Chapter 5

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The comprehensive study was undertaken to assess the nutritive value, physico-chemical qualities, heavy metal and pesticide residue level of meat arising out from some principal wholesale cuts from three most important meat producing animals in India, i.e. cattle (Indian zebu cattle), poultry (one of the strains of common broiler breed) and two goat breeds (Black Bengal and Jamunapari). The study was carried out at the Department of Livestock Products Technology of West Bengal University of Animal and Fishery Sciences, Kolkata-700037 during the period of April, 2012 to July, 2013.

In case of beef, the samples were collected from 20 slaughter cattles (4-5 years of age) slaughtered by Halal method at Tangra Slaughter House prior to 24 hours of fasting of animals. The body weight of the animals was recorded just before the slaughter. The hot carcass weight was measured 45 minutes after slaughter and defined as the carcass weight of the slaughtered animal’s body after being skinned, bled and eviscerated and after removal of the genitalia, limbs at the carpus and tarsus, the head of the tail, the kidneys as well as the perirenal, omental and intestinal fat. Subcutaneous adipose tissues were dissected from the surface of the carcass and inside of the skin. The left side of the cold carcass (after being chilled at 6°C for 24 hours) was dissected in various cuts, i.e. hip, sirloin, loin, flank, rib, plate, chuck, brisket and shank from which round, loin, flank and chuck were taken for the present investigation. Samples in triplicate were collected for analysis and the mean values were taken. Muscle samples from different cuts which were supposed to be used for the cooked analysis were vacuum packed and frozen at -20°C for 3 months before the cooking process started. The cuts were defrosted for 24 hours and cooked according to the standardized moist heat cooking method at 163°C to an internal temperature of 73°C.

The carcass characteristics, i.e. slaughter weight, hot carcass weight, chilled carcass weight, carcass length and loin eye area showed the values of 227.43 ± 1.62, 123.95 ± 0.88, 121.68 ± 0.87, 83.78 ± 0.40 and 52.13 ± 0.36 respectively which were in agreement with the standard values for those characteristics in case in Indian zebu cattle. The weight of the wholesale cuts, i.e. chuck, fore shank, brisket, rib, plate, flank, short loin, sirloin and round were having the mean values of 32.96, 6.52, 7.31, 10.42, 11.00,
6.24, 8.83, 13.68 and 27.45 respectively depicting significance with the standard values for those cuts. The mean weight of the heart, liver, lung + trachea, spleen, head, blood and skin were found to be 0.80, 2.46, 2.55, 0.61, 7.28, 4.73 and 20.10 respectively.

The proximate composition among the four raw wholesale beef cuts showed that the moisture content, crude protein and total ash content were highest in round whereas the total lipid and energy values were highest in loin. The loin part showed the least moisture content. All the parameters of proximate composition varied significantly (P<0.05) among those four parts except the crude protein. In case of cooked samples, again the values differed significantly (P<0.05) among those parts and the round had the highest moisture, crude protein and total ash content whereas the total lipid and energy content were highest in loin. Cooking significantly reduced the moisture content in cooked meat samples but it significantly increased the crude protein, total lipid, energy and total ash content in the cooked muscle samples than that of raw ones. The correlation study revealed that the moisture was significantly but negatively correlated with total lipid, energy and total ash. The total lipid was significantly and positively correlated with energy and energy was significant and positively correlated to total ash content.

The different fatty acid profile among the four raw wholesale beef cuts revealed that the round was having the highest content of Oleic acid and 18:2cis-9, trans-11, the loin had the highest concentration of myristic acid, palmitic acid, trans vaccenic acid and linoleic acid, the flank had the highest content of myristic acid, stearic acid and 18:2 trans-10,cis-12 and the chuck had the highest content of myristoleic acid, palmitoleic acid, cis vaccenic acid, 18:2cis-9, trans-11 and 18:2 trans-10, cis-12. All the different fatty acids differed significantly (P<0.05) among the wholesale raw beef cuts as well as in cooked cuts. Cooking significantly increased the fatty acids content in cooked meat samples than that of raw ones. The oleic acid was found to be the most abundant among all the fatty acids investigated in the present study. Significant correlations were also observed among the different fatty acids in beef cuts.

