PREDICTING THE NUTRITIVE VALUE OF DIFFERENT ROUGHAGES USED IN RUMINANTS FEEDING BY SOME LABORATORY METHODS

SALEH, M. S.

Animal Production Dept., Faculty of Agriculture, Kafr El-Sheikh Univ.

ABSTRACT

To test the possibility of developing quick laboratory methods for predicting the nutritive value of different roughages with a reasonable degree of accuracy, thirteen roughages commonly used in livestock feeding were tested. Chemical composition including fiber fractions, organic cell wall (OCW) including highly digestible fiber (Oa) and slowly digestible fiber (Ob), gross energy (GE) and *in vitro* dry matter disappearance (IVDMD) using pepsin-cellulase assay were estimated. Also, *in vivo* dry matter digestibility (DMD) was predicted from IVDMD using prediction equation of Goto and Minson (1977) for roughages. Simple, multiple and stepwise regression was calculated between CF and its fraction contents, also between each of IVDMD, GE and Ob and chemical components of roughages to determine the strength of the relationships between them, so examining the limits of their use in practical application. The results indicated that, highly positive relationships ($p<0.01$) were detected between CF content and its fractions (NDF, ADF and "ADL+Silica"). Since the regression equations for IVDMD, GE and Ob varied according to the values of adjusted of determination coefficient (r^{-2}) and also affected strongly by specific chemical components of roughages namely CF and its fraction contents.

Values of IVDMD, GE and Ob for the different roughages can be predicted from chemical composition values using the more precise equations as following :-

a) IVDMD (%) = 146.48 -1.52 CF - 0.646 Ob -1.24 "ADL+Silica" ($r^{-2} = 0.85$, $p<0.01$).

b) GE (cal/ g DM) = 3234.02 + 14.73 NDF ($r^{-2} = 0.46$, $P<0.01$).

c) Ob (%) = 26.95 + 0.604 NDF - 0.665 Oa ($r^{-2} = 0.85$, $P<0.01$).

***Keywords**: roughages, chemical components, nutritive values, enzymatic methods, pepsin-cellulase assay, ∝- amylase- actinase- cellulase assay, prediction.*

INTRODUCTION

In Egypt, the animals are suffering from feed shortage particularly during the summer season. Shortage of both concentrates and their ingredients with their relatively high prices are the major problem in the animal production sector. These necessitate using agricultural by-products in animal feeding to minimize the feed cost and improve the economical efficiency. The development and application of laboratory methods for predicting the nutritive value of feedstuffs have been an active and successful area of research during the latter half of last century. Although the digestion trials are an accepted technique for determining the nutritive value of forages for ruminants, the high cost of equipment, animals and labor, also require large quantities of test feed and time, these limit using it in evaluation of forage quality. For these reasons, a variety of laboratory methods have been developed to estimate the *in vivo* digestibility of domestic ruminants (Iantcheva et al, 1999). *In vitro* methods include the incubation in rumen liquor (Tilly and Terry, 1963), cellulase enzymes (Jones and Hayward, 1975) and other methods depend on empirical equations that are nearly based on statistical association to predict digestibility from chemical components (Minson, 1982). The pepsin-cellulase assay is recommended for estimate the digestibility of feeds especially with high starch content than the other laboratory methods. Moreover, with cereal grains or forage cereal grain mixtures, using pepsin-cellulase plus amylase or *in vitro* Tilly and Terry (1963) method is recommended. Using pepsin-cellulase plus amylase is preferred for better repeatability, as involves less biological variation than inocula based methods (Kitessa et al, 1999).

The aim of this study was to evaluation of some common roughages used in feeding ruminants by quick laboratory enzymatic methods and predicting their nutritive values from chemical components. Fiber fractions, organic cell wall (OCW) content and *in vitro* dry matter disappearance (IVDMD) were estimated. Moreover, *in vivo* dry matter digestibility (DMD) was predicted from IVDMD using prediction equation of Goto and Minson (1977) for roughages.

MATERIALS AND METHODS

This study was carried out at the laboratory of Feed Science, Department of Animal Science, Faculty of Agriculture, Kyushu University, Fukuoka, Japan and Department of Animal Production, faculty of Agriculture, Kafr El-Sheikh University, Egypt.

