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EFFECTIVENESS OF HIGH INPUT FEEDING SYSTEM IN RELATION TO GROWTH AND CARCASS QUALITY OF VARIOUS CLASSES OF BEETAL KIDS

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High input feeding system results in better growth performance in goats as compared to low input feeding system. Traditionally goats are reared under low input system while to see the effectiveness of high input feeding system, current project was planned to study the growth performance and carcass quality among various classes of Beetal breed. Total 16 Beetal kids (12 male + 4 female) were selected considering 120 (±10) days average age and weight ranging 16 (±2) kg for male and 14(±2) kg for female. The kids from various classes were divided into four treatment groups designated as S1 (Entire male or not castrated), S2 (castrated at 4 mo), S3 (castrated at 6 mo) and S4 (female). Animals were castrated during pre-fattening period and managed under same conditions before fattening. The duration of the study was 120 days (60 days pre-fattening + 60 day fattening). Total 12 animals (randomly 3 from each treatment group) were slaughtered at the end of study for detail carcass quality evaluation. The average daily gain (ADG) was significantly affected ($P<0.001$) by the treatments. There was higher ADG noticed in S3 group (93.75 gm/d) as compared to S1 (90.42 gm/d), S4 (63.89 gm/d) and S2 (33.75 gm/d). Average daily feed intake was significantly ($P<0.05$) highest in S3 (878.00 gm/d). The serum cholesterol and serum glucose were also affected ($P<0.05$) by the treatments. There was non-significant ($P>0.05$) effect of treatments on the sensory panel score about color, chewability, flavor, tenderness and overall acceptability of the cooked meat. It is concluded that sex and castration affected the growth in kids while the carcass traits were not affected. The age of castration need consideration in Beetal kids because castration at early age adversely affected the growth of kids in this study.
Keywords: Beetal kids, **c**astration, carcass, sensory evaluation, blood metabolites.

INTRODUCTION

Improvement of the meat quality and quantity cannot be overemphasized to meet the international nutritional standards for the people in Pakistan who are deficient in animal protein by consuming 18 gm/capita/year (Ali and Khan, 2013). The meat from goat has better demand and price in the local market because of more preference by majority of people (Arain *et al.*, 2010). The Beetal is one of the most popular breed of goat in the local sooqs due to its beauty, better growth rate and meat demand especially at eve of Eid-ul-Adha (Khan *et al.*, 2005).
Traditionally, the small ruminants are raised on the low input feeding system, which results in lower growth of the animals (Sarwar *et al.*, 2010). In some recent studies, high input-feeding system has been found to be more efficient in enhancing the growth performance of Beetal by improving the nutrient availability (Nisa *et al.*, 2013; Sarwar *et al.*, 2012; Mukhtar *et al.*, 2010). Many studies showed that the carcass quality are imperative to figure out growth performance in goats (Oramari, *et al.*, 2014; Najafi *et al.*, 2012; Limea *et al.*, 2009; Titi *et al.*, 2008). The scanty information is available about the carcass characteristics of Beetal goat. The current study is a step forward to explore the effectiveness of high input feeding system while considering about the growth and carcass quality analysis simultaneously.
The meat available in the markets are from the various classes i.e. castrated male, entire or non-castrated male and female animals. There are fair amount of studies which depicts about the consideration of various factors like sex, castration, age of castration, type and breed while studying the growth, carcass traits and attributes of meat (Alkass *et al.*, 2014; Ozcan *et al.*, 2014; Mudalal *et al.*, 2014; Poore *et al.*, 2013; Ekiz *et al.*, 2009; Lambe *et al.*, 2009). The information on aforementioned factors is flimsy regarding Beetal breed especially while raising them under high input feeding system. Thus the data generated during current study will be helpful not only to validate the utility of high input feeding system but also to compare the carcass attributes of various classes of Beetal kids.

MATERIALS AND METHODS

***Selection of animals*:** The study was conducted at Livestock Experiment Station (LES), Allahdad, Tehsil Jahania, District Khanewal. Total 16 Beetal kids (12 ♂ + 4 ♀) were selected.

