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Nutritional evaluation of total mixed ration comprising of pigeon pea (*Cajanus cajan*) straw in cattle

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Abstract
An experiment was conducted for nutritional evaluation of *arhar* (pigeon pea) straw. Twelve cattle (150-200 kg) divided into 2 equal groups were offered treatments *viz.* T_1 (control) having concentrate mixture (45%) + wheat straw (55%) and T_2 (Treatment): concentrate mixture (30) + *arhar* straw (70). The growing cattle were fed as per ICAR (1998) feeding standards to meet their nutrient requirements in terms of DM, DCP and TDN. The DMI on% basis and CP intake was comparable (P>0.05) between treatment T_1 and T_2 while DMI on kg/kg $W^{0.75}$ and kg/day was higher (P<0.05) in T2 than T1 similarly DCP and TDN intakes were (P<0.05) higher in T2. The total and average daily gain were significantly higher (P<0.05) in T_2 than T_1. The digestibility of CP were significantly (P<0.05) higher in T2 than T1 while digestibility of other nutrients (DM, OM, EE and CF) was comparatively higher (P>0.05) in T_2 than T_1. The average values of NH_3-N, total-N and protein-N concentrations in rumen liquor under T_2 were higher as compared to T_1 while TVFA content was similar between the groups. The efficiency of feed utilization was also superior in T_2 than T_1.The daily cost of feeding was Rs 48.80 and 42.66, while the cost of feeding (Rs/kg gain) was 108.27 and 76.94, respectively in T_1 and T_2 group.

Keywords: Arhar straw; Cattle; Nutrient utilisation; Total Mixed Ration, digestibility

1. Introduction
The huge livestock population of India needs to be fed with balanced rations in order to maintain productivity potentials [20]. The scarcity of green fodder and escalating demand of concentrate ingredients for human consumption has led to the utilization of non-competitive and non- conventional crop residues in livestock feeding. Use of locally available feed ingredients can substantially reduce the cost of production of livestock [15]. The scarcity of green fodder and high cost of conventional feed ingredients have prompted the researchers to improve the feeding value of poor quality crop residues [1]. Inadequate availability of good quality feed regarded as a major constraint to prevalent small ruminants production system [11]. The portion of crop remaining after threshing of the seed is available in abundance and is staple feed stuff for ruminants. There is a need for better utilization of crop residues and agro-industrial by-products to maximum through different feed processing methods and technologies to ensure better profit from the livestock. Feeding of crop residues particularly leguminous straws for livestock as a major roughage source has been observed during harvest season as they are most abundantly available. Inclusion of cereal grains not only increases the cost of concentrate mixtures, but also causes its scarce use for the feeding of monogastric animals to meet their energy requirements. Therefore, ruminant's diet devoid of grains will help sparing them for human and non-ruminants [5].Leguminous straw/*bhusa* appears to be a valuable edible biomass due to its high nutritive value and feeding quantities and can serve as a potential feed resource during the lean period. These crop residues could be incorporated as basal roughage in the complete diets of small ruminants up to 60% [10]. Such crop residues after fortification of deficit nutrients provide adequate balanced diet to the animals as well as overcome associated problems of handling and storage.
The cost of feeding is a significant factor dictating the economic viability of livestock feeding which must be reduced by adopting the alternative method of utilizing agricultural crop residue. India is the largest producer and consumer of pulses in the world accounting for 22% of world production of pulses [12]. India stood out as the topmost pigeon pea producing countries in the world (CRN, India) www.crnindia.com/2016-2010. Gujarat stands fifth in pigeon pea production which is 100000 tonnes. Pigeon pea is used as an animal feed due to

relatively high crude protein content. Pigeon pea straw contains 94% organic matter (OM), 11.8% crude protein (CP), 2.7% ether extract (EE), 48.5% nitrogen free extract (NFE) and 8.0% lignin [3]. Pigeon pea straw is readily consumed by ruminants, and hence utilized as the roughage source in the total mixed ration, therefore the present study was conducted to evaluate the effect of pigeon pea straw based TMR on the rumen metabolite and growth performance of cattle.

2. Material and Methods

Twelve cattle (150-200 kg) of similar age and confirmation divided into 2 equal groups were offered treatments *viz.* T_1 (control) TMR having (concentrate mixture 45% + wheat straw 55%) and T_2 (Treatment) TMR (concentrate mixture 30 + *arhar* straw 70). The growing cattle were fed as per ICAR (1998) feeding standards to meet their nutrient requirements in terms of DM, DCP and TDN for 5 weeks. The proportion of ingredients used to prepare is presented in Table 1.

