**LM-402**

**Principles of Meat Production**

**Animal cleanliness is an important factor in hygienic meat processing**

A hygienic treatment of meat is highly important for the final quality of the meat. The used animals need to be kept clean before they reach the processing stage. The cleanliness of the animals is a major source of contamination. Failures in slaughter hygiene, meat handling or transportation, meat cutting, the hygiene of by-products in the process and additives in the meat can contribute to quality losses, and moreover the final processed meat products will deteriorate. Hygiene is a very important factor in minimizing hazards and risks as much as possible since contaminated raw meat is unfit for further processing.

A lower level of hygiene in the meat production will have an impact on the final products since end products which are made from unhygienic raw meat are tasteless, unattractive in color, untypical in taste and will have a shorter shelf life. Furthermore, unhygienic meat production will always increase the risk of food poisoning microorganisms – these small microorganisms can pose a significant public health hazard. In regard to living animals, the muscle meat is as good as sterile, but other parts of the animals contain a massive number of bacteria, such as their hooves and intestines. These bacteria are transferred to the carcass and contaminate the meat during the slaughter process, if the slaughter does not maintain good hygiene. But the bacterial contamination of meat does not stop after slaughtering – it is ongoing both during meat cutting and meat processing. To keep the meat unspoiled from bacteria, keep the meat cooled down (-1°C – +4°C) or frozen (below 1°C). Most bacteria will be able to grow in the range between 30°C and 37°C.

**How can certain types of hygienic controls reduce the risk of contamination?**

There are different control and monitoring systems in food plants with the goal of minimizing or eliminating health hazards to consumers as well as avoiding spoilage meat.  There are different work procedures surrounding the slaughtering of the creature that they should be aware of and follow. The following section will address how these procedures can actively support the reduction of contamination risks.

The slaughterhouses must follow some general hygienic rules and apply recognized hygienic principles, as well as regulations and laws issued by the authorities. Some of the general hygienic rules include that all staff receive regular training on hygiene requirements, and that all raw materials must meet hygiene quality standards etc. Moreover, the slaughterhouses must prevent health hazards before or during the production of meat to counteract suspected or emerging health risks.

**he right production equipment is designed to maximize a hygienic meat production**

A careful instruction and implementation of the best meat practices are important when designing a hygienic meat production. Further, the hygiene needs to be built into the design of the production or equipment facility. Even the tiniest details or components of the facilities must be hygienic, [for instance the stainless steel castors, the conveyor belts or the side guides for conveyor belts in the processing equipment](https://www.nhkmachineryparts.com/product-line/category/44-stainless-caster-noise-reducing-caster.html). If the components are hygienic and implemented correctly in the production plant, the entire meat production will be of a great quality.

Meat Spoilage Mechanisms and Preservation Techniques

CAUSES OF MEAT SPOILAGE Preslaughter handling of livestock and postslaughter handling of meat play an important part in deterioration of meat quality. The glycogen content of animal muscles is reduced when the animal is exposed to pre-slaughter stress which changes the pH of the meat, to higher or lower levels, depending on the production level of lactic acid (Miller, 2002; Chambers and Grandin, 2001; Rahman, 1999a). Lactic acid is produced due to the breakdown of glycogen content of animal muscles via an anaerobic glycolytic pathway as shown in Fig. 1 (Rahman, 1999a). Higher levels of pH (6.4-6.8) result in Dark, Firm and Dry (DFD) meat. Long term stress causes DFD meat which has a shorter shelf life (Miller, 2002; Chambers and Grandin, 2001). Sever short term stress results in a Pale, Soft and Exudative (PSE) meat. PSE meat has a pH lower than normal ultimate value of 6.2 which is responsible for the breakdown of proteins, providing a favorable medium for the growth of bacteria (Miller, 2002; Chambers and Grandin, 2001; Rahman, 1999a). Figure 2 shows the texture and color of the DFD, PSE and normal meat. The factors affecting the shelf life of meat and meat products are summarized in Table 2. There are three main mechanisms for meat and meat products spoilage after slaughtering and during processing and storage: (a) microbial spoilage, (b) lipid oxidation and (c) autolytic enzymatic spoilage.

: Factors affecting shelf life of meat (Rahman, 1999a) Type Factors Intrinsic Type of animal (bovine, porcine) Breed and fed regime Age of animal at time of slaughter Initial microflora Chemical properties (peroxide value, pH, acidity, redox potential) Availability of oxygen Processing conditions and control Hygiene (standard of personnel and equipment cleaning) Extrinsic Quality- management system Temperature control Packing system (materials, equipment, gases) Storage types

Microbial spoilage: Meat and meat products provide excellent growth media for a variety of microflora (bacteria, yeasts and molds) some of which are pathogens (Jay et al., 2005). The intestinal tract and the skin of the animal are the main sources of these microorganisms. The composition of microflora in meat depends on various factors: (a) preslaughter husbandry practices (free range Vs intensive rearing), (b) age of the animal at the time of slaughtering, (c) handling during slaughtering, evisceration and processing, (d) temperature controls during slaughtering, processing and distribution (e) preservation methods, (f) type of packaging and (g) handling and storage by consumer

Hayes et al. (2003) found Enterococcus spp. to be the most dominant bacteria on 971 of the 981 samples (99%) of all meat (chicken, turkey, pork and beef) in the state of Iowa. About 97% of pork samples contained Enterococci with 54% of isolates identified as Enterococcus faecalis and 38% as Enterococcus faecium, 3.4% as Enterococcus hirae, 2.4% as Enterococcus durans, 0.8% as Enterococcus casseliflavus, 0.4% Enterococcus gallinarum and 1% as unindentified. All of beef samples contained enterococci with 65% of isolates identified as Enterococcus faecium, 17% as Enterococcus faecalis, 14% as Enterococcus hirae, 2% as Enterococcus durans 0.7%, as Enterococcus casseliflavus, 0.4% Enterococcus gallinarum and 0.9% as unindentified. Cerveny et al. (2009) stated that storage conditions affect the type of microbes found in meat and meat products. They reported that Pseudomonas spp., Moraxella spp., Psychrobacter spp., Acinetobacter spp. and Gram-negative psychrotrophic members of the family. Enterobacteriaceae are frequently present on refrigerated meat product. They also indicated that psychrotrophic lactic acid bacteria, Enterococci, Micrococci and yeasts are predominately found in raw, salted-cured products such as corned beef, uncooked hams and bacon due to their resistance to curing salts.

Lipid oxidation: Autoxidation of lipids and the production of free radicals are natural processes which affect fatty acids and lead to oxidative deterioration of meat and off-flavours development (Gray, 1978; Pearson et al., 1983; Simitzis and Deligeorgis, 2010). After slaughtering of animals, the fatty acids in tissues undergo oxidation when the blood circulation stops and metabolic processes are blocked (Gray and Pearson, 1994; Linares et al., 2007). Lipid oxidation is the reaction of oxygen with double bonds of fatty acids (Hultin, 1994). It involves three stage free radical mechanisms: initiation, propagation and termination

Autolytic enzymatic spoilage: Enzymatic actions are natural process in the muscle cells of the animals after they have been slaughtered and are the leading cause of meat deterioration. The enzymes have the ability to combine chemically with other organic compounds and work as catalysts for chemical reactions that finally end up in meat self deterioration (Tauro et al., 1986). In the autolysis process, the complex compounds (carbohydrates, fats and protein) of the tissues are broken down into simpler ones resulting in softening and greenish discoloration of the meat. These autolysis changes include proteolysis and fat hydrolysis which are prerequisite for microbial decomposition. Excessive autolysis is termed “souring” (Tauro et al., 1986). Postmortem breakdown of polypeptides are the result of tissue proteases and is responsible for flavour and is textural changes in meat (Toldra and Flores, 2000). Post mortem aging of red meat results in the tenderization process (Huss, 1995). Post-mortem autolysis takes place in all animal tissues but at different rates in different organs, quicker in glandular tissue such as the liver and slower in striated muscle (Fearon and Foster, 1922). The enzymes calpains, cathepsins and aminopeptidases are found to be responsible for the post mortem autolysis of meat through digestion of the z- line proteins of the myofibril (O’Halloran et al., 1997; Huss, 1995). Among these enzymes, calpains has been described as a preliminary contributor to the proteolytic tenderization process of meat. Cathepsins were, also, found to contribute to tenderization at low pH. The mechanism of calpain catalyzed meat proteolysis is shown in Fig. 3 (O’Halloran et al., 1997). Proteolytic enzymes are active at low temperatures (5°C) which lead to deterioration of meat quality due to growth of microbes and biogenic amines production (Kuwahara and Osako, 2003). PRESERVATION OF MEAT Meat preservation became necessary for transporting meat for long distances without spoiling of texture, colour and nutritional value after the development and rapid growth of super markets (Nychas et al., 2008). The aims of preservation methods are: (a) to inhibit the microbial spoilage and (b) to minimize the oxidation and enzymatic spoilage. Traditional methods of meat preservation such as drying, smoking, brining, fermentation, refrigeration and canning have been replaced by new preservation techniques such as chemical, biopreservative and nonthermal techniques (Zhou et al., 2010). Current meat preservation methods are broadly categorized into three methods (a) controlling temperature (b) controlling water activity (c) use of chemical or biopreservatives (Zhou et al., 2010). A combination of these preservation techniques can be used to diminish the process of spoilage (Bagamboula et al., 2004). Low temperature methods: The basic aim of cooling techniques is to slow or limit the spoilage rate as temperature below the optimal range can inhibit the microbial growth (Cassens, 1994). Low temperature methods of storage are used in three levels: (a) chilling (b) freezing and (c) superchilling. All these levels help t(b) freezing and (c) superchilling. All these levels help to inhibit or completely stop bacterial growth (Zhou et al., 2010). However, the growth of psychrophilic group of bacteria, yeasts and molds is not prevented by all levels of refrigeration (Neumeyer et al., 1997) and both enzymatic and non enzymatic changes will continue at a much slower rate (Berkel et al. 2004). Chilling: Chilling is employed at slaughtering plants immediately after slaughtering and during transport and storage. It is necessary to reduce the temperature of carcass immediately after evisceration to 4°C within 4 h of slaughtering (USDC, 1995). Chilling is critical for meat hygiene, safety, shelf life, appearance and nutritional quality

