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Feed value of selected tropical grasses, legumes and concentrates

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ABSTRACT

Feed value is the potential of the feed to supply the nutrients required by an animal both quantitatively and qualitatively in order to support a desired type of production. Where chemical composition and digestibility of a given feed is known it is possible to calculate its energy content by using appropriate regression equations. Eleven tropical grass species and mixed grass hay, seven legumes and browse trees, and six concentrates were evaluated in terms of chemical composition (CP, EE, OM, CHO and NDF), digestibility (*in vitro* organic matter digestibility -IVOMD and enzyme solubility of organic matter- EZOM) and calculated energy values. The grass species were: *Andropogon timorensis* (Kunth), Rev. Gram., *Brachiaria brizantha*, (A.Rich) Stapf, *Bothriochloa radicans* (Lehm) A. camus, *Chloris guyana* Kunth, *Cynodon dactylon* (L.) Pers, *Hyparrhenia rufa* (Nees) Stapf, *Panicum maximum* (Jacq.), *Pannisetum purpureum* (Schumacher), *Setaria sphacelata* Stapf & C. E. Hubb, and *Tripsacum fasciculatum* Trin. ex Aschers. Most of the grasses were cut at an advanced stage of growth. The legumes and browses included *Acacia catechu* (L. f.) Willd., *Gliricidia sepium* (Jacq.) Kunth ex Walp, *Leucaena leucocephala* (Lam.) de Wit, *Lannea grandis* Lannea grandis Engl., *Macroptilium atropurpureum* (DC.) Urban, *Sesbania grandiflora* (L.) Poir and *Zyziphus Mauritania* (Lam.). The concentrates were: cotton seed cake, fishmeal, maize bran, soybean meal and sunflower cake. Mean CP and EE content (g/kg DM) were highest with the concentrates (310 and 97, respectively), followed by the legumes and browse trees (183 and 33, respectively) and lowest in the grasses (65 and 15, respectively). The OM and the CHO content varied least between

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the feed types. Mean NDF content (g/kg DM) was lower in the legumes/browse trees (378) and concentrates (314) compared to the grasses (698). The metabolic energy (ME) content (MJ/kg DM) in the feeds was highest with concentrate (11.9) and nearly of the same order in the grasses and legumes/browse trees (7.0). The organic matter digestibility using the conventional Tilley and Terry method and the enzymatic methods varied greatly among the feeds. The enzymatic method showed overall higher OM solubility values with some feeds compared to the *in vitro* organic matter digestibility method (overall mean of 63.4 Vs 53.2%). However, there was good agreement between the two methods with grasses (r^2 = 0.80) compared to legumes/browse trees (r^2= 0.34) and concentrates (r^2=0.22). It is concluded that with increasing modernisation of ruminant livestock production in the tropics, there is a need to evaluate locally available feed resources and place the data in feedstuff tables in order that producers can select the feeds for optimal productivity.

Key words: feed, enzyme solubility, energy

Introduction

Feed value is the potential of the feed to supply the nutrients required by an animal both quantitatively and qualitatively in order to support a desired type of production. Feed value of a given feed is influenced not only by its chemical composition but also its digestibility, physical nature, intake level, associative effects when given in a ration, and the physiological status of the animals (LUND, 2002; THOMAS, 1988).

The most basic method of feed evaluation involves the determination of chemical composition and digestibility, followed by calculation of energy values. Research efforts over the years have led to the development of some reliable and quick methods of determination of chemical composition of feeds in terms of fibre content (VAN SOEST et al., 1991), ether extract (EE) and crude protein content (CP), which are fairly reliable.

Determination of feed digestibility by *in vivo* trials gives reliable results. However, this method is expensive, time consuming and laborious (JOSHI, 1972). Therefore, laboratory methods are resorted to, and then the data is converted to *in vivo* values using regression equations (JOSHI, 1972; GIVENS et al., 1997).

The most commonly employed laboratory method for determination of feed digestibility include those employing rumen liquor microbes to digest the feed under controlled conditions and then to determine the dry matter disappearance with time (TILLEY and TERRY, 1963). The in sacco method (ØRSKOV and McDONALD, 1979) is also widely used, although there is a need to standardise its procedures in order to avoid variability within and between laboratory analyses (MADSEN et al., 1995). Alternatively, feed digestibility can be estimated by the use of enzymes to digest proteins (pepsin) and digestible fibre constituents (mainly hemicelullases and cellulases). The aim of this study was to determine the chemical composition and energy contents of some tropical feeds and to compare organic matter digestibility (DOM) values obtained through the method of TILLEY and TERRY (1963), or the enzymatic solubility method (ESOM).