Table 1: Formula for concentrate mixture

Ingredients	Proportion
Maize	24
Soyabean	33
DORB	30
Mineral mixture	2
Salt	1
Rovimix	.02
Molasses	10
Total	100

The cattle of T_1 and T_2 groups were fed respective total mixed ration (TMR) in pellet form and daily DM intake and feed residue were recorded. The experimental cattle were let loose for exercise for two hours in the morning and one hour in the afternoon during which they had free access to fresh water. Weekly body weights of animals were recorded for two consecutive days in the morning before feeding and watering during the entire experiment. A 30 day preliminary period was followed by seven day collection period. The rumen liquor trial was conducted at the end of an experiment. About 150 ml of rumen liquor were collected through a stomach tube against negative pressure created by the suction pump [5] from each animal at 0, 2, 4 and 6 hrs post feeding. The rumen liquor was immediately brought to the laboratory and strained through four layered muslin cloth. The samples of SRL were analyzed for NH_3-N and total-N by Kjeldahl method. pH of SRL was determined immediately after collection. The concentration of total TVFA was determined in SRL by steam distribution method [2], using Markham micro-distillation apparatus. The feed samples of complete rations and faeces were dried at 70 °C for 24h, ground to pass through 2 mm medium mesh screen and analyzed for proximate composition as per [1] and fibre fractions [15]. The data collected during the study were statistically analyzed as per method suggested by [13].

Table 2: Chemical composition (% DM basis) of pelleted feeds

Parameters	T_1 (Control)	T_2 (Treatment)
DM	95.30 ± 0.09	95.46 ± 0.18
OM	84.68 ± 0.33	82.06 ± 0.41
CP	15.70 ± 0.05	15.75 ± 0.15
CF	26.39 ± 0.55	25.90 ± 0.22
EE	2.65 ± 0.07	2.70 ± 0.06
NFE	39.94 ± 0.80	37.71 ± 0.70
Total ash	15.32 ± 0.11	17.94 ± 0.51
NDF	41.03 ± 0.22	40.16 ± 0.20
ADF	19.86 ± 0.54	20.11 ± 0.56
Ca	1.18 ± 0.15	1.22 ± 0.03
P	0.68 ± 0.21	0.56 ± 0.18

3. Results and discussion

The DM intake (kg/d and kg/kg $W^{0.75}$) and DCP intake were significantly higher ($P<0.05$) in T_2 as compared to T_1 (Table 3) and in agreement with the result reported by [10] in goats observed higher DM intake for diets comprised of *arhar* straw as compared to gram straw. The data for % DM and daily CP intake revealed non-significant difference between treatments while DCPI and TDNI significantly higher in T_2. The DM intake kg per kg weight gain for cattle required 8.68 and 7.22 kg under treatments T_1 and T_2, respectively while CPI, DCPI and TDNI/ kg gain was 0.99, 0.62 and 4.65kg in T1 and 0.84, 0.56 and 3.98 in T_2, respectively due to which better feed conversion efficiency was observed in T_2 group similar findings were also reported by [9] in the goat fed pelleted complete diet containing 60% *arhar* straw.

The ADG and total gain was also significantly higher ($P<0.05$) in T_2 in comparison to T_1 group. The ADG was higher than 102.38g in T_2 group, as similar findings were also observed by [8] as they reported significantly higher average daily gain in the group fed pelleted red gram straw.

The digestibility coefficients for different nutrients found to be non-significant between treatments except for CP digestibility [4]. reported more or less similar value (56.01%) of DM digestibility in buffalo bulls fed red gram straw as compared to value observed (57.63%) under present study while [6] reported lower digestibility of red gram stalks in Murrah buffaloes fed at different levels. The experimental cattle in both the treatments were in positive balance of Ca and P without showing any significant difference between the treatments.

