SUMMARY

Meat and meat products make important nutritional contribution to the diet of the people. Significant percentage of the recommended dietary allowances for proteins, vitamins-B, magnesium, phosphorous, iron and zinc are contributed by red meat and poultry (Pearson and Brooks, 1978). Primitive men recognized that a meat rich food was for more concentrated than vegetable foods and in early days mankind survived on animal foods, which now a days after development of food science are claimed to be more nutritious than other foods. It is recognized as a highly nutritious food having high quality proteins, a good balance of the essential amino acids and high biological value.

The meat is the center of attraction for microorganism especially bacteria because of favourable pH, sufficient moisture content and highly nutritious. As a result of microbial growth and multiplication meat is rendered unfit for human consumption within few hours at ambient temperatures. Preservation of meat by freezing and frozen storage maintains the characteristics almost similar to fresh meat by preventing the microbial growth. However this method is expensive for preserving the meat and meat products intended for long storage and export.

With the development in refrigeration and freezing, the meat processing has taken sharp turn and now all types of convenient meat products including traditional and western like steak, hamburger, restructured meat, paties, kababs, meat kofta, tikki, nuggets, biryani, frankfurter, bologna etc. are available round the year. The demand for processed meat products has been further accelerated by a relatively large number of women being employed outside the home and consequent lack of available time for preparation of meat products. Since meat has always required the largest period of preparation, it has benefited most from the development of convenience food items.

During the last two decades the demand for buffalo meat and its products has increased all over the world. India is a major producer of buffalo
meat because of large population of the animals (Approx. 92.0 million, FAO Year Book 2000). The total meat production in India is 4.59 million tonnes and the share of buffalo meat is 1.40 million tones (FAO, 1998). The share of meat production of India is only 2% of the world’s total 216.2 million tonnes (FAO, 1998). Despite India’s vast live stock resources and huge share (about 12%) of the world’s live stock population and 56.5% of world share in buffalo population, the export share of meat are very meager. Buffalo meat alone contributes 85% of the total meat export from India. It is the cheapest muscle food of the country ($5.0 per 5 kg).

In India buffalo meat is produced from the young calves, old spent animals and also from mature animals. Meat from old animals is usually fibrous and tough and fetches lower price as compared to meat from buffalo calves and other mature animals. Number of studies have been conducted in past to improve quality and acceptability of such products (Sahoo et al., 1998, Anjaneyulu et al., 1989). However it is reported that Indian buffalo meat is suitable for production of a variety of convenience and value added products (Govnidrajan, 1973). Buffalo meat can be very well used for the production of sausages, a ready to eat/ready to heat and serve products.

Utilization of edible by products of buffalo meat is also vital aspect of meat industry. The proper disposal of such organic is also of major importance both in terms of maintenance of environment and economic production of human and animal feed. Edible byproducts may be used in meat products formulation viz. sausages for the reason that some of them have significant nutritional value (Pearson and Duston, 1988).

Sausage is a food that is prepared from comminuted and seasoned meat and is usually formed into a symmetrical shape. The world sausage is derived from the Latin *salsus*, which means salted or literally meat preserved by salting. Sausage making has developed over a number of centuries, beginning with simple process of salting and drying meat (Tauber, 1976), which basically aimed to preserve fresh meat that could not be consumed immediately. The
typical flavours, textures, and shapes of many sausages known today such as frankfurters, braunschweiger, and salami were named due to geographical locations of their origin. Some sausages are smoked after preparation and cooked before consumption. Fresh sausages are uncured, comminuted, seasoned and usually stuffed into some type of casing and cooking before serving e.g. bratwurst. Cooked sausages are cured/uncured meats, comminuted, seasoned and stuffed into casing, cooked and sometimes smoked and served cold e.g. liver sausage, braunschweiger and liver cheese. Fermented sausages are a very stable meat product and prepared from the comminuted mixture of mainly meat, fat, salt, spices and condiments and then allowed fermenting under strict conditions of temperature and humidity. The mixed culture of lactic acid bacteria is combined to accelerate the fermentation. The product finally takes the composition of intermediate moisture food with low pH as a result of lactic acid production during fermentation. Fermented sausage are either dry or semi dry sausages.

