CHAPTER-2
LITERATURE REVIEW

This chapter presents an in depth study of the various issues relevant to present study.

2.1 Some popular meat products and sausage

Buffalo meat is making considerable head way as popular meat in several countries. It is consumed either as fresh meat or in the form of processed products viz. kabab, chicken, biryani, tandoory chicken, meat tikki, samosa and kofta, steak, hamburger, restructured meat, luncheon meat, patties etc. It is also suitable for preparation of sausages. Products like corned beef and soup concentrates are made commercially from buffalo meat. In India genius meat products like Seekh kabab, Shami kabab and Kofta are popular. Considerable quantities of variety meat products in India are being used in traditional manner.

Sausage made from buffalo meat developed a dark brown colour and lost visual appeal on cooking. The acceptability of Chinese style salami sausages made from buffalo meat could be further enhanced by improving the colour (Almira and Siscn, 1975). Buffalo meat patties containing hydrogenated vegetable oil 15 and 20% level of combination of 10% vegetable oil and 5% buffalo fat had better organoleptic acceptability, but incorporation of 15% or 20% buffalo fat alone resulted in mouth coating (Padda et al., 1986). In general the meat products manufactured from buffalo meat possesses dark color and mouth coating as two major problems, which need to be solved successfully.

2.2 Some sausage products

2.2.1 Coarse - ground sausage

The manufacture of coarse–ground products such as fresh pork sausage, semidry and dry sausage is described here below:

(i) Fresh park sausage: Fresh pork sausage is prepared by selecting fresh, chilled pork, trimmings approx 65% lean and grounding the trimmings through a ½ to 1 in plate. To 100 lb trimmings add 1.5 lb salt, 3.0 oz cane sugar, 2 oz sage, 0.25 oz
ginger, and 4 oz white or decorticated pepper. These are blended in a mixer and finally passed through a 0.25 in. plate. The ground mixture is transferred to a piston stuffer and stuffed into sheep, hog, or collagen casing. Cloth bags, cellulosic casing and plastic pouches are sometimes used 1 to 6 lb units.

The stuffed casing is linked and draped on a smoke sticks and showed with 140-150°F hot water for 5 s to melt any fat adhering to the casing inner wall. When the internal temperature reaches 10°–15°F the sausage is packed by splitting the casing with a Knife blade and removing the split casing.

(ii) **Low acid sausage:** In the case of low acid products, high temperature drying may be utilized to lower the water activity and to inactivate the microbial flora. Drying at high temperature is common in production of some semidry Chinese sausage. Drying is accomplished more slowly and increases the salt concentration so that the water activity (aw) reaches less than 0.90 for long cured hams. The moisture content of low acid fermented meats may be as little as 18 to 22%. The total weigh losses during processing may be as high as 40 to 50%. The end products may have a water activity as low as 0.40 for dry sausage or 0.65 for semidry sausage.

(iii) **High acid sausage:** In this type of sausage preparations, carbohydrates are necessary for fermentation, so are commonly added at the rate of 0.3 to 0.7% by weight. The water activity of high acid sausage must be lower than 0.95 to prevent microbial spoilage. Dry sausage shall have an aw of about 0.40 and semidry sausage about 0.65 to 0.70. This is usually accomplished by adding starter cultures or sometimes by the addition of bacteria in a meat culture commonly known as back slopping. Today commercial cultures of bacteria selected for their ability to produce acid are commonly used. These cultures are either pure or mixed cultures of lactic acid producing bacteria such as lactobacillus, pediococus cervical, or Micrococcus species which are capable of reducing the added carbohydrates to lactic acid.
(iv) **Semidry sausage:** Semidry sausage is usually made from coarse ground pork or beef or a mixture of the two and is characterized by a moisture content averaging 40 – 45%. Dextrose (glucose) should be added at a level of 6 to 12 g per 100 lb of meat for bacteria to use in forming lactic acid. A variety of sausages are included in this group viz. summer sausage, gotenberg, cirvelat, thuringer, and holsteiner. They have excellent quality with little refrigeration because (1) some reduction in microbiological contaminants is achieved in the cooking process, (2) a high salt to moisture ratio contributes to retarding bacterial growth, (3) a low pH of 5.3, provides the tangy flavour and serves protective function.

Summer sausage is prepared by grinding pork trimming through a ¼ in plate and beef trimmings a 1/8 in plate. The ground meats are placed in a mixer and salt, sugar, spices curing agent and starter culture are added and mixed for 2 to 3 min. stuffing is done with a warm water shower for 2 min. to wash the sausage surface free from any adhering particles. The sausages are smoked for 16 hr at 110° F.

(v) **Dry sausage:** Semidry sausage are smoked and cooked to varying degrees, whereas dry sausage is not cooked. Fermentation is common to the production of both semidry and dry sausage.

The manufacturing of dry sausage is more difficult to control than that of semidry or more conventional type sausage. The initial dry sausage mixes are held under specified conditions of refrigeration to establish a medium for bacterial culture. After this the mixture is stuffed into casing of suitable size. During the drying cycle the products lose about 25-30% of their weight. The temperature relative humidity and airflow must be controlled so that drying properly takes place. Hand salami is cooked, Genoa is simply air-dried, while pepperoni may be either cooked or air-dried.

A dry sausage prepared in a beef bladder illustrates very precisely the problems and limitations when sampling dry sausage. The surface or periphery is considerably different in composition from the center of the product. This
condition occurs in sampling all types of sausage but is more pronounced in dry sausage.

2.3 Protein matrix functionality

The manufacture of comminuted processed meat products is dependent on the formation of the functional protein matrix within the product. The properties of this matrix, which are different for each class of processed meats, give the product its characteristics texture and bite.

Saffle (1964) described the basic structure of a meat emulsion as a mixture in which finely divided meat constituents are dispersed as a fat in water emulsion with the discontinuous phase as fat and the continuous phase as water containing solublized protein components. The water and salt soluble proteins of the meat emulsify fat globules by forming a proteins matrix on their surfaces (Swift and Sculzbacher, 1963). These proteins accomplish the function of stabilization because of the presence of reactive groups that are oriented across the fat water interface. (Becher, 1965) concluded that the binding quality of emulsion type sausage is an outcome of the heat denaturation, and accompanying changes in solubility of these emulsifying proteins.

The mechanism of binding between meat chunks could be similar to the mechanism behind the heat initiated emulsion stabilization in finely chopped sausages. However, the major difference would be that in emulsion sausages. Large chunks of meat are present. The binding between chunks of meat is a phenomenon involving structural rearrangement of solubluized meat proteins. A loose protein structure is built up from previously dissolved protein.

Protein gels are formed by intermolecular interaction resulting in a three dimensional network of protein fibers that promotes structural rigidity. The continuous intermeshing system of protein molecules holds or traps water. Critical parameters important to the type of gel formed include temperature, pH, salt and protein concentration. These parameters alter the degree of cross binding by changing the quarter nary structure of the protein or the charged distribution of the
polymers molecules. It is flexibility of the polymer molecules and the numbers of connection between them that determine the elastic/plastic nature of the gel structure. (Paul and Palmer, 1972).

Hassan et al. (1998) conducted research work on effect of different additives on the equality of low fat cooked emulsion sausage of beef. He selected seven treatments. Besides control, six samples were prepared to study the influence of sodium diphosphate, soy protein isolate emulsion, dry soy protein isolate, sodium caseinate emulsion, dry casein and modified starch. He observed that moisture and moisture protein ratio were relatively high, while protein, fat and connective tissue contents and water activity (aw) were relatively low. Colour brightness and total organoleptic scores showed that disodium phosphosphate was the best among the treatments. dry soy protein isolate developed a beany flavour. The aw values were low particularly for the diphosphate treatments nevertheless, sodium diphosphate and dry sodium caseinate treatments gave the best results.