The cholesterol and other physico-chemical qualities, i.e. pH, WHC, fiber diameter and sarcomere length also differed significantly among the four raw wholesale beef cuts. The cholesterol content was found to be highest in round and lowest in flank but after cooking, it was found to be highest in chuck. Cooking significantly (P<0.05)
increased the cholesterol content in cooked samples than that of raw ones. The pH and WHC were found to be highest in raw chuck whereas the fiber diameter and sarcomere length were highest in round among the raw cuts. Cooking significantly (P<0.05) increased the WHC, fiber diameter and sarcomere length in all the cooked samples than that of raw ones. In cooked samples, the WHC was highest in flank muscles and the round had the highest fiber diameter and sarcomere length. The correlation study revealed that cholesterol was having significant and positive correlation with pH but negative correlation with WHC. The pH was having negative but significant correlation with WHC, fiber diameter and sarcomere length. The WHC, fiber diameter and sarcomere length were having positive and significant correlation among them.

The present investigation also revealed that among the various macro and micro minerals present in raw beef cuts, Fe and Na were highest in round, Ca was highest in loin and flank and K, Mg, Zn, Se and P were highest in chuck. The concentration of these minerals also varied significantly (P<0.05) among the four raw wholesale beef cuts. The K was recorded as the most abundant mineral among the beef cuts followed by P. The present study also proved that beef is a rich source of Fe, Zn and Se. Interestingly, the concentration of all the minerals except Ca was found to be highest in round after cooking and flank had the highest Ca value. Cooking significantly (P<0.05) increased the concentration of K, Mg, Zn, Se and P in cooked samples than that of raw ones. The correlation study revealed that Ca was having significant but negative correlation with all the investigated minerals. However, significant and positive correlation were detected among the Fe, Na, K, Mg, Zn, Se and P.

The concentration of some heavy metals, i.e. Pb, As, Cd and Cr and pesticide residues such as DDT, Endosulfan and Aldrin were also investigated in the present study. However, the concentration of Aldrin was found to be below the detectable limit. As it is postulated by early workers that the heavy metals and pesticide because of their lipophilic nature tend to accumulate in the fatty tissues, the present investigation also revealed that the concentration of Pb, As, Cd, Cr, DDT and Endosulfan was highest in loin part than the other cuts both in raw and cooked samples. Significant (P<0.05) differences were recorded regarding the concentration of various heavy metals and pesticide residues among the four wholesale beef cuts both in raw and cooked conditions. The correlation
study expressed that there was significant and positive correlation among all the investigated heavy metals and pesticide residues.

From the above study, it can clearly be concluded that the beef chuck was supposed to be the best part among the four wholesale beef cuts because of its high protein content, lower lipid and cholesterol content, lower SFA but higher MUFA and PUFA content, rich mineral content and lower heavy metal and pesticide residue content. The loin part was the most inferior among the four cuts because of its high lipid and cholesterol content, high SFA, heavy metals and pesticide residue content. It can also be concluded that cooking significantly ($P<0.05$) influenced the nutrient content within the four wholesale beef cuts.

In case of poultry, a total number of 120 broiler birds of 35-42 days of age were selected at the FARM FRESH, Jadavpur, Kol-32. Broilers were hung by their feet in steel shackles and were electrically stunned by manually placing their heads in a saturated saline bath (11.5 volts, < 0.5 mA AC to DC current for 3 sec). The shackle line speed was constant and set so that approximately 22 broilers were stunned per minute. Unilateral neck cutting was manually performed immediately after stunning, and bleeding lasted for 140sec. Upon completion of exsanguination, the broilers were scalded at 53.3 C for 191 sec, picked for 35 sec using a rotary drum picker and then mechanically eviscerated after recording the carcass characteristics. The cut-up parts, i.e. drumstick, breast and wings were separated. The samples were wrapped in poly-ethylene bags and were transferred to the LPT laboratory of West Bengal University of Animal and Fishery Sciences, Kol-37 and muscle samples intended to be used for cooked analysis were vacuum packed and frozen at -20°C for 3 months until the cooking process commenced. The cooking process was done as per the standard procedure of American Meat Science Association (AMSA, 1965). The raw and cooked nutrient content data were analysed. Fatty acid profile, Physico-chemical qualities, concentration of various macro and micro minerals of meat as well as some heavy metals and pesticide residues were also assessed. All the determinants were done in triplicate and the mean values were reported.

