A study on making complete feed blocks for cattle with different combination of fodder grasses and agricultural wastes

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Abstract- Present study was carried out to develop a cost effective complete feed block with long shelf life using locally available fodder grasses and agricultural wastes. Three different complete feed blocks (T1, T2 and T3) were formulated to meet the daily requirement of 250kg heifers. Compacted blocks were formed in T1 and T2, while, T3 formed loose mass. The lowest (P< 0.05) free fatty acid content was observed in T2 while T3 had the highest. The highest (P< 0.05) dry matter, ash, ether extract, crude fiber and acid detergent fiber percentage were recorded in T1. Higher (P< 0.05) neutral detergent fiber, calcium and phosphorus contents were observed in T2 compared to T1 and T3. The highest (P< 0.05) crude protein and total digestible nutrient content were recorded in T3. The costs of production of T1, T2 and T3 to fulfil daily requirement of a heifer (250 kg) were Rs 130.55, Rs 149.75, and Rs 160.60, respectively. Based on the findings of this study, the feed block T3 found to be the best considering total digestible nutrient and crude protein contents but it failed to form the compact block, hence in the present form it is not suitable to make the complete feed block. Considering the shelf life and cost of production, the feed block T1 found to be the best. However, a feeding trial is required to evaluate the growth rate and feed conversion efficiency of heifers to select the best complete feed block.

Index Terms- Agricultural wastes, Complete feed block, Fodder grasses, Nutritive values

I. Introduction

The dairy industry is very important and has tremendous potential in developing the economy of the country (Jayaweera *et al*., 2007). Inadequate feeding is one of the main reasons for sub-optimal productivity of the animals (Karangiya *et al.*, 2016). In Sri Lanka, about 98% of the smallholder dairy farmers neither cultivate nor conserve forage, but instead depend entirely on naturally available forage (Makkar *et al*., 2012). Improper management of feed resources especially that of the bulky and fibrous crop residues is another factor contributing to low productivity of ruminant livestock in tropics. Use of these locally available feed ingredients can substantially reduce the cost of production of livestock. Suitable feeding practices and processing technology would enable the livestock farmer to utilize these resources more effectively resulting in better performance of the animals (Karangiya *et al*., 2016). It is essential to strengthen these interventions without looking for other possibilities to increase local milk production.

In the recent years, the concept of feeding complete rations comprising of fibrous crop residues to dairy animals are popular among farmers. The role of complete ration is to provide a blend of the feed ingredients including roughages without giving any choice to the animal for selection of specific ingredient (Konka *et al*., 2015). Complete feed blocks are solidified high density blocks comprising forage, concentrate and other supplementary nutrients in desired proportion capable to fulfill nutrient requirements of animals (Pankaj Kumar Singh *et al*., 2016).

The technology also has the potential to provide complete feed to livestock under emergency situations created by natural calamities. Production of these types of feeds are very much important for enhancing the productivity of animals and for making use of the available low cost feed material. Therefore this research was carried out to check the feasibility of making complete feed blocks using fodder grasses, concentrates and other agricultural by-products as an economic animal feed and to evaluate the physical and chemical properties and shelf life of formulated feed blocks under Sri Lankan perspectives where the complete feed block is not popular among farmers and commercial livestock feed producers.

II. Materials and Methods

Preparation of complete feed block

Three different complete feed blocks were formulated to meet the daily nutrient requirement of heifers on average weighing 250kg. The composition of the three different treatments are presented in Table 1.

All the raw ingredients were visually inspected and weighed according to the formulae. Straw was chopped into small pieces. Fodder grasses were harvested separately, cut into small pieces with grass cutter and dried under the shade to reduce the moisture content up to 10%.

In order to prepare the complete feed blocks the roughages and the mixture of concentrates and micro nutrients were mixed thoroughly with the binding agent of Palmyra molasses. The complete diets containing the roughages and concentrates at the ratio of 60:40 were subjected to the preparation of complete feed blocks at 2900psi in a compressed solid feed block making machine developed at the National Engineering Research and Development Center of Sri Lanka (NERDC), Ekala, Sri Lanka. Length and width of the blocks were 21cm x 21cm while the height of the block varied 9 -14 cm.

