**Effect of Transport Stress and Pre-slaughter Practices on Meat Quality of Animals**

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**A PRODUCTION REPORT SUBMITTED**

**BY**

**Avijit Dutta**

**Intern ID: F-60**

**Roll No : 09/107**

**Registration No : 464**

**Report Submitted in Partial Satisfaction for the Requirements fo the Degree of**

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**Khulshi, Chittagong-4225**

**December, 2015**

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**Approved by**

**…………………………………**

**Signature of Supervisor**

**DR. Mahabub Alam**

**Lecturer**

**Department of Animal Science and Nutrition**

**Chittagong Veterinary and Animal Sciences University**

**Khulshi, Chittagong-422**

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**LIST OF ABBREVIATION AND SYMBOLS USED**

|  |
| --- |
| **Abbreviation and symbol Elaboration** |
| % Percent |
| / Per |
| **±** Plus-minus⁰ C Degree Celsiuscm CentimeterDFD Dark Firm and Dryet al Et alii (and others)ERV Extract Release Volume Fig. Figurehrs HoursLtd. Limitedmg Milligramml MilliliterNO. NumberPSE Pale Soft and ExudativeSL SerialTVC Total Viable CountTV Tyrosine ValueVFA Volatile Fatty AcidWHC Water Holding Capacitywww World Wide Waveµg Microgram |

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 **December, 2015**

**ABSTRACT**

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 Now-a-days the meat consumers are increasingly demanding the animal meat of high aesthetic value which directly or indirectly indicates the quality of meat. The present study was conducted aiming to investigate the effect of transport stress and pre-slaughter practices on the meat quality of cattle and buffalo. A total of 20 meat samples (cattle: 10 and buffalo: 10) were collected from Firingibazar City Corporation slaughter house, Chittagong, Bangladesh. The quality of collected meat samples were determined in laboratory by using the parameters: moisture content, PH, water holding capacity (WHC), extract release volume (ERV), total viable count (TVC) and tyrosine value (TV). The differences between cattle meat quality parameters of two transport duration groups (≤2 hours and >2 hours) were statistically insignificant (p>0.05). But significant variation (p<0.05) between the groups was found for carabeef in terms of PH. In case of resting duration, only ERV values of beef quality varied significantly (p<0.05) between two groups (≤12 hours and >12 hours) whereas all parameters of carabeef quality were statistically indifferent (p>0.05) between the groups. The feed withdrawal period had statistically insignificant (p>0.05) effect on the beef and carabeef quality of two categories (≤12 hours and >12 hours). Finally, the water withdrawal period and fasting period also showed statistically insignificant (p>0.05) effect between meat quality parameters of two categories (≤6 hours and >6 hours). The study revealed that the transport duration in buffalo and resting period in cattle might be an important factor of affecting meat quality. To ensure the quality of meat the pre-slaughter management of the animals should be efficient.

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| --- |
| **Key words:** Beef, carabeef, meat quality, pre-slaughter practices and transport stress. |

**Chapter-1**

**INTRODUCTION**

Being omnivorous humans have hunted and killed animals for meat since pre-historic times. Now-a-days in almost every country of the world meat is considered as one of the most important foods and in some countries it is evaluated as an essential product with very high consumption rates. Consumption of meat varies worldwide depending upon cultural or religious preferences, as well as economic status. Family income, prices, individual preferences and beliefs, culture and traditions, as well as geographical, environmental, social and economic factors interact in a complex manner to determine dietary consumption of meat of any type (Grunert, 2006).

Generally the term “meat” is used to denote the animal flesh that is taken as food by human beings. Most often “meat” refers to the skeletal muscles associated with fat and other tissues, but it may also describe other edible tissues such as offal. Sometimes “meat” is also used in more restrictive sense “the flesh of mammalian species (cattle, pigs, sheep, goat, buffalo etc) raised and prepared for human consumption, to the exclusion of fish, other sea foods, poultry or other animals.

Meat is an excellent source of many nutrients. All muscle tissue is very high in protein, containing all of the essential amino acids and in most cases is a good source of zinc, vitamin B12, selenium, phosphorus, niacin, vitamin B6, choline, riboflavin and iron. Muscle tissue is very low in carbohydrates and does not contain dietary fiber. As a nutrient dense food, meat provides a major nutritive contribution to diet relative to the amount of calories it contains.

