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Indexing Ethiopian Feed Stuffs Using Relative Feed Value: Dry Forages and Roughages, Energy Supplements, and Protein Supplements

Dereje Fekadu* Mulugeta Walelegn Geberemariyam Terefe
Holetta Agricultural Research Center, Holetta, P.O.Box 31, Holetta, Ethiopia

Abstract
Once hay is harvested, it is important to determine the nutrient composition so as to match feeds to animal requirements. Crude protein (CP) and relative feed values (RFV), to most livestock farmers, are the basis on how much hay to buy or feed livestock. Relative feed value (RFV) is a prediction of feeding value that combines estimated intake and estimated digestibility into a single index. Digestibility and intake estimates are calculated from the concentration of acid detergent fiber (ADF) and neutral detergent fiber (NDF). This study was designed to compare the values of different feed stuffs. This study was base on three feed types: Dry forages and roughages, Energy supplements, and Protein supplements. The RFV among the grasses natural pasture showed the highest RFV (83%) and the list was seen on rhodus grass (63%); among the crop residues pulse straw was with the highest and the list being wheat straw [pulse straw was the only legume straw with RFV of 96%, between the stovers: maize stover was with the higher RFV (69%), and among the cereal straws barley straw had the highest RFV (68%) and the list was found in wheat straw (61%)]; among the energy supplements sorghum grain was with the highest (246%) and the list is found to be wheat short (130%). In the protein supplement feed stuffs among the foliages cassava leaf had have the highest RFV (223%) while the list was on luceana (101%), among the legumes alfalfa had the highest RFV (218%) and the list was on pigeon pea (95%), among the oil seed cakes linseed cake had the highest RFV (201%) and list was on noug seed cake (175%).
Keywords: bran, foliages, grasses, oil seed cakes, peals, straws, stovers, legumes

1. Introduction

Forages play a significant role in livestock nutrition where feed cost accounts 70% of the total cost of production and in Ethiopia approximately 85% of all feed units are from pasture, hay and crop residues. Natural pasture is estimated to contribute 80 – 90% of livestock feeds while crop residues contribute up to 50% of the feed in mixed farming system (Negesse *et al.* 2009). In well-managed systems, these feed resources can supply year-round nutrition to the livestock with minimal supplementation from agro-industrial byproducts.

Once hay is harvested, it is important to determine the nutrient composition so as to match feeds to animal requirements. Crude protein (CP) and relative feed values (RFV), to most livestock farmers, are the basis on how much hay to buy or feed livestock.

Relative feed value (RFV) is a prediction of feeding value that combines estimated intake and estimated digestibility into a single index. This is an equation that nutritionists have come up with to simplify the interpretation of hay analyses and to give more general estimates of forage quality. It was designed to help rank the potential energy intake of different feed stuffs by ruminants and takes into account the expected digestibility as well as the expected level of consumption. That is, it is used to compare similar forages for two important qualities—how well it will be consumed and how well it will be digested. Basically, the assumption is the better the quality the more easily the animal will digest and the more it can consume. Digestibility and intake estimates are calculated from the concentration of acid detergent fiber (ADF) and neutral detergent fiber (NDF). As a forage plant matures, it becomes more fibrous and stemy, which results from increased ADF and NDF concentrations. So as ADF and NDF increase, RFV decreases. That is, RFV is determined by its content of Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF). The ADF component evaluates the content on cellulose and lignin in forage and is closely related to digestibility. NDF is an evaluation of the total fiber content which includes hemicelluloses in addition to the cellulose and lignin content. The NDF content is related to intake because it evaluates the bulkiness of forage.

This study was designed to compare the values of different feed stuffs, or make an overall assessment of the feed stuffs nutritional value on which nutritionists have come up with equations to give more general estimates of forage quality.

2. Material and methods

2.1 This study was base on three feed types

Dry forages and roughages (grasses: Napier grass, Pasture, Thatch grass (*Hyparrenia rufa)*, Sugarcane top, Hay, Panicum, and Rhodus, and crop residues: Barley straw, Sorghum stover, Maize stover, Maize leaf, Oats straw, Pulse straw, Tef straw, Wheat straw), Energy supplements: Cassava root (tuber), Cassava peal, maize grain/flour,

Rice bran, Sorghum grain, Wheat bran, Wheat middling, Wheat short, and Protein supplements: (foliage: Acacia, Cassava leaf, Lucanea, Moringa leaf and/or twig, Sesbania; legumes: Alfalfa, Cowpea, Pigeon pea, Vicia; and oil seed cakes: Cotton seed cake, Linseed cake, Noug seed cake)

2.2 Sampling sites

All samples were collected in Ethiopia. That is, samples of dry forage and roughages (grass and crop residues), energy supplements, and protein supplements (foliages, legumes, and oil seed cakes) were collected from DZARC (Debre zeit agricultural research center) area, Andassa area, Bako area, Shashemene area, Adamitulu area, Addis Ababa area, HARC (Holetta agricultural research center) area, Areka area, and Hashenge area as per availability of the feed samples.