It is employed by two methods: (a) immersion chilling, in which the product is immersed in chilled (0- 4°C) water and (b) air chilling, in which the carcasses are misted with water in a room with circulating chilled air (Carroll and Alvarado, 2008). Carcass surface temperature is reduced at faster rate by air chilling which improves carcass drying and minimizes microbial spoilage (Ockerman and Basu, 2004). The microbial quality of the air-chilled product is better than that of a water-chilled product (Barbut, 2002; Sanchez et al., 2002). Young and Smith (2004) reported that air-chilled carcasses lost 0.68% of their postslaughter weight in storage prior to cutting but lost no more during cutting or postcutting storage. On other hand water chilled carcasses absorbed 11.7% moisture in the chillers, of which 4.72% was lost within 24 h of intact carcass storage, 0.98% was lost during cutting and 2.10% was lost during storage resulting in 3.9% net water retention. Tuncer and Sireli (2008) studied microbial growth on broiler carcasses stored at 0, 4 and 7°C for 14 days after air- and water-chilling. Samples were taken on days 0, 4, 8, 10 and 14 of storage and analyzed for total bacterial count and Pseudomonas spp., Enterobacteriaceae, yeasts and molds. The results indicated that the air-chilling procedure was safer than the water-chilling procedure with respect to microbiological count. With regard to shelf-life, storage at 0°C was better than storage at 4 and 7°C in preventing spoilage. Zhou et al. (2010) stated that rapid chilling also helps to prevent denaturing of proteins which may lead to bacterial attack as they are more susceptible to denaturated protein than native protein. On the other hand, cold-shortening and toughening may result from ultra-rapid chilling of pre-rigour meat (Ockerman and Basu, 2004). Saide-Albornoz et al. (1995) found several foodborne pathogens in pork during processing at 3 slaughtering plants. They reported that Salmonella spp., Yersinia enterocolitica decreased, Staphylococcus and S. aureus increased while Listeria monocytogenes remained same during 24 h of chilled storage. Epling et al. (1993) examined pork carcasses immediately after slaughtering and then after 20 h of chilling at 4°C and found that Campylobacter coli caused contamination and 29% of Salmonella was not affected by chilling. Freezing: Freezing is an excellent method of keeping the original characteristics of fresh meat. Meat contains about 50-75% by weight water, depending on the species, and the process of freezing converts most of water into ice (Heinz and Hautzinger, 2007). Meat freezing phenomenon is fast and almost 75% of tissue fluid freezes at -5°C. The freezing rate is increased with decreases in temperature, almost 98% of water freezes at -20°C and complete crystal formation occurs at - 65°C (Rosmini et al., 2004). However, more than 10% of muscle bound water (chemically bound to specific sites such as carbonyl and amino group of proteins and hydrogen bonding) will not freeze (Rosmini et al., 2004; Garthwaite, 1997). Freezing rate (slow and fast) affects the quality of frozen meat significantly. Fast freezing produce better quality meat than slow freezing. During slow freezing formation of large ice crystals damages the cell and results in protein denaturation. Concentration of enzymes and presence of other compounds govern the process of protein denaturation (Rahman, 1999b; Rahelic et al., 1985). The preservation capacity of frozen meat is limited because the physical, chemical or biochemical reactions that take place in animal tissues after slaughtering do not stop absolutely after cold treatment (Rosmini et al., 2004). Microbial growth stops at -12°C and total inhibition of the cellular metabolism in animal tissues occurs below -18°C (Perez-Chabela and MateoOyague, 2004). Complete quality changes of meat can be prevented at a temperature of-55°C (Hansen et al., 2004). However, enzymatic reactions, oxidative rancidity and ice crystallisation will still play an important part in spoilage (Zhao et al., 2010). During freezing, about 60% of the viable microbial population dies but the remaining population gradually increases during frozen storage

Super chilling: Super chilling is a different concept than refrigeration and freezing and it has the potential to reduce storage and transport costs (Reynolds, 2007). Super-chilling refers to the temperature zone below its initial freezing point (1-2°C) but where ice crystals are not generated. In this process, instead of adding external ice to the food product, part of the internal water is frozen and works as a refrigeration reservoir, ensuring its refrigeration during distribution and transportation (Bahuaud et al., 2008) Respiratory metabolism and aging process are repressed but cell activity is maintained during the storage period of superchilling (Ando et al., 2005). This method is mainly used for preservation of fish (Bahuaud et al., 2008; Ando et al., 2005; Hansen et al., 2004; Chang et al., 1998) and poultry (Frperc, 2004). The main advantage of this method of preservation over traditional methods is that it increases the shelf life of meat for upto 4 times (Magnussen et al., 2008). Although most microbial activities are stopped or inhibited, chemical and physical changes may progress and in some cases are even accelerate (Magnussen et al., 2008). James et al., (2006) reported that to eliminate the surface freezing of the chicken carcass during chilling, they were water chilled after eviscerated then kept at -15°C in an air freezer for approximately 30 min and stored and distributed at 1-2 °C.

Sodium chloride: NaCl in growth media or foods can be a source of osmotic stress by decreasing water activity (Doyle, 1999). Borch et al. (1996) stated that salt-sensitive microorganisms, such as Pseudomonas spp. and Eriterobacferiuceae, did not grew in meat when the water activity (aW) was reduced from 0.99 to 0.97 with the addition of 4% sodium chloride. However, salt tolerant microorganisms such as lactic acid bacteria and yeasts could grow at that level of water activity. Chawla et al. (2006) reported a reduction in water activity of fresh lamb intestine from 0.95 to 0.80 with the addition of 10% (w/w) of sodium chloride. Bennani et al. (2000) reported that Enterobactereaceae species were eliminated in kaddid (dry-salted meat product) as a result of reduced water activity (aw) below 0.9 after 3 days due to the subsequent actions of salting, spicing and drying. Domowe (2010) reported that adding 3% salt reduced initial water activity level to 0.97 in sausages which was further reduced to 0.95 through the 6 day drying process and as a result pathogenic bacteria (Salmonella, Bacillus) stopped multiplying. Wijnker et al. (2006) studied antimicrobial properties of salt (NaCl) for the preservation of natural sheep casings at different water activity (aw) levels and found the activities of most spoilage and pathogenic bacteria (Escherichia coli, Salmonella typhimurium, Listeria monocytogenes, Staphylococcus aureus and E. coli O157:H7) stopped when an aw of 0.89 was reached

Use of Novel Feed Additives in Beef Cattle Production

Evaluating feed additives Factors that should be considered when evaluating the potential addition of a feed additives to the ration are anticipated response, economic return, available research, and field responses (Hutjens, 1991). Feed additives act in many different ways – some affect the ruminal environment, others impact post-ruminal digestion and metabolism; and still others act to depress subclinical problems (acidosis, liver abcesses, heat stress) in which there are no visible disease symptoms or to improve immune response. Examples of ruminal effects include stabilization of the rumen environment and pH, stimulation of rumen microbial growth, improved nutrient digestibility (fiber, starch, etc…), mitigation of methane production, or increased rate of passage or flow of nutrients out of the rumen. Post-ruminally, nutrient digestion may be increased in the small intestine, intestinal absorption and liver metabolism may be increased, and insulin sensitivity may be improved. Benefits to health, safety, and quality of meat products may also result from use of feed additives. Ultimately, the decision whether or not to use a feed additive largely comes down to profitability. Do improvements in ruminal and post-ruminal metabolism have a measurable impact on the primary influencing factors of profitability – average daily gain, feed intake, and feed efficiency?

If average daily gain is the measurable response, a breakeven can be calculated based on expected response and anticipated live cattle prices (Table 1). For example an additive that costs 10 cents per day must increase average daily gain in every steer by 0.10 lb/d to recover the added expense. As live cattle price increases, the gain required to recover costs decreases. A similar breakeven can be calculated for dry matter intake. Another consideration when evaluating feed additives is duration of effectiveness. If the additive is not strategically used only in populations of cattle that will respond favorably, for example receiving cattle, responding animals must cover the cost for non-responding cattle (Hutjens, 1991)

accumulation of hydrogen and other compounds that are not energy substrates for ruminants and often results in decreased fermentation, fiber degradability, feed intake, and animal productivity

Probiotics/direct fed microbials The term ‘probiotic’ has been used to describe viable microbial cultures, culture extracts, enzyme preparations, or various combinations of the above (Yoon and Stern, 1995). Therefore, the U.S. FDA has required feed manufacturers to use the term “direct-fed microbial“ (DFM) instead of probiotic (Miles and Bootwalla, 1989) and has narrowed the definition to “a source of live, naturally occurring microorganisms” (Yoon and Stern, 1995). Microorganisms used as DFM for ruminants include viable cultures of bacteria and/or yeast. The bacterial DFM strains may be classified as lactic acid producing bacteria, lactic acid utilizing bacteria, or other microorganisms including Lactobacillus, Propionibacterium, Bifidobacterium, Enterococcus, Streptococcus, and Bacillus, and strains of Megasphaera elsdenii and Prevotella bryantii. The most commonly used yeast preparations are from Aspergillus oryzae or Saccharomyces cerevisiae. Direct fed microbials are generally supplied as dried preparations of live cells with their spent growth medium. Bacterial DFM are fed to establish a population in the rumen to improve function, however, bacterial DFM frequently fail to persist in the rumen (Krause et al. 2000) and thus have to be fed daily for them to be effective. Yeasts are aerobic and cannot survive for long in an anaerobic environment such as the rumen and also must be supplied continuously in feeds to reach a minimum effective concentration. Both types of DFM are most effective when fed to beef cattle during stress situations when the microbial balance could be disturbed (in calves, at weaning, during feedlot receiving, or during diet transition). During stress, DFM work to prevent the colonization of the GI tract by enteropathogens (E. Coli, Salmonella), which often results in diarrhea.

Amylolytic enzymes Amylases have been used in some studies with mixed results on animal performance. Feeding exogenous amylase increased intake and consequently average daily gain in the early stages of the finishing period in feedlot steers fed cottonseed hulls as the roughage source (Tricarico et al., 2007). However, another experiment by the same authors found no differences in growth performance over the entire feeding period when steers received cracked corn or high moisture corn (Tricarico et al., 2007). Burroughs et al. (1960) demonstrated improvements in gain and efficiency when amylase was added to high forage feedlot diets, whereas DiLorenzo et al. (2011) reported that exogenous amylase improved organic matter digestibility but had no effect on performance of cattle fed 5% alfalfa hay and 5% cottonseed hull diets. Fibrolytic enzymes Commercial fibrolytic enzyme products used in the livestock industry are of fungal (Aspergillus oryzae and Trichoderma reesei) or bacterial (Bacillus subtilis, Lactobacillus acidophilus, Lactobacillus plantarum, and Enterococcus faecium spp.) origin (McAllister et al., 2001). Although commercial enzyme preparations are commonly referred to as cellulases or xylanases, secondary enzyme activities such as amylases, proteases, esterases, or pectinases are invariably present as these preparations seldom consist of a single pure enzyme (McAllister et al., 2001). This diversity is advantageous, as it facilitates targeting of a range of substrates using a single product, yet it complicates the identification of the specific enzymes responsible for any positive responses observed in feed digestion.