Sen (1999) conducted studies on comparison of mutton, rabbit and their combination of meats for sausage processing. He concluded that mutton produced significantly (p<0.05) less stable emulsion than did either rabbit or combination of mutton and rabbit (50:50). He carried out studies on phyico-chemical and sensory parameters and reported that the water holding capacity (WHC) of rabbit meat was superior (p<0.05) to that of mutton while its fat content was lower (p<0.05) as compared to mutton or combination of meat sausage. The mutton sausage was darker red and firmer (p<0.05) than the rabbit sausage confirmed by Hunter lab and Instron reading. He concluded that flavour, juiciness and tenderness (p<0.05) of rabbit sausage was comparable to combination meats and slightly inferior to those of mutton. However over all palatability score were higher (p<0.05) in mutton sausage and the product prepared from chicken (Hargus et al. 1970; Schnell et al.1972), chicken and rabbit (Baker et al.1972), mutton (Marshall et al., 1977) and chicken, pork and rabbit (Mendiratta and Panda, 1992). They also
carried out studies on combination of meats for various products such as frankfurters and patties (Anjaneyulu et al., 1990).

**2.4 Meat ingredients functionality**

Some meat has a very high myosin content and through appropriate technology this myosin can be extracted and utilized to enhance the quality of finished products (Webb 1974). Meats that are high in stromal protein or collagen have the lowest functionality. Meats that are high in fat also have a very low functionality.

Fat is an important constituents of meat products. Fat content affects the tenderness and juiciness of sausage. The degree of fat dispersion within the product affects the product appearance and texture. The basic process is one of bacterial fermentation to produce lactic acid. Originally wild bacterial were used to ferment the sausages.

The technique of "back slopping" has been replaced to a large extent by the use of starter cultures. The starter cultures are usually a mixture of Lactobacillus and Carbohydrate (Acton, 1978).

Chemical acidultants such as glucono-8 lactones have been used alone or in combination with starter cultures to decrease pH and create the acid tangy taste (Terrell 1978).

Numerous authors have provided extensive and detailed reviews of technology of meat fermentation, fermented products, and starter culture technology (Bacus and Brown, 1981; Smith and Palumbo, 1983).

Research opportunities in meat fermentation include food safety and health concern, economic incentive for efficient production, evolving government regulations and public concern about meat products in general. These issues can be grouped in to three general categories (a) regulatory requirements (b) the need for technological innovations that enhance the quality and production efficiency; and (c) enhancement of meat product nutrition and quality. The latter may be accomplished through development of cultures which provide essential nutrients, increase nutrient availability in situ via fermentation through improved utilization
of non traditional meat sources (fish pastes and sauces), accelerate curing of traditional meat products, generate natural antioxidant to inhibit mutagen formation and produce antimycotic agents for mold inhibition. These suggestions are examples, which offer opportunities to improve fermented meats develop and expand existing market and reduce processing cost.

The fermentation and drying of a comminuted mixture of mainly meat, fat, salt and spices, stuffed in to a casing is a traditional means of meat conservation. Several recent excellent reviewers have underlined the complexity of changes determining flavour and safety, the major quality characteristics of fermented sausages (Montel, et al., 1998, Verplaetse, 1994). Northern and Mediterrenean products are characterised by specific flavours and safety both in “Mediterranean” and “Northern” products. Demeyer et al., (2000) brought extensive research activity on control of bioflavour and safety in fermented sausage, two using Mediterranean technology (Belgium and Italy). They reported that Mediterranean sausages showed higher values and highest residual amounts of myosin and actin. Free fatty acid concentration reflected the nature of raw material, rather than the ripening period. Italian sausages contained the highest amount of hexanol. Norwegian sausages contained highest amount of both free fatty acids and free amino acids. Mediterranean sausages were characterized with “popcorn odour” identified as 2-acetyl-pyrroline. They also noticed that bacteria showed antioxidant activity, enhanced by the presence of magnese.

2.5 Effects of treatments on qualities of meat and meat products

According to Grabien and Raeuber (1988) sodium chloride and phosphate as well as the regime of water addition may cause an improvement in the water holding capacity (WHC) and sensory attributes. Riechert (1992) reported the importance of water binding by meat proteins for quality of meat products like sausage with special reference to the adverse effects of cations present in water besides the beneficial effects of ice on the equality of sausage and other meat products. Sodium chloride (NaCl) has three major functions in processed meat products:
solubilises proteins to create desired texture, provides flavour, and controls microbial growth (Ingram and Kitchell, 1967).

Hand et al. (1987) advocated that up to 35% of the total 2.5% NaCl in beef/pork or turkey frankfurters can be replaced by KCl or MgCl₂ without changing the overall acceptability of a freshly made product; however, after six weeks of storage, the two NaCl replacement treatments were found inferior as compared to 2.5% NaCl treatment with respect to overall acceptability. Replacement of 50% of the total 2.5% NaCl with KCl or MgCl₂ plus phosphate addition was reported acceptable in bologna (Seman et al., 1980).

Puolanne et al. (2001) conducted studies on combined effects of NaCl and raw meat pH on water holding capacity in cooked sausage with and without added phosphate. They reported that pH value of raw batter increased to a level of 0.7 units higher than the pH values of the respective meat mixtures. The increase was higher in lower pH values, with higher salt levels and with added phosphate. Maximum WHC was reached in 2.5% NaCl in all pH values both with and without added phosphate. The pH-values of meat raw materials for the maximum water holding capacity were 6.3. The combined effect of salt and pH is important in high salt content and low pH-values. By 2.5% NaCl, when the maximum WHC was obtained, raw meat pH has the largest effect, but in low NaCl contents, (below 1.0%) only a minor effect in pH-values below 5.9 and above that, showed almost no effect. Approximately the same WHC as with 2.5% NaCl in pH 5.7 can be reached with 1.5% NaCl in pH 6.1 and above.

Anjaneyulu et al. (1994) conducted studies on the effects of salt and polyphosphates blends on quality of buffalo meat patties under hot, chilled and frozen condition. They reported that addition of salt+polyphosphate increased significantly (P<0.01) pH, water holding capacity, emulsion stability, yield and sensory attributes of patties, but reduced cooking losses irrespective of the methods of meat handling. They further noticed that chilling or freezing of ground buffalo meat, preblended with salt+polyphosphate had no significant advantage.
in terms of emulsion stability, yield and palatability of patties, in comparison to incorporation of salt+ polyphosphphate, while processing.

2.5.1 Effects of antioxidants

Not only microorganisms are the cause of major deterioration in meat and meat products, but lipid oxidation also poses severe problem in meat deterioration. The lipid oxidation leads to discoloration, drip losses, off odour, and off flavour development and production of potentially toxic compounds (Morrissey et al, 1994, Gray et al, 1996). Meat and meat products have low oxidative stability. Control of lipid oxidations is major challenge for meat and food scientists. The oxidative effects can be minimized or prevented by chemicals/synthetic antioxidant but for the carcinogenic and other adverse effects of BHA (Ito et al., 1986), natural antioxidants are preferably better and avoid health risk.

BHT (Takahasi, 1992), TBHQ (Van Esch, 1986) and other synthetic antioxidants, the health conscious meat consumers now disapprove the use of chemical preservative is meat foods because of their residual effects. Naturally occurring antioxidant vitamin C and E are very effective in controlling oxidation of meat and meat products.

