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CARCASS CHARACTERISTICS AND BEEF COMPOSITION OF BUFFALO CALVES UNDER THE INFLUENCE OF RECOMBINANT BOVINE SOMATOTROPIN (RBST)

[1]Sanjrani, M.N., [2]Malhi, M., [2]Arijo, A.G., [1]Sethar, A., [2]Saghir, S.A., [2,*]Kachiwal, A.B. and [3]Sethar, G.H.

[1]Livestock and Fisheries, Government of Sindh, Pakistan
[2]Sindh Agriculture Uinersity Tandjam, Pakistan
[3]Al-Amiri Hospital, Kuwait City, Kuwait

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ABSTRACT

Experiments were conducted to evaluate the effects of recombinant bovine somatotropin (rbST) on feed and energy intake, feed efficiency, daily weight gain, carcass traits, quality and composition of meat in buffalo calves. Sixteen male buffalo calves of weighing 55$\pm$5 kg live body weight (approximately 16 $\pm$ 2 wks of age) were purchased from local animal market located at a distance of 40 km from Tandojam, Pakistan. They were randomly divided into two groups, placing eight calves in control group on scientific balance ration containing 18% crude protein and eight in treatment group on scientifically balanced ration containing 18% CP and rbST treatment @ 1.0 mg/kg b.w. Data was collected on the proforma starting from 20 weeks and continued for (36 wks) at veal stage and 52 weeks at beef stage. The body weight gain significantly enhanced ($P \leq 0.01$) in rbST treated calves as compare to control calves. The body condition score (BCS) showed transient increase in rbST treated calves but there was no significant difference in BCS of rbST treated and control calves. The carcass physical and chemical characteristics of beef were significantly different from control group animals than rbST treated animals. It is concluded that the use of rbST as growth promoter has enhanced beef quality, quantity and net profit in buffalo calves.

Corresponding author

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INTRODUCTION

Livestock is a potential economic source for 30-50 million of total rural population of Pakistan. This population generates about 30 to 40 percent income by rearing cattle, Kundhi buffalos, sheep and goats (Qudus *et al*., 2013). Livestock sector is major source to reduce the percentage of unemployment in shape to engage the educated and uneducated person in respective indoor and outdoor field work (Hagmann, 2012). Livestock is the most significant component of agriculture sector, which contributes 55.91 percent of agriculture value addition and 11.8 percent to GDP (GOP, 2014).

The population of livestock in Pakistan is about 125 millions heads and the estimated buffalo population was 29.6 million heads in 2011-2012 (Mahmood *et al*., 2014). Bovine somatotropin (bST) also known as bovine growth hormone is a major regulator of meat and milk production and other body functions (Etherton *et al*., 1995). It coordinates metabolism to allow more nutrients for milk production, body growth and development of mammary glands (Buskirk *et al*., 1996). Bovine somatotropin (bST) is among the first protein produced through the application of biotechnology which led to commercial production of rbST and is biologically equivalent to natural pituitary derived bST (Raymond *et al*., 2009).

Bovine somatotropin also has been shown to positively affect growth (Dikeman, 2007) carcass composition (Dikeman, 2007; Vestergaard, 1993) and meat production (Buskirk *et al*., 1996). Research on effect of growth hormone (GH) or recombinant bST in heifers revealed that these hormones increases an average daily gain (ADG) and to reduce energy consumption per kilogram of gain, whereas feed and energy intake and glucagon concentration were not altered (10). Bovine somatotropin (bST) administration increases ADG by increasing Dry matter intake (DMI) and improving efficiency of feed utilization (Puchala, 2011).

There could also be variability in growth performance at different ages, state of sexual maturity and nutritional status within the same species and amongst different species and breeds (12-14). The most accurate method for determining the body or the carcass chemical composition consists of grounding and analyzing the whole body or the whole carcass, generating highly reliable data (Paulino *et al*., 2005). Specific Bovine somatotropin studies have positively reflected its effect on growth (Dikeman, 2008) and carcass composition (Dikeman, 2007; Vestergaard *et al*., 1993). Synthetic bovine Somatotropin (rbST) increases leanness and decreases carcass fatness in finishing beef steers (Nkrumah, 2004) and increases in overall body weight gain(16). Keeping in view the present day nutritional status of buffalo calves coupled with their maintenance on commercial farms through traditional methods where the animals are already in the state of inadequate feeding regimen, the use of rbST may resorted to, in an effort to combat lower yields which is apprehended to adversely affect the animals visa-a-vis their health and reproductive status in the long run. It is in this context the study was embarked upon to determine the effect of rbST on feed and energy intake, feed efficiency, daily weight gain, carcass traits, quality and composition of meat.

METHODS AND MATERIALS

Experiments were conducted to evaluate the effects of recombinant derived bovine somatotropin (somatech) on feed and energy intake, feed efficiency, daily weight gain, carcass traits, quality and composition of meat in buffalo calves. Sixteen male buffalo calves of weighing 55±5 (mean±SD) kg live body weight (approximately 16 ± 2 wks of age) were purchased from local animal market located at a distance of 40 km from Tandojam. They were randomly divided into two groups, placing eight calves in control group on scientific balance ration (Table-1) and other eight were used as treatment group on scientifically balanced ration and rbST treatment @ 1.0 mg/kg b.w fortnightly. The calves were allowed to accustom with nutrious feeds and surroundings at Livestock Experimental Station, Department of Livestock and Management, Sindh Agriculture University Tandojam, Pakistan. The calves were placed on well balanced ration consisting concentrate mixture, wheat straw and non-leguminous green fodder for a period of two months. The calves were allowed to develop a taste for such feeds gradually during 8-weeks period of adaptation. All animals were fed *adlibitum* twice a day with normal maintenance ration (18% CP) and provided free access to clean drinking water as per their requirements. All calves were vaccinated against Foot Mouth Disease and Hemorrhagic Septicemia as per schedule of vaccination and dewormed regularly during the experimental period.

An economic fattening ration (concentrate mixture) having maize grain as major energy ingredient was formulated (Table-1) as described by Ahmad, *et al.* (2004). The chemical composition and nutritive values of the ration was determined as per methods described by Horwitz, (2000). The high energy level ration containing 18% crude proteins were prepared and fed to calves in control group. While treated groups were fed on same ration along with rbST treatment 1.0 mg/kg b.w. Calves were fed maize fodder or burseem as main roughages. Amount of green non-leguminous fodder were added to the ration to meet the carotene requirement of individual animal. Mixed feed were offered daily at 0800 hrs and at chopped green fodder were mixed subsequently at 1100 hrs, All the time care were taken to ensure the weighed quantity of feed should remain in feeder.