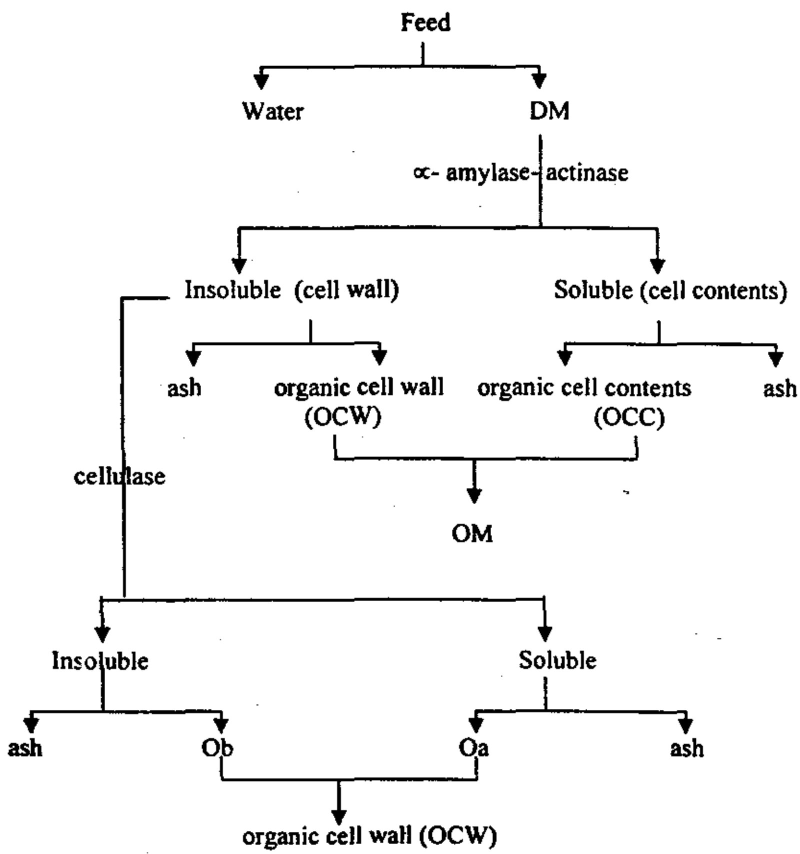
I- Preparation of roughage samples:

Thirteen samples representing different roughages including legumes, non-legumes and its by- products were tested. Samples including: 1- Alfalfa hay (AH); 2- Berseem (*Trifolium Alexandrinium*) hay (BH); 3- Elephant grass (EG); 4- Corn (*Zea mays, L*) silage as whole plants form (CS); 5- Corn stalk silage (CSS); 6-Sugar beet pulp (fresh, SBP_F); 7- Dried sugar beet pulp (pellets, $DSBP_P$); 8- Peanut vine hay (PVH); 9- Sweet potato (*Ipomoea batatas*) tops (fresh, SPT_F); 10- Sweet potato tops hay (SPT_H); 11- Watermelon vine hay (WMVH); 12- Wheat straw (WS); 13- Rice straw (RS). All samples were collected from El-Behera and Kafr El-Sheikh Governorates, five samples of each roughage from the different five sites in the same location were collected, dried and then mixed together, blended and representative samples were taken for chemical analysis.

II- Laboratory measurements

Chemical composition was determined according to A.O.A.C. (1990). Gross energy (GE) estimated using an adiabatic Bomb Calorimeter, while crude fiber fractions were adopted according to Goering and Van Soest (1970). Organic cell wall (OCW) and slowly digestible fiber (Ob) contents were determined using α- amylase-actinase- cellulase assay as described by Japan Grassland Association (1994), while highly digestible fiber (Oa) was estimated by difference between OCW and Ob as shown in Fig. 1. Furthermore, *in vitro* dry matter disappearance (IVDMD) estimated using pepsin-cellulase assay according to method of Jones and Hayward (1975). Moreover, *in vivo* dry matter digestibility (DMD) was predicted from IVDMD using prediction equation of Goto and Minson (1977) for roughages as follows:-

$Y = 0.69 X + 20.32$, were Y: predicted *in vivo* DMD and X: IVDMD values.



* Oa: highly digestible fiber & Ob: slowly digestible fiber

Figure (1): Flowchert for fractionizing of feeds in the analysis of digestion *in vitro* (Japan Grassland Association, 1994).

III- statistical analysis

Relationships between fiber fractions (NDF, ADF, ADL and "ADL+Silca") as independent variables (ŷ) and CF content as dependant variable (x) were estimated. Moreover, relationships between IVDMD, GE and Ob as independent variables (ŷ) and chemical components such as CP and CF and its fractions as dependent variables (x) were calculated. Every variable was studed alone and cumulative with the other variables. Data were statistically analyzed using Linear Regression Models procedure adapted by SPSS (1997) for user' s Guide, where appropriate means were separated using Duncan's multiple range test.

Simple, multiple and stepwise regression was calculated. Moreover, some statistic measurments such as adjusted of deterimination coefficient (r^{-2}), T and F values at levels 1% and 5% were determined. Predicting equations were studied and arranged according to these importance in affecting on independent variables. The regression relationships were calculated from the equation of liner regression ($\hat{y} = a + bx$) between the following parameters: -

1 - Crude fiber content as dependent variable (x) and its fractions (NDF, ADF, ADL and "ADL+Silica") as independent variables ($\hat{y}$).
2- Chemical components (CP, CF, NDF, ADF, "ADL+ Silica", Ob and Oa) as (x) from one side and IVDMD, GE and Ob ($\hat{y}$) from the other side.

The predicting equations of IVDMD, GE and Ob values from some chemical components such as CF, NDF, "ADL+ Silica", Oa and Ob were calculated for the tested roughage samples.