The age of all the animals were 120 (±10) days while the weight of the animals were 16 (±2) kg for males and 14(±2) kg for female group. All animals were grouped into four animal class types designated as S1 (4 male entire), S2 (4 male castrated at 4 mo), S3 (4 male castrated at six mo) and S4 (4 female).

***Pre-fattening management*:** The S2 group was castrated at 120 days of age while S3 group was castrated at 180 days of age. All the animals were grown on Maize fodder (*Zea mays*) for two months (60 days) and managed on same conditions before fattening.

***Fattening*:** After completion of growing period at 180 days of age, all the experimental units were fattened on the pelleted feed under high input feeding systems (Table 1). Animal were offered ad-libitum feeding and watering for 24 hrs in individual pens. The duration of this phase was 60 days including 7 days adjustment period at start of fattening.

Table 1. Ingredient and Chemical composition of ration.

Ingredient	Inclusion level (%)
Maize (yellow hybrid)	10
Oats	30
Corn Gluten Feed (30%)	5
Rice Polishing	12
Wheat Bran	20
Molasses	08
Wheat Straw	12
Oil	1
Lime stone	1
Salt	1
Chemical composition (%)	
Proximate composition	
Dry matter	90.80
Crude Protein	10.85
Ether Extract	6.58
Crude Fiber	14.55
Ash	9.75
NFE	58.27
NDF	25.75
ADF	16.40
Gross Energy (Mcal/Kg)	3.55

Note: Derived from NRC (2007)

***Statistical design*:** The animals were exposed to treatment under completely randomized design. The model equation is given below.

$$Y_{i,j} = \mu + (\textit{Class of Animal})_i + \epsilon_{i,j}$$

***Data collection*:** The data were collected on body weight, fattening ration intake, blood metabolites, slaughter and carcass traits. Body weight were measured weekly. Daily orts were collected to measure feed intake during fattening period. Average daily gain (Kadim *et al.*, 2003), feed conversion ratio (Sen *et al.*, 2004) and Kleiber ratio (Mohammadi *et al.*, 2010) were calculated at the end of the trial. Blood samples were collected at day one and at the end of the fattening period for determining serum glucose, serum creatinine, blood urea nitrogen (BUN) and cholesterol to know the physiological response in treatment groups (Nudda *et al.*, 2013).

The fattening ration and minced meat sample were analyzed by proximate analyses procedures detailed out by AOAC (2003) for determining the detail chemical composition at Institute of Animal Nutrition and Feed Technology (IAN&FT), UAF. Twelve animals (3 from each group) selected randomly for slaughtering at the end of the experiment, were transported to the University of Agriculture, Faisalabad, through vehicle. The duration of journey was 6 hours. The animals were given rest, water and feed after 3 hours. Final weights of all animals were recorded after 12 hr fasting and then after 24 hr fasting prior to slaughter. Hot carcass weight was recorded after excluding the weight of testes, kidney, pelvic fat and tail and used to calculate the dressing percentage (Bonvillani *et al.*, 2010). The carcasses were chilled for 24 hr at 4°C and weight was recorded. The carcasses were split into two symmetrical parts with the aid of meat saw. Then left side carcasses were frozen at -20°C (aged for 30 day). The rib eye muscle from aged carcasses were used for further meat tests and sensory evaluation at National Institute of Food Science and Technology (NIFSAT), UAF, except meat colour index which was performed at Ayub Agri Research Institute, Faisalabad. The eye muscle or ribeye area was determined between 12-13th rib by Grid-EMA while following Plant and Maden (1996). The meat was thawed, minced and used for determination of pH by slurry method using Hanna Instruments (HI 98107 pHep pH Tester, +/-0.1 Accuracy). The pH of meat was evaluated by taking 10 gm of the minced meat samples and homogenized in 100 ml of distilled water for about 30 seconds at high speed. Homogenized samples were transferred into a beaker and pH was noted by placing the pH electrode into the samples (Arain *et al*., 2010).

