Effect of Spatial Distribution on Meat Quality Traits of Buffalo in Bangladesh

Md. Moinul Hasan[1*], Md. Touhiduzzaman Sarker[2], Adhita Sri Prabakusuma[3], Md Shahidul Islam[4]

[1] Animal Science, Bangladesh Agricultural University, Mymensingh, Bangladesh
[2] Department of Dairy Science, Bangladesh Agricultural University, Bangladesh
[3] Department of Food Technology, Universitas Ahmad Dahlan, Indonesia
[4] Department of Plant Pathology, Yunnan Agricultural University, Kunming, China

Email Address

hasan.scholarzone@yahoo.com (Md. Moinul Hasan)
*Correspondence: hasan.scholarzone@yahoo.com

Received: 6 December 2017**; Accepted:** 17 December 2017

Abstract:

The experiment was carried out in to find out the Buffalo rearing practices and meat quality. Data were collected from three upazila namely Trisal in Mymensingh, Madargonj in Jamalpur and Pauba in Rajshahi districts of Bangladesh through interview schedule by selecting 15 respondents from these upazila who were involved in buffalo rearing. Data were collected from February to April 2016. The farmers of Pauba fed highest amount roughage (70%) and concentrate (8%) feed to the buffalo than other two regions of Bangladesh as well as give more permanent shelter (5%). But the farmers of Trisal in Mymensingh take more training (17%) on buffalo rearing than other two regions. Comparision of body height, face length, and ear length differs significantly ($p<0.01$) among the three groups. On the other hand, body length, chest girth, paunch girth, face width, horn length and tail length does not differ significantly among the three groups. CP contents differ significantly ($p<0.05$) among the three groups. The highest CP content was found in Mymensingh region than other two regions. On the other hand, EE, DM and Ash content does not differ significantly among the three groups. Comparision of pH, drip loss, cooking loss, and color differ significantly. The highest pH and drip loss were found in Jamalpur region than other two regions, but the highest cooking loss was found in Rajshahi region than other two regions. On the other hand, meat color also differs from region to region. TVC, TCC and YMC content of meat do not differ significantly among the three groups. On the basis of proximate analysis and microbial count quality, buffalo meat of Mymensingh region was better than other two regions in Bangladesh.

Keywords:

Buffalo, Meat Quality, Spatial Distribution, Bangladesh

1. Introduction

The economy of Bangladesh is mainly based on Agriculture [1]. Livestock plays a crucial role in the agricultural economy of Bangladesh. Countries 25% peoples are directly engaged in the livestock sector and 50 percent peoples are partly associated

with livestock production. The buffalo farmers of the riverine island areas depend on buffalo farming and it helps to earn money and maintain their livelihood and food security [2, 3, 4]. It is a popular farming in some areas of Bangladesh where it helps to reduce the rural poverty [5, 6, 7]. Buffalo farming is also meeting the growing meat of the large population and creates job opportunity for a large number of people. About 36 percent of the total animal protein comes from the livestock products in our everyday life [8]. The contribution of the livestock sub-sector to gross domestic products (GDP) during FY 2012-13, from this sub-sector, was 2.73 percent (DLS, 2013). Though the share of the livestock sub-sector in GDP is small, it has an immense contribution towards meeting the daily protein (animal protein) requirements. Among 53.03 million ruminant livestock (cattle, buffalo, goat, and sheep) population buffalo comprises 1.45 million (2012-13) which is about 2.729% of total livestock population and represent the higher population in Bangladesh (DLS, 2013). There are approximately 24.0 million cattle, 1.465 million buffaloes, 55.6 million goats and 1.9 million sheep in Bangladesh [9].

Buffaloes in Bangladesh may be classified into 3 categories: (i) Riverine types found in sugarcane belt of the country and mainly migrated from India, (ii) Swamp types found in the coastal areas and marshy land of the country and mainly indigenous in nature through a small number might have migrated from Burma and (iii) Crossbred type (swamp x river type) found in the coastal area of the country [10]. More than 95.8% of the world population of water buffalo are found in Asia including both river and swamp types. Swamp buffalo occur only in small areas in the north-eastern part of the country and are not distinguished into breeds [11]. The indigenous buffaloes are medium in size having live weight from 350 to 550 kg with a birth weight of 20 kg. Buffaloes have a number of advantages over cattle in the utilization of low-quality roughages to produce more protein and to gain more body weight, more disease resistance power and outstanding draught capacity and longer lifespan [12]. The main advantages of buffalo over cattle are that the dry or growing buffaloes may utilize coarse feeds more efficiently than Zebu cattle [13]. These advantages with buffaloes are also noticed in the indigenous buffaloes. They are 3 times heavier than indigenous cattle. Available literature indicates that indigenous buffaloes are three times heavier than indigenous cattle. Indigenous buffalo cows produce 2 times more milk than cows, having more milk fat and total milk solid [14]. A pair of buffalo has more draught capacity than a pair of cattle [15]. Another notable advantage, especially in the coastal areas, is that they can survive against a tidal wave. Buffaloes are well-adapted to the wet conditions often encounters in flooded native pastures where bovine cattle do not normally thrive [16]. This is possible because the water buffalo has long benefitted from its efficient utilization of a low-quality, high-roughage diet [17]. It seems now widely accepted that buffaloes under a harsh condition are capable of digesting fiber and cellulose better than cattle [18]. They are more versatile and hence popular among rural farmers since they are able to continue to work in hot, muddy fields much longer than oxen. Buffaloes have a large body size than the native cattle. It is a multipurpose animal, used for milk, meat, draught etc [19]. Farmers prefer to use buffaloes for farm work because of their great draught power, long working life, and docile temperament. Most of them are kept by small-scale farmers for draught purpose [20]. Domestic buffaloes occupy an important position in animal agriculture of the South Asian region. Ninety-six percent of world river buffalo population is found in Asia and buffaloes are almost exclusively raised by smallholders and landless farmers [21]. The buffalo cows yield 600 to 1000 kg milk in 275 day lactation period and have 10.5% fat and 21% total solids in milk. Buffalo

