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Residual feed intake and its association with blood biochemical parameters and metabolic hormones in buffalo calves

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Abstract
The present study attempts to assess the relationship of residual feed intake (RFI) with rumen fermentation and blood biochemical profile in growing buffalo calves. Twelve healthy buffalo calves of 7 to 9 month of age were selected and fed with green fodder and concentrate mixture as per ICAR 2013 feeding standards. Weighed amount of feed and fodder was offered and residue was also weighed next day, early in morning. Dry matter (DM) of feed and fodder offered and residue left was estimated on daily basis to assess DM intake. After completion of feeding trial of 90 days, RFI value for individual animals was calculated and divided into two groups (RFI +ve and RFI –ve). Experimental animals were weighed before starting the actual experiment and thereafter at fortnightly intervals. Using the data of fortnightly body weights ADG was calculated. Blood samples were collected thrice, once at the beginning, in the middle and at the end of trial, from all the animals for estimation of blood biochemical parameters in blood plasma. The results obtained regarding RFI values for high and low RFI groups were 0.235±0.04and -0.235±0.06, respectively. The results revealed that IGF-1 was negatively but non-significant correlated with RFI. Plasma albumin concentration was significantly positively correlated (r = 0.56) with RFI (P<0.01). RFI was positively correlated with Aspartate aminotransferase (r =0.44) while negatively correlated (r = 0.35) with Alanine aminotransferase.

Keywords: Residual feed intake, buffalo calves, biochemical, hormones

Introduction
Residual feed intake, an alternative approach to measure feed efficiency, defined as the difference between actual feed intake and its predicted intake based on body size and level of performance. This trait is moderately heritable and genetically independent of growth and body size (Crews, 2005) [5].

Residual feed intake can be a promising selection tool for the selection of buffaloes for increased feed efficiency. It is independent of the level of production, lower the RFI value, the more efficient the animal is. Selection for the low RFI will result in progeny that consume less feed for the same level of production as progeny of high RFI animals benefitting economically. Residual feed intake can be used as a potential trait for studying the physiological mechanisms underlying variation in feed efficiency. The physiological mechanisms by which variation in RFI may occur are associated with the intake of feed, digestion of feed, metabolism, activity and thermoregulation (Herd *et al.* 2004) [12]. Body composition, metabolic rate, and stress are some factors that influence energy consumption and utilization in animals that subsequently alter the functioning of the hypothalamic-pituitary-adrenal axis affecting hormonal balance.

The physiological parameters such as blood indicators predictive of RFI may became useful as a means for early indirect selection in large herds. Systemic concentration of metabolic hormones and metabolites, mediators of nutrient uptake as well as inhibitors of tissue catabolism, have been examined to identify potential physiological biomarkers for feed efficiency in cattle (Richardson *et al.* 2004) [12]. This can lead to better understanding of the possible physiological variation in the efficiency of diet use among individuals. Keeping in view of the above facts, the present investigation was undertaken to determine the residual feed intake and its relationship with blood biochemical and hormonal profile in growing buffalo calves.

Material and Methods

Twelve healthy buffalo calves in the age group of 7 to 9 month of age were selected from buffalo farm of the Department of Livestock Production Management of College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar after approval from Institutional Animal Ethics Committee. Hisar city is situated in semi-arid region and climatic condition is sub-tropical in nature. Geographically, Hisar is situated at 29° 10' N latitude, 75° 40' E longitude and 215.2 meters altitude. The animals were kept individually under loose housing system. Proper cleanliness and healthy surroundings were ensured throughout the experimental period. Body weights of the animals were taken at fortnightly intervals. After a preliminary feeding of one month, a feeding trial of 90 days was conducted. During the experimental period, the animals were given green fodder and concentrate mixture to meet their protein and energy need for growth as per ICAR (2013) feeding standards. The quantity of different feeds given to each group was adjusted at fortnightly intervals so that the overall DCP and TDN requirements of calves were met according to the change in body weight. Animals were allowed *ad lib* fresh drinking water throughout the experimental period.

Chemical Analysis of Feed Ingredients for Proximate Principles

The composition of concentrate mixture (kg/100kg) has been given in Table 1 and chemical compositions (on Dry matter basis) of concentrate mixture and green fodder have been presented in Table 2.

Table 1: Composition of concentrate mixture.