Sausages are packed in natural and artificial casing, which provide size and shape. Casing serves as processing mould handling, shipping and merchandising it for display. The natural casing is preserved in salt solution. The artificial casing are of different types i.e. cellulosles non-edible collagen and plastic and are to be peeled before consumption. In the light of above facts with regard to meat processing and keeping in view the dearth of information on quality evaluation of buffalo meat sausages (Fresh and fermented) as ready to eat and ready to heat and serve convenient food, which can be consumed in India and exported as well to other countries provided they have good quality characteristics and reasonably good shelf life. Experimental studies were carried out in the present research work with the following comprehensive objectives.

i. Development of fresh and semi dry fermented sausages of buffalo meat incorporating different levels of heart (in lean meat) and fat keeping other ingredients constant.
ii. Evaluation of physicochemical, microbiological sensory and textural characteristics of the developed products.

iii. Evaluation of shelf life of developed sausages under refrigerated conditions (0°C and 4°C for fresh and semi dry fermented sausages respectively).

Keeping in view these objectives of the study, a number of experiments were carried out to evaluate the physico-chemical, microbiological, sensory and textural quality and shelf life of the products.

Meat samples collected from the local meat shop in the study were from buffaloes slaughtered according to traditional *halal* methods at slaughterhouse of Municipal Corporation of Aligarh. The animals were kept in the lairage for a period of 20 hours before slaughtering. Meat samples from round portion (biceps femoris muscle) of 2.5, 3 and 3.5 years aged female carcasses of good finish, were obtained from meat shop within 4 hr. of slaughter. Buffalo fat from brisket and back and buffalo heart were also procured along with other meat ingredients. Meat samples were packed in low-density polyethylene (LDPE) and brought to the laboratory with in 15 min after separation from carcass. The meat, fat and heart were kept inside ultra low temperature cabinet (Yarco, India) at 2°C for 20 hours.

For preparation of fresh sausage, two different types of samples viz controlled and treated (with antioxidant, sodium hexa metaphosphate) were taken and the sample size was kept on the basis of 1.0 kg lean meat. Three levels of fat and four levels of heart was taken for study of fresh sausages. Twelve samples, each of controlled and treated fresh sausages (each containing different combination of heart and fat) was prepared. The spice mix was prepared with 10% black pepper, 15% red chili, 5% cardamom, 5% cinnamon, 3% cloves, 20% cumin seed, 10% turmeric, 17% coriander and 10% mace. The onion, ginger and garlic paste was prepared by grinding the three condiments in ratio: onion (160 g), garlic (20g) and ginger (20g). They were cut in to small bits and mixed in laboratory blender (Braun Co., India) to a fine paste. The
composition of fresh sausage was kept as: lean meat (1.0kg), heart, (100g), spice mix (15g), fat (200g), condiment paste (20g), salt (35g), sugar (10g), ice (150g) and monosodium glutamate (5g).

Lean meat along with heart was ground in a grinder (PRS, Tech. India) at 11°C (adding half of ice) through a 0.95cm plate. It was further chopped at slow speed (18 rpm) in a bowl cutter (PRS Technology, India) for further comminution and mixing of fat salt, spices, sugar, condiments and the remaining ice was added and chopping was continued for five minutes to a final temperature of 14-16°C. Entire mix was transferred to stuffing machine (PRS, Technology, India) and collagen casing (25mm dia) was used for filling fresh sausages. The finished sausages were evaluated for different characteristics and also stored at 0°C in an ultra low temperature cabinet for shelf life study.

