Factors affecting animal growth

Modern cattle are descendants of Bos indicus and Bos Taurus (Gillespie, 1992). According to Lawrie (1991) these breeds are believed to be descended from Bos primigenius, the wild cattle. The last representative of the wild species died in Poland in 1627 (Zeuner, 1963). Lawrie (1991) reported that domestication of cattle followed the establishment of settled agriculture about 5000 B. C. and domestication of hump-back cattle (Bos indicus) existed in Mesopotamia by 4500 B. C.

Garner (1944) stated that the immediate predecessor of majority of the breeds of British cattle was Bos longifrons, which was of relatively small frame rather than Bos primigenius which is massive in size. The development of many present British breeds was due to the early improvements initiated by Bakewell in the middle of the eighteenth century, who introduced in-breeding, the use of proven sires, selection and culling (Lawrie, 1991). Since 1790, the focus on cattle improvement is towards smaller, younger and leaner animals; and there has been growing realization that breed potentialities will not be fully manifested without adequate food given at the right time in the growth pattern of the animal (Hammond, 1932a).

Lawrie (1991) suggested that a beef animal should be well covered with flesh, blocky and compact-thus reducing the proportion of bone whereas in a dairy animal the frame should be angular with relatively little flesh cover, the body should be cylindrical thus accommodating the large digestive tract necessary for efficient conversion of food into milk and mammary tissue should be markedly developed. Aberdeen Angus has been regarded as the premier breed for good-quality meat (Gerrard, 1951).

Lawrie (1991) reported that one of the reasons for the good eating quality of the Aberdeen Angus is its tenderness which is due to the small size of the muscle bundles, smaller animals having smaller bundles. Good-quality meat can also be attained by feeding concentrates such as barley to beef cattle (Preston et al., 1963).

Efforts have been made to cross various breeds of Bos indicus (Zebu cattle) with British breeds, to combine the heat resisting properties of the former with the meat-producing characteristics of the latter (Lawrie, 1991).

Unfortunately, unusual breeds of cattle are found within a normal breed: dwarf ” Snorter” cattle occur within various breeds in U. S. A., and pronounced muscular hypertrophy, which is often more noticeable in the hind quarters and explains the name ” doppelender” given to the condition, arises in several breeds e. g. Charollais and South Devon (McKellar, 1960). Recessive genes are thought to be responsible in both cases (Lawrie, 1991).

FACTORS AFFECTING THE GROWTH AND DEVELOPMENT OF CATTLE

Lawrie (1991) reported that as an animal grows two things happen: first, it increases in weight until mature size is reached; this is called growth and secondly it changes in its body conformation, shapes and its various functions and faculties come into full being; this is referred to as development.

- Genetic factors

According to Lawrie (1991) several economically important traits in meat animals are heritable to some degree and can thus be selected for by

breeding. In cattle, certain growth features are controlled by recessive genes which have not so far been controlled, complicating breeding. One such trait is dwarfism; another is the doppelender or “ double muscling” condition, which causes muscle hypertrophy and thereby increases the animal’s commercial value (Lawrie and Ledward, 2006). Genetic analysis continues to reveal the genetic mechanisms that control numerous aspects of the endocrine system and, through it, meat growth and quality as concluded by Lawrie and Ledward (2006).

Genetic engineering techniques can shorten breeding programmes significantly because they allow for the identification and isolation of genes coding for desired traits, and for the reincorporation of these genes into the animal genome as reported by Lawrie and Ledward. Experimental reproductive cloning of commercially important meat animals such as sheep, pig or cattle has been successful. The multiple asexual reproductions of animals bearing desirable traits can thus be anticipated, although this is not yet practical on a commercial scale.

- Environmental Factors

Heat regulation in livestock especially cattle is of great economic significance, because mammals attempt to maintain a constant optimal body temperature (Lawrie and Ledward, 2006). Low temperatures tend to prolong animal development and high temperatures tend to retard it. Depending on their size, body shape and insulation through tissue and fur, some animals have a relatively narrow zone of temperature tolerance and others (e. g. cattle) a broad one. Static magnetic fields, for reasons still unknown, also retard animal development.