Buffers/alkalizers True degradation of lignin is an oxidative process that is primarily performed by aerobic fungi. As the rumen is anaerobic, lignin is not truly degraded, but rather its solubilization is a key step in increasing the amount of cellulose and hemicellulose available for microbial fermentation. Various strategies have been attempted to hydrolyze the ferulic acid ester bonds and improve forage quality by ruminant livestock, including treatment with physical agents such as heat, steam, and pressure, with chemicals such as acids, alkalis, ammonia (NH3), and ozone, with biological agents such as white rot fungi, or via natural selection, breeding, or molecular engineering (Berger et al., 1994, Buanafina et al., 2008). However, none of these methods is widely used for improving forage quality and ruminant animal performance. This is due to the capital and energy intensive nature of physical methods such as steam or pressure treatment, the potential of pelleting, chopping, or grinding to limit salivary buffering of ruminal acids, the cost and corrosive and/or hazardous nature of chemicals such as NH3 and NaOH, the potential for excessive DM losses following hydrolysis by white rot fungi, and the protracted nature of breeding approaches

Principles and Practices of Modern Meat Technology

IMPROVED PROCESSING EFFICIENCY Cutting and processing of carcasses soon after slaughter and before conventional chilling holds considerable potential in improving processing efficiencies. Hot processing involves removal of excess fat and bone before chilling and can result in significant savings, particularly in energy, labor and product weight loss (12,13,14). However, because one is working with a product that is near body temperature, special care must be taken to prevent excessive microbial growth. Researchers have defined chilling and handling conditions required to produce a microbially acceptable hot-processed product (10,17). Some aspects of hot processing are being applied in the U.S. industry; however, other countries are using this technique more extensively.

TENDERIZATION TECHNOLOGY Because tenderness is an extremely important quality of meat, the industry is currently using a variety of techniques to insure tenderness and reduce its variability. Historically cooler aging has been used to increase tenderness and this technique is still employed even though for most meat today the time period between slaughter and marketing has been reduced as compared to previous years. Most of the tenderizing benefits of aging are realized within the current slaughter-to-marketing time frame, and the risks (i.e. excessive microbial growth) associated with prolonged aging are minimized. The aging process, caused principally by muscle enzymes, begins soon after death and continues until cooking unless the product is frozen. Aging primals or subprimals in vacuumized packages is a grnwing trend as it allows the aging process to continue yet retards microbial growth, and reduces trim and moisture losses (14,21). Nonetheless, microbial spoilage will result if the product is aged too long, whether or not it is packaged. An aged, partially degraded product is an excellent source of nutrients for microorganisms.

Principally enzyme preparations from plant sources have and are being used to tenderize meat. These may be applied by spraying or dipping cuts into the enzyme solution. Antemortem or postmortem distribution via the vascular system and random muscle pumping are also used. The antemortem injection is the patented Swift Proten process. The proteolytic plant enzymes (ficin, papain and bromelin) have received the most emphasis and act primarily during the cooking process. Even though product uniformity is difficult to control, this practice continues to grow. All solutions and application equipment should have low microbial counts to avoid unnecessary product contamination (14,2/). Mechanical blade tenderization is accomplished by passing meat under a bank of long slender needles or blades which disrupt the integrity of the muscle, thus tenderizing it. This is a very effective, commercially applicable method of tenderization. However, unless strict sanitation of equipment and product is maintained, large quantities of meat can be unnecessarily inoculated with microorganisms (14,21). These microorganisms may not pose a health hazard, but can increase the rate of color deterioration which shortens the display life and reduces the value of the product. Conditioning carcasses or cuts at elevated temperatures of approximately l5°C (60°F) for up to 24 h after slaughter speeds the aging process and avoids the toughening effects that may accompany rapid chilling soon postmortem. Carcass insulation has also been used to accomplish this same end. When the concept of elevated temperature conditioning of carcasses was patented (Tenderay process) several years ago, it was recognized that microbial growth could be a problem upon prolonged conditioning; therefore, ultraviolet lights were used to limit the growth. More recently shorter elevated temperature conditioning times have been used to help insure muscle tenderness, and microbial problems have been avoided (14,21). Suspension of the carcass by the pelvic girdle stretches and improves tenderness in some muscles in the carcass that would normally contract and become less tender during the process of rigor mortis. Even though this process, developed by Texas A&M University, is effective, it has not been used commercially because of the unconventional shape of the chilled carcass. Other methods of stretching the muscles during the onset of rigor mortis have also proved effective in increasing tenderness, but are seldom used commercially (14,21). Electrical stimulation of the carcass, usually within 1 h postmortem, improves the tenderness of some muscles either by accelerating the aging process, disrupting muscle integrity, increasing connective tissue solubility, avoiding cold-induced toughening, or a combination of these mechanisms. It has been proposed that electrical stimulation might also be effective in controlling microbial growth, but this proposition has not been consistently demonstrated (14,16,17.,21). The meat industry in the U.S. and other countries is using this technique. Pre-rigor muscle subjected to rapid cooking or a pressure heat treatment is significantly improved in tenderness because of super-contraction which disrupts the muscle integrity. Even though it is an effective method of tenderization, it is not being used commercially (14). Cooking the product, before marketing to the ultimate consumer, will significantly lower microbial counts found on the raw product; however, recontamination of the product must be controlled as potential pathogens may flourish in the absence of the normal microbial flora (23). PRODUCT SANITATION The most desirable approach to achieving a high quality product from a microbial standpoint is to minimize product contamination during slaughter and subsequent processing. However, some technologies are designed to retard or prevent microbial growth as invariably microorganisms will be found on the product. Refrigeration, freezing, canning, curing, smoking and dehydration are examples of technologies used in achieving this end. Aqueous chlorine solutions have also been applied to carcasses of a variety of species (15). The patented Swift Clor-Chil process of intermittent spraying of a dilute chlorine solution on carcasses during the first few hours of chilling has been effective in reducing microbial populations and growth (14). Other compounds not necessarily approved or controlled in their usage on the whole spectrum of meat products also possess antimicrobial potential. These include acetic acid, sorbic acid, ethylene diamine-tetraacetic acid (EDTA), polyphosphates, phenolic compounds such as butylated hydroxyanisole (BHA), and naturally occurring compounds such as those produced by lactic acid producing bacteria (1). Unless the surface has been violated, the interior of the muscle from healthy animals is virtually free of microorganisms, thus surface sanitizing treatments are quite effective. Precooking of meat to provide convenience products or as a part of the normal processing sequence, such as in cured cooked products, also lowers microbial counts found in raw product. Short-term treatment with microwaves may also be used to reduce microbial counts in an effort to increase the shelf-life of meat products (3,4,5,9). As with the cooking of pre-rigor meat, recontamination of the product must be avoided as potential pathogens may flourish in the absence of the normal flora on fresh meat (23). The preservative properties of heat treatments have been demonstrated to increase shelf-life from a microbial standpoint, but because a product is heat treated, consumers and possibly processors may have a tendency to disregard proper post-heat treatment preservation and handling practices. The microbiological characteristics of these products must be understood and proper handling procedures conveyed to processors and ultimate consumers. Irradiation of meat products is an effective means of controlling microorganisms but not enzymes. Therefore, combinations of irradiation and heat treatment are being studied to improve shelf-life. Sub-sterilization irradiation doses in combination with heat treatments and other forms of preservation increase shelf-life yet minimize the off-flavors caused by irradiation (2). Many of the shelflife benefits to be realized by old, new and potentially beneficial technologies may be lost by handling products as if they would no longer have shelf-life or wholesomeness difficulties. CONTROLLED ATMOSPHERE STORAGE OF MEAT During the past several years there has been an increased interest in using modified atmospheres to increase the shelf-life of meat. This practice has fostered continued interest in centralizing processing practices such as the boxed beef concept. Vacuum packaging and packages containing elevated levels of carbon dioxide and nitrogen are examples of modified atmospheres used to effectively extend shelf-life. Storage in modified atmospheres has been demonstrated to improve shelf-life and limit growth of some potential pathogens, but may also encourage proliferation of other potential pathogens, if the product is temperature abused (23). Additional research is needed to realize the full potential and further define the limitations of this technology. COMMUNUTED AND RESTRUCTURED MEAT PRODUCTS Comminuted meats continue to be an extremely important part of the industry. Fresh ground meat, such as ground beef, holds a prominent and growing position in the market. Comminuted meats used in sausages are also of vital importance. However, with the trend to decrease residual nitrite levels, one must consider the microbial implications of this practice on shelf-life and wholesomeness. The nutritional concerns over sodium intake will likely result in decreased levels of sodium chloride in cured meats. Such a practice holds potential for not only influencing functional and sensory properties of cured meats, but also the microbial characteristics of these products Recovering meat and marrow from bones by mechanical deboning is a relatively inexpensive way to recover over 2 million metric tons of red meat each year (6). In this process, meat and bone are forced against a screened or slotted face plate with meat and some marrow passing through the openings, thus being separated from broken or coarsely ground bone. Poultry and fish are treated in a similar way, to economically retrieve additional high quality protein (8,19). Mechanical deboning produces a highly nutritious product that can be easily used in other comminuted products (7). With any comminuted food, the product surface area is increased and exposed to microorganisms and the temperature of the product is increased during processing, both of which encourage microbial growth. To continue to realize and maximize the full economical and nutritional potential of comminuted products, in part, hinges on our understanding and control of those factors which influence their shelf-life and wholesomeness.

Beef cattle breeding systems

Beef cattle breeding systems Regardless of the breeding system chosen, the breeder must struggle for genetic improvement in the traits identified as economically important for both the current and future performance of the herd. The basic objective of animal breeding is to enhance the efficiency of production and the quality of the product for the end-consumer through planned genetic change.

Beef cattle breeding systems The choice of whether to straight breed or cross breed will be related to your ability to match your cattle, the environment and the market.

Straight breeding programs Straight breeding produces not only progeny for further finishing, but also replacement females for the herd. For this reason, many traits have to be selected in balance, as they contribute to the overall package. it is important to identify and select those cattle that are superior for specific traits.