Fermented sausages (semi type) were prepared from comminuted mixture of meat, fat salt spices, condiments and sugar using mixed culture of Lactobacillus brevis and Lactobacillus plantarum. The recipe was kept as: meat (1.0kg), fat (200g), heart (150g), spicemix (10g), salt (30 gm), garlic paste (20g), Sugar (10g), dextrose (5.5g), sodium nitrate (0.25g), monosodium glutamate (1.2g) and mixed culture of L. brevis and L. plantarum (0.5%). Buffalo meat, heart and fat were ground in a grinder (PRS Technologies, India). Then ground buffalo meat, heart and fat was transferred to bowl cutter and chopped for 2 min. Other ingredients viz. spicemix garlic paste, sugar and dextrose were added and further mixed in a mixer (PRS Tech., India) for 5 min. Mixed culture were added at the very end of mixing. The mass was well mixed and finally placed in a shallow pan and held under refrigeration temperature (7°C) for 2 days to enable curing process and stabilization of micro flora. The presence of air pocket in the pan was avoided and was excluded during kneading. After remixing again the mix was transferred and packed in the stuffing machine (PRS Technologies, India) as firmly as possible to exclude air from the products. Stuffing in to casing was done firmly and carefully to
exclude air inside the casing, which might discolour the meat mix and reduce shelf life of the semi dry sausage. After stuffing the mix into casing the open end was tied and a loop was formed so that sausages could be suspended on hot rods during smoking. Now the sausage stuffed in to casing, were held at 15°C and 90% relative humidity (RH) for two days to complete fermentation. The completion of fermentation was indicated by drop in pH of the product. Sausages were smoked at 20°C for 8 hours continuously, and further the temperature for last 1.5 hour was increased for last 1.5 hour to 45°C to improve flavour and colour. The smoked sausages were dried at 20°C and at relative humidity of 70% for 5 days. Sausage samples were packed in HDPE bags. Dried sausages were evaluated for quality characteristics and also stored at refrigerated temperature of 4°C for future study.

Raw buffalo meat and heart were analyzed moisture, protein, ash and fat content (AOAC, 1990). pH of these samples and sausages samples was evaluated by digital pH meter (Yarco, India), total plate count (TPC) and yeast and mold count (Y & MC) by serial dilution method spread plate technique with nutrient agar and potato dextrose agar respectively (APH, 1992). Fresh and fermented sausages were evaluated for physicochemical (pH, moisture content and TBA number), microbiological (total plate count, and yeast and mold count), Sensory and textural characteristics. Moisture content of the sausage sample was evaluated by standard hot air oven method. TBA number was measured by the method described by Strange et al., (1975). Sensory characteristics were evaluated by hedonic rating test method as described by Ranganna (1994). The sensory attributes evaluated were colour, aroma, texture, taste and juiciness by a trained panel. Texture analysis of sausage samples was conducted by TAHD type texture analyzer (SMS, England). The instrument measured the positive peak force, indicating the hardness of the samples. Data obtained from experimental observations (n=6), were subjected to analysis of variance (ANOVA) as described by Cochran and Cox (1992). Polynomial and linear regression was also determined to study the storage behaviour of
physicochemical, microbiological and sensory properties. Salient features of research findings were as follows:

- The results of analysis for proximate composition of raw buffalo meat and heart, showed that the raw buffalo meat had 74.5% moisture content, 7.0% fat, 17.5% protein, and 1.0% ash content and the heart had 76.21% moisture content, 4.3% fat, 17.2% protein, and 1.0% ash content. Carbohydrate was absent in lean meat, while the heart had 1.3% carbohydrate. The pH values of raw buffalo meat and heart were respectively 5.67 and 5.93 an log TPC/g values, respectively 3.17 and 3.75.

- Incorporation of different levels of heart significantly (p<0.01) increased the pH of fresh sausage. Increasing fat levels from 15% to 20 and 25% also significantly (p<0.01) increased the pH of fresh sausage.

- Treatment of sodium hexametaphosphates (SHMP) in fresh sausage caused enhancement in pH as compared to controlled counterpart. SHMP treatment caused polyanion formation in meat, which ultimately increased pH of fresh sausage.