RESULTS AND DISCUSSIONS

1- Chemical composition:

As presented in Table 1, CP, EE, CF, NFE and ash contents of the different roughages were ranged from (2.63-12.47), (1.24-3.40), (19.25-39.10), (38.85-63.84) and (5.94-19.33) %, respectively. These results indicated that, legumes and its by-products such as AH, BH and PVH had higher of CP content (8. 96-12.47 %) than non-legumes and its by-products such as EG, CS, CSS, WS and RS (2.63-8.53 %). Similar trend was observed by many workers (Ahmed et al., 1990; De Boever, 1994 and Saleh et al., 2000). Chemical analysis could provide valuable information about the actual chemical constituents influencing digestion and *in vitro* methods (Van Soest, 1994). The actual nutrient contents for by- products of feedstuffs are differing, this may be due to variation in plant varieties and handling after processing (De Peters et al., 1997). Generally, chemical composition of different roughages or crop residues is depending on many factors such as plant age, species, climate, soil types, fertilizers, system of crop harvesting and others. Using statistical associations, characterization of fiber, lignin, protein and other chemical components are used to predict the animal performance (Cherney, 2000).

Table 1. Chemical composition of the tested different roughage sources (on DM basis, n = 39 samples).

Feedstuffs*	DM, %	DM composition, %						GE, Cal/g DM
		OM	CP	EE	CF	NFE	Ash	
1- AH	90.73	90.39	9.76	1.92	30.43	48.28	9.61	4301.84
2- BH	89.90	88.20	12.47	2.02	31.57	42.14	11.80	4164.62
3- EG	19.25	89.59	6.59	2.73	26.71	53.56	10.41	4134.84
4- CS	30.26	92.50	8.53	2.89	28.58	52.50	7.50	4277.27
5- CSS	32.24	88.95	6.78	1.90	27.98	52.29	11.05	4129.26
6- SBP_F	21.25	93.66	9.94	1.24	19.25	63.23	6.34	4180.02
7- $DSBP_P$	89.75	94.06	9.24	1.26	19.72	63.84	5.94	4200.01
8- PVH	91.35	88.46	8.96	3.40	26.81	49.29	11.54	3927.75
9- SPT_F	21.85	82.55	10.93	2.73	19.96	48.93	17.45	3842.52
10- SPT_H	88.45	85.06	9.19	2.34	24.60	48.93	14.94	3790.01
11-WMVH	83.57	80.67	10.99	2.67	28.16	38.85	19.33	3689.05
12- WS	90.15	88.90	2.63	1.66	39.10	45.51	11.10	4093.84
13- RS	89.74	83.38	4.33	1.88	33.59	43.58	16.62	4858.53
Ov. mean	**69.73**	**88.18**	**8.49**	**2.20**	**27.42**	**50.07**	**11.82**	**4122.27**

*1- Alfalfa hay (AH); 2- Berseem hay (BH); 3- Elephant grass (EG); 4- Corn silage as whole plants form (CS); 5- Corn stalk silage (CSS); 6-Sugar beet pulp (fresh, SBP_F); 7- Dried sugar beet pulp (pellets, $DSBP_P$); 8- Peanut vine hay (PVH); 9- Sweet potato tops (fresh, SBT_F); 10- sweet potato tops hay (SPT_H); 11- Watermelon vine hay (WMVH); 12- Wheat straw (WS); 13- Rice straw (RS).

2- Fractions of the crude fiber contents:

As shown in Table 2, highest values of both NDF and ADF contents were recorded for WS (79.59 and 54.80 %) and RS (73.63 and 52.84 %), respectively. However, PVH and SPT_F had the highest ADL content (10.31 and 11.95 %), respectively. Meanwhile, SPT_H, $DSBP_P$ and SBP_F had the lowest NDF, ADF and ADL, being 39.33, 25.49 and 2.07 %, respectively, however RS had the highest silica content (8.53%). These results are in close agreement and within the range reported by Saleh et al. (2000), Mahmoud et al. (2003) and Saleh (2005). Otherwise, the present values were higher than those reported by Koller et al. (1978) and Ahmed et al. (1990). The differences in the chemical components, especially CF and possibly ash content may explain the differences in their NDF, ADF and ADL contents (Koller et al., 1978). Higher lignin content for some roughages may be related to stage of plant maturity (El-Talty, 1973). However, higher silica content of some roughages was possibly related to their high ash content (Ahmed et al., 1990). Forages digestibility is determined by structural fractions, such as degree of lignification also influenced by some factors such as physical processing, level of intake, protein content and other associative effects within mixed diets (Mc Donald et al., 1995).

Table 2. Crude fiber fraction contents of the tested different roughage sources (on DM basis, n = 39 samples).