Materials and methods

Feeds. The analysed feeds were those commonly used by tropical dairy and beef smallholder farmers in Morogoro, Tanzania and Bali in Indonesia, respectively. The feeds included eleven tropical grass species and mixed grass hay, seven legumes and browse trees and six concentrates. The grass species were: *Andropogon timorensis* (Kunth), Rev. Gram., *Brachiaria brizantha*, (A.Rich) Stapf, *Bothriochloa radicans* (Lehm) A. camus, Chloris Guyana Kunth, *Cynodon dactylon* (L.) Pers, *Hyparrhenia rufa* (Nees) Stapf, *Panicum maximum* (Jacq.), *Pannisetum purpureum* (Schumacher), *Setaria sphacelata* Stapf & C. E. Hubb, and *Tripsacum fasciculatum* Trin. ex Aschers. Most of the grasses were cut at an advanced stage of growth. The legumes and browses included *Acacia catechu* (L. f.) Willd., *Gliricidia sepium* (Jacq.) Kunth ex Walp, *Leucaena leucocephala* (Lam.) de Wit, *Lannea grandis Lannea grandis* Engl., *Macroptilium atropurpureum* (DC.) Urban, *Sesbania grandiflora* (L.) Poir and *Zyziphus Mauritania* (Lam.). The concentrates were: cotton seed cake, fishmeal, maize and rice brans, soybean meal and sunflower cake.

Dry and organic matter and crude protein (CP) determination. Dry matter and organic matter analyses were carried out using the procedure as outlined by ANONYM (1990). CP content in samples was calculated from the nitrogen content estimated by the Kjeldahl method (ANONYM., 1990) multiplied by a factor of 6.25. Neutral detergent fibre NDF analyses were carried out according to the methods described by VAN SOEST et al. (1991).

In vitro solubility (IVOMD). *In vitro* solubility of organic matter was estimated using the TILLEY and TERRY (1963) method with some slight modifications. About 0.5 g of milled sample (1 mm) was weighed into a tube. A10 mL rumen liquor and 50 mL buffer solution was added to the sample in the tube. The mixture was incubated at 39 ^{o}C for 48 h, ensuring that it was carefully shaken from time to time. Finallly, the tubes were centrifuged and the supernatant decanted. The residue was again incubated with 60mL pepsin-hydrochloric acid solution (to digest protein) for another 48 h at 39 ^{o}C. This was followed by centrifugation, filtering, drying the residues and ashing. Two blanks (rumen liquor mixed with buffer only) and two standards with known digestibility were included to correct for the indigestible dry matter from the rumen liquor and to check whether the system was working perfectly.

Enzymatic solubility (ESOM). Enzymatic solubility of organic matter was carried out using the standard procedure as outlined by WEISBJERG and HVELPLUND (1997). About 0.5g of sample milled to 1mm size was weighed into a filter crucible with porosity 1 and with a rubber stopper at the bottom. 30 mL of pepsin-hydrochloride solution (for protein hydrolysis) previously heated to 40 ^{o}C was added to the tubes. The tubes were stoppered and incubated at 40 ^{o}C for 24 h, shaking at least twice during that period. The tubes were

transferred to water bath at 80 °C for 45 m (to hydrolyse starch) followed by sucking dry and washing with water to neutralise the acid.

An enzyme-acetate buffer was prepared as follows: first, 8.16 g sodium acetate trihydrate were dissolved in about 0.5 L demineralized water, followed by the addition of 2.36 mL 96% acetic acid and then making the solution to 1 l, with pH adjusted to 4.8 using acetic acid or sodium acetate. Then, about 0.5 L of the buffer was placed in a 1 L container to which 20 g of cellulase (Celloclast® 1.5 L, Novo Nordisk), 10 g cellobiase (Novozym® 188, Novo Nordisk, 10 g hemicellulase (Gamanase™ 1.5 L, Novo Nordisk), 10 g hemicellulase (Viscozyme® 120 l, Novo Nordisk), 320 mg amyloglucosidase (E. Merck, 100 U/mg) and 0.1 g chloramphenicol (sigma, No. C-0378) were added and made up to 1 L using acetate buffer.