Numerous aspects of the nutritional composition of meat vary in complex way depending on the species, breed, age, sex, plane of nutrition, training and exercise of the animal, as well as on the anatomical location of the musculature involved. According to many researchers the factors that affect the quality of meat can be classified broadly into intrinsic and extrinsic factors. The intrinsic factors are species, breed or crossbreed, individual genetics, gender, age and weight at slaughter. The extrinsic factors prior to slaughter include management, diet, production system and pre-slaughter conditions. Extrinsic factors related with slaughter and post-slaughter are slaughter and blood loss, freezing, preservation, ageing, commercialization and consumption (Guerrero *et al*., 2013).

Transporting animals to slaughter is different than shifting of animals from one place to another. Animals experience a great deal of stress during transportation. During transport numerous microbial, physical and environmental hazards have the potential to affect the health and meat quality of the animals negatively (Southern *et al*., 2006). In case of food animals much of the pain and stress takes place prior to slaughter, particularly during the events of transportation. Mode of transport, type of animal transported, duration of transport, feed and water deprivation, ambient temperature, air or water quality, stocking density etc play vital role regarding animal welfare and product quality during transport. It may also have psychological origin, such as separation from group, fear, mixing with unfamiliar animals and environment etc. This stress has both long and short term effect on animal. The exposure of an animal to the stressors results in release of catecholamines (epinephrine and nor-epinephrine) and glucocorticoids in blood. But the level varies based on species, age, sex, breed and individual differences. The secretion of catecholamines results in significant changes in energy metabolism including lipolysis, glycogenolysis in muscle and gluconeogenesis (Kuchel, 1991). They also decrease the protein degradation (Rooyackers and Nair, 1997). Again increased release of glucocorticoids amplifies the mobilization of energy triggered by catecholamines. Significant depletion of muscle glycogen reserves has a thoughtful and well-recognized effect on key parameters of meat quality such as PH, tenderness, ageing potential, color and water holding capacity (Gregory and Grandin, 2007). The longer the transit time the greater the tendency to have a high muscle PH and dark meat. Ultimate PH is related to tenderness, color, flavor, acceptability, water holding capacity and keeping quality of meats. Maria *et al*. (2003) have analyzed the effect of transport time (30 min, 3 hours or 6 hours) on the quality of beef. They found that transport time have a significant effect on the texture, tenderness, color and overall liking. Thus transport stress affects the quality of meat significantly.

In case of food animal practice the pre-slaughter management after transport includes resting, feeding, watering and fasting. Among those one of the important segments is the period of time spent by the animals in lairage prior to slaughter. The duration at lairage and the conditions in lairage are important regarding pre-slaughter stress. Adequate resting at lairage with other practices facilitates the rehydration and recovery from transport stress. The practice of resting duration varies country to country. In case of European countries and North America animals are slaughtered on the day of arrival whereas in Australia, New Zealand and other countries slaughtering is practiced on the day after arrival. As far know there is no standard practice followed in our country. The environment conditions in lairage such as temperature, air quality, noise, stocking density are also important to minimize the stress. According to Warner *et al*., (1998) the time spent by the animals in lairage tends to increase the incidence of dark cutting in beef. But there is little evidence for the duration of lairage having any effect on the eating quality or tenderness of meat. Experimentally it is shown that stay time in lairage has no effect on ultimate PH, WHC and color of meat (Maria *et al*., 2003). Commercially ultimate PH is used as the main indicator to measure meat quality (Gregory and Grandin, 2007). There is found no difference in consumer sensory scores for 5 days aged meat of lamb or mutton animals kept in lairage for 0, 1 or 2 days prior to slaughter (Jacob *et al*., 2005). In case of feedlot cattle no difference is observed in terms of shear force value between animals of 3 hours and 18 hours lairage time (Ferguson *et al*., 2007).

