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Priya
Department of Livestock Production Management, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Mandeep Singla
Department of Livestock Production Management, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Sandeep Kaswan
Department of Livestock Production Management, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

RS Grewal
Department of Livestock Production Management, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

DS Malik
Department of Livestock Production Management, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Corresponding Author:
Priya
Department of Livestock Production Management, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Growth performance of beetal kids fed total mixed ration under stall-fed

Priya, Mandeep Singla, Sandeep Kaswan, RS Grewal and DS Malik

Abstract
Present study was planned to highlight the effect of Total Mixed Ration (TMR) feeding on the growth performance of Beetal kids under stall-fed conditions. Twenty three weaned Beetal kids were taken randomly distributed in three treatment groups which were on basis of average body weight, gender and age. The selected groups were further sub-grouped for the feeding purposes. The experimental diets were offered to the animals as follows: 1) Conventional feeding method 2) Hay based TMR 3) Fresh fodder based TMR. Results showed that TMR feeding resulted in improvement of live body weight of T_1 group kids over the T_2 and control group. The average daily gain was also found to be higher in T_1 group as comparison to T_2 and control group (P<0.1). Likewise, animals under T_1 group followed by T_2 group have shown numerically higher values for overall body measurements except body length than the control group. An increase in pattern of Body Condition Score (BCS) of all the kids was observed from day 0 to day 120 of the trial.

Keywords: Total mixed ration, Beetal kids, stall feeding, body weight, BCS

Introduction
Goats were domesticated as early as 7000-8000 BC, as evidenced by archaeological remains collected in Asia. The socio economic importance of goats is greatest in developing nations. Their small size is especially relevant and relates directly to economic, managerial and biological advantage over other species. Goats are the principal meat producing animals, therefore, major emphasis needs to be aimed at nutritional augmentation for their growth and production (Sahoo *et al.* 2015) [5].

Majority of the farmers are rearing goats by grazing methods (extensive method). However, due to various reasons like urbanization, increasing demand, shrinkage of pasture land, decreased allocation of land for fodder cultivation and day to day increase in the cost of concentrate feed ingredients, goat production is shifting to stall-fed production system characterized by zero grazing (Kumar 2007) [4]. This also drives us in search of non-competitive feeds and use of surplus feed in terms of better utilization by animals in the incoming scarcity period.

Intensive feeding to small ruminants is a challenging job to the nutritionists. Small ruminants tend to select the feed under stall fed conditions (Wahed and Owen 1986) and eat higher amount of easily fermentable carbohydrates. Under intensive farming, roughages and concentrates are fed separately and due to differences in nutrient density, the efficiency of nutrient utilization is also different. So, this often leads to feeding of nutritionally imbalanced ration either in excess or less relevant to nutrient requirement of animal. This imbalanced feeding may adversely affect productivity of goats (Kumar *et al.* 2014) [2]. From the study conducted by Sangameswaran and Prasad (2016) [6], it was analysed that the goat keepers are unable to scientifically compute a balanced ration for their animals.

Therefore, feeding of basal diet in form of Total Mixed Ration (TMR) could be an important management manipulation as poor feeding under stall-fed is affecting the growth potential of indigenous goats to a great extent. Feeding of concentrates and roughages in form of TMR can result in steady supply of nutrients, enhances the feeding value of a poor quality crop residue, simplifies feeding, further adding in better efficiency of nutrient utilization and improved productivity. TMR feeding reduces the wastage, improves the density and decreases the dustiness (Wadhwa and Bakshi 1996) [8]. TMR occupies an important role during draught situations where the availability of green fodder is limited.

Materials and Methods

Experimental details

The present study was conducted at Goat Research Farm, Department of Livestock Production Management, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana 141004, Punjab, India during November 2018 to March 2019. The location of work is located at the Latitude of 30º54' North, Longitude of 75º48' east and at the height of 246 meters above the mean sea level.

Selection of animals and experimental design

A total number of minimum 23 weaned kids were taken and randomly distributed in three treatment groups on basis of average body weight, gender and age. The selected Beetal kids were put in the adaptation trial under stall-fed for about 15 days. During this period, the feeding requirements of all the kids were standardized.