Lipid oxidation is major cause of chemical spoilage in food system. To avoid or delay this auto oxidation process antioxidants have been utilized with the practice being carried successfully for over 50 years Cuvelier et al., (1994). Synthetic antioxidants butylated hydroxyl toluene (BHT) and butylated hydroxyanisole (BHA) are commonly used as food preservative (Verhagen et al., 1990) and thus consumed in appreciable quantities by humans (Nun et al., 1991). However use of such compounds has been related to health risk resulting in strict regulation. BHA has been shown to cause lesion formation in the rat for stomach. Moreover, several studies have shown that BHT may cause internal and external haemorrhaging at high doses that is severe enough to cause death in some strains of mice (Shahidi & Wanasundara, 1992).
Vitamin C (Ascobic acid) acts as an antioxidant by inhibiting radical formation at double bond of mono or poly-unsaturated fatty acids, quenching free radicals, scavenging oxygen and serving as reductant (Cort, 1982). The multiple effects of ascorbic acid include (a) hydrogen donation to regenerate the stable antioxidant radicals. (b) metal inactivation to reduce the rate of initiation by metal (c) hydroperoxide reduction to produce stable alcohols by non radicals processes and (d) oxygen scavenging.

Sodium ascorbate, when added to ground beef at 500 ppm level, showed lower surface and extract metmyoglobin content of 26.67% and 24.5% respectively during 7 days illuminated display at 4°C whereas control sample had corresponding values of 60 and 70%, respectively (Mitsumoto et al., 1991b). Vitamin C incorporation maintained good colour in ground beef up to 5 days refrigerated display (Shivas et al., 1984) when added at concentration of 500 ppm and 1000 ppm as determined by visual colour scores and spectrophotometric colour analysis. Ground buffalo meat containing 500 ppm of sodium ascorbate (SA) has significantly higher colour score, lovi bond tintometer red colour units and lower metmyoglobin contents as compared to other level of SA. The metmyoglobin was positively correlated with thiobarbituric acid reacting substances (TBARS) number (Sahoo and Anjaneyulu, 1996a, 1997a). In ground buffalo meat, sodium ascorbate(500 ppm) had significantly higher pH, lower cooking loss as compared to other levels of sodium asborbate (Sahoo and Anjaneyulu, 1997a). Ascorbate addition proved beneficial in curing meat products (cooked ham, smoked beef sausages), as it helped to reduce the nitrite contents to less than 5% and the residual nitrite could be maintained at lower level.

Vitamin E as an antioxidant has now received much attention for its ability to maintain meat colour, extend shelf life, improve tastes, reduce drip losses and offer health benefit (Armstrong, 1993), reduced heart risk in uses of vitamin E supplementations (Stampfer et al., 1993, Rimm et al., 1993), and reducing susceptibility of food lipoprotein to oxidations. (Jialal and Grundy, 1992)
have encouraged many food scientists to have concerted research efforts in the area of vitamin E supplementation either through diet of meat animals or by exogenous addition, or by directly adding to the foods for increasing lipid stability during storage and improving flavour and taste of meat products. Vitamin E had been used successfully to enhance product quality and to extend shelf life during storage condition of buffalo meat nugget and ground buffalo meat (Asghar et al., 1991).

Verma and Sahoo (2000) carried out research work on improvement in the equality of chevon during refrigerated storage by tocopherol acetae (TA) preblending. They reported that optimum level of TA for improving the quality of meat was 10 ppm. They observed that 10 ppm TA preblending to chevon meat had significantly (P<0.05) higher water holding capacity, colour score, odour score and lower metmyoglobin (MMb) perent, TBARS number, peroxide value, free fatty acid percent and psychrotrophic plate count as compared to other levels of TA.

Interactive effect of vitamin C and E has also been studied. The mixture of Tocopherol acetates TA, and Ascorbic acid (AA) exhibiting a strong synergistic effect is well recognized (Uri, 1981), Tappel et al., 1961). It was advocated that combined treatment of Tocopherol acetates (TA) and Ascorbic acid (AA) had better effects on quality of the beef loin steaks as compared to dipping the product in to ethanol containing solutions of α–tocopherol acetate or ascorbate alone during 13 days in cold room at 4°C (Okayama et. al., 1987). 10-ppm vitamin E and 500 ppm vitamin C showed the strongest synergism to inhibit pigment and lipid oxidations of beef (Mitsumoto et al., 1991b).

Antioxidants from natural resources have been effectively used to prevent lipid oxidation and deterioration of foods (Kikuzaki and Nakatani, 1993). Plant kingdom offers a rang of phenolic compounds, among which α-tocopherol (vitamin E) is best known as on of the most efficient naturally occurring liposoluble antioxidant (Mallet et al., 1994). Several researchers recommended the use of α-
tocopherol which is consumer friendly and an effectively lipid soluble chain breaking antioxidant (Faustman et al., 1992). Meat containing high contents of unsaturated fatty acids oxidizes more rapidly than either beef or lamb (Pearson, Love and Shorland, 1977). Precooked pork is more susceptible to lipid oxidation with warmed over flavour (WOF).

Natural spices notably the Labitae family, are well known for their antioxidant properties and two plants namely rosemary (R) and sage (S) have been widely reported as having especially potent antioxidant effects (Bishov et al. 1977; Gerhardi & Shroter, 1983; Saito et al., 1976; Watanable and Ayano, 1974).

McCarthy et al. (2001) conducted studies on the evaluation of the antioxidant potential of natural food/plant extracts as compared with synthetic antioxidants and vitamin E in raw and cooked pork patties. They made trials with optimum levels of aloevera (AV), fenugreek (FGK), ginseng (G), mustard (M), rosemary (R), sage (S), soy protein isolate (SPI), tea catechins (TC), and whey protein concentrates. The optimum levels determined were AV (0.25%), FGK (0.01%), G (0.25%), M (0.10%), R (0.10%), S (0.05%), SPI (0.10%), TC (0.25%) and WPC (4%). They evaluated the test ingredients against synthetic antioxidants butylated hydroxyanisole (BHA/BHT) (0.01%) and a supplemented meat containing neutral antioxidant, α-tocopherol (1000 mg α-tocopherol acetate/Kg feed). Ranking the decreasing antioxidant effectiveness of added ingredients in raw patties on day 9 showed that: Control>G>SPI>FGK>AV>M>WPC>S>α-tocopherol >R>TC> BHA/BHT. Cooking resulted in four-fold increase in TABRS values over raw patties with tea catechins being the most effective antioxidant having significantly (P<0.01) lower TABRS value than the cooked control on days 3, 6, and 9. They reported that ranking of decreasing antioxidant effectiveness of added ingredients were as follows: M>SPI>G>FGK>α-tocopherol >AV> control >S>BHA/BHT>R>WPC>TC.BHA/BHT had the most beneficial effect on cooked meat redness.
Aguirrezabal et al. (2000) conducted studies on the effects of paprika, garlic and salt on rancidity in dry sausages. The evolution of rancidity in these products was evaluated by means of free fatty acids contents, peroxide value and TBARS during the ripening period. He reported that the paprika was even able to inhibit the pro-oxidant effect of salt. Also four batches of chorizo were made to compare the antioxidant effects of spices (garlic and paprika) with mixture of nitrate, nitrite and ascorbic acid. In this respect, paprika and garlic were as effective as mixture of additives in inhibiting lipid oxidation.

Ockerman and Sun (2004) conducted studies on effect of different garlic products on Chinese-style sausage. They incorporated fresh garlic, garlic powder and essential oil of garlic in sausage formulation. They concluded that there was no difference between the effects of different garlic products on either total plate count or on oxidation value. However, the garlic oil resulted in lowest acceptability scores. They referred that there are lot of reports concerning the antibacterial and antioxidant effects of garlic on meat products (Jurdi-Haldeman et al., 1987, Al-Deaimy and Barakat, 1970, Dewitt et al., 1978, Lin et al., 1991E1-Khateib and El-Rahman, 1987, 1987; Ismaiel and Pierson, 1990).

The use of polyphosphates (PP) in processed meat products have been widely accepted due to their desirable effects. Food grade phosphates are incorporated in the formulations of meat curing brines, sausages, sectioned and formed meat products and restructured meat to improve the quality of processed products with respect to yield, water binding capacity, emulsion stability, colour, texture, flavour and to inhibit oxidative rancidity.