Feeding and watering prior to slaughter are important practice in meat science. During transport animals are deprived of feed and water. This practice is accomplished with increased dressing percentage by recovering the lost weight of animals. By feeding sugar to cattle and pig, the incidence of DFD (Dark, Firm and Dry) meat and the number of dark cutters in fatigued animals can be reduced (Galwey and Tarrant, 1978). Dehydrated cattle have lighter carcasses than the animals that receive water. In a number of experiments it is shown that access to water does not wholly prevent carcass weight losses and offering animals with feed did not slow carcass weight loss more than when the animals were offered water only. Watering prior to slaughter also reduces the gut microbial load thus has a significant effect on hygienic meat production.

Finally, fasting prior to slaughter is the ultimate practice offered to the food animals. Animals intended to slaughter should not be allowed to take feed and water until slaughtering. Animals should be kept in starvation condition at least for 6 hours before slaughtering. Fasting prior to slaughter helps in hygienic meat production.

However, there is limited published information regarding effect of transport stress and pre-slaughter practices on the meat quality of animals in Bangladesh. As far known this is the first research work regarding the meat quality of slaughtered animals in Chittagong. This first attempt is taken to find out the relationship between transport stress and pre-slaughter management with the meat quality of slaughtered animals.

**Specific objectives of the current study are as follows:**

* To determine the quality of beef and carabeef using different parameters including moisture content, PH, water holding capacity (WHC), extract release volume (ERV), total viable count (TVC) and tyrosine value (TV).
* To identify the effect of transport stress on the quality of beef and carabeef.
* To find out the effect of pre-slaughter practices (resting, feeding, watering and fasting) on the quality of beef and carabeef.

**Chapter-2**

**MATERIALS AND METHOD**

**2.1: Study area and duration of study:**

The Firingibazar slaughter house, City Corporation approved only slaughter house in Chittagong Metropolitan area, was selected for the present study. It is located on the bank of Karnafully River. On an average 100 animals are slaughtered daily. For slaughtering purpose it receives different species of animals mainly cattle, buffalo, goat and sheep. Pre-slaughter and post-mortem inspection of animals are performed by registered veterinarian to ensure the public health welfare. Here animals are slaughtered following “halal” method.

 The study was conducted during the period of March to May, 2015.

**2.2: Collection of meat samples:**

A total of 20 meat samples (cattle: 10 and buffalo: 10), preferably meat of longissimus dorsi were collected for the study. About 20 grams of meat sample was collected. Samples were collected in zipper bag and immediately transferred into ice box. Finally the samples were transported to Department of Animal Science and Nutrition Laboratory, CVASU for details meat quality parameters investigation.

**2.3: Preservation of samples:**

During the study period the samples were preserved in a refrigerator.

**2.4: Determination of meat quality of collected samples:**

The quality of collected meat samples were determined by using following parameters: moisture content, PH, Water Holding Capacity (WHC), Extract Release Volume (ERV), Total Viable Count (TVC) and Tyrosine Value (TV). Briefly the procedure to determine each parameter is described below.

 **2.4. Ι: Determination of moisture content of meat samples:**

To determine the moisture content 5gms of meat sample was taken in a petridish. Then the petridish was placed in the hot oven at a temperature of 105⁰C. The sample was heated until constant weight. After gaining the constant weight the sample was allowed to cool in desiccators and then weighted. Finally the moisture content of the sample was calculated using formula and expressed in percentage.

**2.4. ΙΙ: Determination of PH of meat samples:**

 ***Slurry method of PH determination:***

50gm of collected meat sample was grinded by using electric grinder. Approximately 30gm of finely chopped ground meat was taken into a blender. 100ml of distilled water (3 times higher that meat sample weight) was added to the blender and blended at high speed for 15 to 20 seconds to make a slurry. Finally the PH of that slurry was determined by using PH meter that was calibrated with standard buffer solutions, one buffer at PH 7.0 and another having PH value of 4.0.

 **2.4. ΙΙΙ: Determination of water holding capacity of meat samples:**

300mg of meat sample was taken to assess the water holding capacity of meat. The collected meat sample was placed on a Whatman No 1 filter paper (GE Healthcare UK Ltd., Buckinghamshire, UK) and was placed between two glass slides. On the top of the upper glass slide a 100gm weight was placed for a period of 3minutes so as to exert a downward force. This arrangement was kept on a hard table and the released water from the meat sample was absorbed by the filter paper thus created an impression. The boundary of the area was demarcated carefully by using a sharp pencil. Finally the area of the impression was expressed as square centimeters (cm2). An increase in the area wetted by the meat sample was interpreted as a decrease in water holding capacity.

