EFFECTS OF FEED RESTRICTION ON MORPHOMETRIC AND BIOCHEMICAL PARAMETERS IN CATTLE

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The present study was conducted to evaluate the effect of dry matter restriction on morphometry (live body weight and body condition score) and blood biochemistry (glucose, blood urea nitrogen, creatinine and total protein) in unproductive cattle. Nine non-descript, crossbred cows (BCS over 4) were randomly distributed in 3 treatments (T₀, T₁ and T₂). T₀: the control group was fed with dry matter (DM) @ 2.5% of the body weight. T₁ and T₂ were fed with the restricted DM i.e., @ 2% and 1.5% of the body weight, respectively up to 21 days. After 21 days of feed restriction all the cows were fed normal diets i.e., 2.5% of the body weight for next 21 days. Declining rate in body weight were observed (P<0.05) in T₁ and T₂ during the restriction period as well as in re-alimentation. Body condition score was not significantly (P>0.05) affected in restriction period. A declining trend was observed in blood glucose and urea nitrogen concentrations during feed restriction but an increasing trend was also observed during re-alimentation. By this study we can conclude that upto 60% reduction in feed intake will not exert any harmful effect on morphology and physiology of cattle during feed scarcity.

Key words: Blood biochemistry, Body condition score, Cattle, Feed restriction

India is one of the top most disaster prone zones in the world. Livestock of our country is greatly influenced by the recurrent natural calamities. During the disaster, scarcity of feed leads to starvation and death of the livestock. Such scarcity conditions ultimately have an impact on well-being (welfare) and survivability of livestock (Das, 2011). According to the report of Animal Husbandry and Dairying department, there is a huge gap between the demand and

availability of fodder in terms of dry matter (Draft report AHD, 2001).

Stray cattle population in India has reached approximately 43 million as per the 19th livestock census as the Indian Government prohibition act on the slaughter of cows and calves (The Constitution of India 1949, Article 48). As a result useless and non-productive cattle are left as stray and forced to feed on garbage in cities

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and viewed as pests by rural farmers causing road blocks, accidents and public obstructions (Lynching, 2016). These stray animals should be kept with a minimum management as they can play a crucial role in improvement of the socio-economic condition in our country by providing some milk, dung, hide and hooves and by relieving public hazards as well.

From the socio-economic as well as aesthetic point of view for the welfare of the cattle, there is need to develop a feeding management practice with limited resources in India. The prime consideration during livestock feeding is to ascertain and to meet up the nutritional requirements in terms of dry matter. In cattle, dry matter requirement is 2.0-2.5 percent of the total body weight (Das, 2011). Restricted feeding or restricted dry matter intake (DMI) can be assumed as a way to feed the animals with limited resources without creating any critical health issue.

MATERIALS AND METHODS

All the experimental procedures were carried out under the Institutional Ethics Committee and according to local laws and regulations.

Experimental design: In the preliminary phase 9 non-descript, over conditioned (BCS>3.5), unproductive female cattle of average 6 years old were randomly divided into 3 groups according to the dry matter (DM) restriction. Cattle under each experimental treatment were fed according to reduced dry matter intake (DMI) of its body weight for 3 weeks as per the availability of feed and feeding schedule followed in the Dairy Farm, Ludhiana. Adequate water was provided to all the animals throughout the experimental period.

In order to access the effect of restricted DMI followed by compensatory feeding on the

morphological (body weight and body condition score) and biochemical parameters (glucose, BUN - blood urea nitrogen, creatinine and total protein) of adult cattle, the experiment was planned and executed in two phases along with a conditioning phase prior to the onset of experiment. A conditioning phase of 10 days, a restricted phase (phase-I) of 21 days and a compensatory phase (phase-II) of 21 days were adopted.

Animals were offered conventional diet as per NRC (2001) feeding standard. The roughage to concentrate ratio in the diet was maintained at 60:40. In which roughage was divided into dry and green (Berseem and Napier) in 1/3 and 2/3 ratio respectively and the rest part was associated with concentrate mixture (maize 30%, wheat bran 25%, rice polish 20%, soybean cake 11%, mustard cake 11%, mineral mixture 2%, salt 1%). The conditioning phase lasted for 10 days.