Phosphates perform the following three basic functions (1) maintaining pH by buffering (2) sequester metal ions and (3) act as polyanions to increase the ionic strength of solutions. Orthophosphates are the best buffers. Buffering capacity is greatest for polyphosphates among PP and decreases with increasing chain length. Pyrophosphates are the best among the short chain PP for sequestering heavy metal ions such as iron and copper.
Pyro, Tripoly and hexa-metaphosphate have effective antioxidant effects (Tims & Watt, 1958). The PP provides protection against development of oxidative rancidity in cooked meat at concentrations as low as 0.01-0.05 % (Watts, 1962). Sodium chloride acts as a pro-oxidant in processed meat products by accelerating oxidative reactions of unsaturated lipids causing increased rancidity (Gray, 1978). Use of phosphates decreased off-flavour and rancidity development in many meat products and the pro-oxidant effect of NaCl was marked by the antioxidant properties of PP (Huffman et al., 1987). However, Schwartz and Mandigo (1976) reported synergistic effect between NaCl and STPP in retarding oxidative rancidity and enhancing sensory traits of restructured meat.

The reduction in oxidation is probably related to complexing of trace heavy metal contaminant in the curing salts and binding of ferrous ion by the phosphates since free ferrous ion is an active antioxidant in the cooked meat (Pearson and Tauber, 1984).

2.6 Microbial contamination in meat and meat products

Highly offensive substances may not be produced if abundant glucose is present at the tissue surface or the flora is dominated by organisms that do not produce offensive by-products from amino acids, such as Acinetobacter and Morale species (Lerker et al., 1965). In these circumstances, spoilage will become apparent only at higher bacterial numbers, when visible colonies of slims appear on moderately offensive by-product of glucose metabolism accumulates (Shelef, 1977).

Gill and Newton (1978) advocated that under aerobic conditions, when tissue surface was exposed, the spoilage flora were dominated by pseudomonas species irrespective of the tissue pH. Under anaerobic conditions, the microbial flora will usually be dominated by species of Lactobacillus, provided the tissue pH is below 5.8. If the tissue pH is above 5.8, or conditions a micro aerobic rather than strictly anaerobic, enterobacteria or Brochothrix thermosphacta may predominated (Grau, 1980, 1981). If tissue pH is above 6.0 the potent spoilage
organism altermonas may grow under either aerobic or anaerobic conditions. (Taylor and Shaw, 1977).

These observations on pH sensitivity apply only to tissues held at chiller temperature. As the temperature increase with in the growth range, an increasing fraction of pH-conditions and be capable of initiating and maintaining growth (Gill and Newton, 1978; 1982).

Gill et al. (2001) conducted studies on the effects of hot water pasteurizing treatment on the microbiological condition of beef used for hamburger and patty manufacture. They reported that effective pasteurization was established at 85°C for 60 S and the flavour of patties was not distinguished from the normal products. Samples of patties pasteurised below this time viz. 30S, 45S yielded E.coli. In a previous study, conducted by Gill et al. (1999b), it was reported that a treatment with water of 85°C for 10 S of commercial carcass would reduce the number of Escherichia coli on carcass by two order of magnitude. It was reported that beef was frequently contaminated with during carcass breaking process (Gill et al., 1999).

Kakar and Udipi (2000) carried out research work on microbial quality of ready-to-eat (RTE) meat products sold in Mumbai (India). A wide range of meat products (RTE) chicken burger, chicken pizza, chicken lollypop, chicken patties, chicken role, mutton chop, mutton burger, mutton kabab and mutton samosa were selected for study. They reported that all the RTE had high total viable counts (log cfu/g 7.2±1.55), Staphylococcus count (log cfu/g 3.88±2.10), Fecal coli form count (log cfu/g4.70±2.37) and fecal streptococcal count (log cfu/g 3.56±2.25). Coagulase positive S. aureus was isolated from 7.7% samples of chicken roll and mutton chop, 7.1% of mutton burger and 6.6% of chicken pizza. S. enteritidis was detected in one sample each of chicken roll and mutton chop, S. gallinarum in chicken pizza, chicken burger and chicken patties and S. typhimurium in mutton burger. Street samples were more hazardous followed by small shops and railway stall samples.
Tiwari et al. (2002) conducted studies on microbiological status of buffalo meat from slaughterhouses and related outlets. They collected 103 samples from Municipal slaughterhouses of three different cities. The samples were subjected to standard plate count (SPC), Staphylococcal, Coliform, Psychrophilic and yeast and mold counts. They reported that SPC of buffalo meat samples collected from slaughterhouses and retail shops varies from 6.2 to 6.7 (log cfu/g) and 7.0 to 7.9 (log cfu/g) respectively. Staphylococcus counts of the same samples were in the range of 4.8 to 5.4 in slaughterhouses and 5.3 to 6.5 (log cfu/g) in retail shop samples. Coliform count varied from 3.6 to 4.4 (log cfu/g) and 3.6 to 4.5 (log cfu/g) in slaughterhouses and retail shops samples respectively.

Sachindra et al., (2004) conducted studies on microbial profile of buffalo sausage during processing and storage. They reported that the microbial count in raw meat were total plate count (TPC) (log cfu/g) 5.41±0.23, coliform (MPN/g) 23.2, staphylococcus aureus (log cfu/g) 1.57 ± 0.11; yeast and mold (log cfu/g) (0.60 ± 0.20). Cooked sausages had the microbial counts: TPC (log cfu/g) 3.75 ± 0.31; coliform (MPN/g) 0.2; LAB (log cfu/g) 0.07 ± 0.01; yeast and mold (log cfu/g) 0.72 ± 0.07. Staphylococcus aureus, Clostridium perfringens and Bacillus Cereus were not detected in cooked sausages. The results of their study revealed that shelf life of cooked buffalo sausage was 31 days in either vacuum or CO₂ at 4 ± 1°C. They advocated that measures such as low initial microbial counts, hygienic precautions during preparation of sausage, steam cooking for 45 min., vacuum or CO₂ packing and storage at 4 ± 1°C would control the microbial growth and provide wholesomeness and safety to the buffalo sausage.

2.7 Microorganisms associated with edible organs

This group comprises live, kidney, spleen, pancreas, testicles, heart and brain. Available literature deals largely with livers. Kidney and heart have received some attention, but other tissues have been almost totally neglected. It is therefore necessary to consider the microbiology of tissue in detail and inference for these observations can be extended to the other tissues.
Livers obtained soon after removal from the carcass carry both an external and an internal flora. The external flora is dominated by Gram-positive mesophile, mainly micro cocci and is therefore similar to the external flora, indicating that it has arisen from bacteria migrating in the open sinusoidal structure after the organ has been removed from the carcass. Even if an increase flora was presenting the tissues, the numbers of intensive contaminants will be small compared with the extrinsic bacteria invading the tissues during organ removal. The types of organisms presenting an intrinsic flora an equally organisms present in an intrinsic flora an equally likely to be present in large numbers, in the external flora, a major part of which ultimately originates from the excretion of the animal. Initial numbers of external contaminates are between $10^3$ and $10^5$ per cm$^2$ and internal contaminants number about $10^2$/g. Growth of organisms in the external flora commences with little delay, which development of the deep tissue flora shown on extended lag (Gill and Delacy, 1982). Consequently, in comparison with external flora, the internal flora is of little, if any practical significance.

2.8 Pathogenic Organisms:

The characteristics, conditions required for growth, and association with individual tissues of infections and food poisoning organisms occurring in meats and meat products have been described by some reviewers in this series (Brayan, 1986, Silliker and Gabis, 1986). Most of these organisms are known to be capable of growth on meat, and so presumably on meat by products. For individual organism, growth will occur provided that contaminated surfaces remain moist, the tissue pH does not fall below permissible values, a suitable local gaseous environment persist or develops, and temperatures remain within the growth temperature range. A developing spoilage flora is unlikely to inhibit the growth of pathogens before flora numbers approach maximal values (Gill, 1986).