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Straight breeding programs Straight breeding programs appeal to many beef breeders because they produce replacement females from within the herd. They are reasonably easy to manage because only one cattle breed exists on the property.

Straight breeding programs Important points BREEDPLAN estimated Breeding Values (EBVs) and $indexes are available for selecting both bulls and cows. Breeding management options are simple and don’t require you to select sires from different breeds or to mate different sires in different paddocks.

Straight breeding programs Herds are self-replacing: breeder replacements are produced within the herd. Turnoff animals are similar, with little variation. Lines that ‘look’ even (i.e. for colour) may attract a premium. Straightbred females continue to be in demand for use in crossbreeding systems.

Crossbreeding programs Crossbreeding systems can bring together a desired combination of genes more rapidly than can be achieved through within-breed selection. Advantage can be taken of complementarity among breeds, but knowledge of individual breed characteristics is important.

Crossbreeding programs The decision to crossbreed is also often related to the potential gains of hybrid vigour, an additional boost to production. Hybrid vigour, or heterosis, is the difference between the performance of the progeny and the average performance of the parents.

Crossbreeding programs In general, the more distantly the parental breeds are related, the greater the amount of heterosis that can be expected. the greatest level of heterosis results from the crossing of the least related purebred Bos indicus and Bos taurus breeds. Heterosis is greater for some traits than others (e.g. fitness traits: parasite resistance, survivability, environmental adaptation etc.).

Crossbreeding programs For greatest benefit in all crossbreeding programs, it is essential that the programs be based on straightbred animals of high genetic merit for economically important traits. Tools such as Breed Plan EBVs and $indexes can be used to select these animals.

Crossbreeding programs Continuing improvement from a crossbreeding program depends on the genetic merit of the foundation animals used in the cross (i.e. the selection intensity in the populations in which they were bred) and the selection intensity placed on the subsequent crossbred generations.

Crossbreeding provides flexibility because it allows you to quickly alter particular characteristics of a herd for a specific purpose, such as to cater to a particular market, increase production or remedy a problem. there can be disadvantages with cossbreeding, such as management difficulties.

Planned crossbreeding systems Although the potential gains from crossbreeding are large, most of the success depends on good planning and the use of superior genetics to provide the priority traits identified for a specific breeding enterprise. The following briefly outlines the key ‘planned’ approaches to crossbreeding.

Rotational crosses Hereford and Angus rotational cross. Rotational crossing simply means that two or more different sire breeds are used in sequence over the female groups, which are grouped according to their sire breed. Two, three or even four sire breeds may be used. In a simple system that uses two breeds, cows of breed A are mated to sire breed B, with the resulting heifers being joined back to sire breed A. A(f) X B(m) to F(f) X A(m)

Within a three-breed rotation, the progeny of sire breed A over cow breed B are mated to sire breed C. The female progeny of the latter cross are mated back to sire breed A for the rest of their breeding lives. the minimum number of joining groups is equal to the number of sire breeds. A(f) X B(m)to F(f) X C(m)

An increase of 10 to 20 per cent in the weights of calves weaned per cow joined can be achieved from a two-breed rotation (crisscross). A greater increase in the weight of calves weaned per cow joined can be achieved from a three-breed rotation. In a rotational cross system, each breed contributes its strengths and weaknesses equally to the production system over a number of years. The level of heterosis achieved depends on the number of breeds involved (i.e. the more breeds, the more heterosis). However, in a rotational cross system variability among the progeny may make it more difficult to consistently meet a market specification. Therefore, the use of breeds that are not radically different is probably preferred. All animals in the herd benefit from hybrid vigour for both growth and maternal traits. All females from a rotational cross system are potentially available for selection as replacements; this increases the selection intensity and subsequent opportunities for genetic improvement.

Important points of rotational crosses: \*The system generates its own replacement females. \*Hybrid vigour is retained, giving a 10 to 20 per cent increase in weaning weight. \*Cows can be run as one mob for most of the year, as they need to be separated by sire group only for joining. \*Depending on the breed chosen, some variability will occur within the progeny. \*Breeds with good maternal traits should be used, as the female progeny of all sire breeds are kep

Beef Carcass Grading and Evaluation

Evaluation of beef quality and composition is important to cattle producers, meat packers and retailers, and consumers. Consumers desire cuts of beef that are lean, nutritious, and possess desirable eating characteristics. Meat researchers have developed reliable methods for measuring the factors that influence eating characteristics and factors affecting yield of lean cuts. Using these evaluation techniques, producers and packers can produce and sell carcasses that meet consumer demand.

This guide provides information about standard U.S. Department of Agriculture beef carcass yield and quality grading systems. Other useful and accurate evaluation procedures will also be introduced.

Beef carcass grading is divided into quality grading and yield grading.

**Quality grading**

Quality grades indicate the factors related to the sensory characteristics of tenderness, flavor, color, texture and juiciness. The quality grade is intended to reflect the cooked product's overall acceptability.

The USDA quality grades for steer and heifer carcasses are prime, choice, good, standard, and utility. These grades are determined by balancing maturity and degree of marbling.

Maturity refers to the physiological age of the live animal. Maturity in the carcass is determined by the degree of ossification (bone development) of the split chine bones (back bones) and the color and texture of the cut lean surface.

Cartilage changes into bone as the animal matures. This process of ossification proceeds from the back toward the front portion of the vertebral column. The degree of ossification in the vertebral buttons near the thorax, which is the cavity containing heart, lungs, etc., is the most useful in evaluating maturity. Rib bones also become flatter and whiter as the animal matures.

Meat from young animals is lighter colored and finer textured compared to older beef. Generally, a fine-textured lean will be more tender than a coarse textured lean. Carcass maturity is closely related to beef tenderness. As the animal matures, changes in the connective tissue cause the meat to be less tender.

**The degrees of maturity are A, B, C, D and E. Age ranges for these maturity groups are approximately**

Maturity group Age

A 9 to 30 months

B 30 to 42 months

C 42 to 72 months

D 72 to 96 months

E more than 96 months

Dark-cutting beef is not necessarily from older animals but can also result from cattle that were physiologically stressed before slaughter. Dark-cutting beef is highly discriminated against by consumers and retailers. Dark-cutting beef may be reduced up to one full quality grade.

Marbling is fat within the muscle and is evaluated in the rib eye between the 12th and 13th ribs. The 10 USDA degrees of marbling are abundant, moderately abundant, slightly abundant, moderate, modest, small, slight, traces, practically devoid, and devoid. Marbling has a strong correlation with the juiciness and flavor of beef.

Final quality grades are arrived at by a composite evaluation of maturity and marbling.

Yield grades estimate the quantity or the amount of closely trimmed boneless retail cuts from the loin, round, chuck and rib. There are five USDA yield grades, 1 through 5. Yield grade 1 carcasses have the highest yield of retail cuts and yield grade 5, the lowest.

The expected boneless retail yield from the round, loin, rib and chuck is as follows:

| **Yield grade** | **Percent of carcass weight in boneless, uniformly trimmed retail cuts** |
| --- | --- |
| 1 | more than 52.3 |
| 2 | 52.3 to 50.1 |
| 3 | 50.0 to 47.8 |
| 4 | 47.7 to 45.5 |
| 5 | less than 45.5 |

These yield figures are sometimes used in carcass show results as a measure of cutability.

Yield grade also can be used to predict the total retail cuts from a carcass or quarter.

Total percent retail cuts (closely trimmed, semi-boneless)

| **Yield grade** | **Carcass** | **Forequarter** | **Hindquarter** |
| --- | --- | --- | --- |
| 1 | 82 0 | 84.0 | 79 9 |
| 2 | 77 4 | 79.0 | 74.9 |
| 3 | 72 8 | 75.6 | 69.9 |
| 4 | 68.2 | 71.4 | 64.9 |
| 5 | 63.6 | 67.2 | 59 9 |

The USDA yield grade is based on four factors:

* Hot carcass weight (pounds)
* Rib eye area at the 12th rib (square inches)
* Adjusted fat thickness over the rib eye at the 12th rib (inches)
* Percent kidney, pelvic, and heart (percent of carcass weight).

These measurements are used in the official USDA formula as follows:

Yield grade = 2.5 + [(2.50 x adjusted fat thickness, inches) + 0.2 percent of kidney, pelvic, and heart + (0.0038 x hot carcass weight, pounds) - (0.32 x area rib eye, square inches)]

When computing yield grades, any decimal is dropped; yield grades are presented as whole numbers. Care and accuracy of these measurements are essential to derive reliable estimates of the cutability. The USDA grader, in practice, estimates the factors and uses a short-cut formula.

**Fat thickness**  
The amount of fat on a beef carcass has the greatest effect on the percent retail yield. As the percent fat increases, the percent muscle decreases. Fat thickness is measured at a point three-fourths of the length of the rib eye (longissmus) muscle from the chine bone, perpendicular to the surface fat, at the 12th rib. This measurement may be adjusted according to the total amount of fat on the carcass.

**Rib eye area**  
Total square inches of rib eye is used to estimate muscular development of a beef carcass. This measurement can be taken objectively between the 12th and 13th rib. A calibrated transparent plastic grid placed over the rib eye is commonly used to determine the area.

An alternative method is to trace the perimeter of the rib eye on acetate paper and calculate the area with a compensating planimeter, which is an instrument that measures area of irregularly shaped objects.

**Hot carcass weight**  
Hot carcass weight, or 102 percent x chilled carcass weight, is the weight of the carcass after slaughter. The carcass weight has an inverse effect on the percent retail yield.

**Kidney, pelvic, and heart fat**  
The amount of kidney, pelvic and heart fat is fat accumulated in the body cavity of the carcass. The weight is reported as a percent of the carcass weight. The range of kidney, pelvic and heart fat is 1 to 8 percent (with a typical average of 3.5 percent).

Yield grades estimate the proportions of lean and fat. Meat graders determine yield grades with fast, simple visual appraisals of fat and muscle of the carcass. Fat thickness, hot carcass weight and rib eye area are objective measures with kidney, pelvic and heart fat being a subjective measure.

USDA grading is done on a voluntary basis by the packer. The packer absorbs the cost. When a carcass is submitted for grading, it must be both quality and yield graded.

USDA grades should not be confused with the USDA inspection for wholesomeness.

**Beef carcass evaluation**

The purpose of beef carcass evaluation is to assist beef producers in:

* Producing high-quality beef carcasses
* Producing high-yielding beef carcasses
* Identifying superior lines of breeding stock
* Promoting a desirable, marketable product.