S. No	Ingredient	Parts
1.	Barley	15
2.	Maize	15
3.	Groundnut Cake (GNC)	30
4.	Soyabean Meal	15
5.	Deoiled Rice Polish	22
6.	Mineral Mixture	2
7.	Salt	1
	Total	100

Table 2: Chemical composition (% on DM basis) of concentrate mixture and green fodder

S. No	Ingredient	Concentrate Mixture	Green Fodder
1.	Dry matter (DM)	91.10	90.17
2.	Crude protein (CP)	24.51	24.88
3.	Crude fiber (CF)	7.40	6.49
4.	Ether extract (EE)	5.40	5.02
5.	Ash	7.70	7.77
6.	Organic matter (OM)	92.30	92.23
7.	NFE	55.35	55.84

All the animals were offered more than their requirement keeping in view that some animals consume more than expected intake. Animals were fed weighed amount of green fodder and concentrate individually. DM intakes of the animals were recorded daily on the basis of feeds and fodder offered and residues.

Methodology for measuring Residual feed intake (RFI) in buffalo calves

Daily residual feed intake was recorded for each animal and body weight was taken fortnightly. Average DMI for the 90 days feeding period was regressed on average metabolic body weight ($BW^{0.75}$) and average daily gain (ADG) (Kelly *et al.*, 2010) [10]. RFI was computed for each animal and was assumed to represent the residuals from a multiple regression model regressing Dry matter intake (DMI) on ADG and average metabolic BW ($BW^{0.75}$). The actual DMI minus the predicted DMI corresponds to the RFI. The base model used was:

$$Yj = \beta0 + \beta1MBWj + \beta2ADGj + ej,$$

Where
Yj is the DMI of the jth animal
β0 is the regression intercept
β1 is the regression coefficient on MBW
β2 is the regression coefficient on ADG
ej is the uncontrolled error of the jth animal (RFI)
A more efficient animal has a negative RFI (observed feed intake is less than predicted feed intake), and a less efficient animal has a positive RFI (observed feed intake is greater than predicted feed intake). The grouping of the animals was done based on RFI calculated into low and high RFI groups. The groups were compared for different parameters like feed intake, blood biochemical, enzymes and hormonal profile.

Blood-biochemical parameters

During 90 days of experimental period, blood samples were collected thrice, once at the beginning, in the middle and at the end of trial, from all the animals by jugular puncture in heparinized vacutainer, mixed well by rotating tubes between palms to ensure proper mixing of blood and anticoagulant and brought to the laboratory after placing in ice box. Then, the samples were centrifuged at 3000 rpm 15 minutes to separate the plasma. The plasma samples were stored at -20 °C for further analysis.
Estimation of blood biochemical parameters in plasma viz triglyceride (mg/dl), cholesterol (mg/dl), total calcium(mg/dl), phosphorus (mg/dl), and enzymes viz. aspartate aminotransferase (AST) (IU/L) and alanine aminotransferase (ALT) (IU/L) were carried out using kits procured from M/s Transasia Biomedical Limited with semi-automated Random Access Clinical Chemistry Analyzer (EM 200 ™ Erba Mannheim – Germany). Metabolic hormones viz. triidothyronine (T_3) (ng/dl), thyroxine (T_4) (µg/dl), and insulin like growth factor-1 (IGF-1) (pg/dl) were analysed by Bovine ELISA Test kit from Bio-Detect.
The results obtained during this study were statistically analyzed by using software package SPSS.

Results and Discussion

After completion of feeding trial of three months duration, RFI value for individual animals was calculated using the formula (Archer *et al.*, 1997) [1] (Fig. 1)

$$MI = \beta0 + \beta1\ BW^{0.75} + \beta2\ ADG + \varepsilon$$

Where β0 is the intercept, β1 and β2 are the coefficients of the equation, and ε is the residual (i.e., RFI). Based on this, the animals were divided into low and high RFI groups.

