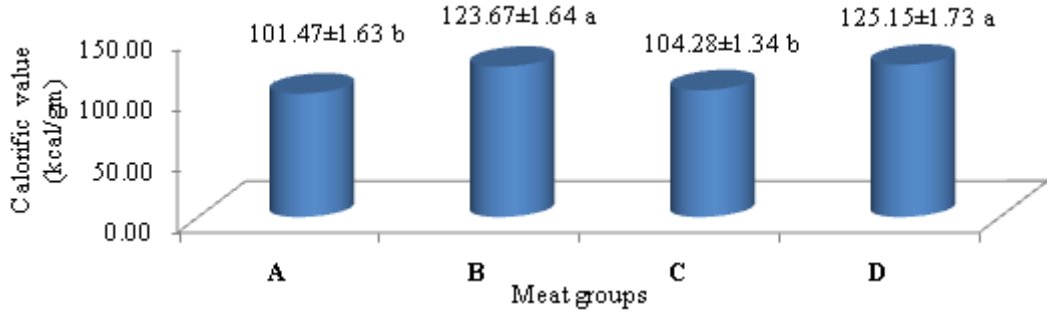
5. Calorific values

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

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

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	-	-	-

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