Tenderness (using TA.XT.PLUS Texture Analyzer) were measured while following the protocols as described by Cavitt *et al.* (2005) with some modifications. Meat piece from the loin part (*longissimus dorsi*) was used to determine the force (in kg/cm^2) with needle puncture shear force Texture Analyzer having a 5-kg load cell using a needle puncture probe with a height of 25 mm and a diameter of 2 mm set to a penetration depth of 20 mm. Crosshead speed was set at 80 mm/min and the test was triggered by a 10-g contact force.

Water Holding Capacity (WHC) was determined according to the procedure described by Wardlaw *et al.* (1973) with some modifications. The frozen right fillets were thawed at 4°C for 8 hrs in a refrigerator. The loin area meat were cut and ground for 1 min in a food processor to achieve the desired particle size of approximately 3 mm of diameter. Five gram portions of the ground meat were weighted and placed in 35 ml assay tubes containing 80 ml of 0.6 M NaCl. The solution was mixed for 30 sec, incubated for 30 min at 4°C and centrifuged at 5000 rpm for 15 min. After centrifugation, the volume of the supernatant was measured using a 10 ml volumetric cylinder.

Cooking loss (%) was measured following Kondaiah *et al.* (1985) by placing meat sample (20 gm) was placed in polyethylene bag and heated in a water bath at internal temperature of 72°C. Cook-out was drained and the cooked mass was cooled and weighed to determine the weight loss.

Drip loss (%) was determined according to the procedure described by Earl *et al.* (1996) with some modifications. Three pieces of Whatman 14 # 3 paper (5.5 cm) and one piece of Whatman # 50 filter paper (7.0 cm) were formed into a thimble by shaping the filter papers around the outer round bottom of an inverted 16×150 mm test tube with the # 50 filter paper as the internal surface of the thimble. The filter paper thimble was weighed and approximately 5 gm of ground meat wrapped and folded in a 15 cm^2 piece of 0.1 mm mesh white tulle netting was placed inside the thimble and then stored at 4°C for 24 hrs. The filter paper with moisture was weighed and expressible moisture was reported as the percentage weight lost from the original samples.

The Color index (*L*, *a**, *b** values) of meat samples were measured after blooming the meat samples using Minolta Chroma Meter CR-200 (Accuracy Microsensors, Inc., USA). These color index values were used to calculate the chromaticity and hue angle (Caneque *et al.*, 2004). The meat samples were analyzed for chemical composition by proximate analysis procedures (AOAC, 2003). The sensory evaluation of the cooked meat samples (by boiling while following Eneji *et al.*, 2012) was carried out by eight trained panelists (within the age range of 25-40 years) for different attributes like appearance, flavor, juiciness, chewiness and overall acceptability by using nine point hedonic scales following the method described by Meilgaard *et al.* (2007).

Statistical analysis**:** The data were analysed using linear model procedures run in R-software (3.0.3 version). The means were compared by Tukey's HSD test during post-hoc analyses (R Core Team, 2014).

RESULTS

The statistical analysis of data (Table 2) showed that the ADG

Table 2. Growth performance and carcass characteristics of various classes of Beetal kids under high input feeding system.

