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Research Article

EFFECT OF DIETARY INCLUSION OF FORMALDEHYDE TREATED GUAR MEAL AND RUMEN PROTECTED FAT ON PLANE OF NUTRITION AND CONCENTRATE: ROUGHAGE INTAKE IN GROWING SURTI BUFFALO CALVES

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Abstract: A feeding trial was conducted to ascertained the effect of dietary inclusion of formaldehyde treated guar meal (FTGM) and rumen protected fat (RPF) on plane of nutrition and concentrate: roughage intake in growing Surti buffalo calves for the 280 days. The calves were fed basal diet including concentrate and roughage as per ICAR (2013) nutrient recommendation. 16 Surti growing buffalo calves were assigned in to 4 dietary treatments (T), T_1 (control) which supplied basal diet without any supplement, T_2 supplied 30% crude protein (on dry matter basis) in concentrate mixture included with FTGM in basal diet, T_3 supplied basal diet along with 100 g RPF and T_4 supplied 30% crude protein (on dry matter basis) in concentrate mixture included with FTGM in basal diet + 100 g RPF. The mean dry matter intake (DMI) from concentrate (C) was lower ($P \leq 0.05$) in T_2 and T_4 group whereas DMI from roughage (R) was higher ($P \leq 0.05$) over T_1 and T_3 group. Maximum reduction in the DMI and crude protein intake (CPI) were recorded in T_2 and T_4 groups than the recommendation. Results indicated the inclusion of FTGM with or without RPF reduced the concentrate usage without any adverse effect on growth of Surti buffalo calves.

Keywords: *Concentrate, Guar meal, Rumen protected fat, Calves*

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Introduction

The reduction in growth rate and poor performance in buffaloes are attributed to the famers' adherence to the traditional feeding system, thereby the poor or imbalance nutrition. Growing calves are most often deficient for the metabolizable protein at lower GIT. Hence, there is need to increase the availability of metabolizable protein for the efficient growth of the growing calves. Rapid expansion of livestock and human population and their need for animal protein is correspondingly accelerated. Rising the feed cost and shortage of protein and energy resources create a necessity to utilize unconventional sources of protein. Guar (*Cyamposis tetragonoloba*) is known as cluster bean. It is a high temperature and drought tolerant summer annual leguminous crop of high social and economic significance [1].

India alone contributes 80% of total guar production in the world [2]. The guar meal is an untraditional source of protein, having very good source of higher protein approx. 40-60 % with an excellent amino acid profile. But the protein of guar meal is highly degradable. Therefore, it is necessary to protect this protein and increase the availability of metabolizable protein for absorption in lower gastro intestinal tract (GIT) of dairy calves. Formaldehyde treated guar meal contains 72 % of rumen undegradable protein (UDP) [3]. In ruminants, for the efficient utilization of protein there is need of energy supply [4]. Rumen protected fat is the concentrated form energy, it escapes the rumen biohydrogenation and available for utilization at the lower GIT. Therefore, the study was planned for investigate the effect of dietary inclusion of formaldehyde treated guar meal and rumen protected fat on plane of nutrition and concentrate: roughage intake in growing Surti buffalo calves.

Material and methods

The present experiment was undertaken during the month of May, 2020 to February, 2021 including of three seasons (Summer, Monsoon and Winter) at Reproductive Biology Research Unit (RBRU), College of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand, 388110. Gujarat, India. Total 16 growing Surti buffalo (Bubalus bubalis) calves (male and female) of was homogeneously distributed in to four dietary treatment groups based on 5-9 months of age and body weight for the duration of 280 days.

All the animals were fed basal diet with roughages and concentrate mixture as per ICAR (2013) [5] nutrient requirements. The roughages (green and dry) were offered as per availability. In T_1 - Control (CON) group, basal diet without any inclusion was offered. In T_2 - 30 % protein of concentrate mixture replaced with formaldehyde treated guar meal (FTGM) in basal diet was supplied, in T_3 - basal diet + 100 g rumen protected fat (RPF) was supplemented and in T_4 group- 30 % protein of concentrate mixture replaced with FTGM in basal diet + 100 g RPF was supplemented.

