



## Effect of Paddy Straw plus Non-Forage Fibre Sources Based Complete Feeds Containing Different Levels of Neutral Detergent Fibre on Body Weight and Reproductive Parameters of Lactating Dairy Cows

Biju Chacko<sup>1\*</sup>, K. M. Syam Mohan<sup>2</sup>, K. Ally<sup>3</sup> and K. Shyama<sup>4</sup>

<sup>1</sup>Assistant Professor and Head (I/c), Department of Animal Nutrition, College of Veterinary and Animal Sciences, Pookode, P.O. Lakkidi, PIN- 673576. Wayanad District. Kerala State

<sup>2</sup>Professor and Head, University Livestock Farm and Fodder Research and Development Scheme,

<sup>3</sup>Professor and Head, Department of Animal Nutrition, College of Veterinary and Animal Sciences, Mannuthy, P.O. Mannuthy, PIN- 680651. Thrissur District. Kerala State

<sup>4</sup>Professor and Head, Cattle Breeding Farm Thumboormuzhy, P.O. Konnakkuzhy, PIN- 680721. Thrissur District. Kerala State

\*Corresponding Author E-mail: [bijuchacko@kvasu.ac.in](mailto:bijuchacko@kvasu.ac.in)

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### ABSTRACT

A study of six months duration was conducted to assess the body weight and reproductive parameters of lactating dairy cows fed on paddy straw plus non-forage fibre sources based complete rations containing different levels of NDF, in two phases, viz., early and mid lactation. Three isonitrogenous and isocaloric complete rations, T1, T2 and T3 with 25, 30 and 35 per cent NDF, respectively were formulated as per ICAR-NIANP (2013). Paddy straw was the sole source of roughage NDF, with the rest of NDF being met from non-forage sources, in all the three rations. Eighteen dairy cows yielding approximately 10 kg of milk per day were divided into three groups of six each, and allotted to the three experimental rations. During the first four fortnights of phase I, the cows fed on ration T3 had a significantly higher ( $P < 0.05$ ) body weight than those fed on T1 and T2, while T1 and T2 were similar ( $P > 0.05$ ). From the fifth fortnight onwards till the end of the experiment, the body weight of animals fed on all three rations, were similar ( $P > 0.05$ ), even though it tended to be higher with in cows fed on ration T3, than those fed on T1 and T2. Average period for the first postpartum heat of cows fed on the three rations were similar ( $P > 0.05$ ), even though it was earlier in case of cows fed on the experimental ration T3 than those fed on T1 and T2.

A thorough evaluation of the results obtained in the present study, reveal that the animals in all the three dietary treatments performed well, with the complete rations T3 with 35 per cent NDF, showing better performance than and T2 with 30 per cent NDF and T1 with 25 per cent NDF. The cows fed on ration T3 were able to manage negative energy balance better, started gaining weight from the first fortnight onwards and came into heat earlier than the animals fed on rations T1 and T2, indicating that T3 was the best ration. These results suggest that complete rations with 25 to 35 per cent NDF, containing paddy straw as the sole source of roughage NDF, with the rest of NDF being met from non-forage sources, can be recommended for use among early and mid lactation dairy cows, with 35 per cent being the ideal NDF level.

**Keywords:** Complete feeds, NDF, Paddy straw, Non forage fibre sources, Body weight, Reproductive parameters, Cows

## INTRODUCTION

The fibrous and non-fibrous carbohydrate fractions of the diet are the principal sources which contribute to the energy requirements of lactating dairy cows. To achieve maximum production, dairy rations should be balanced in neutral detergent fibre (NDF), i.e., the useful fibre, at the same time not compromising on the non-fibrous carbohydrate fractions so that optimum energy intake and rumen health are ensured. The National Research Council (NRC) of USA has recommended that a milking cow should be fed with a ration containing at least 25 to 33 per cent of fibre in the form of NDF (NRC, 2001).

However, providing even this minimum quantity of fibre, from forage sources alone, is very difficult because, currently in India, green fodder is deficit to the tune of 56.73 per cent (Datta, 2013) and in Kerala, the deficit was 78.02 per cent (Government of Kerala, 2013). This scarcity of green fodder could only be met in a sustained manner through the efficient use of crop residues that do not compete with human food.

Paddy and wheat straws are the staple feeds for ruminants in India. In the Northern states of India, wheat straw was preferred for feeding of livestock while most of the paddy straw was burnt. The need of the time was to blend crop residues such as straws along with locally available agro-industrial by products like brans and oil cakes like coconut cake, which are non-forage fibre sources and also good sources of NDF. Once the NDF requirement is met in this manner, other concentrate ingredients can be added to it to form a complete feed or complete diet (Lailer et al., 2005).