Table 1: Grouping of animals according to their body weight and age

Treatments→		Control (C)	T_1	T_2	Overall Mean
Particulars		Conventional feeding method	Dry fodder based TMR	Fresh fodder based TMR	
Number of kids (Male + Female)		4 + 4	4 + 4	4 + 3	
Initial body weight (kg)	Male	16.05±2.98	16.05±3.51	16.65±2.67	16.25±1.61
	Female	12.35±4.07	12.15±2.47	12.60±4.24	12.35±1.86
	Mean body weight	14.20±2.44	14.10±2.12	14.91±2.30	14.38±1.26
Initial age (days)	Male	182.00±17.24	186.75±16.85	185.00±34.48	184.58±8.96
	Female	165.25±18.32	151.50±26.62	163.33±27.00	159.73±12.55
	Mean age	173.63±12.07	169.13±16.04	175.71±14.43	172.70±7.89

Methodology

The basal diet of each kid was formulated as per recommendations (NRC 2007) [1]. Diet of each animal under study was reviewed and formulated at fortnightly interval. Feeding of all the kids was done by taking dry matter requirement as 4% of body weight. The kids were fed ration containing Roughage: Concentrate in the ratio of 60:40 on the DM basis (Malisetty *et al* 2014) [3]. Further, feed requirement for each pair was calculated for animals of all the groups.

Preparation of Hay

Good quality available green fodder i.e. berseem (*Trifolium alexandrium*), mustard (*Brassica rapa subsp oleifera*) and oat (*Avena sativa*) was procured daily from Directorate of Livestock Farm, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana and chaffed to 2.0 – 2.5 cm and spread in thin layers on the concrete floor for sun drying. It was turned upside down 4-5 times a day. The dried hay was stored in gunny bags.

Estimation of growth parameters

a) Body weight

The body weight (BW) of the animals was recorded at fortnightly intervals. Weight of the animals was taken in the morning hour, before feeding and watering, on standard digital weighing balance.

b) Average Daily Gain (ADG)

of different growth indices like ADG and FCR as per following formulas:

$$\text{ADG} = \frac{\text{Body weight gain (kg)}}{\text{Interval between two BW recordings (days)}} \times 1000$$

c) Morphological measurements (height, length, girth etc.)

It was done at the fortnightly interval as per the method prescribed by Pesmen and Yardimci (2008). All measurements were done in the morning before feeding the animals. The animal was erected squarely on even surface for recording of linear measurements with the help of measuring tape as presented in Fig. 4 to Fig. 10.

Table 2: Description of body measurements

Body measurements	Description
Height at wither	Vertical distance between ground surface to highest point of wither
Body length	Linear distance between point of shoulder (external occipital protuberance) to point of pin bone (os-ischii) near dock
Chest girth/Heart girth	Circumference of chest just behind shoulder
Abdominal circumference/girth	Circumference of abdomen at umbilicus
Abdominal width	Measured with the help of vertical planks at the point of umbilicus.
Chest width	Measured with the help of vertical planks just behind forelegs.
Pin to pin distance	Distance between right and left pin bone joints
Hook to hook distance	Distance between two os-coxae of the hip bone

d) Body Condition Score (BCS)

The standardization of the body condition scoring technique in the Beetal goats was done by performing it in all of the goats available at the goat farm for a period of about 1 month before the actual onset of experiment. The variation in BCS of all the kids under study was recorded based on a nine point scale i.e. 1-5 scale with increment of 0.5. BCS was assessed by visual and palpation technique. The observation chart on the basis of which, BCS was given is as described below (Sharma 2016) [7] in Table 3.

e) Physical examination of lumbar and sternal regions using vernier caliper

Manually vernier caliper with least count of 0.1mm was used to record observations before feeding and watering of animals in the morning. The animal was restrained in proper position and plane. In lumbar region, lumbar thickness (LT) measurement was taken using vernier caliper with slight pressure at the L_4 position (4^{th} lumbar vertebrae), approximately half distance away from the dorsal midline/vertebral column. LT of kids was recorded twice i.e.

at initiation and completion of trial. In the sternal region, brisket fold's measurements depicting sternal thickness (ST) were taken near to the 3rd sternbrae position by using vernier caliper with slight pressure (Sharma 2016) [7].

