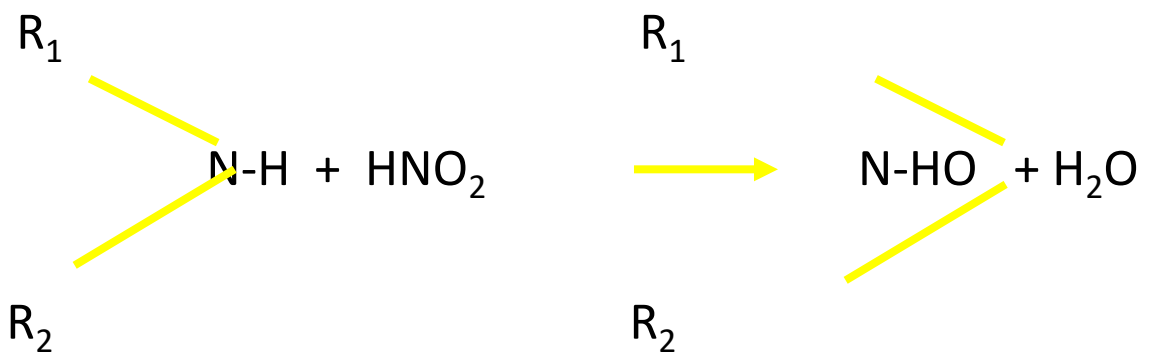
Metabolic pathways of the some di- and polyamines



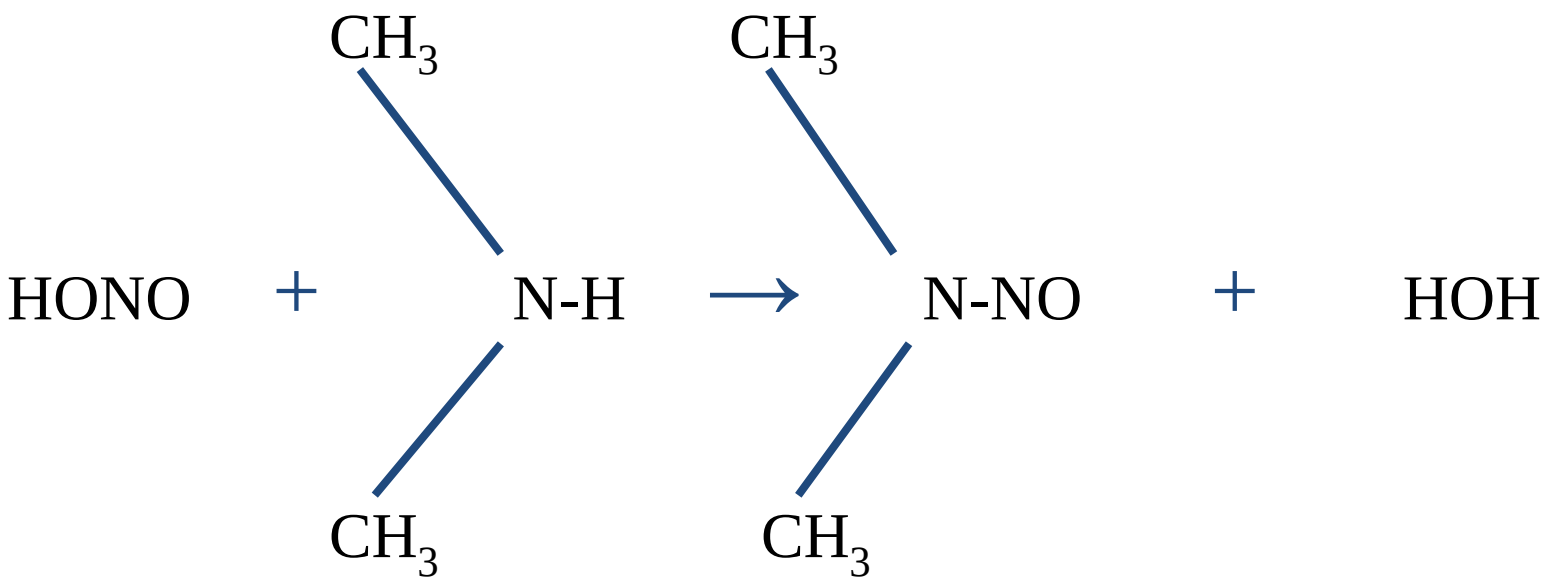
Sayem-El-Daher et al., 1984.