Feedstuffs	Fiber fraction contents, %*						
	NDF	ADF	ADL	Silica	"ADL+ Silica"	Hemi-cellulose	Cellulose
1- AH	64.50	44.74	9.56	0.60	10.16	19.76	35.18
2- BH	56.64	43.29	7.78	0.25	8.03	13.35	35.51
3- EG	73.41	40.33	4.42	2.01	6.43	33.08	35.91
4- CS	65.19	36.21	4.73	2.36	7.09	28.98	31.48
5- CSS	68.25	39.27	4.27	1.87	6.14	28.98	35.00
6- SBP_F	56.30	25.67	2.07	0.28	2.35	30.63	23.60
7- $DSBP_F$	50.10	25.49	4.12	0.27	4.39	24.61	21.37
8- PVH	60.78	52.28	10.31	1.01	11.32	8.50	41.97
9- SPT_F	39.59	37.73	11.95	0.80	12.75	1.86	25.78
10- SPT_H	39.33	33.26	6.31	0.34	6.65	6.07	26.95
11-WMVH	39.78	38.20	6.55	0.51	7.06	1.58	31.65
12- WS	79.59	54.80	7.30	4.02	11.32	24.79	47.50
13- RS	73.63	52.84	4.37	8.53	12.90	20.79	48.47
Ov. mean	**59.01**	**40.32**	**6.44**	**1.76**	**8.20**	**18.69**	**33.88**

NDF: Neutral detergent fiber (Cellulose + Hemicellulose + lignin).
ADF: Acid detergent fiber (Lignin + cellulose), ADL Acid detergent lignin (Lignin).
Hemicellulose = NDF – ADF & Cellulose = ADF – ADL.

As presented in Table 3, there is a highly significant (P<0.01) positive correlation was observed between fiber fractions (NDF, ADF and "ADL+Silca") and CF content. Values of r^{-2} were 0.41, 0.66 and 0.23 for Equations No.1, 2 and 3, respectively, this mean that about 41, 66 and

23% from the variations in these fiber fractions are attributed to CF content, while 59, 34 and 77%, respectively due to the other unknown factors. Meanwhile, effect of CF content on ADL was insignificant , so it excluded from data presented in Table 3. Based on the obtained results, it is possible to predict the NDF, ADF and "ADL+silica" contents of tested roughages from their CF content. Such practice is of prime importance in practical and applied conditions as Van Soest assay is costly, time consuming and requires high technically-skilled personnel compared to the CF assay (Ahmed et al., 1990). Fiber and lignin assays should be continue to be important, due to their strong assocation with factors affecting animal performance (Cherney, 2000).

Table 3. Predicting equations of fiber fractions (NDF, ADF and "ADL+Silica") from crude fiber content of the different roughage sources (n=39 samples).

Independent variables ($\hat{y}$)	Equ No.	Predicting equations	± SE	r	r^2	r^{-2}	F value
NDF	(1)	$\hat{y}$ = 16.31+1.56 CF (1.98)* (5.28)**	10.17	0.66	0 .43	0.41	27.84**
ADF	(2)	$\hat{y}$ = 3.56+1.34 CF (0.829) (8.73)**	5.29	0.82	0.67	0.66	76.30**
"ADL+ Silica"	(3)	$\hat{y}$ = 0.261+ 0.289 CF (0.113) (3.52)**	2.83	0.50	0.25	0.23	12.40**

Ŷ: determined values of independent variables, r: correlation coefficient, r^2: coefficient of deterimination value, r^{-2}: adjusted of r^2 value, SE: standerd error, Values between brackets refer to calculated T values, Value of T table at level of 1%= 3.106 and at level of 5%= 2.250 & * : Significant at 5% level of probability , **: Significant at 1% level of probability.

3- Organic cell wall contents:

As presented in Table 4, WS had the highest OCW and Ob values, being 81.08 and 70.29%, respectively, while PVH was the lowest Oa content (10.41%). However, SPT_F contain the lowest OCW and Ob values (50.80 and 32.31%), respectively, wherease, SBP_F contain the highest Oa (30.58%). Increase of slowly digestible fiber (Ob) content was attributed to increase of NDF or and highly digestible fiber (Oa) content (Tables 2&4). Robertson and Van Soest (1977) indicated that, starch contamination of NDF, particularly in forages contaning grain lead to overstimates of NDF value. In the presnt study, increase of Ob content was accompaned by decrease of Oa value because Oa was estimated by difference between OCW and Ob as shown in Fig. 1. Generally all feedstuffs had higher Ob than Oa values, these may be related to higher both ADL and silica contents for some roughage samples (Table 2). Haaksms (1993) concluded that, sugar beet pulp is an excellent feed for dairy cows because it contain carbohydrates that low lignin content and high digestibility.

Table 4. Organic cell wall contents of the tested different roughage sources (on DM basis, n = 39 samples).

Feedstuffs	OCW, %	Ob, %	Oa, %
1- AH	68.41	53.76	14.65
2- BH	60.48	48.72	11.76
3- EG	75.26	55.09	20.17
4- CS	77.38	60.32	17.06
5- CSS	73.17	59.35	13.82
6- SBP_F	66.86	36.28	30.58
7- $DSBP_P$	73.40	46.10	27.30
8- PVH	70.47	60.06	10.41
9- SPT_F	50.80	32.31	18.49
10- SPT_H	56.59	39.36	17.23
11- WMVH	60.51	44.20	16.31
12- WS	81.08	70.29	10.79
13- RS	73.22	60.52	12.70
Overall mean	**68.28**	**51.26**	**17.02**

OCW: Organic cell wall, Ob: slowly digestible fiber, Oa: Highly digestible fiber.
OCW = Oa + Ob & Oa = OCW – Ob.