With the bottom stoppers in place, 30 mL of enzyme-acetate solution was added to each tube and tubes were incubated at 40 °C for 24 h. The tubes were then transferred to an oven at 60 °C and left for 19 h. Finally, the tubes were sucked dry, then washed twice with acetone (20 mL per wash) with the initial addition done while the bottom stoppers were in place for at least 5 m. The residue was dried, weighed and ashed. The insoluble organic dry matter was obtained by the difference between the two weights. Two standard samples (one with very high digestibility and the other of low digestibility) were also included in each run to crosscheck the validity of the results.

Calculations of energy values. The gross energy (GE), digestible energy (DE), total digestible nutrients (TDN) and metabolisable energy (ME) of feeds were calculated using equations from HVELPLUND et al. (1995) as follows:

GE (MJ/kg DM) = CP content (kg) *24.237 + crude fat content (kg)*34.116 + CHO Content (kg)*17.300

DE (MJ/kg DM) = 24.237*digestible CP (kg/kg DM) + 34.116*digestible crude fat (kg/kg DM) + 17.300*digestible CHO (kg/kg DM)

Where

Digestible crude protein (kg/kg DM) = (0.93 x % crude protein in DM -3)/100

Digestible crude fat (kg/kg DM) = (0.96 × % crude fat in DM -1)/100

Digestible carbohydrates (kg/kg DM) = digestible OM/100) × 100-% crude ash in DM)/100.

TDN (kg/kg DM) = digestible CP + digestible CHO + digestible Crude fat*2.25 (all in g/kg DM)

ME = DE*0.82

Conversion of IVOM and ESOM to in vivo digestibility. This was done using the formulas by MØLLER et al. (2001) which are:

In vivo OM digestibility (%) = 4.10 + 0.959 × IVOM (%) for hays and straws.

For concentrates, *in vivo* organic matter digestibility (%) was calculated using the formula DOM (%) = 5.38 + 0.867 × ESOM (%).

Results

Table 1 presents the chemical composition of the selected feeds. Mean CP and EE content (g/kg DM) was highest with the concentrates (310 and 97, respectively) followed by the legumes and browse trees (183 and 33, respectively) and lowest in the grasses (65 and 15, respectively) (Table 1). The OM and the CHO content varied least between the feed types. Mean NDF content (g/kg DM) was lower in the legumes/browse trees (378) and concentrates (314) compared to the grasses (698).

Table 1. Chemical composition (g/kg DM) of selected tropical feeds

Latin name	Common name	Part and stage of growth	CP	EE	ASH	OM	CHO	NDF
Grasses								
Andropogon timorensis		Lv, st, pre-bloom stage	151	19	140	860	690	596
Brachiaria brizantha	Signal grass	Lv, st, Mat.	64	16	93	907	827	748
Bothriochloa radicans	Veld grass	Lv, st, ads	38	19	134	866	809	718
Chloris guyana	Rhodes grass	Lv, st, ads	55	9	69	931	867	784
Cynodon dactylon	Star grass	Lv, st, Mat.	89	14	84	916	813	675
Hyparrhenia rufa	Thatching grass	Lv, st, ads	40	16	116	884	828	693
Mixed hay		Lv, st, ads	47	18	79	921	856	740
Panicum maximum	Tanganyika grass	Lv, st, Mat.	62	17	120	880	801	693
Pannisetum purpureum	Napier grass	Lv, st, Mat.	61	15	136	864	788	703
Setaria sphacelata	Setaria	Lv, st, ads	58	12	65	935	865	688
Tripsacum fasciculatum	Guatemala grass	Lv, st, ads	54	8	103	897	835	639
Mean			65	15	104	897	816	698
Legumes/browse tree								
Acacia catechu	Catechu	Lv, tw	163	29	62	938	746	170
Gliricidia sepium	Gliciridia	Lv, tw	217	27	98	902	658	324
Leucaena leucocephala	Leucaena	Lv, tw	244	34	134	866	588	315
Lanea grandis	Kayu ende	Lv, tw	94	57	98	902	751	415
Macroptilium	Siratro	Lv, st	130	33	91	909	746	758

Table 1. Chemical composition (g/kg DM) of selected tropical feeds (Continuing)