A feasible and practical feeding practice that can hence be adopted is to provide feed in the form of complete diets with the minimum amount of forage NDF. Paddy

straw can be used as the sole source of forage NDF in complete rations for cows (Sadagopan & Sunder, 1997). Among the various roughages like grasses and straws, straw has got the highest rate of chewing and hence is most effective when added to complete feeds (Stone, 2004).

However, the optimum level of NDF in complete feeds, required to obtain maximum milk production, at the same time not compromising on its body weight and reproductive performance, needs to be studied. Most of the researches done on complete feeds in the western countries are grass based. In India, not much research has been conducted for formulating a paddy straw plus non-forage fibre sources based complete feed with the optimum NDF level for lactating dairy cows. Therefore, this investigation was carried out to assess the effect of paddy straw plus non-forage fibre sources based complete feeds containing different levels of NDF on body weight and reproductive parameters of lactating dairy cows.

## MATERIALS AND METHODS

Eighteen crossbred dairy cows in the early stage of lactation (within 2 weeks of calving) were selected from the University Livestock Farm and Fodder Research and Development Scheme (ULF & FRDS), Mannuthy. They were divided into three groups of six each, as uniformly as possible with regard to age, parity, milk yield and body weight and were allotted randomly to three complete rations, T1, T2 and T3, containing different levels of NDF, viz. 25, 30 and 35 per cent, respectively. The rations were made isonitrogenous (12.00 to 12.70 per cent CP) and isocaloric (63 to 65 per cent TDN) and were compared on the basis of feeding trials of total 180 days duration, in two phases of three months each, the first 90 days being the early lactation and the next 90 days being the mid lactation.

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The ingredient composition of the experimental rations and their calculated nutrient content in phases I and II of the experiment are depicted in Tables 1 and 2, respectively. All the animals were fed with the respective rations *ad libitum* and were maintained under uniform management conditions prevailing in the farm. Proximate principles of feed were determined as per standard procedure (AOAC, 2012). The acid detergent fibre and neutral detergent fibre (NDF) were estimated by the method of Van Soest et al. (1991).

The animals were weighed at fortnightly intervals and the body weights were recorded. The animals were carefully observed for the signs of oestrus and those that showed the signs were inseminated regularly. Days to first post partum heat, conception rate and service period of the conceived animals were recorded.

Data gathered on the various parameters were analysed statistically using repeated measures of analysis of variance (ANOVA) technique as per Snedecor and Cochran (1994), using the software, statistical product and service solutions (SPSS) version 21.0 (SPSS 2012). Homogenous subsets were separated using Duncan's multiple range test, described by Duncan (1955). Differences among treatments were considered to be significant, when  $p \leq 0.05$ .

## RESULTS AND DISCUSSION

**Body weight:** The data on body weight of cows fed on the experimental rations, at fortnightly intervals in phase I, given in Table 3, reveal that the initial body weight of the animals in the three groups, T1, T2 and T3 were  $318.50 \pm 7.68$ ,  $313.17 \pm 8.49$  and  $322.67 \pm 11.62$  kg, respectively. On perusal of the data, it could be seen that during the first four fortnights of phase I, the cows fed on ration T3 had a significantly higher ( $P < 0.05$ ) body weight than those fed on T1 and T2, while T1 and T2 were similar ( $P > 0.05$ ). These results of significant increase in body weight in cows fed on the high NDF ration as compared to those fed on the low NDF ration

are in agreement with the previous work with complete feeds in early lactation dairy cows by Ruiz et al. (1995) who reported that the body weight of cows increased linearly with increase in NDF content of the diet. The body weight of animals fed on all the experimental rations were similar in the fifth and sixth fortnights and the body weight of the animals at the end of phase I were  $336.67 \pm 8.31$ ,  $338.33 \pm 9.85$  and  $357.00 \pm 13.92$  kg respectively, for the cows fed on T1, T2 and T3. Similarity in body weight between cows fed on the three experimental rations from the fifth fortnight onwards, found in this study is in accordance with the work of Kendall et al. (2009) who reported that the body weight of cows fed on wheat straw based complete diets with 28 and 32 per cent NDF, were similar.