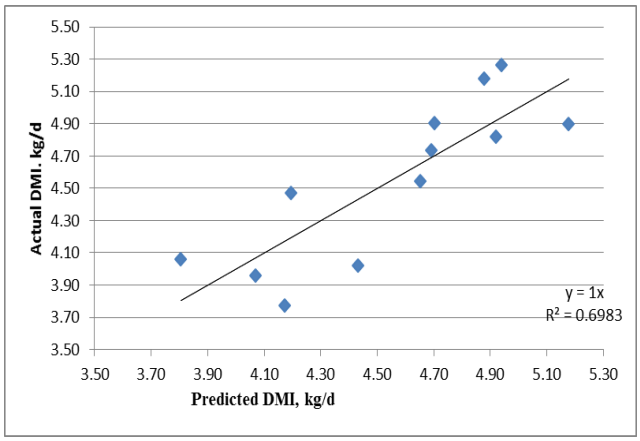

Fig 1: Actual v/s predicted DMI of growing buffalo calves

The table 3 shows the two groups (High and Low RFI). The results revealed that the dry matter consumption was lower in low RFI group compared to high RFI group. The overall mean average DMI per kg metabolic body weight for high and low RFI groups were 106.92 and 94.64 (g/kg $W^{0.75}$) respectively and the difference was highly significant ($P \leq 0.01$). Cruz *et al.* (2010) did not observe any difference in dry matter digestibility coefficients between low and high RFI groups of Angus x Hereford cross bred steers. Gomez *et al.* (2007) [6] reported that low RFI steers consumed 19.1% less dry matter than high RFI steers. Difference in metabolism might be the major factor contributing to differences in feed efficiency. Average daily body weight gain of high and low RFI groups during the whole experimental period was 646.30 and 648.15 g/d, respectively. The data did not show any significant difference between the groups.

Table 3: Animals in high and low RFI groups

Animal No.	+ RFI value	Animal No.	- RFI value
1	0.26	1	-0.11
2	0.3	2	-0.28
3	0.2	3	-0.41
4	0.04	4	-0.1
5	0.33	5	-0.11
6	0.28	6	-0.4
Overall mean± SE	0.235±0.04	Overall mean± SE	-0.235±0.06

Blood biochemical parameters and enzymes

The results of blood biochemical parameters, enzymes and hormones have been presented in Table 4. Average blood AST levels were 105.67, 106.00, 112.67 (IU/L) in high and 103.33, 100.50, 97.67 (IU/L) in low RFI groups at different interval. The values were lower ($P<0.05$) in low RFI group compared to high RFI group. RFI was positively correlated with AST (r = 0.44). Baban (2013) [2] also reported higher AST values in high RFI than low RFI group. AST is a key enzyme in amino acid metabolism (Stryer, 1988) [15]. Richardson *et al*. (2004) [12] found AST to be only liver enzyme to demonstrate an association with RFI. The enzymatic activity of ALT was recorded non-significant in low RFI group and were negatively correlated (r = -0.35) with RFI.

Blood plasma hormones (T_3, T_4 and IGF-1)

Mean values of T_3 and T_4 were found to be higher non-significantly ($P<0.05$) in low RFI group and were negatively correlated (r = -0.37 and -0.30 respectively) with RFI. A decrease in T_3 has been observed insignificantly over a period of time in both groups. Average mean values of IGF-1 in high and low RFI groups at different interval were found to be 857.02, 722.68, 808.55 and 830.21, 820.97, 933.53 (pg/ml) respectively. Mean values of IGF-1 were found to be higher non- significantly ($P<0.05$) in low RFI group and were negatively correlated (r = -0.49) with RFI. Iveta *et al.* (2011) [9] also observed that the concentration of the T_3 decreased over a period a period of six months when compared with the initial values, while the concentration of the T_4 decreased insignificantly over the same period of the time. While in a study done on the piglets, the concentration of the both T_3 and T_4 decreased over the period of the study. Smith *et al.* (2013) [13] postulated that T_3 concentration decreased over a period of time and the concentration of T_3 was found to be positively correlated with the RFI at the young stage in both the low and high RFI heifers. Zhang *et al* (2017) [18] reported lower plasma concentrations of T_4 and ACTH in the Low-RFI group than in the High-RFI group ($P<0.01$). However, the concentrations of insulin, leptin, IGF-1, GC, and TRH were not significantly different between the groups ($P>0.05$). Walker *et al* (2015) [16] found that the plasma level of T4 was affected by BW but not by RFI during the lactation and post-weaning period in cows. In the later growth stages, he found that the plasma level of T4 was not affected by BW but by RFI; this difference may be due to the role of thyroid hormones, as the developing heifers required thyroid hormones to remain active. Circulating levels of IGF-1 are genetically associated with growth (Herd *et al*. 2002) [7]. A genetic and economic evaluation of the use of IGF-1 as an indirect selection criterion in beef cattle showed that it can increase the profitability of selection decisions and would best used as a screening test to identify animals to be placed into RFI tests in a two-stage selection program (Wood *et al*. 2002) [17]. Insulin-like growth factor-I, a known mitogen for cell proliferation, was determined to be phenotypically (Brown *et al*. 2004) [4] and genetically (Moore *et al* 2005) [11] and correlated in a positive manner with RFI in growing bulls and heifers. Bose *et al* (2014) [3] did not observe any significant difference in levels of IGF-1 and creatinine concentration between high and low RFI groups at both initial and final periods of study.

