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# Comparative Studies on Nutritional Quality of Cattle and Buffalo Meat

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**Abstract:** ***Present study was conducted to compare the nutritional qualities and calorific values of cattle and buffalo meat. Meat samples (n=40) from different age groups i.e. <2 years and above two years of buffalo and cattle were collected from local meat market of Tandojam/Hyderabad city. Group A (<2 years) and B (>2 years) was accredited for buffalo meat, while Group C (<2 years) and D (>2 years) for cattle meat. Macro nutrients such as moisture, protein, fat, glycogen, and total minerals and calorific value were determined according the established methods. In the result, it was found that the average moisture content in group A was statistically similar (P>0.05) to that of group C, while average moisture content of group B was statistically similar (P>0.05) to that of group D. The average protein content of buffalo meat in group B was significantly (P<0.05) higher than that of group D, A and C. The average fat content in group D was significantly higher (P<0.05) than that of group B, C and A. Fat content was significantly varied (P<0.05) between A, B, C and D and remarkably different (P<0.05) from one another (LSD, 0.05). The average glycogen content in group C was comparatively higher than that of group A, B and D. Glycogen content of group A and C was significantly different (P<0.05), whereas non-significant difference (P>0.05) was noticed between group B and D (LSD, 0.05). The average ash content in group D was comparatively higher (P<0.05) than that of groups B, A and C. Groups B and D were non-significant (P>0.05) to each other however, significant difference (P<0.05) was observed in groups, A and C. Groups B and D were also significantly different from A and C (LSD, 0.05). The average Calorific values in group A was significantly lower (P<0.05) than that of groups C, B and D. It was observed that the calorific values of group B and D were similar (P>0.05) with each other but significantly higher (P<0.05) than group A. Groups A and C were similar with each other for calorific values (P<0.05).***

**Keywords:** Glycogen, Calorific value, Moisture, Protein, Fat, Mineral

## 1. Introduction

Meat is used as a major source of animal protein in the world (FAO, 1998). It is an edible postmortem component originating from animals that are used as food for humans. These animals include cow, buffalo, sheep, goat, camel and some wild animals' i.e. dear, hog and rabbit. In addition, poultry have become a major meat producing species, while various game animals and birds provide a substantial amount of meat particularly in localized areas (Arain *et al*., 2010). Gross composition of meat shows that meat is composed of moisture, protein, lipid, ash and carbohydrate. Meat also contains other elements such as vitamin $B_{12}$, niacin, vitamin B6, vitamin D, iron, zinc and phosphorus. Because of its distinct and high nutritional value meat preserves its role in a rational human nutrition (Williams, 2007). Muscles vary considerably in these components, and the accumulation of lipid is the most influential on this variation. On average, most muscles should contain about 1% ash (primarily represented by the elements potassium, phosphorus, sodium, chloride, magnesium, calcium and iron), 1% carbohydrate (primarily glycogen ante mortem, and lactic acid postmortem), 5% lipid, 21% nitrogenous compounds (predominantly proteins), and the rest 72% as moisture (Hui *et al*., 2001).

In Pakistan, buffalo meat is mostly produced from culled animals or surplus male calves of 1-2 years age group (Rey and Povea, 2012). Buffalo meat is the healthiest meat (among red meats known for human consumption) and economical (2-3 folds cost advantage over mutton and goat meat). In Asia, buffalo meat is consumed either in curry form with high spices and/or as processed meat products. Only 2% of the meat is processed in Asia, the remaining meat is sold in fresh or frozen form. More pigmentation or less intra muscular fat (1-2% marbling compared with 3-4% in beef) causes darker appearance of buffalo meat. Such type of meat possesses good binding properties and is preferred in product manufacture (Kandeepan *et al.,* 2010*).* Buffalo meat is becoming more popular worldwide because of its some inherent properties over cattle meat with respect to attributes such as lower intra muscular fat, cholesterol and high calories and units of essential amino acids, biological value and iron content (Anjaneyulu *et al*., 1990).

The origin of animals, carcass characteristics and its meat quality are important criteria for butchers and consumers when it comes to making purchasing decisions. Therefore, meat quality trademarks promote the use of bovine breeds reared under traditional production systems. The fatty acid composition and cholesterol levels in meat have received increasing attention owing to their implications in human health and product quality (Orellana *et al*., 2009). Meat quality is affected by many factors, such as age, sex, feed type, nutritional status, postmortem aging, slaughtering methods, body weight, and physiological condition, physical activity of animal and microbiological load on carcass in slaughter house and/or at meat shops (Owen *et al*., 1978). Breed is one of the main productive factors that influence the quality of meat (Lin-qiang *et al.,* 2011).

Regardless, the meat of cattle and buffalo assumed to be very nutritious and plays integral role in human diet, very little research has been so far conducted with respect to the


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assessment of nutritive qualities as well as calorific values of buffalo and cattle meat. In Pakistan, as abundant quantity of meat of both species is used, so for processing purpose, the nutritive quality analysis of meat is crucial. Because the present study was carried out to evaluate nutritive qualities of buffalo and cattle meat.

## 2. Materials and Methods

### 2.1 Sample collection and experimental design

A total of forty (n=80) meat samples of cattle (n=40) and buffalo (n=40) were randomly collected from the local meat market of Tandojam and Hyderabad city. Sample weighing 100 grams was aseptically collected in sterile plastic bags and transported to the Dairy and Meat Chemistry Laboratory, Department of Animal Products Technology, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tandojam in 4-5 hours for further processing. All the meat samples were grouped on the basis of the age at slaughter (as per butcher's information) into four groups i.e. Group A (<2 years) and B (>2 years) for buffalo, while Group C (<2 years) and D (> 2 years) for cattle. The samples were analyzed for macronutrients: protein, fat, glycogen and total minerals, and for calorific values.