- Nutritional Factors

Acker and Cunningham (1991) reported that the quality and quantity of usable meat depends on the animal’s plane of nutrition, i. e., whether it is over or underfed. The composition of the diet, especially the amount of protein provided, is also an important factor regulating animal growth and development (Wardlaw, 2000). Cattle digest cellulose which is better adapted to poor-quality diets, but their ruminal microorganisms degrade high-quality protein if supplied in excess, because producing high-quality protein animal feed is expensive.

Several techniques are employed or experimented with to ensure maximum utilization of protein. These include the treatment of feed with formalin to protect amino acids during their passage through the rumen, the recycling of manure by feeding it back to cattle mixed with feed concentrates, or the partial conversion of petroleum hydrocarbons to protein through microbial action (Gillespie, 1998).

In plant feed, environmental factors influence the availability of crucial nutrients or micronutrients, a lack or excess of which can cause a great many ailments. In Australia, for instance, where the soil contains limited phosphate, cattle are being fed additional phosphate to increase the efficiency of beef production. Also in Australia, cattle and sheep in certain areas were often found losing their appetite and dying in the midst of rich pasture; this was at length found to be a result of cobalt deficiency in the soi (Acker and Cunningham, 1991).

Gillespie (1998) stated that plant toxins are also a risk to grazing animals; for instance, fluoracetate, found in some African and Australian plants, kills by disrupting the cellular metabolism. Certain man-made pollutants such as methyl mercury and some pesticide residues present a particular hazard due to their tendency to bioaccumulate in meat, potentially poisoning consumers.

SLAUGHTERING AND KILLING OF CATTLE

Slaughtering

- Religious slaughtering

The Welfare of Animals (Slaughter or Killing) Regulations 1995 (as amended) (WASK) require that all animals are stunned before slaughter, using the methods of stunning prescribed by the Regulations, subject to specific exemptions. One of these exemptions refers to slaughter without the infliction of unnecessary suffering by the Jewish method for the food of Jews; or by the Muslim method for the food of Muslims, provided the requirements for the licensing of slaughter men under the Regulations are met. Since a complete bleed is necessary, cattle are not stunned before bleeding (Donin, 1972).

Religious issues surrounding slaughter without pre-stunning were explored in detail in the FAWC report on religious slaughter published in 1985 and have not been reiterated in this report. Council has taken account of relevant information generated since then in drawing its conclusions.

- Jewish method

The Jewish method of slaughtering animals for food (Shechita) requires that they be healthy at the time of slaughter and must not have suffered any physical injury. For this reason, pre-slaughter stunning methods that are judged to cause physical injuries prior to cutting the throat have been considered unacceptable for this slaughter method. Cattle are restrained in an upright position in a specialized pen with the head held fast and the neck exposed in a suitable position for incision of the throat.

A transverse cut is made using a reciprocal, uninterrupted motion of the knife. The intention is to produce an immediate outpouring of blood by severing both jugular veins and both carotid arteries. The knife used for cattle has a long, extremely sharp and undamaged blade. After the cut has been made the animal must remain restrained until it is bled out before being released, shackled and hoisted. With Rabbinical approval some premises have adopted a post-cut stun for cattle.

- The Islamic method

The Muslim method of slaughter (Halal) is, in many respects, similar to Shechita. However, pre-slaughter stunning methods for cattle and sheep that have been demonstrated not to kill the animal, such that the heart is still beating, have been deemed acceptable and have routinely been adopted in many Halal slaughterhouses. The level of restraint required to expose the throat, perform an effective cut and hold the animal still until it has bled out is greater than is needed for conventional slaughter.

The restraining pens used for this purpose require Ministerial approval. This is designed to protect bovine animals from any avoidable pain, suffering,

agitation, injuries or contusions in the pen and in particular to ensure effective means of restraint and support" (WASK). The design and operation of restraining pens are assessed by the SVS before Ministerial approval is given.