Table 1. Chemical composition of fattening ration on dry matter basis

Ingredient	Ration at Veal stage	Ration at Beef stage
Maize	40	-
Cotton seed meal	28	
Wheat bran	10	13
Rice polishing	-	10
Maize gluten 20%	-	20
Maize gluten 30%	10	10
Sunflower meal		15
Molasses	10	20
Mineral mixture	2	2
Total	100	100
Dry matter, %	88.10	85.30
Crude protein, %	18.01	18.00
Nitrogen, %	2.61	2.57
Crude fiber. %	5.75	11.72
Total digestible nutrient%	76.50	75.00
Calcium, %	0.8	0.8
Phosphorus, %	0.51	0.51
Magnesium, %	0.22	0.22
Potassium, %	0.84	0.84
Sodium, %	0.23	0.23
Sulfur, %	0.35	0.35
Cobalt, ppm	0.1	0.1
Iron, ppm	248	248
Copper, ppm	7.0	7.0
Manganese, ppm	109	109
Zinc, pmm	109	109
Vitamin A, IU/kg	2,200	2,200
Vitamin D, IU/kg	440	440

Feed efficiency was evaluated by food consumed in kilograms for one-kilogram weight gain. Body weight gain was recorded weekly throughout the experimental period. The growth observations of male calves were recorded for 250 day (36wks) at veal stage and 360 days (52 wks) at beef stage. These were calculated as: Weight gain in (kg) = Present weight (kg) - Last weight (kg). Body condition was recorded and scored (1-9, thin to fat) in cattle as described by Eversole, *et al.* (2009). Scores of buffalo calves were recorded in 'A point intervals at the same day fortnightly (08:00 to 12:00 h) before morning feeding. Blood samples were collected for analysis of biochemical, hormonal and hematological parameters once a week from jugular vein under aseptic conditions in 10 ml sterile syringe. Two types of test tube were arranged i.e. plain and heparinized vaccutainers (BDH, UK) for the collection of the serum and whole blood respectively. Samples were placed in ice box immediately after collection and brought to the Postgraduate Research Laboratory in the Department of Veterinary Physiology and Biochemistry, Faculty of Animal Husbandry and Veterinary Sciences, SAU Tandojam. Pakistan.

Blood sample in heparinized tubes (whole blood) was used for complete blood count (CBC) whereas blood in plain tube (clotted blood) was centrifuged within 2 hours at 3,000 rpm for 30 minutes at 5 ^{0}C (Jouan GR 412 centrifuge, Winchester, VA), serum was collected in 1.5 ml sterile storage polypropylene tubes, tubes were labeled for date and time of collection and number of animal and then stored at -20 ^{0}C until analyzed. Hormonal parameters were analyzed from serum samples of buffalo calves weekly at the Department of Physiology and Biochemistry and NIMRA Jamshoro, Pakistan. Haemotological parameters: neutrophil granulocytes percentage (GR %), Neutrophil granulocytes (GR#), Hematocrit Percentage (Hct %), Hemoglobin (Hgb g/dL), Lymphocytes percentage (LY %), Lymphocytes (LY#), Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC), Mean corpuscular volume (MCV), Monocytes Percentage (MO %), Monocytes (MO#), Mean Platelet Volume (MPV), Platelets (P1t), Pct (%), Platelet distribution width (PDW), Red blood cells (RBC), Red blood cell distribution width (RDW %) and White blood cells (WBC) were analyzed using Beckman Coulter AcT Diff Hematology Analyzer (Beckman Coulter, Tokyo, Japan). Double antibody radioimmunoassay and Enzyme linked immunoassay procedures were used to determine concentrations of progesterone, Tri-iodothyronine (T_3), Thyroxine (T_4) and Bovine Somatotropin (BST) Kachiwal, *et al.,* (2015). Serum Glucose, Protein, Calcium, Lipid, Cholesterol, Uric Acid, Sodium and Potassium were determined by using an UV/VIS double Beam spectophotometer, (Hitachi U-2800, Japan) Kachiwal, *et al.,* (2015). Carcass and meat quality of the buffalo calves in control and treated animals were recorded at the age of 36 weeks (veal stage) and 52 week (beef stage). All calves of buffaloes were slaughtered. Animal was off fed prior to slaughter for more than 24 hours and weighed on plat farm animal scale. The animals were slaughtered from each group for meat analysis. After slaughter and dressing, the hot carcasses were weighed, split along the spine in two halves and right half carcass was randomly selected and cut into hip, sirloin, loin, flank, rib, plate, chuck, brisket and shank Aganga, *et al .,*(2003). Different body measurements including shoulder (wither) height, height at hind legs, chest depth (Half of the circumference of chest girth) and body length (point of elbow to point of hip) were recorded.

Buffalo calves were slaughtered with sharp knife with single quick transverse cut on throat which results in cutting of major nerve and blood vessel. Skull was removed from rest of the body at the oxipito-atlantal joint. Hooves were separated below the carpals (knee bones) in the fore legs and tarsals in the hind legs. Abdominal cavity was opened by giving incision at mediastinum. Entire digestive tract and visceral organs (Liver, lungs, spleen, heart, brain) were removed. The percent composition of the cuts was calculated as a proportion of the chilled half carcass weight. The half of the carcass was chilled at 0°C for I8 h and then dissected into lean, fat and bone by Paulino, *et al., (2005).* Samples for chemical analysis were prepared from fat and lean tissues both from 9-11th rib cut, half right carcasses. The fat and lean tissues both from 9-11th rib cut and the soft tissues about 25.0 gms were then ground twice and samples of the grounded material was collected and stored frozen at -20^0 C until they were thawed for moisture, bone, fat and chemical analysis by Horwitz (2000). Chemical analysis for Fat (ether extract), Protein, Moisture, Ash, pH, Calcium (Ca), Phosphorus (P), Magnesium (Mg), Potassium (K), Sodium (Na), Zinc, Iron (Fe), Copper (Cu), Magnese (Mn).was performed on meat sample at Department of Animal Product Technologies and Central Scientific Diagnostic Laboratory, Faculty of Animal Husbandry and Veterinary Sciences.

All portions of the meat cuts (hip, sirloin, lion, flank, rib, plate, chuck, brisket and shank) and liver, spleen, kidney, brain, lung and heart were stored at -20 ^{0}C until dissection. Thawing was done at 4^{0}C for 24 h. Each portion of all cuts and visceral organs were weighed and separated into pieces. Rib was weighed and separated into muscle, bone, dissectible fat and other tissues (blood vessels, tendons, fascia, and ligamentum nuchae). Weight of each tissue was expressed as a percentage of total dissectible tissues weight Drip losses and water holding capacity (WHC) in the longissimus thoracis was estimated by three press (300 mg, 10 min under 1 kg) and cooking losses by McDonald *et al.,* (22), Garcia (23) and Honikel, (24). Water losses were expressed as percentage of initial weight. Drip loss, Water Holding Capacity, Water losses and Cooking loss. Mechanical properties of raw and cooked meat were measured with a Brookfield LFRA Texture analyzer by Veira *et al., (25)* **.** Organoleptic tests were performed after thawing the samples (24h at 4 ^{0}C), all portions of the meat cuts were cooked in an electric air convention oven (preheat at 220 ^{0}C for 10 min) until the sample reached 70 ^{0}C. Each steak was trimmed of any external connective tissue, cut into 2 cm^2 sections, wrapped in codified aluminum paper and maintained hot until tasted. Each steak was given to panel of randomly selected tasters Veira *et al., (25)*. The total number of tasters was 25, being composed of 14 men and 11 women. The panelists were given the guidelines on meat attributes and were asked to assess each sample for the following attributes Colour, liking of aroma (odour), Strength of aroma, liking of flavor, Strength of flavor, Juiciness, Tenderness and Firmness

Statistical Analysis

Data collected was analyzed statistically using statistical software Minitab 15

RESULTS

Effect of rbST treatment on Body Weight and Body Condition Scoring

The body weight gain significantly increased ($P\leq0.01$) in rbST treated buffalo calves as compare to control group (Table-2). The body condition score showed transient increase in all rbST treated animals but there was no significant difference in BCS of rbST treated and corresponding control animals. Average daily gain was also significantly increased ($P\leq0.01$) in rbST treated animals as compare to control animals.