Improving the efficiency of beef cattle production is important to feeders, cow/calf ranchers and seed stock producers. Feeders can evaluate their feeding and management practices with cutability scores or the percentage or number of their cattle grading choice. cow/calf ranchers may use grades to rank or performance-test their stock. Seed stock producers can ultimately use quality and yield grades in sire evaluation.

Some other guidelines or indexes that may be useful in beef carcass evaluation are a growth factor or loin eye index.

Growth factors can be used to express the composition of growth. Expressing the pounds of retail cuts per day of age is one method.

This figure is determined by this formula: pounds of trimmed retail cuts per day of age = (carcass weight x cutability) divided by age in days.

**Example** A 600-pound carcass, 400 days old with a yield grade 3 (50 percent retail yield) produces 0.75 pounds of retail cuts per day of age:

(600 x 0.5) ÷ 400 = 0.75 pounds of retail cuts per day of age.

Loin eye area has been highly correlated to the percent muscle in a carcass. A goal of progressive beef producers is to produce cattle yielding at least 2 square inches loin eye area per 100 pounds of carcass.

**Example**  
A 550-pound carcass with a 12.5 square inch loin eye would yield 2.27 square inches loin eye area per 100 pounds of carcass (12.5 ÷ 5.5 = 2.27 square inches loin eye area per 100-pound carcass).

Use of the USDA's Beef Carcass Data Service is a service designed to provide carcass data to breeders or others who don't own the animals at the time of slaughter. Cattle are ear tagged with USDA ear tags and upon slaughter the proper quality and yield grade data are forwarded to the purchaser of the ear tags. This is especially helpful to seed stock producers.

For information on source of ear tags and cost of the service, contact Livestock Division, Agricultural Marketing Service, U.S. Department of Agriculture, Washington, D.C. 20250.

Carcass Evaluation and Grading: Step Forward to Ensure Meat Quality

**Introduction**

The part of the food animal body that remains after commercial dressing procedures is popularly called  carcass. Evaluation and constant maintenance of carcass quality is the measure of output which paves the way for upbringing trade in meat sector which in turn pays the efforts of farmers and uplifts their living standards. According to Polkinghorne et al. (2010) carcass classification affects the price determination and is responsible for meeting the consumer expectations, which is a concept called “consumer grading system”. It helps the farmer to recognize quality of animal which they are producing and hence can have  improved and better planning to have high grade animals and carcasses. In addition, it can certify their animals and carcasses for class, quality and condition through authorized agencies. It also helps the meat processing sector to select the different meat grades on the basis of market and consumer demands. The classification depends upon the description of carcasses using specifically defined anatomic features which are simultaneously important to the sellers as well as buyers (Sather et al., 1991). Thorough knowledge, how this grading system can help in upbringing the output of meat sector in upgrading quality as well as for meeting consumer demands is very much necessary.

[**Evaluation of carcass**](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/carcass-evaluation)

Evaluation of carcass simply means to evaluate all those factors which determine the average value per unit weight of carcass (Purchas, 2012). Evaluation of carcass primarily depends on the carcass weight, dressing out percentage and the composition of carcass. According to Jones (1989), evaluation of carcass has at two significant functions; that are evaluation of carcass composition as a part of scientific experiments and a system for evaluation of commercial carcasses based on lean meat content.

[**Why carcass evaluation is necessary**](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/carcass-evaluation#:~:text=The%20ability%20to%20accurately%20measure,can%20be%20very%20operator%20subjective.)

The evaluation of potential carcass qualities in live animal  is an important requirement in case of breeding males since they can have a greater population characteristic influence in comparison to females. Carcass evaluation is an important aspect of grading and classification of carcass. With grade or class there can be some similar characters in common and with that classification becomes a comparatively easier process, but with different grades one may be superior or inferior to another while classes are just different (Kempster et al.,1982). In some instances, the carcass evaluation can be done mainly for research purpose (Purchas, 2012).

Factor Influencing Carcass Value

The carcass weight and dressing out percentage along with carcass composition chiefly determines the value of carcass.Carcass weight or hot carcass weight can be defined as the hot or un-chilled weight of carcass after removing head, hides, internal viscera and gastrointestinal tract. Carcass confirmation and length of the carcass are significant in increasing the weight of it. Carcass with a good confirmation tends to have a thicker appearance and well-defined muscles. If the level of fatness remains the same, well confirmed animal tends to have more lean meat (Warris, 2001). Carcass length is a straight line from the forward edge of the first rib to the forward edge of the aitch bone. If all other factors influencing the composition remain the same, carcass with more weight tends to have an increased carcass value.

The dressing percentage can be simply defined as the carcass weight as a percentage of live weight immediately prior to slaughter or in other words, the live weight multiplied by the dressing percentage gives the carcass weight (Coyne et al., 2019). Dressing percentage is directly depended on the live weight. According to Coyne et al. (2019), dressing percentage is influenced by both genetic and non-genetic factors. The animal factors influencing dressing percentage include sex, age, fatness, muscularity and pregnancy status. Factors affecting live weight such as gut fill and carcass weight such as bruising or decoction for shrink influence dressing percentage. The dressing percentage increases as the live weight of the carcass decreases (McKiernan et al., 2007).

Purchas (2012) illustrated that carcass composition is determined  primarily by the lean meat yield percentage which in turn is determined by the carcass fat percentage and the muscle to bone ratio. The lean meat quality depends on external factors which involve mainly the processing of meat and intrinsic factors which include palatability factors (viz., odour, juiciness, flavour etc.); appearance (viz., colour, texture etc.); nutritive value, safety, wholesome characters and the processing properties. Carcass composition is also influenced by the distribution of lean and fat and the carcass shape. Yet another study states that the carcass composition is highly determined by genetic factors, age of the animal status of nutrition, hormonalbalance, environmental condition and the changes can even occur during pre-slaughter handling. Dry firm and dry condition in beef and Pale soft exudative condition in pigs are the commonly encountered carcass conditions (Irshad et al., 2013).

Grading Of Carcass

Polkinghorne et al. (2010) defined carcass classification as a set of terms describing characteristics of the carcassthat are helpful to thosewho are involved in trading of carcasses. Grading is the placing of different values on the carcasses for the pricing purposes, depending upon the requirements of traders and market.It is a systematic way to express value and quality of carcass by sorting in to groups according to selected characteristics. Grading plays a very significant role in marketing and merchandising of carcass. The animals which score high, fetches higher grades in carcass too. Different countries have their specific grading patters to suit their consumers and market patterns. The most popular among them is the system developed by United States department of Agriculture, popularly called the USDA system or Federal system of carcass grading. Grading is done so that it helps the farmer to recognize their quality of animal and for better planning to improve program and produce high grade animals and carcasses.It helps the producer to certify their animals and carcasses for class, quality and condition through authorized agencies and it helps meat processing sector to select a required type according to the needs of market and consumers.

**Indian standards**

According to Bureau of Indian standards (BIS) –IS:2537, which came into existence in 1995,there are six standards in India based on conformation, finish and quality. They are Prime, Choice, Good, Commercial, Utility, Cutter and Canner. Likewise, lamb and poultry are also classified.

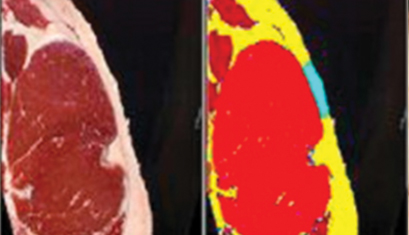
**Fabrication of carcass**

Cutting procedure or fabrication of carcasses of food animals refers to the method of separating a chilled carcass into different commercial parts. The fabricated cut up parts fetch an improved price range in the market compared to a whole carcass. Fabrication also helps in proper cooking of different cut up parts each fetching a different value. Fabrication is more or less same for all slaughter animals except pigs.

**Novel upcoming grading strategies**

At present, majority of the on-line evaluation of carcass uses back fat thickness and depth of the muscle to determine the overall yield and this technique seems to reach its maximum potentiality and accuracy.

The novel strategies for improvement need to be sorted out since dissection of carcass is time consuming, expensive and subjected to biases, newer methodologies using magnetic resonance imaging (MRI), X-Ray technologies are on research. Certainly, future evaluation and grading system will be based on weight of commercial cuts, its economic market value and the ration of lean and fat it contains. Colour, marbling which deals the aesthetic quality will also be given much importance (Kerry, 2009). Video Image Analysis (VIA) systems using electronic camera technology, and with computer-based digital image analysis techniques, to derive the significant features from multiple images of carcasses and which estimates of various carcass attributes including carcass composition and yield will be soon coming into existence. VIA can be effectively utilized to get direct measures of fat cover, eye muscle size, and dimension to infer composition and yield (Fig 2) (Craigie et al., 2012).



Conditioning Scoring Of BEAF cATTLE

he objective of condition scoring is to obtain a simple and reliable estimate of the body fat reserves of live cattle. The condition score provides an estimate of fat reserves that is independent of size, and is a more reliable description of condition than liveweight alone.

Novel Feed Additives for Beef Cattle

Function and effectiveness of feed additives targeting the rumen Four main targets have been identified for feed additives to optimize rumen function and achieve more efficient nutrient utilization: 1) shift methane (CH4) production to propionate to improve the energy balance of animals; 2) decrease feed protein degradation to increase bioavailability of amino acids in the small intestine; 3) decrease the rate of degradation of rapidly fermentable carbohydrates to control lactic acid concentration; and 4) improved fiber digestion (Jouany and Morgavi, 2007). Because of the benefits for the host ruminant in terms of health and energy utilization, improvements of these ruminal functions have been a goal for beef nutrtionists and microbiologists for decades. Ionophores achieve most of the 4 listed objectives in the rumen. Lawrence and Ibarburu (2007) analyzed the use of pharmaceutical technologies in modern beef production and reported a value of $20 per animal when using ionophores. Ionophores are considered the “gold standard” to which alternative technologies are often compared, both in terms of function and cost/benefit ratio. The vast array of recent research into modifying ruminal fermentation to mitigate methane production or to find an effective “natural” alternative to antibiotics has resulted in many potential feed additives that can enhance productivity.