Table 4: Biochemical parameters in high and low RFI Groups (Mean± S.E.)

Parameter	Group	Day 0	Day 45	Day 90	P Value		
					Time	T_X	$T \times T_X$
Cholesterol (mg/dl)	H-RFI	92.33±1.96	91.67±3.74	93.0±2.35	.59	.472	.737
	L-RFI	90.67±3.53	88.0±3.39	89.0±4.03			
Triglyceride (mg/dl)	H-RFI	9.95±0.38	10.48±0.32	10.63±0.22	.13	.923	.502
	L-RFI	10.25±0.38	10.47±0.36	10.47±0.27			
T_3 (ng/dl)	H-RFI	0.97±0.14	0.79±0.13	0.93±0.13	.353	.38	.712
	L-RFI	1.21±0.18	1.04±0.23	1.00±0.22			
T_4 (µg/dl)	H-RFI	2.61±0.11	2.68±0.11	2.94±0.09	.03	.664	.728
	L-RFI	2.76±0.21	2.65±0.11	3.03±0.12			
IGF-1 (pg/dl)	H-RFI	857.02±37.4	722.68±17.7	808.55±57.9	.132	.148	.263
	L-RFI	830.21±21.8	820.97±80.1	933.53±49.8			
Calcium (mg/dl)	H-RFI	10.48±0.22	10.25±0.28	10.4±0.25	.208	.154	.224
	L-RFI	10.5±0.32	10.58±0.16	11.17b0.17			
Phosphorus (mg/dl)	H-RFI	5.95±0.08	6.05±0.007	5.98±0.08	.129	.664	.261
	L-RFI	5.92±0.11	6.05±0.10	5.88±0.08			
ALT (IU/L)	H-RFI	24.17±2.93	27.5±0.50	29.5±1.77	.219	.291	.250
	L-RFI	29±2.70	28.33±0.56	29.17±1.99			
AST(IU/L)	H-RFI	105.67±6.55	106±1.63	112.67±3.78	.794	.082	.190
	L-RFI	103.33±3.9	100.5±3.63	97.67±2.29			

TIME = Time effect, T_X = Treatment effect and $T \times T_X$ = Time × Treatment effect

Correlation of residual feed intake with blood biochemical parameters

Pearson correlation value between RFI and blood biochemical parameters has been presented in Table 5. The results revealed that there was no significant correlation between RFI and blood biochemical parameters.

Table 5: Correlation of residual feed intake with blood biochemical parameters

Parameter	Correlation	P Value
Cholesterol (mg/dl)	0.055	0.865
Triglyceride (mg/dl)	-0.02	0.934
T_3 (ng/dl)	-0.375	0.23
T_4 (µg/dl)	-0.305	0.335
IGF-1 (pg/dl)	-0.49	0.106
Calcium (mg/dl)	-0.491	0.105
Phosphorus (mg/dl)	-0.073	0.822
ALT (IU/L)	-0.356	0.253
AST (IU/L)	0.448	0.144

According to Stick *et al*. (1998) [14] and Wood *et al*. (2002) [17], the blood concentrations of IGF-1 are potential physiological markers of feed efficiency and are phenotypically positively correlated with RFI in beef cattle. However, Kelly *et al*. (2010) [10] reported significantly negative correlations between RFI and IGF-1 receptors in heifers divergent for RFI. Furthermore, he also reported that the correlations between serum IGF-1 concentrations and RFI varied between different sampling times on the same day.