Effect of rbST on Carcass Characteristics (composition/ meat quality) Carcass Physical Characteristics/Meat quality;

The carcass physical characteristics and meat quality assessment was made through questionnaire from group of panelist (Plate-1-9). Questions were asked about colour, odour, odour intensity, juiciness, tenderness and firmness. Assessment was scored as 1-5 as summarized in table (3). The assessment results about colour indicated that meat from rbST treated animals were slightly darker than control animals (Table-3).

Table 2. Effect of rbST on Body Weight (BW), Average daily gain (ADG) and Body Condition Scoring (BCS) buffalo calves

Parameters	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
Initial Body Weight (BW) (kg)	$66\pm5^{<<}$	$64 \pm 2^{<<}$
Initial Body Condition Scoring (BCS)	8± 0.5	8.1 ± 0.52
Veal Body Weight (BW) (kg)	$170\pm 5^{**<<}$	$226\pm 6^{**<<}$
Veal Condition Scoring (BCS)	8.2 ± 0.5	8.5 ± 0.2
Average Daily Gain (ADG) at veal stage (gms)	867±8.9	1350±12
Final Body Weight (BW) (kg)	$250 \pm 1^{**<<}$	$336\pm9^{**<<}$
Final Body Condition Scoring (BCS)	8.5 ± 0.5	8.7± 0.5
Average Daily Gain (ADG) at final weight (gms)	$511\pm6^{**<<}$	$756\pm9^{**<<}$

**= Control values significantly increased ($P\leq0.01$) than rbST treated animals.
<< = Veal and final weight in rows significantly increased ($P<0.01$) than initial weight of animals.

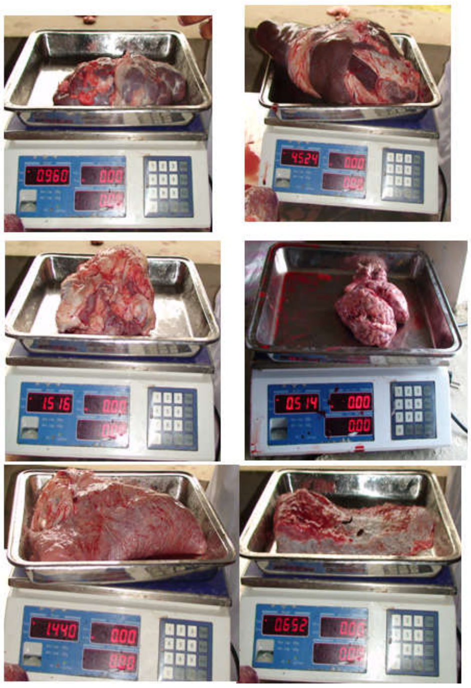


Plate-1 Weight of various visceral organs of rbST Treated Buffalo calves

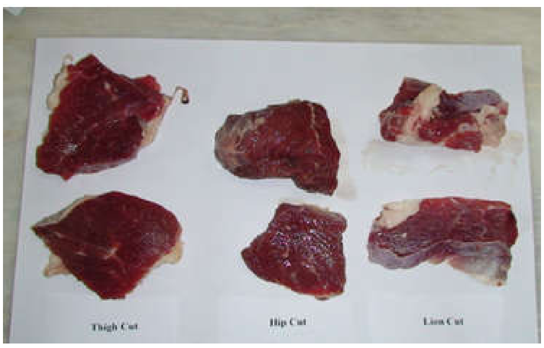


Plate 2. Fresh beef cuts of Buffalo calves from control group

The results obtained from respondent indicated that average aroma and intensity scores were higher in rbST treated animals than control group (Table-3). As per panelist respond the average scoring flavor quality of meat from control animals was higher than those treated with rbST (Table-3).

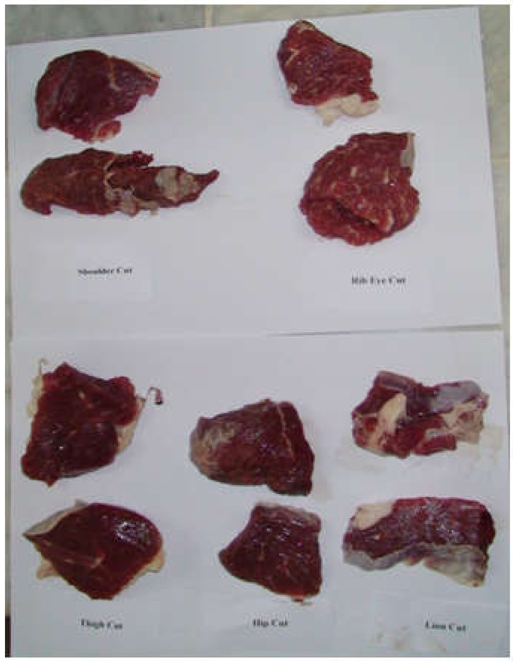


Plate 3. Fresh meat cuts of rbST treated Buffalo calves

Plate 4. Rib eye cuts of rbST treated and control buffalo claves

A greater percentage of respondents (80%) for control and (84%) for rbST treated animals believed that beef meat from control animals were moderately juicy (44% male and 36% female) and for rbST treated animals was (44% male and 40% female) (Table-3). The water holding capacity of the meat influences juiciness of the meat. Meat with low WHC losses a lot of fluid in cooking and may test dry and lack succulence. When measuring meat texture, some estimation of potential juiciness is made and may have been on account of some fat in the meat. Since beef meat happens to be moderately juicy on lesser fat contents and may have been due to it.

Sixty eight percent (28% male and 40% female) and 72% (30% male and 42% female) found that the meat was more tender in control animals than rbST treated animals. Average score of assessment of firmness was higher for rbST treated groups than control groups. Out of 25 each respondents, 48% (20% male and 28% female) and 52% (24% male and 28% female) reported firmness for control and rbST treated animals respectively. The cooking method and ease of penetration the meat by teeth also influenced firmness. The age of the animal, the species and the purpose of the animal would also influenced the firmness of meat.The investigation thus suggest that tenderness, juiciness, flavor and odour as being the main criteria by which consumers to judge the quality of beef meat. This indicted by the average values of controlled animal's meat and rbST treated animals for colour, odour, flavor, juiciness, tenderness and firmness in table-3.