Formation of Nitrosamines

Presence of secondary and tertiary amines react with nitrogendioxide and nitrose acids to form nitrosamines



Nitrosamins are - cancerogenic
- mutagenic
- teratogenic



HONO + Dimethylamine → Dimethyl nitrosamine + HOH

Chemical Criteria	Limits
Moisture (mass)	max. 40 %
Salt (mass)	max. 5 %
Coloring matter	None
pH	min. 5.4 - max. 5.8
Fat (mass) for first quality for second quality for third quality	max. 30 % max. 40 % max. 50 %
Protein (mass) Nx6.25 for first quality for second quality for third quality	min. 22 % min. 20 % min. 20 %
Microbial Criteria	**Limits**
Total Aerobic Mesophilic bacteria (CFU/g)	10^5-10^6 in 2 sample out of 5 sample
Escherichia coli (CFU/g)	None
Staphlococcus aureus (CFU/g)	0-100
Salmonella (CFU/g)	None in 25 g sample
Mold and yeast (CFU/g)	0-100
Clostridium perfingens (CFU/g)	10-100 in 2 sample out of 5
Coliform bacteria (CFU/g)	Maximum 10

Organoleptic Properties of Sausages

- Organoleptic characteristics of sausages could be divided into three groups; appearance, cooking and eating properties.

Appearance Properties

- Casings shouldn't have torn, it should have characteristic taste, odor and good appearance. Desired taste in sausage is lactic acid taste because sausage is fermented product.

Cooking Properties

- Under normal conditions of frying or grilling sausages should not loose more than 10 % of their weight as water or fat and a loss exceeding 20 % is not acceptable. As well as suffering only a limited weight loss, sausages should not shrink or distort excessively when cooked.

Factors Affecting Fermentation, Maturation and Storage of the Sausage

1. External Factors

- **Temperature**
- **Relative Humidity**
- **Air-condition**

2. Internal Factors

- **Raw Material**
- **Salt and sugar**
- **Water activity**
- **Initial Number o**
- **pH**
- **Additives**

Quality of Turkish Style Sausage

- **Physical criteria**
- **Chemical criteria**
- **Microbial criteria**
- **Organoleptic criteria**

Defects

1. Appearance Defects

- shape deformation
- saltiness
- oil diffusion
- unstabilized color

good →

dark →

2. Color Defects

- unsufficient and unstabilized color formation
- core color defects
- dark and rancid color formation.

3. Flavor and Taste Defects

unsufficient color →

- souring
- microbial
- bitter and rancidity

Conversion of muscle to meat

- After understanding structure of muscle we know that is highly complex contractile system.
- Exsanguination— It is removal of blood from the body of a slaughtered animal.
- Homeostasis comes into play as soon as the process of exsanguination begins. Homeostasis is a system of checks and balances which through these efforts tries to maintain a physiological balance of internal environment. It executes the efforts to support the desire of a living being to live. The biological systems function efficiently within a narrow range of physiological conditions (pH, temperature oxygen concentration and energy supply).
- Homeostatic system is regulated by nervous systems. These systems trigger mechanisms of checks and balances in an attempt to live. The homeostasis is important because–
- **a)** reactions and changes during conversion of muscle to meat are result of homeostasis.
- **b)** pre-slaughter conditions may alter postmortem changes and thereby have bearing on quality of meat.

Animal slaughtered

↓

Exsanguination

↓

Blood pressure drops
(In an attempt to maintain the blood pressure and ensure blood supply to vital organs)

↓

i) Heart pumping increases
ii)peripheral vasoconstriction

↓

Results in stoppage of nutrient supply to muscle and removal of waste products loss of oxygen supply to muscle. Temperature of carcass rises due to failure of temperature control mechanism.