- Moisture content of fresh sausage was found in between 61.3% and 69.3% on wet basis. Moisture contents of fresh sausages were significantly (P<0.05) lowered by increasing levels of fat. However incorporation of heart did not significantly (P<0.05) affect moisture content of fresh sausages. It was noted that decrease in moisture content during refrigerated storage was less in SHMP treated fresh sausage samples as compared to their controlled counterpart.

- Increasing levels of fat significantly (P<0.05) enhanced thiobarbituric acid (TBA) number in controlled fresh sausage while incorporation of different levels of heart did not significantly (P<0.05) affect TBA number of sausage samples. In case of SHMP treated samples, neither different levels of fat nor levels of heart significantly (P<0.05) increased the TBA number of sausage samples. Interactive effect of heart and fat were also noted and it was found
that interaction significantly (P<0.05) affected TBA number of controlled fresh sausage, while this interaction did not significantly (P<0.05) affect TBA number of SHMP treated sausage.

- Total plate count (measured as log TPC/g) of fresh sausages was found to be in the range of 3.23-3.86 just after preparations. The increasing levels of heart and fat did not significantly (P<0.05) affect the log TPC/g of fresh sausage samples. Yeast and mold count was found to be absent and not detected.

- Sensory characteristics were measured on nine-pint hedonic scale. The colour score of controlled fresh sausage samples were in between 7.4 and 7.9 while colour score of treated sausage samples were in the range of 7.1-7.3. The score values of colour were less as compared to score values of aroma, texture, taste and juiciness. The score values of aroma, texture, taste and juiciness of all fresh sausages were found in between ‘8’ and ‘9’. This indicated the condition between very good and excellent. Score values of texture of treated samples were found to be a little higher than their controlled counter part. Different levels of fat and heart significantly (P<0.05) improved the colour of controlled sausage, while in case of treated fresh sausage, only different levels of fat significantly (P<0.05) affected colour. Interactive effects of heart and fat also did not significantly (P<0.05) affect the colour of treated fresh sausage. Aroma of both controlled and treated fresh sausages was significantly (P<0.05) improved by increasing levels of fat. Interactive effects of heart and fat also did not significantly (P<0.05) improve the aroma. Similar effects were also noticed in case of treated sausage. Different levels of heart and fat also did not significantly (P<0.05) improve the taste of controlled samples. However, the taste of treated fresh sausage was improved by increasing levels of heart and fat. Juiciness of controlled fresh sausages was significantly (p<0.05) improved by increasing levels of fat. However increasing heart levels did not significantly (P<0.05) improve juiciness of controlled fresh sausages. In
case of treated fresh sausages, different levels of fat significantly (P<0.05) improved juiciness. However, different levels of heart did not significantly (P<0.05) affect juiciness of fresh sausage.

- Study on instrumental texture analysis concluded that increasing levels of heart reduced hardness/increased tenderness. It is clear from the decreasing pattern of positive peak forces (PPF) of fresh sausages with different levels of heart (0, 10, 15 and 20%). The values of PPF were respectively 705.2g, 658.7, 655.3g and 640.5g. Increasing fat level further reduced hardness and increased tenderness. The fresh sausages with 25% fat had lowest value of PPF of 285.39g. Additional effect of SHMP treatment was that PPF increased as compared to controlled fresh sausage. SHMP treatment improved compactness of the product. Increasing levels of heart and fat significantly (P<0.05) decreased hardness/increased tenderness of fresh sausages in both controlled and treated samples.

- In case of cooked fresh sausage, the hardness was increased as a result of cooking. Cooking caused denaturation and coagulation of meat protein. The PPF considerably increased after cooking of sausages. Increasing levels of heart and fat significantly (P<0.05) decreased the tenderness of the cooked fresh sausages. Interactive effect of heart and fat also significantly (P<0.05) decreased hardness of the fresh sausage.