Table-1 Proportion of ingredients (%) used in commercial compound concentrate mixture

SN	Name of ingredients	Proportion (%)
1	Deoiled rice bran (DORB)	39
2	Rapeseed (Untreated)	17
3	*Guar* Bhardo (Untreated)	2
4	Grain	13
5	Shea extract	4
6	Rice polish	10
7	*Tur* chuni	3
8	Premix*	12
	Total	100

Table-2 Chemical composition of feed ingredients used for feeding during feeding trial

	%Nutrients (on dry matter basis)									
Ingredients	DM	CP	EE	CF	NFE	TA	Silica	P	Ca	OM
Concentrate mixture	91.67±0.33	19.69±0.32	4.43±0.23	12.24±0.44	48.36±1.51	14.30±0.28	3.28±0.37	0.65±0.02	1.30±0.03	85.70±0.28
Formaldehyde treated *guar* meal	91.41±0.24	54.30±0.43	4.94±0.34	14.45±1.18	18.24±0.48	8.07±0.38	1.43±0.11	0.64±0.03	0.37±0.01	91.93±0.38
Hybrid Napier	24.63±0.43	7.80±0.29	2.19±0.30	22.95±0.19	55.10±0.68	11.95±0.39	9.35±0.26	0.61±0.01	0.59±0.02	88.05±0.39
Green jowar	23.55±0.59	8.78±0.18	2.41±0.25	30.76±0.47	50.25±0.60	7.80±0.62	3.09±0.13	0.58±0.03	0.44±0.03	92.20±0.62
Jowar hay	89.51±0.33	4.93±0.07	1.44±0.29	28.04±0.37	54.96±0.35	10.63±0.17	4.14±0.17	0.23±0.01	0.56±0.01	89.37±0.17
Paddy straw	90.68±0.56	4.57±0.23	1.92±0.41	30.38±0.90	46.35±0.70	16.79±0.48	12.08±0.27	0.25±0.02	0.43±0.02	83.21±0.48
Green gram gotar	90.62±0.15	9.87±0.19	2.28±0.34	29.54±0.38	45.54±0.36	10.77±0.13	3.29±0.10	0.72±0.01	2.65±0.08	89.23±0.13

Table-3 Mean body weight (kg) of buffalo calves under feeding trial of bypass protein and bypass fat

Days of Experiment	Body Weight (kg)				Mean Body Weight (kg)
	T1	T2	T3	T4	
14	100.25	95.50	93.25	95.25	96
70	121.00	120.50	114.25	118.25	119
140	153.68	157.30	145.00	160.50	154
210	190.10	199.65	183.08	212.25	196
280	224.35	248.60	227.87	261.62	241
Mean	157.88	164.31	152.69	169.57	161.11
±SD	45.07	54.88	48.26	60.88	52.25

Table-4 Plane of nutrition (DM) of buffalo calves under feeding trial of bypass protein and bypass fat

Body Weight (kg)	Targeted Growth (g/day)	Requirement as per ICAR (2013)		DM (kg) Consumed			
		DM (kg)					
		F	M	T1	T2	T3	T4
100	600	3.1	3.1	2.12	1.88	2.11	2.08
120	600	3.1	3.1	2.38	2.06	2.36	2.16
150	800	5.4	5.6	3.48	2.92	3.43	3.23
200	800	5.4	5.6	4.48	4.00	4.44	4.04
240	800	7.5	7.5	5.05	4.57	5.05	4.57
162	720	4.90	4.98	3.50	3.09	3.48	3.22
Mean		4.94					
% Decrease				29.11	37.53	29.60	34.90

Table-5 Plane of nutrition (CP) of buffalo calves under feeding trial of bypass protein and bypass fat

Body Weight (kg)	Targeted Growth (g/day)	Requirement as per ICAR (2013)		CP (g) Consumed			
		CP (g)					
		F	M	T1	T2	T3	T4
100	600	549	641	369.32	320.61	361.81	361.98
120	600	549	641	418.34	352.96	412.35	378.71
150	800	669	783	638.27	541.84	636.97	591.23
200	800	669	783	791.23	703.25	786.71	716.17
240	800	688	784	888.82	801.7	890.28	804.49
162	720	624.80	726.40	621.20	544.07	617.62	570.52
Mean		675.60					
% Decrease				8.05	19.47	8.58	15.55