↓

Myoglobin stores little oxygen which is sufficient for short period as a result stored oxygen is depleted.

↓

The above sets in anaerobic metabolism

leading to production of lactic acid.

↓

The energy so produced is less and is only sufficient to maintain structural integrity and temperature.

↓

Lactic acid produced as an end product of anaerobic metabolism can not be removed and is thus stored in muscles

↓

The above leads to fall in pH (the final pH would depend on amount of glycogen in the muscle at the time of exsanguination)

↓

As all homeostatic mechanisms have failed by this stage means that all defense mechanisms including those which protect a live animal against microorganisms are lost . As a result muscle becomes susceptible to microbial invasions.

- If pH continues to fall it will reach a range where the cathepsins get activated and lead to proteolysis.
- A normal pH drop should be from pH 7 to 5.6 - 5.7 in 6 - 8 hrs postmortem and to an ultimate pH in range 5.3 - 5.7 in 24 hrs post mortem.
- In some animals it will remain 6.5- 6.8 during the first hour after exsanguination.
- An early accumulation of lactic acid is linked with rise in carcass temperature which leads to denaturation of proteins. The level of denaturation of proteins is species specific with pork being more susceptible than beef.
- Denaturation will cause –
  - ***i) Loss of protein solubility***
  - ***ii) Loss of water holding capacity***
  - ***iii) Loss in the intensity of muscle`s pigment coloration.***
  - ***i+ii + iii* = pale muscle**

with highly wet surfaces which in pork is PSE All above needs to be monitored so that conversion of muscle is guided through regulated values to become meat. This can be done by understanding the status of the animal subjected to slaughter and by proper handling and cooling of the carcasses.

<u>Rigor mortis</u>

- Rigor mortis is a latin word which means "stiffness to death".
- The contraction and relaxation of muscle constantly requires ATP i.e. to release the actin and myosin filaments from strong binding ATP is required.
- In absence of ATP (which happens postmortem) the actin and myosin remain bound together as an actomyosin complex.
- The above conditions lead to rigor mortis.
- All possible measure should be adopted to ensure that minimum of actomyosin complexes are formed.
- One of the common practices in the meat industry of hanging carcasses helps the muscles stretch by help of gravitational force.
- The period before rigor mortis during which muscle is relatively extensible and elastic is called the delay phase.
- Completion of rigor mortis is signalled by total depletion of creatine phosphate and other sources of rephosphorylation.

Postmortem changes in Color

- The color of muscle in living animal is bright red due to abundance of oxygen.
- postmortem there is shortage of oxygen and color becomes dark purplish red.
- Fresh meat when cut has dark red color but on exposure to atmospheric air within few minutes changes to brighter red color. This happens due to oxygenation of myoglobin.

Factors affecting post-mortem changes

1. Stress

Any external or internal stress activates the homeostatic mechanism which generates variable physiological responses so as to tide over the stress symptoms. These are executed through hormones. Most important are –

- Epinephrine – breaks down glycogen stored in liver & muscles, also breaks down fat.
- Epinephrine & norepinephrine – maintains the blood circulation
- Adrenal hormones – provide stress resistance.
- Thyroid hormones - increase metabolic rate.

2. Environmental effects

- Temperature – Too low a temperature to which an animal is not acclimitized will lead to all such changes which generate and conserve heat like shivering, higher rate of metabolism etc. Too high a temperature will not allow an animal to dissipate body heat leading to ATP splitting and glycolysis.
- Humidity – High levels of humidity add to discomfirt stress in a cold environment it increases heat loss and in a hot one it makes heat losses difficult.
- Light , sound, and space – Darkness – stresses the animal through the efforts made by it to go towards light.Less space – not providing an animal free mobility causes stress. Unfamiliar sounds – frighten the animal and cause stress.