### 2.2 Examination of macronutrients

#### 2.2.1 Moisture content

Moisture content was observed according to the method of Association of Official Analytical Chemists (AOAC, 2000). The fresh minced meat sample (5g) was transferred in pre-weighed flat bottom aluminum dish, which was transferred to hot air oven at 101 ± 1$^0$C for 4 h. Dried sample was then placed in desiccator having silica gel as desiccant. After 1h, the dish was weighed. Moisture content was calculated by applying the following formula.

$$\text{Moisture (\%)} = \frac{W_2 - W_1}{W_2 - W_3} \times 100$$

Where,

$W_1$ = weight of empty dish
$W_2$ = weight of dish + sample
$W_3$ = weight of dish + dried sample

#### 2.2.2 Total protein content

Protein content was determined according to the method as described by AOAC (2000). Briefly, two gram sample was digested using Micro-Kjeldhal digester (LABCONCO Mod 60300-01) in the presence of catalyst (0.35g copper sulfate and 7g sodium sulfate) where 30 ml sulfuric acid was used as an oxidizing agent and diluted with 250 ml distilled water. Five milliliter of the diluted sample was distilled with 40% NaOH solution using Micro-Kjeldhal distillation unit (LABCONCO Mod 60300-01) where steam was distilled over 5 ml of 2% boric acid containing bromocresol green as an indicator for 3 minutes. The ammonia trapped in boric acid was determined by titrating with 0.1N HCl. The nitrogen percentage was calculated using the following formula:

$$\text{Protein (\%)} = \frac{1.4\,(V_1 - V_2) \times \text{normality of HCl}}{\text{Wt of sample} \times \text{vol of diluted sample}} \times 250$$

Where,

$V_1$ = Titrated value of sample
$V_2$ = Titrated value of blank sample

Finally, the protein percentage was determined by converting nitrogen percentage to protein by using conversion factor (6.25) assuming that all the nitrogen in meat was present as protein.

**Formula:** Protein percentage = N% × CF.

#### 2.2.3 Total fat content

Total fat content (TF) was extractedin Soxhlet Extraction Unit (Lablin Melrose park, ILL) as described by AOAC (2000). Soxhlet Extractor was set with reflux condenser and distillation flask which has been previously dried and weighed. Two grams of dried meat sample was taken into fat free extraction thimble and placed in extraction apparatus (soxhlet). One hundred and fifty milliliter of ether was poured in to extraction flask and condenser was joined and placed on electric heater in order to boil the solvent gently. After completion of extraction process (6 hours), the solution was removed. Fat content was calculated by using following formula.

$$\text{Fat (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where

$W_1$ = weight of empty distillation flask
$W_2$ = weight of distillation flask + Fat
$W_3$ = weight of sample taken

#### 2.2.4 Glycogen Level

Glycogen content was determined according to method developed by Kemp *et al.,* (1953). Briefly, a total of 200 mg meat sample was placed in a centrifuge tube together with 5 ml of deproteinizing solution (Trichloroacetic acid 5g and $Ag_2SO_4$ 100 mg up to 100 ml water). The tube was placed in boiling water bath for 15 minutes and cooled in running water. After centrifugation (Model Tj-6 Beckman USA) (4$^0$C) at 3000 rpm for 5 minutes, 1 ml of clear supernatant was decanted in tube and 3 ml of $H_2SO_4$ was added in it. Sample was mixed by Vigorous shaking and boiled for 6 min. Subsequently it was cooled in running tap water and the intensity of color was measured using spectrophotometer (Model U-1800 UV-VIS, Japan) at 520 mμ and the concentration of glycogen was recorded from a standard curve.

#### 2.2.5 Ash content

Ash content was determined by Gravimetric method as described by AOAC (2000). In brief, 5g of fresh minced meat sample was put into pre-weighed empty crucible. The crucible containing sample was then transferred to muffle furnace (Nevertherm Mod; L9/11/8KM, Germany) set at 550 $^0$C for 5 h. Finally, ashed sample was shifted to desiccator containing silica gel as desiccant. After 1 h of desiccation, the dish was weighed and the ash content was calculated applying the following formula.

$$\text{Ash (\%)} = \frac{\text{Weight of ashed sample}}{\text{Weight of sample taken}} \times 100$$


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### 2.2.6 Calorific value

Calories were calculated from the proximate analysis results using the following generalized equation.

K.cal (per 100g)= [(% protein) (4)] + [(% fat) (9)] + (% Carbohydrates) (4)]

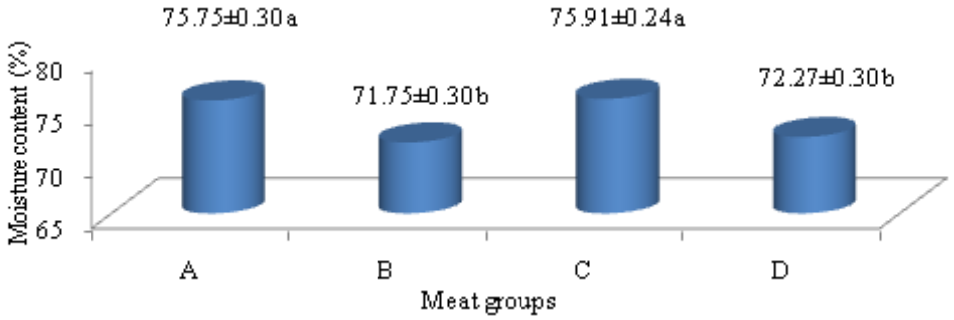
## 3. Statistical Analysis

The data was subjected to analysis of variance (ANOVA) on different age groups and in case of significant differences noticed among the means, the least significant difference (LSD) was computed using statistical software, Student Edition of Statistix (SXW) (copyright 2005, Analytical Software, USA).