Sesbania grandiflora	Sesbania	Lv, tw	275	42	90	910	593	225
Zyziphus Mauritania	Bidara	Lv	161	12	70	930	757	437
Mean			183	33	92	908	691	378
Concentrates								
Cotton seed cake			359	70	55	945	516	481
Fish meal			630	140	181	819	49	0
Maize bran			109	107	51	949	733	319
Rice bran			90	50	158	842	702	335
Soybean cake			438	171	64	936	327	158
Sunflower cake			236	45	43	957	676	591
Mean			310	97	92	908	501	314

CP: crude protein, EE: ether extract, OM: organic matter, CHO: carbohydrates (OM-CP+CF), NDF: neutral detergent fibre; Lv: leaves; st: stem; tw: twigs; Mat.: mature; Ads: advanced stage

Table 2 presents the digestibility and energy contents of the analysed feeds.

Table 2. IVOM, ESOM, total digestible nutrients (TDN) (kg/kg DM) and calculated energy values of selected tropical feeds

Latin name	Common name	Part and stage of growth	IVOM	ESOM	TDN	GE	DE	ME
*Grasses								
Andropogon timorensis		Lv, st, pre-bloom stage	68.3	66.5	0.609	16.2	11.26	9.23
Brachiaria brizantha	Signal grass	Lv, st, Mat.	56.5	50.6	0.535	16.4	9.44	7.74
Bothriochloa radicans	Veld grass	Lv, st, ads	35.7	35.0	0.342	15.6	5.92	4.85
Chloris guyana	Rhodes grass	Lv, st, ads	42.8	41.0	0.419	16.6	7.40	6.06
Cynodon dactylon	Star grass	Lv, st, Mat.	38.7	29.2	0.382	16.7	6.95	5.70
Hyparrhenia rufa	Thatching grass.	Lv, st, ads	56.6	48.4	0.523	15.8	9.07	7.44
Mixed hay		Lv, st, ads	48.4	50.5	0.474	16.6	8.27	6.78
Panicum maximum	Tanganyika grass	Lv, st, Mat.	53.9	56.1	0.499	15.9	8.79	7.21
Pannisetum purpureum	Napier grass	Lv, st, Mat.	56.0	49.7	0.505	15.6	8.90	7.30
Setaria sphacelata	Setaria	Lv, st, ads	42.4	45.1	0.421	16.8	7.44	6.10

Tripsacum fasciculatum	Guatemala grass	Lv, st, ads	56.1	48.2	0.516	16.0	9.09	7.45
Mean			50.5	47.3	0.475	16.20	8.41	6.90
*Legumes/browse trees								
Acacia catechu	Catechu	Lv, tw	50.9	86.6	0.519	17.8	9.74	7.98
Gliricidia sepium	Gliciridia	Lv, tw	56.0	77.0	0.541	17.6	10.48	8.60
Leucaena leucocephala	Leucaena	Lv, tw	46.8	69.2	0.453	17.2	9.09	7.45
Lanea grandis	Kayu ende	Lv, tw	17.1	54.5	0.241	17.2	4.35	3.57
Macroptilium atropurpureum	Siratro	Lv, st	65.3	60.6	0.634	17.2	11.49	9.42
Sesbania grandiflora	Sesbania	Lv, tw	58.4	84.9	0.585	18.4	11.53	9.46
Zyziphus mauritania	Bidara	Lv	27.1	61.3	0.282	17.4	5.70	4.67
Mean			45.9	70.6	0.465	17.5	8.91	7.31
**Concentrates								
Cotton seed cake			53.8	78.5	0.765	20.0	15.1	12.4
Fish meal			98.5	72.1	0.899	20.9	18.8	15.4
Maize bran			64.9	75.2	0.786	19.0	13.6	11.2
Rice bran			45.5	58.4	0.519	16.0	9.2	7.5
Soybean cake			73.0	95.1	1.000	22.1	19.4	15.9
Sunflower cake			45.9	56.0	0.558	18.9	10.8	8.9
Mean			63.6	72.6	0.755	19.48	14.48	11.88

Lv: leaves; st: stem; tw: twigs; Mat.: mature; ads: advanced stage

* Energy calculation done by using IVOM values to obtain *in vivo* OM digestibility

** Energy calculation done using ESOM values to obtain *in vivo* OM digestibility

The organic matter digestibility using the conventional TILLEY and TERRY (1963) method and the enzymatic method varied greatly among the legumes and concentrates, but less so with the grasses. The enzymatic method showed overall higher digestibility values with the legumes and concentrates compared to the TILLEY and TERRY (1963) method (70.6 and 72.6 Vs 45.9 and 63.6, respectively). There was good agreement between the two *in vitro* methods with grasses ($r^2 = 0.80$) compared to legumes/browse trees ($r^2 = 0.34$) and concentrates ($r^2 = 0.22$).