 **2.4. ΙV: Determination of extract release volume of meat samples:**

 ***Preparation of extraction reagent:***

50ml of 0.2M potassium dihydrogen orthophosphate (Merck KGaA, Darmstadt, Germany) was mixed in 3.72ml of 0.2M sodium hydroxide (Merck, Germany) and diluted to 200ml with distilled water to prepare the extraction reagent.

 ***Procedure of determining of ERV:***

15gm of meat sample was added to 60ml of extraction solution and blended for 2 minutes in a homogenlser. The whole blended content was transferred to a glass funnel (10cm diameter) with a Whatman No 1 filter paper (18.5cm diameter; Whatman International Ltd., Maidstone, UK) folded trice as to make eight sections. The filtrate was collected in a 100ml capacity measuring cylinder. The quantity of filtrate obtained in 15minutes at room temperature was reported as milliliters (ml) of extract release volume of the meat sample.

 **2.4. V: Determination of total viable count of meat samples:**

5gm of collected meat sample was added to 45 ml volume of phosphate buffer solution (PH 7.0±0.05; Buffer capsule of Merck Specialities Pvt. Ltd, Mumbai, India). After blending the content for 2 minutes at the rate of 10,000 to 12,000 rpm, 1ml of the extract was transferred to 9ml of diluents and then a 1:10 serial dilation was done up to the dilution factor 1010. From each dilution 1ml was added into two separate and accurately marked petridish. 20ml of previously prepared plate count agar (PCA; HiMedia Laboratories Pvt. Ltd, Mumbai, India) was added to each petridish within 15 min of dilution. Mixing of the diluted sample and the agar medium was done thoroughly and uniformly then it was allowed for solidification (15 to 20 min). At 35⁰c the petridishes were incubated for 48±2 hours. The colonies of double petridishes (for each dilution) were counted by using colony counter (Stuart Scientific, UK) where the number of colonies ranges from 25 to 250 per petridish was considered for counting. Those having less than or more than 250 were discarded.

 **2.4. VΙ: Estimation of tyrosine value of meat samples:**

 ***Preparation of trichloro acetic acid extract:***

Meat sample of 20gm weight was blended in a mincer with 50ml of cold 20% trichloro acetic acid for 2 minutes. The whole blended content was rinsed in 50ml distilled water. After mixing properly it was filtered by using Whatman No 1 filter paper (18.5cm diameter; Whatman International Ltd. Maidstone, UK) and the filtrate was collected in a 100ml measuring cylinder. Thus trichloro acetic acid extract was prepared for estimation of tyrosine value of meat sample.

 ***Procedure for determination of tyrosine value:***

2.5ml of trichloro acetic acid extract was diluted with equal volume of distilled water in a test tube. To that 10ml of 0.5M sodium hydroxide (Merck, Germany) was added followed by 3ml of diluted folin ciocalteu phenol reagent (1 part of folin ciocalteu phenol reagent : 2 parts of distilled water; Loba Chemie Pvt. Ltd, Mumbai, India). After mixing it was left for 15minutes at room temperature. The developed blue color was then measured as absorbance at 660nm weave length in a spectrophotometer using a blank for comparison. With reference to the standard graph the tyrosine value was calculated and expressed as milligram (mg) of tyrosine in per 100gm meat sample.

**2.5: Statistical analysis:**

All data were inputted into the Microsoft Office Excel-2007 and transferred to the software STATA/IC-11 for analysis. Descriptive statistics was done by using the STATA software and t-test was done to compare the data. Differences between the variables were accepted as being significant if P<0.05.

**Chapter-3**

**RESULTS**

Stress of any kind prior to slaughter may affect the quality of meat adversely. In this regard stress due to transport and pre-slaughter management are the major concerning issue in case of food animal practice. This chapter describes the effect of transport stress and pre-slaughter practices on the quality of beef and carabeef.