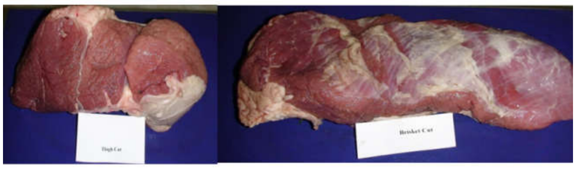


Plate 5. Thigh and Brisket cuts of rbST treated buffalo calves

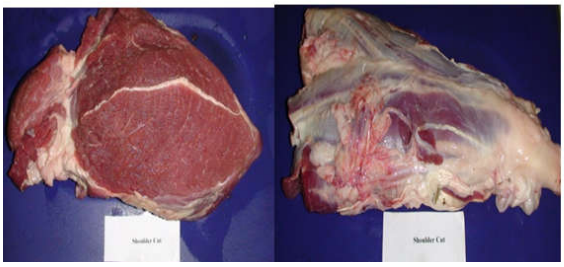


Plate 6 Shoulder cuts of rbST treated and control buffalo calves

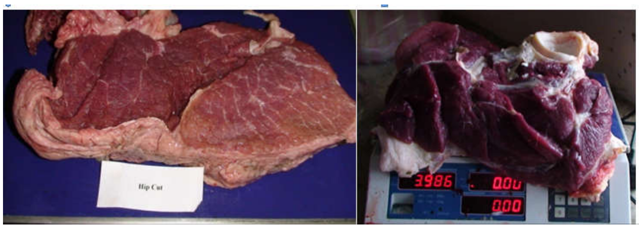


Plate 7. Hip cut of rbST treated buffalo calves

Table 3. Predicted means for taste panel assessment (1-5 scale) of colour, aorma (odour), odour intensity, flavour, juiciness, tenderness of buffalo calves

Variable	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
Colour	2.24±0.2	2.36±0.5
Odour	3.24±0.5	3.32±0.6
Odour intensity	3.09±0.7	3.13±0.8
Flavour	3.8±0.6	3.56±0.4
Juiciness	3.16±0.5	3.2±0.4
Tenderness	3.72±0.6	3.76±0.4
Firmness	2.87±0.7	2.91±0.5

Water Holding Capacity and Instrumental texture:

The results of water holding capacity and instrumental texture are shown in table (4). The statistical analysis of the results showed no significant effect of rbST treatment on water holding capacity (Plate-8-9). Similarly there was no significant difference in instrumental texture between control group and rbST treated animals.

Carcass Chemical Composition:

Carcass chemical composition was determined by chemical analysis of meat samples from different regions of body. The results of moisture contents, dry matter, ash , organic matter and crude protein are shown in Table-.6-7.The moisture content was lower for rbST treated buffalo calves (Table-6) and slightly higher for non rbST treated animals. Statistical analysis of results showed non significant ($P>0.05$) difference in moisture content between the meat of control and rbST treated animals. Water is a major constituent (67-78%) of lean muscle tissue with in a muscle is inversely related to the fat content.

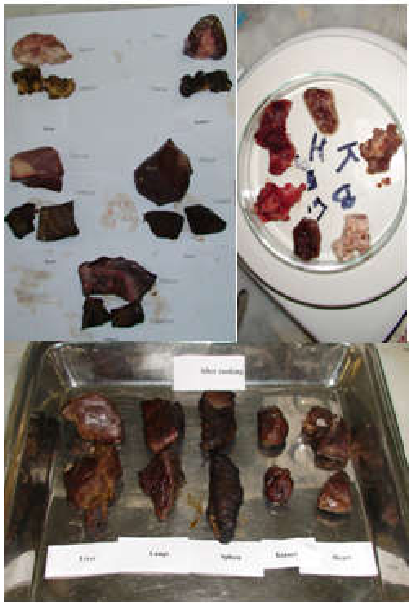
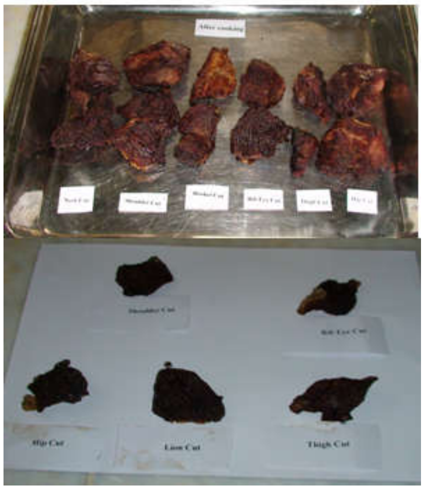


Plate 8. Fresh and after cooking samples of visceral organs of rbST Treated and control Buffalo calves



Plat 9. Meat Cuts of rbST treated and control Buffalo calves after cooking

The results indicate that the hip was composed of more lean meat than fat and the plate was composed of more fat than lean.

The dry matter contents for rbST treated buffalo calves were slightly higher (29.44%). All the cuts were not significantly different ($P<0.05$) except the hip which showed the lower mean value of (22.68%) and the plate with the higher mean of 29.44%. (Table-6) There was non significant difference between dry matter content in meat of rbST treated animals and control groups. The total ash content in buffalo calves was too high (5.62-8.89%). Ash, (almost synonymous with inorganic minerals) content of muscle tissue was approximately (1%). The organic matter was lower in rbST treated buffalo calves was (90.81-96.81%) than control. There was no significant difference ($P>0.05$) in the means of the rbST treated animal's cuts. The protein content is high (54.55-62.26% on dry matter basis) for rbST treated buffalo calves meat than control group. However, the hip was significantly different ($P<0.05$), from other cuts, showing a higher mean (62.27%) crude protein. The cuts were not significantly affected by rbST treatment for values of protein contents.

Table 4. Water holding capacity of carcass cuts and visceral organs of buffalo calves.

Cuts and Organs	Drip loss (%)		Press loss (%)		Cooking Loss (%)	
	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
Hip	1.27±0.11	1.25±0.21	1.19±0.21	1.2±0.21	78.12±4.5	79.88±3.5
Sirlion	0.44± 0.15	0.44± 0.16	0.45± 0.22	0.45± 0.21	65.21±10.2	66.21±12.2
Lion	1.6±0.21	1.8±0.3	1.6±0.21	1.7±0.21	66.66±14.5	67.88±13.5
Flank	1.5±0.04	1.5±0.06	1.24±0.03	1.24±0.02	60.68±10.5	65.68±20.5
Rib	0.98±0.1	0.87±0.1	0.98±0.1	0.97±0.1	65.55±11.6	66.98±13.6
Plate	1.4±0.2	1.4±0.2	1.6±0.2	1.7±0.2	65.55±2.4	66.55±2.4
Chuck	1.6±0.5	1.7±0.5	1.7±0.5	1.7±0.5	67.64±6.6	68.64±5.6
Brisket	1.6±0.6	1.7±0.7	1.8±0.4	1.9±0.4	63.98±6.6	62.98±5.6
Shank	1.42±0.2	1.32±0.2	1.5±0.2	1.5±0.2	69.88±5.6	68.44±6.5
Heart	2.45±0.4	2.46±0.3	2.47±0.4	2.48±0.2	50.94±7.6	50.94±7.5
Lungs	2.45±0.1	2.46±0.1	2.44±0.1	2.45±0.1	28.52±4.6	29.52±4.6
Kidney	0.39±0.32	0.39±0.31	0.36±0.3	0.37±0.3	60.34±5.2	60.22±4.2
Brain	5.1±0.2	5.2±0.2	5.32±0.2	5.32±0.2	70.88±4.2	68.88±4.2
Liver	2.8±0.24	2.9±0.24	2.35±0.24	2.45±0.23	32.44±2.1	31.77±2.2
Spleen	4.5±0.23	4.6±0.23	4.55±0.24	4.65±0.22	36.13±4.5	37.13±2.5

Table 5. Rheological measurement of beef cuts and visceral organs of buffalo calves.