After the completion of conditioning phase of 10 days, the animals were divided into 3 groups with 3 animals in each group. The animals in the T_0 (control) were offered conventional diet @ 2.5% of body weight for 21 days. Animals of T_1 and T_2 were offered diet @ 2% and 1.5% of their live weight for 21 days, respectively. The roughage to concentrate ratio in the diet was maintained at 60:40.

After 21 days of restricted feeding, all animals were fed basal diet as per NRC (2001) for further 21 days. The roughage to concentrate ratio in the diet was maintained at 60:40.

During the phase of restricted DMI (0-21st day) the intake of feed was according to the percent of DM restriction and after 21 days of restricted feeding resumption of normal diet continued for next 21 days to compensate the growth

reduced in feed restriction period.

Measurement of body weight (BW) and body condition scoring (BCS): Initially after conditioning phase all the animals were weighed at the same day by using digital weighing balance and at the same time body condition scoring on 5 point scale (Pennington, 2010) also evaluated by visual and palpation method. After the initial recording, body weight and BCS were measured at weekly interval up to 42 days of the experimental period. Dry matter content of the dietary samples were determined by drying in hot air oven at 100°C for 12 hours.

Measurement of biochemical parameters: Blood samples were taken from the jugular vein at 0, 21st and 42nd day of trial using evacuated tubes without anticoagulant. Blood samples were left at room temperature until clotting was finished. Tubes were then centrifuged for 5

minutes at 4000 rpm at 15°C for the separation of serum. After centrifugation serum was collected in the serum vials and kept at -20°C until it was analyzed. Blood glucose, blood urea nitrogen (BUN), creatinine and total protein level were assayed using commercial kits from Siemens® autopak (for glucose) and BPC BioSedSrl kit (for BUN, creatinine and total protein).

Statistical analysis: Data were analyzed using the GLM procedure (SAS, 2004). Data were also subjected to orthogonal polynomial contrast model to know whether response of animal to decreasing DM content of feed is of linear or quadratic nature.

RESULTS

Feed intake: As per the data, during the phase of restricted DMI (0-21st day), the intake of feed estimated according to the percent of DM restriction was linearly decreased ($P < 0.05$).

Table 1. Dry matter intake (DMI) (kg) of cattle¹ during phase I and phase II (0-21st day of restricted feeding followed by 22nd-42nd day of compensatory feeding)

Graded % reduction in DM	Phase II (22 nd -42 nd day compensatory feeding)					
	Concentrate		Dry fodder		Green fodder	
	DMI-I	DMI-II	DMI-I	DMI-II	DMI-I	DMI-II
2.5	3.40 ^c	3.41 ^c	2.27 ^c	2.27 ^c	4.63 ^c	4.63 ^c
2.0	2.90 ^b	3.63 ^b	1.94 ^b	2.43 ^b	3.95 ^b	4.94 ^b
1.5	2.58 ^a	4.30 ^a	1.73 ^a	2.88 ^a	3.51 ^a	5.85 ^a
SEM ²	0.180	0.205	0.120	0.136	0.245	0.278
Probability, P≤						
Treatment effect	0.0489	0.049	0.0481	0.047	0.0479	0.048
Linear effect	0.0185	0.021	0.0183	0.020	0.0182	0.021
Quadratic effect	0.7136	0.42	0.6979	0.41	0.6996	0.41

^{a, b} Means in column not sharing a common superscript are significantly different ($P < 0.05$)

¹ Each value represents the mean of three replicates

² Pooled standard error of mean

However during compensatory phase (22nd-42nd day) of feeding, feed intake increased linearly with increasing restriction of feed intake during phase I.

Body weight and body condition scoring:

During the phase of restricted and un-restricted feeding, the change in body weights of cattle were linearly ($P>0.05$) affected. During phase I, body weight loss of cattle was statistically significant ($P<0.05$) amongst the group of animal fed with graded percent reduction in dry matter intake. Weight loss was almost equal in both the groups, fed with 1.5% (16.37 kg) as well as 2.0% (13.33kg) dry matter intake. Linear effect ($P<0.05$) was observed. Cumulative body weight loss of cattle decreased linearly with decrease in percentage of DMI.