Table 3: Performance of cattle on different treatments

Performance of experimental cattle	T_1	T_2
Initial BW (kg)	144.83 ± 5.28	145.50 ± 5.66
Final BW (kg)	160.67 ± 5.95	164.92 ± 5.87
ADG (g)	452.38^{a} ± 22.64	554.76^{b} ± 11.90
DMI (kg/d)	3.88^{a} ± 0.16	4.05^{b} ± 0.14
DMI (kg/kg $w^{0.75}$)	90.91^{a} ± 0.90	92.58^{b} ± 0.73
DMI (kg/100kg BW)	2.58 ± 0.01	2.62 ± 0.01
Daily CPI (g)	448.33 ± 18.57	465.37 ± 16.43
Plane of nutrition		
Daily DCPI (g)	278.45^{a} ± 11.53	310.98^{b} ± 10.98
Daily TDNI (kg)	2.10^{a} ± 0.09	2.21^{b} ± 0.08
Efficiency of feed utilization		
DMI (kg/kg gain)	8.68^{a} ± 0.22	7.22^{b} ± 0.23

CPI (kg/kg gain)	0.99[a] ± 0.03	0.84[b] ± 0.03
DCPI (kg/kg gain)	0.62 ± 0.02	0.56 ± 0.02
TDNI (kg/kg gain)	4.65[a] ± 0.12	3.98[b] ± 0.12
Digestibility coefficients		
DM	0.56 ± 1.42	0.57 ± 1.03
OM	0.60 ± 0.01	0.62 ± 0.01
CP	0.62[a] ± 0.01	0.67[b]± 0.01
CF	0.57 ± 0.01	0.57 ± 0.01
EE	0.68 ± 0.02	0.69 ± 0.01
NFE	0.60 ± 0.02	0.61 ± 0.02
NDF	0.57 ± 0.04	0.58 ± 0.03
ADF	0.45 ± 0.02	0.47 ± 0.01
Nutritive value (%)		
DCP	9.75 ±0.18	10.52 ±0.07
TDN	52.83 ± 1.01	52.67 ± 0.63
Cost of feeding		
Rs/d/animal	48.80 [a]± 2.02	42.66[b] ± 1.51
Rs/kg/gain	108.27[a] ± 2.60	76.94 [b]± 2.42
*The mean value bearing the different superscript within row differ significant (P<0.05)		

Table 4: Rumen liquor profile on different treatments

Parameters	T_1	T_2
pH	6.47 ± 0.10	6.66 ± 0.15
NH_3-N (mg/100 ml SRL)	11.68[a] ± 2.05	13.24[b] ± 2.13
TVFA(mEq/100ml SRL)	14.48 ± 2.99	14.40 ± 2.54
Total-N(mg/100ml SRL)	66.49 [a]± 11.80	71.77[b] ± 11.82
NPN (mg/100ml SRL)	23.67 [a]± 5.30	27.38[b] ± 6.11
Protein nitrogen (mg/100ml SRL)	42.82 ± 6.68	44.92 ± 6.38
Soluble nitrogen (mg/100ml SRL)	39.12[a] ± 4.54	41.52[b] ±4.09#
* The mean value bearing the different superscript within row differ significant between treatments (P<0.05). #(P<0.01)		

The rumen fermentation profile conducted at 0, 2, 4 and 6 hrs post feeding at the end of experimental period indicated significant variation (P<0.05) for all the parameters except pH, TVFA and protein nitrogen (Table 4). There was no significant difference for pH between the treatments T_1 and T_2 so rumen pH and TVFA concentration were not affected by the type of complete diet; similar findings were also reported by [14]. However, the values for pH under present study are in normal range (6.2 to 7.2) as reported by [7] for ruminants. The total-N and NH_3-N concentration were significantly higher in T_2 in comparison to T_1 but the values observed under present study was lower than the values reported by [10] for total and NH_3-N. Similarly, the values for NPN, protein and soluble nitrogen also revealed significant difference between the treatments but the values of NPN was lower than the value observed by [9] and similarly higher value of soluble-N was also observed by [11] in comparison to value observed under present study.

The daily cost of feeding (Rs/animal) and cost of feeding (Rs/kg gain) was lower in T_2 (P<0.05) in comparison to T_1. The daily feed cost was 14.39% less for cattle fed TMR incorporated with *arhar* straw as roughage source (T_2) in comparison to cattle fed control TMR (T_1) while feed cost Rs/kg gain was reduced by 40.72% in cattle fed *arhar* straw based TMR (T_2) in comparison to cattle fed control TMR (T_1).

These findings lead to conclusion that cattle can be raised economically by feeding *arhar straw* based TMR with improvement in growth rate, better feed efficiency in terms of DM, CP and TDN required per kg gain with reduction in daily feed cost by 14.39% and feed cost Rs/kg gain by 40.72% in comparison to cattle fed control TMR (T_1).