Cuts and Organs	Peak Load (gm)		Final Load (gm)	
	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
Hip	687±4.5	697±3.3	656±5.4	647±5.3
Sirlion	828.3±45.2	829.3±55.1	827.3±45.2	827.3±45.2
Lion	446.6±10.5	448.5±12.6	448.4±12.5	446.7±10.5
Flank	510.5±20.5	506.5±23.4	507.7±24.6	517.7±22.6
Rib	498.3±10.4	494.5±13.5	495.5±12.6	499.5±11.6
Plate	542.6±3.6	534.6±3.6	565.7±5.5	545.8±4.6
Chuck	466.4±3.8	466.6±3.7	456.1±3.5	455.1±2.5
Brisket	482.2±2.5	484.2±2.4	488.2±2.2	498.2±2.4
Shank	633.4±6.2	644.4±6.3	622.8±7.7	624.6±6.5
Heart	296.5±6.6	298.8±4.5	287.5±6.5	288.2±6.4
Lungs	182.1±2.6	185.1±2.6	189.1±2.6	188.1±2.8
Kidney	255.5±2.6	254.6±2.5	256.6±2.5	255.6±2.3
Brain	47.4±3.6	48.1±3.44	46.2±3.3	49.3±2.6
Liver	277.95±4.4	278.55±4.2	268.5±4.6	266.7±4.2
Spleen	777.5±3.5	790.2±3.5	777.8±4.2	788.8±4.3

Table 6. Chemical composition of carcass and visceral organs of buffalo calves.

Cuts and Organs	Moisture (%)		Dry Matter (%)		Ash (%)	
	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
Hip	75.22 ± 0.85	76.72 ± 0.85	25.67 ± 1.54	25.65 ± 1.34	8.24 ± 1.45	8.25 ± 1.46
Sirlion	75.72 ± 0.86	74.22 ± 0.84	23.64 ± 1.5	24.66 ± 1.25	8.4 ± 1.54	8.1 ± 1.59
Lion	74.57 ± 0.94	75.51 ± 0.92	29.44 ± 0.92	26.48 ± 0.93	8.49 ± 1.44	8.49 ± 1.42
Flank	76.31 ± 0.55	76.41 ± 0.66	28.34 ± 0.82	29.33 ± 0.82	8.89 ± 1.55	8.29 ± 1.55
Rib	71.24 ± 1.5	72.24 ± 1.4	27.66 ± 1.33	26.98 ± 1.82	5.68 ± 0.47	5.67 ± 0.45
Plate	72.24 ± 1.66	73.24 ± 1.77	29.44± 1.85	28.35 ± 1.84	5.84 ± 0.64	5.84 ± 0.66
Chuck	73.44 ± 0.44	74.44 ± 0.66	27.45 ± 0.94	27.49 ± 0.95	8.22 ± 1.55	8.39 ± 1.56
Brisket	76.44 ± 0.86	77.62 ± 0.86	27.56 ± 0.93	26.56 ± 0.94	8.49 ± 1.49	8.48 ± 1.48
Shank	73.34 ± 1.6	72.4 ± 1.7	28.30 ± 0.75	27.30 ± 0.76	8.8 ± 0.26	8.95 ± 0.27
Heart	71.24 ± 1.44	72.24 ± 1.84	23.64 ± 1.34	23.67 ± 1.34	8.44 ± 1.55	8.48 ± 1.93
Lungs	79.45 ± 2.7	76.45 ± 2.8	24.64 ± 1.45	25.65 ± 1.55	8.5 ± 1.89	8.5 ± 1.54
Kidney	70.25 ± 2.5	72.35 ± 2.72	27.49 ± 0.91	27.49 ± 0.91	8.44 ± 1.46	8.14 ± 1.44
Brain	72.55 ± 1.74	74.44 ± 1.74	27.46 ± 0.86	27.45 ± 0.85	8.29 ± 1.57	8.28 ± 1.55
Liver	71.82 ± 1.66	72.66 ± 1.23	27.66 ± 1.55	27.88 ± 1.55	5.68 ± 0.48	5.68 ± 0.46
Spleen	71.25 ± 1.6	72.5 ± 1.5	28.46 ± 1.86	28.22± 1.85	5.84 ± 0.68	5.88 ± 0.65

Mineral analysis revealed that beef meat is good in nitrogen, phosphorus, potassium, zinc and iron. However, statistical analysis showed non significant difference (P>0.05) in P and Ca contents in meat samples of control group and rbST treated group. The Nitrogen content was higher (8.81-9.99%), indicating higher levels of crude protein. The hip was higher in N (9.99%) and the brisket was lower (8.819%). The sirloin and the flank were not significantly different, 9.362 and 9.368% N respectively and other cuts also differed significantly (P>0.05), in these contents.

The magnesium levels were not significantly different in meat of rbST treated animals than control group. The K levels in beef ranged from (118±10 – 144 ± 10). The cuts from control animals had slightly higher K level than rbST treated animals. The iron concentration in rbST treated beef and mutton cuts were slightly higher than control animals. Zinc was in scarcity in the rbST treated animals (0.003-0.004 ppm). Copper and Manganese concentrations were not significantly different between the buffaloes cuts (P>0.05).

Table-7 Organic matter (%) and Protein (%) of carcass cuts and visceral organs of buffalo calves

Cuts and Organs	Organic matter (%)		Protein (%)	
	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
Hip	94.91 ± 1.48	95.11 ± 1.43	62.26 ± 0.75	61.26 ± 0.74
Sirlion	91.90 ± 1.49	91.99 ± 1.44	62.27 ± 0.75	61.97 ± 0.72
Lion	90.81 ± 1.58	92.81 ± 1.56	58.48 ± 1.4	58.48 ± 1.6
Flank	92.82 ± 1.45	93.82 ± 1.88	57.44 ± 1.56	57.87 ± 1.58
Rib	95.82 ± 0.66	94.85 ± 0.67	54.55 ± 1.65	54.56 ± 1.52
Plate	94.43± 0.65	94.45 ± 0.66	55.56 ± 1.66	55.56 ± 1.55
Chuck	91.83 ± 1.57	93.81 ± 1.55	58.48 ± 1.45	58.66± 1.55
Brisket	95.81 ± 1.55	96.81 ± 1.54	57.45 ± 1.45	57.87 ± 1.55
Shank	92.99 ± 1.31	92.95 ± 1.43	56.87 ± 1.55	56.87 ± 1.65
Heart	93.92 ± 1.46	92.98 ± 1.44	57.51 ± 1.12	60.22 ± 1.32
Lungs	92.91 ± 1.44	92.92 ± 1.47	56.82 ± 1.6	56.82 ± 1.8
Kidney	92.82 ± 1.55	92.82 ± 1.55	55.82 ± 1.23	55.82 ± 1.32
Brain	92.82 ± 1.44	92.88 ± 1.46	55.65 ± 0.87	55.64 ± 0.86
Liver	93.88 ± 0.79	94.82 ± 0.64	56.65 ± 0.84	55.64 ± 0.82
Spleen	94.45 ± 0.66	94.45 ± 0.66	56.35 ± 1.8	56.65 ± 1.88