milk covers around 3% of total market milk of the country [21]. Buffalo has significant contribution in GDP through the production of meat, milk, and skin representing about 27.0, 23.0 and 28.0%, respectively to the total production from livestock sector in Bangladesh [22]. Meat consumption per head per day is only 10.1 gm of which 71.7% comes from cattle and buffalo though the daily requirement is 120 gm per head per day [23].

In Bangladesh, management systems are very poor for buffalo rearing. Most of the farmers are rural smallholders who have traditionally integrated their livestock with crop production and buffaloes are raised mainly to provide draught power in crop production. The feed resource base for these buffaloes are scavenging and consists of crop residues, household waste, tree fodder, roots and tuber, grain by-products and anything edible found in the immediate environment [24]. The management practices adopted by buffalo raisers usually depends on the type of production in which they are involved [25]. At the village level production is usually based on a small herd of mixed ages and sexes generally for draught and breeding purposes [26]. Some of the farmers are used extensive rearing system. The intensive system is not being used by farmers in our country. In a semi-intensive production system, buffaloes are kept mainly for specific purposes, i.e., either for draught or for milk production [27]. They are usually maintained on tree leaves, shrubs, and bushes in the rural condition. But the pasture lands are limited semi-intensive system is better [28]. Semi-intensive system is mostly used for buffalo rearing in Bangladesh. Semi-intensive system is mainly focused on this study on buffalo rearing.

The major attractive features of buffalo meat are red color, reduced fat, and cholesterol with poor marbling, low connective tissue, desirable texture, high protein, water-holding capacity, myofibrillar fragmentation index, and emulsifying capacity [29, 30]. Buffalo meat quality was often studied in comparison with cattle meat (beef), and lots of similarities were reported for various meat quality characteristics and sensory attributes between these two meats [31, 32]. Post-mortem muscle P^H ranging from 5.5 to 5.7 has been reported in fresh buffalo meat cubes [33, 34] and ground buffalo meat patties [34]. Meat quality mainly refers to the parameters of crude protein, ether extract, drip loss, cooking loss, dry matter content, ash, microbial count, pH, and color etc. In Bangladesh, no works have been done so far on the meat quality of the buffalo in relation to the management practices. However, it may not possible to investigate the management status of buffaloes and the meat quality throughout the country at a time. Therefore, an attempt was conducted to find out the relationship between meat quality and management practices in three different location of Bangladesh with the specific objectives (a) To investigate the management practices of buffaloes in some selected areas of Trisal upazilla in Mymensingh district, Madargonj upazilla in Jamalpur and Pauba upazilla in Rajshahi, and (b) To observe the meat quality on the basis of management practices in the selected areas.

2. Materials and Methods

2.1. Site of the Experiment

The present study was carried out at the three villages in Mymensingh, Jamalpur and Rajshahi district of Bangladesh under the Department of Animal Science, Bangladesh Agricultural University, Mymensingh to investigate the meat quality in relation to management practices.

2.2. Preparation of Interview Schedule

The interview schedule was carefully prepared based on the objectives of the present study. A draft schedule was developed before preparing the final interview schedule. The draft schedule was then pre-tested with selected farmers in the study area and then it was rearranged and modified as required. The schedule was developed in a simple manner to avoid misunderstanding and to get an accurate answer. Eventually, it was finalized according to the experience gathered in the preliminary field survey. This helped the respondents to understand the interview Schedule easily and furnish the required information swiftly and systematically.

2.3. Selection of Respondent

In total 15 respondents were chosen from three villages for the collection of data to satisfy the objectives. The respondents were classified into three distinct groups according to the Upazila (local administrative unit) level.

2.4. Data Collection Procedure

The information was collected through the personal interview with the individual respondent present in their own house. An introductory visit was made to the study area when the aims and objects of the study were explained to most of the respondents. This helped to have a friendly orientation of the respondents. Brief information regarding the nature and purpose of the study was made to the respondents before actual interview [35]. The researchers also established desire rapport with respondents. Questions were asked systemically and explain whenever it was felt necessary [36]. The respondents were interviewed at their own house so they could give accurate information without any hesitation and sound mind. The information supplied by the respondents was recorded on the interview schedule. The information was checked carefully before leaving the study area in order to minimize errors. No serious problem was faced by the respondents during data collection [37]. Data were collected from February to April 2016.

2.5. Survey Variables

The selection of variables and their measurements constitute is an important task in research. The selected variables in this study area were feeding condition, housing condition, problems of buffalo rearing, training of farmers, farmer's suggestion to increase buffalo production.

2.6. Meat Collection

Meat samples (about 2kg) were collected after completion of a survey or data collection from that particular area. P^H of meat samples was measured by using P^H meter on that day [38]. Then meat samples were stored in therefrigerator.