Table-6 Plane of nutrition (TDN) of buffalo calves under feeding trial of bypass protein and bypass fat

Body Weight (kg)	Targeted Growth (g/day)	Requirement as per ICAR (2013)		TDN (kg) Consumed			
		TDN (kg)					
		F	M	T1	T2	T3	T4
100	600	1.9	1.96	1.35	1.29	1.4	1.44
120	600	1.9	1.96	1.51	1.42	1.56	1.51
150	800	3.37	3.4	2.19	2.01	2.26	2.24
200	800	3.37	3.4	2.8	2.72	2.91	2.79
240	800	4.4	4.44	3.16	3.11	3.3	3.15
162	720	2.99	3.03	2.20	2.11	2.29	2.23
Mean		3.01					
% Decrease				26.84	29.90	24.05	26.05

The chemical composition of feeds and fodders was analyzed as per methods of AOAC, (2012) [6], including calcium [7] and phosphorus [6]. The chemical composition of treatment diets and feeds and fodders used during experiment are given in [Table-1] and [Table-2]. On the daily basis, weighed quantity of feed including green roughages, dry roughages and concentrate were offered in each pen and leftover feed was recorded to estimate the voluntary feed intake. Based on voluntary feed intake and composition of feed ingredients the dry matter intake was derived for each calf in particular treatment group separately from concentrate and roughages and the ratio percentage wise calculated.

The plane of nutrition (DM, CP and TDN intake) of experimental buffalo calves were fulfilled as per nutrient requirement for cattle and buffalo, ICAR (2013) [5]. The plane of nutrition was compared then by considering feed intake by animals and actual standard nutrient requirement of ICAR (2013) [5]. Data were subjected to analysis using IBM SPSS (Version 20). The means were compared and interpreted by Tukey's test of significance using

Results and Discussion

Plane of Nutrition

The calves under both the T_2 and T_4 treatment groups consumed less dry matter (DM) (kg) than recommendation of ICAR (2013) [5] nutrient requirements [Table-4]. However, the DM intake (DMI) was more in T_1 and T_3 groups as compared to T_2 and T_4 groups. The mean DMI required as per DMI was 4.94 kg against which the buffalo calves under T_1, T_2, T_3 and T_4 consumed 3.50 kg, 3.09 kg, 3.48 kg and 3.22 kg, respectively. So, the calves consumed 29.11 %, 37.53 %, 29.60 % and 34.90 % less DM than the nutrient requirement of ICAR (2013) [5]. Same trend was also observed for crude protein (CP) consumption [Table-5]. The intake of CP was also less than the nutrient requirement of ICAR (2013) [5] in calves under all the treatment groups. Amongst the groups lesser CP intake was recorded in T_2 and T_4 groups over the T_1 and T_3 groups. Percentage wise different treatment groups consumed 8.05, 19.47, 8.58 and 15.55 % less CP against the requirement of ICAR (2013) [5].

Table-7 Concentrate to roughage (C: R) ratio during the feeding trial of bypass protein and bypass fat in buffalo calves