4- In vitro and predicted in vivo dry matter digestibility:

As shown in Table 5, sugar beet pulp ($DSBP_P$ and SBP_F) had the highest values of both IVDMD (93.23 and 92.32%) and predicted *in vivo* DMD (84.65 and 84.02%), respectively. While, WS had the lowest value, being 29.82 and 40.90% for IVDMD and DMD, respectively. As expected, most of roughages especially SBP_F and $DSBP_P$ were higher of both IVDMD and DMD values than straws (WS&RS) or corn silage (CS&CSS). It was noticed that, DMD values took the same trend of IVDMD because it is predicted from IVDMD values. Values of IVDMD are in accordance with those reported by Ahmed et al. (1990).

The higher values of NFE and CP contents were reflected in the higher values of both IVDMD and DMD. Contrary, the higher CF and its fraction contents were associated with the lower of these values. These results support those found by Koller et al. (1978) with different roughages. In the present study, both IVDMD and DMD were higher than those reported by Delgado-Pertinesz et al. (2000), who found that IVDMD estimated by pepsin-cellulase method ranged from 57.3 to 57.8%, while the range of *in vivo* DMD was 47.5-53.9% for different roughages, they also recorded that IVDMD values were higher than those reported by Tilly and Terry method (47.2-48.3%). Andrighetto et al. (1992) reported that, IVOMD estimated by pepsin-cellulase assay for mountain forage hay, silage and fresh grasses was 50.5, 56.0 and 48.5%, respectively.Moreover, Jarrige et al. (1970) found that, solubility in cellulase was highly correlated (r = 0.92) with *in vivo* DMD for grass and legume forages.

Table 5. *In vitro* dry matter disappearance (IVDMD) and predicted *in vivo* dry matter digestibility (DMD) of the tested different roughage sources (on DM basis, n = 39 samples).

Feedstuffs	IVDMD,%	DMD, %
1- AH	60.60	62.13
2- BH	61.87	63.01
3- EG	55.33	58.50
4- CS	48.06	53.48
5- CSS	47.54	53.12
6- SBP_F	92.32	84.02
7- $DSBP_P$	93.23	84.65
8- PVH	60.39	61.99
9- SPT_F	71.42	69.60
10- SPT_H	77.85	74.04
11- WMVH	66.14	65.96
12- WS	29.82	40.90
13- RS	39.86	47.82
Overall mean	**61.88**	**63.02**

IVDMD: *In vitro* dry matter disappearance, DMD: predicted *in vivo* dry matter digestibility.

5- *Prediction of in vitro data from chemical components of roughages:*

5- 1. *Prediction of in vitro dry matter disappearance:*

As shown in Table 6, there is a highly significant (P<0.01) negative correlation between IVDMD as independent variable and CF, Ob and "ADL+Silica" as dependent variables (Equations No. 1, 2 and 3) for tested roughages. Values of r^{-2} were 0.77, 0.81 and 0.85 for previous equations, respectively. These values indicated that, Equ. No. 3 was the best one because it the highest r^{-2} value (0.85), this mean that about 85% from the variations in IVDMD values caused by CF, Ob and "ADL+Silica", while 15% only was due to the other factors. However, the direct effect of other chemical components such as CP, NDF, ADF, ADL and Oa on IVDMD value was insignificant, so it excluded from data presented in Table 6.

Generally when introducing more chemical components such as Ob or and "ADL+silica" with CF in the equation No. 3 gives more a significant improvement in prediction of IVDMD value. Moreover, the current values are nearly similar with those reported by Aufrere et al. (1992) in prediction of OMD from chemical composition and *in vitro* pepsin-cellulase digestibility for traditional forages. Delgado-Pertinesz et al. (2000) indicated that, highly significant negative correlalions were observed between IVDMD and each of NDF, ADF and ADL contents for different roughages. Furthermore, Jarrige et al. (1970) found that, solubility in cellulase was highly correlated (r = 0.92) with *in vivo* DMD for grass and legume forages. Goto and Minson (1977) found that, pepsin-cellulase solubility was highly correlated (r = 0.94) with *in vivo* DMD of grasses, it was ranged from 40 to 70%. In the present study it may be concluded that, each of CF, Ob and "ADL+Silica" contents can be used as a good predictors for IVDMD in roughages.