## 4. Results

### 4.1 Moisture content

Moisture content in buffalo and cattle meat of two age groups is shown in figure 1 (Appendix I, II and III). The average moisture content in group A (75.75±0.30%) was statistically similar (P>0.05) to that of group C (75.91±0.24%), while average moisture content of group B (71.75±0.30%) was statistically similar (P>0.05) to that of group D (72.27±0.30%). Coefficient of variation (CV) was higher in group B (1.85%) followed by groups D (1.84%), A (1.80%) and C (1.41%). It was noticed that group A and C were non-significant (LSD, P>0.05) to each other. Group B and D were non-significant (LSD, P>0.05) to each other however, they were statistically different (P<0.05) from A and C

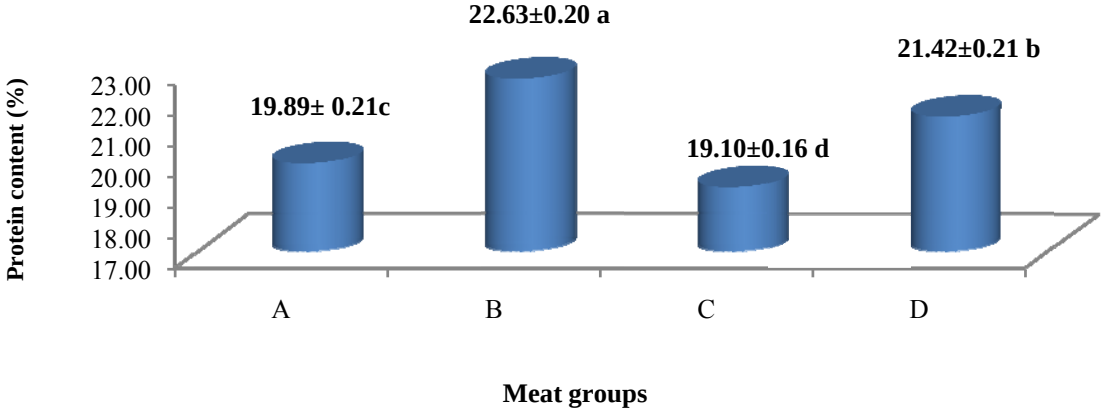



LSD (0.05) = 0.8052
SE ± = 0.4043

**Figure 1:** Moisture content (%) of cattle and buffalo meat

### 4.2 Protein Content

Protein content in buffalo and cattle meat of two age groups (Fig 2, Appendix I, II and III) and the results showed that the average Protein content of buffalo meat in group B (22.63±0.20%) was significantly (P<0.05) higher than that of group D (21.42±0.21%), A (19.89±0.21%) and C (19.10±0.16%).Coefficient of variation (CV) was found the highest in group A (4.76%) followed by D (4.49%), B (4.09%) and C (3.78%) groups. On computation of data for least significant difference (LSD) among the mean values, it was observed that all age groups of buffalo and cattle meat were different (p<0.05) from each other.




LSD (0.05) = 0.5635
SE ± = 0.2829

**Figure 2:** Protein content (%) of cattle and buffalo meat

### 4.3 Fat content

Figure 3 (Appendix I, II and III) shows the results of fat content in buffalo and cattle meat of two age groups. A wide variation was observed in all groups of cattle and buffalo meat. Coefficient of variation (CV) was found to be higher (28.56%) in group A while groups C, B and D showed 20.74%, 15.45% and 13.96%, respectively. Furthermore, it was observed that the average fat content in group D (3.92±0.12%) was significantly higher (P<0.05) than that of group B (3.15±0.11), C (2.17±0.10%) and A (1.68±0.11). Analysis of variance revealed that fat content was significantly varied (P<0.05) between A, B, C and D and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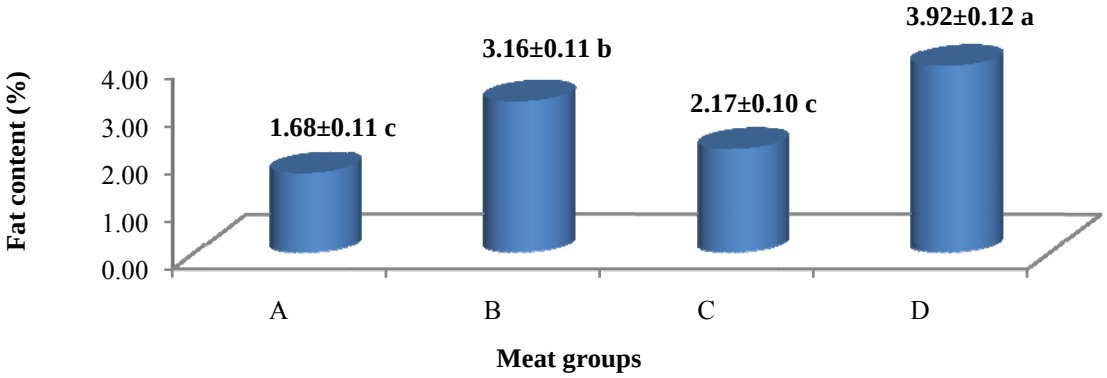
remarkably different (P<0.05) from one another (LSD, 0.05).