Table 3: Description of body condition chart for Beetal goats

Body Codition Chart for Beetal goats		
BCS	**Body Condition**	**Comment**
1.5	Very thin, frame visible	Wasting in appearance; ribs visible; individual spinal processes evident and depressions obvious (rib, hips) and sunken between pins and hooks; sternum easily palpable.
2.0	Slightly thin	Spinous processes (dorsal/transverse) are prominent and sharp; thin flesh covering between hooks and pins; some ribs visible; definite depression between hooks; sternum palpable.
2.5	Frame covered, balanced	Spinous processes smooth; transverse processes have smooth concave curve; hooks and pins smooth; muscle becoming obvious; sternum palpable.
3.0	Slightly fleshy (smooth cover)	Spinous processes rounded; spinous to transverse processes smooth sloped; hooks and pins covered; slight depression between hooks and pins; sternum less defined.
3.5	Fleshy (frame not visible)	No spinous processes noticeable, ribs not visible, hooks and pins rounded with some cover; flatness between hooks; difficult to palpate sternum; more skin fold thickness.
4.0	Obese	Edge of transverse processes barely noticeable; tail head cavity filled with fat

Statistical analysis

Data was initially processed by Microsoft Excel 2010 and presented as Mean ± S.E., one-way analysis of variance (ANOVA) to test the difference between treatments with Tukey-Kramer multiple comparison test. The collected data was analysed using Software Package SAS available in University Library, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana.

Results and Discussion

Effect of feeding different experimental diets on fortnightly live body weight changes and overall ADG (Average Daily Gain)

The average live body weight at the beginning of experiment was 14.20 ± 2.18, 14.10 ± 2.18 and 14.64 ± 2.34 kg in C, T_1 and T_2, respectively. The corresponding body weights at the completion of experiment were 21.85 ± 3.18, 25.63 ± 3.18 and 23.12 ± 3.41 kg, respectively. The final body weight was higher in T_1 by 17.30% and T_2 by 5.81% over the control group, though not differed significantly. The improved live body weight of TMR fed groups over the control group might be due to their better feed intake, FCR (Feed conversion ratio) and PER (Protein efficiency ratio) during the study period.

The average daily gain (ADG) during study period of 4 months as depicted in Table 5 and Fig. 2 showed that it was marginally significant ($P<0.1$) higher in T_1 group than the control group, whereas value for T_2 group falls in-between the other two treatment groups. Kids under T_1 and T_2 group had gained daily 50.65% and 10.93% higher over the control group, respectively.

Body morphometric parameters

Different body morphometric parameters of kids sorted under different groups are presented in Table 6 and Fig. 3 to 10 The animals under T_1 group followed by T_2 group had shown numerically higher values for almost all body measurements except body length than the control group.

Abdominal width (cm) at the start of experiment was 14.63, 15.88 and 15.25 for control, T_1 and T_2 groups, respectively which was increased to 16.63, 18.88 and 18.33 at the end of trial for the respective groups. Chest width (cm) at the day 0 of trial was 10.00 for the hay based TMR group which was increased to 15.25 at day 120 of trial. Chest girth and abdominal girth in cm were almost same for all the animals of three groups but at the completion of trial these were found to be higher for the hay based TMR group as comparison to the control and fresh fodder based TMR groups. Likewise, height at wither (cm) was 58.63, 58.13 and 59.03 for control, T_1 and T_2 groups, respectively at the beginning of trial which was increased to 68.88, 69.75 and 68.78 at the end of trial for the respective groups. Similarly, pin-to-pin and hook-to-hook distance (cm) were numerically more for T_1 group over the control and T_2 groups. However, body length (cm) was found to be numerically higher for the conventional fed group (67.00) as compared to hay based (66.50) & fresh fodder based (64.61) TMR groups. There is no literature available showing the effect of total mixed ration manoeuvre on the body morphometric measurements of Beetal kids.