Table 8. Mineral composition of carcass of buffalo calves

Cuts and Organs	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
Sodium (N)	46.25 ± 8.25	54.45 ±6.25
Potassium (K)	144 ± 12	145 ± 12
Calcium (Ca)	10 ± 7.6	9.2 ± 6.1
Iron (Fe)	2.7 ± 0.9	2.8 ± 1.2
Copper (Cu)	0.17 ± 0.08	0.19 ± 0.11
Magnesium (Mg)	0.03 ± 0.01	0.04 ± 0.001
Phosphorus (P)	0.15 ± 0.01	0.14 ± 0.02
Zinc (Zn)	0.004 ± 0.001	0.003 ± 0.0001
Manganese (Mn)	0.29 ± 0.02	0.26 ± 0.012

Table 9. Effect of rbST treatment on Hematological parameters of buffalo calves

Parameters	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
GR (%)	29.8±11.97	25.7±7.44
GR# (x10^3/µL)	2.9±1.28	2.4±0.84
Hct (%)	29.5±3.48	30.5±3.64
Hgb (g/dL)	10.4±1.55	10.5±1.32
LY (%)	55.4±1.55	57.1±7.17
LY# (x10^3/µL)	5.7±1.70	5.7±1.16
MCH (pg)	18.2±1.16	18.6±1.42
MCHC (g/dL)	34.7±2.32	34.5±2.19
MCV (fL)	52.0±1.15	53.9±1.54
MO (%)	13.1±7.41	14.4±6.29
MO# (x10^3/µL)	1.3±0.70	1.4±0.64
MPV (fL)	6.9±1.28	7.0±0.69
P1t (x10^3/µL)	143.1±101.00	148.6±65.82
Pct (%)	0.1±0.09	0.1±0.05
PDW	16.6±0.95	16.6±1.02
RBC (x10^6/uL)	5.7±0.72	5.7±0.74
RDW (%)	19.7±1.45	17.9±1.19
WBC (x10^3/µL)	9.9±2.00	10.3±3.76

Effect of rbST on Hematology

Results of hematological parameters of buffalo calves fed with high energy ration, with and without rbST treatment are shown in Table (9). Hematological values were within normal range and did not differ significantly (P>0.05) between control and treatment group.

Effects of rbST on blood biochemical parameters

The results of blood biochemical parameters are shown in table (10). Blood biochemical values of buffalo calves were not significant different in control and treated calves.

Effects of rbST on Serum Electrolytes and Metabolic Hormones

The effects of rbST treatment on the Serum Electrolyte and Metabolic Hormones are shown in table (11). There was significant difference (P<0.01) in Serum calcium levels between different treatment groups during study period. However no significant difference was observed in concentrations of calcium, Sodium, potassium, T3, T4 and GH in buffalo calves during study period.

Economics of rbST use

The cost effectiveness of rbST treatment is shown in table (12).

Table 10. Effect of rbST treatment on Biochemical parameters of buffalo calves

Parameters	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
Glucose (mg/dl)	53.2±15.05	57±13.56
Protein (mg/dl)	6.4±0.54	6.2±0.75
Calcium (mg/dl)	7.8±1.18$^{<<}$	7.7±0.99$^{<<}$
Lipid (mg/dl)	528±59.62	543.7±100.24
Cholesterol (mg/dl)	433±43.34	437.4±42.69
Uric Acid (mg/dl)	8.8±1.33	9.1±1.21

Table 11.Effect of rbST treatment on Electrolytes and Metabolic Hormones of buffalo calves.

Parameters	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
Calcium (mg/dl)	7.91±1.97	8.88±1.59
Sodium mmol/L	142.46±35.21	150.46±16.28
Potassium mmol/L	5.31±1.15	5.67±0.52
T3 (n mol/L)	1.6±0.26	1.8±0.26
T4 (n mol/L)	14.5±5.4	18.5±6.5
GH (µiu/l)	0.02±0.1	0.01±0.25

Table 12.Economics of using of rbST in buffalo calves

Parameters	Group-A (Control) Mean±SE	Group-B (rbST treated) Mean±SE
AV. Daily feed intake /animal (Kg)	21± 2	22 ± 1.5
Value of feed @Rs /Kg	3.5±1.3	3.5±1.2
Value of feed @Rs/animal	66.15±2.5	69.3±2.5
Cost of rbST/animal/day	0±0	17.85±3
Total cost (feed+rbST)/day (Rs)	66.15±2.5	87.15±5.5
Total feed cost on animal	24144.8±2.5	31809.8+5.5
Value of meat @ Rs./Kg	400±0	400±0
Total Value of veal meat @ Rs./animal	68000±64	90400±70
Total Value of meat @ Rs./animal	100000±90	134400±60
Net Income in Profit on veal weight (Rs)	43855.2+25	58590.2+65
Net per animal Profit on ration+treatment /Final body weight (Pak Rs)	75855.2+55	102590.2+8
Initial investment and other expenses	40000±2000	40000±3000
Net profit per animal (Pak rupee)	35000±2500	60000±35000

The economics of using rbST in buffalo calves revealed that the average daily feed intake was 15 kg per day in each buffalo calf. The cost of feed per animal per day was Rs. 66 at the rate of Rs. 3.5 per kg. The rbST was given to group-B at the dose rate of 250 mg/animal fortnightly which cost Rs. 17.85 per day, hence the total expenses on each animal was Rs. 87.15 per day. Whereas, the income received from meat of each animal was Rs. 68000 and 100000 from veal and beef stages control group respectively, whereas income received from rbST treated group was Rs. 90400 and 134400 at veal and beef stages respectively. Net profit received from rbST treated Group-B was significantly higher (P<0.01) than control group (Table-12).

DISCUSSION

Bovine somatotropin (bST) also known as bovine growth hormone is a major regulator of meat and milk production and other body functions. It coordinates metabolism to allow more nutrients for milk production, body growth and development of mammary glands. Bovine somatotropin (bST) is among the first protein produced through the application of biotechnology which led to commercial production of rbST and is biologically equivalent to natural pituitary derived bST. The use of rbST has also produced a number of issues. Bovine somatotropin (bST) administration increases ADG by increasing Dry matter intake (DMI) and improving efficiency of feed utilization (Schlegel, 2006).

