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Comparatives Study of Paddy Straw Based Complete Ration with Pineapple Waste as Unconventional Feed Source on the Production Performance of Cross Bred Dairy Cows in Early Lactation in Hilly Regions of Wayanad

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Abstract

A study was conducted for the comparative evaluation of conventional and Pineapple waste-based TMR in dairy cows on the basis of production performance. Two isonitrogenous and isocaloric complete rations, T1 with conventional feed ingredients and T2 by replacing 1/3rd of maize with pineapple waste, respectively, were formulated. A feeding trial of 90 days duration was conducted in dairy cows yielding approximately 10 litres of milk per day and within ten days of lactation. It could be found that the body weight, DMI and The milk yield of cows fed on T1 and T2 started increasing from the first fortnight onwards and was similar between treatments (P>0.005) in all the fortnights and average daily milk yield of cows fed on ration T2 (12.94 kg) was significantly higher (P<0.01) than those fed on T1 (11.94 kg). The milk composition parameters were similar (P>0.05) between treatments. These findings indicate that pineapple waste could be used to substitute maize and can be successfully incorporated in paddy straw based complete ration containing 35 per cent NDF for lactating dairy cows.

Keywords: Complete Ration, Dairy Cow Rearing, Milk Yield, Pineapple Waste, Unconventional Feeds

Introduction

India ranks second in cattle population (FAO Stat Data, 2015) and first in milk production in the world, accounting for 18.50 per cent of the world's milk production with an annual output of 155.50 million tonnes in 2015-16 (DAHD, 2017). We have a population of 190.90 million heads of cattle as per the 2012 livestock census (DAHD, 2017). The cattle population in Kerala as per the 2012 census was 13.28 lakhs, which was only 6.96 per cent of the Indian cattle population (Government of Kerala, 2015). However, Kerala had a milk production of 27.11 lakh tonnes in the year 2015-16 which came to nearly 1.85 per cent of the Indian milk production. This indicates that cows in Kerala, pulls the weight by nearly three times in milk production as compared to the population strength. Six per cent of households of the state comprising, nearly 3.50 lakh farmers, depend on livestock and dairying activities as their principal source of income in Kerala (Government of Kerala, 2015). Dairy farming assumes great significance due to shift of farmers from widely cultivated cash crops to dairying due to fall in prices.

In Kerala, feeding management of dairy cattle involves feeding of concentrate mixtures available in the market along with locally available oil cakes such as groundnut cake and coconut cakes and available roughages such as straw and green fodder. Increased cost of concentrate cattle feed (Rs. 21 per kg) and paddy straw (Rs. 16 to 17 per kg) are the major stumbling blocks in the state as far as profitable dairying is concerned. These reasons have contributed to several dairy farmers quitting the vocation as a result of which cattle population in the state is decreasing, even though the demand for milk and milk products is on the rise. A practical solution for this is to provide feed in the form of complete feed, Complete feeds formulated using conventional feed ingredients having 25 to 35 per cent NDF can be recommended for use among dairy cows, with 35 per cent being the most ideal as observed in a study of six month duration carried out in lactating dairy cows (Chacko, 2015). Complete feeds formulated using conventional feed ingredients were found to be costly. Hence, we have to explore ways of incorporating cheaper unconventional feed ingredients such as agricultural by products, to the extent possible, to make cost effective complete rations for dairy cows.

The growth rate of the agriculture sector in the country has been stagnant since the beginning of the twenty first century and showed a negative growth (-0.20 per cent), for the first time in the year 2014-15. Even though it gained lost ground in the subsequent years by showing 1.20 per cent growth rate in 2015-16 and 4.20 per cent growth rate in 2016-17(Ministry of statistics and implementation, 2017), extraneous factors beyond the farmer's control, for instance climatic variations such as low rainfall and heavy drought; fluctuating and many a times low prices for produce and exploitation by middlemen have cast a gloomy spell over it, indicating that the prospects of the agricultural sector are more or less saturated. This sounds promising for the dairy and meat sectors. In such a scenario, where crop farming is beset with stagnating growth, dairying assumes great significance and is considered as a vital component in the diversification of Indian agriculture. Nearly 70 per cent of the total cost of rearing a cow comes under feed cost (Mondal *et al.,* 2010). The milk yield as per the genetic potential of a cow can be achieved only by giving an adequate amount of concentrates. Feeding practices in India are primarily based on crop residues which give poor milk yield from the animals and the productivity of our animals continues to be low. The average yield of cross bred cows in India at present is only 7.33 litres per day (DAHD, 2017). The green fodder requirement of Kerala in the year 2014 was 7.04 million tonnes per year, but only 25 per cent of this (1.75 million tonnes) was produced per year and there existed a deficit of 5.29 million tonnes (75 per cent). In 2014, the state had a dry fodder requirement of 5.29 million tonnes per year, but only 19 percent was produced with a deficiency of 81 percent (Government of Kerala, 2015).