As by products are usually collected in bulk soon after their removal from the carcass, tissue surfaces are generally not subjected to the evaporative drying that assists in restricting the growth of organisms on carcasses (Nottingham,
The pH of many other tissues does not fall to the low values (5.5-5.8) that can be inhibitory to pH sensitive organism. Many of the organisms of public health concern are facultative anaerobic, so they may grow on both exposed surfaces or within tissue masses. Micro aerobics such as compylobacter, may grow in areas close to the surface of tissue masses while conditions suitable for growth of cold tolerant pathogens such yersina and listeria. It is generally considered that a temperature of 10°C is adequate to control pathogen proliferation during the collection and processing of meats, but for profound storage chilling below 3°C is required to limit the growth of cold tolerance pathogens (Ingram and Simonsen, 1980).

Some problems encountered with fermented meat products include staphylococcal food poisoning, caused by ingestion of heat-stable enterotoxin, from defective fermented dry or semi-dry sausage, especially with an initial S. aureus inoculum greater than $10^4/g$ (Bacus and Brown, 1981; Smith and Palumbo, 1983). Salmonelloses has rarely been attributed to fermented meat products because lactic acid–forming bacteria are inhibitory (Bacus and Brown, 1981). An enteropathogenic strain of Escherichia colli was somewhat resistant to fermentation by P. cerevisiae followed by drying in making turkey, since viable cells were only decreased by 90%. Smith and Plumbo (1983) who reviewed relevant research indicated that pH drop resulting from fermentation of glucose was single most important factor in controlling formation of botulinum toxin in fermented sausage. Fermentation and drying of turkey sausage using P.cerevisiae as the starter culture prevented growth of C. perfringens and reduced viable cell numbers. Growth of Yersinia enterocolytica in cured meat at 35°C was controlled by Pedicoccus pentosaceus, P. acidilactici, and Lactobacillus plantarum.

Fermented dry and semi-dry sausage may contain the pressor amines, tyramine, truptamine, phenylethylamine, and histamine. These have been associated with some outbreaks of food poisoning in United States. Presence of biogenic amines can be controlled in fermented sausages by rigid employment of
good hygiene and by use of short fermentation times employing active starter cultures that lack amino acid decarboxylates (Smith an Palumbo, 1983).

2.9 Composition and nutritive nature of meat and meat products

Water presents largest proportion of muscle with average of 75% for raw muscle that is very low in fat content, water is present in muscle to soluble some components. Percentage water in muscle is inversely proportional to fat percentage and directly proportional to protein percentage and directly proportional to protein percentage. From 8 to 20% of the water is likely to tightly bound with approximately 5% of the water (representing 4% of muscle weight) being tightly bound by electronic attraction to hydrophilic groups on the proteins. It can remain tightly bound even during application of severe mechanical or other physical force and is scarcely altered in amount by changes in structure and changes in protein. Additional water molecules are attracted to the bound ones in layers with progressively weaker attractive forces as the distance from hydrophilic groups becomes greater.

The remainder of the water is relatively free. Most observed charges in water-holding capacity (WHC) involve alternation in the form of water, which is immobilized by the physical configuration of the protein, but is not bound to then. Forrest et al. (1975) refer to this as immobilized water. A third category of water is termed “Lose” water by Lawrie (1974) and free matter by Forrest et al. (1975) and Judge et al (1989).

The nutritive value of all food, including meat and meat products, is being seriously considered in view of consumer interest and demand. Nutritional labeling is now required for most manufactured meat products. The major meat packers and processors are providing information on the nutritional value of most products. Such information is also now going to be required fresh meat in spite of its variability and the difficulty of controlling composition. The Food and Drug Administration does not require absolute compliance with label declaration but allows some degree of flexibility is accordance with estimates of variability.
Labeling has, however, resulted in less product variability. Development of more manufactured meat products, will no doubt increase, the drug of compliance.

This is important since the consumer can no longer recognize the traditional food groups and utilize such information in properly balancing his own diet. Processed meat items are also manufactured foods, and are required to have labels specifying their nutritive content.

2.10 Nutritional value of edible by-products and their utilization

Edible by products may be used in sausage formulation for the reason that some of them have significant nutritional value. Pearson and Duston (1988) advocated that liver that is the best source of niacin and vitamin B₆ among edible meat by products and could be used in combination with lean meat. In a 100g serving, liver contributes between 37% and 97% of Recommended Daily Allowances (RDA) niacin and 65% of RDA of vitamin B₆. While other edible meat by products like lungs, tongue and simmered or braised brain most of the organ meats contribute between 16 and 44% of RDA niacin. Beef and pork kidney contribute 24 and 21% of vitamin B₆ RDA respectively. The other by products provides less than 18% of the RDA for vitamins. Liver and kidney provide highest level of folacin of the meat by products. The folacin contribution of 100g of liver to RDA ranges from 41 to 82%. Beef and lamb kidney contribute 25 and 21% of the RDA respectively. The remaining by products contributes less than 2% of the RDA folacin.

Many organs meat contain more polyunsaturated fatty acids than does the skeletal muscle tissue. Among the by products, brain, chitterling, heart, kidney, liver and lungs are lowest in monounsaturated fatty acids (Hunchinson et al., 1987). A number of edible by products have considerable nutritional value due to their low fat and energy, high level of protein, riboflavin, niacin vitamin B₁₂, iron, zinc and copper. Liver contains the greatest quantity of most nutrients in edible meat by products. In spite of the high nutritional values of many edible by
products, their consumption is relatively low as compared to lean beef, pork and poultry (Bunch, 1987).

Generally, protein, fat and calories show an apparent increase and moisture an apparent decrease when data for raw and cooked meat by-products are examined on an equal weight basis. Ears, feet, lungs, and pork tails are exceptions. On cooking these products, there is decrease in protein and increase in moisture, which is probably due to the water absorption properties of the collagen in the tissues. Moisture loses on cooking are usually greatest for those products, which have the lowest cooking yields (Pearson and Gillett, 1997).

Many of the cooked by-products have less protein and fat, and are higher in calories than the cooked lean meat tissues from animal. However in the raw state, brains, pancreas, thymus, tongue, tail and chitterlings contain more fat and/or calories than lean tissues. The cooking method also affects fat content. As expected, fried products contain more fat and calories than the same product cooked without the addition of fat. For example, fried beef liver has 8.00g fat/100g and 217 cal/100g, whereas braised beef liver has 4.89g-fat/100g and 161 cal/100g food. Part of this difference can be attributed to the lower yield on frying than braising beef liver.

Muscle tissue and organ meat proteins have a higher biological value than other edible meat by-products, since the relative amounts of essential amino acids present in these products are similar to those amounts required to maintain nitrogen balance in man (Rice, 1971). The amino acids of meat products are highly available. The protein from meat products are 91-100% digestible where as digestibility of protein from plant sources can be as low as 65-75% (Hopkins, 1981). The variation in amino acid composition between products and species is small and the essential and non-essential amino acid composition of lean meat and organ tissues is fairly constant. The exceptions occur in products containing large amounts of connective tissue-up. The protein quality of these foods is lower than that of products with little connective tissues (Dvorak and Vognarova, 1969,
A number of offal tissues have a greater proportion of connective tissues than lean meat (Gault and Lawrie, 1980). Connective tissue presents about 10% of total protein lean meat tissue-up. It is two to three time higher in some offal meats (Lawrie, 1981). The amino acid composition of connective tissues protein differs from that of lean tissue and organ meats due to its relatively high amount of proline, hydroxylproline and glycine and its low levels of tryptophan and tyrosine (Rice, 1971). Ears feet lungs, stomach and tripe have high amounts of those non-essential amino acids since they contain a relatively high proportion of connective tissue.