- Evaluation of shelf life under refrigerated condition was dependent on different quality characteristics viz. total plate count (TPC), yeast and mold count, TBA number and sensory properties. These quality characteristics were evaluated periodically after every seven days during storage. All quality characteristics were under safe limit till 28 days of storage of fresh sausages. The shelf life of buffalo meat fresh sausages was found to be 28 days under refrigerated storage (0°C).

- The polynomial linear regression was done showing the difference between experimental and predicted values of quality characteristics (pH, moisture content, TBA number, total plate count, yeast and mold count and
sensory characteristics) during storage period (days). Yeast and mold count was not detected till the last day of safe storage. However very few colonies (reported as too few to count, TFTC) were noticed on 35th day of storage. The correlation was found to be strong as all the values of correlation coefficient ($R^2$) were found to be near to unity.

- **The semi dry fermented sausages** were developed from buffalo meat using different levels of heart and fat. The fermentation was carried out using mixed cultures of Lactobacillus brevis and Lactobacillus plantarum. Fermentation lowered the pH and drying reduced the moisture content of fermented sausage. Low pH and reduced moisture content became the important hurdle factors for microbial growth. The effect of different levels of heart including control (with 0% heart) and different levels of fat was studied on physico-chemical characteristics like pH, moisture content and TBA number, microbiological characteristics namely total plate count, yeast and mold count, sensory and textural characteristics of the product in fresh condition and during refrigerated storage (4°C).

- pH of semi dry fermented sausage (six controlled samples) was found in the range 5.15 and 5.28 in fresh condition while six samples of sodium ascorbate treated batch had pH values between 5.18 and 5.27. Different levels of fat significantly ($P<0.05$) increased the pH of semi sausage samples. However different levels of heart incorporation did not significantly ($P<0.05$) affect pH of sausage samples. Storage study was conducted under refrigerated condition (4°C) after every fifteen days. Refrigerated storage significantly ($p<0.05$) reduced the pH of fermented sausage. Storage study was carried out (after every 15 days) till the end of shelf life, which was assessed on the basis of microbiological characteristics, TBA number and sensory characteristics. The samples were in edible condition till 60 days but were found to be in spoiled condition on 75th day.

- Moisture contents of semi dry sausages were found in between 42.4 and 47.4% on wet basis after completion of fermentation, smoking and drying.
Increasing levels of heart did not significantly (P<0.05) increase the moisture content, while increasing levels of fat significantly (P<0.05) decrease the moisture contents of sausage samples. During refrigerated storage, moisture content decreased consistently and the study was carried out till 75 days. Refrigerated storage significantly (p<0.05) decreased moisture contents of all samples. On 60th day, the moisture contents of all twelve samples were found in the range of 36.8-44.4%. The spoilage conditions were detected on 75th day as indicated by growth of mold, increasing values of log TPC/g and sensory characteristics.

- TBA number expressed malonaldehyde/kg represented the oxidation state/oxidative rancidity of the product. The fat present in meat product may be oxidized and lead to development of warmed over flavour (WOF). WOF is related to the sensory quality of the products (Tarladgis et al., 1960, and Zisper et al., 1964). TBA number was determined as mg of malonaldehyde/kg. Malonaldehyde is produced as a result of fat oxidation and it reacts with TBA reagent to produce coloured complex with an absorption max/min at 530-532 mm. The red pigment produced is the reaction product obtained from condensation of two moles of TBA reagent with one mole of molanaldehyde (Sinnhuber et. al., 1958). The extent of colour formation measures the TBA number. In semi dry fermented sausage the values of TBA number were on lower side as compared to fresh sausage. TBA number values (mg malonaldehyde/kg) of controlled sample were found between 0.073 and 0.134 in fresh condition. The treated sausage had still lower values of TBA number viz. between 0.062 and 0.111. The incorporation of heart did not significantly affect TBA number while increasing levels of fat significantly (P<0.05) increased TBA number. During storage (4°C) consistent increase in TBA number was noted till 75 days. Refrigerated storage significantly (p<0.05) increased TBA number of controlled samples while the storage did not significantly (p<0.05) increase TBA number of SA treated sausage samples. The TBA number after 75 days were found to be in between 0.147 and 0.107 mg of
malonaldehyde/kg. Tarlagdig et al (1960) reported that BA number was highly correlated with the sensory scores of trend panelists for rancid odour/aroma in meat. Similar results were reported by Lyon et al. (1988), who reported that threshold range of TBA number for detecting off odour in cooked buffalo/beef meat was in the range of 0.6 – 2.0. The values of TBA number of fermented sausage sample were found to be far below than the limit described above.