Conclusion

Results from the study indicate that RFI can be a promising tool for selection of animal having better feed conversion efficiency but multifactorial approach should be adopted to enhance understanding of potentially measurable predictors of RFI to be used in future studies. Blood metabolites could be useful to the overall characterization of animals different in feed efficiency taking other factors like diet, energy status, stress and environment into consideration.

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References

1. Archer JA, Arthur PF, Herd RM, Parnell PF, Pitchford WS. Optimum post weaning test for measurement of growth rate, feed intake, and feed efficiency in British breed cattle. Journal of Animal Science. 1997; 75:2024-203.
2. Baban BN. Assessment of residual feed intake and related biochemical parameters in growing male Sahiwal Calves. Thesis submitted to National Dairy Research Institute (NDRI), Karnal, India, 2013.
3. Bose BKS, Kundu SS, Tho NT, Sharma VK, Sontakke UB. Residual feed intake as a feed efficiency tool and its relationship with feed intake, performance and nutrient utilization in Murrah buffaloe calves. Tropical Animal Health and Production. 2014; 46:615-621.
4. Brown EG, Carstens GE, Fox JT, Curley Jr KO, Bryan TM, Sla LJ *et al.* Physiological indicators of performance and feed efficiency traits in growing steers and bulls. Beef Cattle Research. Texas. 2004, 163-166.
5. Crews Jr DH. Genetics of efficient feed utilization and national cattle evaluation: A review. Genet Molecular Res, 2005; 4:152-165.
6. Gomez RR, Bourg BM, Paddock ZD, Carstens GE, Lancaster PA, Miller RK *et al.* Evaluation of feed efficiency in Santa Gertrudis steers and relationship with temperament and feeding behavior. Journal of Animal Science. 2007; 85:454-455.
7. Herd RM, Arthur PF, Hegarty RS, Archer JA. Potential to reduce greenhouse gas emissions from beef production by selection for reduced residual feed intake. Proc. 7th World Congress. Genetics Applied Livestock Production. 2002; 31:281-284.
8. ICAR. Nutrient composition of Indian feeds and fodders, 1st edn, Indian Council of Agricultural Research and National Institute of Animal Nutrition and Physiology, 2013.
9. Iveta P, Seidel H, Nagy O, Tóthová C, Kovác G. Concentrations of thyroid hormones in various age categories of ruminants and swine. Acta Veterinaria (Beograd), 2011; 61(5, 6):489-503.

10. Kelly AK, McGee M, Crews Jr DH, Fahey AG, Wylie AR, Kenny DA. Effect of divergence in residual feed intake on feeding behavior, blood metabolic variables, and body composition traits in growing beef heifers. Journal of Animal Science. 2010; 88:109-123.
11. Moore KL, Johnston DJ, Graser HU. Genetic and phenotypic relationships between insulin- like growth factor-I (IGF-I) and net feed intake, fat and growth traits in Angus beef cattle. Australian Journal of Agriulture Research. 2005; 56:211-218.
12. Richardson EC, Herd RM, Archer JA, Arthur PF. Metabolic differences in Angus steers divergently selected for residual feed intake. Australian Journal of Experimental Agriculture. 2004; 44:441-452
13. Smith BA. The assessment of Replacement heifer production efficiencies through residual feed intake and key hormone profiles. Thesis submitted to the University of Guleph, 2013.
14. Stick DA, Davis ME, Loerch SC, Simmen RC. Relationship between blood serum insulin-like growth factor I concentration and postweaning feed efficiency of crossbred cattle at three levels of dietary intake. Journal of Animal Science. 1998; 76:498-505.
15. Stryer L. 'Biochemistry (3rd ed.). (WH Freeman and Company: New York), 1988.
16. Walker RS, Martin RM, Buttrey B. Effects of residual feed intake and dam body weight on replacement heifer intake, efficiency, performance, and metabolic response. Journal of Animal Science. 2015; 93:3602-3612.
17. Wood BJ, Archer JA, Werf JHJ. Genetic and economic evaluation of the use of IGF-1 as an indirect selection criterion in beef cattle. Proc. 7th World Congr. Genet. Appl. Livest. Prod., Montpellier, France, 2002, 02-26.
18. Zhang X, Wang W, Mo F, La Y, Li C, Li F. Association of residual feed intake with growth and slaughtering performance, blood metabolism, and body composition in growing lambs. Science Reproduction. 2017; 7:12681-12684.