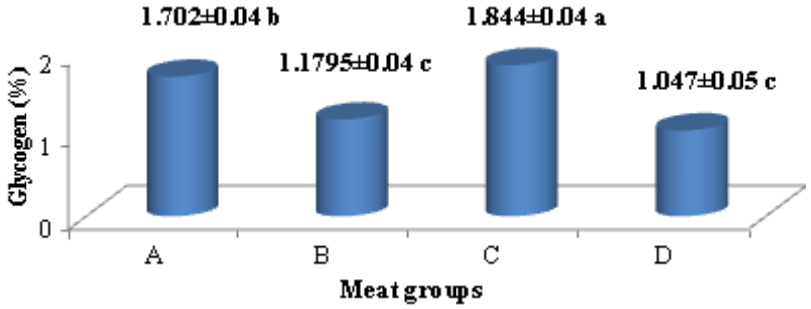



LSD (0.05) = 0.3100
SE ± = 0.1556

**Figure 3:** Fat content (%) of cattle and buffalo meat

### 4.4 Glycogen Content

Glycogen content in buffalo and cattle meat of two age groups was examined and results are shown in Figure 4 (Appendix IV, V and VI). Glycogen content varied between two groups of buffalo meat; Group A (1.40 to 2.11%) and B (0.85 to 1.47%). However, in case of cattle meat it varied between 1.47 to 2.16% in group C and 0.63 to 1.37% in group D. Coefficient of variation (CV) was found to be higher in group D (23.84%) followed by B, A and C (16.00%, 11.53% and 11.51% respectively). Results further showed that the average glycogen content in group C was comparatively higher than that of A, B and D. It was computed that glycogen content between group A and C was significantly different (P<0.05), whereas non-significant difference (P>0.05) was noticed between group B and D (LSD, 0.05).

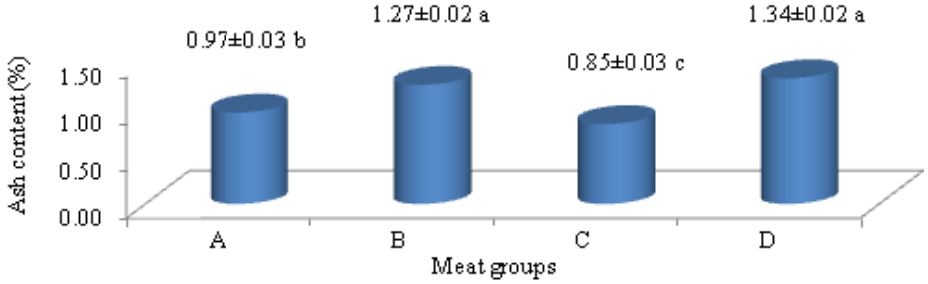



LSD (0.05) = 0.1342
SE ± = 0.0674

**Figure 4:** Glycogen content (%) of cattle and buffalo meat

### 4.5 Ash content

Ash content varied between 0.71 to 1.19% in group A and 1.03 to 1.40% in group B, while it varied between 0.68 to 1.16% in group C and 1.13 to 1.46% in group D (Fig 4.5, Appendix IV, V and VI). Coefficient of variation (CV) was found to be higher in group C (16.67%) followed by groups A, B and D (14.71%, 8.12% and 6.27%, respectively). Moreover, the average ash content in group D was comparatively higher (P<0.05) than that of groups B, A and C. ANOVA revealed that groups B and D were non-significant (P>0.05) to each other however, significant difference (P<0.05) occurred in groups A and C. Groups B and D were also significantly different from A and C (LSD, 0.05).




LSD (0.05) = 0.0759
SE ± = 0.381

**Figure 5:** Ash content (%) of cattle and buffalo meat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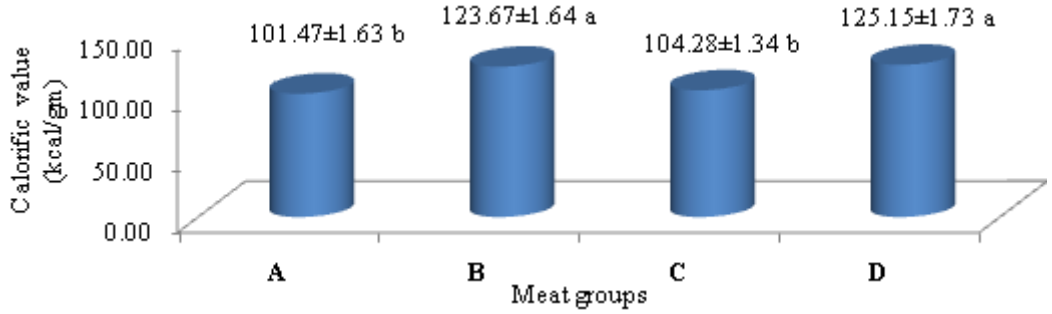
## 5. Calorific values

Calorific values in buffalo and cattle meat of two age groups were analyzed (Fig 4.6; Appendix V and VI). Calorific values varied between two buffalo groups; A (91.21 to 112.49k.cal) and B (111.59 to 133.32k.cal). Similarly cattle groups i.e. C and D showed variation (92.78 to 111.72k.cal and 115.21 to 136.94k.cal, respectively). Coefficient of variation (CV) was higher in group A (7.17%) followed by D (6.19%), B (5.94%) and C (5.76%).Results further showed that the average Calorific values in group A (101.47±1.62k.cal) was significantly lower (P<0.05)than that of groups C, B and D (104.28±1.34k.cal, 123.67±1.64k.cal and 125.15±1.73k.cal, respectively). The LSD (0.05) was applied for the comparison of mean values, it was observed that the calorific values of group B and D were similar (P>0.05) with each other but significantly higher (P<0.05) than group A. Groups A and C were similar with each other for calorific values (P<0.05).