Negative energy balance (NEB) in early lactation characterised by mobilisation of body tissue reserve which is manifested as reduction in body weight is an accepted phenomenon in early lactation dairy cows and cows usually take about six weeks to reach a positive balance and start gaining weight (Ensminger, 1990). From this study it could be seen that cows fed on the ration T3, started gaining weight from the first fortnight itself; while those fed on T2 started gaining weight from the second and those fed on T1 started gaining weight from the third fortnight onwards. These results indicated that the cows fed on all the three experimental rations consumed enough energy to meet their requirements during the most critical period, the first six weeks of lactation, to reach a positive balance earlier and once the positive balance was achieved they continued to increase in body weight.

These results of gain in body weight from the first day onwards till the end of phase I in cows of all the dietary treatments are comparable to that of Delahoy et al. (2003) who reported that the milk yield of cows fed on a ground corn containing complete ration and a NFFS based complete feed, were similar and Raseel (2018) who observed that the body weight of lactating dairy cows fed on a conventional complete ration and a complete

ration in which 1/3<sup>rd</sup> of the energy source maize in the complete ration was replaced with an energy rich unconventional feed, pineapple waste, were similar.

The gain in body weight, observed in the present study was better than those reported by Hundal et al. (2004) who reported a time duration of more than six weeks post-partum to achieve a gain in body weight, in cross bred milking cows fed on a TMR and a conventional hay-concentrate feed, with the values being similar, among groups.

The fact that the cows fed on ration T3 started gaining weight from the first fortnight onwards while those fed on T2 and T1, started gaining weight from only the second and third fortnight, respectively, suggest that the cows fed on the ration T3, with 35 per cent NDF were able to withstand negative energy balance better than those fed on the other two rations, with less of NDF.

The data given in Table 3 reveal that the average body weight of the animals fed on the three experimental rations; T1, T2 and T3 at the beginning of phase II were 336.67±8.31, 338.33±9.85 and 357.00±13.92 kg, respectively. The body weight of the animals at the end of phase II were 372.67±11.53, 378.00±12.73 and 392.83±21.12 kg, respectively, for cows fed on the experimental rations T1, T2 and T3. On perusal of the data, it could be found that there was no significant difference ( $P>0.05$ ) between the three dietary treatments during phase II, but the body weight tended to be higher with higher levels of NDF in the diet.

Similarity in body weight between treatments as observed in phase II of the present study was observed by Pereira et al. (1999) who reported that the body weight of mid lactation cows fed on complete diets in which the NDF of forage was partially replaced with NDF from non-forage fibre sources (NFFS), were similar. Similarity in body weight of cows fed on complete rations with NDF content in the range of 30 to 33 per cent, but varying in peNDF was reported by Yang and Beauchemin (2005) and Yang and Beauchemin (2006a) using corn silage based

complete rations and Yang and Beauchemin (2006b) using barley silage based complete rations.

The average body weight of the animals fed on the experimental rations T1, T2 and T3, in the total experimental period was 343.13±9.50, 344.83±9.47 and 361.60±16.12 kg, respectively, which are comparable to the average body weight of 348.80 kg reported by Paul *et al.* (2004) in a study carried out by analysing the data from 72 cows, yielding on an average 8.82 kg of fat corrected milk per day. These values are however; lower than the average body weights ranging from 424.50 to 453.40 kg, reported by Girdhar and Balaraman (2005) in lactating cows fed on TMRs with varying levels of protein and energy and Raseel (2018) who observed that the body weight of lactating dairy cows fed on a conventional complete ration and a complete ration in which 1/3<sup>rd</sup> of the energy source maize in the complete ration was replaced with pineapple waste, were 373.62 and 388.62 kg, respectively.

A thorough examination of the results of body weight in the present study, given in the Table, indicate that the animals fed on all the three dietary treatments, which started to gain weight in phase I, consumed enough energy to meet their requirements in phase II also and continued to increase in body weight, till the end of the experiment.

Reproductive parameters: The data regarding the reproductive performance of cows fed on the three experimental rations given in Table 4, indicate that the average period for the first postpartum heat was 70.17±8.02, 80.33±8.04 and 65.50±11.76 days respectively, for the cows fed on the three experimental rations T1, T2 and T3, with no significant difference ( $P>0.05$ ) between the three dietary treatments, even though it was earlier in case of cows fed on the experimental ration T3 than those fed on T1 and T2.