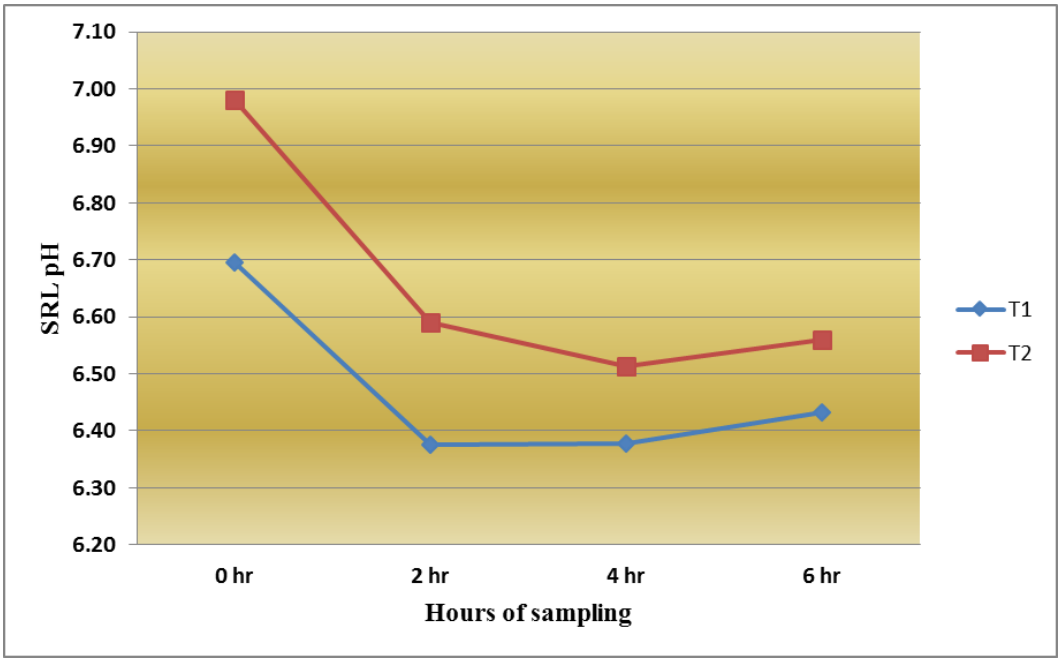

Fig 1: Average periodical changes in SRL-pH of cattle under feeding experiment

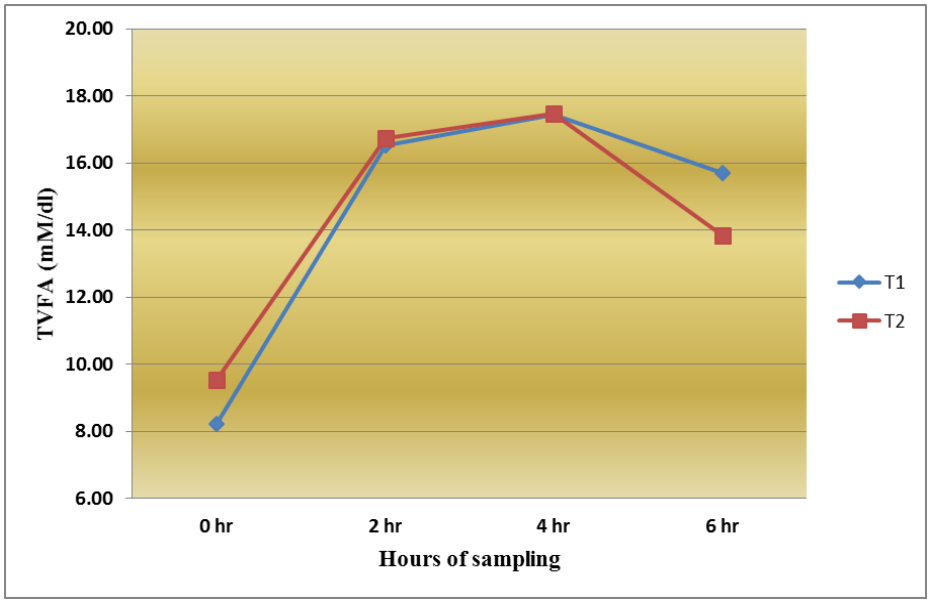

Fig 2: Average periodical changes in SRL-TVFA (mM/dl) of cattle under feeding experiment

Average periodical changes in SRL nitrogen fraction of cattle under feeding experiment