Abnormal Post mortem changes

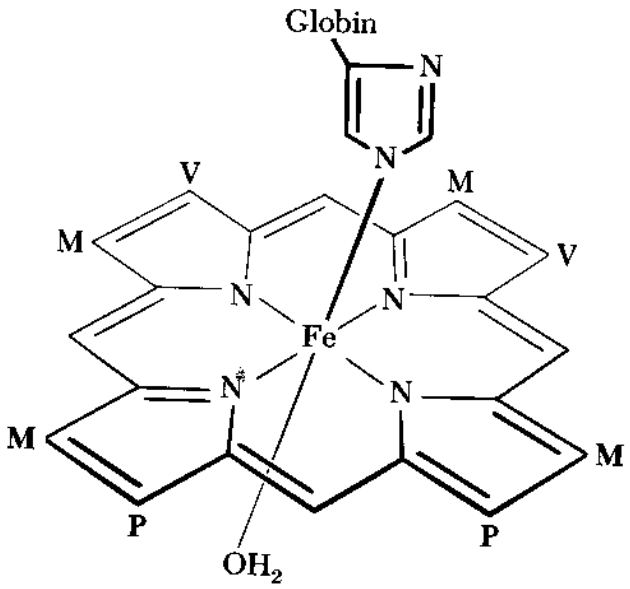
- Different types of stresses cause different of effects on the animal.
- Some of the stresses demand more from activity the muscle requiring more energy use which aerobic metabolism can`t meet fast enough.
- As a result the anaerobic metabolic pathway may also be activated.
- This may lead to generation of lactic acid and if the build is too large it may cause acidosis.
- In pork it is called "porcine stress syndrome" which may lead to death.

1. **PSE (Pale, soft, exudative meat)**
   - Results from low pH at high temperature. pH decreases twice as fast as normal causing PSE. PSE does not result from a low ultimate pH.
   - Pale because light is reflected by denatured sarcoplasmic proteins.
   - Softness and exudation from structural damage (areas of super contraction and Z- line loss, increased denaturation of protein.
   - PSE can be decreased by rapid post-mortem cooling.
   - PSE is common in pigs with defective ryanodiine receptors. The occurrence reflects susceptibility and triggering, not all susceptible pigs will exhibit PSE pork.
   - It must have increased ATP use for glycolysis to occur rapidly causing pH to fall abnormally fast
   - Ca++ leakage ⟶ contraction ⟶ ATP hydrolysis
   - PSE can be caused in normal pigs by improper handling.
2. **DFD (dark, firm and dry)**
   - The DFD condition can be found both in beef and pork.
   - Muscle appears dark and may be so dry as to be "sticky" just like pre- rigor muscle.
   - It is caused due to glycogen depletion pre -slaughter resulting in little or no lactic acid production post slaughter.
   - As a result post rigor muscle pH remains high > 6.0
   - Myosin and actin are far removed from isoelectric point.
   - The glycogen depletion pre-slaughter have already been discussed above.