The general information of the slaughtered animals from whose meat samples were collected is summarized in **Table 3.1**

.

**Table 3.1: General information of the slaughtered animals:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Categories** | **Cattle (n=10)** | **Buffalo (n=10)** |
| Breed | Cattle | Hariana | 70%(7) | **-** |
| RCC | 30%(3) | **-** |
| Buffalo | Murrah | **-** | 100%(10) |
| Sex | Male | 90%(9) | 80%(8) |
| Female | 10%(1) | 20%(2) |
| BCS | 2 | 10%(1) | 10%(1) |
| 3 | 30%(3) | 50%(5) |
| 4 | 60%(6) | 40%(4) |
| Injury due to transport | Yes | 50%(5) | 30%(3) |
| No | 50%(5) | 70%(7) |
| Abnormal discharge | Yes | 30%(3) | 10%(1) |
| No | 70%(7) | 90%(9) |
| Clinical sign(s) | Yes | 30%(3) | 10%(1) |
| No | 70%(7) | 90%(9) |

N=20; BCS=Body Condition Score.

Among the 20 meat samples 10 were from cattle and 10 from buffalo. Cattle of Hariana breed was highest (70%) in number whereas all buffaloes were Murrah breed (100%). Most of the slaughtered animals (cattle: 90% and buffalo: 80%) were male. In terms of BCS 60% cattle were in BCS 4 and 50% of buffalo in BCS 3. About 50% cattle and 70% buffalo had injuries on their body. Most of the slaughtered animals (cattle: 70% and buffalo: 90%) had abnormal discharge.

The effect of transport duration on the meat quality of cattle and buffalo is given in **Table 3.2**.

**Table 3.2: Effect of transport duration on meat quality of cattle and buffalo:**

|  |  |
| --- | --- |
| **Parameters** | **Categories** |
| **Cattle** | **Buffalo** |
| **≤2 hours** **(Mean ± SE)** | **>2 hours****(Mean ± SE)** | **P value** | **≤2 hours****(Mean ± SE)** | **>2 hours****(Mean ± SE)** | **P value** |
| Moisture % | 70.29±1.95 | 67.24±5.64 | 0.65 | 68.07±5.58 | 65.84±0.69 | 0.71 |
| PH | 5.79±0.10 | 5.33±0.44 | 0.41 | 5.08±0.24 | 6.25±0.25 | 0.01 |
| WHC (cm2) | 3.88±0.47 | 3.56±0.83 | 0.75 | 2.55±0.36 | 2.51±0.68 | 0.96 |
| ERV (ml) | 24.42±1.61 | 21.33±1.27 | 0.18 | 23.74±1.63 | 23.50±1.65 | 0.92 |
| TVC (CFU) | 4.68×107±0.78×107 | 9.46×107±1.44×107 | 0.70 | 2.60×107±0.08×107 | 4.95×108±1.52×108 | 0.38 |
| TV (µg) | 1.26±0.21 | 1.28±0.45 | 0.96 | 1.52±0.39 | 0.71±0.22 | 0.13 |

WHC= Water Holding Capacity; ERV= Extract Release Volume; TVC= Total Viable Count; TV= Tyrosine Value.

N=20; SE= Standard Error.

Here, moisture content, WHC and ERV values of both beef and carabeef were lower in animals transported >2 hours though it was statistically insignificant (p>0.05). PH of carabeef varied significantly (p<0.05) between two groups.

The **Table 3.3** shows the effect of resting period on the meat quality of cattle and buffalo.