Bargo *et al.* (2002) conducted a study in lactating Holstein cows and reported that milk production was higher for cows fed on total mixed ration (TMR), intermediate for those fed on pasture plus TMR and lowest for pasture-fed cows. Sruamsiri (2007) observed that pineapple waste from the field or the cannery can be used as dairy feed and dried pine apple waste could replace 50 per cent roughage in total mixed ration for dairy cattle. They reported that the bran (outer peel, skin and core from the pineapple canning industry) and leaves can be used as feed for ruminants. These workers concluded that fermented pineapple waste with higher acidity was preferred over fresh waste from the field. Dried and ensiled pineapple waste can be used as a supplemental roughage source and could replace 50 percent of the same in TMR for cattle (Hossain and Bepary, 2015). Chacko *et al*. (2016) conducted an investigation to assess the effect of complete feeds containing different levels of NDF, *viz*. T1, T2 and T3, with 25, 30 and 35 per cent, respectively, by comparing with the conventional grass- concentrate based feeding system (T4) and reported that the average daily milk yield of cows of groups, T1, T2 and T3, were significantly higher ($p<0.05$) than those fed on T4 and the values were 11.08±0.39, 11.81±0.69, 12.09±0.70 and 8.63±0.50 kg for T1, T2, T3 and T4,

respectively, with T1, T2 and T3 being similar.

Materials and Methods

Two experimental paddy straw based complete rations, T1 with the conventional feed ingredient maize and T2 with one-third of energy source maize grain being replaced by the unconventional feed ingredient identified from *in vitro* study, were formulated. The two experimental rations T1 and T2 were isonitrogenous (15.00 to 16.00 per cent crude protein) and isocaloric (64 to 65 per cent TDN) and were formulated as per the recommendations of ICAR (2013). Twelve crossbred dairy cows yielding approximately 10 litres of milk per day and within 10 days of lactation were selected were divided into two groups of six animals each, as uniformly as possible with regard to milk yield and body weight. The animals were maintained in individual pens to facilitate feeding and watering individually. The animals were checked for signs of health prior to the trial. Five days adaptation period was given prior to the 90 days feeding trial for the cows to get accustomed with the new feeding and management.

Animals were provided *ad libitum* feed. The feed offered and feed residue was measured on daily basis for dry matter analysis and thus dry matter intake of individual cows was calculated, daily milk yield were also observed. Body weight of cows were recorded on fortnightly basis and morning and evening milk samples was collected from individual animals every fortnight and analysed for total solids, solids not fat (SNF) and protein (AOAC, 2016), fat (IS: 1224, 1977) and milk urea nitrogen (Bector *et al*. 1998). A digestibility trial of five days duration was conducted towards the end of the feeding trial by total collection method. Spot urine samples collected over the five days of digestion trial were used to estimate purine derivatives in urine such as urinary allantoin and uric acid and thus the microbial protein production (IAEA-TECDOC-945, 1997). The *in vitro* total gas production from the experimental diets was also determined using the *in vitro* gas production technique (IVGPT) as described by Menke and Steingass (1988) to estimate the ME and also the DOM content in them. From the data gathered on various parameters, the cost of feed per kilogram of milk produced was worked out.

Statistical Method

All the data generated in the above experiments were statistically analysed using SPSS (21) computer package. For comparison of groups, Analysis of Covariance, Independent T-test (Snedecor and Cochran, 1989) were used.

Results and Discussion

Chemical composition of the complete rations used in the experiment are given in Table 1. The CP content (in per cent) of the two experimental rations used were 15.84 and 16.66, respectively on dry matter basis. The TDN content of two experimental rations were 57.60 and 60.57 per cent, respectively on dry matter basis. The NDF content of the rations used were 35.24 and 35.68 per cent, respectively on dry matter basis.