Color of meat

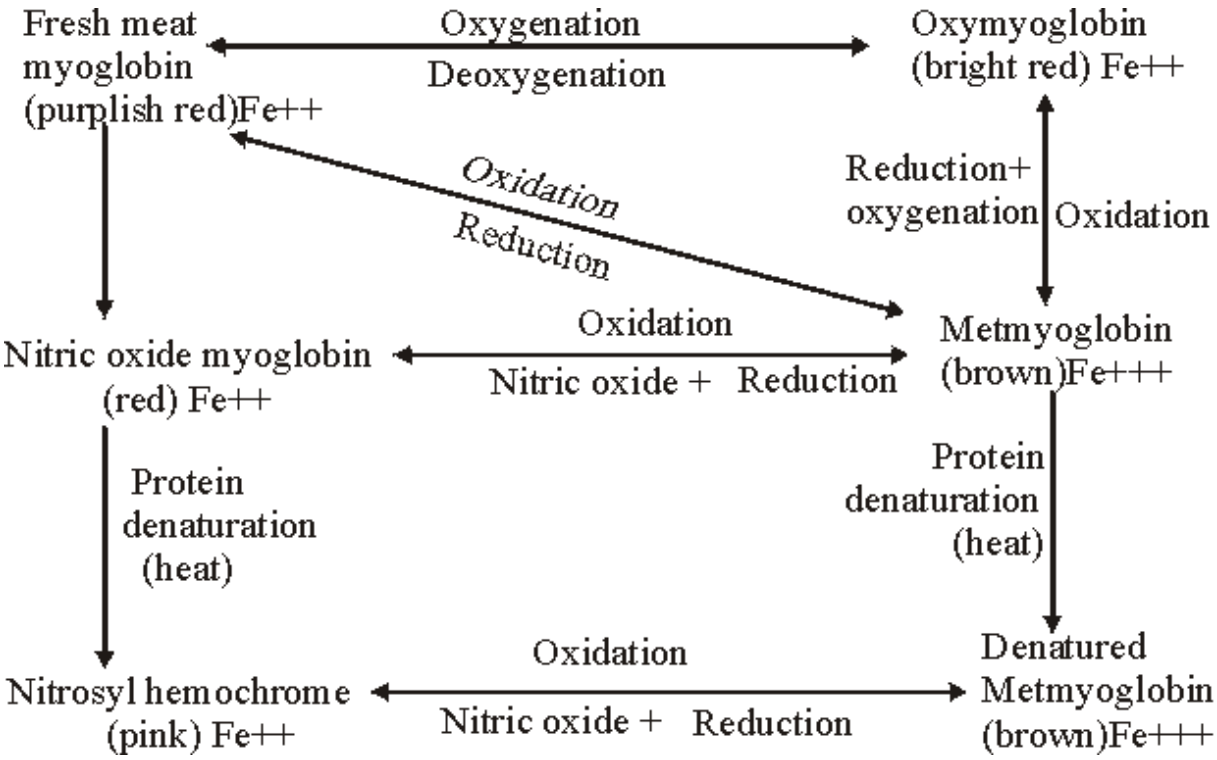
1.Meat is one of the most important factors affecting the consumer`s decision to purchase fresh and processed meat products.

2.**Myoglobin** is the predominant meat pigment and accounts for 80% of the meat pigment.



- Myoglobin consists of a protein called a globin and the non protein portion as heme ring.
- The heme portion is important as color of meat predominantly depends on the chemical state of the iron present in the heme ring.
- The heme group of myoglobin is planar structure with iron atom centrally located.
- Iron atom is a transition metal capable of existing as ferric (oxidized) and ferrous (reduced) forms. It has 6 coordination sites.
- These sites are available for chemical bonds.
- Out of 6 the 4 of these have iron atom attached with heme, the fifth connects iron atom to amino acid chain of globin protein and sixth to coordination site.
- The coordination site is available for binding of a variety of chemical groups.
- The chemical group bound to sixth site (i.e. known as ligand) the oxidation state of heme iron determines the color of meat.
- The oxidation state of heme iron affects the color of meat.
- The oxidation state determines which molecule will bind at sixth site of heme iron.
- The ferrous myoglobin or deoxymyoglobin 9 purplish red 0 bind O2 at the sixth site and form oxymyoglobin (cherry red). This is oxygenation and not oxidation (loss of electrons).
- The oxidation occurs in myoglobin when ferrous form is converted to ferric form and leads to formation of metmyoglobin (brownish red 0 in fresh meat. But the ligand in this case is water molecule.

Therefore there could be variable colors depending upon the oxidation state of central; iron atom and some of the **probable ones could be**. When meat is subjected to curing treatments the color reactions could be like **these.**