The number of days to first post-partum heat, in cows fed on the rations T3 and T1 of the present study were better, while the values of those fed on ration T2 was comparable to those reported in early lactation

by Ally et al. (2007) who obtained values ranging from 79.40 to 122.00 days in dairy cows fed on conventional paddy straw-concentrate rations where the NDF content of the total ration was in the range of 30.72 to 34.76 per cent; Mohan (2003) who reported values ranging from 81.67 to 81.83 days in dairy cows fed on conventional paddy straw-concentrate rations with total NDF content of 38.62 and Dominic et al. (2015) who reported values ranging from 74.17 to 105.17 days in cows fed on the conventional grass – concentrate.

The data on service period given in the Table reveal that the number of days from calving to successful insemination was  $83.00 \pm 16.00$ ,  $97.50 \pm 4.50$  and  $92.00 \pm 4.50$  days for the conceived animals fed on the three experimental rations, T1, T2 and T3, respectively. These values are better than the service period values of 124.33 and 143.33 days observed by Mohan (2003) in his two groups in an experiment conducted on lactating cows fed on conventional paddy straw-concentrate rations.

Two out of the total six animals, in each dietary treatment conceived within the total experimental period, giving a conception rate of 33.33 per cent in all the three treatments of this study. These conception rates obtained in the present study are better than those reported by Ally et al. (2007), where only one animal in each group conceived, with a conception rate of 16.67 per cent in her study conducted in lactating dairy

cows fed on conventional paddy straw-concentrate rations.

The number of inseminations per conception of the animals fed on the three experimental rations T1, T2 and T3 were  $1.00 \pm 0.00$ ,  $2.00 \pm 1.00$  and  $2.50 \pm 1.50$ , respectively. The values of the present study are comparable to that of Dominic et al. (2015) who reported that the average number of inseminations per conception was 1.40, 2.00 and 2.30, in a study conducted on lactating dairy cows. These values are better than the values of Mohan (2003) who reported that the average number of inseminations per conception was 3.66 and 4.33, in the two groups, in a study conducted in lactating cows.

Scrutiny of the data on period of first postpartum heat given in Table 4 as well as the data on body weight given in Table 3 indicated that the cows in T3 fed on the complete ration with 35 per cent NDF started to gain weight from the first fortnight itself and were the earliest to come into heat. Drackley and Cardoso (2014) from studies conducted in high yielding dairy cows under confined TMR systems, reported that the primary factor which impeded fertility was the extent of negative energy balance early postpartum. The earlier postpartum heat observed in cows fed on the experimental ration T3 is in accordance with the above finding, because these cows were able to manage negative energy balance better, started gaining weight from the first fortnight onwards and came into heat earlier than the animals fed on rations T1 and T2.

**Table 1: Ingredient composition of experimental complete feeds offered to cows in phases I and II, kg**

Ingredient	Phase I			Phase II		
	T1	T2	T3	T1	T2	T3
Maize	37	27	16	38	30	21
Coconut cake (de-oiled)	11	12	17	5	8	12
Rape seed meal	11	12	11	10	10	10
De-oiled rice bran	20	19	16.50	26	23	21
Paddy straw	14	21	29	14	22	29
Molasses	5	5	5	5	5	5
Calcite	1.50	1.50	1.50	1.5	1.5	1.5
Salt	0.50	0.50	0.50	0.5	0.5	0.5
Vegetable fat	-	2.00	3.50	-	-	-
<b>Total</b>	<b>100*</b>	<b>100*</b>	<b>100*</b>	<b>100*</b>	<b>100*</b>	<b>100*</b>

\* To every 100 kg of complete feed, 10g of Vitamin AD<sub>3</sub>E supplement (containing 10,00,000 IU of Vitamin A, 2,00,000 IU of Vitamin D<sub>3</sub> and 1,00,000 IU of Vitamin E), 50g of trace mineral mixture (KERAMIN FORTE) and 50g of toxin binder (CURATOX) were added

**Table 2: Chemical composition of experimental complete feeds offered to cows in phases I and II, (% DM basis)**

Nutrient	Phase I			Phase II		
	T1	T2	T3	T1	T2	T3
Crude protein	12.23	12.94	12.18	12.40	12.14	12.08
Crude fibre	10.73	12.68	15.01	10.53	12.70	14.85
Ether extract	4.00	3.60	3.80	4.50	3.50	3.60
Total ash	14.00	12.90	12.90	14.10	13.30	12.98
Nitrogen free extract	59.04	57.88	56.11	58.47	58.36	56.49
Acid insoluble ash	5.30	5.60	6.00	4.80	5.40	6.20
Neutral detergent fibre (NDF)	25.88	30.03	35.59	25.94	30.86	35.38
Acid Detergent fibre (ADF)	21.60	23.10	24.80	21.80	23.00	25.01
Calcium	0.83	0.85	0.87	0.81	0.84	0.86
Phosphorus	0.54	0.52	0.48	0.59	0.55	0.52
Metabolisable energy* (MJ/ kg DM)	9.00	8.87	8.41	9.04	8.54	8.24