The carcass characteristics, i.e. slaughter weight and carcass yield depicted the values of 2241.80 ± 13.60 and 1457.17 ± 8.84 respectively which were in agreement with the standard carcass characteristics of the broiler birds. The weights of the wholesale
cuts, i.e. breast, thigh, drumstick and wing showed the mean values of 430.43, 177.55, 150.65 and 122.71 respectively. The mean weight of the gizzard, head, neck and skin in the present study were recorded to be 34.08, 59.86, 62.77 and 135.63 respectively which were also in agreement to the standard values.

The proximate composition of the raw wholesale broiler cuts, i.e. drumstick, breast and wing showed that the moisture content was highest in wing among the raw cuts but it was highest in drumstick after cooking. Significant (P<0.05) differences were observed regarding the moisture content among the three broiler cuts both raw and cooked conditions. Cooking significantly (P<0.05) reduced the moisture content than that of raw ones. The crude protein, ether extract and total ash content were found to be highest in breast part both in raw and cooked conditions, however significant differences were observed regarding these parameters among the three cut up parts both in raw and cooked samples. Cooking significantly increased the concentration of crude protein, ether extract and total ash content in cooked samples than that of raw ones. The correlation study revealed that moisture had significant but negative correlation with crude protein and ether extract. The crude protein, ether extract and total ash had significant and positive correlation among them.

The fatty acids, i.e. SFA, MUFA and PUFA, cholesterol and energy values in three wholesale broiler cuts revealed that all these parameters were having highest values in breast part than that of other parts both in raw and cooked samples. Significant (P<0.05) variations were also observed regarding the value of SFA, MUFA, PUFA, cholesterol and energy content among the three different cuts. Cooking significantly increased the value of these components in cooked samples than that of raw ones. Correlation study revealed that SFA, MUFA, PUFA, cholesterol and energy values had significant and positive correlation among themselves.

The physic-chemical qualities, i.e. pH, WHC, fiber diameter, sarcomere length and hydroxyprolene content of the broiler meat investigated in the present study revealed that within the raw cuts, the pH, WHC, fiber diameter and sarcomere length were highest in breast part and the hydroxyprolene content was highest in drumstick. In cooked samples, all the parameters, except the WHC were highest in breast muscles and the WHC was found to be highest in drumstick. Significant (P<0.05) differences were
observed regarding the values of these parameters among the three cuts both in raw and cooked conditions. Cooking significantly increased the values of all these parameters except the hydroxyprolene content which was reduced after cooking. The correlation study revealed that pH had significant and positive correlation with WHC, fiber diameter and sarcomere length but had negative and significant correlation with hydroxyprolene content. The WHC had significant and positive correlation with fiber diameter and sarcomere length and negative correlation with hydroxyprolene content. The sarcomere length was having negative but significant correlation with hydroxyprolene content.

The concentration of different important minerals present in broiler meat showed that K was the most abundant mineral in broiler meat. In raw samples, the concentration of Ca, Na and K was found to be highest in drumstick and the concentration of Fe was highest in breast. The concentration of Fe was almost similar in cooked drumstick and breast whereas, all the other minerals, i.e. Ca, Na and K were highest in cooked drumstick than the other cut up parts. Significant differences were observed regarding the concentration of these minerals among the three wholesale broiler cuts both in raw and cooked conditions. Cooking significantly (P<0.05) increased the concentration of Fe and Ca but significantly (P<0.05) reduced the concentration of Na and K in cooked samples than that of raw ones. Correlation study also depicted significant correlations among the four minerals in broiler meat.

While detecting the heavy metal and pesticide residue content in wholesale cuts of broiler, it was revealed that the concentration of Pb, As, Cd, Endosulfan and Aldrin were having the values below the detectable limit (BDL). However, the highest value for Cu was obtained in drumstick and breast in raw samples and after cooking, it was highest in breast. The Zn content was highest in raw wing and almost similar in cooked drumstick and wing. Cooking significantly (P<0.05) increased the concentration of only Zn in cooked samples than that of raw ones. The only detectable pesticide, i.e DDT was having its highest value in drumstick both in raw and cooked conditions.