- Total plate count of twelve sausage samples were found under TFTC (too few to count) limit at the initial stage. Incorporation of different levels of heart and also increasing levels of fat did not significantly (p<0.05) increase the log TPC/g values. There was no considerable growth of spoilage bacteria/mold till 30 days of refrigerated storage. Only species of bacteria (L.brevis and L.plantarum ) which were inoculated for fermentation, was detected by morphological study and they were characterized as Gram positive rod shape bacteria. The microbial count (countable colonies) was reported on 45th day of storage. Log TPC/g of fermented sausage samples (controlled) was found in the range of 3.22- 3.71 on 45th day. Treated samples had Log TPC/g values between 3.08 and 3.95.Refrigerated storage significantly (p<0.05) increased TPC of controlled and treated samples. Study on total plate count was carried out till the samples reached to spoilage conditions. On 75th day, the TPC of all samples exceeded to 10^6 and in most of the cases, it was found to be even more than 10^7. Log TPC/g values were found to be in between 6.94 and 7.51. This indicated the spoiled condition of sausages samples. Ranken and Kill (1993) described the spoilage condition at 10^7 per g of bacteria. The results are also in an agreement with Hytainen et al. (1966). They reported that incipient of spoilage of meat occurred when aerobic mesophiles count of meat samples reduced log 7/g. Similar results were also obtained by Essory et al., (1985), Barnes and Thromily (1966). Panda (1971) had also reported that when total viable count on meat tissue exceeds log 10^7/g, off odour and slim starts.
- Yeast and mold count (\(\log Y & MC/g\)) of twelve samples of semi dry fermented sausages were evaluated in fresh condition and during refrigerated storage at 4°C. Yeast and mold count was not detected before 30 days. Very little count (reported as too few to count (TFTC)) was observed on 30th day of storage. Incorporation of different levels of heart and also increasing levels of fat did not significantly (\(p<0.05\)) increase the \(\log Y & MC/g\) values. The yeast and mold count (countable colonies) was reported on 45th day of storage. Log \(Y & MC/g\) of fermented sausage samples (controlled) was found to be between 2.47 and 3.03 on 45th day. Treated samples had Log \(Y & MC/g\) values between 2.67 and 3.04. Refrigerated storage significantly (\(p<0.05\)) increased \(Y\) and \(MC\) of controlled and treated samples. Yeast and mold count in \(log/g\) was found in the range of 4.21-5.19 on 75th day. This particular range of yeast and mold count defined the spoilage condition. When yeast and mold count exceeded beyond \(10^4\), the spoilage occurs (CUMAIRA, March, 2003).

- Sensory characteristics of semi dry fermented sausage of twelve samples were conducted on 9-point hedonic scale. The fermented sausage were bright red in colour after smoking and subsequent drying. The score values of colour, aroma, texture, taste and juiciness were found between ‘8’ and ‘9’. It represented the condition between liked very much and liked extremely. The treated fermented sausage had higher score values for colour, texture and juiciness as compared to their controlled counterpart. Different levels of heart and fat did not significantly (\(p<0.05\)) affect the colour score of control sausage. The aroma, texture, taste & juiciness score values of control sausage samples were also found to be between ‘8’ & ‘9’. Different levels of fat, significantly (\(p<0.05\)) improved aroma and texture taste and juiciness of control samples, however different levels of heart incorporation did not significantly (\(p<0.05\)) affect aroma, texture and juiciness. During refrigerated storage, the score values colour, constantly decreased and after 75 days storage the colour scores of samples were found between 6 and 7. The score values of aroma, texture, taste and juiciness
were also found to decrease consistently during refrigerated storage (4°C). Refrigerated storage significantly (p<0.05) reduced the score values of all attributes. However, the score values of these attributes were found above 7 after 60 days of storage but reduced below 7 after 75 days of storage. The score value ‘7’ represented the liked moderately condition of samples. The sausages were found to be in acceptable condition of aroma, texture, taste and juiciness after 60 days of storage (4°C). However the acceptability of sausage was found to decrease after 75 days of storage. Due to increase in microbial population and lowering of score values of attributes. The exact value of shelf life of semi dry sausage was found to be 60 days.