Reddy and Vijaya Lakshmi (1998) conducted studies on the effect of skin, gizzard, heart and yolk incorporation on quality of frozen chicken meat sausages. They reported that addition of skin, gizzard, and heart in the preparation of sausages significantly (p<0.01) reduced fat separation value, percent moisture, crude protein, ether extractives and juiciness scores. Sausages prepared from raw meat obtained significantly (p<0.01) higher score for appearance, flavour, juiciness, firmness and over all acceptability as well as higher percent cooking losses and moisture content, while pH and 2-thiobarbituric acid (TBA) values were lower. Frozen storage (\(-18\pm 1^\circ\) C) of sausages for 60 days significantly (p<0.01) increased the pH, TBA value, percent ether extractives and protein contents while the mesophile counts, percent moisture and organoleptic score were reduced.

2.11 Demand for health and nutrition

Recently there has been as increased awareness by consumers of the importance of healthful meat, poultry, and fish products. Although there has been interest in reducing the fat and salt (Sodium) content of these muscle based foods for 10 or 20 years, the demand for so called “Health” food items has led to the development of “reduced” or “low fat” and “reduced salt” products to meet their requirements. To meet the demand for such “Healthful” meat products technology has led to alteration of traditional processing procedure and the use of a number of
non-traditional additive in order to achieve those aims and at the same time to maintain acceptance.

“Reduced” or “low fat” meat, poultry, and fish products require the addition of water binding agent, which is needed to maintain juiciness and tenderness.

Another area of some concern to consumer and processors has been the reduction of cholesterol levels in meat products. The basis for this demand is the fact that blood cholesterol levels are correlated with increased coronary heart disease (CHD). So there are chances of incidence of coronary disease due to increase in blood cholesterol level. Consumers have equated blood cholesterol level with dietary cholesterol although there is actually little evidence of such a relationship nevertheless, some consumers will pay a premium for reduced fat or low cholesterol products. Replacement of greater part of fat by thickening agents provides lubricity or swelling. Examples are gums, starches, and hemi cellulose. A fat mimicking system can develop textural properties of fat in low fat food. Reduced fat system inherently have less fat and more water since many volatile aroma compounds are more oil soluble than water, therefore aroma can be perceived strong.

2.12 Quality Evaluation: (Sensory, Textural and physico-chemical)

Quality of meat products very much depends upon the quality of meat used for its preparations. Evaluation of meat quality is based on two main considerations: first, meeting the requirements of the meat trade, and second, satisfying consumer preferences. The former is concerned with carcass quality and the latter with meat quality. Carcass quality is assessed on the basis of conformation, finish (fat status), and a combination of characteristics including color of muscles and fat, marbling, texture of muscle, and appearance of bone and cartilage as related to the species, sex, and age of the animal (Gerrard, 1964; Yeates, 1965, Post et al., 1972). These factors determine the grade of the carcass, but their relative importance, and hence the grade, varies considerably.
For simplicity, the characteristic of meat quality may be categorized as follows: first, the factors contributing to the appearance of the meat must be taken into account, which include the color of lean and fat, and the texture. These traits may be important in the case of fresh meat, but may be of less significance in cooked meat. Second, the factors contributing to the eating quality of meat must be considered, such as tenderness, juiciness, taste, and aroma. Assessment of these quality parameters may be determined in two different ways:

(i) By overall evaluation using subjective techniques, and

(ii) By analytical assessment utilizing objective techniques.

2.12.1 Subjective Evaluation

This involves evaluation by the physical senses of the consumer, including taste, smell, and feel. Color and general attractiveness are judged visually. Tenderness in registered by the ease with which the teeth and jaw muscles perform their task of mastication (Cover and Hostetler, 1960). Simultaneously, an impression of juiciness is also experienced (Cover, 1962a, b), which depends on the amount of liquid released from the meat together with the amount of saliva added to it. The general belief is that salivation is adjusted to make up for any deficiency of juice in the meat. This naturally results in added fatigue for the salivary glands.

During the mastication process, however, the gustatory papillae, stimulated by the juice, receives the impulse of taste. The perception of flavor originates from the combined perceptions of taste and odor assessed by the gustatory papillae and nasal mucous membrane, respectively. These stimuli are transmitted by nerves to the higher brain centers (Amerine et al., 1965; Beidler, 1967; Amoore, 1967; Amoore et al., 1972) at which level the quality criteria for tenderness, juiciness, and flavor are registered. According to Deatherage (1963) tenderness is the first and foremost quality that is sought in meat, irrespective of the methods of cooking. Tenderness remains the main criterion for judging quality. Since flavour and juiciness are less variable and can be compensated for by liberal use of
gravies, seasonings and vegetables. The fact is that tenderness actually improves the remaining quality characteristics.

The foregoing subjective evaluations are often made by a panel of judges, and this leads to one of the most logical methods for assessing meat and meat products quality—the taste panel on a sound statistical basis. It is sufficient to say that the panel can range from a very highly trained and competent group to a household type without previous training (Amerine et al., 1965). Frequently, the panel uses a scorecard utilizing the hedonic scale, where each quality criterion is described on an arbitrary numerical scale. The ability of the judges to differentiate correctly for various attributes of quality can be ascertained by several statistical methods (Weir, 1959; Amerine et al., 1965).

Within sensory quality characteristics, flavour is very important. Where as purchase and rejection of the product is initiated by appearance (colour) and texture. Flavour is the feature that convinces the consumer to buy the product again. The typical meat colour is associated with the formation of nitric oxide heme pigment stabilised by denaturation of globin component (Acton and Dick, 1977). In some type of mediteranean product, such as Spanish chorizo sausage, its importance is shared with that of colour of added chilli pepper (Fernandez-Fernandez et al., 1998). The importance of cured meat colour for fermented sausage has of course been diminished by the recent legislation in the E U of colouring agents such as Monaseus red (Angkak), cohenille and betanin, derived from yeast, a sea insect and red beet respectively. Methods for their determination have been established (Brockman, 1998) and although their use may facilitate technology, it also allows for use of raw materials subject to less demanding quality characteristics. The aptitude of sausage for slicing is brought about by the combination of gel formation because of acidulation of salt solubilised protein followed by drying. Again the basic interaction of salt extracted muscle protein with pH decrease and water loss is affected by a numbe of additives, including, e.g. milk and soy proteins as well as polysaccharides. Flavour is a complex
sensory reaction involving taste, smell (odour) and texture of a product. Odour or aroma is the most important component, because of the nasal receptor for numerous volatile components released during chewing and ingestion. The number of aroma compounds derived from the spices and smoking exceeds that of the compounds derived from metabolism (Schmidt and Berger, 1998). The latter however are considered very important for the specific sausage flavour (Stahnke, 1995b).

Sensory quality of meat product can be measured in several ways by either sensory or instrumental methods or combination of both. All methods have their advantages and disadvantages. Preferably, sensory panel measures sensory quality of dry sausage. A consumer panel, trained laboratory panel or an expert panel depending on the purpose in question is used. Sensory evaluation can be rather laborious and expensive and are therefore often replaced to various extents by instrumental methods, not only in development and research but also for regular quality control in the factory.

Several sensory methods have been developed and are described in excellent text books (Piggot, 1984; Meilgaard et al., 1991). Sensory evaluation methods can be divided into difference tests, scaling and ranking tests and descriptive tests. In general difference tests can be accomplished with untrained panelists, whose numbers depend on the size of the difference, when a description tests need a carefully trained panel in order to get reasonable results (Meilgaard et al., 1991). Difference test allows the investigator to determine if an ingredient or process change causes significant difference in the sensory perception of the product. Comparison tests (triangle, paired comparison, duo-trio etc.) only indicate whether a difference exists or not, where as ranking tests also give information about the direction of the difference trend.