From the above study, it can clearly be concluded that the breast part of broiler meat was superior in comparison to the other parts because of its low moisture and high crude protein, ether extract, total ash, MUFA and PUFA content, high energy and iron content and lesser heavy metals and pesticide residue content.
However, the drumstick could also be a good supplement of Ca and the wing can be considered as the best lean meat among the three broiler cut up parts. It could again be concluded that cooking had significant effect on the proximate composition, fatty acids, physic-chemical qualities, mineral content and heavy metal content among the wholesale cuts of broiler.

In the present study, while evaluating the goat carcass, castrated male goats of Black Bengal and Jamunapari breeds (9-12 month age group) were purchased from local market. Goats were fasted overnight with free access to water and slaughtered as per standard procedures after recording preslaughter weight. All the carcasses were weighed, covered with plastic wrap to prevent moisture loss and chilled at 4 °C overnight and dissected the following day. Carcasses were sectioned down the vertebral column with a band saw and then divided into six primal wholesale cuts namely neck, shoulder, breast and shank, rack, loin and leg as per Indian Standard Institution (Indian Standard Institution, 1963). Carcass characteristics and physical cut composition of Black Bengal and Jamunapari goats was compared. The right sides of the carcasses were used to determine the physical cut composition. Three cuts (leg, loin and shoulder), taken from both sides were used to determine the cooked and raw nutrient composition (proximate composition, fatty acid and cholesterol). The raw and cooked nutrient data of the three cuts were compared. Physico-chemical and sensory quality of meat as well as some heavy metal residues in meat from both breeds were also assessed.

In the present investigation, slaughter weight, empty body weight, hot carcass weight, chilled carcass weight, dressing percentage on slaughter weight, carcass length and eye muscle area showed significant difference (P<0.01) between the two breeds. Weight of wholesale cuts (neck, shoulder, rack, loin, leg, breast and shank) in Jamunapari goats were significantly higher (P<0.01). Significantly higher values were recorded for weight of head, blood, skin and lung+trachea (P<0.01) in Jamunapari goats. Weight of heart, liver, spleen, kidneys and weight of pluck also vary significantly (P<0.01) between the two breeds.

The percent yield of meat, fat and bone in different wholesale cuts differ significantly between the breeds. The percentage proportion of meat in whole carcass
observed in the present study was 60.40±0.058 and 70.33±0.233 for Black Bengal and Jamunapari respectively.

The moisture, crude protein, ether extract and total ash% in leg, loin and shoulder did not vary significantly (P>0.05) between Black Bengal and Jamunapari goats in case of raw as well as cooked meat. Moisture content of leg was significantly higher (P<0.05) than loin and shoulder cuts in both the breeds, but moisture content of loin and shoulder did not differ significantly. On the other hand, the crude protein content of the three wholesale cuts (leg, loin and shoulder) differed significantly and leg contained significantly higher protein% than the other two cuts in case of both the breeds (P<0.05). Fat% of loin was significantly higher than leg and shoulder cuts in Black Bengal as well as Jamunapari goats (P<0.05), but the leg and shoulder cuts did not vary significantly with respect to fat content. The total ash content did not differ significantly in the three wholesale cuts of both the breeds.

The moisture content of cooked meat from leg and shoulder cuts of Black Bengal and Jamunapari goats differed significantly from loin cut. Cooked loin contained significantly higher amount of protein than the other two cuts in Black Bengal as well as Jamunapari. Protein % of cooked meat from leg, loin and shoulder differed significantly (P<0.05) in both the breeds. Fat% of cooked shoulder was significantly higher than cooked leg and loin in Black Bengal goats. In case of Jamunapari goats, the fat% of cooked leg, loin and shoulder differed significantly with highest fat% in cooked shoulder cut. The total ash content of cooked meat differed significantly in the three wholesale cuts of both the breeds.