Table 4: Average live body weight (kg) and at fortnightly intervals in different treatments

Fortnight	C	T_1	T_2	P value
0	14.20 ± 2.18	14.10 ± 2.18	14.64 ± 2.34	0.98
15	14.39 ± 2.31	13.85 ± 2.31	13.66 ± 2.48	0.98
30	15.30 ± 2.48	15.90 ± 2.48	14.92 ± 2.66	0.96
45	16.65 ± 2.59	17.78 ± 2.59	16.10 ± 2.78	0.90
60	16.65 ± 2.59	17.78 ± 2.59	16.10 ± 2.78	0.86
75	17.60 ± 2.70	18.40 ± 2.70	16.23 ± 2.90	0.91
90	19.18 ± 2.93	20.10 ± 2.93	18.21 ± 3.14	0.92
105	20.83 ± 3.09	23.93 ± 3.09	21.07 ± 3.32	0.74
120	21.85 ± 3.18	25.63 ± 3.18	23.12 ± 3.41	0.70

Values have been presented as Mean ± Standard Error

Table 5: Average daily gain (g) of kids during the study

Fortnight	Gender	C	T_1	T_2	P value
ADG	M	77.08 ± 14.46	113.33 ± 14.46	80.00 ± 14.46	0.20
	F	50.42 ± 14.74	78.75 ± 14.74	62.78 ± 17.02	0.43
	Overall	63.75^{B} ± 9.86	96.04^{A} ± 9.86	70.72^{AB} ± 10.57	0.08

Values have been presented as Mean ± Standard Error; Means bearing different superscripts in capital letters in a row differ marginal significantly (P<0.1)

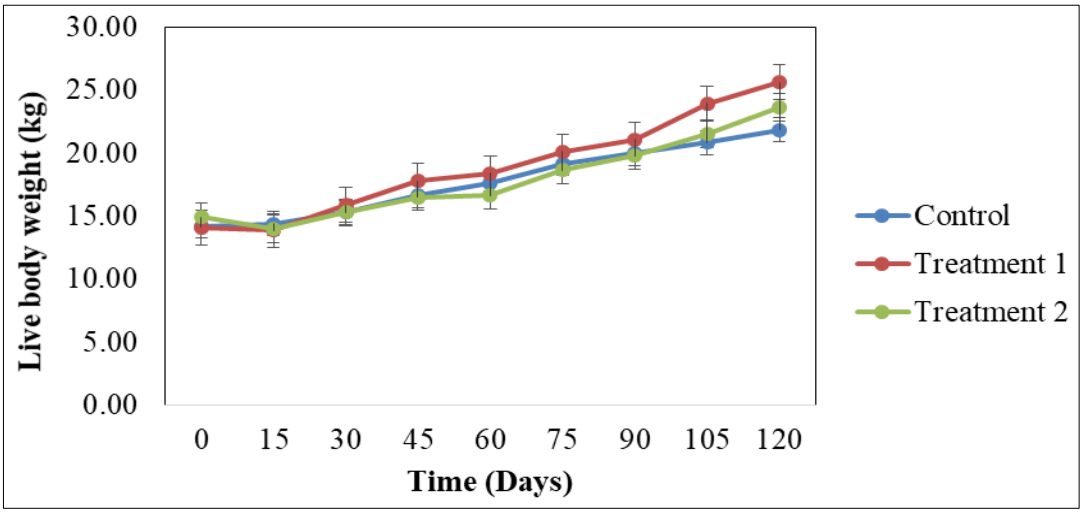

Fig 1: Average live body weight (kg) of kids at fortnightly intervals sorted by groups