5.2. Prediction of gross energy:

As presented in Table 6, there is a highly significant ($P<0.01$) positive correlation between GE and NDF. Value of r^{-2} was 0.46, this mean that, about 46% from the variations in GE value was attributed to the effect of NDF, while 54% due to the other other factors (Equ. No. 4). Meanwhile, the effect of other chemical components such as CP, CF, ADF, ADL,"ADL+Silica", Oa and Ob on GE value was insignificant. Spanghero and Volpelli (1999) reported that, chemical components and gross energy (GE) content were used to predict the digestible energy (DE) content. Also, DE content was closely correlated with NDF (r = 0.91), while ADF and CF were correlated to lesser degree (r = 0.75 and 0.79, respectively). Wiseman et al. (1992) recorded a negative relatioships between both digestible energy (DE) together with digestibility of gross energy (GE) and measurments of fiber. While, highly correlation (r = 0.87) was observed between CF and DE and in fact greater than that recorded for ADF, NDF and ADL (r = 0.81, 0.63 and 0.82, respectively) for raw materials of different roughages. However, Delgado-Pertinesz et al. (2000)

Table 6. Predicting equations of *in vitro* dry matter disappearance (IVDMD), gross energy (GE) and slowly digestible fiber (Ob) from chemical components of the tested different roughage sources (n = 39 samples).

Independent variables ($\hat{y}$)	Equ. No.	Predicting equations	$\pm$ SE	r	r^2	r^{-2}	F value
IVDMD	(1)	$\hat{y}$ = 140.55 – 2.88 CF (19.89)** (-11.39)**	8.71	0.88	0 .78	0.77	129.77**
	(2)	$\hat{y}$ = 145.61 – 1.97 CF – 0.583 Ob (22.00)** (- 5.22)** (- 3.01)*	7.89	0.91	0.82	0.81	83.59**
	(3)	$\hat{y}$ = 146.48 – 1.52 CF – 0.646 Ob – 1.24 "ADL+Silica" (24.38)** (- 4.04)** (- 3.65)** (- 2.97) **	7.15	0.93	0.86	0.85	70.73**
GE	(4)	$\hat{y}$ = 3234.02 + 14.73 NDF (20.87)** (5.75)**	209.87	0.69	0.47	0.46	33.04**
Ob	(5)	$\hat{y}$ = 9.72 + 0.704 NDF (2.31)* (10.13)**	5.69	0.86	0.74	0.73	102.55**
	(6)	$\hat{y}$ = 26.95 + 0.604 NDF – 0.665 Oa (6.06)** (10.94)** (- 5.47)**	4.26	0.92	0.86	0.85	106.38**

$\hat{Y}$: determined values of independent variables, r: correlation coefficient, r^2: coefficient of determination value, r^{-2}: adjusted r^2 value, SE: standard error. Values between brackets refer to calculated T values, Value of T table at level of 1% = 3.106 and at level of 5% = 2.250, *: Significant at 5% level of probability, **: Significant at 1% level of probability.

illustrated that, GE content is not significantly correlated with any chemical parameters and could not be predicted with sufficient precision from chemical components of fresh or dried olive leaf.

*5.3. **Prediction of slowly digestible fiber:***

As shown in Table 6, there is a highly significant (P<0.01) positive relationship between Ob and NDF (Equ. No. 5). Moreover, there is a positive relationship between NDF and Ob, while a negative relationship between Oa and Ob with highly significant (P<0.01) differences (Equ. No. 6). Values of r^{-2} were 0.73 and 0.85 for equations No. 5 and 6, respectively. These values indicated that, Equ. No. 6 was better than Equ. No. 5 because it had higher R^{-2} value (0.85), which mean that, about 85% from the variations in Ob value was attributed to the direct effect of NDF and Oa, while only 15% due to the other factors. Meanwhile, the effect of other chemical components such as CP, CF, ADF, ADL and "ADL+Silica" on Ob value was insignificant. It is observed that, the precision can be improved by adding more chemical components such as Oa as illustratrd in Equ. No.6.

It is noticed that, increase of Ob values were accompaned by decrease of Oa values because the organic cell wall (OCW) including highly digestible fiber (Oa) and slowly digestible fiber (Ob) contents as shown in Fig. 1 (Japan Grassland Association, 1994). Also, higher NDF content of different tested roughages was lead to icrease of Ob values (Table 2). Van Soest (1994) indicated that, chemical analysis could provide valuable information about the actual chemical constituents influencing digestion, and *in vitro* methods. He also found that, lignin and associated phenolics are most often identified as chemical constituents in cell wall most limiting digestion. Moreover, Cherney (2000) indicated that, statistical associations, characterization of forage fiber, lignin, protein and other chemical components are used to predict animal performance. Also, one fraction, soluble fiber that includes non-starch polysaccharides, such as pectic polysaccharides is of particular interest.

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REFERENCES

A.O.A.C. (1990). Association of Official Analytical Chemists Official Methods of analysis.15 th Ed., Washington, D.C.

Ahmed, M. Sawsan; A. M. El-Serafy; M.A. El-Ashry; H. M. Aly; H. S. Soliman and A.A. El-Nagar (1990). A New Approach for Screening Roughages and Predicting Their Nutritive Values. Egypt. J. Anim. Prod.,27: 75.

Andrighetto, I.; L. Gruber; G. Cozzi; G. Uray; G. Guidetti and K. Buchgraber (1992). Prediction of digestible organic matter in dry matter in vivo from the chemical composition in vitro and in situ measurments on native mountain forages. Anim. Feed. Sci. Technol., 39: 323.