Period	Particular	Treatment Groups								Overall	
		T1		T2		T3		T4			
		C	R	C	R	C	R	C	R	C	R
1	Mean	38.37	61.63	30.36	69.64	36.89	63.11	37.08	62.93	35.67	64.33
	±SE	0.19	0.18	4.09	4.09	1.79	1.79	2.39	2.39	1.64	1.64
2	Mean	35.91^{a}	64.09^{b}	26.30^{b}	73.70^{a}	37.35^{a}	62.65^{b}	33.47^{ab}	66.53^{ab}	33.26	66.74
	±SE	4.09	4.09	1.79	1.79	2.39	2.39	1.96	1.96	1.64	1.64
3	MEAN	36.42^{a}	63.59^{b}	27.73^{b}	72.27^{a}	37.97^{a}	62.03^{b}	32.36^{ab}	67.64^{ab}	33.62	66.38
	±SE	2.84	2.84	1.12	1.12	2.75	2.75	1.77	1.77	1.43	1.43
4	Mean	24.24^{a}	75.76^{ab}	17.00^{b}	83.00^{a}	28.05^{ab}	71.95^{b}	22.68^{ab}	77.32^{ab}	22.99	77.01
	±SE	2.73	2.73	2.03	2.03	3.32	3.32	2.93	2.93	1.62	1.62
5	Mean	37.63	62.37^{b}	27.50	72.50^{a}	36.53	63.47^{b}	31.35	68.65^{ab}	33.25	66.75
	±SE	3.18	3.1800	1.68	1.68	2.11	2.11	2.19	2.19	1.49	1.49
6	Mean	42.05^{a}	57.95^{b}	37.15^{b}	62.85^{a}	42.67^{a}	57.33^{b}	37.65^{b}	62.35^{a}	39.88	60.12
	±SE	1.38	1.38	2.15	2.15	0.51	0.51	1.05	1.05	0.90	0.90
7	Mean	44.89^{a}	55.11^{b}	38.59^{b}	61.41^{a}	44.33^{a}	55.67^{b}	39.02^{b}	60.98^{a}	41.71	58.29
	±SE	1.13	1.13	0.65	0.65	1.42	1.42	0.97	0.97	0.89	0.89
8	Mean	47.60^{a}	52.40^{b}	42.21^{ab}	57.79^{ab}	46.61^{ab}	53.39^{ab}	41.80^{b}	58.20^{a}	44.56	55.44
	±SE	2.16	2.16	2.10	2.10	1.17	1.17	1.29	1.29	1.02	1.02
9	Mean	53.95^{a}	46.05^{b}	46.01^{b}	53.99^{a}	53.95^{a}	46.05^{b}	48.47^{ab}	51.53^{ab}	50.60	49.40
	±SE	2.82	2.82	1.40	1.40	2.33	2.33	1.71	1.71	1.31	1.31
10	Mean	52.43^{ab}	47.57^{bc}	46.46^{c}	53.54^{a}	54.19^{a}	45.81^{c}	47.51^{bc}	52.49^{ab}	50.15	49.85
	±SE	1.87	1.87	1.66	1..66	1.64	1.64	1.26	1.26	1.11	1.11
11	Mean	50.77^{a}	49.24^{b}	45.00^{b}	55.05^{a}	50.45^{a}	49.55^{b}	45.88^{b}	54.12^{a}	48.02	51.98
	±SE	1.48	1.48	1.45	1.45	1.34	1.34	1.12	1.12	0.91	0.91
12	Mean	51.71^{a}	48.29^{b}	46.54^{b}	53.46^{a}	52.14^{a}	47.86^{a}	45.20^{b}	54.80^{a}	48.90	51.10
	±SE	1.06	1.06	0.73	0.73	1.81	1.81	1.30	1.30	0.91	0.91
13	Mean	51.47^{a}	48.53^{b}	45.43^{b}	54.57^{a}	51.87^{a}	48.14^{b}	45.14^{b}	54.86^{a}	48.48	51.52
	±SE	1.54	1.54	1.20	1.20	1.64	1.64	1.29	1.29	1.04	1.04
14	Mean	51.65^{a}	48.35^{b}	45.91^{b}	54.09^{a}	51.42^{a}	48.58^{b}	45.88^{b}	54.12^{a}	48.72	51.28
	±SE	1.55	1.55	1.16	1.16	1.24	1.24	1.26	1.26	0.94	0.94
15	Mean	51.11^{a}	48.89^{b}	45.30^{b}	54.70^{a}	50.84^{a}	49.15^{b}	46.37^{b}	53.63^{a}	48.41	51.59
	±SE	1.36	1.36	1.22	1.22	1.41	1.41	1.26	1.26	0.89	0.89
16	Mean	51.74^{a}	48.27^{b}	45.99^{b}	54.01^{a}	51.28^{a}	48.72^{b}	46.96^{b}	53.04^{a}	48.99	51.01
	±SE	1.26	1.26	1.05	1.05	1.24	1.24	1.07	1.07	0.84	0.84
17	Mean	51.89^{a}	48.11^{b}	46.54^{b}	53.46^{a}	51.95^{a}	48.06^{b}	46.89^{b}	53.11^{a}	49.32	50.68
	±SE	1.35	1.35	1.06	1.06	1.18	1.18	0.98	0.98	0.85	0.85
18	Mean	51.05^{a}	48.95^{b}	46.00^{b}	54.00^{a}	50.92^{a}	49.08^{b}	45.91^{b}	54.10^{a}	48.47	51.53
	±SE	1.28	1.28	0.85	0.85	0.95	0.95	0.80	0.80	0.79	0.79
19	Mean	50.58^{a}	49.42^{b}	46.18^{b}	53.82^{a}	51.01^{a}	48.99^{b}	46.09^{b}	53.91^{a}	48.46	51.54
	±SE	0.98	0.98	0.62	0.62	0.97	0.97	0.79	0.79	0.71	0.71
20	Mean	50.59^{a}	49.41^{b}	45.72^{b}	54.28^{a}	50.99^{a}	49.01^{b}	46.04^{b}	53.96^{a}	48.33	51.67
	±SE	1.23	1.23	0.83	0.83	1.02	1.02	0.77	0.77	0.77	0.77
Treatment Mean	Mean	46.30^{a}	53.70^{b}	39.90^{b}	60.10^{a}	46.57^{a}	53.43^{b}	41.59^{b}	58.41^{a}	43.59	56.41
	±SE	1.93	1.93	1.01	1.01	1.57	1.57	1.33	1.33	1.01	1.01