Therefore, the study was designed to investigate the effects of rbST on quantity and quality of meat in buffalo calves. Effect of rbST treatment on Body weight has significantly produced (P<0.01) than initial body weight of buffalo calves. The body weight gain significantly enhanced (P≤0.01) in rbST treated animals as compare to control animals (Table-9). The body condition score showed transient increase in all rbST treated animals but there was no significant difference in BCS of rbST treated and corresponding control animals The average daily gain was also significantly increased (P<0.01) in rbST treated animals as compare to control animals Schlegel, *et al.,* (2006) and Brown *et al.,* (2005). Similar studies conducted on the effect of rbST on growth and blood composition of Kundhi buffalo calves revealed that rbST significantly increases the body weight gain in calves when given 0.5-mg/kg b.wt on alternate days by Atta-ur-Rahman, (2015). There was an increase growth performance when calves were also fed high-energy protein ration by Brown *et al.,* (2005). However, some studies show very little benefit of rbST administration on growth performance and carcass traits in finishing steers by Vann *et al.,* (1998) and Vann *et al*., (2001). Treatment with somatotropin (ST) improved ADG and feed efficiency (FE) in bovine animals Holzer *et al*., (2000). The injection of rbST also resulted in enhanced plasma protein levels in heifers and buffaloes by Gabr, (2013) and Kachiwal *et al*., (2015). More average daily gain was observed by Chaiyabutr, *et al.,* (31) and Helal and Lasheen (2008) after daily administration of bST at doses ranging from 25 to 600 pg/kg BW daily in young heifers that weighed between 70 and 109 kg increased ADG by 7.1 to 10.8 kg, whereas feed efficiency was improved by 2 to 8% compared with control animals. Feed intake was increased by 2 to 6% (). In Holstein heifers of 295 kg BW/daily injection of rbST increased ADG by 9.8 and 7.7% and improved feed efficiency by 7.7 and 10.2% by Schwarz, *et al.,* (1993). Average daily gain was even more than 23.5% and a 20.3% improvement in FE in finishing beef heifers receiving a daily dose of 50 pg of pituitary bST similarly reported by Schwarz, *et al.,* (1993). Consistent with these results, they observed an increase in ADG when averaged over the entire test period in rbST-treated finishing beef heifers. Similar findings were observed for feed intake in lambs increased with decreased energy level ration by Abdel-Baset, (2009) and Mahgoub *et al.,* (2008) also found increased feed intake with Low energy diet as compared to other medium and high energy diet in lamb. In contrast to finding of Syed (2009), and Abbasi *et al.,* (36) found low feed intake and FCR and increase live weight gain in Kids fed with high Energy Ration as recorded in this study. This could be genetic characteristic of buffalo calves to obtain rapid gain in weight with less feed intake.

Similar findings were also observed by Atta-ur-Rahman, (2015) after administration of rbST on daily feed intake in the buffalo calves. Who observed that daily feed intake was significantly (P<0.05) higher in rbST treated calves than control calves. In accordance with increased body weight gain, the feed intake was increased in rbST treated buffalo calves compared to control calves by Atta-ur-Rahman, (2015).The DFI was increased linearly by increasing dose of rbST in treated calves indicating that rbST exerts marked effect on nutrient intake by promoting appetite of animals. Helal and Lasheen, (2008); Moallem *et al., (2000)* and Moseley *et al.,* (1992) also observed similar findings in another study performed on cattle calves. The increase in DFI in response to rbST treatment depends on nutritional status of the animal.
Thus, when nutritional status is excellent, rbST has indirect effects on the dry matter intake (DMI) via the IGF system was observed by Gulay *et al.,* (2005). However, there are some contradictory results in the literature not supporting the above findings regarding the effect of rbST on DMI in animals. Velauyudhan *et al.,* (2007) and Schlegel *et al.,* (2006) reported a reduced DMI in rbST -treated cattle than in controls. In dairy goats and ewes, dry matter intake did not differ significantly between control and rbST treatment (Chadio *et al.,* (2000) and Sallam *et al.,* (2005). DMI may depend on the stage of production, energy status, environmental condition and the nutrients of diet (particularly energy). These variations in DFI may be due to species, breed and sex differences and different environmental condition in which the experiments have been carried out.

Boonsanit *et al.,* (2010), Chanchai *et al.,* (2010) and Nascimento *et al.,* (2003) also reported similar findings in cattle calves. The results reported by Helal and Lasheen, (2008) and Moallem *et al., (*2000*)* have further confirmed the findings and observed increased feed consumption in rbST treated calves. In both beef and dairy animals, supplementation with rbST has been shown to affect feed intake. However, Chaiyabutr *et al.,* (2007); Sallam *et al.,* (2005) and Chadio *et al.,* (2000) disagree with the above findings and found no effect of rbST treatment on feed intake in lactating buffaloes, sheep and goats respectively. This discrepancy information suggested that these results probably came from the different experimental condition and reflected that this behavior was controlled by multiple factors. The increase in feed intake may depend on the increase in production (milk and meat), energy status, environmental condition and the nutrients of diet (particularly energy). Overall, both dairy and beef animals in production stages supplemented with rbST appear to adjust their voluntary feed intake in relation to the additional nutrient required for production. The effect of rbST therefore, on yield, quality, contents and composition of meat has been reviewed during varying seasons and age coupled with feed intake and energy intake.

Carcass weight and dressing percentage of buffalo calves were significantly affected by rbST treatment as compare to control groups. Similarly, Schwarz *et al.,* (1993) found that rbST treatment led to a dose-dependent reduction of kidney fat. Dressing percentage was reduced by rbST and increased by Syn.. However, no effect of rbST on dressing percentage was found in steers by Dalke *et al.,* (1992) or heifers by Schwarz *et al.,* (10); again, no interaction existed between the two materials. Atta-ur-Rahman *et al.,* **(**2015**)** also reported that the treatments did not affect the proportion of protein or water in the longissimus muscle. The rbST treatment reduced the proportion of fat by 32%, but the difference was not significant. Still, the numerical reduction is consistent with the findings of Dalke *et al.,* (46) and Moseley *et al.,* (1992). There were no significant effects on tenderness, as measured with Warner-Bratzler shear values, either by rbST, which elicited a small increase, or by Synovex treatments. A small increase in the Warner- Bratzler shear value of the rbST treatment, similar to the one seen in our experiment, was found by Sejrsen *et al.* (47).Similar findings were observed in young heifers, increases in dressing percentage were absent or slight (Sejrsen *et al.,* (1986); Kandeepan *et al.,* (2010) and Moreira, *et al.,* (2003). In contrast, a reduction of 2 to 3% in dressing percentage was reported for heavier heifers and steers by Schwarz, *et al.,* (1993)
The results obtained for carcass characteristics (Table 3-8 & 10-12) indicate that diet compactness index or conformation and fatness score. The moisture content was higher for rbST treated animals (Table-6) and slightly lower for control animals as shown by Paulino *et al*., (2005) and Srivnivasan *et al.,* (50) which reported similar mean values of 75 and 77.12% respectively. Garcia, *et al.,* (2007), supported Paulino *et al.,* (2005) by reporting moisture content of 75% in lean beef. Water is a major constituent (70-78%) of lean muscle tissue and within a muscle is inversely related to the fat content. The fatter the animal, the less the moisture, Paulino *et al.,* (2005). The hip had a higher mean (74-78%) followed by the shank (73.35%) and the plate had the least mean of (71.35%). Other cuts did not have any significant difference (Table-12). However, as the animals mature, they also usually increase in fatness, which causes an even greater decline in the percentage of water by Pearson and Gillett, (1999).The dry matter content for rbST treated buffaloes was slightly higher (25.75-31.22), compared to beef. Paulino *et al.,* (Paulino, 2005) reported a dry matter content of 25% in beef, while Srinivasan *et al.,* (Srinivasan *et al*., 1998) reported slightly lower value of 22.9%. All the cuts were not significantly different (P>0.05) except the hip, which showed a lower mean value of (22.68%) and the plate with a higher mean of (30.68%) (Table-12). Meat tenderness did not affected by rbST treatment. Cooking by boiling can tenderize meat containing large amounts of connective tissue by converting it to gelatin reported by Warris, (2001). The perception of tenderness is also based on the ease of penetration of the meat by the teeth, ease of

fragmentation of the meat and the size of the residue remaining after chewing (the chewy bit). Other factors affecting tenderness are: prerigor meat temperatures, rate of pH fall, ultimate PH of the meat, preservation and cooking methods, sex, age and the species of the animal as observed by Warris, (2001).