2.3 Collection and sample processing

Representative samples of each material collected from respective sites were prepared and made ready for chemical analysis. The neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined according to (Van Soest and Robertson 1985; Undersander *et al*. 1993) and Crude protein (CP) was determined according to AOAC (1990) procedure.

2.4 Developing index

Relative feed values were calculated following an equation developed (Rohweder *et al.* 1978; Linn *et al.* 1987; Holland and Kezar 1990). Data were analyzed using MINITAB statistical package (MINITAB for Windows, release 17).

3. Result

The relative feed value index which ranked dry forages and roughages (grasses and crop residues), energy supplements, and protein supplements (foliages, legumes, and oil seed cakes) by potential digestibility and dray matter intake to be used to allocate them to the proper livestock classes with a given level of expected performance clearly shown in the tables below (Table 1, 2, and 3respectively). The relative feed value index is calculated from digestible dry matter and dry matter intake. Where, digestible dry matter is an estimate of the total digestibility of the feed and is calculated from acid detergent fiber (ADF) and dry matter intake is an estimate of the amount of feed an animal will consume in percent of body weight and is calculated from percent neutral detergent fiber (NDF).

4. Discussion

Relative feed value (RFV) is a simple empirical prediction system that fundamentally relies on linear equations to predict dry matter intake from NDF and digestible dry matter from ADF. It is commonly used in forage indexing which in this case is designed to help ranking of potential energy intake of varying classes of feed stuffs (dry forages and roughages, energy and protein supplements legumes) among themselves accordingly. Within dry forages and roughages two groups of feed sources that is, grasses and crop residues was compared separately. Similarly was done for protein supplement sources: foliages, legumes, and oil seed cakes.

In general, in terms of RFV there was significant difference ($p<0.05$) among the feed types in the classes of feed stuffs tested. However, among the grasses there was no significant difference ($p<0.05$) between panicum and napier, napier and thatch grass (*Hyparrenia rufa*); and among the crop residues between oats straw and tef straw. With regards to the RFV among the grasses natural pasture showed the highest RFV and the list was seen on rhodus grass; among the crop residues pulse straw was with the highest and the list being wheat straw [pulse straw was the only legume straw, between the stovers: maize stover was with the higher RFV, and among the cereal straws barley straw had the highest RFV and the list was found in wheat straw (Table 1)]; among the energy supplements sorghum grain was with the highest and the list is found to be wheat short (Table 2). The protein supplements were sub grouped into foliages, legumes, and oil seed cakes. Hence, in the protein supplement feed stuffs among the foliages cassava leaf had have the highest RFV while the list was on luceana, among the legumes alfalfa had the highest RFV and the list was on pigeon pea, among the oil seed cakes linseed cake had the highest RFV and list was on noug seed cake (Table 3). In all the cases, the higher relative feed value indicates betterment of forage quality (Jeranyama and Garcia 2004).

Relative feed values provide a basis of comparison between different feeds of same types of feed sources. For example, if one has a choice between natural pasture and rhodus grass (Table 1) natural pasture provide 20% more value than the rhodus grass if this sources have same price keeping in mind the more in relative feed value able to provide more nutrition per expense. The higher a relative feed value, the fewer amounts will be needed to feed (Lawrence 2011) up on which the amount of concentrate needed for supplementation will decrease. Same is true for all feed classes within their types having higher feeding value as compared to those with lower relative feed value in Table 1, 2, and 3. The relative feed value of natural pasture grass (Table 1) agrees with the report of

Lawrence (2011) and Hackmann et al (2014) on very mature large seed heads grass hay value and fall in the range obtained for cool-season grass respectively while the alfalfa value in table 3 is higher by 62% (than that of early bloom leafy small stem alfalfa) – 114% (than that of full bloom some leaves large stem alfalfa) from Lawrence (2011) result. However, the value obtained in this study for alfalfa falls in the range of the result of late cutting alfalfa (Hackmann et al 2014). The sugarcane top RFV value (Table 1) agrees with the range value obtained for the study of 10 top cultivars of sugarcane crosses at Mānoa, University of Hawai'i (Lee *et al.* 2017).

The relative feed values greater than 100 indicate that quality of the forage were sufficient to ensure relatively high intake with better digestibility by livestock (Robinson *et al.* 2007).

The classes of feed stuffs tested was determined for CP value and the content for grasses (escept panicum and napier grass) and the crop residues (Table 1) were not sufficient to meet the requirements of ruminants, and in the case of energy supplements (Table 2) except cassava peal and root all were found to be sufficient to meet the requirements of ruminant animals for CP (Preston and Leng 1987; Moore *et al.* 1991; Bowman and Sowell 1998). The CP statistical relation of the feeds in their respective feed class is shown in the tables (Table 1, 2, and 3).