LSD (0.05) = 4.4859
SE ± = 2.2541

**Figure 6:** Calorific values (kcal/100gms) of cattle and buffalo

## 6. Discussion

The human health mainly depends on the quality of food and nutritional status. Health status of people particularly in under-developed countries is not satisfying which is associated with utilization of poor quality foods such as meat (Brown *et al*., 2000). Physico-chemical characteristics of meat are known to closely correlate with its nutritional and commercial value (Li and Zan, 2011). There are many factors which are responsible for the physic-chemical and nutritional qualities of the meat. Among these, slaughtering age is one of the predominant factors which greatly influence the quantity and quality of the final product (Geay *et al*., 2001).

In the present study, negative correlation was observed in moisture content of cattle meat and slaughtering age; with increasing age, moisture content decreases. The moisture content of meat decreases as the age of the animal increases, which is probably associated with an increase in fat content (Lawrie, 1998) and lower capability of meat to bind with water (Zaujec *et al*., 2012). The present findings are in agreement with Lin-qiang *et al., (*2011) and Mojto *et al.,* (2009) who observed similar trend of decrease in moisture content with increasing age of cattle. Further it was observed that moisture content of buffalo meat also decreases as animals grow older. Kandeepan *et al.,* (2009) conducting a study on young and spent buffaloes meat and noted that moisture content of young buffalo meat was higher (74.99) than spent buffalo meat (72.63). Awan, (2010) evaluated the physico-chemical and sensorial quality of buffalo meat and reported that moisture content decreases as the animal grows older. Whereas moisture content of cattle and buffalo meat of same age groups were found to be comparable to each other. The results of these findings are in line with Lapitan *et al* (2008) and Spanghero *et al.,* (2004).

It was observed that average protein content of cattle meat and buffalo meat increased at the rate of averaging 19.10-21.42% and 19.98-20.27%, respectively with the advanced slaughtering age. Mojto *et al.,* (2009) conducted a study on effect of age at slaughter on quality of carcass and meat in cows and noted an increase (19.98-20.27) in protein content with increasing age of cows. Lin-qiang *et al.,* (2011) also observed a significant influence of slaughter age on protein content in cattle meat. Kandeepan *et al.,* (2009) noted a similar trend for protein content as noted in present study. Awan, (2010) reported that age has a significant effect on the protein content of an animal, a trend of increase with advancing age. Muscle growth, or protein accretion, occurs when protein synthesis exceeds protein degradation. The significant protein accretion occurs probably due to hyperplasia (increase in cell number), hypertrophy (increase in cell size) and a decrease in protein degradation while the protein synthesis levels remain the same (Koohmaraie *et al*., 2002). Another reason behind this could be the post natal growth under which satellite cells fuse and contribute nuclei to muscle fibers, which intern leads to an increase in muscle mass, protein production and concomitant muscle growth (Hawke and Garry, 2001).The meat protein content of both species (cattle and buffalo) was statistically significant from each other; buffalo meat contained higher content of protein than cattle. These results are in line with the findings of Lapitan *et al.* (2008) who reported lower protein content (21.4%) in cattle meat compared to that of buffalo (21.7%).

Average fat content of young age cattle meat was comparatively low than the average fat content of old age cows. These findings are in line with the findings of Mojto *et al*., (2009) who also observed that old age cows have more fat content compared to their young ones. Another study conducted by Lin-qiang *et al*., (2011) also confirmed an increase in fat content of animal with advancing age. Fat content of buffalo meat also increases with the increasing age. Kandeepan *et al.,* (2009) reported that spent buffalo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meat had higher fat content than young buffalo meat. Results of Awan, (2010) also supported present study, and showed a trend for increase in fat content of buffalo meat with increase in age at slaughter. It has been well studied that as animal get older and heavier the proportion of fat in their carcasses increases and proportion of muscle and bone decreases (Warriss *et al*., 2000). The meat fat content of both species (cattle and buffalo) was statistically significant from each other; cattle meat contained higher content of fat. Similarly, Lapitan *et al.* (2008) reported higher fat content in cattle meat as compare to that of buffalo meat.

Present study shows a negative trend of relation for glycogen content with increasing age of cattle and buffalo meat. The results of present study agreed with Gracy *et al.,* (1999) who reported that the old animals have lower reserve of glycogen than that of younger. Nevertheless, the concentrations of glycogen in buffalo meat observed in the present study is in a range of findings reported by Warriss *et al*., (2000) that the muscles which produce meat with normal pH contain about 10-20 mg/g glycogen. Many pre-slaughter and post-slaughtering factors influence the glycogen contents of meat. Among them stress is the most important pre-slaughter factors (Grandin and Gallo, 2007). Long term stress depletes the muscle glycogen storage after slaughter which leads to low acid production thus pH becomes high. The increased pH improves the space availability therefore more water remains retained within myo fibrillar proteins (Bruce *et al.,* 2003). Regular exercise was known to increase the level of glycogen in the muscle of a variety of animals (Tan *et al.,* 1984; Topliff *et al.,* 1985). Pre-slaughter glycogen depletion in muscle may result in meat with a higher ultimate pH (pHu) Kannan *et al.,* (2002). Low levels of muscle glycogen at the time of slaughter leads to meat with a high pHu and a dark color due to the presence of deoxymyoglobin (Moss, 1992). Moreover in beef, it is stress rather than under nutrition that lowers the glycogen content and consequently elevates ultimate pH. (Marsh, 1993)