In animals, fed with, 2.0% and 1.5% DMI, the live body weight of cattle during phase I (0-21st day restricted DMI feeding) decreased continuously up to 21st day. In both the treatment groups (2.0% and 1.5% DMI of the body weight) the live body weight increased gradually during the Phase II (22nd - 42nd day compensatory feeding).

During the whole study of graded percent reduction in dry matter intake of feed during phase I (0-21st day restricted DMI feeding) and phase II (22nd -42nd day compensatory feeding), the cumulative change in body condition score was statistically non-significant. Neither the linear nor the quadratic effects were observed in treatment groups fed with graded % reduction in DMI with resumption of normal diet.

Table 2. Change in body weight (BW) at different stages of restricted feeding and realimentation

Graded % reduction in DM	Live body weight						
	Phase I (0 - 21st day restricted DM feeding)				Phase II (22nd - 42nd day compensatory feeding)		
	0 day	7 day	14 day	21 day	28 day	35 day	42 day
2.5	601.50	603.00	606.00	609.00	612.00	609.00	613.50
2.0	620.00	618.00	614.00	611.00	613.00	617.00	621.00
1.5	637.50	627.50	621.50	618.00	620.50	623.00	627.50
SEM ²	67.954	68.154	69.077	69.543	69.275	66.858	67.227
Probability, P≤							
Treatment effect	0.9762	0.9680	0.9875	0.9954	0.9955	0.9891	0.9892
Linear effect	0.8285	0.8158	0.8840	0.9329	0.9363	0.8917	0.8923
Quadratic effect	0.9735	0.9758	0.9978	0.9784	0.9719	0.9910	0.9955

Table 3. Change in body weight (BW) and body condition scoring (BCS) of cattle¹ during phase I (0-21st day restricted DM feeding) and phase II (22nd-42nd days un-restricted feeding)

Graded % reduction in DM	Phase I (0-21 st day restricted DM feeding)		Phase II (22 nd -42 nd day compensatory feeding)	
	BW change	BCS	BW	BCS
2.5	4.33 ^b	-0.08	13.67	0.08
2.0	-16.67 ^a	-0.33	9.33	0.00
1.5	-13.33 ^a	-0.33	13.67	-0.08
SEM ²	3.711	0.117	4.198	0.107
Probability, P≤				
Treatment effect	0.0147	0.2963	0.1762	0.5787
Linear effect	0.0151	0.1843	0.2101	0.3153
Quadratic effect	0.0367	0.4198	0.1494	1.0000

^{a, b}Means in column not sharing a common superscript are significantly different (P<0.05)

¹ Each value represents the mean of three replicates

² Pooled standard error of mean

Biochemical parameters: During the phase of restricted dry matter feeding, the blood biochemical parameters of cattle were statistically non-significant (P>0.05) except

glucose. During the phase of restricted DM feeding in phase I, value of glucose was significantly affected (P<0.05) between the respective treatment groups.

Table 4. Blood biochemical parameters (glucose, blood urea nitrogen, creatinine, total protein) of cattle¹ during phase I (0 - 21st day restricted DM feeding) and phase II (22nd - 42nd day compensatory feeding) in 3 respective groups

Graded % reduction in DM	Glucose		BUN		Creatinine		Total protein	
	Ph-I	Ph-II	Ph-I	Ph-II	Ph-I	Ph-II	Ph-I	Ph-II
	21 day	42 day	21 day	42 day	21 day	42 day	21 day	42 day
2.5%	65.91 ^a	87.38	44.76	40.03	1.34	1.38	8.61	8.18
2.0%	56.48 ^b	86.05	43.60	44.30	1.29	1.56	8.40	8.15
1.5%	53.73 ^b	80.17	38.03	40.40	1.57	1.57	8.48	8.16
SEM ²	2.191	3.558	6.000	1.893	0.138	0.163	0.186	0.406
Probability, P≤								
Treatment effect	0.018	0.37	0.71	0.28	0.39	0.67	0.74	1.0
Linear effect	0.023	0.20	0.46	0.90	0.29	0.44	0.64	0.97
Quadratic effect	0.032	0.62	0.77	0.13	0.38	0.68	0.55	0.98