Methane inhibitors

Methane inhibitors are chemical compounds that are toxic to methanogens. These compounds act by inhibiting some aspect of methanogen metabolism and include halogenated methane analogues, alcohol–halogen derivatives, diaryliodonium derivatives, coenzyme-M analogues, hydroxymethylglutaryl-S-CoA reductase inhibitors and uncouplers of the proton motive force. Among the most successful compounds tested in vivo in various ruminant species are bromochloromethane, 2-bromoethane sulfonate, chloroform, and cyclodextrin (Hristov et al., 2013). Inhibition of methanogenesis by these compounds in vivo can be up to 60% with the effect of bromochloromethane shown to last long-term (Hristov et al., 2013). However, some studies have suggested adaptation of the rumen microbiota to this class of compounds (Hristov et al., 2013), thus reducing their long-term efficacy. Furthermore, concerns for animal health, food safety, or environmental impact have limited their potential. Recently a synthetic methane inhibitor, 3-Nitrooxypropanol (3NOP), that overcomes these obstacles has been developed (Duval and Kindermann, 2012). 3-Nitrooxypropanol resembles coenzyme-M (CoM), which is used by methanogens in the last step of methanogenesis – the reduction of methyl CoM and coenzyme B (CoB) by methyl coenzyme M reductase into a CoM-CoB complex + methane (Ermler et al., 1997). Because Methanobrevibacter ruminantium, the predominant methanogen in the rumen, is unable to produce its own CoM it must rely on environmental CoM (Leahy et al., 2010), thus the ability of 3NOP to interfere. In short-term metabolism studies, 3NOP decreased CH4 production per unit of DMI by 24% in sheep (Martinez-Fernandez et al., 2013) by 60% in dairy cows (Haisan et al., 2013), and by 33% in beef heifers (Romero-Perez et al., 2014). In a 146 d metabolism study, 3NOP decreased CH4 production per unit of DMI by 59%, increased ruminal propionate and butyrate concentrations, and decreased ruminal acetate in beef heifers (Romero-Perez et al., 2015). The effect of 3NOP on performance of beef cattle has not been determined, however, in a 12 week study Hristov et al. (2015) demonstrated a 30% decrease in CH4 per unit of DMI and an 80% increase in body weight gain in lactating Holstein cows, with no effect on DMI or milk production.

Essential oils Plants synthesize a broad range of compounds that originate from secondary metabolism that are not directly involved in their growth or development (Balandrin et al., 1985; Jouany and Morgavi, 2007). These compounds are responsible for the odor and color of plants and spices, have important ecological functions as chemical messengers between the plant and its environment, protect them from predators and competition, and they often exhibit antimicrobial activity against a wide range of bacteria, yeasts, and molds (Calsamiglia et al., 2007). The term ‘essential oils’ (EO) includes a large number of compounds extracted from the plants volatile fraction by the general process of compression, steam distillation, solvent extraction, or CO2 extraction (Benchaar et al., 2011). Essential oils are not essential for nutrition or metabolism of animals nor are they composed of glycerol, rather, they contain specific essences that provide the plant with their characteristic odor and flavor. Essential oils are hydrophobic, and thus interact with the cell membrane of gram+ bacteria altering ion transport, analogous to ionophores

Probiotics/direct fed microbials The term ‘probiotic’ has been used to describe viable microbial cultures, culture extracts, enzyme preparations, or various combinations of the above (Yoon and Stern, 1995). Therefore, the U.S. FDA has required feed manufacturers to use the term “direct-fed microbial“ (DFM) instead of probiotic (Miles and Bootwalla, 1989) and has narrowed the definition to “a source of live, naturally occurring microorganisms” (Yoon and Stern, 1995). Microorganisms used as DFM for ruminants include viable cultures of bacteria and/or yeast. The bacterial DFM strains may be classified as lactic acid producing bacteria, lactic acid utilizing bacteria, or other microorganisms including Lactobacillus, Propionibacterium, Bifidobacterium, Enterococcus, Streptococcus, and Bacillus, and strains of Megasphaera elsdenii and Prevotella bryantii. The most commonly used yeast preparations are from Aspergillus oryzae or Saccharomyces cerevisiae. Direct fed microbials are generally supplied as dried preparations of live cells with their spent growth medium. Bacterial DFM are fed to establish a population in the rumen to improve function, however, bacterial DFM frequently fail to persist in the rumen (Krause et al. 2000) and thus have to be fed daily for them to be effective. Yeasts are aerobic and cannot survive for long in an anaerobic environment such as the rumen and also must be supplied continuously in feeds to reach a minimum effective concentration. Both types of DFM are most effective when fed to beef cattle during stress situations when the microbial balance could be disturbed (in calves, at weaning, during feedlot receiving, or during diet transition). During stress, DFM work to prevent the colonization of the GI tract by enteropathogens (E. Coli, Salmonella), which often results in diarrhea

Amylolytic enzymes Amylases have been used in some studies with mixed results on animal performance. Feeding exogenous amylase increased intake and consequently average daily gain in the early stages of the finishing period in feedlot steers fed cottonseed hulls as the roughage source (Tricarico et al., 2007). However, another experiment by the same authors found no differences in growth performance over the entire feeding period when steers received cracked corn or high moisture corn (Tricarico et al., 2007). Burroughs et al. (1960) demonstrated improvements in gain and efficiency when amylase was added to high forage feedlot diets, whereas DiLorenzo et al. (2011) reported that exogenous amylase improved organic matter digestibility but had no effect on performance of cattle fed 5% alfalfa hay and 5% cottonseed hull diets.

Fibrolytic enzymes Commercial fibrolytic enzyme products used in the livestock industry are of fungal (Aspergillus oryzae and Trichoderma reesei) or bacterial (Bacillus subtilis, Lactobacillus acidophilus, Lactobacillus plantarum, and Enterococcus faecium spp.) origin (McAllister et al., 2001). Although commercial enzyme preparations are commonly referred to as cellulases or xylanases, secondary enzyme activities such as amylases, proteases, esterases, or pectinases are invariably present as these preparations seldom consist of a single pure enzyme (McAllister et al., 2001). This diversity is advantageous, as it facilitates targeting of a range of substrates using a single product, yet it complicates the identification of the specific enzymes responsible for any positive responses observed in feed digestion.

Buffers/alkalizers True degradation of lignin is an oxidative process that is primarily performed by aerobic fungi. As the rumen is anaerobic, lignin is not truly degraded, but rather its solubilization is a key step in increasing the amount of cellulose and hemicellulose available for microbial fermentation. Various strategies have been attempted to hydrolyze the ferulic acid ester bonds and improve forage quality by ruminant livestock, including treatment with physical agents such as heat, steam, and pressure, with chemicals such as acids, alkalis, ammonia (NH3), and ozone, with biological agents such as white rot fungi, or via natural selection, breeding, or molecular engineering (Berger et al., 1994, Buanafina et al., 2008). However, none of these methods is widely used for improving forage quality and ruminant animal performance. This is due to the capital and energy intensive nature of physical methods such as steam or pressure treatment, the potential of pelleting, chopping, or grinding to limit salivary buffering of ruminal acids, the cost and corrosive and/or hazardous nature of chemicals such as NH3 and NaOH, the potential for excessive DM losses following hydrolysis by white rot fungi, and the protracted nature of breeding approaches

Meat Spoilage Mechanisms and Preservation Techniques

Different technical operations are involved in slaughtering: (a) stunning, (b) bleeding, (c) skinning, (d) evisceration and (e) carcass splitting. Inadequacy at one stage will result in a rigorous negative impact on the product and/or process in the following stage (FAO, 1991). In addition to the hygiene and storage temperature, the acidity of the meat and the structure of the muscular tissue also affect the rate of meat spoilage. For example, liver will spoil faster than the firm muscular tissue of beef (Berkel et al., 2004). After few hours of slaughtering of animals, muscles becomes firm and rigid, a condition known as rigor mortis. The process of rigor mortis depends on the stress induced on the animals during the slaughtering process (Miller et al., 2002). Raw meat quality is reported to be severely affected by the stress conditions during slaughtering process and the slaughtering methods (Miller et al., 2002; Chambers and Grandin, 2001). Fat, protein, minerals, carbohydrate and water are the constituents of meat (Heinz and Hautzinger, 2007). The quality of meat and meat products degrade as a result of digestive enzymes, microbial spoilage and fat oxidation (Berkel et al., 2004). Lipid oxidation, protein degradation and the loss of other valuable molecules are the consequence of meat spoilage process. Table 1 shows the chemical composition of fresh raw and processed meat. Proteins and lipids can break down resulting in the production of new compounds causing changes in meat flavor, tenderness, juiciness, odour and texture. It is therefore, important to understand the causes of spoilage of meat and meat product in order to develop optimum preservation techniques to maintain the freshness of these food products.

CAUSES OF MEAT SPOILAGE

Preslaughter handling of livestock and postslaughter handling of meat play an important part in deterioration of meat quality. The glycogen content of animal muscles is reduced when the animal is exposed to pre-slaughter stress which changes the pH of the meat, to higher or lower levels, depending on the production level of lactic acid (Miller, 2002; Chambers and Grandin, 2001; Rahman, 1999a). Lactic acid is produced due to the breakdown of glycogen content of animal muscles via an anaerobic glycolytic pathway as shown in Fig. 1 (Rahman, 1999a). Higher levels of pH (6.4-6.8) result in Dark, Firm and Dry (DFD) meat. Long term stress causes DFD meat which has a shorter shelf life (Miller, 2002; Chambers and Grandin, 2001). Sever short term stress results in a Pale, Soft and Exudative (PSE) meat. PSE meat has a pH lower than normal ultimate value of 6.2 which is responsible for the breakdown of proteins, providing a favorable medium for the growth of bacteria (Miller, 2002; Chambers and Grandin, 2001; Rahman, 1999a). Figure 2 shows the texture and color of the DFD, PSE and normal meat. The factors affecting the shelf life of meat and meat products are summarized in Table 2. There are three main mechanisms for meat and meat products spoilage after slaughtering and during processing and storage: (a) microbial spoilage, (b) lipid oxidation and (c) autolytic enzymatic spoilage.