**Table 3.3: Effect of resting period on meat quality of cattle and buffalo:**

|  |  |
| --- | --- |
| **Parameters** | **Categories** |
| **Cattle** | **Buffalo** |
| **≤12 hours****(Mean ± SE)** | **>12 hours****(Mean ± SE)** | **P value** | **≤12 hours****(Mean ± SE)** | **>12 hours****(Mean ± SE)** | **P value** |
| Moisture % | 68.93±2.37 | 71.78±0.28 | 0.27 | 65.43±4.30 | 72.65±0.97 | 0.16 |
| PH | 5.67±0.17 | 5.25±0.25 | 0.30 | 5.63±0.31 | 5.25±0.25 | 0.40 |
| WHC (cm2) | 3.86±0.43 | 3.30±0.16 | 0.25 | 2.47±0.41 | 2.77±0.07 | 0.50 |
| ERV (ml) | 23.91±1.25 | 19.60±0.40 | 0.01 | 23.37±1.38 | 24.65±1.05 | 0.49 |
| TVC (CFU) | 6.71×107±1.10×107 | 1.60×105±0.45×104 | 0.07 | 2.67×108±0.27×108 | 2.11×106±0.55×105 | 0.28 |
| TV (µg) | 1.16±0.20 | 1.19±0.01 | 0.89 | 0.78±0.14 | 2.11±0.43 | 0.17 |

N=20; SE= Standard Error.

Here, only extract release volume of beef of two categories varied significantly (p<0.05) whereas all parameters of carabeef quality indicator were statistically insignificant (p>0.05). In both beef and carabeef moisture content and TV increased and PH and TVC decreased in the animals rested >12 hours though the results were statistically insignificant (p>0.05)

The **Table 3.4** shows the effect of feed withdrawal period on the quality of beef and carabeef.

**Table 3.4: Effect of feed withdrawal period on meat quality of cattle and buffalo:**

|  |  |
| --- | --- |
| **Parameters** | **Categories** |
| **Cattle** | **Buffalo** |
| **≤12 hours****(Mean ± SE)** | **>12 hours****(Mean ± SE)** | **P value** | **≤12 hours****(Mean ± SE)** | **>12 hours****(Mean ± SE)** | **P value** |
| Moisture % | 72.19±0.53 | 65.63±4.30 | 0.22 | 65.96±6.67 | 68.51±2.71 | 0.74 |
| PH | 5.83±0.11 | 5.38±0.31 | 0.25 | 5.25±0.14 | 5.75±0.40 | 0.29 |
| WHC (cm2) | 4.24±0.37 | 3.11±0.74 | 0.24 | 2.62±0.55 | 2.48±0.44 | 0.85 |
| ERV (ml) | 24.26±1.96 | 22.30±1.32 | 0.44 | 25.03±1.32 | 22.56±1.59 | 0.27 |
| TVC (CFU) | 3.82×107±0.23×107 | 9.30×107±1.45×107 | 0.44 | 3.80×107±0.06×107 | 3.31×108±0.04×108 | 0.38 |
| TV (µg) | 1.26±0.21 | 1.28±0.45 | 0.96 | 1.72±0.47 | 0.75±0.17 | 0.16 |

N=20; SE= Standard Error.

Both in case of beef and carabeef there were no statistically significant variation between two groups (p>0.05). Meat of both types showed decreased WHC and ERV values where feed withdrawal period was >12 hours. Again moisture content and PH values decreased in case of beef but increased in carabeef of animals deprived of feed for >12 hours. All results were statistically indifferent (p>0.05).

The effect of water withdrawal and fasting period on the meat quality of cattle and buffalo are given in **Table 3.5.**

**Table 3.5: Effect of water withdrawal and fasting period on meat quality of cattle and buffalo:**

|  |  |
| --- | --- |
| **Parameters** | **Categories** |
| **Cattle** | **Buffalo** |
| **≤6 hours****(Mean ± SE)** | **>6 hours****(Mean ± SE)** | **P value** | **≤6 hours****(Mean ± SE)** | **>6 hours****(Mean ± SE)** | **P value** |
| Moisture % | 69.48±0.81 | 69.15±2.40 | 0.89 | 71.50±1.05 | 66.47±3.79 | 0.24 |
| PH | 6.00±0.29 | 5.61±0.16 | 0.32 | 5.00±0.29 | 5.61±0.27 | 0.18 |
| WHC (cm2) | 3.18±0.18 | 3.83±0.43 | 0.20 | 1.57±0.44 | 2.69±0.32 | 0.16 |
| ERV (ml) | 24.40±0.40 | 23.21±1.37 | 0.43 | 22.20±0.19 | 23.81±1.22 | 0.23 |
| TVC (CFU) | 8.97×107±0.73×107 | 4.33×107±0.72×107 | 0.66 | 1.61×107±0.55 ×106 | 2.35×108±0.02×108 | 0.31 |
| TV (µg) | 0.89±0.05 | 1.32±0.22 | 0.13 | 1.15±0.25 | 1.11±0.26 | 0.93 |

N=20; SE= Standard Error.