Kulkarni et al. (1993) conducted studies on the storage stability and sensory quality of washed ground buffalo meat and meat patties during refrigerated
storage. They reported that washing generally reduced thiobarbituric acid (TBA) value and EDTA washed meat had lowest TBA value.

Reddy et al (2004) conducted studies on quality evaluation of Emu bird sausages and patties during refrigerated and frozen storage. They concluded that frozen stored (-18± 1°C) that emu sausages and patties during refrigerated and frozen storage (4±1°C and -18± 1°C respectively) showed a significantly (P<0.05) increasing trend in mean pH, thiobarbituric acid (TBA) and extract release volume (ERV) values with storage period up to 42 days under refrigeration and 90 days in frozen storage. Frozen stored sausages had significantly higher scores for colour, flavour, juiciness and over all acceptability up to 60 days of storage.

2.12.2 Objective evaluation:

Various methods have been adopted to assess the quality criteria of meat objectively (Pearson, 1963; Olson et al., 1976). Although certain limitations are associated with this approach, the results are fairly promising for some of the criteria, i.e., color, tenderness, and juiciness.

The color of fresh meat is determined largely by the concentration of the heme pigment, myoglobin, but often does not yield results that can be closely related with visual color ratings this is because color measurement by this method does not reflect the chemical state or distribution of the myoglobin; nor does it takes into account the degree of dehydration of the meat, especially at the surface. However, the measurement of light reflected from the meat surface (Snyder, 1965; Stewart et al., 1965a; Snyder and Armstrong, 1967; Govindarajan, 1973; Francis and Claydesdale, 1975) or the comparison of meat color with known standards (Doty, 1959; Forrest et al., 1975; Eagerman et al., 1977 gives information that is closely related to visual assessment.

More than a dozen mechanical devices have been developed to measure tenderness and texture of meat, usually based on one of the following principles shearing, penetrating, biting, mincing, or compressing actions. These mechanical devices have been reviewed in detail by different authors. Sale, (1960), Pearson
(19630, Szczesniak and Tergeson, 1965), who had pointed out some of their inherent errors and limitations. Nevertheless, the Warner-Bratzler shear seems to be the most widely used and has come to be regarded as the objective standard for the determination of tenderness.

Extensive work has shown that there is a correlation between Warner-Bratzler shear values and taste panel evaluation of tenderness. Correlation coefficients between shear value and organoleptic tenderness rating vary from low to high values. Earlier findings have been reviewed by different workers (Doty and Pierce, 1961; Pearson, 1963; Szczesniak and Torgeson, 1965) summarized 41 sources of information reporting a significant correlation between shear value and sensory evaluation of tenderness; however, there were another 10 references showing insignificant results. According to the review by Pearson (1963), the correlation coefficients from different studies ranged from 0.6 to 0.85 with an average of about 0.75. He suggested that a relationship of this magnitude is quite satisfactory considering the variability within the sensory panels alone, and that with sufficient repetition and standardization of the procedure, the Warner-Bratzler shear test gives a good estimate of tenderness. Similar views were also expressed by Doty and Pierce (1961).

Asghar (1969) also found a significant correlation between subjective and objective evaluation of tenderness based on both shear values and the rigidity index. However, his data suggested that shear value is not sensitive enough to be a complete substitute for taste panel evaluation. Firstly, he pointed out that the standard deviation for the shear readings was large, and secondly, that the shear force or rigidity index measured only one of the criteria of importance to mouth feel by consumers.

Baldini et al. (2000) conducted studies on the effects of thermo hygrometric conditions on microbiological and physico-chemical characteristics of dry fermented sausage. Five partners conducted the study, 3 partners salami-producing companies and 2 partners manufacturers of conditioning plants for
ripening of meat products. The aim of the study was to promote knowledge of chemical, physico-chemical and microbiological characteristics of salamis and of the parameters directly connected to water loss (rate of evaporation and diffusion) during various phases of industrial preparation.

Ronrong et al. (1998) conducted studies on sensory and instrumental properties of smoked sausage made with mechanically separated poultry (MSP) meat and wheat protein. They reported that added wheat protein affected hardness, springiness and juiciness, where as flavour ($p<0.05$). Instrumental data showed that hardness, springiness and cohesiveness decreased with increasing water content ($p<0.05$) and increasing wheat protein levels, increased hardness and cohesiveness ($p<0.05$). Functional improvement of processed meat products by non meat protein additives (Parks and Carpenter, 1987) has been well documented. Also due to off flavour of soy products (Lecomte et al., 1993) and high value airy products, oat and other cereal products are preferred by products manufacturers over dairy and soy products as additives for meat products (Lapvetelainen et al., 1994). Wheat protein, an abundant and economical source of food protein, have the unique ability to form visco-elastic mass of gluten when mixed with water (Prithard and Brock, 1994) and thus have great potential as non meat-additives.

Since Szczesnaik (1963) defined a classification system for texture properties in sensory evaluation. The method has extensively used by many research groups (Lyon et al., 1980; Cohen et al., 1982; Cardello et al., 1983; Berry and Civille, 1986; Jhonson et al., 1990; Mecerlinet et al.1994) who had conducted sensory and instrumental Texture Profile Analysis (TPA) of meat products. It was reported by another group of research workers that sensory characteristics have often correlated highly with corresponding instrumental attributes in meat products (Lyon et al., 1980). Tenderness is a critical attribute for quality of meat products. The tenderness and hardness are inversely related (Cross et al., 1986). Both sensory and instrumental hardness, springiness and cohesiveness and primary mechanical properties that can be used to characterize the texture of smoked
Instrumental procedures quantify physical and textural change over time and measure different component characteristics of meat system (Lyon and Wilson, 1986; Smith et al., 1988) studied both Allo-Kramer shear procedure and TPA methods using an Instron Universal Testing Machine and detected differences among samples of broiler breast meat.

Cofrades et al. (2000) conducted studies on plasma protein and soy fiber content on the properties like colour and texture of bologna sausages as influenced by fat level. Higher soy fiber and plasma protein content favoured the formation of harder, chewier structures with improved fat and water binding properties. Fat reduction decreased texture properties and the increased weight loss. Cooking loss was affected ($p<0.05$) by interactions between plasma protein and fat and chewiness was affected ($p<0.05$) by interactions between soy fiber and fat plasma protein influenced binding and textural properties more than soy fiber and was thought best to limit the effect of fat structure. Earlier studies were conducted on this aspect of low fat meat products and it was reported from the results of the studies that a major goal of meat industry in recent years has been to develop healthier meat products, containing less fat and incorporating health enhancing ingredients. Fat has a major influence on the binding properties, tenderness, juiciness and mouth feel and over all appearance of processed meat such as emulsion type products (Sofos and Allen, 1977; Hand 1987; Claus, 1989, 1990; Cavestany, 1994). Fat reduction entails replacement of fat with water, but this can render products unacceptable due to a number of problems including those associated with texture and water binding properties. Non-meat ingredients have been used to limit the detrimental effects of reducing fat (Sofos and Alen, 1977; Fogeding and Ramsey, 1986).

Functional improvement of processed meat products by non-meat protein additives (Parks and Carpenter, 1987) has been well documented. Also due to off flavour of soy products (Lecomte et al., 1993) and high value airy products, oat and other cereal products are preferred by products manufacturers over dairy and
soy products as additives for meat products (Lapvetelainen et al., 1994). Wheat protein, an abundant and economical source of food protein, have the unique ability to form visco-elastic mass of gluten when mixed with water (Prithard and Brock, 1994) and thus have great potential as non meat-additives.