2.7. Chemical Analysis

2.7.1. Dry Matter (%)

At first, the weight of crucible was measured by using electric balance. Then 5gm meat sample was put in the crucible at 105oc for 24 hours in the oven for the estimation of dry matter [39]. The formula is given below to calculate of DM (%).

$$\% \text{ Dry matter} = 100\% - \% \text{ Water}$$

2.7.2. Crude Protein (%)

About 1gm sample was taken with 20ml H_2SO_4 acid and 1.5gm catalyzer mixer or tablet in kjeldahl flask for boiling at 420oc in digestion machine for 45 min. After 30min cooling, it was set for distillation with a 20 ml boric acid solution (2%) in a conical flask. NH_4 was collected for 5min. Then titration was performed by using 0.1N HCL solution up to pink color to estimate the crude protein in meat sample. The formula is given below to calculate CP (%).

$$\%\text{CP} = \frac{\text{B} \times 0.014 \times 0.1 \times 100 \times 6.25}{\text{Sample weight}}$$

Here, B=Burette reading

2.7.3. Ether Extract (%)

Ether extract content was determined by Soxhlet apparatus using diethyl ether. At first flask, weight was taken. Then 2 gm sample was taken in a thimble and added 200 ml acetone in a Soxhlet. Extraction was done at 40-45 ℃ which took about 7-8 hours. After extraction, the flask was taken out and dried in an oven for 30 minutes at 100 ℃. The flask containing ether extract was cooled in desiccators and weighed. The calculated value for ether extract content was obtained as a percent of the sample. The formula is given below.

$$\%\text{EE} = \frac{\text{Final wt.} - \text{Initial wt.}}{\text{sample wt}} \times 100$$

2.7.4. Ash (%)

Weighed samples were taken in porcelain crucibles and pre-ashed at 100 ℃ in an electric oven. The crucibles were then placed in a muffle furnace and heated at 550 ℃ for 6 hours. The crucibles were then cooled in desiccators. The average weight in the percentage of each sample of the remaining material was taken as ash. The formula is mentioned below:

$$\%\text{ of ash content } = \frac{\text{E}}{\text{C}} \times 100$$

2.7.5. Estimation of Cooking Loss (%)

The fresh meat samples were weighted (initial weight). Firstly, weighted meat boiled at water bath (700c) for 30 minutes. After completion of boiling samples were removed from the water bath. The formula of cooking loss is Cooking loss (%) = [w1 - w2] x 100; where, w1 = meat weight before cooking and w2 = meat weight after cooking.

2.7.6. Estimation of Drip Loss (%)

Firstly, samples were collected and weighted by using electric balance. After that, it was kept in the refrigerator for 24 hours. After 24 hours, meat sample was collected and weight to estimate the drip loss. The formula is given below

Drip loss (%) = [w_1 - w_2] x 100; where, w_1 = meat weight before freeze and w_2 = meat weight after freeze.

2.8. Microbial Count

For microbial assessment total viable count, total coliform count and total yest-mould count were undertaken. To determine these parameters, the procedures which were followed are described below:

2.8.1. Preparation of Samples for TVC, TCC and Yeast-Mould Count

A quantity of 10gm of meat sample was aseptically excised from the stored stock sample. Each of the stored samples was thoroughly and uniformly macerated in a mechanical blender using sterile diluents (0.1% peptone water) as per the recommendation of International Organization for Standardization [14]. A quantity of 10gm of the minced meat sample was taken aseptically transferred into a sterile container containing 90ml of 0.1% peptone water. A homogenized suspension was made in a sterile blender. Thus, 1:10 dilution of the samples was obtained. Later on, using whirly mixture machine different serial dilutions ranging from 10^{-2} to 10^{-6} were prepared according to the institution of the standard method [24].

2.8.2. Glassware

Different types of glassware were used during the experimental period. These were as follows: Test tubes (with or without Durham's fermentation tube and stopper), petridishes, conical flask, pipette (1 ml, 5 ml, 10 ml and 25 ml capacities), glass rod spreader, test tube stand, mortar and pestle, whirly mixture machine, blender machine, water bath, incubator, refrigerator, sterilizing instruments, hot air oven, ice boxes, electronic balance, electronic pH meter etc [24].

2.8.3. Media Employed for TVC, TCC and Yeast-Mould Count

The media employed for this bacteriological analysis included plate count agar (PCA), MacConkey agar (MA) and potato dextrose agar (PDA). The commercial media were prepared according to the direction of the manufacturers.

2.8.4 Preparation of Media

A quantity of 11.50 g of plate count agar (PCA) and 15.6 g of MacConkey agar (MA) was dissolved in 500 ml and 300 ml of cold distilled water in two separate conical flasks and heated to boiling for dissolving the ingredients completely. In case of PDA, 200 g of previously peeled and sliced potato was taken in 1000 ml of distilled water and boiled for an hour. After boiling, sieving was done through clean cheesecloth. 20 g of commercial dextrose and 15g of agar were added to the potato infusion solution and heated up to boiling to dissolve the ingredients completely. Later, the media were sterilized at 121 ℃ (6.795 kg pressure/sq inch) for 15 minutes in an autoclave. The final reaction was adjusted to pH 7.0 $\pm$ 0.1. The agar was then ready for pouring. Before pouring, the medium was kept in a boiling water bath at 45oC [19].