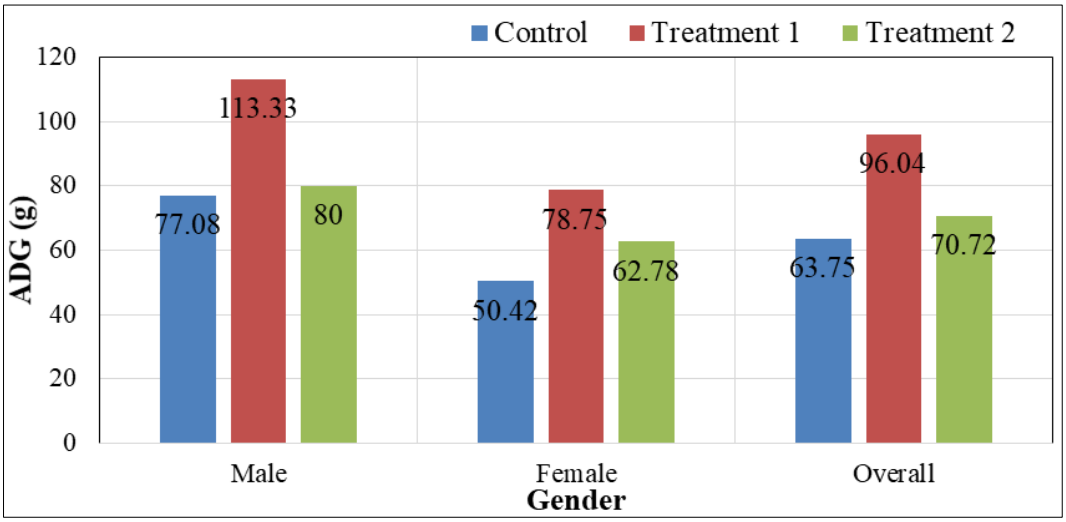

Fig 2: Average daily gain (g) of kids sorted by groups

Body condition scoring (BCS), lumbar thickness (LT) and sternal thickness (ST) of kids

Data recorded on BCS, LT and ST of kids under study is presented in Table 7. Variations in BCS demonstrated that BCS had increased from day 0 to day 120 of the study in all the treatments being highest for T_2 (2.25 ± 0.09) followed by T_1 (2.09 ± 0.14) and then the control group (2.0 ± 0.07) on completion of trial.

Table 6: Body morphometric measurements of kids recorded at the start and completion of trial

Days	Height at wither (cm)			Abdominal circumference (cm)		
	C	T_1	T_2	C	T_1	T_2
0	58.63 ± 2.88	58.13 ± 2.88	59.03 ± 3.09	62.88 ± 3.65	62.50 ± 3.65	61.54 ± 3.92
120	68.88 ± 2.75	69.75 ± 2.75	68.78 ± 2.95	71.13 ± 3.41	75.88 ± 3.41	72.31 ± 3.65
Days	Pin-to-pin distance (cm)			Hook-to-hook distance (cm)		
	C	T_1	T_2	C	T_1	T_2
0	6.38 ± 0.48	6.63 ± 0.48	6.80 ± 3.92	9.00 ± 0.58	9.00 ± 0.58	9.24 ± 0.62
120	8.50± 0.48	9.13 ± 0.48	8.84 ± 0.52	11.50 ± 0.65	12.38 ± 0.65	11.24 ± 0.69
Days	Body length (cm)			Chest girth (cm)		
	C	T_1	T_2	C	T_1	T_2
0	56.00 ± 3.05	53.13 ± 3.05	52.99 ± 3.27	54.13 ± 2.68	54.13 ± 2.68	54.19 ± 2.88
120	67.00 ± 2.84	66.50 ± 2.84	64.61 ± 3.04	64.50 ± 2.85	67.25 ± 2.85	65.76 ± 3.06

Table 7: Body condition score (BCS), lumbar thickness (LT) and sternal thickness (ST) of Beetal kids sorted under different groups

Particulars		C	T_1	T_2
BCS at day 0	M	1.94 ± 0.12	1.88 ± 0.13	1.94 ± 0.06
	F	1.75 ± 0.10	1.63 ± 0.07	1.83 ± 0.17
	Overall	1.84 ± 0.08	1.75 ± 0.08	1.89 ± 0.07
BCS at day 120	M	2.06 ± 0.12	2.25 ± 0.23	2.31 ± 0.16
	F	1.94 ± 0.06	1.94 ± 0.16	2.17 ± 0.08
	Overall	2.00 ± 0.07	2.09 ± 0.14	2.25 ± 0.09
LT at day 0	M	10.25 ± 1.61	10.00 ± 1.61	10.75 ± 1.61
	F	7.25 ± 1.56	7.75 ± 1.56	10.67 ± 1.80
	Overall	8.75 ± 1.09	8.88 ± 1.09	10.58 ± 1.17
LT at day 120	M	16.00 ± 1.94	16.75 ± 1.94	17.25 ± 1.94
	F	12.00 ± 2.38	14.00 ± 2.38	17.33 ± 2.74
	Overall	14.00 ± 1.48	15.38 ± 1.48	17.12 ± 1.59
ST at day 0	M	5.00 ± 1.24	6.75 ± 1.24	5.50 ± 1.24
	F	5.00 ± 1.23	5.00 ± 1.23	5.33 ± 1.42
	Overall	5.00 ± 0.84	5.88 ± 0.84	5.38 ± 0.90
ST at day 120	M	10.75 ± 1.45	11.50 ± 1.45	11.00 ± 1.45
	F	8.00 ± 1.58	8.50 ± 1.58	8.67 ± 1.82
	Overall	9.38 ± 1.01	10.00 ± 1.01	9.81 ± 1.09