Figure 1: Compressed solid feed block making machine

Figure **2**: Solid complete feed blocks

Table 1: Composition of the experimental complete diets (%)

Ingredients	Treatment 1	Treatment 2	Treatment 3
Rice bran	13.6	1.1	-
Coconut poonac	13.6	13.6	-
Mysore dhal husk	1.1	13.6	-
Cattle mash	-	-	28.3
Rice straw	40.8	29.5	-
Gliricidia	15.9	-	-
Sugar graze	-	27.2	-
CO-3	-	-	56.7
Molasses	10	10	10
Urea	1	1	1
Mineral mixture	2	2	2
Salt	1	1	1
Lime	1	1	1

Data collection

The physical and chemical properties and shelf life of the blocks were evaluated.

Chemical analysis

Composite samples were obtained from 10 random blocks of each treatment. The samples were dried, ground and sieved through 1mm sieve and used for chemical analysis. Percentage of dry matter, ash, crude fiber, ether extract, and crude protein were determined according to Horwitz (2000). Percentage of Acid detergent fiber and Neutral detergent fiber were analyzed as per Soest *et al* (1991). Calcium and Phosphorus % of feed blocks also were determined according to Horwitz (2000).

Physical properties
Mean weight and thickness of complete feed blocks were determined. Durability percentage was determined by dropping three blocks of each treatment from a height of 2m on a concrete floor and the weight retention after the fall was used to estimate the durability%.

Shelf life
Moisture content and free fatty acid percentage as oleic acid were used to examine the keeping quality. In addition visual observation also was done for any change in appearance, color and the odour of the blocks with time.

Cost of production of complete feed blocks
Cost of production of blocks of different treatments was calculated based on the current market price.

Data analysis
Data were analyzed by ANOVA using SAS version 9 and means were separated by Duncan's Multiple Range Test.

III. Results and Discussion

Chemical composition

Table 2: Proximate composition of locally available agricultural wastes and fodder grasses

Feed stuffs	Dry matter (%)	Ash (%)	Crude protein (%)	Crude fiber (%)	Ether extract (%)
Concentrates					
Rice bran	90.07	8.1	9.44	13.69	7
Coconut poonac	87.94	7.1	17.5	15.39	11.1
Mysore dhal husk	89.03	3.4	14.44	22.29	8
Roughages					
Rice straw	89.36	9.8	5.56	36.19	0
Gliricidia	30.64	7.5	17.94	17.74	4.3
Sugargraze	12.78	10.5	10.94	32.23	5.97
CO-3	12.15	13.2	5.25	30.19	6.71

The estimated proximate compositions of the locally available feed stuffs are in par with the values reported by Ibrahim (1988) for the feedstuff in Sri Lanka (Table 2). Nutrient content of commercial cattle mash was about crude protein 16% (min), crude fat 4 % (min), crude fiber 10% (max), ash 12% (max), and moisture 12% (max) as per the leaflet distributed by the company.

Table 3: Percentage of total digestible nutrients (TDN) and digestible crude protein (DCP) of locally available agricultural wastes and fodder grasses (DM %)

Feed stuffs	TDN (%)	DCP (%)
Concentrates		
Rice bran	60.09	4.69
Coconut poonac	53.79	12.09
Mysore dhal husk	77.23	9.28
Roughages		
Rice straw	41.55	1.75
Gliricidia	71.36	12.48
Sugargraze	46.99	6.41
CO-3	48.05	1.49

The estimated TDN (%) and DCP (%) values of the locally available feed stuffs were in par with the values reported by Ibrahim (1988) under Sri Lankan condition (Table3).

Physical characteristics

Table 4: Physical characteristics of complete feed blocks

Complete feed block	Weight (kg)	Thickness (cm)	Durability (%)
Treatment 1	2.13 ± 0.25^{b}	8.9 ± 1.60^{b}	91.32 ± 0.23^{a}
Treatment 2	2.29 ± 0.33^{b}	12.20 ± 1.92^{a}	84.63 ± 0.10^{b}
Treatment 3	3.16 ± 0.25^{a}	13.6 ± 2.07^{a}	6.36 ± 0.11^{c}

Note: Means within a column followed by same superscripts are not significantly different at $P< 0.05$