3. The myoglobin content varies with species, age, sex muscle and physical activity.

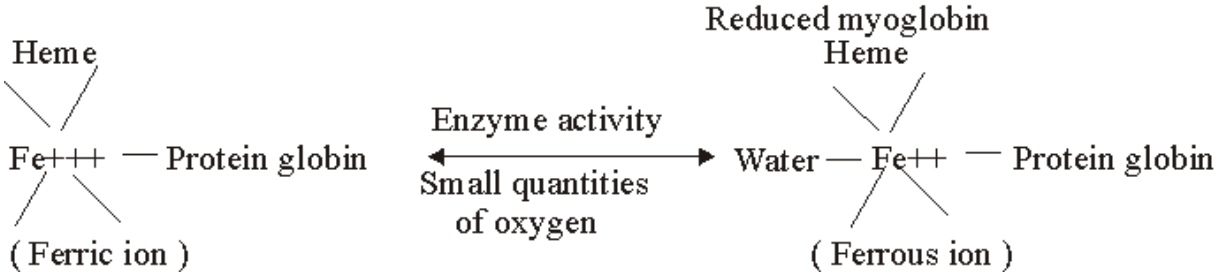
- ***Beef –*** bright , cherry red
- ***Fish –*** gray- white to dark red
- ***Horse –*** dark red
- ***Lamb and mutton –*** light red to brick red
- ***Pork –*** grayish pink
- ***Poultry*** – gray – white to dull red
- ***Veal–*** brownish pink

4. Approximately 20 % of the pigment in meat is hemoglobin. However, the bulk of hemoglobin is found in the arteries, veins and capillaries.

5. The normal color of the surface of fresh meats in an oxygen environment is bright red/pink due to oxymyoglobin. As oxygen penetrates into muscle, it is utilized to oxidize reduced compounds (co-enzymes). This results in an oxygen gradient ranging from saturation on the surface to zero a few centimeters in the muscle. At low partial pressures of oxygen metmyoglobin is formed. The effect of oxygen is shown in the figure below —

6. The **chemical state** of myoglobin affects the color– Oxidized myoglobin Reduced myoglobin Heme

Chemical state of myoglobin affects the color



Enzyme activity.

7. There are certain factors that affect the color of pigments

Discoloration of meat–

- Apart from the reasons discussed above there could be certain other reasons which could lead to discoloration of meat.
- PSE meat has a pale color due to presence of more water in the on the surface of the meat and the low pH causes denaturation of proteins.
- The DFD meat appears to be more darker . This is due to increased bound water in meat which minimizes the white light reflection and color absorption is enhanced. The dark cutting meat also has a high rate of oxygen using enzyme activity. due to high pH this in turn reduces the proportion of the pigment in the oxymyoglobin.
- The color of the meat also serves as an indicator of the quality of the meat. The color is to an extent indicator of physical, chemical and bacterial contamination.
- The microbes change the physiological environment by changing the pH and by producing amino acids and amines. They may also produce compounds which may react with the heme pigments to produce other colors. Catalase negative bacteria produce hydrogen peroxide that results in a green color.
- Microorganisms change the color also by producing pigments themselves.
- Salt works as a prooxidant for heme pigment oxidation and thereby also influences the color.
- Light can cause the dissociation of oxygen from the heme which may result in the fading of fresh meat color.
- Cooking causes protein denaturation and the browning reactions. During cooking the heme pigment protein denatures and the iron undergoes oxidation to the ferric state and ability of the pigment to complex oxygen is lost.

FROZEN MEAT

Freezing has long be recognized as an excellent method for the preservation of meat. It results in less undasirable changes in the qualitative and organoleptic properties of meat than other methods of preservation. In addition to that most of the nutritive value of meat is retained during freezing, and through period of frozen

storage. The only loss can be occur only water soluble nutrients are lost in the drip during thaving and the amount of drip varies with freezing and thawing condition. Nutrients found in drip are –salt, amino acids, some proteins and peptides, and water soluble vitaminc. When proper freezing and storage methods are used there is little change in color, flovor, odor and juiciness of cooked meat product.
Quality of frozen meat is influenced by the freezing rate , length of freezer storage, and freezer storage condition. And these conditions include such important factors; temperature, humidity, and the packaging material.
Changes which can occurs during frozen storage are the development of rancidity and discoloration, with the latter change being due to surface dehydration as well as microbial activity.