^{a, b}Means in column not sharing a common superscript are significantly different (P<0.05)

¹Each value represents the mean of three replicates

²Pooled standard error of mean

DISCUSSION

Feed intake: Feed intake of cattle during phase I (0-21st day restricted DMI feeding) and Phase II (22nd - 42nd day compensatory feeding) is presented in Table 1.

As per the experimental design, linear reduction in dry matter intake percentage in the treatment groups was clearly evident of linear decrease in feed intake during the feed restriction phase. In support of this study Nowak *et al.* (2013) mentioned an increase in DMI during lactation after a reduction in energy intake during far-off period. O'Donovan *et al.* (1972) reported higher feed intake in compensatory growth feeding after a phase of feed restriction.

Body weight and body condition scoring: The influence of graded percent reduction in dry matter intake of feed on cumulative change in body weight and body condition score during phase I (0 - 21st day restricted DMI feeding) and phase II (22nd - 42nd day compensatory feeding) is presented in Table 3.

Murphy and Loerch (1994) in their experiment observed similar results in terms of hot carcass weight which reduced linearly ($P < 0.04$) for the restrictedly fed growing steers compared with the control. Puchala *et al.* (2011) noted the similar results on Angora goats that reduced body weight with lengthening of the feed restriction. From the results of this experiment, it is evident that restricted DM intake reduces the live body weight of cattle up to 21 days feed restriction which can be compensated by offering unrestricted feeds in the re-alimentation period. There is significant gain in body weight in the phase II after a feed restriction due to greater feed intake by the restricted feed intake group, which was also

observed in other study (Puchala *et al.*, 2011).

Douglas *et al.* (2006) found similar results for restricted feeding in the far-off period which lead to decrease the BCS by 0.5 units, while in this period BCS can be improved by 0.14 units by providing ad libitum feeding. From the present study it is evident that restricted DM intake can reduce the BCS and compensatory feeding helps in recovering the BCS as well within a quarter point in 21 days restricted DMI and 21 days compensatory feeding respectively.

Biochemical parameters: Findings of this study were in accordance with Toerien and Cant (2007) who reported a significant decrease in blood glucose concentration in dairy cows as a result of restriction in feed intake. In the present study, a decrease in blood glucose level in 0-21st day of restricted DM intake was noted but there is no significant difference in the blood glucose concentration among the treatment groups during the period of compensatory feeding. The concentration of BUN and creatinine level resembled the study of Sahlu *et al.* (1999) who reported that severity of feed restriction was linearly related to plasma urea levels during re-alimentation of angora wethers and reported lower plasma urea concentrations in feed restricted animals. From the results of this study it is evident that there is significant change in BUN concentration during 0-21st day DMI restriction whereas re-alimentation increases the BUN concentration value closer to the initial value in next 21 day after feed restriction. The creatinine concentration in blood showed a declining trend due to the effect of DM restriction but no significant change was found probably due to shorter period of feeding (21 days). This result is also in accordance with the study of Sahlu *et al.* (1999) who found

decreased level of plasma creatinine concentration during the restriction period and an increased concentration was found with an increasing level of feed intake. The result on total protein in this study was contrary to the study of Saekkinen *et al.* (2005) who found that reduction in feed consumption resulted in lower concentration in plasma protein in deers. In the present study, total protein concentration had no significant effect due to DM intake restriction for 21 days but there was an inclining

trend in serum total protein concentration due to re-alimentation after a period of feed restriction.

During feed scarcity up to 60% reduction in DMI can be done without any appreciable adverse effect on their morphology and physiology for a short duration of 21 days. After experiencing a short feed restriction, animals can attain similar body conditions and blood profiles on resumption of a normal diet for 21 days.

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