There was a significant difference (P<0.05) between raw and cooked meat with respect to moisture, crude protein and total ash content of leg, loin and shoulder cuts of Black Bengal goats. Ether extract% did not vary significantly between raw and cooked leg and loin cuts (P>0.05), but in case of shoulder cut, ether extract% differed significantly between raw and cooked meat. With respect to Jamunapari goats, the moisture, crude protein and total ash content differed significantly between raw and cooked leg, loin and shoulder cuts (P<0.05). Ether extract% also differed significantly between raw and cooked cuts except in case of loin.
The fatty acid content among the three wholesale cuts of Black Bengal and Jamunapari goats depicted that significant (P<0.05) differences were observed in almost all the fatty acid components between the two breeds both in raw and cooked conditions. C18:1(cis-9) was found to be the most abundant fatty acid in both the breeds. The concentration also varied significantly (P<0.05) among the muscles both in raw and cooked samples except C16:0, C18:0, C18:2(c9c12) and C18:2(c10t12) in Black Bengal goats. Cooking significantly (P<0.05) increased all the fatty acid components in cooked samples than that of raw ones.

In the present study, the cholesterol content of leg, loin and shoulder cuts of Jamunapari goat was significantly higher than that of Black Bengal. In both the breeds, the cholesterol content was significantly varied between raw as well as cooked leg, loin and shoulder cuts. Highest cholesterol content was found in shoulder cuts. In the present study, cholesterol content of cooked wholesale cuts (leg, loin and shoulder) were significantly higher (P<0.05) in both Black Bengal and Jamunapari goats.

No significant difference in pH, water holding capacity, extract release volume and cooking loss% exist between Black Bengal and Jamunapari goats with respect to leg, loin and shoulder cuts (P>0.05). However, fiber diameter of Jamunapari goats was significantly higher than Black Bengal in the respective wholesale cuts. No significant difference between Black Bengal and Jamunapari goats exist in case pH value of cooked leg, loin and shoulder cuts.

pH value of loin and shoulder cuts differed significantly in Black Bengal goats, but pH value of leg did not differ significantly from the other two wholesale cuts. On the other hand, in Jamunapari goats pH value did not differ significantly between leg, loin and shoulder. WHC of leg and shoulder did not vary significantly however, WHC of loin was significantly lower than the other two cuts in both the breeds. Extract release volume (ERV) of leg, loin and shoulder differed significantly in both the breeds (P<0.05). In Black Bengal goats, fiber diameter of shoulder muscles was significantly higher (P<0.05) than the other two wholesale cuts. Fiber diameter significantly differed between all the three wholesale cuts in Jamunapari goats. Cooking loss% differed significantly between leg, loin and shoulder cuts (P<0.05) in both the breeds.
pH of cooked loin and shoulder differed significantly (P<0.05), however, there was no significant difference between pH value of cooked leg and the other two cuts in case of Black Bengal goats. In case of Jamunapari goats, pH of cooked leg, loin and shoulder cuts did not differ significantly.

In the present study, no significant difference in pH value was observed between raw and cooked wholesale cuts (leg, loin and shoulder) in Black Bengal as well as Jamunapari goats.

The amount of copper, cadmium, chromium, manganese and lead in different wholesale cuts in Black Bengal and Jamunapari goats were below detectable limit (BDL). Zinc and Iron content of leg, loin and shoulder cuts were higher, though not statistically significant, in Jamunapari goats (P>0.05). However, Iron content of shoulder cut in Black Bengal goats was slightly higher than the respective value in Jamunapari goats. Zinc and Iron content did not vary significantly between leg, loin and shoulder cuts of Black Bengal goats. However, significant difference in zinc content between loin and shoulder cuts was observed in Jamunapari goats (P<0.05).

From the present study, it may be concluded that Jamunapari goats are better with respect to carcass characteristics, however, with respect to proximate composition and physico-chemical quality, there was no significant difference between Black Bengal and Jamunapari goats except in case of fiber diameter. Considering the cholesterol content and sensory attributes, meat from Black Bengal was more acceptable than that of Jamunapari. Therefore, this study contributes valuable data to more accurately assess dietary intake by providing an accurate nutrient profile of Black Bengal and Jamunapari goats.