Microbial spoilage:

Meat and meat products provide excellent growth media for a variety of microflora (bacteria, yeasts and molds) some of which are pathogens (Jay et al., 2005). The intestinal tract and the skin of the animal are the main sources of these microorganisms. The composition of microflora in meat depends on various factors: (a) preslaughter husbandry practices (free range Vs intensive rearing), (b) age of the animal at the time of slaughtering, (c) handling during slaughtering, evisceration and processing, (d) temperature controls during slaughtering, processing and distribution (e) preservation methods, (f) type of packaging and (g) handling and storage by consumer

Lipid oxidation: Autoxidation of lipids and the production of free radicals are natural processes which affect fatty acids and lead to oxidative deterioration of meat and off-flavours development (Gray, 1978; Pearson et al., 1983; Simitzis and Deligeorgis, 2010). After slaughtering of animals, the fatty acids in tissues undergo oxidation when the blood circulation stops and metabolic processes are blocked (Gray and Pearson, 1994; Linares et al., 2007). Lipid oxidation is the reaction of oxygen with double bonds of fatty acids (Hultin, 1994). It involves three stage free radical mechanisms: initiation, propagation and termination

Autolytic enzymatic spoilage: Enzymatic actions are natural process in the muscle cells of the animals after they have been slaughtered and are the leading cause of meat deterioration. The enzymes have the ability to combine chemically with other organic compounds and work as catalysts for chemical reactions that finally end up in meat self deterioration (Tauro et al., 1986). In the autolysis process, the complex compounds (carbohydrates, fats and protein) of the tissues are broken down into simpler ones resulting in softening and greenish discoloration of the meat. These autolysis changes include proteolysis and fat hydrolysis which are prerequisite for microbial decomposition. Excessive autolysis is termed “souring” (Tauro et al., 1986). Postmortem breakdown of polypeptides are the result of tissue proteases and is responsible for flavour and is textural changes in meat (Toldra and Flores, 2000). Post mortem aging of red meat results in the tenderization process (Huss, 1995). Post-mortem autolysis takes place in all animal tissues but at different rates in different organs, quicker in glandular tissue such as the liver and slower in striated muscle

PRESERVATION OF MEAT Meat preservation became necessary for transporting meat for long distances without spoiling of texture, colour and nutritional value after the development and rapid growth of super markets (Nychas et al., 2008). The aims of preservation methods are: (a) to inhibit the microbial spoilage and (b) to minimize the oxidation and enzymatic spoilage. Traditional methods of meat preservation such as drying, smoking, brining, fermentation, refrigeration and canning have been replaced by new preservation techniques such as chemical, biopreservative and nonthermal techniques (Zhou et al., 2010). Current meat preservation methods are broadly categorized into three methods (a) controlling temperature (b) controlling water activity (c) use of chemical or biopreservatives (Zhou et al., 2010). A combination of these preservation techniques can be used to diminish the process of spoilage (Bagamboula et al., 2004).

Low temperature methods: The basic aim of cooling techniques is to slow or limit the spoilage rate as temperature below the optimal range can inhibit the microbial growth (Cassens, 1994). Low temperature methods of storage are used in three levels: (a) chilling (b) freezing and (c) superchilling. All these levels help to inhibit or completely stop bacterial growth (Zhou et al., 2010). However, the growth of psychrophilic group of bacteria, yeasts and molds is not prevented by all levels of refrigeration (Neumeyer et al., 1997) and both enzymatic and non enzymatic changes will continue at a much slower rate (Berkel et al. 2004).

Chilling: Chilling is employed at slaughtering plants immediately after slaughtering and during transport and storage. It is necessary to reduce the temperature of carcass immediately after evisceration to 4°C within 4 h of slaughtering (USDC, 1995). Chilling is critical for meat hygiene, safety, shelf life, appearance and nutritional quality

It is employed by two methods: (a) immersion chilling, in which the product is immersed in chilled (0- 4°C) water and (b) air chilling, in which the carcasses are misted with water in a room with circulating chilled air (Carroll and Alvarado, 2008). Carcass surface temperature is reduced at faster rate by air chilling which improves carcass drying and minimizes microbial spoilage (Ockerman and Basu, 2004). The microbial quality of the air-chilled product is better than that of a water-chilled product

Sodium chloride: NaCl in growth media or foods can be a source of osmotic stress by decreasing water activity (Doyle, 1999). Borch et al. (1996) stated that salt-sensitive microorganisms, such as Pseudomonas spp. and Eriterobacferiuceae, did not grew in meat when the water activity (aW) was reduced from 0.99 to 0.97 with the addition of 4% sodium chloride. However, salt tolerant microorganisms such as lactic acid bacteria and yeasts could grow at that level of water activity. Chawla et al. (2006) reported a reduction in water activity of fresh lamb intestine from 0.95 to 0.80 with the addition of 10% (w/w) of sodium chloride. Bennani et al. (2000) reported that Enterobactereaceae species were eliminated in kaddid (dry-salted meat product) as a result of reduced water activity (aw) below 0.9 after 3 days due to the subsequent actions of salting, spicing and drying. Domowe (2010) reported that adding 3% salt reduced initial water activity level to 0.97 in sausages which was further reduced to 0.95 through the 6 day drying process and as a result pathogenic bacteria (Salmonella, Bacillus) stopped multiplying. Wijnker et al. (2006) studied antimicrobial properties of salt (NaCl) for the preservation of natural sheep casings at different water activity (aw) levels and found the activities of most spoilage and pathogenic bacteria (Escherichia coli, Salmonella typhimurium, Listeria monocytogenes, Staphylococcus aureus and E. coli O157:H7) stopped when an aw of 0.89 was reached.

Principles and Practices of Modern Meat Technology

IMPROVED PROCESSING EFFICIENCY Cutting and processing of carcasses soon after slaughter and before conventional chilling holds considerable potential in improving processing efficiencies. Hot processing involves removal of excess fat and bone before chilling and can result in significant savings, particularly in energy, labor and product weight loss (12,13,14). However, because one is working with a product that is near body temperature, special care must be taken to prevent excessive microbial growth. Researchers have defined chilling and handling conditions required to produce a microbially acceptable hot-processed product (10,17). Some aspects of hot processing are being applied in the U.S. industry; however, other countries are using this technique more extensively.

TENDERIZATION TECHNOLOGY Because tenderness is an extremely important quality of meat, the industry is currently using a variety of techniques to insure tenderness and reduce its variability. Historically cooler aging has been used to increase tenderness and this technique is still employed even though for most meat today the time period between slaughter and marketing has been reduced as compared to previous years. Most of the tenderizing benefits of aging are realized within the current slaughter-to-marketing time frame, and the risks (i.e. excessive microbial growth) associated with prolonged aging are minimized. The aging process, caused principally by muscle enzymes, begins soon after death and continues until cooking unless the product is frozen. Aging primals or subprimals in vacuumized packages is a grnwing trend as it allows the aging process to continue yet retards microbial growth, and reduces trim and moisture losses (14,21). Nonetheless, microbial spoilage will result if the product is aged too long, whether or not it is packaged. An aged, partially degraded product is an excellent source of nutrients for microorganisms.

PRODUCT SANITATION The most desirable approach to achieving a high quality product from a microbial standpoint is to minimize product contamination during slaughter and subsequent processing. However, some technologies are designed to retard or prevent microbial growth as invariably microorganisms will be found on the product. Refrigeration, freezing, canning, curing, smoking and dehydration are examples of technologies used in achieving this end. Aqueous chlorine solutions have also been applied to carcasses of a variety of species

CONTROLLED ATMOSPHERE STORAGE OF MEAT During the past several years there has been an increased interest in using modified atmospheres to increase the shelf-life of meat. This practice has fostered continued interest in centralizing processing practices such as the boxed beef concept. Vacuum packaging and packages containing elevated levels of carbon dioxide and nitrogen are examples of modified atmospheres used to effectively extend shelf-life. Storage in modified atmospheres has been demonstrated to improve shelf-life and limit growth of some potential pathogens.

HE TEHSIL/TOWN MUNICIPAL ADMINISTRATION [NAME OF THE TMA] (SLAUGHTER OF ANIMALS AND MAINTENANCE OF SLAUGHTERHOUSES) BYE-LAWS

Definitions.–In these bye-laws unless there is anything repugnant in the subject or context, the following expressions shall have the meaning hereby respectively assigned to them:- (a) “Animal” means a buffalo, buffalo-bull, camel, cow, cow-bull, goat sheep and ostrich and any other Halal animal of any age; (b) “Carcass” means slaughtered eviscerated body of an animal; (c) “Cull” means to pick an animal which is suitable neither for breeding purposes nor for draught purposes; (d) “Government” means Government of the Punjab; (e) “Flesh” means the meat of animals as distinguished from the edible tissue of fish or fowl; (f) “In-charge of Slaughterhouse” means an officer in-charge/Veterinary officer of slaughterhouse maintained by TMA; (g) “Slaughterhouse” means any building or premises used for slaughtering animals and approved by the TMA and includes modern „abattoir‟ fully equipped with modern techniques &machinery; (h) “Larraige” means any enclosure, approved by the TMA, where animals are assembled for examination by the Veterinary Officer to determine whether they are suitable for slaughter or not, or where animals approved for slaughtering are housed until they are removed to the slaughter house; (i) “TMA” means the Tehsil / Town Municipal Administration \_\_\_\_\_\_\_\_\_; (j) “TO(R)” means Tehsil / Town Officer (Regulation); (k) “Useful Animals” include; (i) a female sheep and goat below the age of one year and six months; (ii) a female sheep or goat of the age exceeding one year and six months but not exceeding four years except, which is pregnant or fit for breeding purposes; (iii) a female animal, other than sheep or goat, below three years of age; (iv) a female animal, other than sheep or goat, which is pregnant or in milk or fit for breeding purpose; (v) a female cattle, between three to ten years of age, which is fit for draught purposes, but does not include any such animal which on account of culling, injury, illness or other cause, is certified in writing by the Veterinary Officer as not likely to live or as no longer a useful animal. 3. Provision of Slaughter House.– (1) The TMA shall provide and maintain at such site or sites, one or more Slaughterhouses for the slaughter of animals within its local area

(2) The slaughterhouse should be situated away from residential areas and access for animals - either by road, rail and/or stock route shall be assured. (3) Fence shall be erected around the slaughterhouse to prevent access of unauthorized persons, the public, dogs and other animals. (4) Essential equipment shall be provided by the TMA. 4. Operation of Slaughter of Animals.–(1) Slaughterhouses will be provided for the slaughtering operation of animals during such hours as the TMA may, from time to time, determine. (2) The in-charge of slaughterhouse shall fix at a conspicuous place in a slaughterhouse a notice board showing: - (a)The hours of the working of slaughterhouse. (b) The fee payable. (c) Any other directions that the in-charge of slaughterhouse deemed appropriate to issue. (3) No animal shall be slaughtered in a Slaughterhouse at any time other than that fixed for the purpose. 5. Prohibition.–(1) No animal shall be slaughtered for the purpose of sale of meat at any place other than a slaughterhouse except: (a) When on account of accident, injury or other cause not related to any disease likely to die before it is presented to the In-charge of slaughterhouse; (b) On the days of Eid-ul-Azha or any other religious purpose. Provided that a fully aware of the mode of Halal slaughtering as mention in bye-law No.10 shall be observed and the contents of stomach &bowels shall not be washed into the drain but shall be emptied into the buckets or other receptacles so that the same are disposed of at proper place, to keep the environment clean and hygiene. (2) No person shall slaughter an animal on Tuesday and Wednesday or on such other days as Government may, by notification in official gazette, specify in this behalf. 6. Pre-Slaughter Conditions.–(1) No person shall slaughter a useful animal. (2) No person shall bring into or any part of slaughterhouse; (i) a diseased, emaciated, widely bruised, or otherwise unhealthy animal; (ii) a male animal which is less than three months of age in case of sheep/goat and six months in other case; (iii) an animal which is pregnant, or with weaning young; (iv) a buffalo or cow during the period of lactation; (v) a carcass; (vi) a carnivorous e.g. dog, cat etc. ; (vii) an animal not meant for slaughter or for the slaughter of which slaughterhouse is not provided; (viii) an animal for which restrictions have been imposed by the Government on its slaughter; and (ix) a starved or under-fed animal