The average ash content of cattle meat and buffalo meat increased with the increasing age. These findings are in line with Lin-qiang *et al*., (2011) who also reported the similar trend of increase in ash content with slaughter age. (Awan, 2010) also reported that old buffalo meat had more ash content as compared to their young ones. The meat ash content of both species (cattle and buffalo) having age above 3 years was statistically non-significant from each other. These results are in line with the findings of Spanghero *et al,* (2004) who found ash content as 1.15% and 1.11% in cattle and buffalo meat, respectively. Whereas' average ash content of buffalo meat was statistically higher than cattle meat for age group 1-3 years. These findings agreed Lapitan *et al.,* (2008) who observed higher ash content for buffalo meat than cattle meat in 18 -24 months animals.

The calorific value in cattle and buffalo meat was significantly ($P<0.05$) increased with advanced slaughtering age of animal. The results of the present study agreed with the findings of Mojto *et al*., (2009) who compared two age groups of cattle and found that cows over 4 years of age had high energy or calorific value than the cows below than 4 years. The present study was also in line with the findings of Brzostowski *et al*., (2008), who reported that due to a high protein content (19.44 and 19.74 %), a desirable water-to-protein ratio (4.18 and 3.89), low levels of intramuscular fat (1.67 and 1.96 %) and cholesterol (48.76 and 56.63 mg/100g), a low energy value (96.36 and 101.47) in 50 days old kid. Johnson *et al*. (1995) calculated total caloric content (100 g basis) of cooked composite sample of goat meat slaughter at the age of 6-8 months age was from 220-238 kcal. Moreover, it was observed that calorific value of cattle meat was higher than that of buffalo meat at same slaughtering age.

**Appendix-I:** Descriptive statistics for moisture, protein and fat of different age groups of buffalo meat

| *Descriptive variables* | *Buffalo meat* | | | | | |
|---|---|---|---|---|---|---|
| | *Moisture%* | | *Protein%* | | *Fat%* | |
| | *A* | *B* | *A* | *B* | *A* | *B* |
| Min | 73.75 | 69.98 | 18.37 | 21.20 | 1.05 | 2.35 |
| Max | 77.80 | 73.90 | 21.21 | 23.84 | 2.45 | 3.80 |
| Mean | 75.75 | 71.75 | 19.89 | 22.63 | 1.68 | 3.15 |
| SE | 0.30 | 0.30 | 0.21 | 0.20 | 0.11 | 0.11 |
| Variance | 1.85 | 1.76 | 0.90 | 0.86 | 0.23 | 0.24 |
| C.V | 1.80 | 1.85 | 4.76 | 4.09 | 28.56 | 15.45 |

**Appendix-II:** Descriptive statistics for moisture, protein and fat of different age groups of cattle meat.

| *Descriptive variables* | *Cattle meat* | | | | | |
|---|---|---|---|---|---|---|
| | *Moisture%* | | *Protein%* | | *Fat%* | |
| | *C* | *D* | *C* | *D* | *C* | *D* |
| Min | 74.45 | 70.20 | 17.71 | 20.12 | 1.50 | 3.20 |
| Max | 78.00 | 74.00 | 20.12 | 22.96 | 2.80 | 4.70 |
| Mean | 75.91 | 72.27 | 19.10 | 21.42 | 2.17 | 3.92 |
| SE | 0.24 | 0.30 | 0.16 | 0.21 | 0.10 | 0.12 |
| Variance | 1.15 | 1.77 | 0.52 | 0.93 | 0.20 | 0.30 |
| C.V | 1.41 | 1.84 | 3.78 | 4.49 | 20.74 | 13.96 |

**Appendix-III:** One-way (ANOVA) for moisture, protein and fat of different age groups of buffalo and cattle meat.

| | | DF | SS | MS | F | |
|---|---|---|---|---|---|---|
| Moisture | Between | 3 | 294.474 | 98.1581 | 60.06 | 0.0000 |
| | Within | 76 | 124.212 | 1.63436 | - | - |
| | Total | 79 | 418.686 | - | - | - |
| Protein | Between | 3 | 149.012 | 49.6706 | 62.05 | |
| | Within | 76 | 60.8394 | 0.80052 | - | |
| | Total | 79 | 209.851 | - | - | |
| Fat | Between | 3 | 60.3616 | 20.1205 | 83.06 | 0.0000 |
| | Within | 76 | 18.4109 | 0.24225 | - | - |
| | Total | 79 | 78.7725 | - | - | |

**Appendix IV:** Descriptive statistics for glycogen and ash of different age groups of buffalo meat

| *Descriptive variables* | *BUFFALO MEAT* | | | |
|---|---|---|---|---|
| | *Glycogen%* | | *Ash%* | |
| | A | B | A | B |
| Min | 1.40 | 0.85 | 0.71 | 1.03 |
| Max | 2.11 | 1.47 | 1.19 | 1.40 |
| Mean | 1.70 | 1.18 | 0.97 | 1.26 |
| SE± | 0.04 | 0.04 | 0.03 | 0.02 |
| Variance | 0.04 | 0.03 | 0.02 | 0.01 |
| CV% | 11.53 | 16.00 | 14.71 | 8.12 |