Response Factor	Parameters (Units)	Classes of Beetal Kids (Treatment)				P–Value	SEM
		S1*	S2**	S3***	S4****		
Growth Performance	Av. daily gain (gm/d)	90.42a	33.75b	93.75a	63.89b	P<0.001	10.75
(Fattening Stage)	Klieber ratio	7.54a	3.87b	8.56a	7.07a	P=0.002	0.966
	Av. daily feed intake (gm/d)	743.5a	307.5b	878a	739a	P<0.01	58.71
Slaughter Traits	Hot carcass wt. (kg)	9.66a	7.00b	12.67a	11.25a	P<0.05	1.122
	Dressing (%)	48.96b	39.89c	51.51b	58.38a	P<0.001	1.933
Carcass Traits	Cold carcass wt.(kg)	9.33ab	6.91b	12.33a	10.88ab	P<0.001	1.159
	Eye area (sq. In)	1.83	1.20	2.20	1.20	P>0.05	0.481
	pH of meat	5.63	5.60	5.47	5.50	P>0.05	0.446
	Tenderness/Needle Puncture (kg/cm)	0.73	0.38	0.48	0.44	P>0.05	0.056
	Water holding capacity	57.22	54.50	56.67	51.11	P>0.05	3.181
	Cooking loss (%)	31.40	33.60	33.02	30.93	P>0.05	2.253
	Drip loss (%)	1.34ab	2.32a	2.15a	0.81b	P<0.05	0.391
	Hue angle	19.09ab	14.97b	17.14a	16.87ab	P<0.05	0.150
	Lightness	41.28	44.18	44.03	41.59	P>0.05	2.845
	Chromaticity	29.41	28.40	32	31.36	P>0.05	4.583
Meat Composition	Moisture (%)	72.61	76.32	75.68	74.50	P>0.05	3.190
(% of Fresh meat)	Fat by Ether extract method (%)	5.67	5.33	5.83	5.67	P>0.05	0.499
	CP (%)	17.94	18.32	18.20	18.00	P>0.05	0.165
	Ash (%)	1.70	1.50	1.50	1.33	P>0.05	0.996
Sensory Evaluation	Color	7.04	6.75	7.08	7.17	P>0.05	0.254
(Average Panel Score)	Texture	6.92	7.00	6.92	5.83	P>0.05	0.556
	Flavor	6.75	6.79	6.46	6.50	P>0.05	0.661
	Juiciness	6.54	6.88	6.96	6.58	P>0.05	0.406
	Chewability	6.83	7.04	7.17	7.17	P>0.05	0.312
	Overall acceptability	6.76	6.94	6.97	6.30	P>0.05	0.273
Blood Metabolites	Serum glucose (mg/dl)	42.50ab	52.25ab	59.25a	38.25b	P<0.05	5.885
	Blood urea nitrogen (mg/dl)	7.68	9.75	10.05	8.84	P>0.05	1.121
	Serum cholesterol (mg/dl)	71.00ab	64.00b	90.50a	55.50b	P<0.01	7.530
	Serum creatinine (mg/dl)	0.235b	0.174c	0.279a	0.238ab	P<0.001	0.014

Note: Superscript of means (a,b,c) shows the means comparison by Tukey's HSD test. Where same alphabet means no difference. *Entire male, **Castrated at 4 month age, ***Castrated at 6 month age, ****Female.

of Beetal kids were significantly (P<0.001) affected by the class of the animals. The detail post hoc analysis showed that overall males showed better ADG than female group. Within the males, S3 (93.75 gm/d) had shown highest ADG followed by S1 (90.42 gm/d) and S2 (33.75 gm/d). However, Tukey's HSD test revealed that S3 had non-significant (P>0.05) difference with S1. Similarly, the Klieber ratio calculations also validated that the S3 group had shown better performance (P<0.05) than other classes. Average daily feed intake (ADFI) was significantly (P<0.001) affected by the treatment groups. S2 group had showed lowest average feed intake (307.50 gm/d) than rest of the groups. Class of animals significantly (P<0.001) affected the dressing percentage. S3 and S4 had shown better dressing percentage 51.51 % and 58.38%, respectively, followed by S1 (48.96%) and S2 (39.89%). The hot carcass showed significant effect of the treatments. It was least in S1 (7 kg) and highest in S2 (12.61 kg).

However, the detailed carcass analyses showed that except the hot carcass weight, cold carcass weight, hue angle and drip loss all other parameters were not different (P>0.05) among treatment groups. The drip loss was highest (P<0.05) in S2 (2.32%) and lowest in S1 and S4 groups. It was also proved by the outcomes during meat composition and sensory evaluation by the expert panel using 9 point hedonic scale exhibited no difference of carcass fattened on iso-caloric and iso-nitrogenous rations. It was further found that the castration and sex of animals did not affect the carcass traits during the current experiment.