Concentrate				Roughage			
Source of variation	T	P	T×P	Source of Variation	T	P	T×P
Sem	0.41	0.92	1.84	SEm	0.41	0.92	1.84
CD (0.05)	1.14	2.56	NS	CD(0.05)	1.14	2.56	NS
CV %	8.44			CV%	6.53		

Similar findings were also revealed for the intake of TDN, it was also recorded less than the ICAR (2013) [5] recommendations in buffalo calves [Table-6]. The TDN consumption was 26.84 %, 29.90 %, 24.05 % and 26.05 % lesser than the recommended levels [5]. The results revealed that calves under all the treatment groups were on similar plane of nutrition, which was 8 to 35 per cent lesser than the recommended level of nutrient requirement by ICAR (2013) [5]. Lesser consumption of DMI and nutrient might be due to the inclusion of formaldehyde treated guar meal @ of 30 % CP replacement of concentrate mixture which was higher than the recommended level of inclusion of guar meal in dairy animal ration. In addition to that the bitter odor and bitter taste of guar meal might have led to a less consumption of feed. Further, the nutrient requirement of buffalo varies according to breed, its physiological characters, region and environmental conditions and Surti breed of buffalo has medium and as per targeted growth rate we chosen it might be more for this particular breed than its average characteristics, thus, it may be the reason for buffalo calves under T_1 and T_3 groups consumed less DM and nutrient than the ICAR, (2013) [5] recommendations. Similar results were also recorded for the male buffalo calves had a lesser requirement of CP than the NRC (1976) [8] recommendation Sengar *et al*., (1986) [9]; Baruah *et al.,* 1988 [10]). Though, Sengar *et al*. (1986) [9] reported contradictory finding for the ME requirement of buffalo male calves, which was same as recommended by NRC (1976) [8] for exotic calves. Further, Patel (2008) [11] suggested that the buffalo calves fed control basal diet and formaldehyde treated bypass protein diet revealed 10 to 27 per cent higher plane of nutrition than the recommended by ICAR (1997) [12].

C: R ratio

The concentrate to roughage ratio was derived based on the dry matter intake received from concentrate and roughage. The data of concentrate to roughage ratio (C: R) are presented in [Table-7]. The C:R ratio differed amongst the treatment groups during most of the periods of experiment. Overall mean C:R ratio in treatment group T_1 to T_4 was 46.30:53.70, 39.90:60.10, 46.57:53.43 and 41.59:58.41, respectively. It was statistically different between the treatment groups. The dry matter intake from concentrate was greater ($P \le 0.05$) in T_1 and T_3 groups whereas dry matter intake from roughages were greater ($P \le 0.05$) in T_3 and T_4 groups, respectively. The periodic effect on DMI from concentrate and roughages was found significant, although the interaction effect between treatment and period was non-significant.