- **Instrumental texture analysis** measured by the positive peak force (PPF) of the sausage samples. PPF described the hardness of the product. Hardness is inversely related with tenderness. Three samples of controlled sausage with 0, 15 and 20% heart and each with 20% fat were found to have PPF values 1910.5g, 755.5g and 554.1g respectively. This showed that hardness was found to decrease by increasing the levels of heart. Similarly the increasing fat level also reduced PPF and so hardness of product. Increasing heart and fat levels significantly (P<0.05) decreased the hardness of sausage samples.

- **Following conclusion was drawn from the study:**

  (i) Buffalo meat could be successfully used for development of fresh and fermented sausages. In fresh sausages, the colour of the product was not excellent particularly the colour of SHMP treated fresh sausage was a little dark. However, the aroma, texture, taste and juiciness were found to be in the range of ‘like very much’ to ‘like extremely’. Other properties like pH, moisture content, TBA number and microbiological characteristics (total plate count and yeast and mold count) were also found to be with in safe limit for 28 days during refrigerated storage (0°C).

  Semi dry fermented sausage was found to e in cherry red colour after fermentation, smoking and drying. Especially colour of sodium ascorbate treated sausage was more attractive and was liked by the panelist. Buffalo meat
semi dry fermented sausage were highly acceptable as reported by panelist during sensory evaluation. The score values of all attributes (colour, aroma, texture, taste and juiciness) were found in the range of 8-9, which represented either like very much or like extremely conditions.

(ii) Different levels of heart incorporation in lean meat (both for fresh and fermented sausages development) were studied to explore the utilization of edible by-product but without impairing the quality of final products. Incorporation of heart up to 20% (of the quantity of lean meat) level could be incorporated. Treatment of SHMP in fresh sausage increased water-binding capacity and therefore moisture loss rate during storage was less as compared to control sample. In fermented sausage, heart incorporation had important role in providing carbohydrate to culture micro flora. Heart muscle has carbohydrate (1.3%) while the lean meat has no carbohydrate. It was ascertained in one of the trial when carbohydrate source (dextrose+sucrose) was not added (due to mistake) in the mix for development of fermented sausage. The sample without heart could not carry out fermentation, which was detected by negligible change of pH. However, in case of heart-incorporated sample, there was a drop in pH by 0.7 units during fermentation, smoking and drying. Sodium ascorbate treatment improved colour due to reduction in metmyoglobin content.

In fresh sausage, different levels of heart incorporation did neither decrease quality nor shelf life. It also did not significantly (p<0.05) affect the total plate count or yeast mol count. Heart incorporation decreased hardness (as measured by instrumental texture) and increased tenderness. Increasing levels of fat from 15% to 25% improved aroma, texture, taste and juiciness of fresh sausage. Quality of fermented sausages was also not affected significantly (p<0.05) by incorporation of different levels of heart. Heart incorporation decreased hardness (as measured by instrumental texture) and increased tenderness. Aroma, texture, taste and juiciness were improved by increasing the level of fat.
Shelf life of fresh sausage was found to be 28 days at 0°C while the shelf life of semi dry fermented sausage samples were found to be 60 days at 4°C. Fermented sausages were found to be more stable as compared to fresh sausages because of low moisture and reduced pH.

References:


