# STUDY ON LIVESTOCK BY-PRODUCTS & WASTE MATERIALS MANAGEMENT PRACTICES AT SOME SELECTED SLAUGHTER-HOUSES IN DHAKA CITY

**A Thesis**

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**REGISTRATION NO.: 13-05630**

**A Thesis**

*Submitted to Department of Animal Production & Management,*

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*in partial fulfillment of the requirements for the degree of*

## MASTER OF SCIENCE (MS) IN ANIMAL SCIENCE

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# *CERTIFICATE*

This is to certify that the thesis entitled **STUDY ON LIVESTOCK BY-PRODUCTS & WASTE MATERIALS MANAGEMENT PRACTICES AT SOME SELECTED SLAUGHTER-HOUSES IN DHAKA CITY** submitted to the Department of Animal Production and Management, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) in ANIMAL SCIENCE,** embodies the results of a piece of bona fide research work carried out by **MD. SHEFATH ABDULLA,** bearing Registration No. **13-05630** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.

I further certify that any help or sources of information received during the course of this investigation has duly been acknowledged.

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*DEDICATED TO*
*My Beloved Parents*

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## ABSTRACT

Slaughter-houses are the places from where people get the meat for consumption, but the time is to utilize the by-products to increase the GDP's rate from livestock. A field survey was conducted regarding usage of the by-products of slaughterhouses and/or meat selling centers in Dhaka city of Bangladesh. Data were collected from total 60 slaughterhouses and/or meat selling centers randomly from different part of Dhaka city consisting 20 large animal (cattle, buffalo), 20 small animal (goat, sheep) and 20 poultry bird (chicken, duck) slaughterhouses and/or meat selling centers. Following slaughtering process huge amount of different by-products is also produced that have good economic and nutritive value. The results revealed that edible by-products such as head trimmings, brain, tongue, heart, stomach, lungs, liver, pancreas, spleen, kidney and tail were used by 100% as human food. Inedible by-products had diversified uses but to some extent they were also rejected. However, no one of the inedible by-products was fully rejected. Among the inedible by-products the hides had a great industrial value. Poultry by-products like blood, intestines and feather wastes were generally found to utilize as fish feed. Most slaughterhouses were found to maintain moderate to poor hygienic conditions where very few maintained good condition. Almost two-third (61.67%) slaughterhouses were used water container as water supply followed by hose pipe (33.33%) and tape water (5%) for cleaning purpose. It can be concluded that by-products are valuable materials but due to lack of management and industrial mind slaughterhouses of the Dhaka city cannot utilize those materials. Therefore, proper usages of by-products can run a new prospective business in Bangladesh.

**Keywords:** Slaughterhouse, by-products, usages, hygiene practices

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# LIST OF SYMBOLS & ABBREVIATIONS

| Symbols & Abbreviation | Narration |
|---|---|
| BC | Before Christ |
| BOD | Biological Oxygen Demand |
| BSE | Bovine Spongiform Encephalopathy |
| COD | Chemical Oxygen Demand |
| DLS | Department of Livestock Services |
| e.g. | For example |
| *et al.* | And others |
| etc. | Etcetera |
| FAO | Food and Agriculture Organization |
| Ft | Feet |
| g | Gram |
| Hrs. | Hours |
| i,e, | That is |
| IU | International Unit |
| J. | Journal |
| K. cal. | Kilo calorie |
| Kg | Kilogram |
| Km | Kilometer |
| MBM | Meat and bone meal |
| Mg | Milligram |
| Min | Minute |
| MT | Metric Ton |
| SAU | Sher-e-Bangla Agricultural University |
| TGase | Transglutaminase |
| TSS | Total Suspended Solids |
| USDA | United States Department of Agriculture |

# CHAPTER 01

# INTRODUCTION

# CHAPTER 01

# INTRODUCTION

The slaughterhouse is a facility where food animals are processed for consumption with also a large amount of by-products. Slaughterhouses are the key element in the meat production and supply chain. Meat was the first important food that met up the hunger of ancient people living in cave.

Meat is an important livestock product which includes all those parts of the animals that are used as human food. The Summary of about 3000 BC are said to have been the first livestock breeders and dairymen and were among the first to make butter, salted meats and fish. Since similarities in disease possesses in man and animals were noted in early centuries, the inspection of slaughtering animals and marketing of meats were therefore introduced both in ancient Athens and in Rome. Meat declared condemned by inspectors was thrown into the river Timber (Schwabe *et al.*, 1969).

General slaughterhouses existed in ancient Rome. Slaughtering in public Slaughter houses was made compulsory in Germany in 1276 and meat inspectors were appointed to supervise quality meat.

Building up a healthy nation sound and wholesome meat is essential and it plays an important role in keeping the human body in order to providing energy, health and vigor. It is the most concentrated and easily assimilable nitrogenous food and is a good source of first class protein, as it contains essential amino acids for human body. Polyunsaturated fatty acids of meat are imperative for brain development; especially in the fetus. Meat can be regarded as an imported source of dietary vitamins and minerals. A vegetable diet in comparison with a meat diet is usually incomplete in essential amino acids, the vegetable proteins are less easily digested and remain in the stomach for a shorter period than meat protein with the result that a feeling of hunger recurs more readily (Gracy, 1986).

Awareness about nutritive quality has dictated influencing consumption of more meat among the conscious people.

In developed countries, per capita daily intake of meat is more than 100 g, whereas in Bangladesh it is very low. Butcher meat is a valuable part of the human diet because (a) it is the most concentrated and easily assailable nitrogenous foods and is a good source of first class protein (b) it is stimulating to metabolism due to its high protein content (c) it is satisfactory for the existence of fat in the diet and delays emptying of the stomach. (d) After suitable treatment which includes a palatable flavor, acts as a stimulant to gastric secretion and is easily digested. In spite of these facts the hygienic control of meat production and processing in Bangladesh is a primitive one. Since meat provides an excellent source of protein in human nutrition, the present scarcity of this protein in developing countries makes it necessary to produce, conserve and utilize meat supplies to the fullest possible extent. Keeping this in view, it is an accepted principle in meat hygiene practices that all meats for human consumption originating from food animals should be subjected to ante mortem and postmortem examinations. Meat inspection should be made compulsory. Experiences in developed countries have clearly shown that properly executed inspection services afforded a high degree of protection to consumers. Ante mortem and Postmortem inspection are therefore recognized as defenses to obtain a wholesome meat supply for human consumption and prevent danger to human health in all developed countries. Meat inspection Act and Regulations are enforced strictly to meet the purpose of getting sound and wholesome meat foods. It is unfortunate that the meat inspection services in this country is quite different from developed countries. Almost all public slaughterhouses are run and governed by municipal authorities. In a very few slaughterhouses either a veterinarian or sanitary inspector is deputed to supervise and examine dressed carcasses.

Bangladesh is bestowed with a large amount of livestock population and wealth and it is growing at the rate of 3.4% per annum (DLS, 2018). The contribution

of livestock industry including poultry is increasing substantially in GDP of country which accounts for 13.62% of total agricultural sector and 1.54% of GDP (DLS, 2018). This contribution would have been much greater had the animal by-products been also efficiently utilized. Efficient utilization of by-products has direct impact on the economy and environmental pollution of the country. Non-utilization or under utilization of by-products not only lead to loss of potential revenues but also lead to the added and increasing cost of disposal of these products. Non-utilization of animal by-products in a proper way may create major aesthetic and catastrophic health problems. Besides pollution and hazard aspects, in many cases livestock processing wastes have a potential for recycling raw materials or for conversion into useful products of higher value. Traditions, culture and religion are often important when a meat by-product is being utilized for food. Regulatory requirements are also important because many countries restrict the use of meat by-products for reasons of food safety and quality. By-products such as blood, liver, lung, kidney, brains, spleen and tripe has good nutritive value. Medicinal and pharmaceutical uses of by-product are also highlighted here. Waste products from the poultry processing industries and slaughter-house must be efficiently dealt with as the growth of these industries depends largely on waste management. Treated livestock waste has found many applications among with which the most important are animal feed, biodiesel/biogas, dietectic products (chitosan), natural pigments (after extraction) and cosmetics (collagen). Available information pertaining to the utilization of by-products and waste materials from meat producing ruminant and poultry and their processing industries will be discussed here. Waste in the food industry is characterized by a high ratio of product specific waste not only does this mean that the generation of this waste is unavoidable, but also that the amount and kind of waste product which consists primarily of the organic residue of processed raw materials, can scarcely be altered if the quality of the finished product is to remain consistent. The utilization and disposal of product specific waste is difficult, due to its inadequate biological stability, potentially pathogenic nature, high water content, potential for rapid auto oxidation and high level of

enzymic activity. The diverse types of waste generated by various branches of the food industry can be quantified based on the respective level of production. Waste disposal and by-product management in food processing industry pose problems in the areas of environmental protection and sustainability (Russ and Pittroff, 2004).

Generally raw and auxiliary materials, as well as processing acids, enter the production process and exit as one of the following: a desired product, a nonproduct-specific waste or a product-specific waste. Product-specific waste unavoidably accumulates as a result of processing of raw materials. It is produced during the various steps of production, in which the desired components are extracted from the raw materials. After extraction, there are often other potentially useful components present in the remaining materials.

In Bangladesh slaughter animal gets very little priority from hygienic point of view and is done in an unhygienic way here and there and meat is prepared in dirty places allowing degradation of its quality. The main causes behind it are lack of well facilitated definite place for animal slaughter. In some cities and towns few slaughter-houses are present, but in many cities, it is totally absent. In view of proper management of slaughterhouses and meat selling centers in Dhaka city the present study was undertaken with the following objectives:

- ✓ To investigate the use pattern of livestock slaughter-house by-products of Dhaka city
- ✓ To observe the status of slaughter-house waste management
- ✓ To know the scenario of hygiene conditions of slaughter-houses

# CHAPTER 02

# REVIEW OF LITERATURE

# CHAPTER 02

# REVIEW OF LITERATURE

## 2.1 Meat Industry

In the meat industry most of the waste and waste materials is produced during slaughter and slaughtering process. Slaughterhouse waste consists of the portion of a slaughtered animal that cannot be sold as meat or used in meat-products. Such waste includes bones, tendons, skin, the contents of the gastro-intestinal tract, blood and internal organs. These vary with each type of animal (Sielaff, 1996; Grosse, 1984). The specific amounts of generated waste for each type of animal are listed in (Table 2.1).

**Table 2.1: The specific waste index for slaughter houses with respect to the type of animal.**

| Animal | Specific waste index[a] |
|---|---|
| **Cow** | 0.56 |
| **Calf** | 0.87 |
| **Pig** | 0.2 |
| **Sheep** | 0.1 |

(Russ and Pittroff, 2004)

**[a] Mass of accumulated waste divided by the mass of saleable product**

Efficient utilization of meat by-products is important for the profitability of the meat industry. It has been estimated that 11.4% of the gross income from beef and 7.5% of the income from pork, come from the by-products (Jayathilakan *et al.*, 2012). In the past, by products were a favourite food in Asia, but health concerns have led to an increased focus on non-food uses, such as pet foods, pharmaceuticals, cosmetics and animal feed (Rivera *et al.*, 2000). Meat by-products are produced by slaughter houses, meat processors, wholesalers and

rendering plants. Traditional markets for edible meat by-products have gradually been disappearing because of low prices and health concerns. In response to these problems, meat processors have directed their marketing and research efforts towards non-food uses. The literature indicates that by-products (including organs, fat or lard, skin, feet, abdominal and intestinal contents, bone and blood) of cattle, pigs and lambs represents 66.0, 52.0 and 68.0% of the live weight respectively. More than half the animal by-products are not suitable for normal consumption, because of their unusual physical and chemical characteristics. As a result, a valuable source of potential revenue is lost, and the cost of disposing of these products is increasing. The United States Dept. of Agriculture Economic Research Service has found that 11.4% of the gross income from beef is from the by-products. The figure for pork is 7.5%. In addition to economic losses, unused meat products cause serious environmental pollution. However, with improved utilization, meat by-products can give a good profit to meat processors.

## 2.2 Slaughterhouse

Slaughterhouse or abattoir is defined as scientifically designed any premises that is approved and registered by the controlling authority in which animals are slaughtered and dressed for human consumption (Codex Alimentarius, 1993). The purpose of an abattoir is to produce hygienically prepared meat by the humane handling of the animal using hygienic techniques for slaughtering and dressing (FAO, 1992).

## 2.3 Slaughterhouse By-products

Slaughterhouse By-products are those materials generated during production and processing of meat from live animals, it may be solid, liquid and semi-solid materials. These wastes are to be disposed of appropriately so as to prevent contamination of the environment and the serious consequences such as spread

of diseases, foul smells and unaesthetic view. A major part of the waste generated from the slaughter houses constitutes the by-products which are handled by the animal by-products industry to produce many valuable products such as leather, bone meal, meat meal, meat offal, blood meal, gelatin, casings, catgut, ornamental items etc. (Malav *et al.*, 2018).

## 2.4 Classification of By-products

Based on usage as food, the by-products can be categorized into edible and non-edible, however, some of the by-products have medicinal values and classed under pharmaceutical category. Edible by-products generally include all those organs which can be consumed viz. liver, lungs, heart, brain, intestine etc. They are also known as variety meats or 'fancy meat'. All those by-products that cannot be consumed directly as food are non-edible by-products e.g. hides, horns, ears, hooves, nails, bristles etc. All the condemned parts of animal carcass also fall in this category. This demarcation of edible and non-edible by-products is not universally acceptable as it is largely dependent on customs, traditions, purchasing power, food choices etc. of consumers. In one region, consumption of a particular by-product may be a taboo and in other region it may be a delicacy. The yield of edible by-products from animals varies tremendously depending on species, sex, live weight, fatness and methods of collection. In general, the total by-products range from 10% to 30% of the live weight for beef, pork and lamb and from 5% to 6% of the live weight of chickens (Irshad *et al.*, 2015). The yield of edible byproducts including blood and organs in cattle averages 12%, in sheep 14%, and, if pork rinds are also included, 14% for hogs. The consumption of offal is also influenced by disease outbreaks and government policies e.g. brain and spinal cord were out of the list for consumption since the outbreak of BSE (Mad cow disease). On the basis of live weight of animal, the by-products account for almost 60% and out of this 40% are edible and 20% are inedible (Chatli *et al.*, 2005).

The by-products can also be divided into primary and secondary by-products. Primary by-products also known as principal by-products are harvested directly from the animals whereas the secondary by-products are derived from principal by-products e.g. Bones are primary by-products whereas gelatin is secondary by product. The secondary by-products have a huge market and yield large revenues. Another basis of classification of animal by-products is their ultimate use. It includes agricultural by-products (Meat meal, fertilizers etc.), industrial by-products (Gelatin, glue etc.) and pharmaceutical by-products such as hormones, bio-chemicals etc. (Wani *et al.*, 2014).

On the basis of consistent of waste generated from the abattoir, it may be classified as solid and liquid waste. Solid waste includes edible and non-edible offal, hide and skin, dung, GIT contents, leftover feed, hairs, bristles etc., whereas the liquid waste include effluent generated from slaughter-houses which is the waste water originated from the different slaughtering and dressing operations.

## 2.5 Statistics of By-products Production in the Meat Industry

United States considers everything produced by or from the animal, except dressed meat, to be a by-product. Animal by-products in the USA are divided into two classes, edible and inedible. In United States terminology, offal means slaughter by-products, and includes the entire animal which is not part of the carcass.

Variety meats are the wholesale edible by-products. They are segregated, chilled and processed under sanitary conditions and inspected by the US Meat Inspection Service. In some parts of the world, blood is also utilized as an edible product for human being. In US, meat trimmed from the head is described on edible offal or an edible by-product. Edible fats are obtained during slaughter, such as the cow fat surrounding the rumen or stomach, or the cutting fat which is back fat, pork leaf fat or rumen fat. In commercial slaughter house practice in

UK, the offal is divided into red (head, liver, lungs, tongue, tail etc.) and white (fat), plus the set of guts and bladder, the set of tripe (rumen), and the four feet and trimming. The list originally included the spinal cord and brain, but these are now banned for food use since the outbreak of BSE (Bovine Spongiform Encephalopathy, popularly known as Mad Cow Disease) (Schrieber and Seybold, 1993). It also includes poultry parts such as the heart and liver.

**Table 2.2: By-products as a percentage of market live weight.**

| **Item** | **Pigs** | | **Cattle** | | **Sheep** | |
|---|---|---|---|---|---|---|
| | % | kg | % | kg | % | kg |
| Market live weight | 100 | 100 | | 600 | | 60 |
| Whole carcass | 77.5 | 77.5 | 63.0 | 378.0 | 62.5 | 37.5 |
| Blood | 3.0 | 3.0 | 18.0 | 4.0 | 2.4 | |
| Fatty tissue | 3.0 | 3.0 | 4.0 | 24.0 | 3.0 | 1.8 |
| Hide or skin | 6.0 | 6.0 | 6.0 | 36.0 | 15.0 | 9.0 |
| Organs | 7.0 | 7.0 | 16.0 | 96.0 | 10.0 | 6.0 |
| Head | 5.9 | 5.9 | | | | |
| Viscera | 10.0 | 10.0 | 16.0 | 96.0 | 11.0 | 6.6 |
| Feet | 2.0 | 2.0 | 2.0 | 12.0 | 2.0 | 1.2 |
| Tail | 0.1 | 0.1 | 0.1 | 6.0 | | |
| Brain | 0.1 | 0.1 | 0.1 | 6.0 | 2.6 | 0.156 |

(USDA, 2001)

Some items may not be used in uncooked products. This list includes mammalian parts such as blood, blood plasma, feet, large intestines, small intestines, lungs, oesophagus meat, rectum, stomach (non-ruminant), first stomach (tripe, after cooking), second stomach (tripe, after cooking), fourth stomach, testicles and udder. It also includes poultry part such as gizzards and necks. The average quantity of the different by-products from sheep, cattle and pig are shown in (Table 2.2). The yield of edible meat by-products from pigs is around 6.7% of the carcasses weight. The world production of edible by-products from pigs in

2004 was 625 million MT, most of it from Asia (50.4%) (Jayathilakan *et al.*, 2012). Europe is the second largest producer, with 37.1% of the world total. Asia and Europe are also the two major consumers of meat by-products, including beef and lamb. Usage of meat by-products often requires treatments such as collection, washing, trimming, chilling, packaging and cooling. Whether these products are widely accepted by consumers depends on various factors. These include the nutrient content, the price and whether there are comparable competing products.

Traditions, culture and religion are often important when a meat by-product is being utilized for food. Regulatory requirements are also important, because many countries restrict the use of meat by-products for reasons of food safety and quality. An example is the USDA requirement that mechanically separated meat and variety meats must be specifically identified as an ingredient on labels. If frankfurters and bologna are made with heart meat or mechanically separated poultry meat as an ingredient, this must be listed.

## 2.6 Nutritive Value of By-products

Edible meat by-products contain many essential nutrients. Some are used as medicines because they contain special nutrients such as amino acids, hormones, minerals, vitamins and fatty acids. Not only blood, but several other meat by-products, have a higher level of moisture than meat. Some examples are lung, kidney, brains, spleen, and tripe. Some organ meat, including liver and kidney, contains a higher level of carbohydrate than other meat materials (Devatkal *et al.*, 2004b).

Pork tail has the highest fat content and the lowest moisture content of all meat by-products. The liver, tail, ears and feet of cattle have a protein level which is close to that of lean meat tissue, but a large amount of collagen is found in the ears and feet (Unsal and Aktas, 2003). The lowest protein level is found in the brain, chitterlings and fatty tissue. The United States Dept. of Agriculture (2001)

requires that mechanically deboned beef and pork contain at least 14% protein and a maximum of 30% fat. The amino acids composition of meat by-products is different from that of lean tissue, because of the large amount of connective tissue. As a result, by-products such as ears, feet, lungs, stomach and tripe contain a larger amount of proline, hydroxyproline and glycine, and a lower level of tryptophan and tyrosine. The vitamin content of organ meats is usually higher than that of lean meat issue. Kidney and liver contain the largest amount of riboflavin (1.697-3.630 mg/100 g), and have 5-10 times more than lean meat. Liver is the best source of niacin, vitamin $B_{12}$, $B_6$, folacin, ascorbic acid and vitamin A. Kidney is also a good source of vitamin $B_6$, $B_{12}$, and folacin. A 100-g serving of liver from pork or beef contributes 450%-1,100% of the RDA of vitamin A, 65% of the RDA of vitamin $B_6$, 3,700% of the RDA of vitamin $B_{12}$ and 37% of the RDA of ascorbic acid. Lamb kidneys, pork, liver, lungs, and spleen are an excellent source of iron, as well as vitamins. The copper content is highest in the livers of beef, lamb and veal. They contribute 90-350% of the RDA of copper (2 mg/day). Livers also contain the highest amount of manganese (0.128-0.344 mg/100 g). However, the highest level of phosphorus (393-558 mg/100 g) and potassium (360-433 mg/100 g) in meat by-products is found in the thymus and sweetbreads (Devatkal *et al.*, 2004b). With the exception of brain, kidney, lungs, spleen and ears, most other by-products contain sodium at or below the levels found in lean tissue. Mechanically deboned meat has the highest calcium content (315-485 mg/100 g).

Many organ meats contain more polyunsaturated fatty acids than lean tissue. Brain, chitterlings, heart, kidney, liver and lungs have the lowest level of monounsaturated fatty acids and the highest level of polyunsaturated fatty acids. (Liu, 2002). There is three to five times more cholesterol (260-410 mg/100 g) in organ meats than in lean meat, and large quantities of phospholipids. Brain has the highest level of cholesterol (1,352-2,195 mg/100 g) and also has the highest amount of phospholipids compared to other meat by-products. For this reason, the United States Department of Health recommends that limited amounts of these by-products be eaten, because of health concerns. The high cholesterol

content of many other organ meats, and the possible accumulation of pesticides, drug residues and toxic heavy metals, is another reason for limited consumption.

## 2.7 Utilization of Blood

Animal blood has a high level of protein and heme iron, and is an important edible by-product (Wan *et al.*, 2002). In Europe, animal blood has long been used to make blood sausages, blood pudding, biscuits and bread. In Asia, it is used in blood curd, blood cake and blood pudding (Ghost, 2001). It is also used for non-food items such as fertilizer, feedstuffs and binders. According to the Meat Inspection Act of the United States, blood is approved for food use when it has been removed by bleeding an animal that has been inspected and passed for use in meat food products.

Blood is usually sterile in a healthy animal. It has high protein content (17.0), with a reasonably good balance of amino acids. Blood is a significant part of the animal's body mass (2.4-8.0% of the animal's live weight). The average percentage of blood that can be recovered from pigs, cattle and lambs are 3.0-4.0, 3.0-4.0 and 3.5-4.0%, respectively. However, the use of blood in meat processing may mean that the final product is dark in color, and not very palatable. Plasma is the portion of blood that is of greatest interest, because of its functional properties and lack of color.

### 2.7.1 Use of Blood Plasma in the Food Industry

Blood is used in food as an emulsifier, a stabilizer, a clarifier, a color additive, and as a nutritional component (Silva and Silvestre, 2003). Most blood is used in livestock feed in the form of blood meal. It is used as a protein supplement, a milk substitute, a lysine supplement or a vitamin stabilizer, and is an excellent source of most of the trace minerals. Blood plasma has ability to form a gel, because it contains 60.0% albumin (Silva and Silvestre, 2003). Plasma is the best

water and fat binder of the blood fraction. Plasma gels appear very similar to cooked egg whites. Plasma forms a gel at a protein concentration of 4.0–5.0%. The strength of the gel increases with increasing concentration. Cooked ham to which were added 1.5 and 3.0% frozen blood plasma, and hot dogs with 2.7% added plasma, were more satisfactory in color than those without it (Autio *et al.*, 1985).

Blood plasma also has an excellent foaming capacity (Del *et al.*, 2008), and can be used to replace egg whites in the baking industry (Ghost, 2001). The application of transglutaminase (TGase) from animal blood and organs or microbes to meat products has received a great deal of research. Blood factor XIII is a transglutaminase that occurs as an enzymogen in plasma, placenta and platelets. Transglutaminase was first extracted from bovine blood in 1983, in order to improve the binding ability of fresh meat products at chilling temperature. It showed how myosin was cross-linked by TGase. An important property of the TGase reaction was documented when cross-linking between myosin and proteins (soy, casein and gluten), all commonly used in meat processing Moreover, the restructured meat products can be processed without heating, and their salt and phosphate content reduced, by the addition of TGase from animal blood.

### 2.7.2 Use of Blood in the Medicine and Pharmaceutical Industry

Blood can be separated into several fractions that have therapeutic properties. Liquid plasma is the largest fraction (63.0%). It consists of albumin (3.5%), globulin and fibrinogen (4.0%). In the laboratory, many blood products are used as a nutrient for tissue culture media, as a necessary ingredient in blood agar and as peptones for microbial use (Kurbanoglu and Kurbanoglu, 2004). Glycerophosphates, albumins, globulins, sphingomyelins, and catalase are also used for biological assay. Many blood components such as fibrinogen, fibrino-lysin, serotonin, kalikreninsa, immunoglobulins and plasminogen are isolated for

chemical or medical uses (Young and Lawrie, 2007). Purified bovine albumin is used to help replenish blood or fluid loss in animals. It is used in testing for the Rh factor in human beings, and as a stabilizer for vaccines. It is also used in antibiotic sensitivity tests.

## 2.8 Utilization of Glands and Organs

Animal organs and glands offer a wide variety of flavors and textures, and often have a high nutritional value. They are highly prized as food in many parts of the world, particularly Southeast Asia. Those used as human foods include the brain, heart, kidneys, liver, lungs and spleen. They also include the tongue, the bovine pancreas and udder, the stomach and uterus of pigs, the rumen, reticulum, omasum and abomasum of sheep and cattle, and the testes and thymus of sheep and pigs (Liu, 2002).

### 2.8.1 Use of Glands and Organs as Food

The brain, nervous system and spinal cord are usually prepared direct for the table rather than processed for industrial use. They are blanched to firm the tissue before cooking, because of the soft texture. The membranes are peeled from the brain before cooking. Heart meat is generally regarded as relatively touch, reflecting the nature of the cardiac muscle. Heart is used as a table meat. Whole hearts can be roasted or braised. Sliced heart meat is grilled or braised. Heart meat is often also used as an ingredient in processed meats. Kidneys are generally removed from the fatty capsule which holds the kidney in place. The ureter and blood vessels need to be trimmed before the kidneys are prepared for cooking. Kidneys may be cooked whole or in slices, and are generally broiled, grilled, or braised. Liver is the most widely used edible organ. It is used in many processed meats, such as liver sausage and liver paste (Devatkal *et al.*, 2004a). Livers from lambs, veal calves and young cattle are preferred for the table in the United States and Europe, because they have a lighter flavor and texture.

Consumers in Southeast Asia, however, generally prefer livers from pigs. Livers are braised or broiled. Pig, calf and lamb lungs are mainly used to make stuffing and some types of sausages and processed meats (Darine *et al.*, 2010).

Animal intestines are used as food after being boiled in some countries. Animal intestines are also used in pet food or for meat meal, tallow or fertilizer. However, the most important use of the intestines is as sausage casings (Bhaskar *et al.*, 2007). Animal intestines, when removed from the carcass, are highly contaminated with microbes and very fragile. They must be cleaned immediately after the slaughter of the animal. To make them into sausage casing, they are removed from the abdomen. The ruffle fat is separated from the intestines, and the faeces stripped out. Sometimes they are fermented, though this is not often done today. The inner mucosa membrane is separated from the casing, all strings and blood are removed, and the intestines are finally soaked, salted and packaged.

### 2.8.2 Use of Glands and Organs in the Medicine and Pharmaceutical Industry

Animal glands and organs are traditionally used as medicine in many countries, including China, India and Japan. The endocrine glands secrete hormones (i.e. enzymes that regulate the body's metabolism). These include the liver, lungs, pituitary, thyroid, pancreas, stomach, parathyroid, adrenal, kidney, corpus luteum, ovary and follicle. The glands are collected only from healthy animals. Locating the glands needs some experience. They are often small and encased in other tissue.

Different animals have different glands that are important. The function of glands also depends on the species, sex and age of the animal. The best method of preserving most glands to stop tissue breakdown from bacterial growth is by rapid freezing. Before freezing, the glands need be cleaned, and the surrounding fat and connective tissue trimmed off. The glands are then placed onto waxed

paper and kept at -18 °C or less. When the glands arrive at the pharmaceutical plant they are inspected, then chopped and mixed with different solutions for extraction, or placed in a vacuum drier. If the dried gland contains too much fat, solutions such as gasoline, light petroleum, ethylene or acetone are used to remove the fat. After drying and defatting, the glands or extracts are milled into a powder and made into capsules, or used in a liquid form. They are tested for safety and potency before they are sold.

Brains, nervous systems and spinal cords are a source of cholesterol which is the raw material for the synthesis of vitamin $D_3$. Cholesterol is also used as an emulsifier in cosmetics (Ejike and Emmanuel, 2009). Other materials can be isolated from the hypothalamus of the brain for the same purpose. The hormone melatonin, extracted from the pineal gland, is being evaluated for the treatment of schizophrenia, insomnia and other problems, including mental retardation.

Bile consists of acids, pigments, proteins, cholesterol etc., and can be obtained from the gall bladder. It is used for the treatment of indigestion, constipation and bile tract disorders. It is also used to increase the secretory activity of the liver. Bile from cattle or pigs can be purchased as a dry extract or in liquid form. Some ingredients of bile, such as prednisone and cortisone, can be extracted separately, and used as medicines. Gallstones are reported to have aphrodisiac properties, and can be sold at a high price. They are usually used as ornaments to make necklaces and pendants.

The liver is the largest gland in animals. The liver of mature cattle usually weighs about 5 kg, while that of a pig weighs approximately 1.4 kg. Liver extract is produced by mixing raw ground liver with slightly acidified hot water. The stock is concentrated into a paste in a vacuum at a low temperature, and is used as a raw material by the pharmaceutical industry. Liver extract can be obtained from pigs and cattle, and has been used for a long time as a source of vitamin $B_{12}$, and as a nutritional supplement used to treat various types of anaemia. (Colmenero and Cassens, 1987; Devatkal *et al.*, 2004a, b). Heparin can be extracted from the liver, as well as the lungs and the lining of the small intestines. It is used as an

anticoagulant to prolong the clotting time of blood. It is also used to thin the blood, to prevent blood clotting during surgery and in organ transplants.

Progesterone and oestrogen can be extracted from pig ovaries. It may be used to treat reproductive problems in women. Relaxin is a hormone taken from the ovaries of pregnant sows, and is often used during childbirth.

The pancreas provides insulin, which regulates sugar metabolism and is used in the treatment of diabetes. Glucagon extracted from the cells of the pancreas is used to increase blood sugar, and to treat insulin overdoses or low blood sugar caused by alcoholism. Chymotrypsin and trypsin are used to improve healing after surgery or injury.

The intestines of sheep and calves are used for the manufacture of catgut, to make internal surgical sutures. The lining of the small intestines of pigs and cattle can be collected while the intestines are being processed into casings. It is either preserved in a raw state, or processed into a dry powder for shipment to heparin manufacturers.

## 2.9 Utilization of Edible and Non- Edible Fats

Animal fats are an important by-product of the meat packing industry. The major edible animal fats are lard and tallow. Lard is the fat rendered from the clean tissues of healthy pigs. Tallow is hard fat rendered from the fatty tissues of cattle or sheep. Lard and edible tallow are obtained by dry or wet rendering. In the wet rendering process, the fatty tissues are heated in the presence of water, generally at a low temperature. The quality of the lard or tallow from this process is better than that of products from dry rendering. Low-quality lard, and almost all of the inedible tallow and greases, are produced by dry rendering. Rendered lard can be used as an edible fat without any further processing. However, because of consumer demand, lard and tallow are now often bleached and given a deodorizing treatment before being used in food.

Traditionally, tallow and lard were used for deep frying (Weiss, 1983). However, this use is declining in the fast-food industry, due to consumer health concerns. An alternative liquid tallow product has been developed for the preparation of French fries and other fast foods, since less fat is absorbed. Tallow and lard are also used for margarine and shortening (Ghotra *et al.*, 2002). Some edible lards are used in sausages or emulsified products (Chrysam, 1985).

## 2.10 Utilization of Horn and Bones

Eleven percent of pork carcasses, 15% of beef carcasses and 16% of lamb carcasses are bone. These values are higher if they include the meat clinging to the bone. The marrow inside some of the bones can also be used as food. The marrow may be 4.0-6.0% of the carcass weight (West and Shaw, 1975). For centuries, bones have been used to make soup and gelatine. In recent years, the meat industry has been trying to get more meat from bones, and new techniques have been used for this purpose. The beef, pork or lamb produced by mechanical deboning produces tissue that is called “mechanically separated”, “mechanically deboned” or “mechanically removed”. Such meat is now approved for use in meat products (mixed or used alone) in many countries (Field, 1981). In 1978, mechanically separated red meat was approved for use as red meat in the United States.

Normally, if a high percentage of mechanically separated red meat is incorporated into products, the flavor and quality are reduced. The color becomes darker, and the meat is softer with higher water content. For this reason, the level of mechanically separated meat is usually limited. It should be noted that mechanically recovered meat has a bad consumer perception in some countries connected with health concerns with Bovine Spongiform Encephalopathy (BSE) contamination (Arvanitoyannis and Ladas, 2008). A level of 5.0-20.0% in hamburger and ground beef, and 10.0-40.0% in sausages, has been suggested by the meat industry.

Many countries already have regulations covering products which contain mechanically separated red meat. In the United States, mechanically separated meat cannot be used for hamburgers, baby food, ground beef or meat pies. A level of 20% is the maximum in sausage emulsion. In Denmark, if mechanically separated red meat is used at levels of more than 2% it has to be declared on the label. In Australia, if mechanically deboned beef or mutton is present in exported products, the quantity must be shown on the label, plus the maximum level of calcium, the moisture content and the minimum protein level.

Meat and bone meal (MBM) was widely recommended and used in animal nutrition as a protein source in place of proteinaceous feeds because of its content of available essential amino acids, minerals and vitamin $B_{12}$. MBM and related rendered protein commodities have potential for use in applications other than animal feed, including use as a fuel or a phosphorus fertilizer.

## 2.11 Utilization of Hides and Skins

Animal hides have been used for shelters, clothing and as containers by human beings since prehistoric times. The hides represent a remarkable portion of the weight of the live animal, from 4% to as much as 11% (e.g. cattle: 5.1-8.5%, average: 7.0%; sheep: 11.0-11.7%; swine: 3.0-8.0%). Hides and skins are generally one of the most valuable by-products from animals. Examples of finished products from the hides of cattle and pigs, and from sheep pelts, are leather shoes and bags, rawhide, athletic equipment's, reformed sausage casing and cosmetic products, sausage skins, edible gelatin and glue (Benjakul *et al.*, 2009).

### 2.11.1 Use of Hides and Skins in the Leather Industry

After the hide is removed from the animal, it should be cured quickly to avoid decomposition by bacteria and enzymes. There are four basic treatments. One is

air-drying, the second is curing with salt and the third and fourth are curing by mixer and raceway, respectively. Salt curing is often used for the raw hides. The quality of cured hides and skins is usually based on their moisture and salt content. The moisture level of hides should be in the range of 40-48%, if they are to remain in good condition during storage or shipping.

### 2.11.2 Use of Hides and Skins in the Food Industry

Gelatin is produced by the controlled hydrolysis of a water-insoluble collagen derived from protein. It is made from fresh raw materials (hides or bone) that are in an edible condition. Both hides and bones contain large quantities of collagen. The processing of gelatin from hide consists of three major steps. The first step is the elimination of non-collagenous material from the raw material. This is followed by controlled hydrolysis of collagen to gelatin. The final step is recovery and drying of the final product.

Gelatin extracted from animal skins and hides can be used for food (Choa *et al.*, 2005). The raw material can also be rendered into lard. In the United States, Latin America, Europe and some Asian countries, pork skin is immersed, boiled, dried and then fried to make a snack food (pork rinds) and in U.K they are called “pork scratching”. Collagen from hides and skins also has a role as an emulsifier in meat products because it can bind large quantities of fat. This makes it a useful additive or filler for meat products. Collagen can also be extracted from cattle hides to make the collagen sausage used in the meat industry.

Gelatin is added to a wide range of foods, as well as forming a major ingredient in jellies and aspic (Jamilah and Harvinder, 2002). Its main use is the production of jellied desserts, because of its “melt in the mouth” properties, but is also added to a range of meat products, in particular to meat pies. Gelatin is also widely used as a stabilizer for ice cream and other frozen desserts. High-bloom gelatin is added as a protective colloid to ice cream, yoghurt and cream pies. The gelatin

is thought to inhibit the formation of ice crystals and the recrystallization of lactose during storage.

### 2.11.3 Use of Hides and Skins in the Medicine and Pharmaceutical Industry

Approximately 6.5% of the total production of gelatin is used in the pharmaceutical industry (Hidaka and Liu, 2003). Most of it is used to make the outer covering of capsules. Gelatin can also be used as a binding and compounding agent in the manufacture of medicated tablets and pastilles. It is used as an important ingredient in protective ointment, such as zinc gelatin for the treatment of ulcerated varicose veins. Gelatin can be made into a sterile sponge by whipping it into foam, treating it with formaldehyde and drying it (Estaca *et al.*, 2009). Such sponges are used in surgery, and also to implant a drug or antibiotic directly into a specific area. Because gelatin is a protein, it is used as a plasma expander for blood in cases of very severe shock and injury. Gelatin is an excellent emulsifier and stabilizing agent for many emulsions and foams. It is used in cosmetic products, and in printing for silk screen printing, photogravure printing etc. (Arvanitoyannis, 2002).

Collagen casing products were developed in Germany in the 1920s, but only gained popularity in the United States in the 1960s. The processing does not convert the collagen into a soluble product, as in the case of gelatin. Instead, it results in a product which retains a relatively high degree of the native collagen fiber, and is strong enough to be used as a casing for sausages and other products. The extracted collagen is mixed with water and converted into a dough, which is extruded by either a wet or a dry process. The tube of extruded collagen is then passed through a concentrated salt solution and a chamber of ammonia to precipitate the collagen. The swollen gel contracts to produce a film of reasonable strength. It can be improved by the addition of glycerin, to make it more flexible. The tube is then dried to 10.0-15.0% water content.

## 2.12 Utilization of Poultry By-products

Waste products from the poultry processing and egg production industries must be efficiently dealt with as the growth of these industries depends largely on waste management. Animal and poultry waste management center, at North Carolina State University, North Carolina, USA is engaged in conversion of wastes to valuable products and the work being supported by various organization, agencies, companies etc. (Anon, 1995).

The intensive and large-scale production of food animals and animal products has generated an enormous disposal problem for the animal industry. These wastes, including animal excreta, mortalities, hair, feathers and processing wastes are convertible to useful resources. An efficient thermophilic anaerobic digester system that converts animal manure to methane for an energy source was reported by Shih (1993).

Emulsion—based mutton nuggets, incorporating chicken by-products, i.e., skin, gizzard and heart (SGH) from spent hens were evaluated by Kondaiah *et al.* (1993). Incorporation of SGH resulted in better acceptability of mutton nuggets as compared to that containing mutton fat. Urlings *et al.* (1993) studied the proteolysis and amino acid breakdown of heated and irradiated poultry by products of muscle tissue and concluded that during processing of poultry meat and poultry wastes, enzymic activity has to be reduced or eliminated to ensure safe and high-quality products. Egg white flavoprotein is abundant in low-cost egg processing by-products and could serve as a useful food ingredient, provided a cost-effective procedure for its purification is available (Rao *et al.*, 1997).

### 2.12.1 Use of Feather and Feather Waste

Feathers are unique to the avian species. They represent about 7% of the live body weight of a broiler (Lortscher *et al.*, 1957) and are also considered to be of major economic importance. The feathers are made of a complex keratin protein matrix. The amino acid sequence of a broiler's feather is very similar to that of

other poultry/bird feathers and the keratin found in reptilian claws. Feathers are a rich source of protein with approximately 90% protein, 8% water and 1% fat. Once processed into a regular feather meal, it contains about 70-80% crude protein. However, before using feathers as an animal feed, the protein complex has to be broken down as explained below. Feathers are also used for bedding, ornaments, sporting equipment and as filler in chemical fertilizer (Ockerman and Hansen, 2000).

According to Hardy and Hardy (1949) and Pacific Coast (1997), feathers can be classified as:

a. **Saddle feathers**: - long, narrow, vaned feathers from the saddle and back of a rooster
b. **Hard feathers**: - stiff quills, heavy vanes and a very small amount of fluff
c. **Half fluff**: - vaned feathers with fluff along the lower half of the quill
d. **Three-quarters**: - vaned feathers with fluff along the lower three-quarters of the quill
e. **Fluff**: - body feathers with firm shafts bearing only fluff or the soft part of a feather
f. **Plumules**: - small down feathers with soft shafts, bearing only fluff
g. **Down**: - feathers without a shaft, composed of only a tuft of fluff

**Animal feeding** – At the time feathers are used for animal feed they need to be hydrolyzed to break down the complex protein (keratin) structure; otherwise they would be indigestible. The feathers are first washed to remove dirt and then they are dewatered by compression or centrifugation because they do absorb some moisture during processing and washing. After some of the water has been removed the feathers are cooked for 1-2 h to hydrolyze the complex protein structure. Heating is commonly done in a pressure cooker (under 2-3 atm of pressure), which increases the rate of hydrolysis. The feather's digestibility is proportional to cooking time and temperature where higher temperature and longer cook times result in higher amino acid availability. The cooked feathers

are then dried (e.g. air) and ground, resulting in a product known as feather meal. The common composition of a feather meal is: 75% crude protein (some contains up to 90%), 10% moisture, <6% fat and 3-4% fiber.

Feather meal is rich in sulfur containing amino acids such as cysteine, arginine and threonine, but is deficient in lysine, histidine, methionine and tryptophan. The meal is generally fed to poultry or swine, these limiting amino acids should be added. The common feeding level is 0.5 to 1.5% of the diet (Ockerman and Hansen, 2000). During fed to beef cattle feather meal efficiency can be improved by adding urea.

**Bedding** – this industry commonly uses small, fine feathers. Down is the most preferred because it possesses a unique structure that allows it to hold large volumes of air and down is an excellent insulator. Down usually represents 12-15% of the total feather weight in ducks and geese. The remaining feathers on the bird are designed for water and air flow so the bird can swim/fly.

In the bedding industry feathers are thoroughly washed and rinsed and then blow-dried. This process promotes opening the structure of the down feathers, which enhances the feather characteristics as a bedding material. Breathability, compressibility and the ability to return to its original shape and volume are also important characteristics in selection feathers for bedding (Mountney, 1989). Feathers are sorted into different size groups after cleaning and drying. Sorting is done by air currents which blow the down and feathers through a series of vertical baffles, suspended from both the top and bottom of the separator. Lighter down feathers are blown further away than the heavier feathers (Pacific Coast, 1997). According to US regulations, a product identified as down must contain 80% down and no more than 20% other feathers.

After the introduction of synthetic fibers there was a reduction in the use of down for bedding. However, high quality down is 4X more thermally efficient and 10X more durable than synthetic fibers and a surge of high end down filled bedding/coats has been seen in recent years (Ockerman and Hansen, 2000). Also,

feathers are classified as a natural product and contain no toxins, require no toxins to produce, do not pollute and are biodegradable.

**Ornamental feathers** – tail and wing feathers from pheasant, rooster neck hackles, ostrich etc. need to be removed before exposure to hot scalding water. This is done by hand and is obviously time consuming and more expensive than mechanical defeathering (i.e. a picker uses fast moving rotary rubber fingers in a fairly aggressive way that damages the shape and structure of the feathers). Feathers used for sporting equipment, such as for fetching arrows are carefully hand selected to assure quality. Feathers can also be used for manufacturing artificial fishing lures and for shuttlecocks used in badminton. Colored feathers are used for decorative purposes and are sometimes dyed and trimmed to a desired shape and pattern.

Careful cleaning of feathers is required when feathers are used for bedding, clothing or sporting equipment. If the feathers are going to be saved for more than a day prior to processing, they can be soaked in a 5% salt, 0.3% hydrochloric acid solution. The feathers are washed about half a dozen times with a soap solution and cleaning detergents to remove all dirt. A mild soap should be used to protect the essential oils in the feathers and a neutral pH should be maintained to protect the feathers (Mountney, 1989). Sometimes a special high flash point gasoline is used to remove foul odors. In such a case, the processor can later lightly spray the feathers with mineral oil to replace some of the original oil, in some processes, where decolorization is required, blanching agents such as hydrogen peroxide, chlorine or potassium permanganate are also used. Inappropriate cleaning will cause problems with mildew, degradation due to microbial activity and reduce the insulting properties.

With the increased demand for natural products in the marketplace, feathers are gaining popularity and that is good news for the poultry industry. Attention toward recovering by-products from meat and other ingredients is also expected to rise as the price of material disposal is continually increasing.

## 2.13 Waste Water Generation from Slaughterhouse

The meat industry is a branch of the food industry, which causes degradation of the environment to a large extent. The wastewater produced in it contains a variety of organic and inorganic pollutants, has a high concentration of etheric extract, suspended and biogenic matter as well as variable concentrations. Processes using ultrafiltration–reverse osmosis, chemical precipitation–reverse osmosis and chemical precipitation–ultrafiltration–reverse osmosis have been used in the treatment of meat industry wastewaters (Bohdziewicz and Sroka, 2005).

In poultry processing, water is used primarily for scalding, in the process of feather removal, bird washing before and after evisceration, chilling, cleaning and sanitizing of equipment and facilities, and for cooling of mechanical equipment such as compressors and pumps. Although water also is typically used to remove feathers and viscera from production areas, overflow from scalding and chiller tanks is used. A number of studies also have shown that the volume of water used and wastewater generated by poultry processing on a per unit of production basis (such as per bird killed) can vary substantially among processing plants. Again, some of this variation reflects different levels of effort among plants to reduce their wastewater treatment costs by minimizing their water use. One study of 88 chicken processing plants found wastewater flows ranged from 4.2 to 23 gallons per bird with a mean value of 9.3 gallon per bird (USEPA, 1975).

### 2.13.1 Composition of Waste Water

The principal constituents in waste waters from rendering operations are the same as those in meat and poultry processing wastewaters. In addition, it appears that there is little difference in rendering wastewater constituents or concentrations attributable to the source of materials being processed. The principal sources of wastes in poultry processing are live bird holding and

receiving, killing, defeathering, eviscerating, carcass washing, chilling, cutup, and cleanup operations. Further processing and rendering operations are also major sources of wastes. These wastes include blood not collected, feathers, viscera, soft tissue removed during trimming and cutting, bone, soil from feathers, and various cleaning and sanitizing compounds. Further processing and rendering can produce additional sources of animal fat and other soft tissue, in addition to other substances such as cooking oils.

Thus, the principal constituents of poultry processing wastewaters are a variety of readily biodegradable organic compounds, primarily fats and proteins, present in both particulate and dissolved forms. To reduce wastewater treatment requirements, poultry processing wastewaters also are screened to reduce concentrations of particulate matter before treatment. An added benefit of screening is increased collection of materials and subsequent increased production of rendered by-products. Because feathers are not rendered with soft tissue, wastewater containing feathers is not commingled with another wastewater. Instead, it is screened separately and then combined with unscreened wastewater to recover soft tissue before treatment during the screening process of these mixed wastewaters. However, poultry processing wastewaters also remain high strength wastes even after screening in comparison to domestic wastewaters based on concentrations of BOD, COD, TSS, nitrogen, and phosphorus after screening. Blood not collected, solubilized fat, and feces are principal sources of BOD in poultry processing wastewaters. As with meat processing wastewaters, the efficacy of blood collection is a significant factor in determining BOD concentration in poultry processing wastewaters. Another significant factor in determining the BOD of poultry processing wastewaters is the degree to which manure (urine and feces), especially from receiving areas, is handled separately as a solid waste. Chicken and turkey manures have BOD concentrations more than 40,000 mg/kg on an as excreted basis (American Society of Agricultural Engineers, 1999). The cages and trucks for transporting broilers are washed in U.K but in some Asian countries, although the cages and trucks used to transport broilers to processing plants usually are not washed,

cages and trucks used to transport live turkeys to processing plants are washed to prevent transmission of disease from farm to farm. Thus, manure probably is a more significant source of wastewater BOD for turkey processing operations than for broiler processing operations.

### 2.13.2 Treatments of Waste Water

Meat processing plants generate a significant amount of waste water with a relatively high content of organic matter from protein, fat, and microorganisms. The processor must decide to treat the waste water or send it to a municipal sewage system (note: in recent years, many municipalities have refused to treat water with organic matter levels that are higher than the domestic sewage level). Therefore, it is in the best interest of the meat processor to treat the water, as much as possible, prior to sending the water to a municipal sewage system. The treatment can range from a simple filtration system to sophisticated aerobic lagoons. Overall, volume, capital, and operating costs determine the level to which a plant treats its waste.

Due to environmental and budget constraints, technologies that recycle and treat waste water are increasing. It is indicated that ultrafiltration of poultry waste water improves the quality of the recycled water and provides solution to water resource limitations (Avula *et al.*, 2009). Ultrafiltration is a pressure-driven process that separates materials based on molecular diameter. New membrane bioreactors that integrate biological degradation of waste products with membrane filtration are also quite effective at removing organic and inorganic contaminants from waste water During the process, value added products such as crude proteins could be separated from poultry waste water, which could subsequently reduce the chemical oxygen demand. Ongoing research in membrane separation techniques involves exploration of new membrane materials and of new module configurations to address issues of membrane fouling and treatment of waste streams containing high suspended solids or

viscous waste. Overall, poultry processing plants use large volumes of water at several stages in the process due to set policies regarding pathogen reduction. Recovery of waste water can benefit the plant by reducing fresh water demand, waste water volume, and energy.

## 2.14 Utilization of Slaughterhouse Waste in Re-cycling Plants

The availability of wet biomass as waste from industrial processes and the need to meet the environmental standards stand for the main stimuli towards investigating all options in order to dispose this waste. The thermal recycling of residues as secondary fuel is of increasing interest for power plant operators (Arvanitoyannis and Ladas, 2008). Studies documented the usage of poultry litter as an alternative for natural fuel source generation. It is noteworthy that poultry litter with water contents less than 9% can burn without extra fuel. Therefore, these samples were suitable for being used as fuel for generation of electrical power. Physicochemical treatment of meat industry wastewater is used to increase the organic matter removal efficiency, and it generates great amounts of sludge. Treatment using commercial ferric sulfate as coagulant for this specific wastewater gave high organic matter removals, decreasing considerably the amount of waste material to be treated in biological systems, and also allowing the obtention of 0.83-0.87 kg of biomass fuel for each $m^3$ of treated wastewater (De Sena *et al.*, 2008). Due to sanitary, environmental problems and operational costs related to the discharge, land disposal and re-use of wastes, the utilization of this Biofuel (dried sludge) for steam generation has shown to be a viable alternative. This type of fuel has a high heating value, and it is a renewable energy source. The combustion test with a Biofuel to sawdust ratio of 4:1 met the technical requirements for the characterization of this promising fuel; nevertheless, operating conditions must be well designed to achieve $NO_2$ and $SO_2$ emissions below local and/or international limits.

Biodiesel fuel acquired from the oils and fats of meat and fish is a substitute for, or an additive to diesel fuel derived from petroleum. There is an extensive literature on biogas production from cattle manure, piggery waste waters and by-products of aquaculture (Arvanitoyannis and Kassaveti, 2008).

### 2.14.1 Use of Bio-gas Production

Due to the abundant biomass wastes generated by slaughterhouse, these biomass resources potential for biogas production by the process of biomethenation, this process use slaughterhouse waste for production of biogas. The success of the process, especially the effective removal BOD has led biogas plant to be acceptable for slaughter house (Hejnfelt and Angelidaki, 2009). Wastes consisting of rumen and paunch contents, dung, agriculture residue, fat and blood are processed in biomethenation plant. Power plants have been designed to produce biogas (60% methane, 30% carbon dioxide and traces of hydrogen, carbon monoxide etc.) by digestion of animal waste (Sharma, 2003). The biogas can be used for boiler or power generation.

Large slaughter house are mostly located around cities and congested areas. They generate substantial quality of solid wastes, which have to be processed in environmentally acceptable manner. For the large slaughter houses, bio-methanation of waste is suggested. Bio-methanation requires less space, which is advantageous for the slaughter houses with land constraints. Bio gas produced from this operation may fulfill the energy requirements of slaughter unit and adjoining areas.

### 2.14.2 Use of Composting

Composting involves the aerobic biological decomposition of organic materials to produce a stable humus-like product. The slaughter house waste can be used for compost making. The left-over feed, dung from the lair age, ruminal and

intestinal contents, blood, meat trimmings, floor sweepings, hair, feathers, hide trimmings can be stabilized by composting. It will produce very good quality bio-manure which may be utilized as fertilizers for the agriculture land and gardens (Malav *et al.*, 2018).

# CHAPTER 03

# MATERIALS & METHODS

# CHAPTER 03

# MATERIALS & METHODS

In this research the data were collected from different slaughter-houses personnel by face to face interview using a survey questionnaire. The detail procedure is given below:

## 3.1 Selection of Study Site

The experiment was carried out at some randomly selected slaughter-houses of Dhaka city.

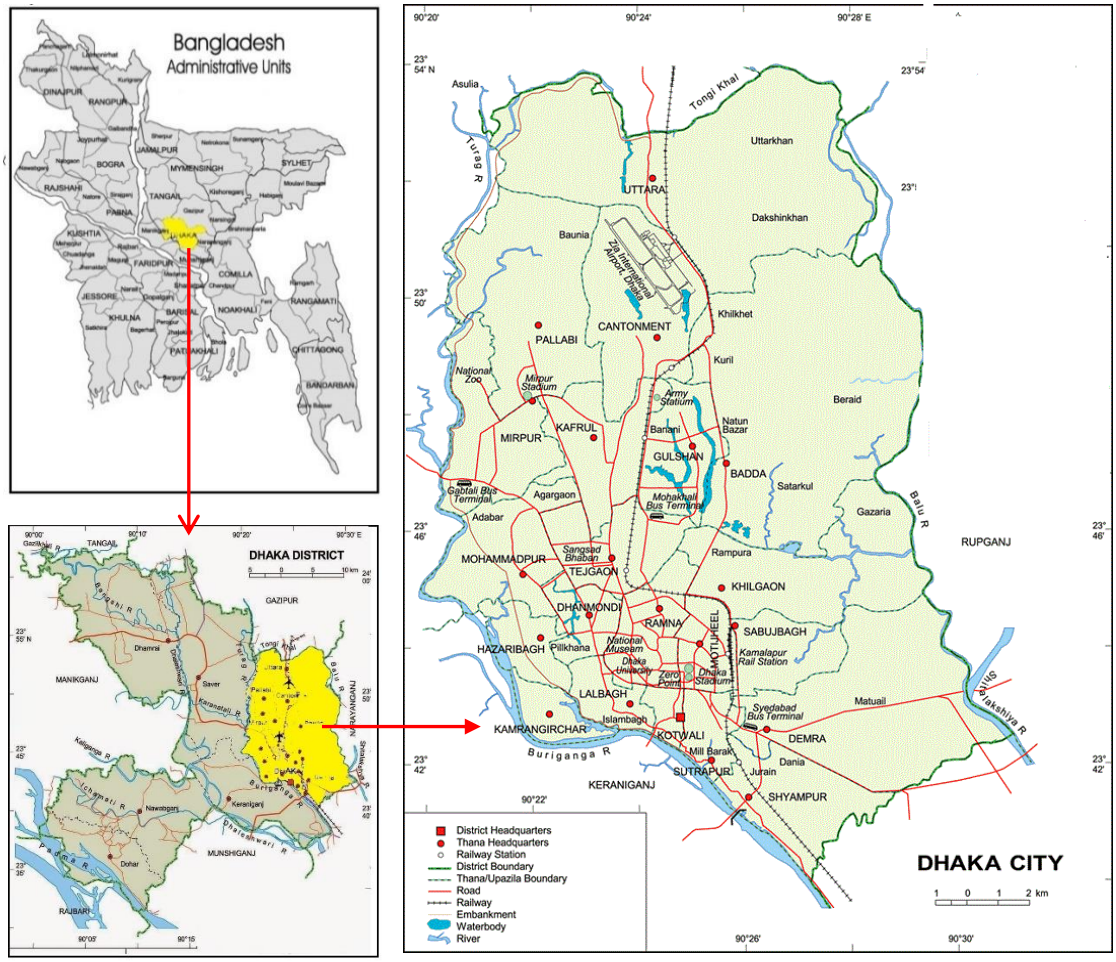



**Fig- 3.1:** Map of Dhaka city, the study area of this survey.

## 3.2 Survey Design

The study was based on field survey where primary data were collected from slaughter-houses of Dhaka City Corporation area. A total of 60 respondents were selected adopting PPRS (Proportional Probability Random Sampling) techniques of Lahiri (Snedecor and Cochrane, 1989). The design of the survey for the present study involved some necessary steps which were outlined in this section. Primary data were collected considering the nature of the study and its objectives.

## 3.3 Study Works for Survey

The study works were selected to target the slaughter-house by-products, wastes and its well management. By this experiment, it was found that the current uses of by-products, its potentiality and status of waste materials management.

From this study it was also found that the various utilization ratio of different by-products from slaughter-houses of large, small animal and poultry. From this experiment or survey, it was try to figure out the potentiality of large and small animals and poultry slaughter-houses by-products. After that it was known the current list of waste materials with its dumping ratio or percentage.

Finally, the survey focus on hygiene conditions or components data of slaughter-houses was collected by observation, interview and investigate the cleanliness condition, availability of drainage facility and water supply techniques. In case of cleanliness and drainage condition; if the appearance of slaughter house is clean and have well drainage was categorized as **Excellent**, if the slaughter house is relatively clean in appearance have better drainage and washing every day it was categorized as **Good**, if abattoir do not have well drainage and also do not washing everyday it was classified as **Moderate** and finally if slaughter-house is dirty in appearance or sometimes do not washing it in a week and drainage system is absent it was mentioned as **Poor**.

## 3.4 Sample Size of Survey

This experiment is related with field survey in slaughter-houses in Dhaka city and data was collected from the direct interview with slaughter- houses owners or personnel.

For this experiment **60** slaughter-houses personnel interview was taken under 3 slaughter-house categories. **20** personnel interviews taken from large animals (cattle, buffalo etc.) slaughter-houses. Other **20** personnel interviews taken from small animals (sheep, goat etc.) slaughter-houses. Another **20**-personnel interview taken from poultry birds (chicken, duck etc.) slaughter-houses.

These **60** personnel and the slaughter-houses were selected randomly from Dhaka city.

## 3.5 Questionnaire Development

For this survey, at first a questionnaire was developed for slaughter-houses personnel interview. An interview schedule was carefully prepared that contained both open and closed form of structured questions keeping in mind the objectives of the study. These questions were set chronologically so that the slaughterhouse and / or meat selling centers personnel (operator / worker / butcher / sellers / owner) can provide data in a systematic manner. Then appropriate slaughter-houses was randomly selected from different meat market of Dhaka City Corporation area. Questionnaire is given in appendices.

## 3.6 Pre-survey Trial

After developing questionnaire, a pre-survey trial was performed with some slaughter-house personnel. The draft interview schedule was pre-tested and necessary correction, additions and rearrangements were made before being used it for final data collection. Then visit the slaughter-house carefully to ensure the questionnaire is appropriate for target data collection properly.

## 3.7 Data Collection

The experiment was carried out by collecting data using questionnaires, direct observation, investigation and face to face interview (see Pic-3.1). The data were collected during the period from **December 2019** to **March 2020** through personal interview. Desired rapport was established to each respondent, so any respondent failing to understand any question, care was taken by the researcher to explain the situation.

**Pic-3.1:** Visiting slaughter-houses for collection of data during survey.

## 3.8 Variables and Its Measurements

The selection of variables and their measurements constitute an important task in research work. The researcher selected some characteristics of by-products from slaughterhouses and/or meat selling centers as the variables of this study. The characteristics are as follows: edible and inedible by-products from large, small animal and poultry slaughterhouses and/or meat selling centers, and hygiene practices followed in slaughterhouses and/or meat selling centers.

## 3.9 Data Analysis

The survey on different qualitative parameters of this study were exploratory descriptive. Therefore, data were collected, tabulated and analyzed with simple statistical method to fulfill objectives of the study. Tabular technique of relative frequency distributions is applied for the analyses of data using descriptive statistical method (Aviva and Paul, 2013), by using IBM® SPSS-v-16™, MS® Excel™ Software and expressed in Bar diagram. The formula of relative frequency calculation is given below-

$$\boldsymbol{RF = \frac{f}{\sum f} \times 100}$$

Where,

$\boldsymbol{RF}$ = Relative Frequency (or Percentage)

$\boldsymbol{f}$ = Frequency

$\boldsymbol{\sum f}$ = Total Frequency

# CHAPTER 04

# RESULTS & DISCUSSION

# CHAPTER 04

# RESULTS & DISCUSSION

## 4.1 Utilization of By-products from Large Animals

The survey findings for the uses of large animal by-products are discussed below.

### 4.1.1 Utilization of Edible By-products from Large Animals

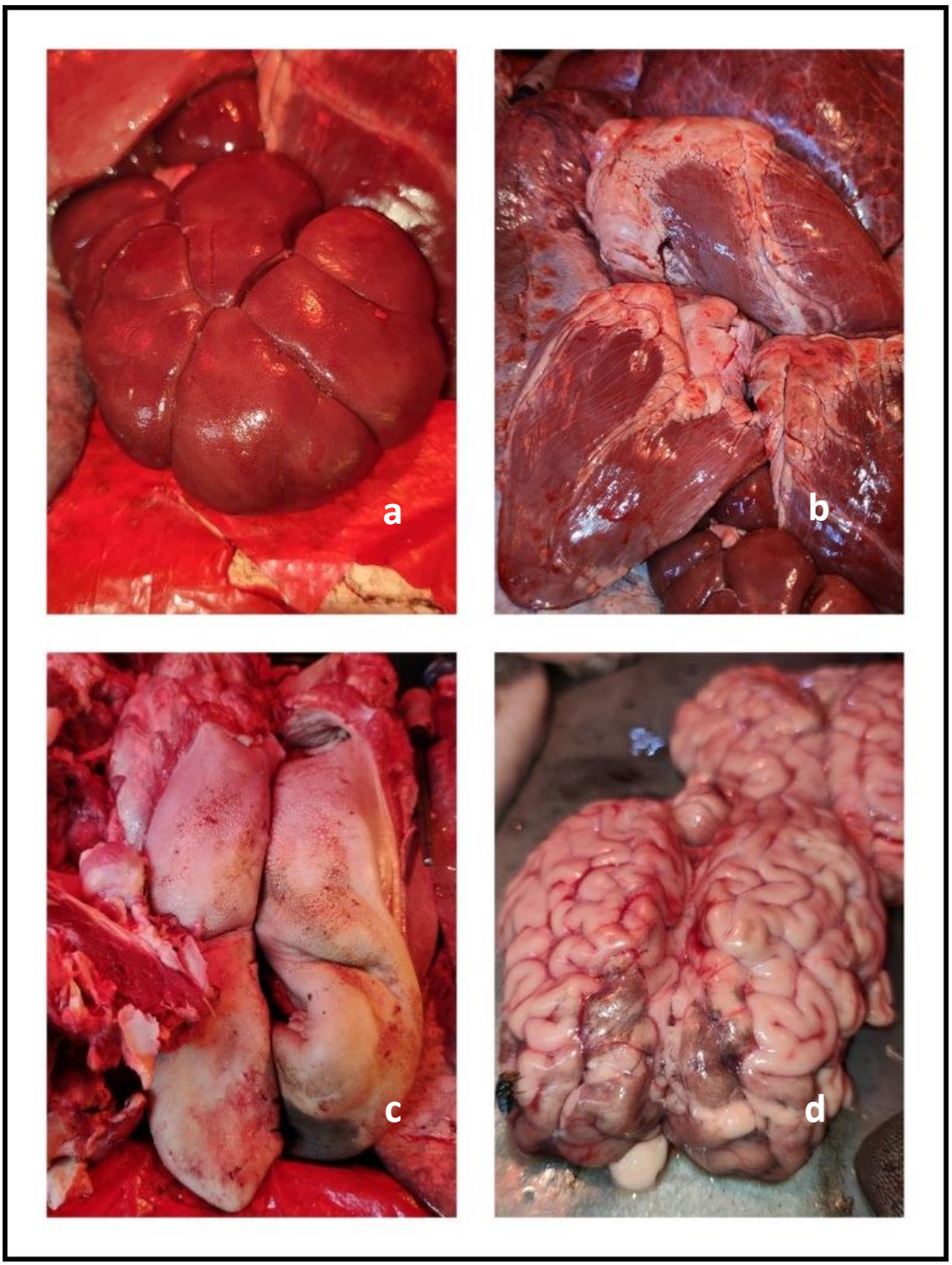
In this research, it was found that some world wide known large animal by-products are only used for human consumption (see Table 4.1). Among 20 respondents of large animal slaughter-house, all gave their 20 (or 100%) opinion to agree with human consume. The list of this by-products given below-

**Table 4.1: The by-products of large animal only used for human consumption.**

| By-products | Uses | Frequency | Percentage |
|---|---|---|---|
| Head Trimmings | Human food | 20 | 100 |
| Brain | Human food | 20 | 100 |
| Tongue | Human food | 20 | 100 |
| Heart | Human food | 20 | 100 |
| Empty Stomach | Human food | 20 | 100 |
| Lung | Human food | 20 | 100 |
| Liver | Human food | 20 | 100 |
| Pancreas | Human food | 20 | 100 |
| Spleen | Human food | 20 | 100 |
| Kidney | Human food | 20 | 100 |
| Tail | Human food | 20 | 100 |

**# Multiple response**

This result agreed with the Ockerman and Hansen (2000) who observed that these by-products like head trimmings, kidney (see Pic- 4.1a), heart (see Pic- 4.1b), liver, tongue (see Pic- 4.1c), brain (see Pic- 4.1d), stomach, pancreas, spleen, lung and tail can be used as human food by cooking and grilling etc.




**Pic- 4.1:** The by-products of large animal only used for human consumption. (a) Kidney, (b) Heart, (c) Tongue and (d) Brain.

### 4.1.2 Utilization of Inedible By-products from Large Animals

Large animal inedible slaughterhouse and/or meat selling centers by-products were being utilized in various ways (see Table 4.2). The list of these type of by-products given below-

**Table 4.2: Existing uses of inedible slaughter-house by-products from large animals.**

| By-products | Uses | Frequency | Percentage |
|---|---|---|---|
| Hides and skin | Sold to businessman for tannery industry | 20 | 100 |
| Horn | Industrial use (comb, buttons etc.) | 20 | 100 |
| | Disposed | 7 | 35 |
| Blood | Fish and/or animal feed | 16 | 80 |
| | Disposed | 14 | 70 |
| | Research | 3 | 15 |
| Intestines | Human food | 4 | 20 |
| | Fish feed | 5 | 25 |
| | Pharmaceutical industry | 10 | 50 |
| | Export (China) | 14 | 70 |
| | Disposed | 9 | 45 |
| Stomach contents | Fertilizer | 14 | 70 |
| | Disposed | 19 | 95 |
| Gall bladder | Pharmaceutical industry | 13 | 65 |
| | Export (India) | 15 | 75 |
| | Disposed | 8 | 40 |
| | Research | 2 | 10 |
| Fats | Human food | 15 | 75 |
| | Soap industry | 20 | 100 |

| By-products | Uses | Frequency | Percentage |
|---|---|---|---|
| | Condensed milk industry | 10 | 50 |
| | Disposed | 1 | 5 |
| Feet and hooves | Human food | 20 | 100 |
| | Pharmaceutical industry | 13 | 65 |
| | Research | 1 | 5 |
| | Disposed | 1 | 5 |
| Bones | Melamine industry | 20 | 100 |
| | Pharmaceutical industry | 5 | 25 |
| | Disposed | 3 | 15 |
| Urinary bladder with contents | Cleaner production | 8 | 40 |
| | Export | 4 | 20 |
| | Disposed | 17 | 85 |
| | Research | 6 | 30 |
| Genital organs | Pharmaceutical industry | 6 | 30 |
| | Export (China) | 17 | 85 |
| | Disposed | 1 | 5 |
| | Research | 1 | 5 |

**# Multiple response**

### 4.1.3 Large Animals Hides from Slaughter-house

In case of large animal hides, all of 20 respondents gave their (100%) opinion that the hides (see Pic- 4.2) are collected everyday by local collectors. After that they send all the hides and skins to the tanneries of savar and Hajaribag. Where it is processed and make different finished lather goods this agreed with the findings of Benjakul *et al.* (2009).

**Pic- 4.2:** Hide of cattle collected for tanneries.

### 4.1.4 Utilization of Horns

In this research, 20 respondents of slaughter-houses gave total 27 opinions about uses of horn. According to 27 opinions, (see Table 4.2 & Fig- 4.1) all the respondents (100%) opined that horn was used in comb producing industry and 35% horn was disposed.

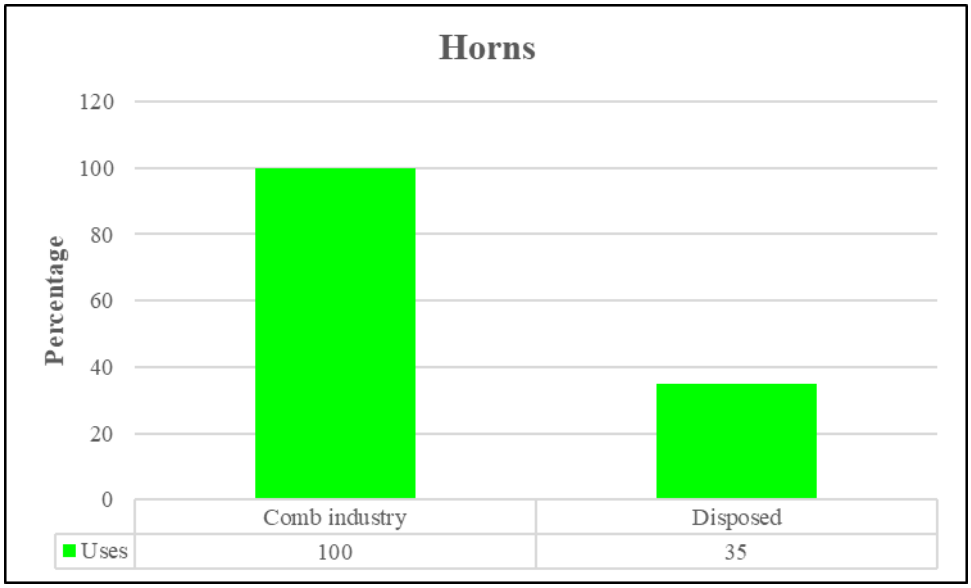



**Fig- 4.1:** Uses of horns as a by-product from large animal.

### 4.1.5 Utilization of Blood

In this research, 20 respondents of slaughter-houses gave total 33 opinions about uses of blood. According to 33 opinions, (see Table 4.2 & Fig- 4.2) blood was used as fish and/or animal feed (80%) while 70% of the respondents left blood in the place where animals were slaughtered. It diminishes automatically but creates environmental pollution. A few respondents (15%) also informed about its research purpose use.


**Fig- 4.2:** Uses of blood as a by-product from large animal.

According to Silva and Silvestre (2003), blood is used in food as an emulsifier, a stabilizer, a clarifier, a color additive, and as a nutritional component, which is agreed with this current finding because most portion of blood is used in feed producing sector especially fish feed. In another point of view Liu (2002) reported that blood is used for black pudding, sausage, blood and barley loaf products which is used as human food.

### 4.1.6 Utilization of Intestines

In this research, 20 respondents of slaughter-houses give total 42 opinions about the uses of intestines (see Pic- 4.3). According to 42 opinions, (see Table 4.2 & Fig- 4.3) about 20% respondents observed to use intestines as human food where 25% as fish feed, 50% in pharmaceutical industry (catgut production) but 70% opined exporting intestines in China.

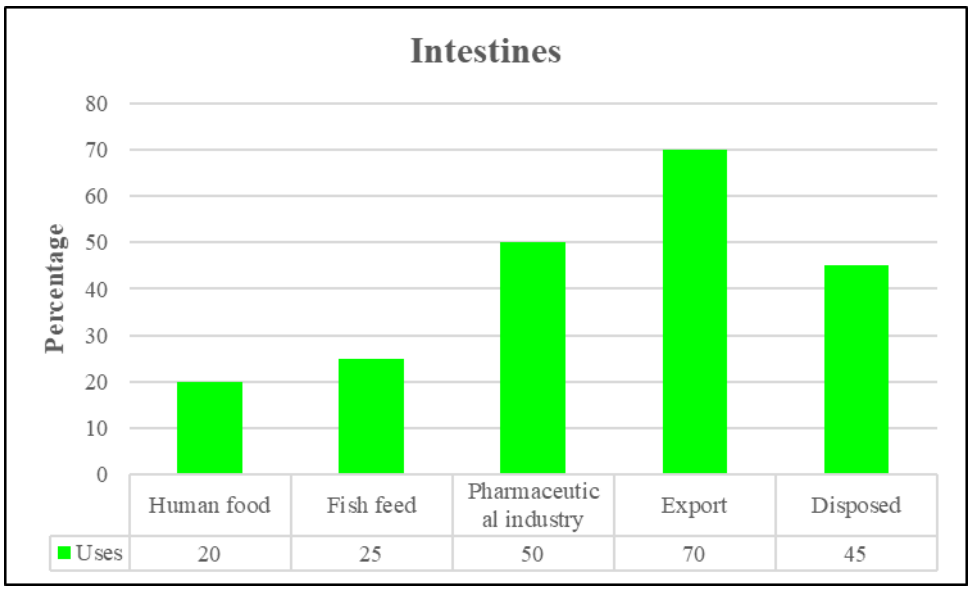



**Fig- 4.3:** Uses of intestines as a by-product from large animal.

In this result it is find that a good amount of intestine uses as human food and exported which is agreed with the findings of Ockerman and Hansen (2000). It is also agreed with that of Liu (2002). Where it was observed intestines is used for sausages casings in case of human consumption.

**Pic- 4.3:** Intestines of cattle.

### 4.1.7 Utilization of Stomach Contents

In this research, 20 respondents of slaughter-houses give total 33 opinions about uses of Stomach Contents. According to 33 opinions, (see Table 4.2 & Fig- 4.4) approximately 70% respondents informed that stomach contents were used as fertilizer where 95% of respondents reported about its disposal.

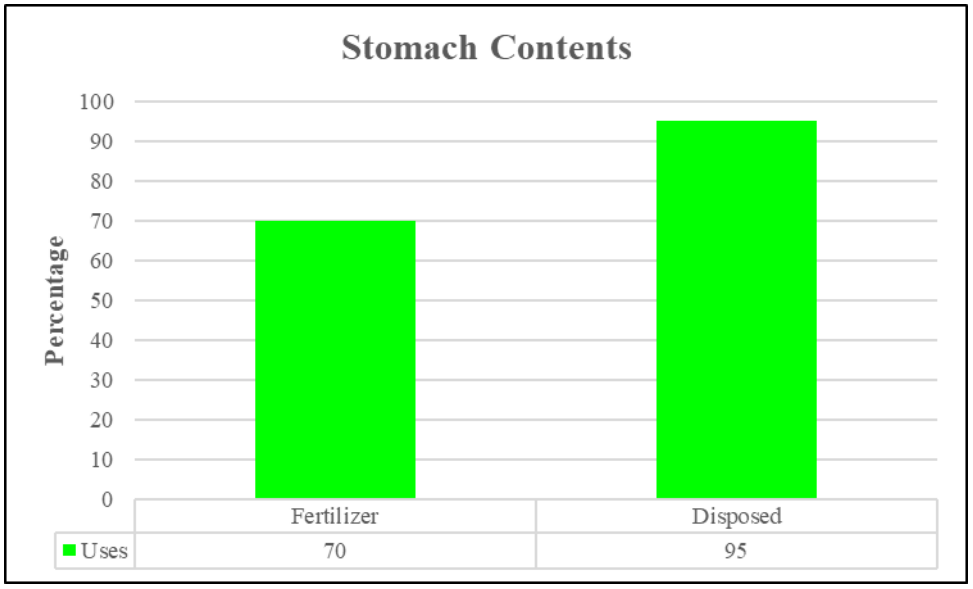



**Fig- 4.4:** Uses of stomach contents as a by-product from large animal.

The research finding showed that the rumen or stomach contents use as fertilizer, which is agreed with the findings of Malav *et al.* (2018). They reported that the stomach contents can produce very good quality bio-manure which may be utilized as fertilizers for the agriculture land and gardens.

### 4.1.8 Utilization of Gall Bladder

In this research, 20 respondents of slaughter-houses gave total 38 opinions about uses of gall bladder. According to 38 opinions, (see Table 4.2 & Fig- 4.5) 65% respondents reported that pharmaceutical industry uses gall bladder where 75% opined about its export, 40% of total respondents mentioned its disposal and a few of respondents (10%) reported its use in research purposes.

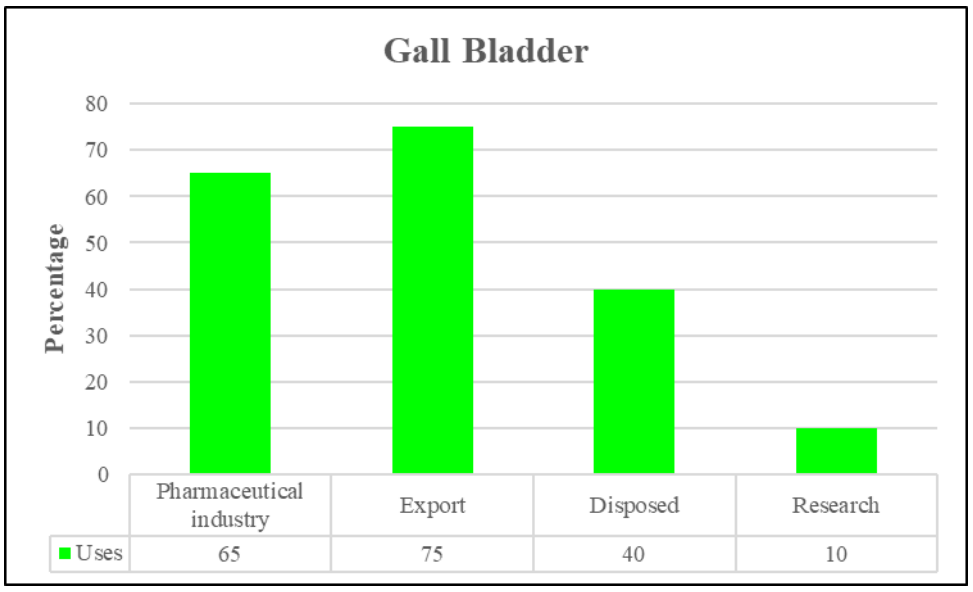



**Fig- 4.5:** Uses of gall bladder as a by-product from large animal.

According to Jayathilakan *et al.* (2012), Bile consists of acids, pigments, proteins, cholesterol etc., and can be obtained from the gall bladder. Some ingredients of bile, such as prednisone and cortisone, can be extracted separately, and used as medicines which agrees with the present findings.

### 4.1.9 Utilization of Fats

In this research, 20 respondents of slaughter-houses gave total 46 opinions about uses of fats. According to 46 opinions, (see Table 4.2 & Fig- 4.6) All the respondent (100%) reported using of fats in soap industry followed by as human food (75%) and in condensed milk industry (50%). Very few respondent (5%) reported about its disposal.

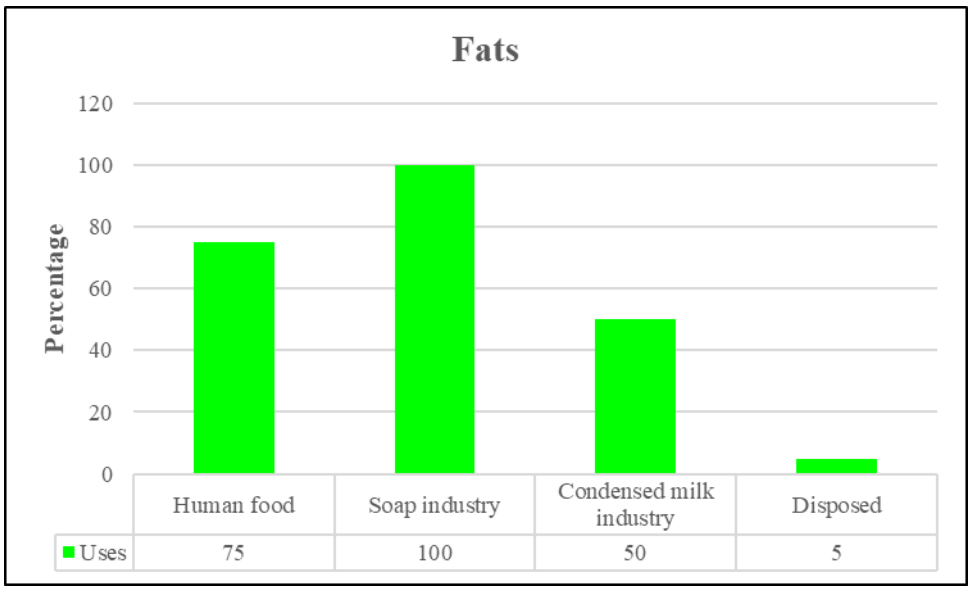



**Fig- 4.6:** Uses of fats as a by-product from large animal.

According to Weiss (1983), tallow and lard were used for deep frying which agreed with this research. In another point of view, Ghotra *et al.* (2002) reported that tallow and lard were also used for margarine and shortening as cosmetic industry.

### 4.1.10 Utilization of Feet and Hooves

In this research, 20 respondents of slaughter-houses gave total 35 opinions about uses of feet and hooves. According to 35 opinions, (see Table 4.2 & Fig- 4.7) all (100%) respondents reported that the large animal's feet and hooves were used as human food but there were other uses also such as pharmaceuticals industry (gelatin production) (37.14%). Feet and hooves was also used in research (5%) and disposed (5%).

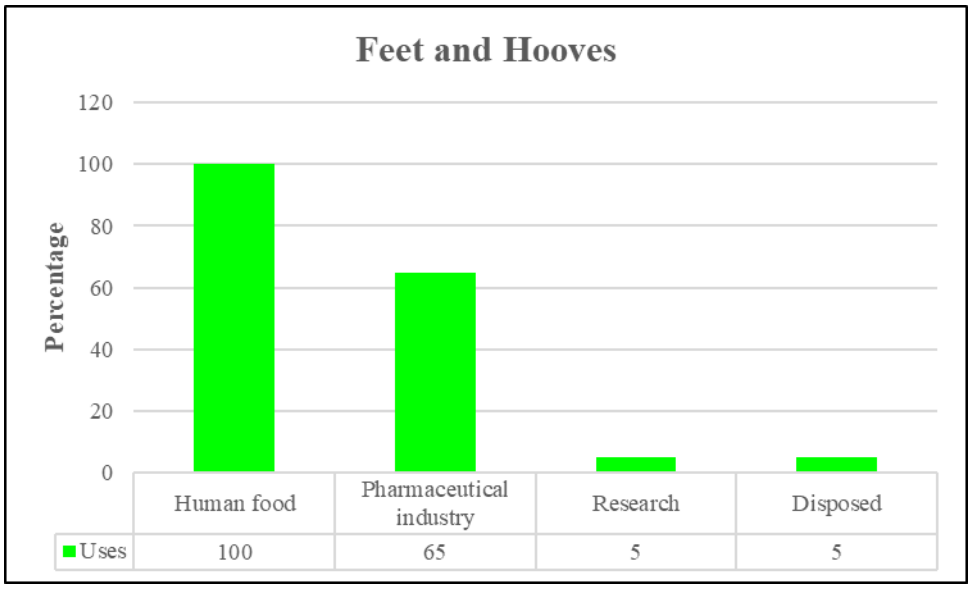



**Fig- 4.7:** Uses of feet and hooves as a by-product from large animal.

In case of feet and hooves, Ockerman and Hansen (2000) observed that it was utilized as human consumption by processing into jelly, pickled, cooked in liquid, boiled and fried which is agreed with this research.

### 4.1.11 Utilization of Bones

In this research, 20 respondents of slaughter-houses gave total 28 opinions about uses of bones. According to 28 opinions, (see Table 4.2 & Fig- 4.8) all (100%) respondents observed that bones were used in melamine industry, whereas one-forth of them (25%) also reported its uses in pharmaceutical industry and 15% of total respondents mentioned its disposal.

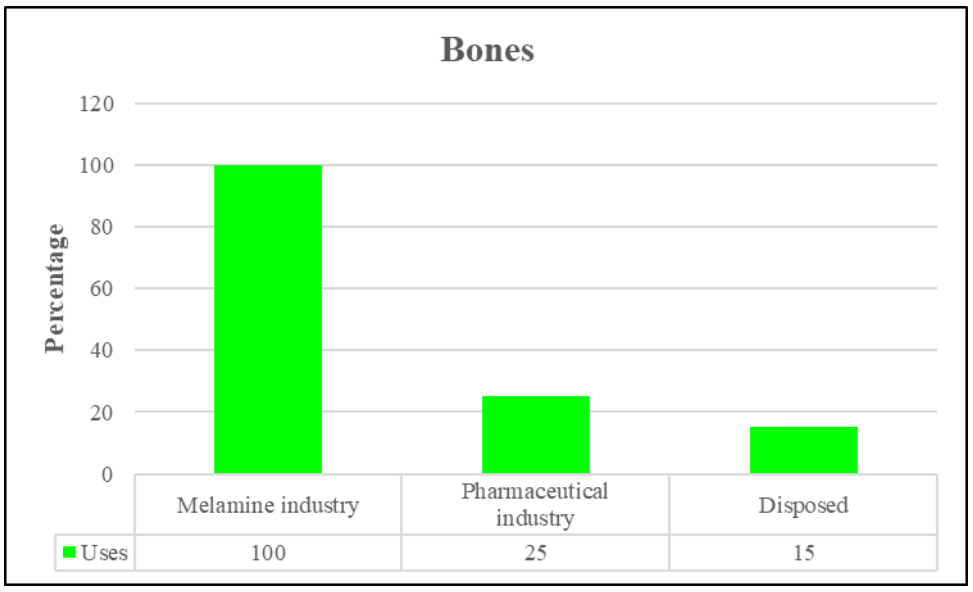



**Fig- 4.8:** Uses of bones as a by-product from large animal.

According to West and Shaw (1975), the marrow inside some of the bones can also be used as food. The marrow may be 4.0–6.0% of the carcass weight. On the other hand, Ockerman and Hansen (2000) observed bones can be used in gelatin, soup, jellied products production which is agreed with this survey findings about pharmaceutical use.

### 4.1.12 Utilization of Urinary Bladder with Content

In this research, 20 respondents of slaughter-houses gave total 35 opinions about uses of urinary organs. According to 35 opinions, (see Table 4.2 & Fig- 4.9) the 40% of respondents informed that urinary bladder with content were used in cleaner production, where 20% of respondents opined about its export, but 85% of them opined about disposal and 30% reported its uses in research purpose.

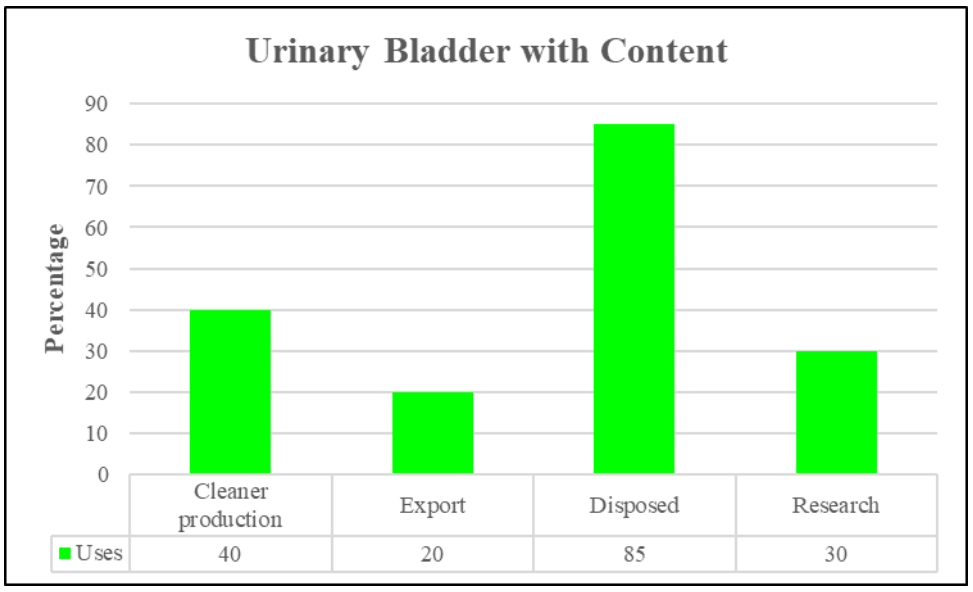



**Fig- 4.9:** Uses of urinary bladder with content as a by-product from large animal.

### 4.1.13 Utilization of Genital Organs

In this research, 20 respondents of slaughter-houses gave total 25 opinions about uses of genital organs (see Pic- 4.4). According to 25 opinions, (see Table 4.2 & Fig- 4.10) around 30% of respondents reported that genital organs (especially penis) were used in pharmaceutical industry, 85% of them reported about its export, but a few respondents (5%) mentioned about its disposal and another 5% of them observed its research purpose use.

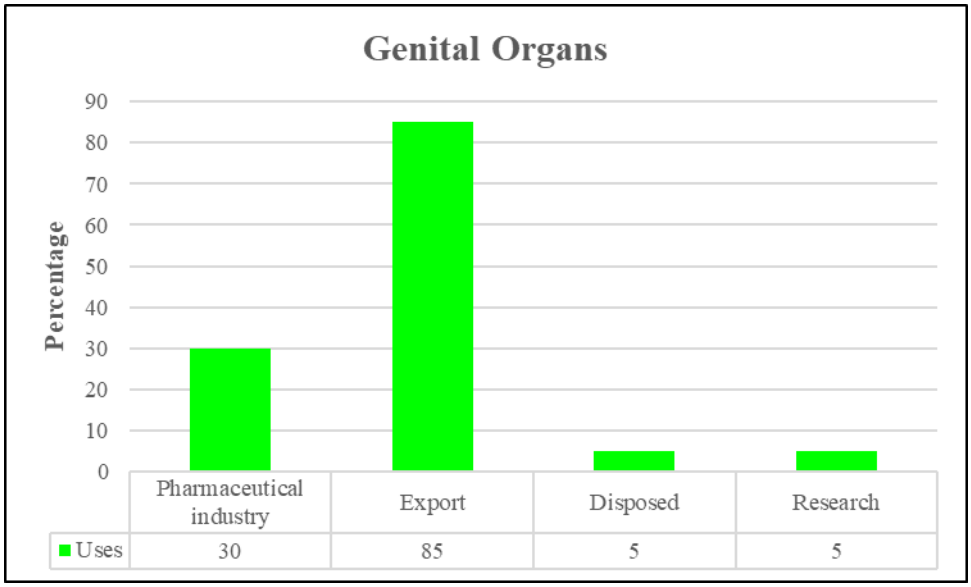



**Fig- 4.10:** Uses of genital organs as a by-product from large animal.

In case of male genital organs, Liu (2002) reported that tastes and penis was used as a human food in some countries and female genitalia was used in hormone production in pharmaceuticals. This survey is agreed with the tastes and penis use because it exported for human consumptions.

**Pic- 4.4:** Male genital organ (Penis) of cattle.

## 4.2 Utilization of By-products from Small Animal

In this section, the utilization or uses of small animal by-products is discussed below.

### 4.2.1 By-products Only Used for Human Food

In this research, it is found that some world wide known small animal by-products are only used for human consumption (see Table 4.3). Among 20 respondents of small animal slaughter-house, all gave their 20 (or 100%) opinion to agree with human consume. The list of this by-products given below-

**Table 4.3: The By-products of Small Animal Only Used for Human Consumption.**

| By-products | Uses | Frequency | Percentage |
|---|---|---|---|
| Head Trimmings | Human food | 20 | 100 |
| Brain | Human food | 20 | 100 |
| Tongue | Human food | 20 | 100 |
| Heart | Human food | 20 | 100 |
| Empty Stomach | Human food | 20 | 100 |
| Lung | Human food | 20 | 100 |
| Liver | Human food | 20 | 100 |
| Pancreas | Human food | 20 | 100 |
| Spleen | Human food | 20 | 100 |
| Kidney | Human food | 20 | 100 |
| Tail | Human food | 20 | 100 |

**# Multiple response**

According to Ockerman and Hansen (2000); head trimmings, brain, tongue, heart, stomach, lung, liver, pancreas, spleen, kidney and tail etc. were used as mainly human consumptions. Another point of view Liu (2002) who also

observed that the above by-products can be used as human food by cooking, grilling etc.

### 4.2.2 Utilization of Inedible By-products from Small Animals

Small animal inedible slaughterhouse and/or meat selling centers by-products were being utilized in various ways (see Table 4.3). The list of these type of by-products given below-

**Table 4.4: Existing uses of inedible slaughter-house by-products from large animals.**

| By-products | Uses | Frequency | Percentage |
|---|---|---|---|
| Hides and skin | Sold to businessman for tannery industry | 20 | 100 |
| Horn | Musical instrument industry | 8 | 40 |
| | Disposed | 19 | 95 |
| Blood | Fish feed | 19 | 95 |
| | Disposed | 8 | 40 |
| | Research | 6 | 30 |
| Intestines | Fish feed | 3 | 15 |
| | Pharmaceutical industry | 18 | 90 |
| | Export (China) | 12 | 60 |
| | Disposed | 12 | 60 |
| Stomach contents | Fertilizer | 15 | 75 |
| | Disposed | 17 | 85 |
| Gall bladder | Pharmaceutical industry | 17 | 85 |
| | Export (India) | 15 | 75 |
| | Disposed | 10 | 50 |
| Fats | Human food | 20 | 100 |

| By-products | Uses | Frequency | Percentage |
|---|---|---|---|
| | Soap industry | 20 | 100 |
| Feet and hooves | Human food | 20 | 100 |
| | Melamine industry | 6 | 30 |
| | Pharmaceutical industry | 9 | 45 |
| | Disposed | 1 | 5 |
| Bones | Melamine industry | 17 | 85 |
| | Pharmaceutical industry | 12 | 60 |
| | Disposed | 6 | 30 |
| Urinary bladder with contents | Cleaner production | 10 | 50 |
| | Disposed | 13 | 65 |
| | Export (China) | 8 | 40 |
| | Research | 6 | 30 |
| Genital organs | Export | 19 | 95 |
| | Disposed | 6 | 30 |

**# Multiple response**

### 4.2.3 Small Animals Skins from Slaughter-house

In case of small animal skins, all of 20 respondents giving 20 (100%) opinion that the skins were collected everyday by local collectors. After that it was sent to the tanneries of savar and Hajaribag. Where it is processed and make different finished lather goods which is agreed with the findings of Benjakul *et al.* (2009).

### 4.2.4 Utilization of Horns

In this research, 20 respondents of slaughter-houses gave total 27 opinions about uses of horns. According to 27 opinions, (see Table 4.4 & Fig- 4.11) around 40% of respondents mentioned that small animal horn (especially goat) was used in musical instrument producing industry and almost 95% of total respondents reported its disposal.

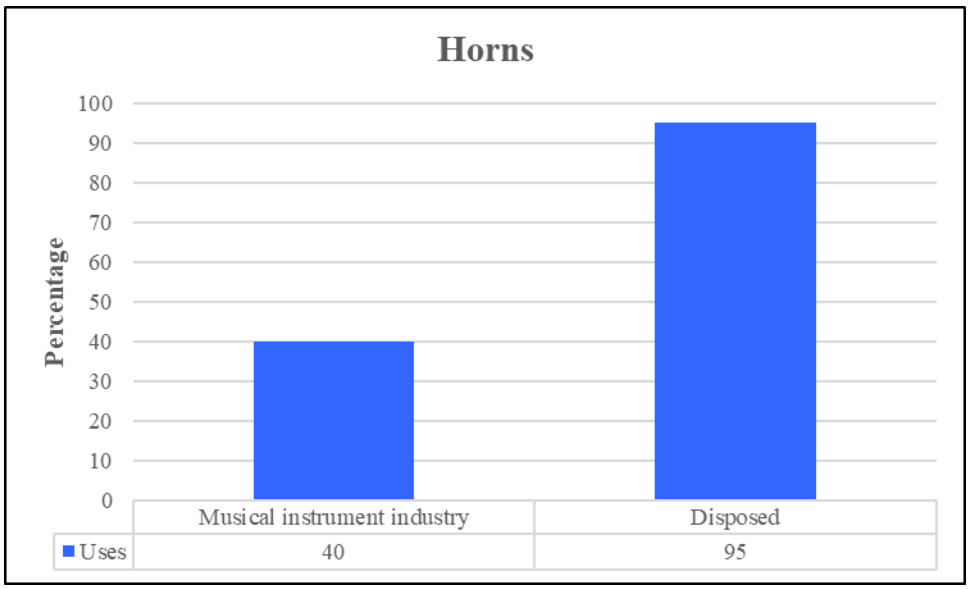



**Fig- 4.11:** Uses of horns as a by-product from small animal.

### 4.2.5 Utilization of Blood

In this research, 20 respondents of slaughter-houses gave total 33 opinions about uses of blood. According to 33 opinions, (see Table 4.4 & Fig- 4.12) blood was used as fish feed which was opined by 95% of the respondents whereas 40% and 30% respondents reported its disposal and use in research field, respectively.

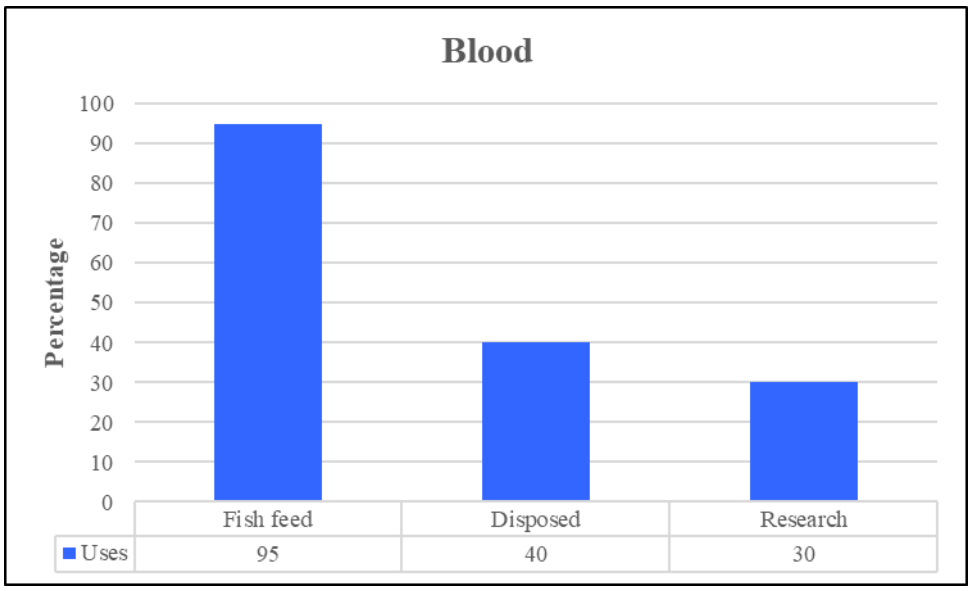



**Fig- 4.12:** Uses of blood as a by-product from small animal.

This research is agreed with the findings of Silva and Silvestre (2003). They observed that blood was used in food as an emulsifier, a stabilizer, a clarifier, a color additive, and as a nutritional component of animal feed. On the other hand, Liu (2002) observed blood of small animal used to produce black pudding, sausage, blood and barley loaf as human consumption. It is not agreed with the survey findings.

### 4.2.6 Utilization of Intestines

In this research, 20 respondents of slaughter-houses gave total 45 opinions about uses of intestines. According to 45 opinions, (see Table 4.4 & Fig- 4.13) it was estimated that 15% of respondents was used intestines as fish feed. Highest percentage (90%) of respondents reported the use of small animal intestines in pharmaceutical industry (catgut production) followed by export in china (60%) and disposal (60%).

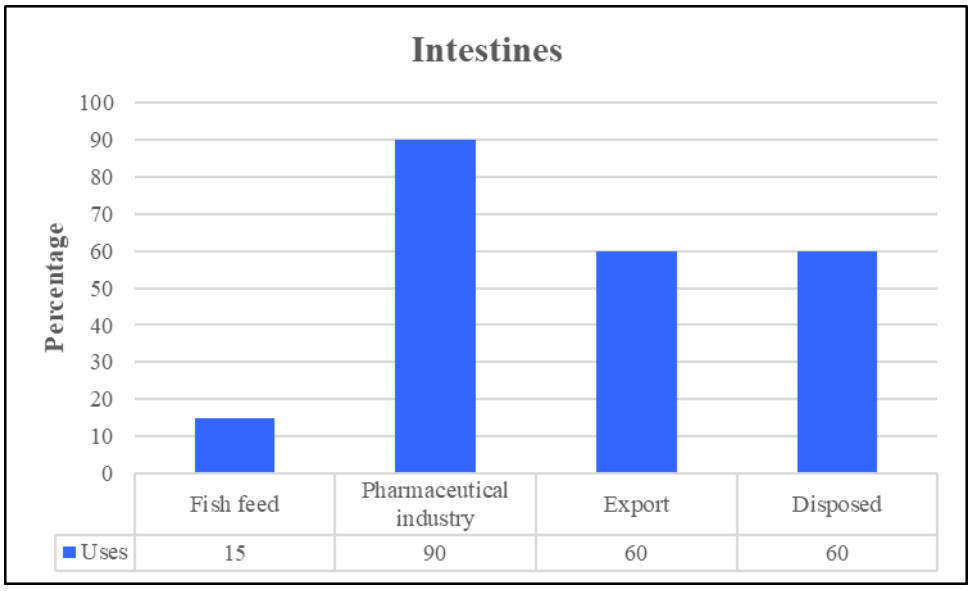



**Fig- 4.13:** Uses of intestines as a by-product from small animal.

According to Liu (2002), where it was showed that intestines was used for sausages casings in case of human consumption.

### 4.2.7 Utilization of Stomach Contents

In this research, 20 respondents of slaughter-houses gave total 32 opinions about uses of stomach contents (see Pic- 4.5). According to 32 opinions, (see Table 4.4 & Fig- 4.14) around three-forth (75%) of respondents reported that stomach contents of small animals was used as fertilizer followed by its disposal (85%).

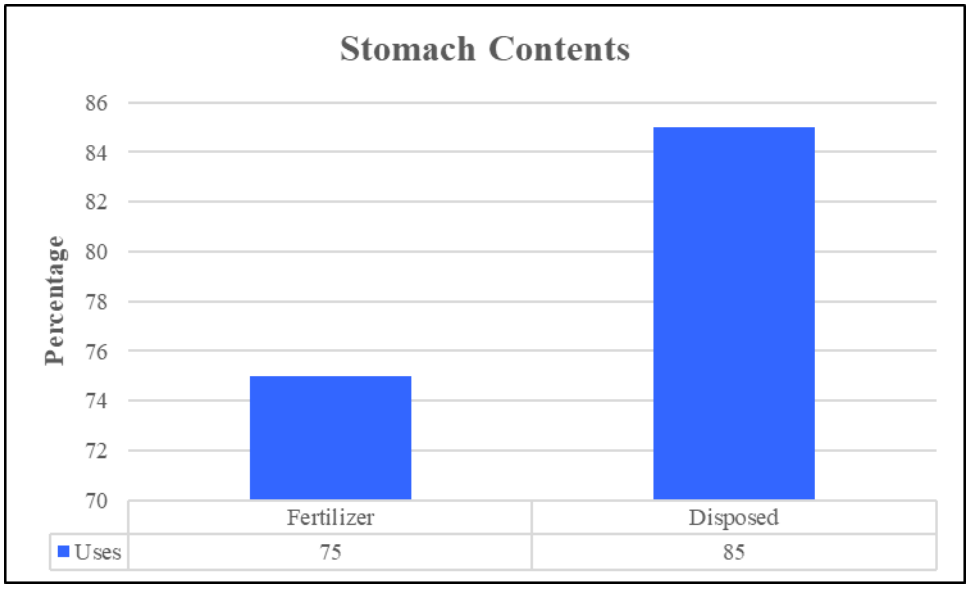



**Fig- 4.14:** Uses of stomach contents as a by-product from small animal.

Using of stomach contents using as fertilizer in this finding is agreed with that of Malav *et al.* (2018). They reported that, it will produce very good quality bio-manure which may be utilized as fertilizers for the agriculture land and gardens.

**Pic- 4.5:** Stomach contents of goat is collected for using as bio-manure.

### 4.2.8 Utilization of Gall Bladder

In this research, 20 respondents of slaughter-houses gave total 42 opinions about uses of gall bladder. According to 42 opinions, (see Table 4.4 & Fig- 4.15) it was mainly used in pharmaceutical industry (85%) followed by its export in India (75%). Finally, 50% of the respondents reported about its disposal.

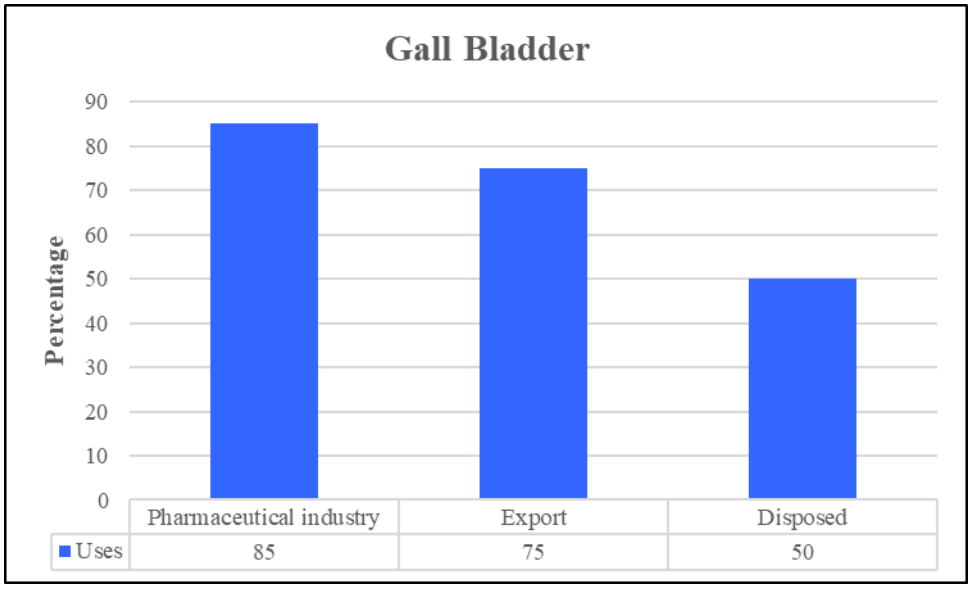



**Fig- 4.15:** Uses of gall bladder as a by-product from small animal.

In case of small animal's gall bladder, Jayathilakan *et al.* (2012) reported that bile consists of acids, pigments, proteins, cholesterol etc., and can be obtained from the gall bladder.

### 4.2.9 Utilization of Fats

In this research, 20 respondents of slaughter-houses gave total 40 opinions about uses of fats. According to 40 opinions, (see Table 4.4 & Fig- 4.16) small animals' fat was used as human food and in soap industry (100%).