Table 1: Chemical composition of complete rations (%, on DM basis)

Nutrient	T1	T2
Dry matter	90.64	89.97
Crude protein	15.84	16.66
Crude fibre	17.55	13.07
Ether extract	1.96	1.91
Total ash	11.28	10.67
Nitrogen free extract	53.37	57.69
Acid insoluble ash	5.76	5.04
Neutral detergent fibre (NDF)	35.24	35.68
Acid detergent fibre (ADF)	23.76	25.03
Calcium	0.91	0.94
Phosphorus	0.42	0.45
DCP†	11.65	12.43
TDN†	57.6	60.57

† Calculated value

The average body weight of animals fed on the two experimental rations, T1 and T2, at the beginning of the

experiment was 332.17 and 325.00 kg, respectively. On perusal of the data, it could be found that there was no significant difference (P>0.05) between the body weight of animals fed on the two experimental rations in all fortnights. The body weight of animals increased in both groups, from the beginning of the experiment. The negative energy balance usually observed in early lactation due to the mobilization of body fat to meet the demand for milk production was not observed in this study indicates that the cows were fed enough to meet the requirement for maintenance and milk production. Fortnightly body weight and DMI of the experimental animals maintained on the two experimental rations are given in Table 2.

Table 2: Fortnightly body weight (kg) of animals maintained on the two experimental rations

Fortnight	Body weight (Mean ± SE)		t-value	p-value	DMI (Mean ± SE)		
	T1	T2			T1	T2	
Initial	332.17±25.91	325.00±10.88	1.242^{ns}	0.242	14.02±1.08	14.76±0.13	F-value for treatment comparison=0.029^{ns}
1	345.83±26.68	338.5±10.47	0.256^{ns}	0.806	14.96±0.93	14.74±0.74	
2	397.67±30.19	369.58±12.34	0.861^{ns}	0.409	15.51±0.57	14.85±1.00	
3	392.91±30.63	379.17±13.20	0.413^{ns}	0.692	14.72±1.25	15.75±0.51	F-value for fortnight comparison=1.039ns
4	401.17±30.20	386.42±12.07	0.453^{ns}	0.66	15.47±0.53	15.61±0.37	
5	406.50±30.09	392.67±11.85	0.428^{ns}	0.078	16.46±1.03	15.74±0.51	
6	416.33±32.93	398.50±12.53	0.506^{ns}	0.624	15.56±0.79	15.47±0.51	F-value for interaction=0.362ns
7	420.50±33.88	402.58±12.81	0.495^{ns}	0.637	15.24±0.76	15.27±0.47	
Mean ± SE	388.62±11.48	373.62±9.98	6.28^{ns}	0.069	14.02±1.08	14.76±0.13	

Ns- Non-significant at 5% level

The average daily DMI of cows fed on experimental rations given in Table 2 indicates that the values were 14.02 and 14.76 kg, respectively, for cows fed on rations T1 and T2, with the values being similar (P>0.05). Perusal of the data indicate that peak DMI was attained by sixth fortnight of experiment in both groups and there were a gradual increase in DMI as the work progresses. The average DMI per 100 kg body weight of animals fed on the two experimental rations, T1 and T2 was 3.87 and 4.043 kg, respectively, with the values being similar(P>0.05). The comparison between the DMI per 100 kg body weight and DMI per kg metabolic body weight of the animals, for the two experimental rations are given in Table 3.

Table 3: DMI per 100 kg body weight and per kg metabolic body weight of the animals maintained on the experimental rations

Parameter	T1	T2	t-value (p-value)
DMI, kg/100 kg body weight	3.87±0.06	4.04±0.07	2.020^{ns} (0.071)
DMI, kg/ kg metabolic body weight	0.17±0.003	0.18±0.03	1.534^{ns} (0.156)

ns- Non-significant at 5% level

The milk yield of cows fed on both the rations started increasing from the first fortnight itself. Peak yield was attained in T1 and T2 at sixth fortnight. The milk yield of animals, though similar (P>0.05) between fortnights, was significantly higher (p<0.01) in T2 than T1, the values being 11.94 and 12.94 kg, respectively. The significantly higher milk yield in cows fed on ration T2 with added pineapple waste, as against those fed on T1 without pineapple waste, might probably be due to the increased level of easily digestible carbohydrate and increased energy digestibility of pineapple waste as reported by Maneerat *et al.* (2013) who obtained similar results in an experiment conducted in mid-lactation Holstein cows. The average fat content of the seventh and final fortnight was significantly higher than (P<0.05) the initial fortnight with the initial and final fat contents being 3.25, 3.60 per cent and 3.97, 4.20 per cent, for T1 and T2, respectively. However, there was no significant difference (P>0.05) in milk fat levels between treatments, in any of the fortnights. Similar observations were noticed in total solid and SNF contents of milk of both groups. Whereas the MUN and milk protein contents were similar between treatments as well as fortnights and are in the normal range of domestic cattle.