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**Appendix-V:** Descriptive statistics for glycogen and ash of different age groups of cattle meat

| Descriptive variables | Cattle Meat | | | |
|---|---|---|---|---|
| | Glycogen% | | Ash% | |
| | C | D | C | D |
| Min | 1.47 | 0.63 | 0.68 | 1.13 |
| Max | 2.16 | 1.37 | 1.16 | 1.46 |
| Mean | 1.84 | 1.05 | 0.85 | 1.33 |
| SE± | 0.05 | 0.05 | 0.03 | 0.02 |
| Variance | 0.04 | 0.06 | 0.02 | 7.02 |
| CV% | 11.51 | 23.84 | 16.67 | 6.27 |

**Appendix-VI:** One-way (ANOVA) for glycogen and ash of different age groups of buffalo and cattle meat

| | | DF | SS | MS | F | P |
|---|---|---|---|---|---|---|
| Glycogen | Between | 3 | 9.08260 | 3.02753 | 66.71 | 0.0000 |
| | Within | 76 | 3.44931 | 0.04539 | - | - |
| | Total | 79 | 12.5319 | - | - | - |
| Ash | Between | 3 | 3.25033 | 1.08344 | 74.62 | 0.0000 |
| | Within | 76 | 1.10343 | 0.01452 | - | - |
| | Total | 79 | 4.35377 | - | - | - |

**Appendix-VII:** Descriptive statistics for calorific value of different age groups of buffalo meat

| Descriptive Variables | Buffalo meat | |
|---|---|---|
| | Calorific Values (k.cal) | |
| | A | B |
| Min | 91.21 | 111.59 |
| Max | 112.49 | 133.32 |
| Mean | 101.47 | 123.67 |
| SE± | 1.63 | 1.64 |
| Variance | 52.93 | 54.01 |
| CV% | 7.17 | 5.94 |

**Appendix-VIII:** Descriptive statistics for calorific value of different age groups of cattle meat

| Descriptive Variables | Cattle meat | |
|---|---|---|
| | Calorific Values (k.cal) | |
| | C | D |
| Min | 92.78 | 115.21 |
| Max | 111.72 | 136.94 |
| Mean | 104.28 | 125.15 |
| SE± | 1.34 | 1.73 |
| Variance | 36.11 | 60.18 |
| CV% | 5.76 | 6.20 |

**Appendix-IX:** One-way (ANOVA) for calorific values of different age groups of buffalo and cattle meat

| | | DF | SS | MS | F | P |
|---|---|---|---|---|---|---|
| Calorific value | Between | 3 | 9376.87 | 3125.62 | 61.51 | 0.0000 |
| | Within | 76 | 3861.65 | 50.8112 | - | - |
| | Total | 79 | 13238.5 | - | - | - |

## References

[1] Anjaneyulu, A.S.R., V. Lakshmanan., N. Sharma and N. Kondaiah. 1990. Buffalo meat production and meat quality. A review. Indian Food Packer. 44(4): 21-31.
[2] AOAC, 2000. Meat and meat products. In : Official Method of Analysis of Association of Official Analytical Chemists, Gaithersburg.
[3] Arain, M.A., M. Khaskheli., I.R. Rajput., S. Rao., S. Faraz., S.A. Fazlani., K. Devrajani and M. Umar. 2010. Examination of physical properties of goat meat. Pak. J. Nut. 9(5): 422-425.
[4] Awan, k. 2010. Physico-chemical and sensorial quality of buffalo meat. Thesis submitted to Sindh Agriculture University Tando jam.
[5] Brown, M.H., C.O. Gill., J. Hollingsworth., R. Nickelson., S. Seward., J.J. Sheridan., T. Stevenson., J.L. Sumner., D.M. Theno., W.R. Usborn and D. Zink. 2000. The role of microbiological testing in system for assuming the safety of beef. Int. J. Food Microbiology. 62: 7-16.
[6] Bruce, H.L., J.L. Stark and S.L. Beilken. 2003. The effect of finishing diet and post mortem ageing on the quality of *M.*
[7] *longissimus thoracis*of the electrically stimulated Brahman steer carcasses. Meat Sci. 67(2): 261-268.
[8] Brzostowski, H., R. Niznikowski and Z. Tanski. 2008. Quality of goat meat from purebred French Alpine kids and Boercrossbreeds. Arch. Tierz., Dummerstorf 51(4): 381-388.
[9] FAO, 1998. FAO Year Book. FAO Rome (www.fao.org).
[10] Geay, Y., D. Bauchart., J.F. Hocquette and J. Culioli. 2001. Effect of nutritional factors on biochemical, structural and metabolic characteristics of muscles in ruminants, consequences on dietetic value and sensorial qualities of meat. Reprod. Nutr. Dev. 41:1-26.
[11] Gracey, J.F., D.S. Collins and R.J. Huey. 1999. Anatomy, Meat composition and quality. Meat hygiene. 10 (2):60.
[12] Grandin, T and Gallo. 2007. Welfare requirements of handling facilities. In: Farm animal housing and welfare. Eds. Baxter, S.H., Baxter, M.R., and MacCormack, J.A.C. Martinus Nijhoff, The Hague, Netherlands. Pp. 137-149.
[13] Hawke, T. J., and D.J. Garry. 2001.Myogenic satellite cells: physiology to molecular biology. J. Appl. Physiol. 91:534-551.
[14] Hui, Y.H., W.K. Nip., R.W. Rogers and O.A. Young. 2001. Gross composition: Meat composition. In: Meat Science and applications. Eastern Hemisphere Distribution. Marcel Dekker AG. Hutgasse 4, Postfach 812, CH-4001 Basel, Switzerland. Pp. 1-19.
[15] Johnson, D.D., J.S. Eastridges., D.R. Neubauer and C.H.M. Gowan. 1995. Effect of sex class on nutrient content of meat from young goat. J. Anim. Sci. 73: 296-301.
[16] Kandeepan, G., A.S.R. Anjaneyalu., N. Kondaiah and S.K. Mendirarta. 2010. Quality of buffalo meat keema at different storage temperature. J. African Food Sci. 4(6): 410-417.
[17] Kandeepan, G., A.S.R. Anjaneyulu., N. Kondaiah., S.K. Mendiratta and V. Lakshmanan. 2009. Effect of age and gender on the processing characteristics of buffalo meat. Meat Sci. 83: 10–14.
[18] Kannan, G., C.B. Chawan., B.Kouakou and S. Gelaye. 2002. Influence of packaging method and storage time on shear value and mechanical strength of intramuscular connective tissue of chevon. J. Anim. Sci. 80: 2383–2389.
[19] Kemp, A., K. Van and A.J.M. Heijningen. 1953. A Calorimetric micro-method for the determination of glycogen in tissues. Biochem. J. Sci. 56, 646.