This indicates that the dry matter is calculated as a residue after determining the moisture content. Therefore, where moisture content is high, then the dry matter is low, as these are inversely related as reported by McDonald (2000).The total ash content in buffalo calves cuts was too high (5.10-19%), compared to that of cow beef. Paulino *et al.,* (2005), reported (1.5%), while Srinivasan *et al.,*(1998), were slightly lower, reporting a mean value of 1.09%. Ash, (almost synonymous with inorganic minerals) content of muscle tissue, is approximately (1%). Ash content accurately reflects the mineral content, but does not differentiate between minerals, because of the relatively low content of minerals in fatty tissues, the fat level also indirectly influences the mineral or ash content of meat and meat products reported by Pearson and Gillett, (1999).The organic matter was lower in rbST treated animals (91.81-94-90%) and higher in beef as the two are also inversely related. The composition of organic matter was within the range of value reported in the literature. Srinivasan *et al.,*(1998) reported a value of (98.91%), while Paulino *et al.,* (2005) also reported values of (95.81%). Organic matter in meat represents complex compounds of Carbon (C), Hydrogen (O) and Oxygen (O) as reported by Warriss, (52).The protein content was high (55.05-62.75% on dry matter basis) for rbST treated animals meat, than the crude protein in beef. Warriss (2001) reported a protein content of 20% in beef, Srinivasan *et al.,*(1998), also reported a mean value of 20.07%, while Paulino *et al.,* (2005), reported a value of 18% crude protein in lean beef muscle tissue. Garcia *et al.,* (2007), reported 19.0% in lean meat.

Mineral analysis revealed that buffalo meat is good in Nitrogen, Phosphorus, Potassium, Zinc and Iron. However, Paulino *et al.,* (2005), reported higher percentage of Potassium and Phosphorus in lean beef and Srinivasan *et al.,*(1998) reported higher mean values of Sodium, potassium and Iron, presented in mg/100g of muscle. Mean is also reported to be a good source of dietary Phosphorus *and* Iron, but low in Calcium by Pearson and Gillett, (1999). Pearson and Gillett (1999) stated that calcium is the most abundant mineral element in the animal's body and described it as an important constituent of the skeleton and teeth, in which about 99% of the total body calcium is found. Calcium is essential for the activity of a number of enzyme system's including those necessary for the transmission of nerve impulses. This clearly explains why the calcium content was low in the flesh of beef as well as in the buffalo's cuts. Pearson and Gillett (1999) reported that meat is a good source of Phosphorus compared to Calcium. The data on donkey cuts agree with Pearson and Gillett (1999), by showing a P mean ranging from 0.167-0.195%, which was higher than that of Ca (0.095-0.160%). Paulino *et al.,* (2005), further supported Pearson and Gillett (51), reported a P % of 0.131, as compared to 0.008% of Ca in lean beef. However, there was no significant difference between the control and rbST treated buffaloes beef (P>0.05) in both P and Ca. The magnesium levels were also higher in beef (0.057-0.081) as compared to (0.018-0.033%), reported by Paulino *et al.,* (15) in beef. Magnesium is closely associated with calcium and phosphorus and about 70% of the total Mg is found in the skeleton. Thus, it can be seen that Mg is a key element in cellular biochemistry and function (McDonald *et al.,*(22). The Mg concentration was not significantly different in buffalo cuts (P>0.05). The K levels in beef ranged from (0.287-0.414%), which agreed with Paulino *et al.,* (2005) who reported (0.184-0.415%) in lean beef. The concentration of K was the highest among minerals that were quantified in semi membranous muscle of steers. This agreed with the published data of Pearson and Gillet, (1999), however this was not the case in Cardiac muscle, where both K and Sodium were present in large quantities (Srinivasan *et al.,*1998). Potassium is important in osmotic regulation of the body fluids and in acid base-balance in the animal. It plays an important part and nerve and muscle excitability and in carbohydrate metabolism (McDonald, *et al.,* 2000).The iron concentration in rbST treated beef was the highest (30.958-35.838 ppm), when compared to other trace minerals, Zinc, Copper and Manganese. Srinivasan *et al.,* (1998) reported that the iron content of 3.7 mg/100g in skeletal muscles and a 5.4 mg/100g in cardiac muscle, which were lower than Sodium, Potassium and Calcium. Paulino *et al.,* (2005), reported 0.001-0.005% of Iron in lean beef which was also lower than Potassium, Phosphorus and Magnesium. Electrons are transported by the oxidation and reduction activity of bound iron reported by McDonald *et al.,* (2000).

Zinc was the second in abundance after Iron in the rbsT treated buffaloes (3.024-3.794 ppm). The sirloin and the brisket were not significantly different and the chuck had the lowest mean (2.623). Other cuts were significantly different (P>0.05). It is an activator of several enzyme systems. It is involved in cell replication and differentiation, particularly in nucleic acid metabolism. It is also involved in production, storage and secretion of hormones, in immune system and electrolyte balance as reported by McDonald *et al.,*(2000). Copper and Manganese concentrations were not significantly different between the buffalo cuts (P>0.05).Since the meat is believed to have a slightly dark red colour, according to Warriss, (2001) the meat has a desirable colour. This colour however explains the depth of Oxyhaemoglobin layer. The depth of the Oxyhaemoglobin layer depends on the extent of penetration of O_2 from the atmosphere. However, describing the colour of meat subjectively is rather difficult, because the perception of colour depends entirely on the individual. There was no significant effect of rbST on haemotological values. Similar observation were also reported by (Kachiwal *et al*., 2015) and Atta-u-Rehaman (Attaur Rahman *et al*., 2015). The use of rbST in buffalo calves had significantly (P<0.01) good effect on meat quantity and net return. It is similarly observed by Capper *et al.,* (2012) and Vieira *et al.,* (2007).

Conclusion

The results of present study indicated that the body weight gain significantly increased ($P\leq0.01$) in rbST treated calves as compare to control calves. The body condition score (BCS) showed transient increase in rbST treated calves but there was no significant difference in BCS of rbST treated and control calves. The carcass physical and chemical characteristics of beef were significantly better from control group animals than rbST treated animals. It is concluded that the use of rbST as growth promoter has enhanced beef quality, quantity and net profit in buffalo calves.

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