- Humane slaughtering

Cattle are slaughtered by being first stunned and then exsanguinated (bled out). Death results from the one or the other procedure, depending on the methods employed. Stunning can be effected through asphyxiating the animals with carbon dioxide, shooting them with a gun or a captive bolt pistol, or shocking them with electric current as reported by Lawrie and Ledward (2006).

According to Lawrie (1991) draining as much blood as possible from the carcass is necessary because blood causes the meat to have an unappealing appearance and is a very good breeding ground for microorganisms. The exsanguination is accomplished by severing the carotid artery and the jugular vein in cattle and sheep, and the anterior vena cava in pigs.

- Bleeding

According to Beinempaka et al., (1990) the neck of the animal is cut and it is allowed to bleed by hoisting it up. They also reported that adequate bleeding is essential to reduce meat spoilage since blood is a good source of moisture and nutrition for most of the contaminating organisms.

This indicates that the amount of blood retained in the beef determines the degree of spoilage of the beef. Panda, (1986) reported that the amount of

blood drained out from different types of birds vary depending on the stunning technique and physiological condition of the cattle.

- Deskinning and dressing

This process of deskinning is done manually or mechanical and manual at the same time. The mechanical and manual ones are normally done at the abattoirs. This involves using a sharp knife to deskin the animal while the machine pulls the skin off the animal.

Dressing involves the opening of the carcass to remove the internal organs (Beinempaka et al., 1990). Care must be taken in removing the intestines, as an unintentional incision may result in the distribution of fecal bacteria onto carcass possibly contaminating the beef (Borch and Arinder, 2002).

- Washing

Following the deskinning and dressing stage is the washing stage. It involves using a stream of water which removes dirt and the amount of blood retained in the carcass. This helps in reducing microbial load present on the carcass.

- Chilling

This is done immediately after the preparation of the carcass and must last for as short a time as possible to avoid bacterial proliferation (Gracey, 1986).

Nester et al., (2001) stated that chilling inhibits the growth of micro-organisms such as Escherichia coli and Salmonella spp at temperature below 3-50C. Chilling in a common bath may result in cross-contamination from Escherichia and Salmonella carriers to free carcasses (Cross et al., 1988).

NUTRITIVE VALUE OF BEEF

The use of lean and clean beef is advisable to include in diet, it could be as an ingredient in stews or traditional recipes. Beef is a popular meat rich in protein, being a red meat had always made it a bad food when it comes to studies and researches (Owen et al., 2005). Wardlaw, (2000) stated that, a lean beef adds to health benefits related to heart and prevention of cancer. As a matter of fact, no one can deny that beef is an important source of protein.

Beef is found to be very rich in Iron, Zinc, Selenium, Phosphorus, Potassium and Magnesium. Sodium and Copper are found in good quantities. However, minute quantities of Calcium and Manganese are also present. According to Acker and Cunningham (1991), beef is one of the best sources for Vitamin B12, Vitamin B6 Niacin and Riboflavin. However, it is also rich in Thiamin and Pantothenic Acid. Small amounts of Vitamin E, Vitamin K and Foliate are present.

According to Owen et al., (2005) the calorie count of Beef per 100 gm is 155. 0; it is meat which is higher in protein and moderate in fat. Beef is good for bones and teeth. It enhances immunity against infections of ear etc., and prevents blood vessel walls from damaging. Moderate consumption of lean beef is altogether good for cardiovascular health and to prevent cancer risks.

The amount of fat in beef carcasses has decreased compared to what it was during the middle of the twentieth century; beef contains about 6 percent less fat (Gillespie, 1998).

FRESHNESS OF DRESSED BEEF

Beef is a perishable product and may cause public health concerns. Fresh beef is most likely to spoil before it will cause food-borne diseases (Gill, 1998). For preserved meat the opposite may be the case, where micro-organisms have been eliminated.