\* Calculated value

**Table 3: Body weight\* of animals maintained on the three experimental rations in phases I and II, kg**

Phase	Fortnight	Body weight (kg)		
		T1	T2	T3
I	<b>Initial</b>	<b>318.50± 7.68</b>	<b>313.17± 8.49</b>	<b>322.67± 11.92</b>
	1	313.67±9.00 <sup>a</sup>	308.33±8.06 <sup>a</sup>	331.83±12.63 <sup>b</sup>
	2	316.67±8.77 <sup>a</sup>	314.50±8.18 <sup>a</sup>	336.00±12.54 <sup>b</sup>
	3	319.00±8.49 <sup>a</sup>	318.00±7.66 <sup>a</sup>	340.17±13.51 <sup>b</sup>
	4	322.17±9.01 <sup>a</sup>	320.67±7.74 <sup>a</sup>	347.00±15.06 <sup>b</sup>
	5	332.50±8.33	328.00±8.14	348.00±15.21
	6 (Final)	336.67±8.31	338.33±9.85	357.00±13.92
	<b>Mean±SE</b>	<b>323.44±8.49</b>	<b>321.31±8.16</b>	<b>343.33±13.68</b>
II	<b>Initial</b>	<b>336.67±8.31</b>	<b>338.33±9.85</b>	<b>357.00±13.92</b>
	1	344.67±9.17	348.67±10.31	365.83±16.59
	2	352.67±10.47	356.33±10.70	368.83±17.68
	3	356.50±10.32	360.83±10.85	372.17±17.83
	4	360.33±10.58	365.50±11.08	375.33±18.03
	5	364.33±10.77	370.50±11.67	380.33±18.53
	6	368.83±11.01	375.17±12.42	385.5±19.32
	7 (Final)	372.67±11.53	378.00±12.73	392.83±21.12
	<b>Mean ± SE</b>	<b>360.00±10.50</b>	<b>365.00±11.11</b>	<b>377.26±18.41</b>
<b>Mean ± SE of total experiment</b>	<b>343.13±9.50</b>	<b>344.83±9.47</b>	<b>361.60±16.12</b>	

\*Average of six values

a,b: means with different superscripts in the same row differ significantly (P&lt;0.05)

**Table 4: Reproductive parameters of animals maintained on the three experimental rations**

Treatment	Animal No.	Period of first postpartum heat (days)	Service period (days)	Number of inseminations per conception
T1	D 135	80	not conceived	
	D 144	99	99	1
	D 060	77	not conceived	
	D 198	54	not conceived	
	D 073	67	67	1
	C 497	44	not conceived	
	<b>Average± SE</b>	<b>70.17±8.02</b>	<b>83.00±16.00</b>	<b>1.00±0.00</b>
T2	D 169	76	not conceived	
	D 214	98	not conceived	
	C 425	102	102	1
	D 145	51	93	3
	D 138	66	not conceived	
	D 081	89	not conceived	
	<b>Average± SE</b>	<b>80.33±8.04</b>	<b>97.50±4.50</b>	<b>2.00±1.00</b>
T3	C 081	70	not conceived	
	D 077	51	not conceived	
	TF 214	51	133	4
	D 168	122	not conceived	
	D 195	48	not conceived	
	D 007	51	51	1
	<b>Average± SE</b>	<b>65.50±11.76</b>	<b>92.00±4.50</b>	<b>2.50±1.50</b>

### CONCLUSION

The results obtained in the present study, reveal that the animals in all the three dietary treatments performed well, with the complete rations T3 with 35 per cent NDF, showing better performance than and T2 with 30 per cent NDF and T1 with 25 per cent NDF. The cows fed on ration T3 were able to manage negative energy balance better, started gaining weight from the first fortnight onwards and came into heat earlier than the animals fed on rations T1 and T2, indicating that T3 was the best ration. These results suggest that complete rations with 25 to 35 per cent NDF, containing paddy straw as the sole source of roughage NDF, with the rest of NDF being met from non-forage sources, can be recommended for use among early and mid lactation dairy cows, with 35 per cent being the ideal NDF level.

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