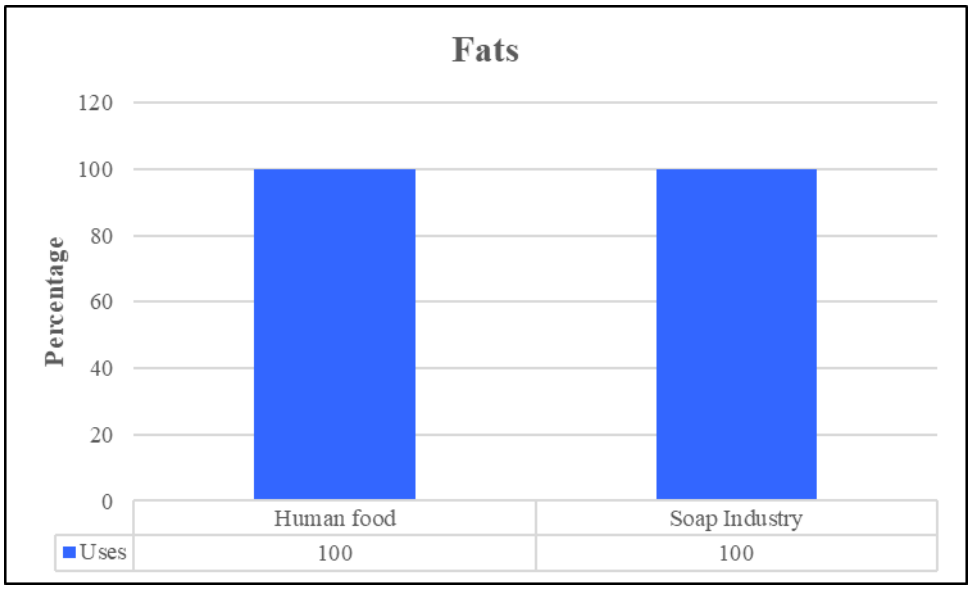



**Fig- 4.16:** Uses of fats as a by-product from small animal.

In case of Fats, Weiss (1983) reported that traditionally tallow and lard were used for deep frying. According to Chrysam (1985), the edible lards were used in sausages or emulsified products as human food it is agreed with human consumption of this survey findings.

### 4.2.10 Utilization of Feet and Hooves

In this research, 20 respondents of slaughter-houses gave total 36 opinions about uses of feet and hooves. According to 36 opinions, (see Table 4.4 & Fig- 4.17) around 100% of respondents informed that feet and hooves were used as human food, whereas 30% of them opined its use in melamine industry, 45% in pharmaceuticals industry (gelatin production) and a few (5%) informed its disposal.

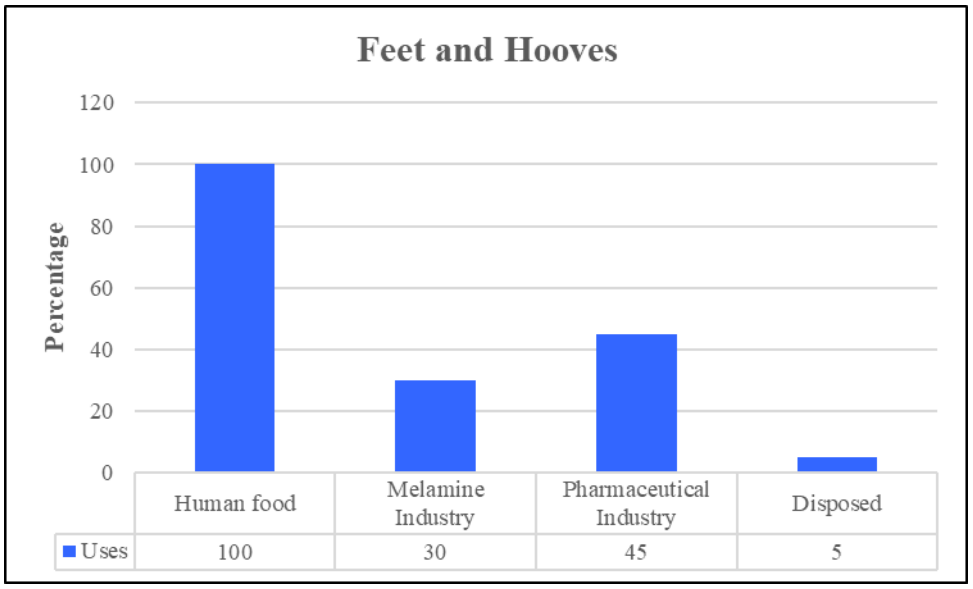



**Fig- 4.17:** Uses of feet and hooves as a by-product from small animal.

In case of feet and hoof, Liu (2002) reported that feet of small animals were used for producing jelly which is use as human food and gelatin in pharmaceuticals. This is agreed with survey findings.

### 4.2.11 Utilization of Bones

In this research, 20 respondents of slaughter-houses gave total 35 opinions about uses of bones. According to 35 opinions, (see Table 4.4 & Fig- 4.18) bones were used in melamine industry and pharmaceutical industry (gelatin production) that was opined by 85% and 60% of the respondents, respectively. 30% of respondents also informed about bones disposal.

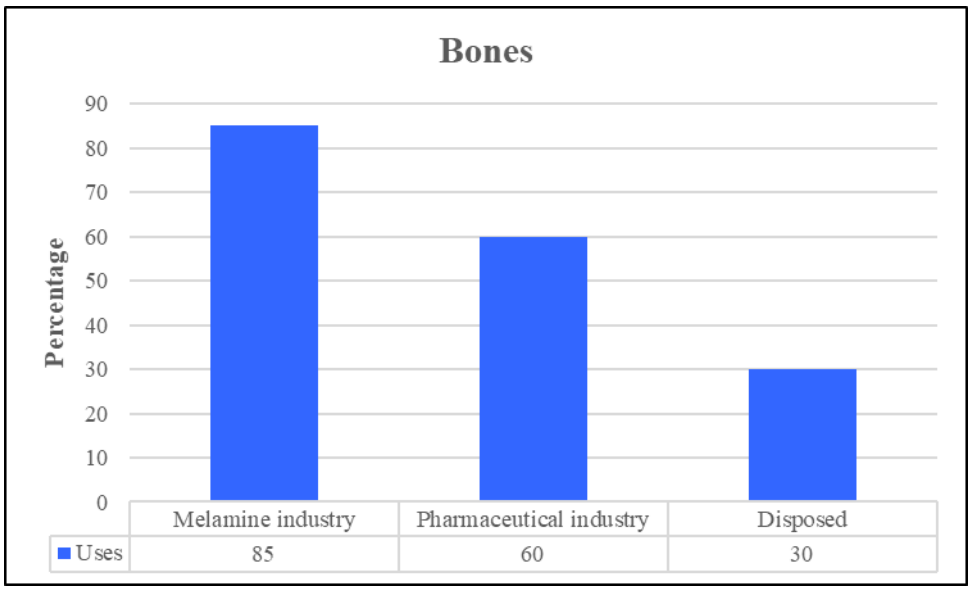



**Fig- 4.18:** Uses of bones as a by-product from small animal.

According to Liu (2002), small animal's bones were used in gelatin, soup, jelly, mechanically deboned tissue production. This survey agreed with gelatin production in pharmaceutical industry.

### 4.2.12 Utilization of Urinary Bladder with Content

In this research, 20 respondents of slaughter-houses gave total 37 opinions about uses of urinary organs. According to 37 opinions, (see Table 4.4 & Fig- 4.19) urinary bladder mainly its contents were used in cleaner production (50%) followed by export in china (40%) and in doing research (30%).

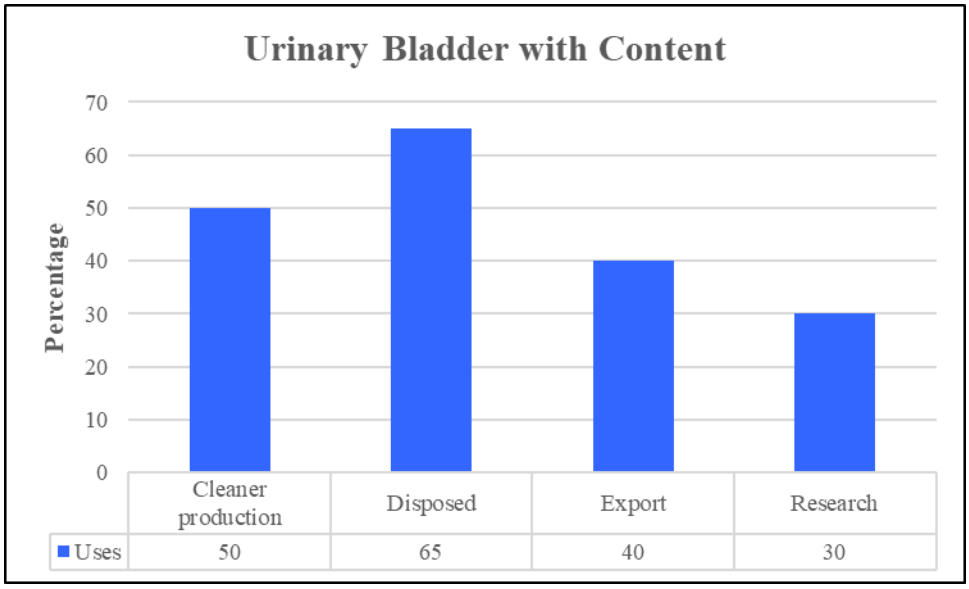



**Fig- 4.19:** Uses of urinary bladder with content as a by-product from small animal.

### 4.2.13 Utilization of Genital Organs

In this research, 20 respondents of slaughter-houses gave total 25 opinions about uses of genital organs (see Pic- 4.6). According to 25 opinions, (see Table 4.4 & Fig- 4.20) almost 95% of total respondents reported that genital organs (especially penis) were exported where 30% of total respondents also reported its disposal.

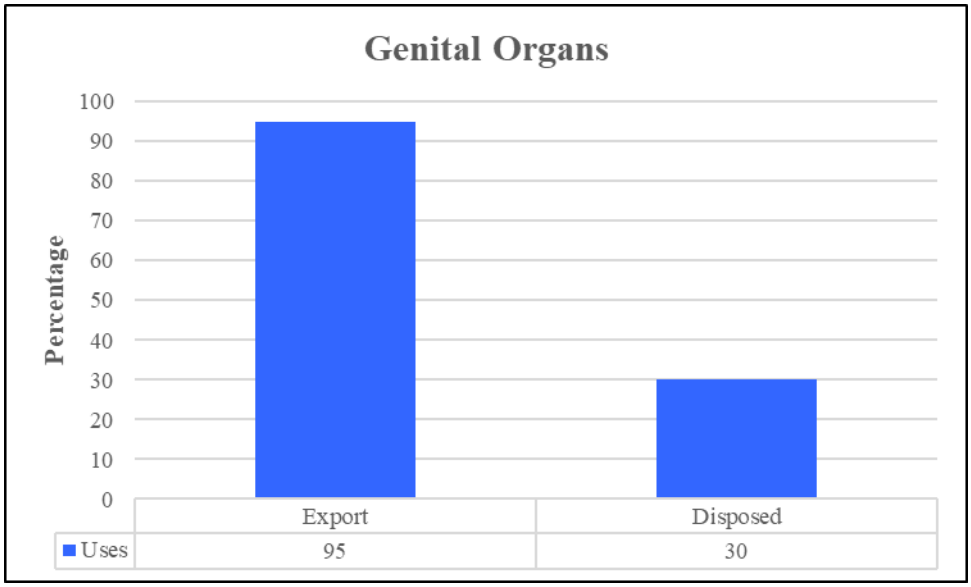



**Fig- 4.20:** Uses of genital organs as a by-product from small animal.

According to Liu (2002), tastes and penis was used as a human food in some countries and female genitalia was used in hormone production in pharmaceuticals. This survey is agreed with the tastes and penis use because it exported for human consumptions.

**Pic- 4.6:** Genital organs of goat (Female).

## 4.3 Utilization of Inedible By-products from Poultry

Current section of results and discussion, here three items were selected for survey study; these are, blood, intestines and feather wastes of poultry. Because other items of poultry carcass is considered for human consumption. Inedible by-products from poultry slaughterhouses and/or meat selling centres had multiple uses (see Table 4.5) found in the surveyed area were given below-

**Table 4.5: Existing uses of poultry slaughter-house and/or meat-selling centre by-products.**

| By-products | Uses | Frequency | Percentage |
|---|---|---|---|
| Blood | Fish feed | 9 | 45 |
| | Disposed | 16 | 80 |
| | Research | 3 | 15 |
| Intestines | Fish feed | 12 | 60 |
| | Disposed | 12 | 60 |
| Feather wastes | Fish feed | 9 | 45 |
| | Disposed | 19 | 95 |

**# Multiple response**

### 4.3.1 Utilization of Blood

In this research, 20 respondents of slaughter-houses gave total 28 opinions about uses of blood (see Pic- 4.7). According to 28 opinions, (see Table 4.5 & Fig-4.21) among the various uses of blood, 45% of the respondents reported using blood of poultry as fish feed, whereas a few number of respondents (15%) observed using blood for research purpose but 80% of the respondents informed that blood was disposed.

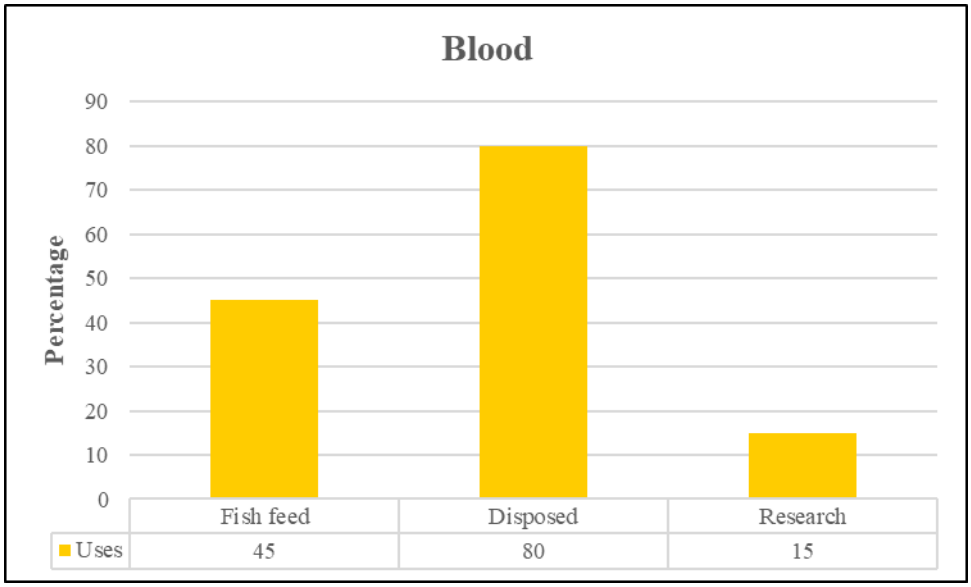



**Fig- 4.21:** Uses of blood as a by-product of poultry.

According to Sams (2001), blood meal can be produced by poultry blood which is used as animal feed ingredient, which is agreed with this research.

**Pic- 4.7:** Poultry blood is collected for using as fish feed.

### 4.3.2 Utilization of Intestines

In this research, 20 respondents of slaughter-houses gave total 24 opinions about uses of intestines. According to 24 opinions, (see Table 4.5 & Fig- 4.22) about 60% of the respondents opined using intestines of poultry as fish feed followed by disposed (60%).

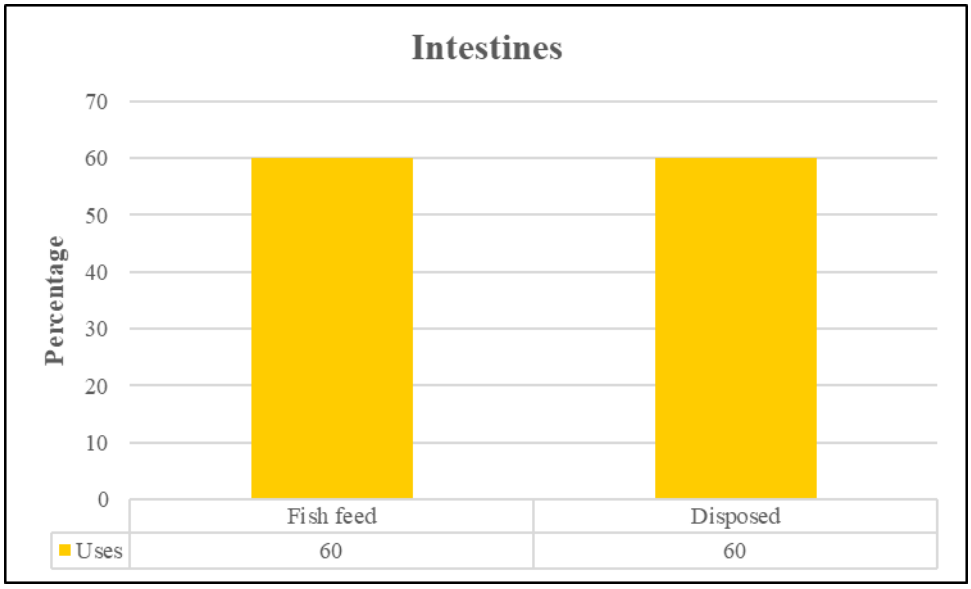



**Fig- 4.22:** Uses of intestines as a by-product of poultry.

In case of intestines of poultry, Sams (2001) showed that meat meal produced from intestines of poultry.

### 4.3.3 Utilization of Feather Wastes

In this research, 20 respondents of slaughter-houses gave total 28 opinions about uses of feather wastes (see Pic- 4.8). According to 28 opinions, (see Table 4.5 & Fig- 4.23) around 45% of the respondents reported that feather wastes of poultry were used as fish feed but rejected by 95%.