2.8.5. Enumeration of Total Viable Count (TVC)

For the determination of total bacteria counts, 0.1ml of each ten-fold dilution was transferred and spread on triplicate plate count agar (PCA) using a sterile pipette for each dilution. The dilution samples were spread as quickly as possible on the surface of the plate with sterile glass spreader. One sterile spreader was used for each plate. The plates were then kept in an incubator at 35oc for 24-48 hours. Following incubation, plates exhibiting 30-50 colonies were counted. Colonies were counted with the aid of a colony counter. The average number of colonies in a particular

dilution was multiplied by the dilution factor to obtain the total viable count. The total viable count was calculated according to ISO standard. The results of the total bacterial count were expressed as the number of the organism of colony forming units per gram (CFU/g) of meat samples.

2.8.6. Enumeration of Total Coliform Count (TCC)

For the determination of the total coliform counts, 0.1ml of each ten-fold dilution was transferred and spread on triplicate MacConkey agar (MA) using a sterile pipette for each dilution. The diluted samples were spread as quickly as possible on the surface of the plate with sterile glass spreader. One sterile spreader was used for each plate. The plates were then kept in an incubator at 35oc for 24-48 hours. Following incubation, plates exhibiting 40-60 colonies were counted. Colonies were counted with the aid of a colony counter. The average number of colonies in a particular dilution was multiplied by the dilution factor to obtain the total viable count. The results of the total coliform count were expressed as the number of the organism of colony forming units per gram (CFU/g) of meat samples [19].

2.8.7. Enumeration of Yeast-Mould Count (YMC)

For the determination of yeast and mould counts, 0.1ml of each ten-fold dilution was transferred and spread on triplicate potato dextrose agar (PDA) using a sterile pipette for each dilution. The diluted samples were spread as quickly as possible on the surface of the plate with sterile glass spreader. One sterile spreader was used for each plate. The plates were then kept in an incubator at 25oc for 48-72 hours. Following incubation, plates exhibiting 40-60 colonies were counted. Colonies were counted with the aid of a colony counter. The average number of colonies in a particular dilution was multiplied by the dilution factor to obtain the total viable count [26]. The results of the total yeast and mould count were expressed as the number of the organism of colony forming units per gram (CFU/g) of meat samples.

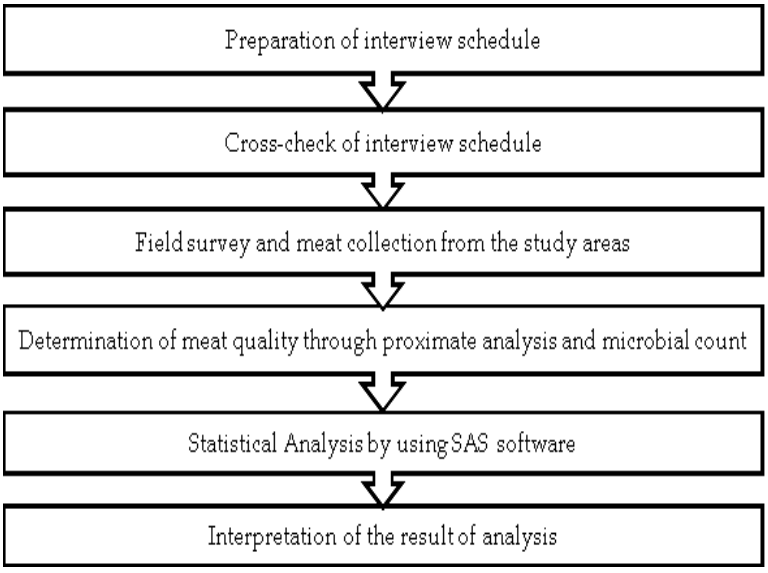

Figure 1. *The flow diagram of the experimental activities.*

2.9. Statistical Analysis

All the collected data were checked and cross-checked before transferring to the master sheets. The data were coded, compiled, tabulated and analyzed to accomplish

the objectives of the study. Qualitative data were converted into quantitative by means of suitable scoring technique wherever applicable [42]. Data were presented mostly in the tabular form widely used and easy to understand. Statistical analyses of all the parameters were analyzed using Statistical Analysis System (SAS) software (SAS Institute Inc., 2009) version 9.1.3. To see the significant differences in the mean values, Duncan's multiple range test (DMRT) was performed.

3. Results and Discussion

3.1. Management practices

Most of the farmers arrange locally available feed which is costless. In the winter season, feeding of buffalo is very difficult due to the scarcity of feed that is why farmers of Trisal in Mymensingh and Madargonj in Jamalpur regions send their animal in Sylhet or Sunamgonj region of Bangladesh for proper rearing.

Table 1. *Survey results at different Location.*

Location	Types of Feeding	Types of Housing	Training Practices
Pauba in Rajshahi	Roughage-70% Concentrate-8%	Permanent-5% Temporary-30% Others-65%	15%
Trisal in Mymensingh	Roughage-63% Concentrate-6%	Permanent-3% Temporary-25% Others-72%	17%
Madargonj in Jamalpur	Roughage-57% Concentrate-5%	Permanent-2% Temporary-28% Others-70%	12%

The farmers of Pauba in Rajshahi fed highest amount roughage and concentrate feed to the buffalo than other two regions of Bangladesh as well as give more permanent shelter. But the farmers of Trisal in Mymensingh take more training on buffalo rearing than other two regions. Saadullah [40] observed that the management practices adopted by buffalo raisers usually depends on the type of production in which they are involved. At the village level production is usually based on a small herd of mixed ages and sexes generally for draught which is similar to the present finding. Saadullah [40] also reported that most of the farmers are smallholders who have traditionally integrated their livestock with crop production and buffaloes are raised mainly to provide draught power in crop production. The feed resource base for these buffaloes are scavenging and consists of crop residues, household waste, tree fodder, roots and tuber, grain by-products this also agrees with the present result. Most of the animals are kept loose in an open paddock throughout the day and night. The open paddock is provided with shelter. A common watering tank and feeding manager is provided to make management more effective which is also quite similar to the finding of Calub [41].