Values have been presented as Mean ± Standard Error

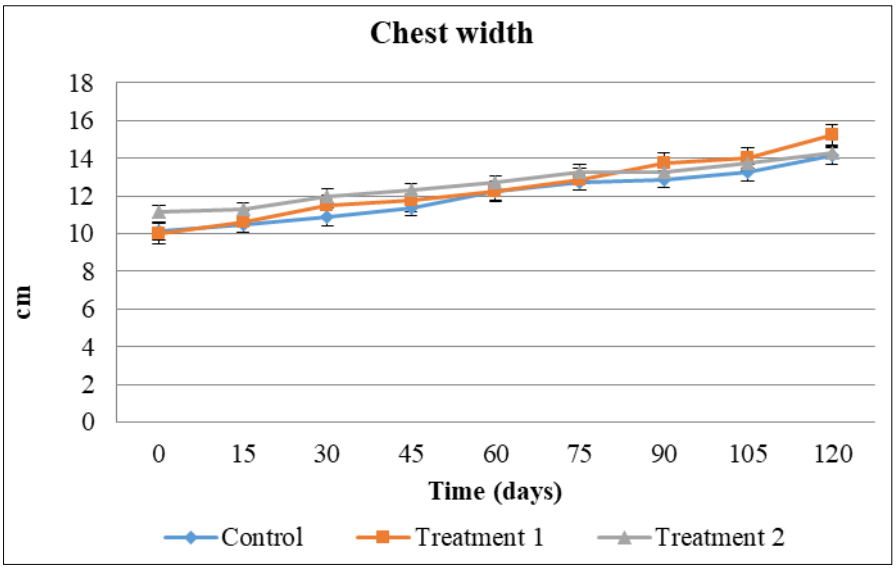

Fig 3: Chest width (cm) of kids sorted by groups

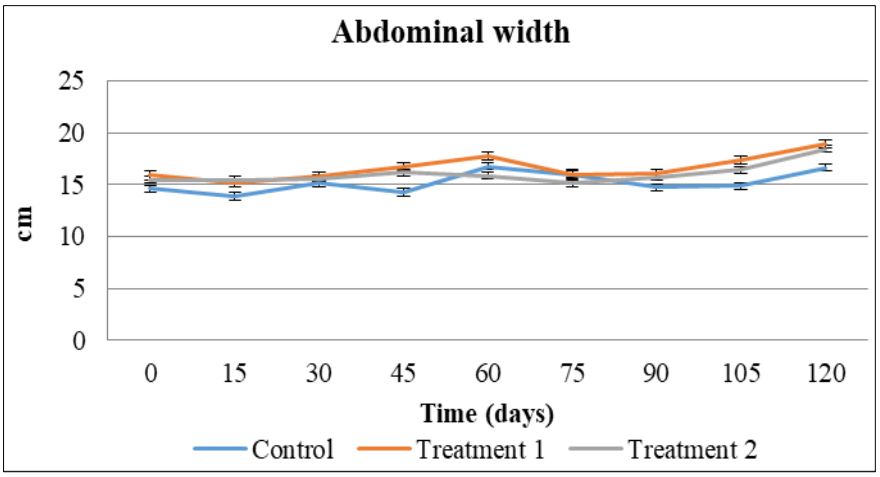

Fig 4: Abdominal width (cm) of kids sorted by groups

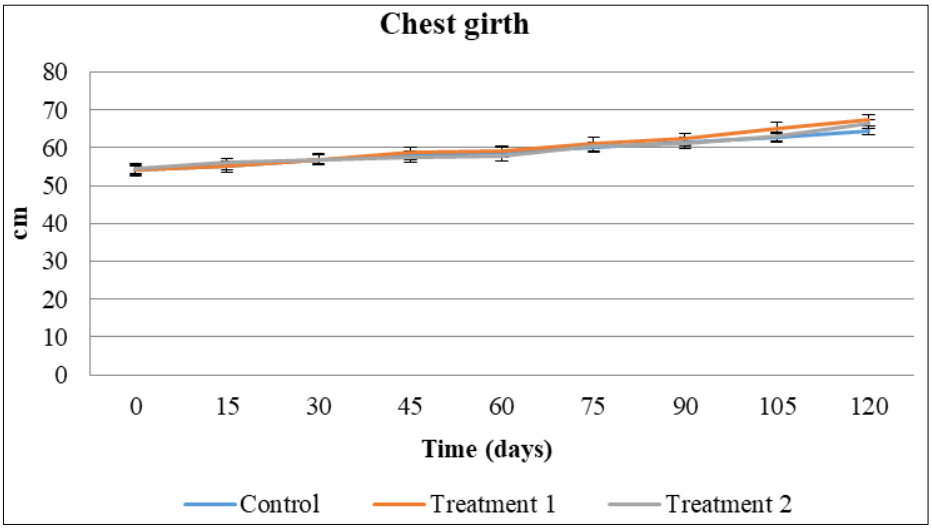

Fig 5: Chest girth (cm) of kids sorted by groups