The differences in physical characteristics weight, thickness and durability are shown in Table 4. The highest and the lowest durability were observed for T1 and T3, respectively. The differences in the weight, thickness and durability may be attributed to the differences in the bulk density of the roughages and roughages cum concentrate mixtures. The differences in bulk density of natural grasses and concentrate mixtures were reported by Samanta *et al*., (2003). In the present study blocks of uniform dimensions were not obtained, the thickness of the block differed among treatment. Current results are not in agreement with the results reported by Pankaj Kumar Singh *et al*., (2016) in India where blocks of similar weight and thickness were obtained for different treatments.
Treatment 3 failed to form the compact block, it might be the reason for its least durability. According to the current study T3 is not suitable to make complete blocks. This may be due to not enough binder for effectively binding the concentrates and roughages and also may be of inadequate pressure created by the compressed feed block making machine, (Ben Saleem *et al*., 2003). If the blocks are more durable it will be easier to handle them both in storage and transportation, (Munasik *et al*., 2013).

Chemical properties

Table 5: Chemical composition (% DM basis) of three different treatments of complete feed blocks

Parameter	Treatment 1	Treatment 2	Treatment 3
Dry matter	90.53 ± 0.14^{a}	89.34 ± 0.58^{b}	86.61 ± 0.30^{c}
Ash	11.22 ± 0.12^{a}	9.68 ± 0.31^{c}	10.42 ± 0.22^{b}
Crude protein	12.56 ± 0.16^{c}	14.59 ± 0.24^{b}	15.73 ± 0.12^{a}
Crude fiber	28.19 ± 0.83^{a}	24.76 ± 0.29^{b}	20.99 ± 0.62^{c}
Ether extract	5.47 ± 0.37^{a}	3.58 ± 0.33^{b}	4.34 ± 0.22^{b}
NDF	46.06 ± 1.18^{b}	49.19 ± 0.94^{a}	38.82 ± 0.36^{c}
ADF	28.70 ± 0.32^{a}	27.94 ± 0.40^{a}	26.67 ± 0.32^{b}
Ca	0.98 ± 0.10^{a}	1.18 ± 0.17^{a}	0.58 ± 0.06^{b}
P	0.14 ± 0.03^{c}	0.91 ± 0.06^{a}	0.49 ± 0.05^{b}
TDN	65.35 ± 0.36^{b}	64.22 ± 0.46^{b}	65.68 ± 0.37^{a}

Note: Means within a row followed by same superscripts are not significantly different at $P< 0.05$

The dry matter percentage of complete feed blocks ranged from 87 to 91 (Table 5), these values are in agreement with the values (87-91%) reported by Kulathunka *et al*., (2015) for different feed blocks. Nutritive value of the complete feed blocks ranged from 12.56 %

to 15.73% and 63.35% to 65.68% in terms of crude protein and total digestible nutrients, respectively. The crude protein percentage of Treatment 2 and 3 was in accordance with the values reported by Munasik *et al*., (2013) in Indonesia who reported that crude protein % was between 13 -14% in the feed blocks made using concentrates and fodder grass Napier. Walli *et al*., 2012 recommended a crude protein (CP) content of the block, varying from 7–14%, and the total digestible nutrients (TDN) content varying from 45–65% for dairy cattle of low producers to high producers. The TDN values obtained were in agreement with the findings of various authors Munasik *et al*., 2013 (64- 65 %) and Buragohain *et al*., 2013 (67 %).

In terms of the percentage of ash the treatment 1 had the highest ash content than the other two treatments. The ash content of the current study was higher than the values (7 to 8%) reported by Somasiri *et al*., 2010, it may be due to the composition of blocks and the addition of mineral mixture to the complete feed blocks in the current study.

The incorporation of higher amount of straw may be the reason for the highest amount of crude fiber in T1 as the fibre content of straw is higher than the other roughages. The crude fiber values are in accordance with the values reported for different crop residue based complete rations by Kulathunga *et al*., 2015 (28-31%).

Ether extract % of treatment 1 was significantly higher than the other two treatments. This may be due to the higher amount of rice bran in the treatment 1 than the others. The results of this study was higher than the findings of Kulathunga *et al*., 2015 in Sri Lanka who reported that ether extract % of different feed blocks made using rice straw, rice bran, coconut poonac, molasses as main ingredients was between the range of 0.35 - 1.5 %. The higher value of ether extract of current study may be due to low level of straw and higher level of rice bran in the formulations.