5. Conclusion

With increasing the prices of feed sources, livestock producers must be aware of and use good economic principles in purchasing feeds to their livestock. In this context, the best use of relative feed value is for selecting forages to be used in rations which require high nutrient density particularly for dairy cows. The relative feed value index is used to assess quality in order compare forages which rely on fiber fractions. However, it is important to keep in mind the protein content of the forages in such considerations.

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Biography of First Author

1. Full name: Dereje Fekadu Fantaye
2. Date of employment in EIAR (Ethiopian Institute of Agricultural Research): June, 1992 Eth.C. (June, 2000 G.C.)
3. Present research center: Holetta Agricultural Research Center
4. Present position: Senior researcher
5. Present post: Researcher in ruminant animals' nutrition
6. Professional qualifications: Animal Nutrition (tropical livestock system – biology)

6.1. Level of qualification

Degree	University	Date	Major field of study
M.Sc. (Sweden)	SLU (Swedish Univ. of Agric. Sc.)	29/05/1996	Biology (Tropical Livestock System)
B.Sc. (Ethiopia)	AUA (Alemaya Univ. of Agric.)	07/12/1991	Animal Sciences
Diplom (Ethiopia)	AAC (Alemaya Agric. College)	08/11/1985	Animal Sciences

Table 1. Dry forages and roughages

Feed type	Feed name	%CP	%NDF	%ADF	NDF:ADF	%RFV
Grasses	Natural pasture	6.80^{bc}	65.31	39.51	1.65	83^{a}
	Sugar cane top	4.57^{d}	63.62	41.41	1.54	83^{a}
	Panicum	9.56^{a}	69.58	41.78	1.67	75^{b}
	Napier grass	8.22^{b}	69.52	44.03	1.58	73^{bc}
	Thatch grass (*Hyparrenia rufa)*	4.01^{d}	68.59	45.88	1.49	72^{c}
	Hay	4.74^{cd}	71.78	46.35	1.55	68^{d}
	Rhodus	6.70^{bc}	74.35	49.57	1.50	63^{e}
Crop residue	Pulse straw	5.85	54.47	42.32	1.29	96
	Maize stover	5.01^{a}	70.94	46.64	1.52	69^{a}
	Sorghum stover	3.32^{a}	72.14	49.01	1.47	65^{b}
	Barley straw	4.47^{b}	73.36	45.47	1.61	68^{a}
	Oats straw	7.46^{a}	72.67	48.62	1.49	65^{b}
	Tef straw	4.57^{b}	76.57	46.32	1.65	64^{b}
	Wheat straw	3.40^{c}	75.84	50.67	1.50	61^{c}

Table 2. Energy supplements

Feed type	%CP	%NDF	%ADF	NDF:ADF	%RFV
Sorghum grain	11.21^{c}	28.38	17.59	1.61	246^{a}
Cassava peal	4.41^{d}	33.83	15.10	2.24	212^{b}
Cassava root	3.05^{d}	38.53	9.24	4.17	197^{c}
Rice bran	13.90^{b}	39.98	16.59	2.41	177^{d}
Maize grain/flour	9.31^{c}	41.67	19.24	2.17	165^{e}
Wheat middling	17.24^{a}	47.11	15.26	3.09	152^{f}
Wheat bran	17.70^{a}	47.62	15.28	3.12	150^{g}
Wheat short	15.04^{b}	51.94	20.70	2.51	130^{h}

Table 3. Protein supplements

Feed type	Feed name	%CP	%NDF	%ADF	NDF:ADF	%RFV
Foliages	Cassava leaf	20.41^{b}	29.52	23.21	1.27	223^{a}
	Sesbania	23.96^{a}	41.30	31.01	1.33	146^{b}
	Moringa	15.94^{c}	42.91	33.39	1.29	136^{c}
	Acacia	15.54^{c}	52.18	38.73	1.35	105^{d}
	Luceana	22.44^{a}	54.09	38.44	1.41	101^{e}
Legumes	Alfalfa	22.53^{b}	29.59	25.11	1.18	218^{a}
	Cowpea	28.01^{a}	46.91	22.71	2.07	141^{b}
	Vetch (Vicia spp)	21.48^{b}	48.26	32.16	1.50	123^{c}
	Pigeon pea	16.43^{c}	56.30	40.42	1.39	95^{d}
Oil seed cakes	Linseed cake	29.74^{c}	33.48	21.24	1.58	201^{a}
	Cotton seed cake	31.09^{b}	39.35	18.17	2.17	177^{b}
	Noug seed cake	34.53^{a}	35.81	27.86	1.29	175^{c}