There is the tendency to use milder preservation methods either because of energy saving, because of consumers' preference for mildly cured or cooked products, or their desire for having more fresh beef products or because of an aversion to the use of preservatives (Panda, 1995).

According to Lawrie and Ledward (2006) in order to satisfy these demands, it will be necessary for meat industry to improve microbial monitoring of production including hygiene and to formulate processes which will give minimal variation in their results. Although intensive work is being carried out by meat industries to find substitutes for known processes with equivalent inactivation or inhibition of microbial froth, no overall acceptable alternative seems to be readily available (Gracey, 1986).

QUALITY OF BEEF

The quality grades are based on the degree of marbling (intramuscular fat) in the beef, and the maturity of the animal at slaughter (USDA, 2007). A quality grade is a composite evaluation of factors that affect palatability of meat; tenderness, juiciness, and flavor. These factors include carcass maturity, firmness, texture, and color of lean, and the amount and distribution of marbling within the lean. Beef carcass quality grading is based on degree of marbling and degree of maturity (Hale et al., 2007).

- Texture

Meat from less tender cuts or older cattle can be mechanically tenderized by forcing small, sharp blades through the cuts to disrupt the proteins (Denver, 2003). Also, solutions of exogenous proteolytic enzymes such as papain, bromelin or ficin can be injected to augment the endogenous enzymes (USDA, 2007). Similarly, solutions of salt and sodium phosphates can be injected to soften and swell the myofibrillar proteins. This improves juiciness and tenderness.

- Flavour

Evaporation concentrates the remaining proteins and increases flavor intensity; the molds can contribute a nut-like flavor. The majority of the tenderizing effect occurs in the first 10 days, although two to three days allow significant effects. Boxed beef, stored and distributed in vacuum packaging, is, in effect, wet aged during distribution. Premium steakhouses dry age for 21 to 28 days or wet age up to 45 days for maximum effect on flavor and tenderness.. Salt can improve the flavor, but phosphate can contribute a soapy flavor.

SOURCES OF CONTAMINATION OF BEEF

Lawrie (1991) suggested that contamination of beef is a continuing possibility from the moment of bleeding until consumption. Contamination of beef from the moment of bleeding until consumption is from microbial to physical contamination. The microbiological contamination of carcasses occurs mainly during processing and manipulation, such as skinning, evisceration, storage and distribution at slaughterhouses and retail establishments (Gill, 1998; Abdalla et al., 2009).

Fecal matter was a major source of contamination and could reached carcasses through direct deposition, as well as by indirect contact through contaminated and clean carcasses, equipment, workers, installations and air (Borch and Arinder, 2002). Cattle slaughter operations, such as bleeding, dressing and evisceration, expose sterile muscle to microbiological contaminants that were present on the skin, the digestive tract and in the environment (Gill and Jones, 1999; Bacon et al., 2000).

Moreover, dirty workers hands, clothes and equipments of the slaughterhouse and at the market by retailers act as intermediate sources of contamination of meat (Gill, 1998; Gilmour et al., 2004; AbdelSadig, 2006; Abdalla et al., 2009).

Also, handling and storage of beef contribute effectively to meat contamination (Beinempaka et al., 1990). The storage place should be clean and preferably cold (400F). Any temperature above will contribute to microbial growth which act on the meat and cause spoilage whereas the beef must be handled with proper care.

METHODS OF MINIMIZING CONTAMINATION OF BEEF

Rangaswani (1983) reported that meat quality could be enhanced and prolonged when the causes of microbial contamination are drastically reduced or removed altogether. He stated further that quality and wholesomeness of meat depend on many factors of which the following are part:

- Source of Beef

Meat from abattoir slaughtered animals and well established farms generally have less bacteria counts than meat from backyard slaughtered animals because at the abattoir or farm, all the necessary safety and hygiene consideration are undertaken. The level of infection is thus minimized unlike backyard slaughtered animals where animals are killed and dressed on the floor with no better hygiene condition (Zeigler, 1966).