3.2. Morphometric Characteristics of Buffalo

Morphometric characters refer to body weight, shoulder height, body length, chest width, chest depth, chest girth, skull length, skull width, skull height, ear width, ear length, cannon girth, horn length, horn girth and distance between horns and body morphology characters refers to horn position, head color, body color and scheme of body color of the buffaloes. Means with different superscripts within the same column differ significantly [12]; the data in Table 2 shows the comparison among the three

groups. Comparison of body height, face length, and ear length differ significantly ($p<0.01$) among the three groups [15]. The highest body height and face length was found in Rajshahi region than other two regions, but highest ear length was found in Jamalpur region than other two regions. On the other hand, body length, chest girth, paunch girth, face width, horn length and tail length does not differ significantly among the three groups.

Table 2. *Phenotypic characters of buffalo at three different regions of Bangladesh.*

Parameters	Mymensingh	Jamalpur	Rajshahi	Level of significance
Body Height (BH)	126.76^{b} ±0.61	130.44^{ab} ±1.11	135.18^{a} ±3.31	**
Body Length BL	128.85±1.29	126.85±3.51	136.12±2.45	NS
Chest Girth(CG)	193.43± 3.43	196.19±2.54	201.10±2.36	NS
Paunch Girth(PG)	201.39±1.50	200.49±6.78	208.53±3.53	NS
Face Length(FL)	41.27^{b} ±0.86	40.38^{c} ±2.05	46.58^{a} ±1.68	**
Face Width(FW)	22.23±0.76	21.62±0.69	22.12±0.43	NS
Horn Length(HL)	33.49±1.42	31.79±0.88	33.09±1.14	NS

*Note: ** = Significant at 1% ($p<0.01$) level of probability; *= Significant at 5% ($p<0.05$) level of probability; NS= Non significant; Figures in the parentheses indicate the number of observation.*

3.3. Chemical Composition of Buffalo Meat

The data shows the comparison of proximate analysis of meat among the three groups. Comparison of CP contents differs significantly ($p<0.05$) among the three groups [15]. The highest CP content was found in Mymensingh region than other two regions. On the other hand, EE, DM and Ash content does not differ significantly among the three groups.

Table 3. *Proximate analysis of meat of three different regions of Bangladesh.*

Parameters	Mymensingh	Jamalpur	Rajshahi	Level of significance
CP (%)	18.09^{a} ±0.43	16.21^{b} ±0.36	14.51^{c} ±0.57	*
EE (%)	8.89±0.09	9.91±0.05	7.97±0.06	NS
DM (%)	25.01±0.11	25.59±1.00	24.83±0.75	NS
ASH (%)	1.35±0.27	1.43±0.09	1.59±0.26	NS

*Note: Means with different superscripts within the same column differ significantly; ** = Significant at 1% ($p<0.01$) level of probability; *= Significant at 5% ($p<0.05$) level of probability; NS= Nonsignificant; Figures in the parentheses indicate the number of observation.*

Kim and Lee [43] also showed that no significant difference was found in crude protein content among the groups. The percent of crude protein contents of 19.77±0.38, 20.63±0.35 and 20.62±0.86 in Grade l, Grade 2 and Grade 3 LD muscles in Hanwoo Korean native beef cattle, respectively which are dissimilar with the finding of this present study. Duarte et al. [44] they found that there was an effect ($p<0.05$) of maturity on the ether extract (EE) content of beef samples. Beef from animals with 2 permanent incisors had lower ($P<0.05$) EE content compared to those from animals belonging to the 4 and 6 teeth groups, which did not differ from each other (>0.05). Kim and Lee [43] carried out an experiment on Hanwoo Korean native beef cattle and reported that Grade 1 LD muscles had the highest fat contents (9.87±0.91 %), and grade 2 LD muscles had higher fat contents (7.67±0.52%) than

third LD muscles (6.13±0.71%; P<0.05) which is almost similar to the results of this experiment. Kim and Lee [43] further mentioned that native beef cattle that no significant difference was found in crude ash content among the groups. They showed the percent of crude protein contents of 1.67±0.21, 1.63±0.34 and 1.58±0.36 in Grade 1, Grade 2 and Grade 3 LD muscles, respectively. In a study of Duarte et al. [44] they showed that dental maturity did not affect (P>0.05) beef ash and these results are also agreed with the result of this study.

3.4. Physicochemical Properties

The following data shows a comparison of meat quality among the three groups. Comparison of P^H, drip loss, cooking loss, and color differ significantly at 1% (p<0.01) and at 5% (p<0.05) level of probability among the three groups [15]. The highest pH and drip loss were found in Jamalpur region than other two regions, but the highest cooking loss was found in Rajshahi region than other two regions. On the other hand, meat color also differs from region to region. pH measurements alone can be used to follow glycolytic changes in muscles.