Table 4: Average daily milk yield (kg) of cows maintained on the experimental rations

Fortnight	Mean ± SE	
	T1	T2
Initial	10.13±0.34	10.98±0.59
1	11.19±0.44	13.39±1.21
2	11.76±0.48	12.38±0.65
3	11.45±0.49	12.32±0.67
4	11.62±0.50	12.61±0.62
5	11.91±0.46	13.00±0.68
6	12.92±0.49	13.47±0.79
7	12.75±0.53	13.38±0.85
Mean ± SE	11.94±0.19	12.94±0.29
F-value for treatment comparison=7.7659**		
F-value for fortnight comparison=1.157ns		
F-value for interaction=0.365ns		

*ns- Non-significant at 5% level; ** Significant at 1% level*

Table 5: Composition of milk from cows maintained on the two experimental rations

Parameters	Treatment	Fortnights							t-value# (p-value)
		1	2	3	4	5	6	7	
Fat (g %)	T1	3.25±0.09	4.13±0.33	3.47±0.23	3.55±0.18	3.52±0.14	4.02±0.21	3.97±0.18	3.196* (0.024)
	T2	3.60±0.11	4.25±0.38	3.80±0.10	3.97±0.06	3.60±0.14	4.30±0.19	4.20±0.16	2.720* (0.042)
Total Solids (g %)	T1	11.95±0.48	12.79±0.44	14.77±0.44	14.97±0.64	13.49±1.00	13.39±0.37	14.72±0.32	4.259* (0.008)
	T2	11.88±0.92	13.31±0.35	14.29±0.38	14.32±0.77	13.54±0.74	12.08±0.73	14.39±0.16	2.873* (0.035)
SNF (g %)	T1	8.69±0.54	8.66±0.68	11.31±0.46	11.43±078	9.97±1.04	9.39±0.41	10.75±0.26	3.497* (0.017)
	T2	8.22±0.89	9.06±0.44	10.49±0.43	10.350.81	9.95±0.74	7.78±0.70	10.17±0.27	0.2.243ns (0.0751)
Protein (g %)	T1	3.23±0.16	2.83±0.08	2.93±0.15	3.14±0.12	3.47±0.07	3.04±0.09	2.85±0.17	1.429ns (0.212)
	T2	2.98±0.14	2.87±0.02	2.99±0.13	3.37±0.15	3.80±0.16	3.04±0.02	3.07±0.04	0.199ns (0.85)
Milk urea nitrogen (mg %)	T1	11.59±0.33	12.23±0.30	12.27±0.17	11.99±0.27	12.14±0.16	12.09±0.21	12.11±0.25	1.936ns (0.111)
	T2	12.02±0.29	12.12±0.29	12.60±0.25	12.37±0.24	12.42±0.22	12.05±0.20	12.10±0.21	3.197* (0.024)

*ns- Non-significant at 5% level; * Significant at 5% level*

The average digestibility coefficient of DM, OM, CP, CF, EE, NFE, NDF and ADF were similar (P>0.05) in cows fed on the two experimental rations, T1 and T2, respectively and the values are in the normal range for dairy cattle. The net corrected gas production of the two experimental rations T1 and T2 was 48.00 and 51.00 ml per 200ml DM, respectively with the values being similar (P>0.05) among the two treatments. The ME of the two experimental rations T1 and T2 was 8.53 and 8.82 MJ/kg DM, with the values being similar (P>0.05) among the two dietary treatments. The DOM of the two experimental rations T1 and T2 was 66.88 and 67.76 per cent, with the values being similar (P>0.05) among the two dietary treatments. The cost per kg milk produced by cows fed on the two experimental rations; T1 and T2 was Rs.36.82 and 34.22, respectively, with T2 having a lower cost of production by Rs. 2.60 than T1.

Table 6: Digestibility coefficient of nutrients of the rations (%, on DM basis)

Nutrient	T1	T2
Dry matter	78.18±0.85	79.30±0.25
Crude protein	73.53±2.09	74.63±1.55
Crude fibre	54.29±1.60	49.87±1.07
Ether extract	63.90±5.79	68.07±4.89
Organic matter	79.74±0.95	81.67±0.37
Nitrogen free extract	62.97±6.37	67.07±10.00
NDF	56.94±0.60	57.85±11.70
ADF	47.90±1.18	46.85±0.85

** Average of six values*

Conclusion

These results indicate that pineapple waste can be used to provide one-third of the energy, as a substitute for the costly ingredient maize and can be successfully incorporated in paddy straw based complete ration containing 35 per cent NDF for lactating dairy cows. Such a complete feed shall contribute a great deal in helping the farmers to rear cows in towns and cities, where the demand for milk is huge, but the availability of feed and fodder is practically nil.

Conflict of Interests

There is no conflict of interest.

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