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[20] Koohmaraie, M., M.P. Kent., S.D. Shackelford., E. Veiseth and T.L. Wheeler. 2002. Meat tenderness and muscle growth: is there any relationship? Meat Sci. 62:345-352.
[21] Lapitan, R.M., A.N. Del Barrio., O.Katsube., T.Ban-Tokuda., E.A. Orden., A.Y. Robles., L.C.Cruz., Y. Kanai and T. Fujihara. 2008. Comparison of carcass and meat characteristics of Brahman grade cattle (Bos indicus) and crossbred water buffalo (Bubalus bubalis) fed on high roughage diet. J. Anim. Sci. 79: 210–217.
[22] Lawrie, R. A. (1998). Meat sci. (6th ed). Woodhead Publishing Limited.Cambridge, England. Pp: 157-183.
[23] Li, L.Q and L.S. Zan. 2011. Distinct physic-chemical characteristics of different beeffrom Qinchuan cattle carcass. J.African Biotech. 10(37): 7253-7259.
[24] Lin-qiang, LI., T. Wan-qiang and Z. Lin-sen. 2011. Effects of age on quality of beef from Qinchuan cattle carcass. Agri. Sci. in China, 10(11): 1765-1771.
[25] Marsh, B.B. 1993. Approaches to manipulate postmortem metabolism and meat quality. Proceedings of the 39th International Congress of Meat Sci. and Technol. Review paper. Session 3. Vol. I. S. 111-124. Calgary, Canada.
[26] Mojto, J., K. Zaujec and M. Gondekova. 2009. Effect of age at slaughter on quality of carcass and meat in cows. *Slovak J. Anim. Sci. 42 (1): 34 – 37.*
[27] Moss, B.W. 1992. Lean meat, animal welfare and meat quality in the chemistry of muscle base foods, Pub. Royal society of chemistry, Camb, UK. Pp. 62-76.
[28] Newton, K.G and C.O. Gill. 1981. The microbiology of DFD fresh meat: a review. Meat Sci. 5: 223-232.
[29] Orellana, C., F. Pena., A. Garcia., J. Perea., J. Martos., V. Domenech and R. Acero. 2009. Carcass characteristics, fatty acid composition, and meat quality of Criollo Argentino and Braford steers raised on forage in a semi-tropical region of Argentina. Meat Sci. 81: 57–64.
[30] Owen, J.E., N.S.D. Jones., G.A. Norman and C.A. Philbrooks. 1978. Studies on the meat production characteristics of Botswana goats and sheep, part III, carcass tissue composition and distribution. Meat Sci. 2: 59-74.
[31] Rey, J.F and I.E. Povea. 2012. Water Buffalo (Bubalus bubalis) and their Technological Advantages for the Design in Healthy Meat Product. J. Buffalo Sci. 1: 183-187.
[32] Spanghero, M., L. Gracco., R. Valusso and E. Piasentier. 2004. In vivo performance, slaughtering traits and meat quality of bovine (Italian Simmental) and buffalo (Italian Mediterranean) bulls. Livestock Prod. Sci. 91:129–141.
[33] Tan, M.H., A. Bonen., W.W. Watson., D. Hood., M. Sopper., D. Curries., A.N. Balcastro and G. Pierce. 1984. Muscle glycogen repletion after exercise in trained normal and diabetic rats. J. Appl. Physiol. 57: 1404-1408.
[34] Topliff, D.R., G.D. Potter., J.L. Krieder., T.R. Dutson and G.T. Jessup. 1985. Diet manipulation, muscle glycogen metabolism and aerobic work performance in the equine. Proceedings 9th Equine Nutrition andphysiology Society Symposium.East Lansing, Michigan State Univ.PP. 224-229.
[35] Warriss, P.D. 2000. The effect of live animal handling on carcass and meat quality. Hand book Meat Sci. School of Vet.Sci. Univ. of Bristol UK. Pp. 144-146.
[36] Williams, P.G. 2007. Nutritional composition of red meat. Nutrition and Dietetics, 64(4): 113- 119.
[37] Zaujec, K., J. Mojto and M. Gondekova**.** 2012. Comparison of meat quality in bulls and cows J. Microbiology, Biotechnology and Food Sci. Pp: 1098-1108.


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