- Health of Animals

Beef from healthy animals keep longer than beef from diseased cattle. This is so because beef from healthy animals are more likely to be free from any microbes unlike diseased cattle. Zeigler (1966) reported that veterinary inspection should be the priority when animals are being slaughtered since it will be proven whether animals are free from any diseases.

- Method of Slaughter

Meat from bruised animals, improperly bled animals, meat contaminated with faeces during evisceration and meat soiled with dirt from skin tends to spoil early.

The normal micro flora from the skin of carcasses includes Salmonella spp., Staphylococcus aureus, and Escherichia coli and organisms of fecal origin (Cross and Overby, 1988). The source of these organisms is not clearly understood but in addition to contamination from the skin and intestines, equipments and tools during slaughter and selling of beef may be responsible for some contamination. To avoid further contamination, potable water should be used for rinsing carcasses and surfaces coming into contact with meat and offal.

PRESERVATION OF BEEF

According to Panda (1995) preservation or meat can be done by adopting several techniques among which are refrigeration, dehydration, curing, smoking, canning, irradiation, microwave heating and use of chemical additives including antibiotics.

- Refrigeration

Refrigeration includes cold storage and frozen storage. In cold storage a temperature between 00C to 70C is employed and in frozen storage at between 150C to 170C (Panda, 1995). Controlled temperature assists in preventing quality loss and maintaining shelf life of the product. Proper air circulation in addition to maintenance of air temperature prevents mould growth and controlled air composition provides fresh air and avoids development of extraneous odour out of undesirable gases. Moisture control assists in preventing excessive dehydration of the product stored (Panda, 1986).

- Smoking

Smoking helps in preserving beef by acting as an antioxidant, bactericidal agent and providing a protective covering on the surface. Smoking also imparts specific flavour to meat. Various types of wood used for generating smoke also impart different flavour to the finished product. However, the best type of wood which could be exploited for producing quality smoked beef is hard wood. Smoke also influences the colour of the smoked beef.

- Curing

This is a process of preserving meat. It is done to preserve and maintain red colour of the meat and also to add flavour. This ingredients used include common salt, sodium nitrate or nitrite, sugar and spices (Beinempaka et al., 1990). Therefore selection of curing formulation is extremely important while using it, as long as large amounts of salt or spice will mask the flavour of meat. The functions of these curing agents are different. Salts assists in preservation of meat while influencing the flavour and texture. Sugar adds to the flavour while checking the drying and toughening effect and nitrate provide the desired pink colour to it (Panda, 1995).

- Chemical Additives

Gill (1998) stated that fresh beef in intact carcass is not severely contaminated except for its surfaces and skinning. However, as it is minced for utilization in further processed products, the solution changes. As the beef gets exposed, added bacterial contamination from hands of operators and machineries used occurs (Borch and Arinder, 2002). According to Panda (1995) the use of additives in beef extends the life of the beef and has a little effect on the colour, flavour and texture.

PACKAGING AND STORAGE

If the beef is to be used for processing, then it is taken straight to the meat cutting and industries to be processed. If they are to be stored for use at a later stage, these are properly packed in suitable polythene bags and kept inside a deep freeze maintained at 15-180C. Panda (1995) reported that the packaging material used for packaging the beef should be colourless, transparent and of adequate strength to safeguard the dressed beef packed during handling and transportation.

Also, the packaging material should not transfer any harmful substances to the packed material. The major objectives in using the packaging material is that it should provide optimum protection to the product packed inside it and to maintain wholesomeness for its anticipated shelf life, while preventing physical, microbial and insect damage with appropriate properties and capacity to preserve its nutritive value in an acceptable way and other quality factors, important in the marketing channel (Panda, 1995).

Various types of primary and secondary containers as well as flexible material are being used for packing beef products. Primary container is one which is in direct contact with the food item. The secondary container is the outer box or wrap that holds the primary units of food such as jars, cans, tins flexible packages which have no direct contact with the food item. Some of the various types of packaging material used for beef packaging include tins, cans, glass, plastic films and laminates.