Total digestible nutrients were highest with the concentrates (mean of 0.755 kg/kg DM) compared to legumes and grasses. Gross energy (MJ/kg DM) was highest with concentrates (mean of 19.5), followed by legumes (17.5), and least in the grass species

(16.2). The metabolisable energy levels in the feeds followed a similar trend as the gross energy, being highest with concentrates and lowest with grasses.

Discussion

Protein, ether extract, and NDF levels in the grasses agreed with those reported by GÖHL (1981) for mature tropical grasses. There were slight variations in the data of grass hay compared to those reported for temperate grass hay by MØLLER et al. (2001). This was expected due to differences in species, climatic and growth conditions in temperate countries. Again as expected, the concentrates had high CP and low NDF compared to legumes and grasses. This was mainly due to the fact that most grasses were harvested at a mature stage. Reports show a drastic fall in CP content and a sharp rise in NDF and lignin content with advancing stage of maturity for tropical grasses (BUTTERWORTH, 1967; PRESTON and LENG, 1987; MLAY, 2001). The low protein levels in mature tropical grasses have been pointed out as being one of the factors that contribute to poor digestibility and animal performance. Supplementation with protein-rich concentrates and legume grasses and browse trees has proved to be effective in improving the intake and utilisation of poor quality roughage (PRESTON and LENG, 1987; MLAY, 2001; JELANTIK, 2001).

The IVOM method appeared to agree with the ESOM in the grasses, but differed greatly in the legumes and concentrate feeds. This contradicts the observation by MØLLER et al. (2001) that the ESOM method overestimates organic matter digestibility in grasses and straws. This proves that tropical feeds can differ from temperate feeds even when they bear the same name (MGHENI et al., 1994; WILSON and KENNEDY, 1996).

The differences observed between IVOM and ESOM values, especially with legumes and concentrate feeds in this study, can be explained by fact that these feeds had a high proportion of anti-nutritive substances such as tannins and alkaloid (legumes) and fats that limit microbial colonisation of the feeds (WILSON and KENNEDY, 1996). Since the ESOM method employs the use of enzymes that act directly on the feed, it is devoid of the need to maintain appropriate microbial attachment and colonisation of the feed particles.

The IVOM method takes about 96 h compared to 48 h in ESOM from the start to when the results are out. Thus, ESOM is highly suitable for routine laboratory work where a large number of feeds need to be analysed. It is easy to obtain enzyme preparations compared to rumen liquor, especially when ruminally fistullated animals are not available.

It has been observed that in most animal production systems, energy, followed by protein, are the most limiting factors in animal performance. Knowledge of the energy content of a particular feed is helpful in feeding animals according to their nutrient requirements to support a desirable level of performance (SKOVER, 1988; ØRSKOV, 1987; LUND, 2002). The energy component in feeds which is of major interest is the metabolisable energy (ME), i.e. that part absorbed from the GIT which is utilised by the animal to meet its

metabolic needs, including production. Estimates of ME in feeds can be done either directly by measuring heat production (animal calorimetry), which, as with *in vivo* digestibility, is expensive, time consuming and laborious. The easiest way is to calculate the energy content from chemical composition and digestibility data, as was done in this study. ME values obtained in this study for grasses and legumes were low and within the range of values reported by THOMAS (1988) for straws (4-7 MJ/kg DM). This was due to the low digestibility found for grasses. However, for the concentrates, with the exception of rice bran and sunflower cake, the remainder had an ME of between 11-16MJ/kg DM, and which were within the range reported by MØLLER et al., (2001) and also by THOMAS (1988). The observed low ME value for rice bran and sunflower cake was a reflection of the low digestibility of these feeds found in this study for reasons that are not readily apparent.

Conclusion

With the advances in modern livestock production in tropical countries such as Tanzania, it is of the utmost importance for farmers to be able to predict as accurately as possible the amount of feed required to formulate an optimal diet to sustain a desirable level of production. Availability of feed databases for as many locally available feeds in the tropics as possible is highly desirable due to the fact that most feedstuff tables portray data derived from non-tropical countries, where feeds, growth conditions and treatments can sometimes be so different that the data become unreliable. Wide use of the enzymatic method in the determination of digestibility will accelerate this process since the method is fast (half the time needed for IVOM) and less laborious.