The class of the Beetal affected (P<0.05) the serum glucose levels. Within the male the serum glucose was non-significantly different while female group (S4) had least serum glucose (38.25 mg/dl). Blood urea nitrogen (BUN) was not affected (P>0.05) by the class of animals. The serum creatinine and cholesterol were significantly affected by the treatments. The S3 group showed higher serum cholesterol (90.50 mg/dl) followed by S1 (71 mg/dl), S2 (64 mg/dl) and S4 (55.50 mg/dl). Serum creatinine was least in S2 group (0.174 mg/dl) while S2 showed highest level of serum creatinine (0.279 mg/dl) during current study.

DISCUSSION

There was significant effect of treatments on the average daily gain (ADG), average daily feed intake (ADFI) and Klieber ratio. The age of castration affected significantly the ADG and ADFI. The animals castrated at 4 month of age (S2) showed less ADG and ADFI as compare to animals castrated at 6 month of age (S3). The reason could be the more average daily feed intake which resulted in more nutrient available for growth. The early age castration might have affected the intake and overall lower the metabolism which resulted in the lower ADG in S2 (Schanbacher *et al.,* 1980). The Kleiber ratio followed the same trend as of ADG with higher the ratio shows better feed conversion (Talebi, 2012).

The age of castration and sex significantly affected the dressing percentage and hot carcass weight. Females had shown better dressing percentage than males. Overall the dressing percentage was not affected by the castration rather age of castration was responsible for lower dressing percentage in S2 while S2 and S1 were same when Tukey's HSD used to compare the means. It was because of depressed growth performance of the S2 group due to early age castration (Zamiri *et al.,* 2012). This early age castration could result in decrease IGF-1 as there has been strong relation between the testosterone and IGF-1 reported by Bani Ismail *et al.* (2009).

Hot and cold carcass weights were more in S3 groups mainly due to better ADG performance (Gokdal, 2013). However, hue angle was less in S2 as compared to other classes which showed statistically same hue angle values when the means were compared by Tukey's HSD test. The castration at 4 mo age resulted in lower glycogen content which may be responsible for lower hue angle value (Ripoll *et al.,* 2008). Higher value of drip loss in S2 group was due to lower water holding capacity of meat as water holding capacity was decreased due to lower growth performance of the S2 (Hwangbo *et al.,* 2009).

Other carcass attributes showed the non-significant effect of the class of animals because the sex and castration did not result in fat deposition at this age of animals and could be due to fattening period was less than 5 months (Zamiri *et al.,* 2012). Similarly, the sensory evaluation score by the expert panels also showed the non-significant effect of the class of the animals on the meat color, chewability, tenderness, flavor and over all acceptability could be due to aforementioned reasons.

Serum glucose was lower in female animals as compared to male which showed that the more nutrient intake for male as evident in ADFI (Turner *et al.,* 2005). While BUN was not significantly different among the treatment groups because of iso-nitrogenous fattening ration (Kadzere and Charama, 1992; Karnezos *et al.,* 1994). The serum cholesterol was highest in S1 and S4 mainly due to better growth performance as better ADG performance of these groups might be responsible for higher levels of the cholesterol in serum (Tripathi *et al.,* 2012). High creatinine shows high muscle mass metabolism and this is obvious as S3 group has better ADG and ADFI (Sun and Zhou, 2010; Wellington *et al.,* 2003).

***Conclusion*:** From the study it can be extracted that growth performance was affected by the classes of Beetal kids while the carcass evaluation, chemical composition and sensory evaluation showed non-significant effect among the various classes. Therefore, all the classes of kids hold a strong scope for rearing under high input feeding system till 8 months of age, however, the effect on carcass traits during fattening need further investigations. The castration at early age resulted in lower growth as well as low quality carcass but late castration provides a better performance and good meat quality.

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