Aufrere, J.; D. Graviou; C. Demarquilly; J. Andrieu; J.C. Emile; R. Giovanni and P. Maupetit (1992). Estimation of organic matter digestibility of whole maize plants by laboratory methods. Anim. Feed. Sci. Technol., 36: 187.

Cherney, D.J.R., (2000). Characterization of Forages by Chemical Analysis. CAB International 2000. Forage Evaluation in Ruminant Nutrition (Eds Givens, D.I.; Owen, E.; Axford, R.F.E. and Omed, H.M.).

De Boever, J.L.; B.G. Cottyn; J. M. Vanacker and Ch.V. Boucque (1994). An improved enzymatic method by adding gammanase to determine digestibility and predict energy value of compound feeds and raw materials for cattle. Anim. Feed. Sci. Technol., 47: 1.

Delgado-Pertinez, A.; A. Gomez-Cabrera and A.Garrido (2000). Predicting the nutritive value of the olive leaf (*Olea europaea*): digestibility and chemical composition and in vitro studies. Anim. Feed. Sci. Technol., 87: 187.

De Peters, E.J.; J.D. Fadel and A. Arosemena (1997). Digestion kinetics of neutral detergent fiber and chemical composition within some selected by-product feedstuffs. Anim. Feed. Sci. Technol., 67: 127.

El-Talty.Y.A.(1973). Some factors affecting the feeding value of roughages with reference to lignine. M.Sc.,Thesis,Cairo Univ., Fac.of Agric.

Goering. H. K. and P. J. Van Soest (1970). "Forage fiber analysis", USDA Agricultural Handbook, No.379. (USDA; Washington, DC).

Goto. I. and D.G. Minson (1977). Prediction of the dry matter digestibility of tropical grasses using a pepsin-cellulase assay. Anim. Feed. Sci. Technol., 2: 247.

Haaksma. J. (1993). Sugar beet pulp in diets for dairy cows. Mededeling Institute Voor Rationele suiker producktie. 27. pp 46.

Iantcheva, N.; H. Steingass; N. Todorov and D. Pavlov (1999). A comparison of in vitro rumen and fluid enzematic methods to predect digestibility and energy value of grass and alfalfa hay. Anim. Feed Sci. Technol., 81: 333.

Japan Grassland Association (1994). Procedures for the analysis of digestion in vitro in roughage. (Cited from Guidebook for Quality Evaluation in Roughages, Tokyo, Japan).

Jarrige, R.; P. Thivend and C. Demarquilly (1970). Development of cellulytic enzyme digestion for predicting the nutritive value of forages. In: Proc of XIth International Grassland Congress. Surfers Paradise, Australia, pp.762.

Jones, D. I. H. and M.V. Hayward (1975). The effect of pepsin pretretment of herbage on the prediction of dry matter digestibility from solubility in fungal cellulase solutions. J.of the Sci.of food and Agric., 26: 711.

Kitessa, S.; P. C. Flinn and G. G. Irish (1999). Compareson of methods used to predict the in vivo digestibility of feeds in ruminants. Aust. J. Agric. Res., 50: 825.

Koller, B.L.; H.F. Hintz; J.B. Robertson and P.J. Van Soest (1978). Comparative cell-wall and dry matter digestion in the cecum of the pony and the rumen of the cow using in vitro and nylon bag techniques. J. Anim. Sci. , 47: 209.

Mahmoud, S. A.; G. E. El-Santeil; N. M. Eweedah; S. F. Kilany and H. K. El-Awady (2003). Efficiency of using groundnut vine hay in rations of growing barki lambs under desert farming systems. Egypt. J. Nutr. and Feeds 4 (Special Issue): 795.

Mc Donald, P.; R.A. Edwards; J.F.D. Greenhalgh and C.A. Morgan (1995). Animal Nutrition, 5th ed. Longman Scientific and Teghnical, Harlow, Essex, UK.

Minson, D.J. (1982). Effect of chemical composition on feed digestibility and metabolizable energy. Nutr.Abst.and Rev.52: 591.

Robertson, J.B. and P.J. Van Soest (1977). Dietary fibre estimation in concentrate feedstuffs. J. Anim. Sci. 45 (Suppl. 1): 254.

Saleh, M. S; N. M. Eweedah and M. F. Ali (2000). Replacement of berseem hay by dried sweet potato tops in sheep rations. The 11th Conf. of Egyptian Soc. Anim. Prod., Alex., (6-9 November): 223.

Saleh, M. S. (2005). Efficiency of using peanut (*Arachis Hypogaea L*) vine hay in rations of growing lambs. J.Agric.Res. Tanta Univ.,31: 168.

Spanghero, M. and L. A. Volpelli (1999). A compareson of the prediction of digestible energy content of compound feeds for pigs by chemical or in vitro analysis. Anim. Feed. Sci. Technol., 81:151.

SPSS (1997). SPSS Basic 7.5 for Windows, User's Guide, SPSS Inc.