Statistically the beef and carabeef quality of two different groups were indifferent (p>0.05). Animals fasted >6 hours showed lower moisture content and higher WHC in case of both beef and carabeef the differences were statistically invalid (p>0.05).

**Chapter-4**

**DISCUSSION**

Food safety is one of the major concerning issues in the present age. Concern regarding food quality is increasing day by day. In case of meat this quality is more or less affected by the transport stress prior to slaughter and the pre-slaughter practices along with other factors.

**4.1: Effect of transport stress on the quality of beef and carabeef:**

Here six parameters of meat quality indicator were used to determine the quality of both beef and carabeef. The mode of transport to slaughter house for all the animals was on foot. The differences of beef quality parameters between two groups (transport duration ≤2 hours and >2 hours) were statistically insignificant. But significant variation was observed in carabeef in terms of PH. Ultimate PH is the basic and most important parameter of meat quality and it is used as the main quality indicator of meat in commercial level (Gregory and Grandin, 2007). This PH value is highly correlated with other parameters of meat quality. The findings of this study showed strong agreement with Ådnøy *et al*., (2005) who found no significant differences in meat PH between lambs that did or did not undergo a long, double transport. Buffalos experiencing transport of >2 hours showed significantly higher PH than others whereas cattle showed lower PH though statistically insignificant. This finding is contradictory to Nearth *et al*., (2007) who stated that there is a decline in ultimate PH in buffalos experiencing long journey. But due to low heat regulation mechanism the buffalos face more stress than cattle and in stress glycogen breaks down into glucose. Due to less glycogen post-mortem PH will not decline rather increase which is the findings of this study. Small increase of 0.1 to 0.2 units of meat PH was reported by Tarrant, (1989) who examined cattle transported for longer duration (e.g. 24 hours) or larger distances (e.g. 20000 km). Fischer, (1996) stated that a reduction in transportation time by as little as an hour and distance travelled (<500 km) has no negative effect on meat quality which is supported by the findings of this study. Many of the previous studies have shown that not only the transport duration but also distance travelled, weather condition, stocking density, feed and water deprivation during transit etc work in complex way to determine the meat quality. Again after transport adequate resting, feeding and watering prior to slaughter help to recover the transport stress.

**4.2: Effect of pre-slaughter practices on the quality of beef and carabeef:**

***4.2.Ι: Effect of resting period on the meat quality of animals:***

On the basis of resting period animals of either species were categorized into two groups (resting period of ≤12 hours and >12 hours). In case of beef there were statistically significant differences between two groups in terms of ERV. Other parameters showed no significant differences. But in case of carabeef all parameters between two groups showed no significant variation. Almost similar result was reported by Jacob *et al*., (2005) who found no significant differences in consumer sensory scores for 5 days aged meat of lamb or mutton animals kept in lairage for 0, 1 or 2 days prior to slaughter. Ferguson *et al*., (2007) stated that feedlot cattle showed no differences in terms of shear force value between animals of 3 hours and 18 hours lairage time which was supported by this study. The findings showed partial similarity with Marıa *et al*., (2003) who experimentally showed that stay time in lairage had no effect on ultimate PH, which also helps to explain the lack of differences in other parameters such as WHC. Miranda-de la Lama *et al*., (2009) showed that color variation of meat was not affected by stay time in lairage which is determined by meat PH. Here ERV values of two beef categories showed significant differences. The ERV values of meat are controlled by its microbial quality and higher microbial contamination caused the lower ERV values. The meat of animals resting ≤ 12 hours had higher TVC values than the animals resting >12 hours though the variation was statistically insignificant. Holding time in lairage allows animals to replenish muscle glycogen and recover from the feed and water withdrawal and other transport stressors. Rest in lairage reduces the meat quality defects (Wesley *et al*., 2005). Animals experiencing higher lairage time reduce the microbial contamination resulting higher ERV value.