Table 4. *Meat quality of three different regions of Bangladesh.*

Parameters	Mymensingh	Jamalpur	Rajshahi	Level of significance
pH	6.34^{b} ±0.02	6.47^{a} ±0.02	5.60^{c} ±0.05	**
Drip Loss	5.47^{b} ±0.19	6.06^{a} ±0.29	4.85^{c} ±0.35	**
Cooking Loss	7.72^{b} ±0.24	7.47^{c} ±0.52	10.15^{a} ±0.55	**
Color	$L=19.14^{b}$ ±0.02	$L=30.91^{a}$ ±0.04	$L=31.76^{a}$ ±0.01	**
	$a=3.92^{b}$ ±0.03	$a=4.24^{a}$ ±0.4	$a=3.23^{b}$ ±0.02	*
	$b=3.38^{c}$ ±0.04	$b=5.19^{b}$ ±0.05	$b=6.14^{a}$ ±0.01	*

*Note: Means with different superscripts within the same column differ significantly; ** = Significant at 1% (p<0.01) level of probability; *= Significant at 5% (p<0.05) level of probability; NS= Nonsignificant; Figures in the parentheses indicate the number of observation.*

Kim and Lee [43] also showed in Hanwoo Korean native beef cattle that twenty-four hours postmortem, when glycolysis is considered to be complete, the pH values were the same in all quality groups (all mean values were between 5.47 and 5.49), and not significantly different. Han et al. (1996) also reported that pH values of quality grade groups from Hanwoo LD muscles were not statistically different (P>0.05). Duarte et al. [44] in their study that there was no effect (P>0.05) of dental maturity on the carcass ultimate P^H, with a mean value (6.4) slightly above values typically observed in the beef carcass (5.5-5.9) which differs from the result of this study. Kim and Lee [43] worked on Hanwoo Korean native beef cattle and reported that the drip loss increased steadily as time postmortem increased, after 7 days postmortem storage, drip loss for grade 1 (4.53%) group was significantly lower than that for grade 3 (6.26%) which is almost similar with result of this experiment. Kim and Lee [43] also showed in Hanwoo Korean native beef cattle that Grade 1 and grade 2 cow LD muscles had a lower cooking loss (27.72 and 28.08% respectively) than grade 3 LD muscle (29.11%) that value highly differs from this result. A survey of Kauffman et al. [45] found that only 16% of the carcass has an ideal lean quality based on color, firmness and water-holding capacity. Color may be the most important factor that influences the appearance and attractiveness of beef to consumers [46]. The appearance of the meat surface to consumers depends on, among other factors, the quantity and physical state of myoglobin. Regardless of species, breed or gender

muscle composition varies with increased animal age [47]. Duarte et al. [44] showed in their study that regarding beef color, there were no differences (P>0.05) for the redness (a*) among dental age maturity groups. Similarly, there was no effect of dental maturity (P>0.05) on L* (brightness).

3.5. Microbial

The data of Table 5 shows the comparison of the microbial count of meat among the three groups. TVC, TCC and YMC content of meat does not differ significantly among the three groups.

Table 5. *Microbial count of meat of three different regions of Bangladesh.*

Parameters	Mymensingh	Jamalpur	Rajshahi	Level of significance
TVC	38 ±5.13	45 ± 4.50	34 ±3.60	NS
TCC	42 ±4.58	54 ±14.50	52 ±11.50	NS
YMC	52 ± 6.08	58 ±14.17	53 ±13.05	NS

*Note: Means with different superscripts within the same column differ significantly; ** = Significant at 1% (p<0.01) level of probability; *= Significant at 5% (p<0.05) level of probability; NS= Nonsignificant; Figures in the parentheses indicate the number of observation.*

4. Conclusions

The present study was conducted to investigate the meat quality in relation to management practices. The selected variables in this study area were feeding condition, housing condition, problems of buffalo rearing, training of farmers. All the data were analyzed by using SAS software. All most 63% farmers have used roughage and 6% farmers are used concentrate. About 97% farmers used roadside grass and tree leaves and only 3% farmer's used cultivated fodder for buffalo feeding. Some of the farmers maintain 3% permanent, 28% temporary and 69% others type of housing system. Most of them (70.0%) kept their buffaloes on their own land, but some of them (30.0%) kept buffaloes on a hired places. Comparison of body height, face length, and ear length differs significantly (p<0.01) among the three groups. The highest body height and face length was found in Rajshahi region than other two regions, but highest ear length was found in Jamalpur region than other two regions. On the other hand, body length, chest girth, paunch girth, face width, horn length and tail length does not differ significantly among the three groups. Meat samples (about 2kg) were also collected after completion of a survey or data collection from that particular area. Proximate analysis and microbial count were performed at Animal Science Laboratory. Parameters under study were dry matter, crude protein, ether extract, ash, P^H, drip loss, cooking loss, and enumeration of the total viable count, total coliform count, and yeast-mould count. The media employed for these bacteriological analysis included plate count agar (PCA), MacConkey Agar (MA) and Potato Dextrose Agar (PDA). The commercial media were prepared according to the direction of the manufacturers. CP contents differ significantly (p<0.05) among the three groups. The highest CP content was found in Mymensingh region than other two regions. On the other hand, EE, DM and Ash content does not differ significantly among the three groups. Comparision of P^H, drip loss, cooking loss, and color differ significantly at 1% (p<0.01) and at 5% (p<0.05) level of probability among the three groups. The highest P^H and drip loss were found in Jamalpur region than other two regions, but the highest cooking loss was found in Rajshahi region than other two regions. On the other hand, meat color also differs from region to region. TVC, TCC and YMC content of meat does not differ significantly among the three groups. On the

basis of proximate analysis and microbial count quality Mymensingh region, buffalo meat was better than other two regions.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

References

[1] Sarker, M.N.I. Role of Banks on Agricultural Development in Bangladesh. *International Journal of Ecology and Development Research,* 2016, 1(1), 010-015.