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References

ANONYMOUS (1990): Association of the Official Analytical Chemists. Official Methods of analysis, 15th ed., Washington D. C., Volume 1, p 62.

BUTTERWORTH, H. M. (1967): The digestibility of tropical grasses. Nutr. Abstr. Rev. 37, 349-368.

GIVENS, D. I., J. L. DE BOEVER, E. R. DEAVILLE (1997): The principles, practices and some future applications of the near infrared spectroscopy for predicting the nutritive value of foods for animals and humans. Nutr. Res. Rev. 10, 83-114.

HVELPUND, T., J. ANDRIEU, M. R. WEISBJERG, M. VERMOREL (1995): Prediction of the energy and protein value of forages for ruminants. In: Recent developments in the Nutrition of Herbivores (Jounet, M., E. Grenet, H-M Farce, M. Theriez, C. Dermaquilly, Eds.). Proceedings of the IVth International symposium on the Nutrition of Herbivores. INRA Editions, Paris, 205-227.

JELANTIK, N. (2001): Improving Bali Cattle (*Bibos bateng* Wagner) Production Through Protein Supplementation. PhD Thesis. The Royal University Veterinary and Agricultural University, Copenhagen, Denmark, pp. 120.

JOSHI, D. C. (1972): Different measures in the prediction of nutritive value of forages. Acta. Agric. Scand. 22, 243-249.

LUND, P. (2002): The effect of forage type on passage kinetics and digestibility of fibre in dairy cows. PhD Thesis. The Royal University Veterinary and Agricultural University, Copenhagen, Denmark, pp. 171.

MADSEN, J., T. HVELPLUND, M. R. WEISBERG, J. BERTILSSON, I. OLSSON, R. SPORNDLY, O. M. HARSTAD, H. VOLDEN, M. TUORI, T. VARVIKKOT, P. HUHTANEN, B. I. OLAFSSON (1995): The AAT/PBV protein evaluation system for ruminants. A revision. Acta Agric. Scand. Suppl. 19, 1-37.

MGHENI, D. M., T. HVELPLUND, M. R. WEISBJERG (1994): Intestinal digestibility of rumen undegraded dietary protein from tropical roughages estimated by mobile bag technique. Acta Agric. Scand. (Anim. Sci.) 44, 230-235.

MLAY, P. S. (2001): Enhancement of smallholder dairy production under tropical conditions through supplementation to optimise roughage intake, digestibility and microbial protein synthesis. PhD Thesis. The Royal University Veterinary and Agricultural University, Copenhagen, Denmark, pp. 175.

MØLLER, J., R. THØGERSEN, A. N. KJELDESEN, M. R. WEISBJERG, K. SØEGAARD, T. HVELPLUND, C. F. BØRSTING (2001): Feedstuff Table. Composition and feeding values for cattle. Report number 91, 2000. The Danish Agricultural Advisory Centre, Denmark, pp. 57.

ØRSKOV, E. R. (1987): The Feeding of Ruminants: Principles and Practice. Chalcombe Publications, 13 Highwoods Drive, Marlow Bottom, Bucks SL73Pu, UK, pp. 92.

ØRSKOV, E. R., I. McDONALD (1979): The estimation of protein degradability in the rumen from incubation measurements weighted according to the rate of passage. J. Agri. Sci. 92, 499-503.

PRESTON, T. R., R. A. LENG (1987): Matching ruminant production system with available ressources in the tropics. Penambul Books, Armidale, NSW, Australia, pp. 459.

SKOVER, S. (1988): Genetic aspects of feed intake and feed efficiency in dairy cattle. A review. Liv. Prod. Sci 20, 1-13

THOMAS, P. C. (1988): Feed Evaluation - Energy In: Feed Science, World Animal Science (Neimann-Sorensen, B. A., D. E. Tribe, E. R. Ørskov, Eds.). Elsvier Science Publishers, B.V. pp. 51-80.

TILLEY, J. M. A., R. A. TERRY (1963): A two stage technique for the *in vitro* digestion of forages. J. Brit. Grass. Soc. 18, 104-111.

VAN SOEST, P. J., J. B. ROBERTSON, B. A. LEWIS (1991): Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. J. Anim. Sci. 69, 973-987.