2.12.3 Physico-chemical properties of meat and meat products

(a) pH

Generally, meat from freshly killed animals has an average pH of 6.8, which falls rapidly to 5.4-5.6 (ultimate pH) in duration of 48 hours post-mortem. Depending on the storage conditions, status of meat chilling and the degree of bacterial contamination, the pH may remain constant for a while or begin to rise gradually due to autolysis and the growth of bacteria. When meat reaches a pH of 6.4, decomposition may set in and at 6.8 and above, the signs of decomposition viz., changes in colour, odour and texture may become apparent. The level of pH attained may depend on several factors, such as kind of animal, level of nutrition, physiological status before death, degree of stress prior to slaughter, amount of muscle glycogen, heredity, type of muscle and temperature during the post-mortem glycolysis.

The accumulation of lactic acid the due to post-mortem glycolysis reduces the pH to 5.8 within 12 to 24 hours of slaughter. The rate of fall of pH chiefly depends on the temperature post-mortem and the amount of muscle glycogen available at slaughter. Fatigued animals show a rapid fall of pH to 5.6 in a short duration while the carcass is still warm. The duration of reaching low ultimate pH depends on the temperature post-mortem. The pH of 5.4 to 5.6 will be reached by meat in 8 hours post-mortem when stored at 37°C, in 24 hours at 15°C and in 48 hours at 1°C. Hence, it is evident that the duration of attaining low ultimate pH will be longer at lower temperatures and vice-versa.

The estimation of pH of meat is of value in determining durability while judging the suitability of borderline carcass meat for further utility. Meat of alkaline nature will exhibit faster rate of microbial spoilage than of the acid. The
pH of meat has a significant relationship to eating quality. The low ultimate pH generally increases tenderness, which is positively correlated to WHC (Govindarajulu, 2002).

The ultimate pH value of raw buffalo meat and time to attain the pH value depends upon many factors, namely, holding temperature, types of muscle i.e. portion of carcass and glycogen content of the muscle. Ziauddin et al., (1994), observed that biceps femoris (BF) muscle with initial pH of 6.97 had ultimate pH value 6.

(b) Water Holding Capacity (WHC)

Water holding capacity is a measure of how much water is bound in the uncooked state. Water holding capacity is a general term used to describe the extent of water held or bound by meat or meat products once cooked. It includes the more specific term used in literature such as cooking yield, cooking loss and water binding value (Trout and Schmidt, 1983).

A high WHC in the lean meat is a decisive factor for producing a high quality sausage (Hamm, 1981). It also prevents rendering out of fat and results in lower losses during smoking, cooking, storage and canning of the sausages. Grinding of meat increases WHC by enhancing the number of polar groups available for binding with the water molecule and the water is bound better when added after the meat is ground (Hamm, 1970) Salt and poly phosphates are extensively used in many meat products due to their desirable effect on WHC and other functional properties of meat. (Huffman et, al .1987).

The water holding capacity is the ability of meat to hold fast to its own or added water during the application of any force (pressing, heating, grinding etc). WHC is directly related to eating quality and influenced by pre-slaughter, slaughter and post-slaughter techniques. The water in muscle is available in two forms- bound and free water, the former amounting to less than 5 percent is directly bound to the hydrophilic groups of proteins and the latter is responsible for most of the changes observed in water holding capacity of meat. A diminution
of in vivo WHC is manifested by exudation of fluid termed as weep in meat that has not been frozen, as drip in thawed meat and as shrink in cooked meat, derived from both aqueous and fatty sources. The techniques of slaughter and post-slaughter seem to influence WHC. The WHC of fresh meat is high and drop gradually within a few hours, reaching the minimum in 24 to 48 h but slowly increasing during further storage.

The water holding capacity may be estimated by various techniques, the filter paper press method or the centrifugal technique where meat is spun in an ultra centrifuge. The appearance of meat before cooking is largely influenced by WHC. The behavior of meat cooking and its juiciness on mastication are directly related to the eating qualities. In the filter paper press method, the area of the resultant impression is inversely proportional to WHC. Microbiologically spoiled meat has a low water holding capacity indicating putrid proteins.

The meat at pH 7 will have a high WHC, the muscle absorbing and retaining approximately equal volume of water, at pH 6 less than 50 percent and at pH 5 (isoelectric point) about 25 percent. Consequent to the death of the animal the loss of WHC is inevitable. The extent of fall of the post-mortem pH will affect the water holding capacity, higher the ultimate pH, greater is the WHC. It is, therefore, clear that the meat possessing high ultimate pH, chilled rapidly before the onset of rigor mortis and undergoing retarded post-mortem glycolysis, will enhance WHC. Much interest has been shown to diminishing weep or drip in meat used for making sausages, emulsion, retail cuts or package cuts. Sausages and comminuted meats are more liable to exude fluid due to destruction of structure during processing there by lowering the ability to retain fluid. It is important to consider the behavior of water added to meat to effect the overall WHC of the mix. The normal ratio of water to meat is about 2:1.

The salts of strong acids and certain weak acids in particular phosphates and poly phosphates as constituents to meat increase the WHC. The water holding capacity is higher in pork than in beef. The meat of younger animals has a higher
WHC than the older. Cow beef has a higher WHC than that of bulls. The damage of proteins caused by freezing lowers WHC (Govindarajulu, 2002).

(c) TBA number

Warmed-over flavour (WOF) in meat was first recognized by Tims and Watt (1958), is a form of oxidative rancidity that develops within a few days in contrast to common rancidity that requires two months to develop fully during freezer storage (Pearson et al., 1977; Igene et al., 1979A, 1980). Although WOF can develop in fresh meat, it most commonly occurs in meats that are cooked or in which membranes are broken down by processes such as restructuring or grinding.

Tarladgis et al. (1960) reported that TBA numbers were highly correlated with sensory scores of trained panelists for rancid odours in ground pork. These workers reported that threshold range of TBA numbers for detecting off odour in pork were approximately 0.5-1.0. There is correlation between sensory attribute (flavour) and TBA number of meat and meat products. Greene and Cumuze (1981) investigated the relation between TBA numbers and assessed oxidized flavour in cooked beef. They reported on the basis of panelists evaluation that the range of TBA number for which these panelist as a group first detected a difference in intensity of oxidized flavour was 0.6 – 2.0. This range was considered by Greene and Cumuze (1981) to be close to that (0.5-1.0) for rancid odour detection. It can be concluded that TBA test can be used to follow oxidation in muscles foods, although the test should be accompanied frequently by corresponding evaluation with trained sensory panel in studies of WOF in meat (Igene et al., 1979, 1985A).

2.13 Fermented meat products as functional foods

Improvement of the nutritional value of meat products has been tried for years by replacement or lowering of fat (Arganosa et al., 1988) and salt content (Gimeno et al., 1999). More recently, the successful enrichment with calcium (Gimeno et al., 2000) and inulin (Mendoza et al., 2001) was reported and the concept of ‘functional foods’, e.g. foods containing naturally, or by addition,
ingredients with clearly identified beneficial effects on a target function of the human body and/or lowering the risk of disease. (Diplock et al., 1999), when introduced in to meat industry (Jimenez-Colemenero et al., 2001). A target function could be lowering of the consumer body’s antioxidant protection system through the production of meat and meat products containing natural or added antioxidants. A well-investigated case is the addition of vitamin E for improvement of colour stability, by vitamin E was much better when supplied with the diet, than post mortem (Mitumoto et al., 1993). For dry sausage production, these findings should stimulate the less of raw materials with improved antioxidant status through selection of animal and muscle and/or dietary through selection of animal and muscle and/or dietary treatment reflecting e.g. glutathione peroxidase activity and soluble selenium content (Raes et al., 2001) and animals fed diet enrichment in polyphenols (Lopez et al., 2000; Tang et al., 2000). Other possibilities are reflected in the identification of angiotensin1-converting enzyme inhibitors in the peptize fraction of fermented sausage (Arihara et al., 1999) and the introduction of probiotic starter cultures (Luck, 2000; Erkhila et al., 2001) (Sameshima et al., 1998).