[2] Sarker, M.N.I. Causes and possible solutions of seasonal food insecurity (Monga) perceived by char dwellers in Bangladesh. *International Journal of Ecology and Development Research*, 2016, 1(1), 002-009.

[3] Sarker, M.N.I.; Barman, S. C.; Islam, M. M.; Islam, M. R.; Chakma, A. S. Role of lemon (Citrus limon) production on livelihoods of rural people in Bangladesh. *Journal of Agricultural Economics and Rural Development,* 2017, 3(1), 167-175.

[4] Sarker, M.N.I.; Sultana, A. An Investigation into the Status of Riverbank (Char) Women Dwellers in Bangladesh. *International Journal of Rural Development, Environment and Health Research*, 2017, 1(1), 86-92.

[5] Sarker, M.N.I.; Kashem, M.A.; Rahman, M.Z. Poverty Alleviation of Rural People through Chars Livelihoods Programme, J. Bangladesh Soc. *Agric. Sci. Technol.* 2007, 4(3-4), 203-208.

[6] Sarker, M.N.I.; Ali, M.A.; Islam, M.S. Causes and possible solutions of poverty perceived by char dwellers in Bangladesh. *International Journal of Natural and Social Sciences*, 2015, 2(1), 37-41.

[7] Sarker, M.N.I. Poverty of Island Char Dwellers in Bangladesh. Hamburg, Diplomica Publishing GmbH, Germany. 2016. Available online: http://www.anchor-publishing.com/e-book/318628/poverty-of-island-char-dwellers-in-bangladesh (accessed on 6 December 2017).

[8] DLS (Department of Livestock Service). A report of livestock in Bangladesh, Directorate of Livestock Services, Ministry of Livestock and Fisheries, Government of the Peoples' Republic of Bangladesh, Dhaka, 2013.

[9] FAO. Breeds reported by Pakistan: Buffalo. Domestic Animal Diversity Information System, Food and Agriculture Organization of the United Nations, Rome, 2013.

[10] Faruque, M.O.; Hasnath, M.A.; Siddiqe, N.U. Present status of buffaloes and their productivity raised by the small farmers of Bangladesh. *AJAS.* 1990, 3(4), 287-292.

[11] Singh, C.V.; Barwal, R.S. Buffalo Breeding Research and Improvement Strategies in India. Pages 1024–1031 in the Buffalo in the World. Proceedings of the 9th World Buffalo Congress, Buenos Aires, April 2010.

[12] Mammen, J.R.; Rhee, H.; Atis, S.; Grape, A. Changes in asthma self-management knowledge in inner-city adolescents following developmentally sensitive self-management training. *Patient Educ Couns.* 2018, 101(4), 687-695.

[13] Singh, G.V.K.; Taneja, L.D.; Bajpai; Bhat, P.N. Studies in Murrah buffaloes (Bubalus bubalis). V. Gestation length. *Indian Journal on Animal Production*, 1973, 4(2), 88-90.

[14] Claps, S.; Rubino, R.; Fedele, V.; Morone, G.; Trana, A.D. Effect of concentrate supplementation on milk production, chemical features and milk volatile compounds in grazing goats. *Options Me` diterrane' ennes, Serie A,* 2006, 67, 201-204.

[15] Abdalla, E.B. Improving the reproductive performance of Egyptian buffalo cows by changing the management system. *Animal Reproduction Science,* 2003, 75(1-2), 1-8.

[16] Camarao, A.P.; Lourenco, J.B.; Dutra, S.; Hornick, J.L.; Silva, M.B.D. Grazing buffalo on flooded pastures in the Brazilian Amazon region: a review. *Tropical Grass-lands.* 2004, 38(4), 193-203.

[17] Czerniawska-Piatkowska, E.; Chocilowicz, E.; Szewczuk, M. Biology of Bubalus bubalis. *Annals of Animal Science,* 2010, 10, 107-115.

[18] Hoffman, L.C.; Cawthorn, D. Game and Exotic Animals. *Encyclopedia of Meat Sciences,* 2nd ed.; Elsevier Ltd., 2014, 3, 345-356.

[19] Konarzewski, M. Meat Animals, Origin and Domestication. Encyclopedia of Meat Sciences, 2nd ed.; Elsevier Ltd., 2014, 3, 357-362.

[20] Sarker, M.N.I. An Introduction to Agricultural Anthropology: Pathway to Sustainable Agriculture. *Journal of Sociology and Anthropology,* 2017, 1(1), 47-52.

[21] FAO. Production Year Book, 2008, 41. 89.

[22] FAO. Production Year Book, 2009, 51. 56.

[23] Hussain, M.A.; Chowdhury, A.B. A report on formulation of livestock development strategies and programme in Bangladesh. Diractorate of Livestock Services, Dhaka, 1989.

[24] Le Roex, N.; Berrington, C.M.; Hoal, E.G.; Helden, P.D.V. Selective breeding: The future of TB management in African buffalo? *Acta Trop.* 2015, 149, 38-44.

[25] Li, Q.; Wang, Y.; Tan, L.; Leng, J.; Lu, Q.; Tian, Shao S.; Duan C.; Li W.; Mao H. Effects of age on slaughter performance and meat quality of Binlangjang male buffalo. *Saudi J Biol Sci.* 2018, 25(2), 248-252.