Slow freezing: During slow freezing , the temperature of the meat product being frozen remains initial freezing point for long time. As a result, a continuous freezing boundary forms and proceeds slowly fom the outside of the product inward. Extracellular water freze more rapidly than intracellular water becouse it has a lower solute concentration.
During the slow freezing process , the long period of crystallization before freezing occurs, produces numerous large extracellular masses of ice crystals that are easy lost as drip during thawing.As shown on figure when freezing temperature getting higher the cristalization period will be longer .

Fast freezing : During fast freezing the temperature of meat product being frozen rapidly falls below the initial freezing point. Numerous small ice crystals tend to form uniformly throughout all of the meat tissues. These small ice crystals are formed with aproximately same speed , both intra and extracellularly. Since most of the water inside the muscle fibers freezes intracellularly , drip loosing during thawing are lower than thawing of slow frozen meat. In addition muscle fiber shrinkage and distortion effects are minimized during fast freezing, resulting in a near normal ultrastructural and strieded appearancein the frozen state, volume changes are less , and the period of crystalization are shorter than slow frozen.

Freezing Methods
Commercially several methods are used to freeze meat products incluiding :

1)Stil air : In this methods air is the heat trasfer medium. This methods of freezing is entirely dependent upon convection , and meat freze very slowly. Commercial temperatures commonly used in stil air freezing range from about -10 to -30 ^{o}C .

2)Plate freezing : the heat transfering medium in this freezing metal, rather than air. Trays containing the products, or the flat surfaces of meat products are placed directly in contact with the metal freezing plates or shelves. Plate freezer temperatures usually range from about -10 to -30 ^{o}C in commercial practise, and the methods is generally limited to thin pieces of meat . conduction is important rather

than convection in this method and the freezing rate is slightly faster than it would be in stil air. Although plate freezing is stil slow it can be speeded up by circulating cold air ower the product.

3)Blast freezing: the most commonly used method for freezing meat product is cold air blast freezing in rooms or tunnels that are equipped fans to provide rapid air movement. Air is the medium of heat transfer, but because of it s rapid air movement the rate of freezing is markedly increased. High air velocity increases both the cost of freezing and the severity of freezer burn in unpacked meat product. Commercially air velocity range from 30-1070 meters/minute and temperatures range from about -10 to -40 ^{o}C in the blast freezing. However, an air velocity of about 760mpm and temperature of -30 ^{o}C are the most practical and economical now being used in the meat industry.

4)Liquid immersion and liquid sprays: liquid immersion or spray is the most widely used commercial method for freezing paultry. However some red meat product and fish are also frozen also by this method. Because of the rapid heat transfer , higher temp. are generally used than in blast freezing.
The products to be frozen are placed in plastic bags, stacked on pallets or in shelved racks, and then either immersed into the freezing liquid by fork lift trucks , or moved through the cold liquid by a conveyor. In other application, the product is conveyed through an enclosed freezing cabient while the cold liquid is continuously sprayed on its surface. After the product is removed from the immersion tank the freezing liquid is rinsed from its surfaces with cold water. The length of time that the product is immesed or sprayed determines extent of freezing. When the surface of product is frozen the product is generally transferred to a freezer room for completion of the freezing process and subsequent storage.
The liquid used for freezing must be non toxic, relatively inexpensive, shuld have a high viscosity , low freezing point, and high heat conductivity. Sodium chloride brine has been commonly used but glycerol and glycols are currently achieving wide usage.

5)Cryogenic freezing: Any one of the three systems may be used for cryogenic freezing.these are direct immersion, liquid spray, or the circulation of the cryogenic agent vapor over the product to be froozen. The most commonly used cryogenic agents are nitrogen(liquid or vapor), carbon dioxide (liquid, vapor or snow).
Large pieces of meat are rarely immersed directly into liquid nitrogen because of extensive shattering or cracking that might occur. Therefore , present systems generally evaporated liquid nitrogen in the freezing chamber and utilize its termendous cooling capacity as it changes into nitrogen gas in order to freeze the meat product. Lquid nitrogen spray or liquid carbon dioxide spray combined with a conveyor belt system , are used to rapidly freze meat products of relatively small size.

Some freezer photo used in meat industry:

Tunnel freezer

Super contact freezer

Cabinet freezer