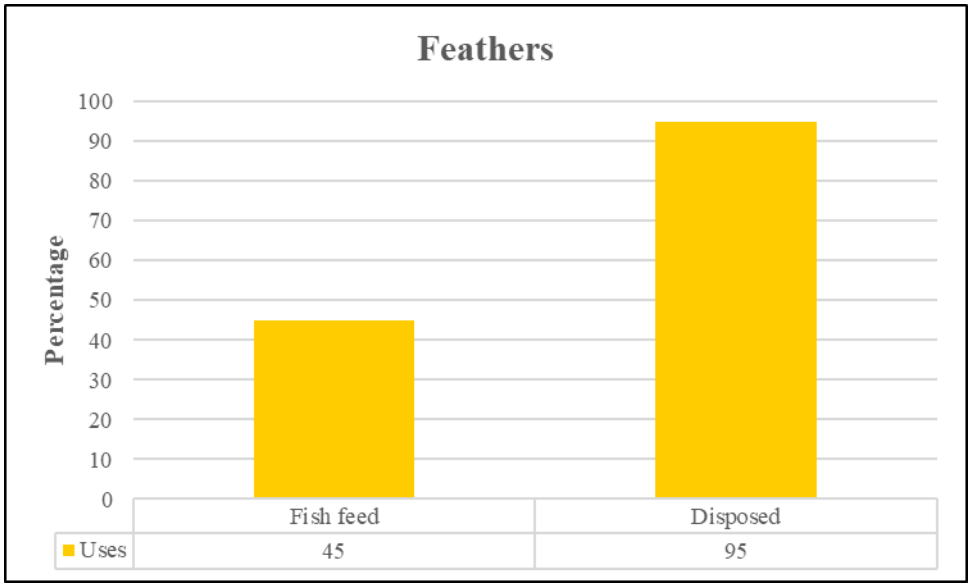



**Fig- 4.23:** Uses of feather wastes as a by-product of poultry.

In this case the experiment findings are disagreed with the findings of Ockerman and Hansen (2000); it reports, feathers are used for bedding, ornaments, sporting equipment and as filler in chemical fertilizer.

**Pic- 4.8:** Collection of feather wastes as a by-product of poultry.

## 4.4 A Brief Scenario of Hygiene of Slaughter-houses

This section is focused on the scenario of hygiene status of slaughter-houses.

### 4.4.1 Cleanliness and Drainage Condition of Slaughter-houses

In case of Cleanliness, 60 slaughter-houses are investigated physically and its includes all three types of slaughter-houses (large, small animal and poultry). It was found that (see Table 4.6 & Fig- 4.24) 1.67% of slaughter-houses were maintained good hygienic practices (see Pic- 4.9), 53.33% were maintained moderate and 45% were maintained poor hygienic practices. In case of drainage condition, it was found that 1.67% of these were maintained good drainage condition (see Pic- 4.10), 55% were maintained moderate condition and 43.33% were maintained poor drainage condition.

**Table 4.6: Cleanliness & drainage conditions of slaughter-houses.**

| Conditions | Frequency | | Percentage | |
|---|---|---|---|---|
| | **Cleanliness** | **Drainage** | **Cleanliness** | **Drainage** |
| **Good** | 1 | 1 | 1.67 | 1.67 |
| **Moderate** | 32 | 33 | 53.33 | 55 |
| **Poor** | 27 | 26 | 45 | 43.33 |
| **Totals** | **60** | **60** | **100** | **100** |

**Pic- 4.9:** Cleaning of floor of slaughter-house.

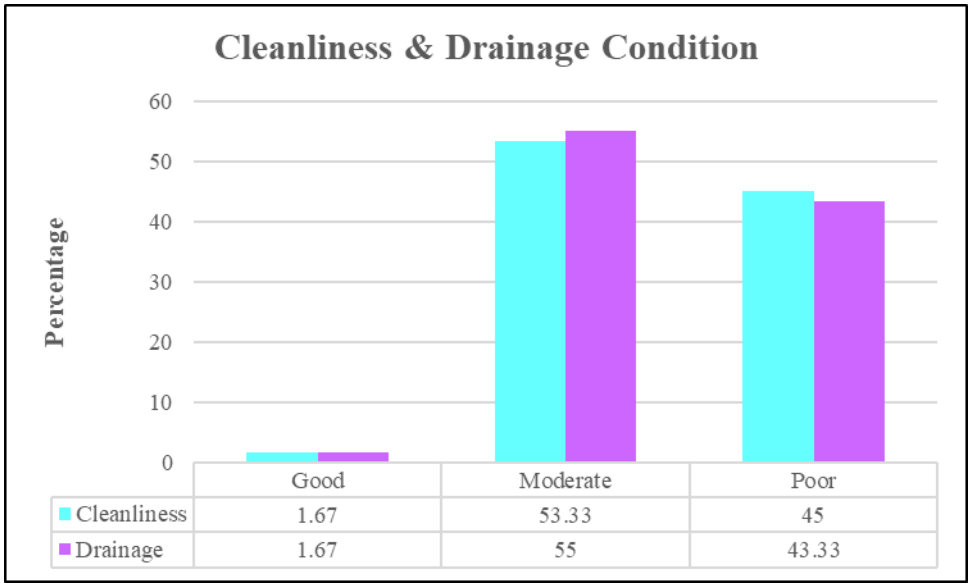



**Fig- 4.24:** Cleanliness and drainage condition of slaughter-house.

**Pic- 4.10:** Drainage system of a slaughter-house.

### 4.4.2 Source of Water Supply of Slaughter-houses

Water Supply (see Table 4.7 & Fig- 4.25) of 60 slaughter-houses were investigated physically and it includes all three types of slaughter-houses (large, small animal and poultry). It was found that 33.33% were used hose pipe, 5% of these were used tape water and 61.67% of these were used water containers as a source of water supply.

**Table 4.7: Different types of water supply of slaughter-houses.**

| Water Supply | Frequency | Percentage |
|---|---|---|
| **Hose Pipe** | 20 | 33.33 |
| **Tape Water** | 3 | 5 |
| **Water Containers** | 37 | 61.67 |
| **Totals** | **60** | **100** |

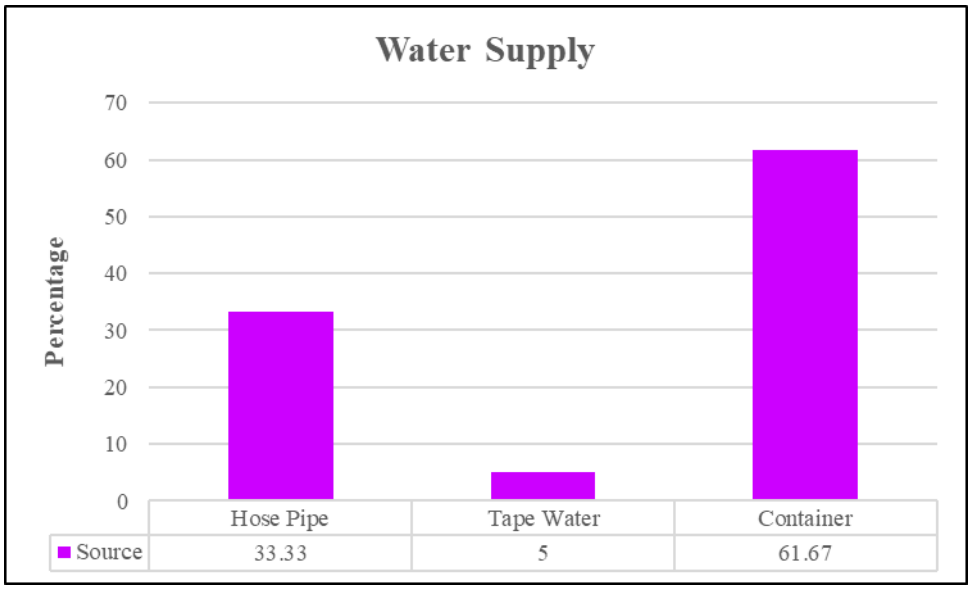
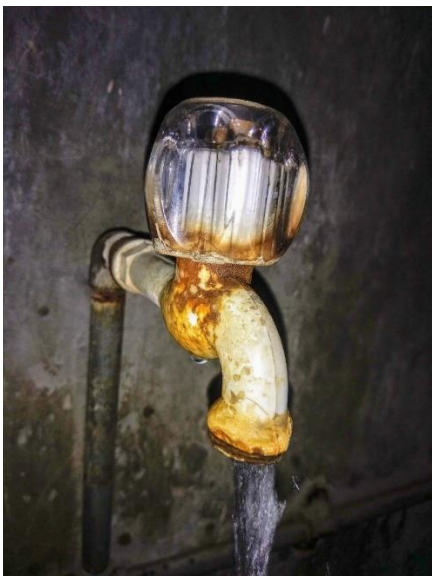



**Fig- 4.25:** Different type of water supply of slaughter-houses.



**Pic- 4.11:** Tape water of a slaughter-house.

# CHAPTER 05

# SUMMARY & CONCLUSION

# CHAPTER 05

# SUMMARY & CONCLUSION

The proper uses of animal by-products is sometimes act as a cushion to cover losses of the meat industry. So, this survey is try to figure out the present both known and unknown utilization of large animal (cattle, buffalo etc.), small animal (goat, sheep etc.) and poultry (chicken, duck etc.) by-products with its wastages. Furthermore, a short hygienics scenario of slaughter-house is trying to show in this study, because, usability of by-products from abattoir is largely depends on it cleanliness and waste managemental procedures.

In this research, utilization of by-products data was collected from total 60 slaughter-houses selected randomly from different parts of Dhaka city. Which consists of 20 large animal slaughter-houses, 20 small animal slaughter-houses and 20 poultry bird selling shops.

In case of large animal's slaughter-house by-products, head trimmings, brain, tongue, heart, stomach, lungs, liver, pancreas, spleen, kidney and tail etc. these items were found 100% use as human food. Large animal inedible slaughterhouse and/or meat selling centers by-products were being utilized in various ways. All the respondents (100%) opined that hides and skin were sold to middlemen who after curing sent them to the tannery for making leather. Different types of goods were being produced from horns like combs, buttons etc. Blood was used as fish and/or animal feed (80%) while 70% of the respondents left blood in the place where animals were slaughtered. It diminishes automatically but creates environmental pollution. About 20% respondents observed to use intestines as human food where 25% as fish feed, 50% in pharmaceutical industry (catgut production) but 70% opined exporting intestines in China. Approximately 70% respondents informed that stomach contents were used as fertilizer where 95% of respondents reported about its disposal. In case

of gall bladder, 65% respondents reported that pharmaceutical industry uses gall bladder where 75% opined about its export, 40% of total respondents mentioned its disposal and a few of respondents (10%) reported its use in research purposes. All the respondent (100%) reported using of fats in soap industry followed by as human food (75%) and in condensed milk industry (50%). All (100%) respondents reported that the large animal's feet and hooves were used as human food but there were other uses also such as pharmaceuticals industry (gelatin production), research. All (100%) respondents observed that bones were used in melamine industry, whereas one-forth of them (25%) also reported its uses in pharmaceutical industry and 15% of total respondents mentioned its disposal. The 40% of respondents informed that urinary bladder with content were used in cleaner production, where 20% of respondents opined about its export, but 85% of them opined about disposal and 30% reported its uses in research purpose. Around 30% of respondents reported that genital organs (especially penis) were used in pharmaceutical industry, 85% of them reported about its export, but a few respondents (5%) mentioned about its disposal and another 5% of them observed its research purpose use.

In case of small animal's slaughter-house by-products like head trimmings, brain, tongue, heart, stomach, lungs, liver, pancreas, spleen, kidney and tail etc. items were also found 100% use as human food as well as large animal. The results of the present study revealed that all the skins (100%) after collection were sent to tanneries of Savar or Hajaribag. Around 40% of respondents mentioned that small animal horn (especially goat) was used in musical instrument producing industry and almost 95% of total respondents reported its disposal. Blood was used as fish feed which was opined by 95% of the respondents whereas 40% and 30% respondents reported its disposal and use in research field, respectively. Highest percentage (90%) of respondents reported the use of small animal intestines in pharmaceutical industry (catgut production) followed by export in china (60%). Around three-forth (75%) of respondents reported that stomach contents of small animals was used as fertilizer followed by its disposal (85%). With regard to small animal's gall bladder, it was mainly

used in pharmaceutical industry (85%) followed by its export in India (75%). Small animals' fat was used as human food and in soap industry (100%).Weiss (1983) reported that traditionally tallow and lard were used for deep frying. Around 100% of respondents informed that feet and hooves were used as human food, whereas 30% of them opined its use in melamine industry, 45% in pharmaceuticals industry (gelatin production) and a few (5%) informed its disposal. Bones were used in melamine industry and pharmaceutical industry (gelatin production) that was opined by 85% and 60% of the respondents, respectively. Urinary bladder mainly its contents were used in cleaner production (50%) followed by export in china (40%) and in doing research (30%). Almost 95% of total respondents reported that genital organs (especially penis) were exported where 30% of total respondents also reported its disposal.

From this experiment it was found that poultry by-products like comb, shank, gizzard, head, skin etc. were used as human food only. Inedible by-products from poultry slaughterhouses and/or meat selling centres had multiple uses found in the surveyed area. Among the various uses of blood, 45% of the respondents reported using blood of poultry as fish feed, whereas a few number of respondents (15%) observed using blood for research purpose but 80% of the respondents informed that blood was disposed. About 60% of the respondents opined using intestines of poultry as fish feed followed by disposed (60%). Almost 45% of the respondents reported that feather wastes of poultry were used as fish feed but rejected by 95%.

In the hygiene point of view, total 60 slaughter-houses was investigated and interviewing the personnel carefully. Highest numbers (53.33%) of the slaughterhouses were found to maintain moderate level of cleanliness followed by poor (45%) and good (1.67%). In case of drainage condition, 55% of the slaughterhouses had moderate drainage condition followed by poor (43.33%) and good (1.67%) drainage condition. About 61.67% of the slaughterhouses used container whereas 33.33% and 5% used hose pipe and tape water as a source of water supply.

Furthermore, although the development of synthetic substitutes in the middle of the 20th century decreased the value of many animal by-products, but their importance in the pet food industry and the medical/veterinary field are contributing to an increase in by-product values in recent years. Utilization of these by-products as fertilizer contributes a lot in organic farming and could reduce our dependence on synthetic fertilizers. Utilization of by-products needs become significantly stronger due to competition. This is important because increasing profit and decreasing the cost is required in the future for the meat industry to remain viable. These contributions and efforts are also necessary for the meat industries to change in an innovative manner and to widen the opportunities to utilize by-products.

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# APPENDICES

# APPENDICES

## SHER-E-BANGLA AGRICULTURAL UNIVERSITY

Sher-e-Bangla Nagar, Dhaka-1207

Department of Animal Production & Management

**Experiment Title**

Study on Livestock By-products & Waste Materials Management at Some Selected Slaughter-houses in Dhaka City

**Questionnaire**

**A. Serial No. of Questionnaire**

| | | |
|---|---|---|
| ☐ Large Animal (Cattle, Buffalo) | **L** | |
| ☐ Small Animal (Goat, Sheep) | **S** | |
| ☐ Poultry Birds (Chicken, Duck & Others) | **P** | |

**B. Address of Slaughterhouse**

| **Area** | **Market Name** (if any) |
|---|---|
| | |

**C. Respondents Information of Slaughterhouse**

| **Name** | **Contact No.** (if any) |
|---|---|
| | |

**D. General Data of Slaughterhouse**

| No. | Information Criteria | Cattle | Buffalo | Goat | Sheep | Chicken | Duck | Other |
|---|---|---|---|---|---|---|---|---|
| 01 | No. of animals slaughtered/market day | | | | | | | |
| 02 | Sources of animals for slaughter | | | | | | | |
| 03 | Hygienic Condition | □ Excellent | | □ Good | | □ Moderate | | □ Poor |
| 04 | Drainage Condition | □ Excellent | | □ Good | | □ Moderate | | □ Poor |
| 05 | Water Supply | □ Hose Pipe | | □ Tape Water | | □ Container | | □ Other |

**F. Date & Signature**

| **Signature of the Researcher** | | **Signature of the Research Supervisor** | |
|---|---|---|---|
| **Md. Shefath Abdulla**<br>MS (Fellow) in Animal Science<br>Sher-e-Bangla Agricultural University | ..... | **Dr. Md. Saiful Islam**<br>Associate Professor<br>Department of APMA<br>Sher-e-Bangla Agricultural University | ..... |

**G. Slaughterhouse By-products of □ Large Animal / □ Small Animal / □ Poultry Birds***

| By-products | By-products Common Use | | | | | Other Use |
|---|---|---|---|---|---|---|
| | Food | Feed | Industrial | Export | Disposal | |
| 01. Horn | □ | □ | □ | □ | □ | □ |
| 02. Cheek and Head Trimmings | □ | □ | □ | □ | □ | □ |
| 03. Brain | □ | □ | □ | □ | □ | □ |
| 04. Tongue | □ | □ | □ | □ | □ | □ |
| 05. Heart | □ | □ | □ | □ | □ | □ |
| 06. Blood* | □ | □ | □ | □ | □ | □ |
| 07. Stomach | □ | □ | □ | □ | □ | □ |
| 08. Intestines* | □ | □ | □ | □ | □ | □ |
| 09. Stomach and Intestinal Content | □ | □ | □ | □ | □ | □ |
| 10. Lung | □ | □ | □ | □ | □ | □ |
| 11. Liver | □ | □ | □ | □ | □ | □ |
| 12. Gall Bladder | □ | □ | □ | □ | □ | □ |
| 13. Pancreas | □ | □ | □ | □ | □ | □ |
| 14. Spleen | □ | □ | □ | □ | □ | □ |
| 15. Kidney | □ | □ | □ | □ | □ | □ |
| 16. Fat | □ | □ | □ | □ | □ | □ |
| 17. Feet and Hoof | □ | □ | □ | □ | □ | □ |
| 18. Tail | □ | □ | □ | □ | □ | □ |
| 19. Bones | □ | □ | □ | □ | □ | □ |
| 20. Urinary Organs | □ | □ | □ | □ | □ | □ |
| 21. Genital Organs | □ | □ | □ | □ | □ | □ |
| 22. Leather | □ | □ | □ | □ | □ | □ |
| 23. Feather Waste* | □ | □ | □ | □ | □ | □ |
| 24. Other* | □ | □ | □ | □ | □ | □ |

**H. Biggest Challenge for Waste Management**

| |
|---|
| |

**I. Current Solution**

| |
|---|
| |

**J. Additional Comments (if any)**

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| |