[26] Pindozzi, S.; Faugno, S.; Okello, C.; Boccia, L. Measurement and prediction of buffalo manure evaporation in the farmyard to improve farm management. *Biosystems Engineering,* 2013, 115(2), 117-124.

[27] Rey, J.F.; Gualdorn, L. The effect of the addition of vegetable oils in the mass and energy efficiency of meat derived product, low in saturated fat from buffalo meat (Bubalus Bubalus). *Procedia Food Science,* 2011, 1, 408-412.

[28] Salem, M.M.I.; Amin, A.M.S. Risk factors and genetic evaluation of stillbirth trait in Buffalo. *Livestock Science,* 2017, 206, 132-134.

[29] Schuler, T.M.; Thomas-Van Gundy, M.; Brown, J.P.; Wiedenbeck, J.K. Managing Appalachian hardwood stands using four management practices: 60-year results. *Forest Ecology and Management,* 2017, 387, 3-11.

[30] Kandeepan, G.; Mendiratta, S.K.; Shukla, V.; Vishnuraj, M.R. Processing characteristics of buffalo meat: a review. *J. Meat Sci. Technol.* 2013, 1(1), 01-11.

[31] Neath, K.E.; Barrio, A.N.D.; Lapitan, R.M.; Herrera, J.R.V.; Cruz, L.C.; Fujihara, T.; Muroya, S.; Chikuni, K.; Hirabayashi, M.; Kanai, Y. Difference in tenderness and p.H. decline between water buffalo meat and beef during postmortem aging. *Meat Sci.* 2007, 75(3), 499-505.

[32] Tateo, A.; Palo, P.D.; Quaglia, N.C.; Centoducati, P. Some qualitative and chromatic aspects of thawed buffalo (Bubalus bubalis) meat. *Meat Science*, 2007, 76(2), 352-358.

[33] Kandeepan, G.; Anjaneyulu, A.S.R.; Kondaiah, N., Mendiratta, S.K.; Lakshmanan, V. Effect of age and gender on the processing characteristics of buffalo meat. *Meat Science,* 2009, 83(1), 10-14.

[34] Naveena, B.M.; Kiran, M.; Reddy, K.S.; Ramkrishna, C.; Vaithiyanathan, S.; S.K. Devatkal. Effect of ammonium hydroxide on ultrastructure and tenderness of buffalo meat. *Meat Science.* 2011, 88(4), 727-732.

[35] Sarker, M.N.I.; Bingxin, Y.; Sultana, A.; Prodhan, A.Z.M.S. Problems and challenges of public administration in Bangladesh: pathway to sustainable development. *International Journal of Public Administration and Policy Research,* 2017, 3(1), 016-025.

[36] Sarker, M.N.I.; Islam, M.S.; Rahman, M.M. Effects of electronic banking on performance of banks in Bangladesh. *Int. J. Appl. Res.* 2015, 1 (1), 28-34.

[37] Sarker, M.N.I. Knowledge, Adoption and Constraint analysis of Chilli Technology in Char Area of Bangladesh. *International Journal of Ecology and Development Research,* 2016, 1(1), 016-018.

[38] Walker, E.L.; Hudson, M.D. *Species of meat animals | Sheep and Goats BT - Encyclopedia of Meat Sciences,* 2nd ed.; Encyclopedia of Meat Sciences. Elsevier Ltd., 2014, 3.

[39] Zhang, W.; Naveena, B.M.; Jo, C., Sakata, R.; Zhou, G.; Banerjee, R.; Nishiumi, T. Technological demands of meat processing–An Asian perspective. *Meat Science,* 2017, 132, 35-44.

[40] Saadullah, M. Buffalo production and constraints in Bangladesh. *The Journal of Animal and Plant Sciences,* 2012, 22(3 Suppl.), 221-224.

[41] Calub, A.D. Range production of buffaloes in Cagayan province, Philippines. In: M.H. Tetangco (Editor), Buffalo Production for Small Farms. Book Series No. 15, Food and Fertilizer Technology Center, Taipei, 1980, 84-98.

[42] Prodhan, A.Z.M.S.; Sarker, M.N.I.; Sultana, A.; Islam, M.S. Knowledge, adoption and attitude on banana cultivation technology of the banana growers of Bangladesh. *International Journal of Horticultural Science and Ornamental Plants*, 2017, 3(1), 047-052.

[43] Kim, C.J.; Lee, E.S. Effects of quality grade on the chemical, physical and sensory characteristics of Hanwoo (Korean native cattle) beef. *Meat Science*, 2003, 63(3), 397-405.

[44] Duarte, M.S.; Paulino, P.V.R.; Fonseca, M.A.; Diniz, L.L.; Cavali, J.; Serao, N.V.L. Influence of dental carcass maturity on carcass traits and meat quality of Nellore bulls. *Meat Science,* 2011, 88(3), 441-446.

[45] Kauffman, R.G.; Cassens, R.G.; Scherer, A.; Meeker, D.L. Variation in pork quality: History, definition, extent and resolution. National pork producers' council Des Moines IA, 1992.

[46] Faustman, C.; Cassens, R.G. The biochemical basis for discoloration in fresh meat: A review. *J. Mus. Foods*, 1990, 1, 217-243.

[47] Lawrie, R.A. *Lawrie's Meat Science,* 6th ed.; Cambridge: Woodhead Publishing – Hill, 1998.