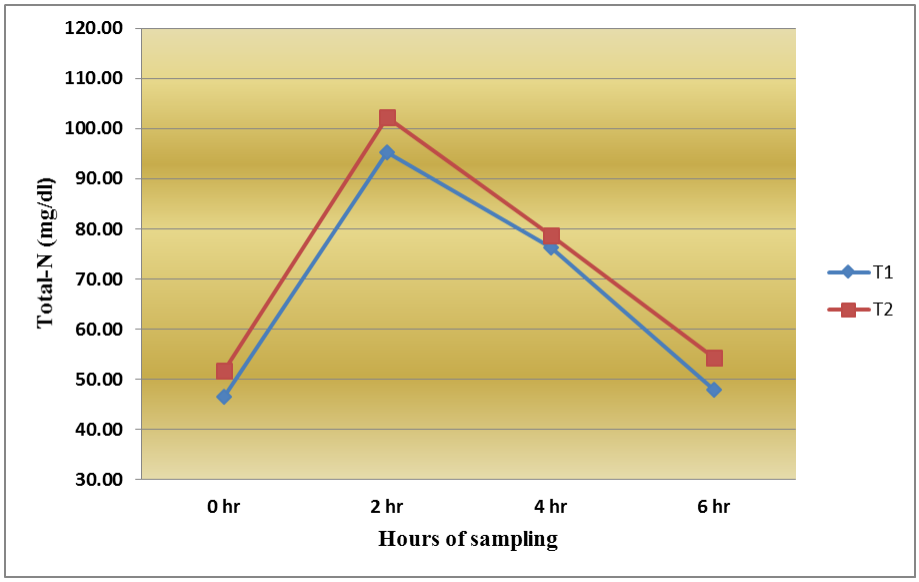

Fig 3(a): Total – N (mg/dl) in SRL

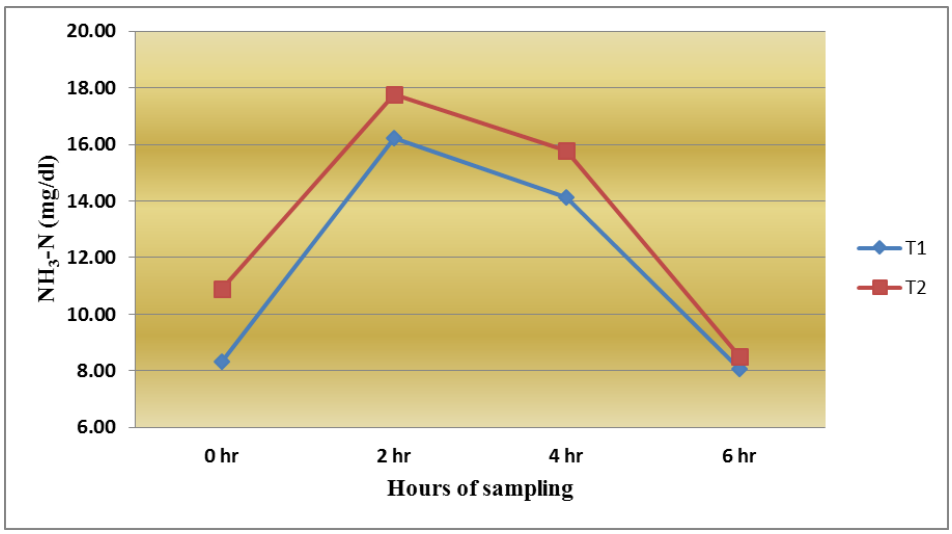

Fig 3(b): NH_3 – N (mg/dl) in SRL

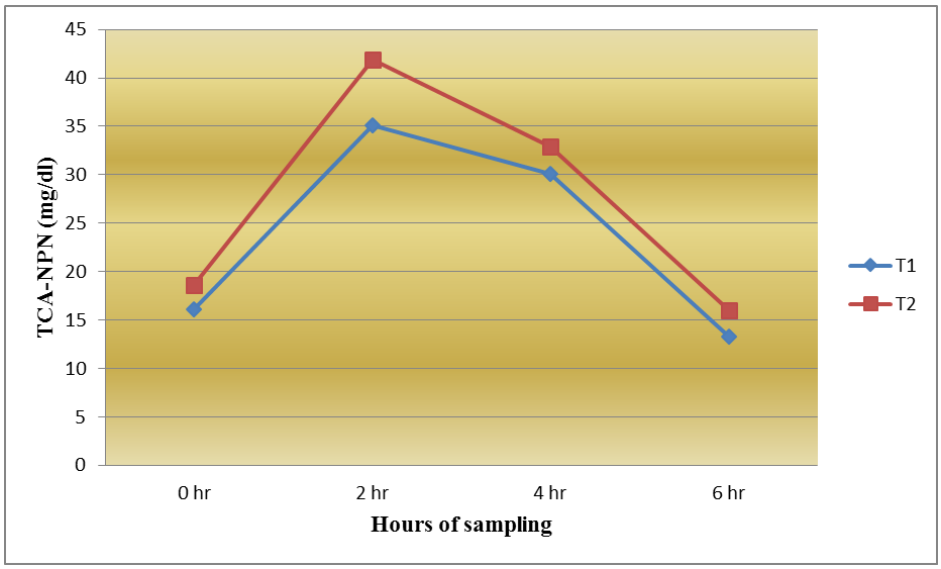

Fig 3 (c): TCA-NPN (mg/dl) in SRL