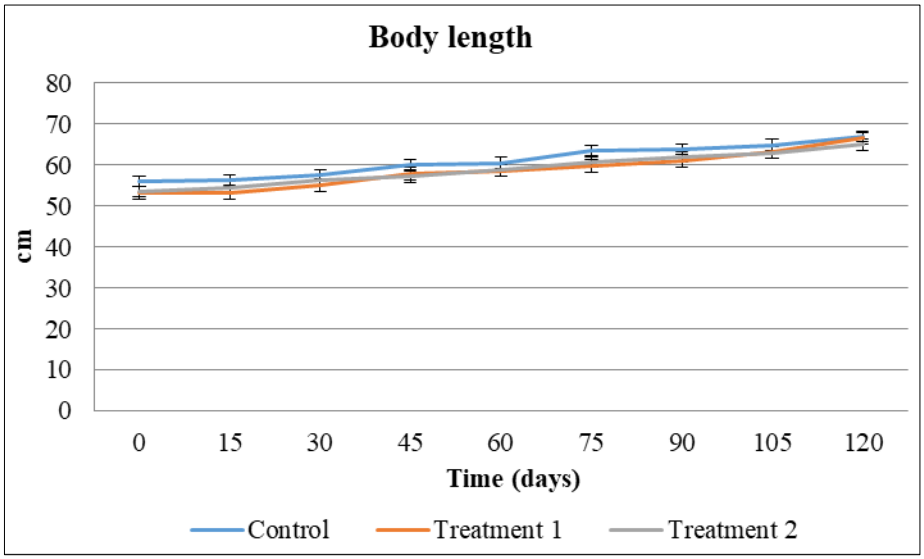

Fig 6: Body length (cm) of kids sorted by groups

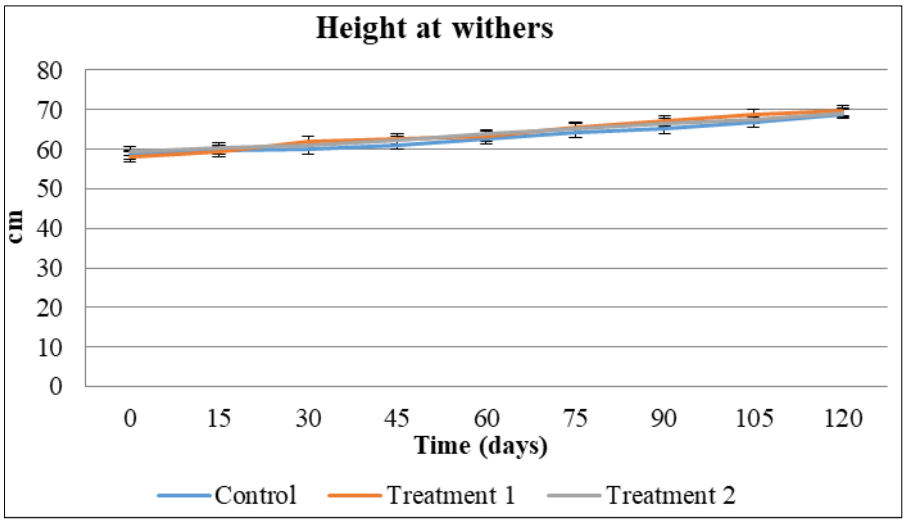

Fig 8: Abdominal circumference (cm) of kids sorted by groups

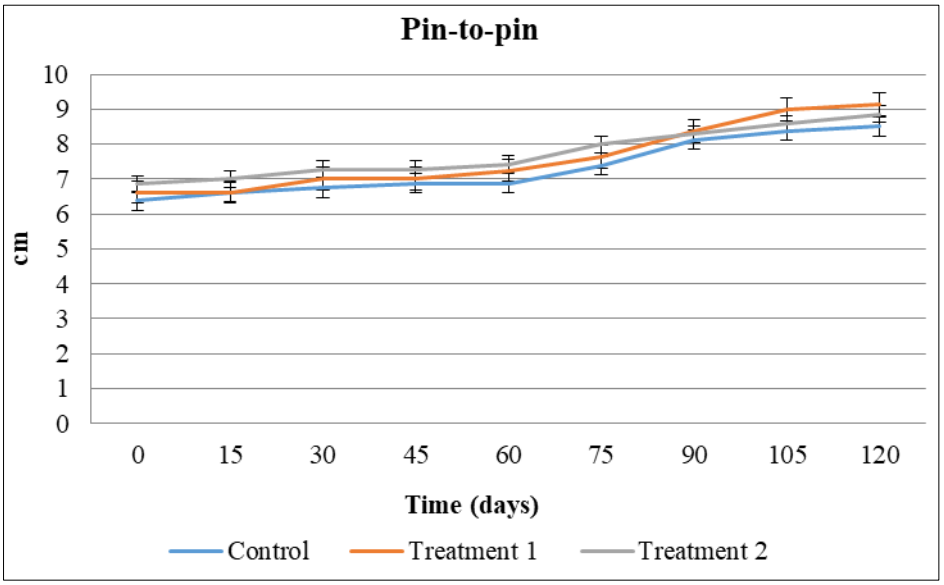

Fig 9: Pin-to-pin (cm) of kids sorted by groups

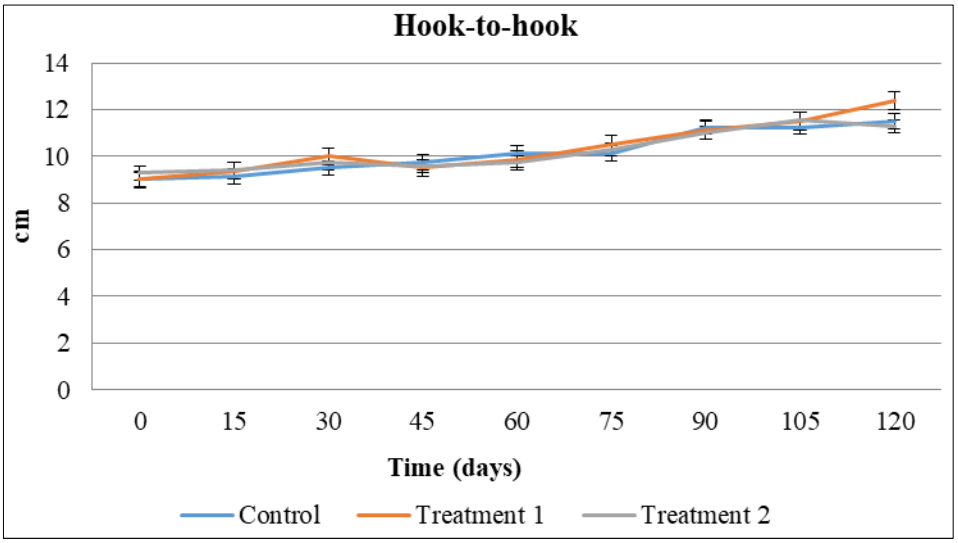

Fig 10: Hook-to-hook (cm) of kids sorted by groups

Conclusion

From this investigation, we can infer that feeding of hay based TMR@ 4% of body weight in growing Beetal kids' results in improved growth performance under stall-fed production system.

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