Tilly, J. M. and R. A., Terry (1963). A two-stage technique for the in vitro digestion of forage crops. J.of the British Grassland Society, 18:104.

Van Soest, P. J. (1994). Nutritional Ecology of the ruminant. Cornell Univ. Ithaca, New York, 476.

Wiseman, J.; M.J. Villamide; C. De Blas; M. J. Carbano and R. M. Carbano (1992). Prediction of digestible energy and digestibility of gross energy of feeds for rabbits. Anim. Feed. Sci. Technol., 39:27.

الملخص العربى

التنبؤ بالقيمة الغذائية لمواد العلف الخشنة المختلفة المستخدمة فى تغذية المجترات بواسطة بعض الطرق المعملية

محمد سعيد صالح

قسم الإنتاج الحيواني- كلية الزراعة - جامعة كفر الشيخ- مصر.

تم تقييم ثلاثة عشر مادة علف خشنة شائعة الاستخدام فى تغذية المجترات بواسطة الطرق المعملية السريعة والمتطورة والتنبؤ بالقيمة الغذائية لها بدرجة دقيقة. كما تم اجراء التحليل الكيميائي لهذة المواد وتقدير مكونات الألياف الخام وكذلك كل من المكونات العضوية لجدار الخلية (الألياف السريعة والبطيئة الهضم) ومعامل اختفاء المادة الجافة المعملى باستخدام بعض الطرق الانزيمية بالاضافة الى تقدير الطاقة الكلية. كما تم أيضا التنبؤ بمعامل هضم المادة الجافة للحيوان من معامل اختفاء المادة الجافة المعملى باستخدام بعض معادلات الانحدار الخطى البسيط للمواد الخشنة. وأيضا تم استخدام اسلوب الانحدار البسيط والمتعدد والمرحلى فى الصورة الخطية وحساب معاملات الارتباط بين القياسات المختلفة لتحديد قوة العلاقة بينها لدراسة امكانية استخدامها فى التطبيق العملى.

وقد تمثلت أهم نتائج الدراسة فيما يلى :-

١-وجود تباين كبير فى التركيب الكيماوى لمواد العلف المختبرة حيث تراوحت نسبة البروتين الخام فى مواد العلف البقولية ومخلفاتها من ٨,٩٦ الى ١٢,٤٧% وكانت أعلى من نظيرتها غير البقولية ومخلفاتها والتى تراوحت من ٢,٦٣ الى ٨,٥٣% كما وجد أيضا تباين لباقي المكونات الأخرى.

٢-وجود علاقة ارتباط موجبة معنوية احصائيا (عند مستوى ٠,٠١) بين الألياف الخام ومكوناتها (الألياف الغير ذائبة فى المحلول المتعادل و الألياف الغير ذائبة فى المحلول الحامضى و "اللجنين +السيليكا").

٣-اختلاف معادلات التنبؤ الخاصة بمعامل اختفاء المادة الجافة المعملى و الطاقة الكلية والألياف البطيئة الهضم تبعا لقيمة معامل التقدير المعدل (ر^-٢) كما تأثرت أيضا بمكونات مواد العلف الخشنة خصوصا الألياف الخام ومكوناتها. ويمكن التنبؤ بهذة القيم من التحليل الكيميائى لهذة المواد وفقا لأفضل معادلات التنبؤ كما يلى :-

أ- معامل اختفاء المادة الجافة المعملى (%) = ١٤٦,٤٨ - x١,٥٢ الألياف الخام- x٠,٦٤٦ الألياف البطيئة الهضم-x١,٢٤ "اللجنين+السليكا"، أى أن العلاقة عكسية و معنوية احصائيا (عند مستوى ٠,٠١) بين معامل اختفاء المادة الجافة المعملى و هذة المكونات الكيميائية للمواد الخشنة.

ب- الطاقة الكلية (كالورى/جم مادة جافة) = ٣٢٣٤,٠٢ + x١٤,٧٣ الألياف الغير ذائبة فى المحلول المتعادل ، أى أن العلاقة طردية و معنوية احصائيا (عند مستوى ٠,٠١) بين الطاقة الكلية و الألياف الغير ذائبة فى المحلول المتعادل.

ج-الألياف البطيئة الهضم (%) = ٢٦,٩٥ + x٠,٦٠٤ الألياف الغير ذائبة فى المحلول المتعادل - ٠,٦٦٥ x الألياف السريعة الهضم، أى أن العلاقة طردية ومعنوية احصائيا (عند مستوى ٠,٠١) بين الألياف البطيئة الهضم والألياف الغير ذائبة فى المحلول المتعادل بينما كانت العلاقة عكسية بينها وبين الألياف السريعة الهضم.

وبناء على نتائج هذة الدراسة فانة يمكن التوصية باستخدام هذة الطرق المعملية للتنبؤ بالقيمة الغذائية لمواد العلف الخشنة الشائعة الاستخدام فى تغذية المجترات نظرا لسهولة اجرائها وتوفير الوقت والجهد والتكاليف.