WEISBJERG, M. R., T. HVELPLUND (1997): The use of enzymatic solubility for the prediction of organic matter digestibility of compounded feedsuffs. In: *In vitro* and *in vivo* methods used in experiments on digestion processes and feed evaluation. International seminar organised by: Antoniewicz, A., K. Sokol (Eds.). The Kielanowski Institute of Animal Physiology and Nutrition, Polish Academy of Sciences, Jablonna and National Research Institute of Animal Nutrition, Krakow, 3-4 October, 1996.

WILSON, J. R., P. M. KENNEDY (1996): Plant and animal constraint to voluntary feed intake associated with fibre characteristics and particle breakdown and passage in ruminants. Aust. J. Agric. Res. 47, 200-225.

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SAŽETAK

Hranidbena vrijednost krmiva je njegov potencijal da kvantitativno i kvalitativno opskrbi hranjivim tvarima životinju u skladu s poželjnim tipom njezine proizvodnje. Za krmiva s poznatim kemijskim sastavom i podacima o probavljivosti moguće je uz pomoć jednadžbe regresije izračunati energetsku vrijednost. Procijenjen je kemijski sastav (CP, EE, OM, CHO i NDF), probavljivost (probavljivost organske tvari in vitro - IVOMD i enzimska topivost organske tvari - EZOM) te izračunata energetska vrijednost u 11 vrsta tropskih trava i sijena od miješanih vrsta trava, 7 leguminoza i brstivog drveća, te kod 6 vrsta koncentrata . Vrste trava bile su: *Andropogen timorensis* (Kunth), Rev. Gram., *Brachiaria brizantha*, (A. Rich) Stapf, *Bothriochloa radicans* (Lehm), *A. camus, Chloris Guyana* Kunth, *Cymodon dactylon* (L.) Pers, *Hyparrhenia rufa* (Nees) Stapf, *Panicum maximum* (Jacq.), *Pannisetum purpureum* (Schumacher), *Setaria sphacelata* Stapf & C. E. Hubb i *Tripsacum fasciculatum* Trin. ex Aschers. Većina trava pokošena je u odmakloj fazi rasta. Od leguminoza i brstivog drveća pretražene su *Acacia catech*u (L. f.) Willd., *Gliricidia sepium* (Jacq.) Kunth ex Walp, *Leucaena leucocephala* (Lam.) de Wit., *Lannea grandis* Lannea grandis Engl., *Makroptilium atropurpureum* (DC.) Urban, *Sesbania grandiflora* (L.) Poir and *Ziziphus Mauritania* (Lam.). Od koncentriranih krmiva analizirani su: pogače od pamučnog sjemena, riblje brašno, kukuruzne posije, sojino brašno i pogače od suncokreta. Srednja vrijednost za CP i EE sadržaj (g/kg DM) bila je najveća kod koncentrata (310 i 97), zatim su slijedile leguminoze i brstivo drveće (183 i 33), a najniže srednje vrijednosti utvrđene su u trava (65 i 15). OM i CHO su pokazali najmanje varijacija između promatranih krmiva. Srednja vrijednost za NDF sadržaj (g/kg DM) bila je niža kod leguminoza/brstivog drveća (378) i koncentrata (314) u usporedbi s travama (698). Sadržaj metaboličke energije (ME u MJ/kg DM) krmiva bio je najveći u koncentrata (11,9) dok su kod trava i leguminoza/brstivog drveća zabilježene približno slične vrijednosti (7,0). Probavljivost organske tvari, mjerena uobičajenom Tilley i Terry metodom odnosno enzimskom metodom, očitovala je značajne varijacije između krmiva. Enzimska metoda pokazala je ukupno veću OM topivost nekih krmiva u usporedbi s *in vitro* probavljivošću organske tvari (ukupna srednja vrijednost 63,4 prema 53,2 %). Također, za dvije korištene metode utvrđena je dobra podudarnost kod trava (r2 =0,80) u usporedbi s leguminozama/brstivim drvećem (r2= 0,34) i koncentratima (r2 = 0,22). Zaključeno je da s modernizacijom proizvodnje preživača u tropskim područjima raste potreba za procjenom lokalnih izvora krmiva. Dobiveni podaci trebali bi se prikazati u tablicama hranidbe kako bi proizvođači mogli odabrati krmiva za optimalnu proizvodnost svoje stoke.

Ključne riječi: krmiva, procjena, in vitro, enzimska topivost, energija