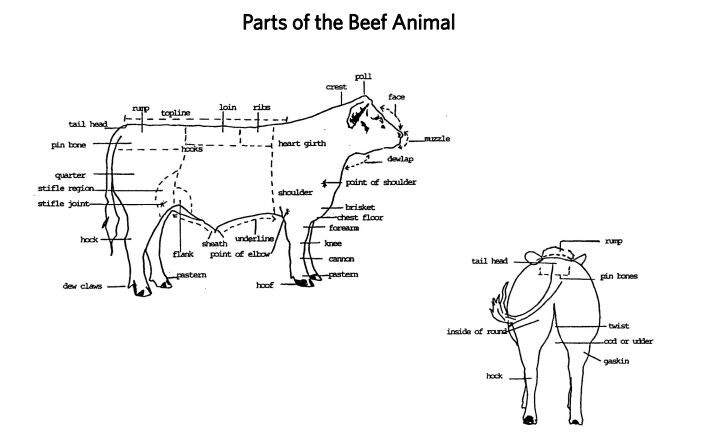
7. Pre-Slaughter (Ante-Mortem) Inspection of Animals.–(1) Every animal for slaughter shall, on being brought to slaughterhouse, be presented for inspection to the incharge of slaughterhouse who shall satisfy himself/herself that: (i) The female animal is not fit for producing milk; (ii) Flesh of the animal will be fit for use as human food. (iii) The animal is not diseased or in dying condition, provided that any animal, which has met with an accident and is otherwise healthy. (iv) The animal fulfills the conditions of these bye-laws and all the instructions issued by the Government from time to time in this regard. (2) The animal shall be brought in slaughterhouse only through the gate fixed for this purpose. (3) An animal brought in contravention of these bye-laws shall immediately be removed from the slaughterhouse premises under the directions of the in-charge of slaughterhouse. 8. Functions of In-charge Slaughterhouse.– (1)The in-charge of slaughterhouse shall maintain a register in which he/she shall enter a brief description of each animal passed for slaughter and the fees recovered thereof. (2) An animal approved for slaughter by the in-charge of slaughterhouse shall be branded with a distinctive mark on ears, hoofs or horns if necessary, and admitted into the larraige of a slaughterhouse having the facility of water supply. (3) All animals when approved shall be kept in the larraige. (4) The in-charge of slaughterhouse shall be responsible for their security when these are in the larraige. He shall also be responsible for the security of the dressed carcasses, while they are in the slaughter hall. (5) No animal shall be admitted into the waiting yard, unless the prescribed fee has been paid. 9. Disposal of Animals Unfit for Slaughter.– (1) Animals rejected as unfit for slaughter shall be removed from the premises of slaughterhouse. (2) Animals found to be affected by any infectious or contagious disease or which may reasonable be suspected of being so affected shall, if in-charge of slaughterhouse so directs, be forthwith apprehended and removed to the Veterinary Hospital or such other place as the TMA may provide for the purpose. The animals so seized shall be disposed of in the manner as given in TMA Regulation for Disposal of Animals Carcasses Bye-laws. (3) Animal suffering from zoonotic diseases, the flesh of which is unfit for human consumption shall be destroyed under order of the in-charge slaughterhouse. 10. Mode of Slaughtering.– (1) Each animal shall be slaughtered by a person having the licence from the Punjab Halal Development Agency, Lahore to slaughter an animal. (2) Slaughter shall be performed by a Muslim, who shall precede the slaughter by invoking the name of Allah, most commonly by saying "Bismillah" and then "Allahuakbar". (3) The animal shall be slaughtered with a sharp knife by cutting the throat, windpipe and the blood vessels in the neck (while the animal is conscious), causing the animal‟s death without cutting the spinal cord. Lastly, the blood from the veins must be drained; see Schedule-I

(4) For short necked animal i.e. cow, sheep, goat, etc, slaughter shall be performed in accordance with the process of “Zibah” and for long necked animal i.e. camel, ostrich, etc, process of “Nahar” shall be followed. Explanation: (i) Zibah – To cut the vessels of the animal between the “lahyain, jawbone and the “labbah”. (ii) Nahar – To cut the vessels of the animal in the lower part of the neck near the chest. (4)The licencee shall drain the blood into bleeding chamber and no blood shall be allowed to flow on the floor. (5)No animal shall be kept waiting at the slaughter floor. (6) Animals intended for slaughter shall be secured in humane way to avoid cruelty and a very sharp knife shall be used for slaughter. (7)Slaughtered animals shall be flayed and evince after all reflexes are over. (8) The contents of the stomach and bowels shall not be washed into the drain or allowed to drop on the floor, but shall be emptied into buckets or receptacles provided at the slaughterhouse or in a separate room. (9)No person shall process any inedible byproducts within any portion of slaughterhouse or in the immediate neighbourhood of the slaughterhouse premises. 11. Dressed Animals.– (1) All dressed carcasses shall, after de-skinning and cleaning, be presented to the in-charge of slaughterhouse for inspection. (2) Carcasses, which have been passed by the in-charge of slaughterhouse as fit for human consumption, shall be branded or stamped so as to define their quality. (3) No person shall remove any dressed carcass from the slaughterhouse premises until it has been duly passed by the in-charge of slaughterhouse. (4) The in-charge of slaughterhouse shall cause any dressed carcass or its part, which is, in his opinion, unfit for human consumption to be buried or destroyed. 12. Post Slaughter conditions. -(1) No person shall remove entrails and offal from the slaughterhouse until they are properly washed and cleaned. (2) No person shall blow or infuse water in meat or lungs within or outside the slaughterhouse premises and the in-charge slaughterhouse shall bury or destroy any meat found blown or stuffed. (3) No whole dressed carcass or meat in parts or skins shall be sold at the premises of the slaughterhouse. (4) No person shall sell any meat within the jurisdiction of TMA, which is not slaughtered and dressed at the TMA slaughterhouse or any other slaughterhouse approved by the TMA, if found unfit for human consumption, and such person shall be liable to fine and imprisonment as per provisions of the Punjab Local Government Ordinance, 2001. If found fit, the same will be stamped as such and auctioned. The sale proceeds shall be deposited into TMA‟s account. (5) No person shall remove or cause to be removed from the premises of the slaughterhouse any dressed carcass or meat except in a clean receptacle and covered in such a manner as to be screened from public view and adequately protected against flies and dust

(6) The in-charge slaughterhouse shall, by general or special order, direct the disposal of all skins or hides, heads, horns and foot of slaughtered animals and all dressed carcasses or meat found or left in the slaughter house after the hours fixed for closing the slaughter house. 13. Prohibition of Using Un-Lincenced Slaughterhouse.– (1)On coming into the notice, it shall be the responsibility of the TO(R) and in-charge slaughterhouse to inspect the unauthorized slaughterhouse/place and shall seize and forfeit the animals and the meat at such place. (2) The animals or meat so seized shall be disposed of in the manner as given in TMA Regulation for Disposal of Carcasses of Animals Bye-laws. (3) Any carcass or meat ordered to be destroyed shall be destroyed/buried immediately. 14. Restriction on entry of Un-authorised Person.–(1) No person affected with leprosy, sores or any other skin disease shall enter the slaughterhouse premises. (2) No person other than the TMA staff on duty and licensed butchers, licensed flayers or their bonafide licensed servants, shall enter the slaughterhouse premises during the process of slaughtering, flaying or dressing the carcass, without permission of the incharge slaughterhouse. 15. Butchers and Flayers.–(1) No butcher or flayer shall be allowed to slaughter and dress more than 5 cattle or buffaloes or 25 sheep and goats per day in a slaughterhouse. (2) No person other than the butcher or the flayer or their staff licensed by the Punjab Halal Development Agency, Lahore shall be allowed to slaughter and dress any animal at the slaughterhouse. (3) The licensed butchers and flayers shall use the special flaying knives as approved by the in-charge of slaughterhouse. (4) No person shall create any disturbance or nuisance in the slaughterhouse premises. (5) A person transgressing the provisions of the bye-laws shall be removed from the slaughterhouse premises under the directions of the in-charge of slaughterhouse, immediately. 16. Responsibilities of TMA.–(1)The blood, unwanted offal, refuse or other offensive material left at the slaughterhouse shall be removed under the supervision and control of the in-charge of slaughterhouse to a place fixed for that purpose by the TMA and the sanitation of the premises properly maintained after the slaughtering operations are over. (2)The TMA may, from time to time, issue necessary instructions in respect of sanitation and other matters connected with the affairs of the slaughterhouse. (3) All slaughterhouses shall be properly paved and have a constant supply of water, proper drainage and well ventilated. (4) Slaughterhouse shall be regularly whitewashed at least twice in each year. (5) Slaughterhouse shall be kept thoroughly clean and in good order and all dung and filth removed therefrom at least once every twenty four hours. (6) Pests (insect, rodents and birds) shall be controlled to prevent their access to slaughterhouse

washed out in a proper manner and blood and offal removed shall be by the person or persons who have slaughtered the animal. (8) All skins, hides, leather and all blood saved in the slaughterhouses shall be removed therefrom within twenty four hours and shall not be again brought back. (9) No deceased, unfit or useful animal shall be slaughtered in the slaughterhouse nor brought the same therein. (10) A person who shall by himself, or anyone in his employment, shall not cruelly beat, ill-treat, abuse or torture any animal in a slaughterhouse or cause such to be done.

Judging Beef Cattle



<https://agriculture.vic.gov.au/livestock-and-animals/beef/health-and-welfare/condition-scoring-of-beef-cattle>