***4.2.ΙΙ: Effect of feed withdrawal period on the meat quality of animals:***

Cattles and buffalos were divided into two groups based of feed withdrawal period (feed withdrawal period of ≤12 hours and >12 hours). In both cases of beef and carabeef there were found no statistically significant differences between meat qualities of two groups. Theoretically practice of feed withdrawal makes sense as gut emptying helps to reduce the chance of cross contamination. Again feed withdrawal for longer period will reduce the dressing percentage. Previous researches on feed withdrawal period found both positive and negative effect on meat quality. Animals fasting prior to slaughter showed increased ultimate PH, WHC, color (Wittmann *et al*., 1994). Again Eikelenboom *et al*., (1991) stated that pig fasting for 24 hours showed increased incidence of DFD (Dark, Firm and Dry). Experimentally it is shown that offering feeds to the animals did not slow the carcass weight loss more than the offering of water. In a study it was hypothesized that gut emptying of animals for longer duration leads to an increase in intestinal PH (due to reduced VFA) which ultimately affect the meat quality (Harvey *et al*., 2001).

***4.2.ΙΙΙ: Effect of water withdrawal period and fasting on the meat quality of animals:***

In the present study the water withdrawal period and the fasting period were similar. On the basis of those criteria animals were grouped into two categories (water withdrawal period or fasting of ≤6 hours and >6 hours). Meat quality parameters of both beef and carabeef showed no statistically significant differences between two groups. Several studies stated that fasting or deprivation of feed and water prior to slaughter for a period of 16 hours to 24 hours increased food safety by reducing microbial contamination as well as improve meat color, and ultimate PH (D'Souza *et al*., 1998 and Eikelenboom *et al*., 1991). Here both cattle and buffalo were fasted for a short duration ranging from 4 hours to 10 hours which may be the cause of absence of variation between two study groups.

**Chapter-5**

**CONCLUSION**

Transport stress and pre-slaughter practices are important contributing factors of meat quality. Findings of this study are important because excess transport stress and lower resting duration in lairage will affect the different quality parameters of meat. Standards for pre-slaughter practices in relation to species, season, and climatic condition should be followed to increase the food value as well as keeping quality of beef and carabeef.

**Recommendations of the study:**

* Animals should be subjected to no or least transport stress.
* Full deprivation of feed and water during transport should be avoided.
* Adequate resting of at least 12 hours should be given.
* Pre-slaughter feeding and watering are important.
* Fasting prior to slaughter will increase the quality of meat.

**Chapter-6**

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**Chapter-7**

**APPENDIX**

**Questionnaire used for the study:**

**Effect of Transport Stress and Pre-slaughter Practices on the Meat Quality of Animal**

**(Data collection sheet/ Questionnaire)**

Date: Time: Place:

Name of the species:

Identification number:

Breed: Age:

Sex: Body temperature:

Body condition score (BCS): Physiological state:

Injury due to transport:

Abnormal discharge:

Clinical sign(s) observed:

Feeding prior to transport:

Duration of transport: Mode of transport:

Feed withdrawal period prior to slaughter:

Water withdrawal period prior to slaughter:

Duration of fasting prior to slaughter:

Duration of resting prior to slaughter:

Amount of meat sample collected (gm):

**BIOGRAPHY**

**Name :** Avijit Dutta

**Father’s name :** Adinath Dutta

**Mother’s name :** Swapna Dutta

**Permanent address :** C/O- Adinath Dutta, Vill: Keyagorh, P.O: Anwara-4376,

 Upzilla: Anwara, District: Chittagong.

**Present address :** Room no: 508, Boy’s hall, Chittagong Veterinary and Animal Sciences

 University, Khulshi, Chittagong-4225.

**Mailing address :** avijitduttadvm@gmail.com

**Academic details :**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Examination** | **Institute** | **Board** | **Group** | **Year of passing** | **GPA obtained** |
| S.S.C. | Anwara Model High School, Anwara, Chittagong | Chittagong | Science | 2006 | 5.00 (scale of 5.00) |
| H.S.C. | Govt. Hazi Mohammad Mohsin College, Chittagong | Chittagong | Science | 2008 | 5.00 (scale of 5.00) |