Higher percentage of NDF % was obtained for treatments 1 and 2. This may be due to the incorporation of *Gliricidia* and sugar graze fodders in treatment 1 and treatment 2 respectively as the grasses contain high amount of fibrous materials. The results of the treatment 1 and 2 were lower than the results obtained by Pankaj Kumar Singh *et al*., (2016) which ranges from 42- 76% for feed blocks which also made using concentrate mixture and rice straw. Samanta *et al*., (2003) also reported a range of 50 to 56% for complete feed blocks with natural grass and concentrate mixture which included leaf meal as well. But the value of treatment 3 was in agreement with Pankaj Kumar Singh *et al*., (2016) of India who reported the NDF % for concentrate feed blocks was 42.8%. The National Research Council recommendations for NDF% in a diet is 25-33 % with minimum 21% coming from forages. The results of the present study were higher than the recommendation of NDF %. This may be due to higher fraction of mature leaves in the ration as stated by Schroeder, (2004).

In terms of ADF% treatment 1 and 2 had higher ADF% than treatment 3. The values obtained for treatment 1 and 2 were lower and the treatment 3 was similar the values obtained by Pankaj Kumar Singh *et al*., (2016) in India. He stated that the ADF % for feed blocks made using roughages and concentrates was between the ranges of 21 to 55%. As the ADF level in feeds increase digestible energy levels decrease, (NRC, 2001). All three treatments in the current study had the lower side of the range which will not hinder the digestibility of complete feed blocks. Samanta *et al*., 2003 reported around 33% of ADF for natural grass cum concentrate mixture complete feed blocks.

Calcium% of current study is in agreement with the finding of Kulathunga *et al*., (2015) in Sri Lanka who reported a range of 0.74 to 1.45%. However the availability on the Ca in the formulated feed blocks are less than the requirement of the animal (1.3%), hence measures should be taken to increase the Ca content of the current diets.

In all diets the available P contentment was lesser than the requirement (1.3%). Kulathunga *et al*., 2015 in Sri Lanka reported a range of 0.5 to 1% P for similar treatments.

Shelf life

Table 6: Moisture content and free fatty acid % of experimental feed blocks

Parameters	Treatment 1	Treatment 2	Treatment 3
Moisture content%	9.47 ± 0.14^c	10.66 ± 0.58^b	13.39 ± 0.30^a
Free fatty acid %	7.09 ± 1.47^b	4.10 ± 0.32^c	11.65 ± 1.31^a

Note: Means within a row followed by same superscripts are not significantly different at $P < 0.05$

The results showed that the treatment 1 had the lowest percentage of moisture content and treatment 3 had the highest (Table 6). Keeping quality will be reduced when the moisture content of feed is high (Hozhabri *et al*., 2006).The down side of increasing moisture levels is that free and 'unprotected' water poses a significant threat to feed quality, as ideal conditions are created for rapid mould growth and the development of mycotoxins,(Heijden *et al*., 2010).

Treatment 2 had the lowest free fatty acid percentage compared to the other two treatments of complete feed blocks whereas treatment 3 had the highest. Keeping quality was reduced when the FFA% of the feed is high. But with the proper packaging and controlling the storage temperature, decomposing rate of oil could be reduced. The maximum limits of edibility vary according to the type of oil but a critical limit of 1% could be taken as a general guide for human food. 5% of FFA was considered as the critical FFA level of animals feeds in some studies, (Somasiri *et al.,* 2010).There was no visible change in colour, texture and no mould growth was noticed during a month of storage.

Cost of production

In order to prepare blocks for 250 kg heifers for a day, the cost of production of T1, T2 and T3 were Rs130.55, Rs149.75 and Rs160.60, respectively. The high cost of commercial dairy mash used as concentrate in T3 might have increased the cost of production of T3.

IV. CONCLUSION

Based on the findings with respect to TDN, and CP, T3 is the best one but it failed to form compact block. But according to durability and cost of production T1 is the best. However, a feeding trial is required to conclude the present findings.

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