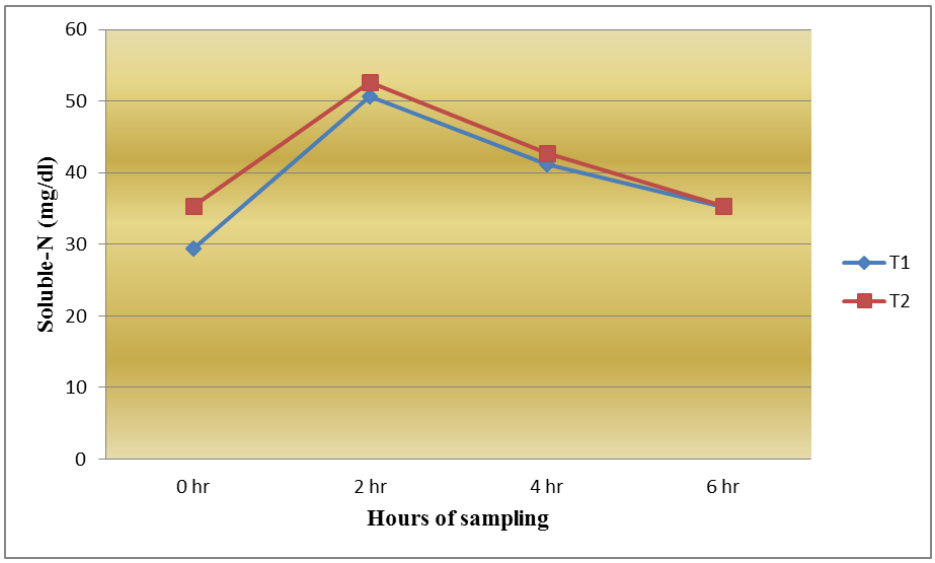

Fig 3 (d): Soluble – N (mg/dl) in SRL

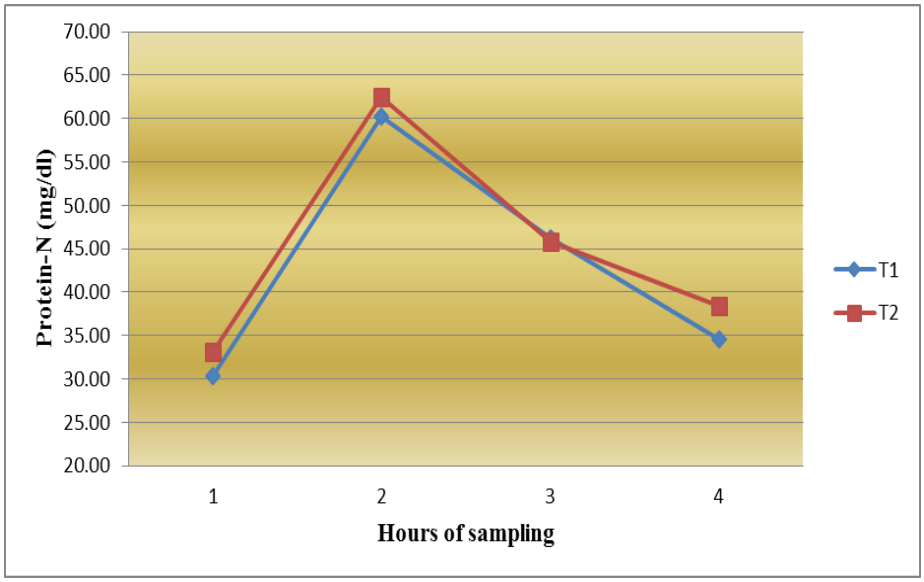

Fig 3 (e): Protein – N (mg/dl) in SRL

4. Acknowledgement
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