Currently for economic dairy animal production, a ration should be designed such a way to get maximum gain and feeding rate with minimum digestive upset and lowest possible feed cost. For this, trends towards the strategic manipulation of concentrate to roughage ratio (C: R), which affects gain and efficiency of gain, is important. In most of feed lot diets, there has been implied higher grain feeding. In general, ration comprised of 75:25 C: R provides better weight gain with lowest health risk, however, it might vary from 50:50 to 90:10 in feed lot ration [13]. The dry matter intake is increased with increased forage part in the ration, but it does not impact effectively on growth of the animal, thereby lowering the feed efficiency [14]. Study showed that feeding concentrate at concentration of 60 % revealed better performance when compared four iso-nitrogenous diets containing 20, 40, 60 and 80 % concentrate, respectively [15].

However, it was contrary to the present study in T_2 and T_4 groups that might be due to the better utilization of quality protein from formaldehyde treated guar meal, which is rich in excellent amino acid profile.

Conclusion

Based on the study, as per the targeted growth rate in buffaloes, the calves under different treatment groups consumed less DM, CP and TDN intake than recommended level. The inclusion of formaldehyde treated guar meal with or without rumen protected fat resulted maximum reduction in DM, CP intakes than the nutrient requirement of ICAR (2013) [5] and inclusion of formaldehyde treated guar meal with or without rumen protected fat reduced the dry mater intake from concentrate, widening the concentrate and roughage ratio in feeding of growing Surti buffalo calves.

Application of research: Effect of feed supplement on plane of nutrient and concentrate: roughage usage in feeding growing dairy buffaloes.

Research Category: Dairy Buffalo Production

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Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Anand Agricultural University, Anand, 388 001 and Kamdhenu University, Anand, 388 001

Cultivar / Variety / Breed name: Surti buffalo (Bubalus bubalis) calves

Conflict of Interest: None declared

Ethical approval: All procedure involving animal care, welfare management, experimentation and sampling were approved by the Institutional Animal Ethics Committee (IAEC), College of Veterinary Science and Animal Husbandry, Kamdhenu University, Anand, 388 001, Gujarat, India
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References

[1] Mishra A., Sarkar S.K., Ray S. and Haldar S. (2013) *Veterinary World*, 6(9), 693-697.
[2] APEDA (2011) *Agricultural and Processed Food Products Exports Development Authority. Ministry of Commerce and Industry, Government of India, Bengaluru*.
[3] Maldhure C. (2008) *MVSc thesis, Anand Agricultural University, Anand, 388 001, Gujarat, India.*
[4] Singh S., Kushwaha B.P., Maity S.B., Singh K.K. and Das N. (2014) *Tropical Animal Health and Production*, 12, 145-150.
[5] ICAR (2013) *Nutrient requirements of cattle and buffaloes. Indian Council of Agricultural Research, New Delhi, India*.
[6] AOAC (2012) *Official methods of analysis, 19th ed. Association of Analytical Chemistry, Virginia, USA*.
[7] Talapatra S.K., Ray S.C. and Sen K.C. (1948) *The Journal of Agricultural Science*, 38, 163-173.
[8] NRC (1976) *Nutrients requirements of beef cattle. (National Research Council, 5th ed.) National Academy of Sciences: Washington, DC, USA*.
[9] Sengar S.S., Joshi D.C., Lakshmanan V. and Anjaneyulu A.S.R. (1986) Buffalo bulletin, 5, 80-85.
[10] Baruah K.K., Ranjhan S.K. and Pathak N.N. (1988) *Buffalo Journal*, 22, 131-138.
[11] Patel (2008) *MVSc thesis, Anand Agricultural University, Anand, 388 001, Gujarat, India*
[12] ICAR (1997) *Feeding of Dairy Cattle and Buffalo. (3rd edn.), Indian Council of Agricultural Research, Krishi Bhawan, Pusa, New Delhi*.
[13] Rashid M.M., Huque K.S., Hoque M.A., Sarker N.R. and Haque Bhuiyan A.K.F. (2015) *Journal of Agricultural Science*, 5, 286-295.
[14] Loerch S.C. and Fluharty F.L. (1998) *Journal of Animal Science*, 76(3), 681-685.
[15] Ribeiro M.D., Pereira J.C., Bettero V.P., Queiroz A.D.C., Costa M.G. and Leonel F.D.P. (2009) *Revista Brasileira de Zootecnia*, 38(6), 1133-1141.